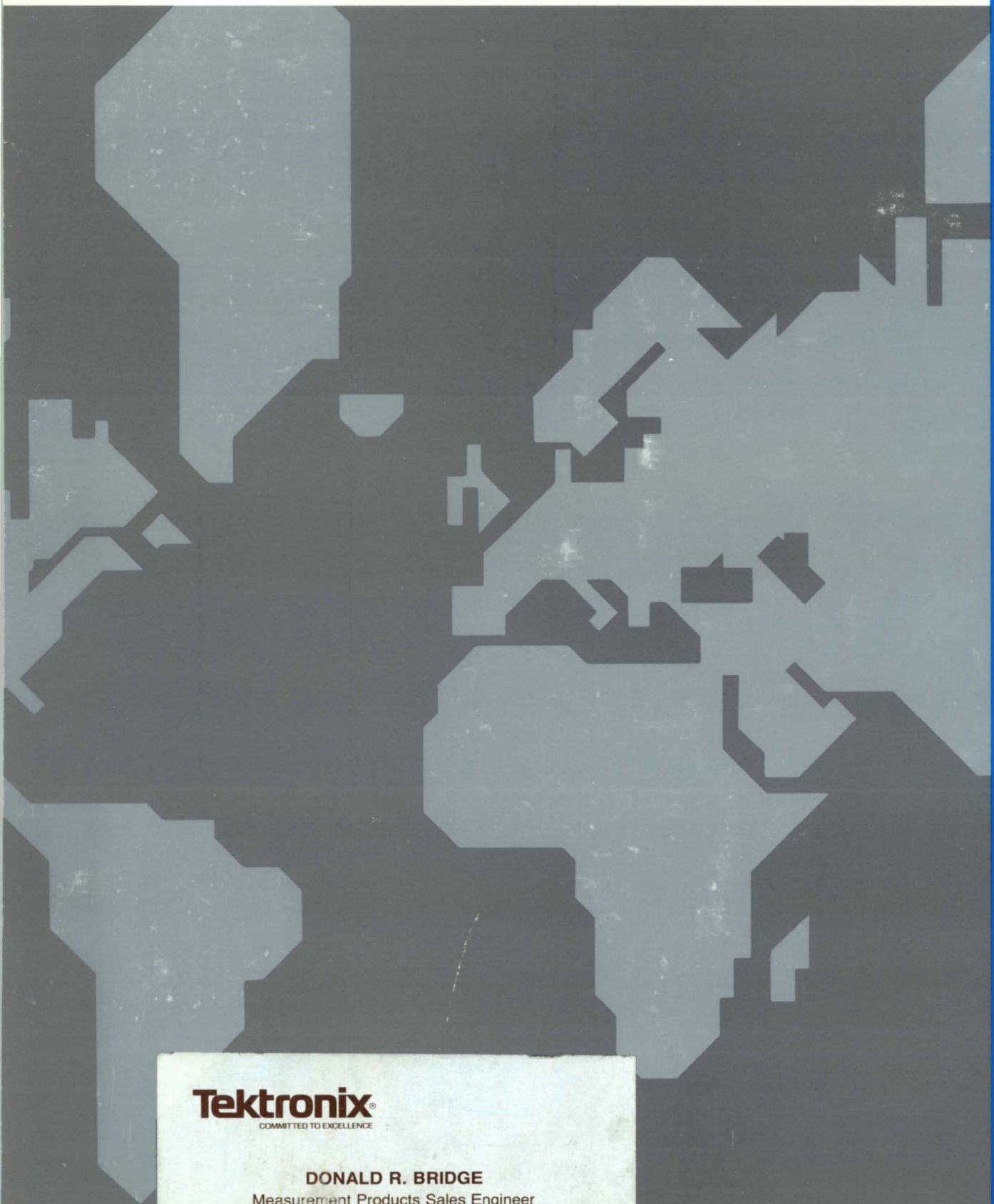
TEK PRODUCTS 1987



Tektronix®
COMMITTED TO EXCELLENCE

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Tektronix®
COMMITTED TO EXCELLENCE

Cover

The cover reflects Tektronix' continuing commitment to global customer understanding and to worldwide customer-service excellence.

First 40 Years

Tektronix' customer base and product lines have expanded substantially since we delivered our first oscilloscope to the University of Oregon Medical School in 1947. After 40 years, Tektronix remains committed to engineering excellence, investing a significant portion of our profits into research and development. You will see the results of innovation in our new product offerings, more than 90 in this catalog, all planned to make you more productive. The new products are identified by a bold color thumb tab on the upper page corner.

Productivity

Productivity is a key word at Tektronix. We've prioritized productivity within our own plants and organizations. You benefit from increased value in Tek products (discussed further on the blue pages, 49, 83, 136, and 181). Your design and/or manufacturing organizations can now access our state-of-the-art components and custom-design resources directly. See page 28.

You will also note an increased number of systems and system-compatible products in this catalog. A convenient "GPIB" thumb tab marks those pages listing products designed to work together over the IEEE-488 bus. The synergism of these products allows you to increase productivity, consistency, and accuracy.

WARRANTY-PLUS Service Options

Warranty-Plus Service Options are an excellent investment in extended service coverage. All options are priced lower than a standard support agreement, receive product quantity discounts, and cover any product equipment options at no additional cost. *Warranty-Plus* Service Plans are available only at time of product purchase.

You can receive additional information on Tek products and service plans by calling your nearest Tektronix Sales Office (listed on pages 502-504).

Each Tek sales engineer specializes in the products and applications for a major area of customer activity: computer graphics, digital design and test, communications, and general test and measurement.

Tektronix Contact
Business Card

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Color identifies *NEW* products

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Color identifies *NEW* products

Tektronix Means . . . Measurement Capability, GPIB Compatibility

Tektronix' Systems Experience

Long before publication of the IEEE Standard 488-1975, Tektronix had entered the test and measurement systems business. The measurement speed and capabilities of the Tektronix automated oscilloscope and Tektronix semiconductor test systems quickly highlighted the benefits to be gained from measurement automation. And just as quickly came the realization that a system interfacing standard was needed. But what standard?

The possibilities of the proposed IEEE Standard 488 were recognized. And, when the IEEE Standard 488 became reality, GPIB compatibility was already an integral part of Tektronix product planning and engineering. The result is that Tektronix is now a recognized major supplier of a full line of GPIB system components—a supplier that puts more than a decade of systems planning, design, and implementation experience into each product.

In 1978 the standard was further refined (IEEE Standard 488-1978) to define an interfacing system that has become a widely accepted instrument industry standard. The major areas it specifies are:

1. Mechanical—the interface connector and cable. See Table 1.
2. Electrical—the logic signal levels and how the signals are sent and received.
3. Functional—the tasks an instrument's interface may perform—such as sending data, receiving data, triggering the instrument, etc.—and the protocols to be used. See Table 2.

Today, a wide variety of instruments include interfaces conforming to this mechanical, electrical, and functional standard. These GPIB-compatible instruments and instrument controllers make it possible to achieve the benefits of automated test systems without paying the previous price of custom system design. With GPIB compatibility, measurement capability can be chosen off-the-shelf and simply cabled with standard bus cables in either a linear or a star configuration.

TABLE 1
GPIB HARDWARE CHARACTERISTICS SUMMARY

- Cable lengths up to but not exceeding 20 meters (approximately 66 feet) with a device load required for every 2 meters of cable.
- Up to 15 devices (1 controller and 14 instruments) may be connected in linear or star configurations.
- Voltages are generally TTL-compatible.
- GPIB signal and data lines are asserted (or true) when pulled low ($\leq +0.8$ V) and released (or false) when high ($\geq +2.0$ V).
- Maximum data rate of up to 250 kilobytes/second over a distance of 20 meters, with 2 meters per device, or faster with some special restrictions (refer to IEEE Standard 488-1978 for details).

TABLE 2
INTERFACE FUNCTIONS
DEFINED BY IEEE STANDARD 488-1978

Function	Description
Source Handshake (SH)	Synchronizes message transmission
Acceptor Handshake (AH)	Synchronizes message reception
Talker (T)	Allows instrument to send data
Listener (L)	Allows instrument to receive data
Service Request (SR)	Requests service from controller
Remote-Local (RL)	Allows instrument to select between GPIB interface and front-panel programming
Parallel Poll (PP)	Allows up to eight instruments to simultaneously return a status bit to the controller
Device Clear (DC)	Puts instrument in known state
Device Trigger (DT)	Starts some basic operation of the instrument
Controller (C)	Sends device addresses and other interface messages

GPIB System Components

An automated test and measurement system usually consists of the following components:

- Multiple instruments: these are either *stimulus* instruments, such as function generators, pulse generators, and power supplies; or *measurement* instruments, such as counters, waveform digitizers, and multimeters.
- Controller with software: this tells the instruments what to do, collects the results, and processes them. The system controller is generally a small computer. The software or firmware operating system must have a powerful, flexible I/O structure to handle GPIB bus traffic. It must also have processing power for waveform manipulation and graphics power for display.
- Computer peripherals: these are devices such as tape drives, printers, and plotters that store or display the results of the tests.
- A keyboard: this enables the user to send commands or information to the system.
- A display: the display allows the user to review intermediate results and to monitor system operation.

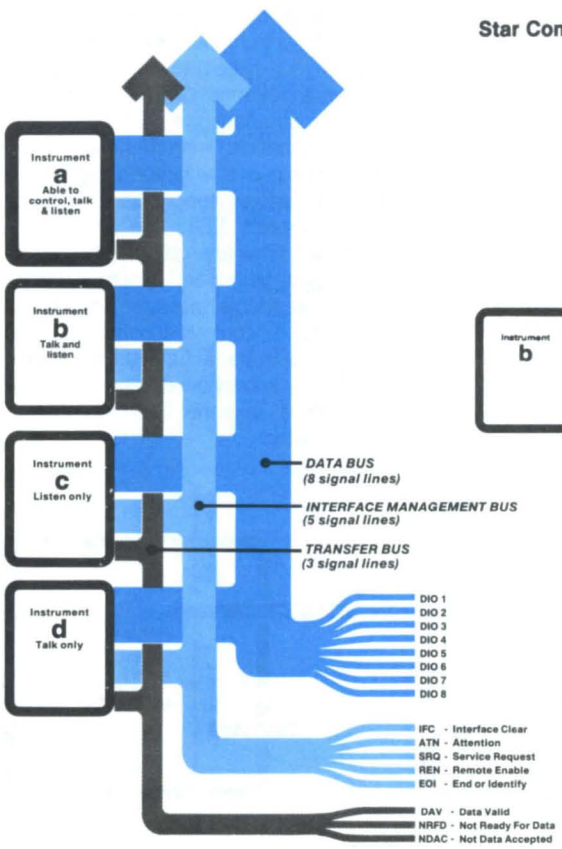
For smaller systems, one or more of these last three components are often incorporated in the system controller. Larger, more powerful systems, however, may be minicomputer-based, augmented by one or more high-speed mass storage devices, a graphic display terminal, and run under specialized instrument control and signal processing software such as TEK SPS BASIC.

All these components can be easily interconnected if the GPIB interface has been built in and appropriate functions made programmable. Before GPIB, most measurement systems were operated by controllers that required a separate connector (port) for each instrument. With the GPIB this is no longer a requirement. Users can directly link up to 14 instruments with the controller via the bus, and set up the systems in linear or star configurations. Additionally, some controllers can drive more than one GPIB port. The Tektronix 4041 has an option for a second port, allowing control of up to 28 instruments. Or, if you need more, TEK SPS BASIC operated with a properly optioned DEC PDP-11 minicomputer can drive up to four GPIB ports, providing a total system potential of 56 instruments.

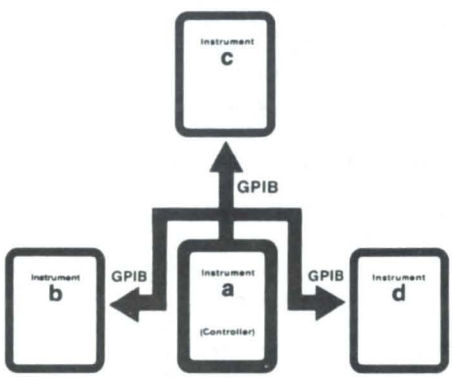
All these devices (the controller, measurement instruments, and peripherals) comprise the hardware. The system cannot operate, however, unless it is driven by software.

There are two levels of software necessary: the operating system software and user written application programs. The operating system software provides a set of commands and functions that the user combines into a program that delineates the measurement and processing task to be performed. The software, guided by the user program, works through the controller to tell the instruments what signals to generate, what measurements to make, and tells the controller what to do with the results.

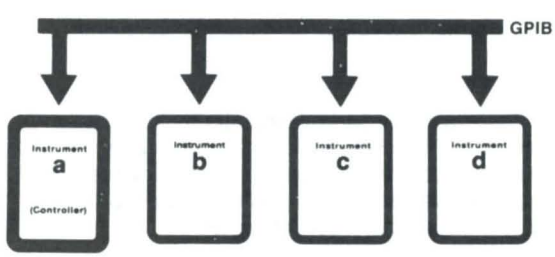
The software and the program in the controller make the system do what the user wants. The GPIB interface allows users to plug system components together, but without software, the system can do nothing.



Star Configuration



Linear Configuration



GPIB

In programmable instrument systems, the "language" of the software or program has several meanings:

1. The controller has its own language, such as BASIC or C, and users must express their intentions in this language.
2. Within the context of the controller's language, the instrument's commands (or "language") have to be sent over the GPIB.
3. The actual control of the GPIB interface is transparent to the user with Tektronix instrument controllers and software.

In order to make the system operate, the user has to know:

1. What tasks the system is to perform—the system can do nothing by itself.
2. The controller's language.
3. The kind of data or language the instruments are designed to exchange.

To make these tasks easier for you, Tektronix has taken several steps beyond simple IEEE Standard 488-1978 compatibility. Consistency has been designed into each system component for the greatest degree of compatibility. Intelligence has been designed in to relieve you from interfacing details. And firmware and software have been designed and written to provide the maximum in programming ease and measurement capability.

Consistency Makes a Big Difference

Tektronix GPIB products are designed and thoroughly evaluated for compliance with IEEE Standard 488-1978 and for compatibility with one another. Because these products are designed to be compatible (i.e., meet the same standards), users usually won't need to make hardware and software modifications for each new addition or deletion to the configuration. Many software routines need to be written only once, after which only minor modifications are needed with the addition of new instruments.

A status check routine, for instance, will work on all Tektronix GPIB instruments. A message terminator common to all Tektronix GPIB instruments is a further benefit. But, since the IEEE Standard 488-1978 allows several optional message terminators, Tektronix instruments go an extra step by providing a switch for selecting optional terminators. These features provide users with the capability of quickly configuring and reconfiguring interactive and automated measurement systems.

The result is a line of products that are not only GPIB compatible—but are capable GPIB instruments. They have the features that make them useful and the compatibility that makes them work together.

Tektronix *Standard Codes and Formats* Means Programming Ease

IEEE Standard 488-1978 specifies the hardware interface and its basic functional protocol. It also specifies a set of codes called interface messages that control interface functions. However, the IEEE Standard 488-1978 does not specify the syntax or coding of device-dependent messages—the messages that control the programmable features of the instrument.

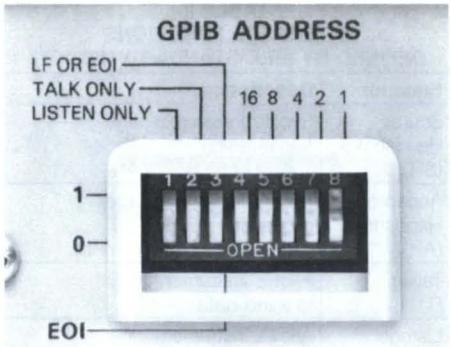
Since the device-dependent messages are not specified, instruments that conform to the IEEE Standard 488-1978 may use inconvenient or even incompatible message formats. It's much like a telephone system—the hardware link is well defined, but unless both parties speak the same language, communication is impossible. That's why Tektronix developed a codes and formats standard that specifies the syntax and coding of device dependent messages, while retaining full IEEE Standard 488-1978 compatibility. The Tektronix *Standard Codes and Formats* specifies message coding to:

- Be simple and unambiguous.
- Use commands that are common among similar devices.
- Use simple, easy-to-remember mnemonics.

The benefits of the Tektronix *Standard Codes and Formats*, a major feature of the Tektronix GPIB communications protocol, are numerous. Because of their natural English-like structure, instrument control commands and messages are easy to use. The result is a GPIB implementation that is specifically designed to overcome the programming rigidity and cumbersome procedures of other GPIB systems.

ASCII Data Standard

Since most controllers accept ASCII data directly, Tektronix GPIB instrument commands are coded in ASCII. This eliminates the need for error-prone data conversions or byte-by-byte encoding. For example, to set the center frequency of the 492AP Spectrum Analyzer to 1.75 MHz, the command is simply written FREQ 1.75 MHz—no more calculated percentages of full-scale or BCD equivalents. Settings for Tektronix GPIB instruments are sent as ASCII data in human readable form.



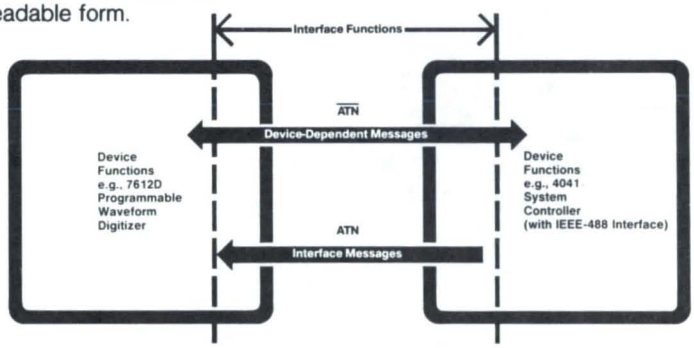
Each GPIB instrument or peripheral, called a device, must be assigned a different system address; this can be done simply by setting switches, usually located on the back panel of the device.

Flexible Formats

Many minor format items that are aggravations in other systems are also taken care of by Tektronix *Standard Codes and Formats*. For example, Tektronix GPIB instruments accept negative zeros and leading and trailing spaces; they also overlook inconsistent use of upper and lower case letters. And, since truncated numbers can drastically affect measurements, Tektronix GPIB instruments round off rather than truncate: e.g., a value of 2.49 becomes 2.5 rather than 2.4. In short, the built-in intelligence is used to make intelligent decisions. That makes your programming job much less rigid and substantially easier.

Common Messages

To make things even easier, Tektronix *Standard Codes and Formats* also specifies messages that are to be common to all Tektronix programmable instruments. For example, you can program your system to learn the current settings of any Tektronix GPIB instrument by sending the instrument the SET? message. Any GPIB compatible instrument from Tektronix—whether it is a waveform digitizer, a programmable power supply, or a function generator—interprets SET? the same way. The instrument firmware gathers the instrument's settings together and assembles them into a human readable message to be sent over the bus to the controlling software. If you know how to operate a function generator, then you already know how to read a settings message from a Tektronix GPIB compatible function generator.



BASIC Languages

Because users are increasingly interacting with GPIB systems at the controller keyboard rather than at instrument panels, GPIB systems must be as friendly as possible. This means, too, that the controller languages should be simple, logical, and easy to interpret and implement. That's why BASIC, the established language for Tektronix instrument controllers, is the preferred language of Tektronix *Standard Codes and Formats*.

BASIC is an established language with wide use and familiarity. It is also an English-like language that is easy to learn and understand. So, combined with the English-like messages used with Tektronix GPIB instruments, it becomes a consistent and familiar means of communicating with your system. And your program listings are easy to read and follow, with very little interpretation required. (For more details on Tektronix *Standard Codes and Formats*, ask your Tektronix Sales Engineer or representative.)

Controllers and Software to Match Your Needs

Tektronix offers controller-software packages to meet varying GPIB system needs.

Controllers/Software Packages

- The 4041 System Controller, optimized for instrument control in a variety of situations, including test and measurement and spectrum analysis.
- The 4132 Intelligent Graphics Workstation, with 32-bit processor capabilities and excellent optional GPIB control.
- TEK SPS BASIC software with the DEC PDP-11 Series and DEC Micro PDP-11 minicomputers, optimized for systems with full waveform acquisition, processing, and graphics.

Software Packages

- GURU II software, an interface package for the IBM PC (or IBM-compatible PC), using National's GPIB card. This package contains a TEST PROGRAM GENERATOR, programming examples and an excellent manual to help the novice user get started or the familiar user be more productive.
- The TekMAP (Tektronix Measurement Applications Programs) library of software products supports the Tektronix 7000 Series GPIB programmable digitizers and extends the digitizers by integrating them with Tektronix controllers, IBM personal computers or HP Series 200 technical computers.

The 4041 System Controller

The 4041 System Controller is a compact, modular controller designed for rackmount, bench-top, or portable use. Its operating system language is an extended BASIC designed for use by both the casual and the sophisticated programmer.

Tektronix 4041 System Controller.

The 4041 controller contains three microprocessors, with the CPU being the powerful 16-bit 68000. Standard memory is 32 Kilobytes with optional expansion to a maximum of 512 Kilobytes. A 20-character alphanumeric LED display, a 20-character thermal printer, a DC-100 magnetic tape cartridge drive, 18 function keys, a GPIB port, an RS-232 port, and a real time clock and calendar capability are all standard. An additional GPIB/RS-232 port pair is optional, with the second GPIB port having Direct Memory Access capability. With 14 GPIB instruments per GPIB port, the 4041 System Controller offers the capability of controlling up to 28 GPIB instruments. Other options include an 8-bit parallel TTL interface (Option 02); SCSI (Small Computer System Interface, Option 03, for external disk mass storage and a second RS-232 port) to support interfacing to floppy and hard disks for greater file and data storage; and a detachable program development/debug keyboard.

The capabilities of standard 4041 BASIC can be expanded by installing ROM (Read-Only Memory) packs to extend operational features of the 4041 into a broad range of systems applications, with functions running faster than equivalent BASIC routines. The program development ROMs (with keyboard, or an RS-232 terminal), give the engineer or production test programmer access to the system language. Its English-like commands, simple syntax, and line-by-line interpreter implementation combine for a friendly and interactive system. A variety of other features are also included to increase friendliness. For example, viable names may be up to eight characters long, allowing meaningful names such as RISE-TIME, VOLTAGE1, or DELAY. And as another example, subprograms and program lines can be named—e.g., 1000 SRQPOLL: or 200 RMS VOLTS—for quick and easy access.

Beyond enhancements for simplicity, 4041 BASIC also has enhancements that make it a powerful tool for sophisticated programmers. It includes capabilities for FORTRAN-like subprograms, variable passing from main program to subprograms, declaration of local and global variables, and many other features.

Yet, for all its sophistication, the 4041 is still particularly desirable for use by lower-skill operators in a production environment. Instrument control programs can be designed and written to print user prompts on the 4041 display and the programs can be assigned to any of the ten user-definable keys on the 4041 front panel. Then the 4041 program development ROM and keyboard can be removed from the controller. This puts the 4041 into an execute-only mode with its programs protected. The lower-skill user need only follow the front-panel display prompts and press the designated keys to execute programs.

To return to the engineering or program development mode, simply plug the program development ROMs (with keyboard or an RS-232 terminal) back into the 4041. You again have access to all of the ease and power of 4041 BASIC programming.

The 4041R01 Graphics ROM pack gives the 4041 the capability to generate graphic commands to interact with peripheral devices using Tektronix compatible graphic codes. These high-level and primitive commands allow you to construct and incorporate graphic images, symbols, charts and diagrams into your system applications, greatly enhancing system usability.

The 4041R02 Plotting ROM Pack gives the 4041 the capability to generate graphs and to plot data. Designed as an easy-to-use tool to automatically generate scientific graphics, the plotting ROM pack requires the presence of the 4041R01 Graphics ROM Pack in order to operate. Graphs can be generated and displayed on any graphic peripheral device supported by the 4041R01. The automatic plotting commands are the heart of the 4041R02. These commands, given your data, draw axes with appropriate tic marks and plot the desired data. You need little experience to program graphics or plotting routines. All you need to do is supply the data to be graphed.

The 4041R03 Signal Processing ROM Pack gives the 4041 the ability to support instrumentation system applications requiring waveform processing. Coupled with our programmable digitizers and oscilloscopes, it will produce broader system configurations and effective solutions for signal analysis. The functions contained in the 4041R03 provide a high level approach to deal with signal processing applications normally solved by lengthy programs requiring extensive knowledge of waveform processing and computer fundamentals. Combined with the graphics and plotting ROM packs, the 4041R03 allows you to produce, analyze and display waveforms semiautomatically.

The 4041R04 Utility ROM Pack adds still more general purpose capabilities to your 4041. These range from such convenience items as one line descriptions of error codes to capabilities for building PROM files for programming your own EPROMS.

4132 Intelligent Graphics Workstation

The 4132 workstation combines state-of-the-art microprocessor technology, advanced architectures, and flexible system software. They are designed to meet a wide range of computing system applications.

GPIB Interface

An important 4132 feature is an optional GPIB interface that supports programmable instruments such as oscilloscopes, digitizers, audio test systems, multimeters, function generators, spectrum analyzers, and logic analyzers. As with other Tek GPIB based products, the 4132 conforms to the

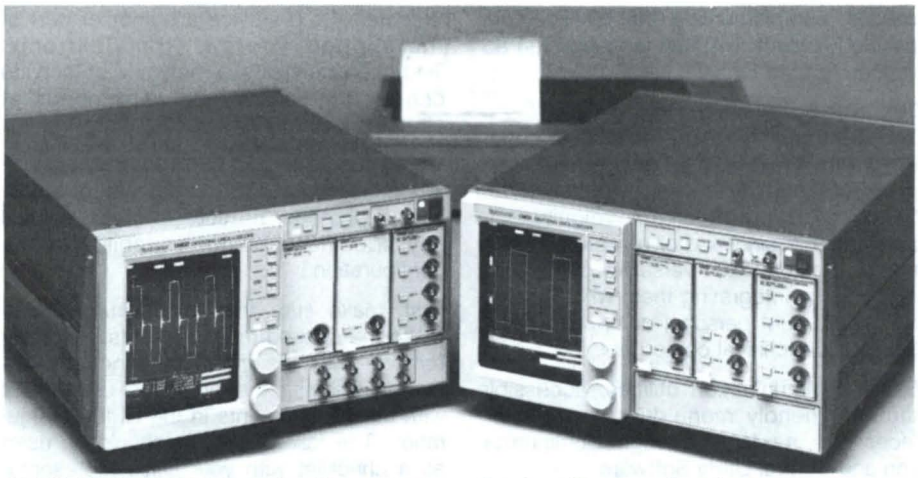
IEEE-488 standards and to Tektronix' own *Standard Codes and Formats* that specifies the syntax and coding of device-dependent messages.

The GPIB interface is capable of supporting up to 14 GPIB-compatible instruments, in addition to the 4132 interface itself. The instruments are classified as either controllers, talkers or listeners. The controller supervises the GPIB, determining which instruments send and receive data over the bus. A talker sends messages and data over the bus, and a listener receives messages and data. The 4132 programmable interface allows the user to specify device-dependent parameters, such as primary and secondary addresses, end-of-message and end-of-header delimiters.

Each 4132 workstation can support up to six high-speed GPIB ports. These high-speed ports use direct memory access (DMA) to transfer block data into a cache memory at rates in excess of 250 Kbytes per second.

The primary language used for GPIB communication is Tek's own version of ANSI BASIC. This version includes 39 GPIB-related routines and has the capability of detecting seven different GPIB conditions. Because it is a compiled rather than an interpreted version, program execution is extremely quick. In addition to having all the standard features of ANSI BASIC, Tek's version adds GPIB functionality, extended I/O, array slices (which facilitates matrix manipulation), I/O enhancements, and an easy-to-use programming environment and compiler. A 4050 sifter program provides a utility for converting 4050 programs into Tek ANSI BASIC format.

Among the I/O enhancements of Tek's ANSI BASIC is the ability to handle synchronous or asynchronous communications automatically, eliminating complicated addressing and control commands. Tek's ANSI BASIC can communicate with the bus itself or with any instrument on the bus.



11400 Series Digitizing Oscilloscopes
The 11401 and 11402 are the first in a new line of programmable digitizing oscilloscopes. These versatile scopes, along with the array of new plug-ins and probes that support them, solve measurement problems equally well on a designer's bench or in a programmable test system. Digital designers will benefit from flexible triggering features and an eight channel display. Analog and power supply designers can apply extensive waveform processing to signals acquired through high performance differential and single-ended amplifiers. 11000 Series digitizing scopes can follow your designs into production. Full programmability via either IEEE-488 or RS-232C, and features like a DMA controller for fast waveform transfers make these scopes a perfect fit for systems. 11000 Series Digitizing Oscilloscopes set new standards in performance and excellence.

Versatility for a Wide Range of Applications
Five new plug-ins and three new probes bring outstanding versatility to the 11401/402. The measurement system and waveform processing functions lead to quick solutions to a wide variety of voltage, time, area and energy problems. The 11401 can process and measure signals from high bandwidth 50 Ω amplifiers, high impedance amplifiers and differential amplifiers. 1 mV sensitivity and 500 V maximum input voltage let users capture small signals from transducers or monitor ac power lines.

See page 207 for complete description and specifications.

Custom System Services
Three tiers of Tek Custom Services are available to ease your selection process.

Custom Systems offer single-shot or repetitive measurement capability and control of up to 56 GPIB instruments per controller, fully configurable to your specifications. Included are full warranties, installation, and other product support services.

While we provide the core system package, specialized drivers and software operating system after consultation with your software engineers and operating personnel, it is generally more cost effective for you to provide your own applications software. This better prepares users to do routine modifications and updating, and gives you the local expertise you need to make the best use of your system investments.

Customized Measurement Packages
Customized Tektronix Measurement Packages are modifications to existing preconfigured systems. Each offers powerful capability in a cost effective benchtop size. Signal acquisition units span bandwidths of up to 750 MHz real time and up to 14 GHz with sampling plug-ins.

Modified Products
Modified Products include the customization of selected digitizers, as well as the "system glue" (specialized internal interfaces, etc.) required to hold the system together.

These off-the-shelf custom items for your system needs include:

- Additional serial I/O drivers for your communications/printing needs. Up to 8 instrument channels and up to 4 peripheral ports may be supported.
- Special disk drivers for RL02 disk pack drives. For TEK SPS BASIC V02.
- GPIB program decoder plug-in that enhances the 7854 oscilloscope by interfacing to programmable vertical and time base settings with selected plug-ins.
- High speed data output modification for the 390AD digitizer.
- A high bandwidth modification (750 MHz) of the 7912AD digitizer.
- Auto-calibration MUX controller and stimulus generator.
- Others per your request.

TEK SPS BASIC Software with DEC PDP-11 Minicomputers
When equipped with Tektronix supplied GPIB interfaces, DEC PDP-11 Series minicomputers can be operated with TEK SPS BASIC software to provide the most powerful big-system instrument control and signal processing. A wide variety of peripherals can be handled, including plotters, line printers, graphic terminals, magnetic tapes, and single or multiple disk storage systems. Additionally, with the proper options, up to four GPIB interface ports can be supported. This means control of and data collection from up to 56 GPIB instruments.

Two versions of TEK SPS BASIC are available, the standard version and the extended memory version. The extended memory version permits processing of very large arrays in computers having up to 128 kilowords of memory with memory management.

Other than memory differences, both versions of TEK SPS BASIC software have the same major features. These include a modular architecture consisting of a resident monitor and an expandable library of over 100 nonresident commands. This unique design lets you configure a software system to meet your specific needs yet leaves the system open for adding new commands and processing modules.

Measurement data can be stored and accessed in a variety of ways. Information can be read or written in either ASCII or binary. Named files can be accessed on hard or flexible disks, magnetic tape, or cassettes. Information can be read from files either sequentially or randomly. TEK SPS BASIC commands give you complete file management capability.

Comprehensive graphics permit waveform plots and X-Y plots between waveforms. Either can be done with single commands. The output is complete with scaled and labeled axes and can be hard-copied to paper.

There's also data logging capability for automated waveform capture. And the software's better than 7-digit precision means much higher resolution than possible in conventional oscilloscope measurements. Plus, there are special data structures to retain both numeric and literal information (scale factors and units) associated with a given waveform. This waveform data

structure, as well as numeric arrays or portions of numeric arrays, can be operated on arithmetically as easily as can simple numeric variables.

Beyond extending the standard mathematical operations and functions to include waveform processing, TEK SPS BASIC also provides special waveform processing functions. Waveforms can be integrated, differentiated, convolved, correlated, and fast Fourier transformed—all with single commands. Polar conversions can also be performed with a single command to present results such as magnitude and phase.

With its large array size capabilities (limited only by memory in most cases), advanced signal processing, and program and instrument tasking capabilities (including error control for independent operation), TEK SPS BASIC offers all of the flexibility and power necessary to control anything from the simplest to the most sophisticated test and measurement system.

SPD Software
Signal Processing and Display (SPD) Software supports 196 processing, analysis, and data-to-display functions using Tek digitizers in conjunction with an IBM PC, PC/XT, or PC/AT. Designed for scientific and engineering applications, this package includes complete mathematical functions plus waveform data, I/O utilities, analysis, processing, and graphic display functions. Access is via disk or GPIB port using popular waveform digitizers.

GURU II Software
GURU II is a simple but powerful package that provides control of GPIB (IEEE Standard 488) electronic instruments from an IBM PC (or compatible). It offers the menu-driven Test Procedure Generator to speed applications programming.

GURU II's Test Procedure Generator (TPG.BAS), written in BASIC, is a self-explanatory menu-driven program. It is the right tool for instrument system users who want fast results or who don't want to learn to program their system in BASIC. It allows users to generate a program that runs a specific test sequence—without writing a single line of code. Users need to know only the details of the test to be performed and the equipment used.

The TPG is most suited to nondigitizer applications where testing of devices is required using programmable power supplies, digital voltmeters, signal sources, and counters.

For users who want to write their own application programs, GURU II provides SUBS.BAS, a set of canned subroutines. These subroutines perform functions common to many test and measurement applications, complementing the IBM PC compatible Microsoft BASICA language (an advanced form of BASIC).

TekMAP Software
The Tektronix Measurement Application Programs (TekMAP) library of software products supports the Tektronix 7000 Series GPIB programmable digitizers in automated engineering or research environments. It extends the versatility of Tektronix digitizers by integrating them with Tektronix controllers, IBM personal computers or HP Series 200 technical computers.

Basic communication utilities, accessible through friendly menu-driven user interfaces, are available through Communication and Control Utility Software.

Extended measurement capabilities (such as automated pulse parameter analysis, Fast Fourier transformation and propagation delay measurements) are provided by the Time and Amplitude Measurement Software products.

Tektronix Support for Your GPIB System
With GPIB products and signal processing systems from Tektronix, you're not left on your own after the product is purchased. Tektronix offers complete support and training for the operation and maintenance of its GPIB products and systems.

Every product is shipped with a complete and comprehensive operating manual. Additionally, a variety of training services are available. Training classes are available both at our home office and at selected sites around the world.

As part of the long-term support for GPIB products and systems, Tektronix offers a variety of application literature and support.

HANDSHAKE is an applications newsletter from Tektronix published quarterly, and contains application and technical articles covering the broad spectrum of instrument control and signal processing.

The Tektronix Instrumentation Software Library provides software and application information for Tektronix programmable measurement instruments and systems. There are three types of software currently available: Measurement Software, Instrument Utility Software, and User-Exchange Software. The Tektronix Instrumentation Software Library catalog provides program abstracts and ordering information.

An extensive collection of application notes and magazine article reprints is another source of information offered by Tektronix. Our Sales Offices and Sales Representatives maintain a list of current literature and will be glad to supply you with items in your areas of interest.

Warranties and service are another part of the support you get from Tektronix. Tektronix maintains a network of service centers for your maintenance needs at strategic locations throughout the world.

Guide for Selecting GPIB Instruments
When selecting GPIB instruments for a specific application, be sure to check several key specifications for suitability in the configuration.

First, make sure that the instrument can make the desired measurements. Next, determine that the interface functions are compatible with the proposed usage and with other instruments in the GPIB configuration. The following items should be used as a checklist with your sales representative when considering instruments to be used in GPIB configurations:

1. Is the instrument intended for interactive measurement analysis or automated measurement; i.e., are all necessary instrument functions remotely programmable, or will an operator be available to adjust settings?
2. Does the instrument's GPIB interface have the necessary set of functions implemented at the desired level? (For example, AH1 is needed for any useful interaction, SH1 is required for instruments supplying measurements to the controller.)
3. Are diagnostics available to check out the instrument from the front panel or over the GPIB interface?
4. Does the instrument use standard codes and format conventions for terminators, numeric formats, etc.?
5. Can the instrument's front-panel setting be read from the controller and saved for later automated set up?
6. Can the front panel be "locked out" via the GPIB?

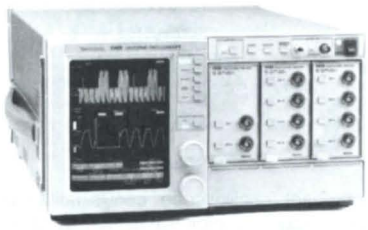
ANALOG OSCILLOSCOPES

NEW 11301 and 11302

These *NEW* oscilloscopes offer a new degree of measurement versatility up to 500 MHz bandwidth. Full programmability via either the GPIB or RS-232C plus a touchscreen operator interface make these plug-in scopes ideal for both automatic test systems and benchtop applications. A built-in 500 MHz counter/timer and peak detecting make measurements that normally require a digitizer. An automatic measurement sequence provides common pulse parameters at the touch of a button. Template waveforms allow comparison of complex signals with predefined limits. Cursors allow dc measurements to within 0.6%. The results of all measurements are displayed numerically on the CRT and are available over either bus. See page 201.

DIGITIZING OSCILLOSCOPES

NEW 11401 and 11402



These *NEW* 500 MHz and 1 GHz bandwidth oscilloscopes are equally at home in a system or on a designer's bench. Full programmability through both the GPIB and RS-232C, direct memory access option for fast waveform transfer through the GPIB, extensive waveform processing along with pulse parameter analysis, and 50 ps single-shot resolution on time A→B measurements combine to make these scopes ideal for automated environments. These scopes are easily adapted to rackmounting and can be equipped with cable feedthroughs that make it possible to connect signals to the rear of the instruments. Accurate, automatic measurements of voltage, timing, and area/energy can easily be set up and read out over either standard bus. See page 207.

PORTABLE OSCILLOSCOPE

NEW 2467 Option 10

The *NEW* 2467 has the fastest visual writing rate available in a portable oscilloscope due to the microchannel plate CRT, which amplifies the brightness of transient events. The 2467 Option 10 can be easily programmed to assist the scope operator to perform a complete sequence of measurements. Front panel settings can be remotely set or changed via the GPIB. Measurement results can be both displayed on the CRT and read back over the bus. Auto Set-Up scales the vertical, horizontal, and trigger systems to provide a stable, automatically triggered display of the waveforms. See page 279.

PORTABLE OSCILLOSCOPES

NEW 2465A, 2455A, 2445A OPTION 10

The *NEW* 2465A, 2455A, and 2445A—350, 250, and 150 MHz oscilloscopes—can be easily programmed to assist the scope operator to perform a complete sequence of measurements. Front panel settings can be remotely set or changed with display prompting of messages, providing guidance for the operator. The results of voltage, time, frequency, phase, and ratio can be both displayed on the CRT and read back over the bus. In addition, Auto Set-Up scales the vertical, horizontal, and trigger systems to provide a stable, automatically triggered display of the probed waveforms. A Save/Recall utility saves and recalls up to 20 setups for automating repetitive measurement sequences. The CT versions are ideal for automatic frequency, period, pulse width, and time between events measurements; the DM for automatic counter and digital multimeter tests and measurements; and the DV for high resolution video applications. See page 278.

PORTABLE OSCILLOSCOPE

2430 and *NEW* 2430M

The 2430 brings the best features of our industry standard 2400 Series into the digital world. It features 150 MHz bandwidth, dual channel simultaneous acquisition, 5 ns maximum sweep speed, 8-bit vertical resolution. The Tek-patented feature, "Save-on-Delta", makes pass/fail decisions. The 2430 is fully programmable over the GPIB. It sends and receives waveforms, front panel settings, custom menus, and operator prompts. Outputs include an analog plotter output. It is compatible with the P6407 Word Recognizer probe.

The *NEW* 2430M offers all features of the 2430, plus CIIL capability for operation in Modular Automatic Test Equipment (MATE) used in testing military avionics and weapons systems. See page 326.

DIGITIZING CAMERA SYSTEM

NEW DCS01 Option 1C*[1]

The *NEW* DCS01 Digitizing Camera System combines CCD technology with an IBM PC, XT, AT, or compatible to acquire and digitize repetitive and transient waveforms displayed on oscilloscopes, spectrum analyzers, and other displays. Used with scopes having the microchannel plate CRT, such as the 7104, 11302, and 2467, the DCS01 can acquire repetitive and transient signals at the full bandwidth of the scope. With other scopes, the DCS01 will acquire repetitive events at the full scope bandwidth and transient events according to the photographic writing rate of the oscilloscope. See page 353.

*[1] *Available first quarter 1987.*

WAVEFORM ACQUISITION PRODUCTS

2230/2220 Digital Storage Oscilloscopes

These portable, high-value oscilloscopes feature both digital storage and nonstorage capability to 100 MHz (2230) and 60 MHz (2220). 100 ns glitch capture is accomplished with the Peak Detect mode (envelope), which digitizes and stores, in acquisition memory as a data pair, the minimum and maximum levels of the input signal. The 2230 and 2220 also feature unlimited storage time; expandable, compressible, repositionable stored traces; save reference memory; pre-/posttrigger viewing; roll and scan modes; standard X-Y plotter output; and optional interfaces. See page 330.

336 Option 01 Digital Storage Oscilloscope

This compact oscilloscope can simultaneously display analog and digital waveforms, and can store up to 16 digitized waveforms for recall and display. Nonstorage bandwidth is 50 MHz; storage bandwidth is 140 kHz. Vertical and horizontal scale factors, delay time position, and voltage and time readouts of cursor positions are displayed on the CRT, as is a menu of many of the features and modes. An Auto mode for both vertical volts/division and horizontal time/division allows "hands-off" operation in many applications. See page 334.

7D20/7D20T Programmable Digitizers

The 7D20 plug-in converts any 7000 Series mainframe into a fully programmable, digital oscilloscope with 70 MHz equivalent time bandwidth. Operating modes include: Envelope, Average, and Roll. Optimized for interactive and automated applications, from biomedical research to radio modulation. Remotely controllable over the GPIB. Shown with R7603 mainframe.

The 7D20T provides the same digitizer capabilities in a compact standalone package. Supported by TekMAP 7D20 Time and Amplitude Measurement software. See page 336.

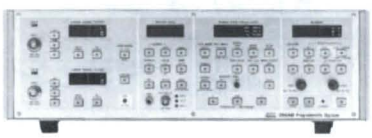
5223 Option 10 Digitizing Oscilloscope

This 10 MHz digital storage oscilloscope provides a digitized display that will never fade or bloom. Selecting Roll mode yields a continually updated display of memory contents by providing a strip-chart-like view of signals at slow sweep rates. Applications range from measuring mechanical displacement transducer signals to biomedical activities. Option 10 GPIB Interface provides I/O of stored waveforms and control of 5223 digital storage functions (except vertical and horizontal expansion and position controls). Waveform output format is selectable through this interface for either BINARY or ASCII. Plug-in functions not remotely controllable. See page 351.

7854 Waveform Processing Oscilloscope

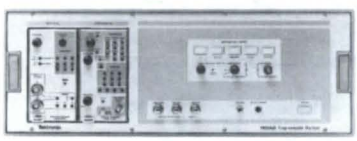
A two-channel, waveform processing, digital storage oscilloscope having 400 MHz equivalent time bandwidth. Keystroke programming of local keyboard and remote Waveform Calculator allows user-designed waveform measurement routines for tests or experiments. Signal averaging capability can recover signals buried in noise and improve measurement accuracy. All mainframe keystroke functions and operating modes can be remotely controlled via the GPIB. (Plug-in functions controllable only with custom interface. Contact your local Sales Engineer.) Supported by TekMAP 7854/IBM PC Communication software. See page 338.

390AD Programmable Digitizer



This two-channel, 10-bit digitizer achieves excellent dynamic accuracy with a two-stage flash-conversion process. Single-channel operation can provide 60 megasamples per second. Built-in self-calibration and self-test features. Remotely controllable over the GPIB. Applications vary from ultrasonic testing to video. See page 349.

7912AD Programmable Digitizer



The 7912AD is designed for interactive and automated applications. It digitizes and stores single-shot or repetitive signals from millisecond to subnanosecond duration. Waveform data is stored in a 4096 word memory. See page 347.

7612D Programmable Digitizer

Two independent waveform digitizers in one compact instrument, the 7612D is ideal for use with Automatic Test Equipment or anywhere highly accurate, time-domain measurements are required. Memory partitioning helps capture fast, successive, randomly occurring events. Multiple sample rate switching is available during waveform acquisition. Remotely controllable over GPIB. See page 344.

SYSTEM CONTROLLER

4041 System Controller

A powerful and expandable system controller intended principally for execute-only environments such as production-line testing. Operating parameters include Interrupt and Error Handling modes. Options and peripherals equip it for interactive flexibility in research lab applications. Programming language is BASIC with English-like commands, extensions, simple syntax, and line-by-line interpreter. A 1.8 lines/second thermal printer is built-in. See page 355.

DESKTOP CONTROLLER-BASED ACQUISITION/PROCESSING MEASUREMENT PACKAGES

MP 2501

Based on the Tektronix 7854 Oscilloscope and the 4207 Color Graphics Display Terminal/4041 System Controller equipped with ROM packs, this system can acquire, process, store, and display electrical signals. 4041 BASIC routines from the Utility Software permit system operation with limited programming experience. The 7854 is remotely controllable over the GPIB. See page 375.

MP 2101
Based on the Tektronix 7912AD Programmable Digitizer, the MP 2101 is a high-speed, signal acquisition and transient digitizing system. The 7912AD is remotely controllable over the GPIB. Utilizes the 4041. See page 375.

MP 2201
Based on the Tektronix 7612D Programmable Digitizer, the MP 2201 is a complete signal acquisition, waveform processing, storage, and display system. The 7612D is remotely controllable over the GPIB. Utilizes the 4041. See page 375.

MP 1101
Based on the Tektronix 7912AD Programmable Digitizer. This compatible signal acquisition and display package can be front-panel controlled or completely programmed via the GPIB Interface from any suitable controller. See page 374.

MP 1201
Based on the Tektronix 7612D Programmable Digitizer. This compatible signal acquisition and display package can be front-panel controlled or completely programmed via the GPIB Interface from any suitable controller. See page 374.

AUDIO MEASUREMENTS PACKAGE

MP 2902
The Audio Test Program Generation software allows rapid development of an automated audio measurement system, even by nonprogrammers. Tests supported include: total harmonic distortion vs frequency, total harmonic distortion vs output level, intermodulation distortion vs level (SMPTE and CCIF), CCIF intermodulation distortion vs frequency, frequency response, signal-to-noise, level (voltage and power), linearity, external stimulus, and others. See page 377.

OSCILLOSCOPE MEASUREMENT PACKAGE

MP 2601
The MP 2601 couples the 4041 Controller with the 2430 Oscilloscope for simultaneous two channel signal acquisition having 150 MHz bandwidth. This portable measurement package provides extensive signal acquisition capabilities with signal analysis to form a system directed at measurement solutions. See page 376.

INCOMING INSPECTION TEST STATION

MP 2901

The MP 2901 addresses two of the most difficult aspects of automating an operation-software development and interfacing to the device-under-test. The multifunction interface (MI 5010) allows easy data acquisition and/or control of the device-under-test by the 4041 System Controller. The task of software development is made rapid and easy. TEK EZ-TEST leads nonprogrammers (via a set of menus) to translate manual procedures into error-free, structured BASIC code. See page 376.

CURVE TRACER

***NEW* 370 Programmable Curve Tracer**

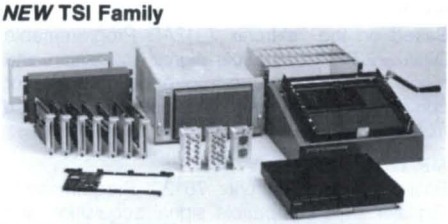
The *NEW* 370 Curve Tracer is remotely controllable via the GPIB for automated acquisition of curve data. Characteristic curve data can be sent in either direction over the bus. The front panel controls, except for those intended for local use only (such as Intensity), can be remotely set with a controller (like the Tek 4041) or with an IBM PC or compatible. See page 379.

RECOMMENDED GPIB CABLES

Part Number	Description
012-1015-00	0.5 meter, single shield
012-0991-01	1 meter, double shield, low EMI
012-0991-00	2 meters, double shield, low EMI
012-0991-02	4 meters, double shield, low EMI

SIGNAL ROUTING/DUT INTERFACING

***NEW* TSI Family**



MI 5010

SI 5010

The *NEW* Test System Interface (TSI) family of off-the-shelf components can be easily configured to fit a majority of signal switching and DUT interfacing needs. The TSI can range in complexity from a mainframe and a single switching assembly to DUT interfacing adaptors and multiple card/module switching configurations for up to 900 channels. Cards and modules are available for switching signals ranging from microvolts to 400 volts, from microamps to 10 amps, and from dc to 18 GHz. Rackmounting and GPIB operation are both standard features. The mainframe and control assemblies have built-in intelligence to free the GPIB for other bus activities. See page 360.

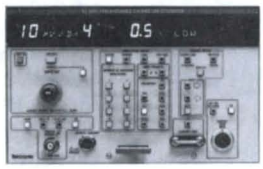
MI 5010
Programmable Multifunction Interface
This TM 5000 Series plug-in interface module accommodates three front-panel plug-in cards. The MX 5010 Multifunction Interface Extender provides space for three additional cards. A total of six function cards can be remotely controlled via the GPIB. Each of the seven types of function cards includes its own ROM and specific function-related firmware. See page 367.

SI 5010
Programmable RF Scanner
This TM 5000 Series plug-in uses 16 RF reed relays to interconnect 20 front-panel BNC connectors in three possible combinations: four groups of four channels, two groups of eight, or one group of 16. Rise time for groups of four channels is approximately one nanosecond. Used for scanning and channel switching, this device is remotely controllable over the GPIB. See page 371.

1360P/1360S
Programmable Signal Multiplexer
A microprocessor-based, programmable, system instrument that can be used to multiplex electrical signals. Switch matrix includes four identical, nine-pole coaxial switches. Operational modes determined by adjustable straps. Switch modes are: individual gangs of 1, 2, or 4. Multiples of eight inputs can be multiplexed to one output. See page 372.

GENERAL PURPOSE INSTRUMENTS

AA 5501/SG 5010



CG 5001

DC 5009

DC 5010

DM 5010

FG 5010

PS 5004

PS 5010

AA 5001/SG 5010
Programmable Audio Test System
Automatically performs such industry-standard tests as harmonic distortion to IHF A202, intermodulation distortion to SMPTE TH 22.51, DIN 45403, IEC 268.3, and IHF A202, frequency response to IHF A202, and noise or signal-to-noise ratio to IHF A202 ("A" weighting filter complies with ANSI specification S1.4 and IEC specification 179 for sound level meters). With the Option 02 capability of the AA 5001, noise measurements may be made to CCIR 468-2 and DIN 45405 standards. The SG 5010 also generates the burst signal for dynamic headroom tests. See page 401.

CG 5001
Programmable Calibration Generator
A microprocessor-based TM 5000 Series plug-in designed to be an integral part of a controller-based system for calibrating and verifying major oscilloscope parameters. Learn mode allows front panel control settings to be assimilated as program data by controller. All front panel settings are remotely controllable via the GPIB. Contains built-in self-test routine. See page 431.

DC 5009
Programmable Universal Counter/Timer
This dual-channel, microprocessor-based TM 5000 Series plug-in provides frequency and period measurement to 135 MHz and features pushbutton automatic trigger-level setting and eight measurement functions. An arming input permits measurement of selected events within complex waveforms. Option 01 provides an oven-controlled 10 MHz crystal oscillator. All front panel settings and features are remotely controllable over the GPIB. See page 394.

DC 5010
Programmable Universal Counter/Timer
A dual-channel TM 5000 Series plug-in that provides measurement of frequency to 350 MHz, period, ratio, and event B during A, using a reciprocal technique. Trigger levels automatically set to optimum. Trigger voltage setting is displayable. Automatic self-test feature. Remotely controllable over and fully programmable via GPIB. See page 392.

DM 5010
Programmable Digital Multimeter
This remotely controllable, TM 5000 Series plug-in measures dc and true RMS ac voltages and resistance. A diode-test function tests semiconductor junctions while a low voltage/ohms function allows in-circuit measurements without turning on diode or transistor junctions. Math functions include: Averaging (up to 19,999 readings), dB (ref to 1 mW or to user-supplied constant). Comparison (user-supplied upper/lower limits). Offset and Scaling (user supplied constants), or any combination of these functions. See page 397.

FG 5010
Programmable Function Generator
This TM 5000 plug-in outputs Sine, Square and Triangle waveforms. Pulses and Ramps are provided with variable symmetry in 1% steps. Phase-lock mode automatically locks to any input signal, 20 Hz to 20 MHz. Dc offset voltage is programmable from 20 mV to 7.5 V. Can store ten front panel setups to reduce programming time. Fully programmable via GPIB. See page 397.

PS 5004
Programmable Precision Power Supply
This TM 5000 Series plug-in provides the high-resolution voltages and currents necessary in the characterization of transistor, IC, and other semiconductor and hybrid circuits and in the operation of high-performance strain gages and other transducer systems. Its entire 0 V to 20 V output is covered with a coarse and fine adjustment to provide rapid setability and ±0.5 mV resolution without the necessity of changing ranges. The supply output is available at the rear interface as well as from the front panel terminals. Overall accuracy is ±0.01% ±2 mV. See page 399.

PS 5010
Programmable Triple Power Supply
This TM 5000 plug-in provides three concurrent outputs: two floating at 0 V to +32 V and 0 V to −32 V dc and a logic level supply at 4.5 V to 5.5 V dc. Operation includes auto-crossover with bus interrupt on continuous-voltage or continuous-current mode change. All three supplies may be remotely controlled over the GPIB while front panel settings are locked out. Overall accuracy is ±(0.5% + 20 mV). See page 399.

LOGIC ANALYZERS

DAS 9100 Series Digital Analysis System*[1]
A general purpose, configurable, and user-upgradable digital analysis system. Available with black and white display (9109 Option 06 mainframe), without display (9119 ATE mainframe) or with color display (9129 Option 06 mainframe). All of the functions that can be accessed from the DAS 9100 Series keyboard may be controlled via GPIB. The I/O Option 06 supports GPIB data rates up to 200 kbytes per second as well as RS-232, serial line printers, hard copy units and master/slave operation. For list of Data Acquisition and Pattern Generation Modules, accessories and probes see page 107.

***NEW* DAS 9200 Series Digital Analysis System Options 1C and 2C**
The *NEW* DAS 9200 expands on all the best features of the DAS 9100 Series. All operations are menu controlled via a high resolution color display. The DAS 9200 can be set up and controlled over either RS-232 or GPIB interfaces. See page 108.

1240/1241 Logic Analyzers
The 1240/1241 support all aspects of the design task, including hardware analysis, software analysis, and integration. For hardware analysis, they offer up to 36 channels of 100 MHz acquisition with 6 ns glitch detection. Software analysis is supported by up to 72 data channels at sampling rates of 50 MHz synchronous/asynchronous. A flexible clocking scheme includes data demultiplexing on each acquisition probe. Acquisition, triggering and display of two independent time bases are tied together, so you can fully monitor the interaction between hardware and software. See page 118.

PORTABLE SPECTRUM ANALYZERS

***NEW* 492AP 50 kHz to 325 GHz Spectrum Analyzer**
This *NEW* Spectrum Analyzer offers built-in signal processing intelligence. Marker intelligence provides hands-off convenience for measuring the bandwidth of filters, amplifiers, and other networks. Menu-selectable signal processing enables the analyzer to mark the peak of a main lobe and the peaks of side lobes at the touch of a button. These features and many more are all controllable via the GPIB for measurement repeatability. See page 161.

***NEW* 495P 100 Hz to 1.8 GHz Spectrum Analyzer**
The *NEW* 495P offers features essential for lab-grade spectrum analysis in a light-weight portable package. This spectrum analyzer incorporates advanced intelligent markers and signal processing capabilities, all controllable via the GPIB. Option 05 provides a precision internal reference, signal counter, external reference input, and macro down-loadable programming capabilities. Frequently used measurement routines can be executed from the analyzer's nonvolatile memory. See page 157.

494P Programmable Spectrum Analyzer
This 10 kHz to 325 GHz portable spectrum analyzer provides lab precision measurement capability in hostile field environments. Full control of the front panel, waveform processing, and storage are accessible via the GPIB. Features keypad data entry, nonvolatile storage of nine CRT displays and ten instrument set-ups, direct plot capability and a built-in 325 GHz frequency counter. See page 163.

***NEW* 2754P 50 kHz to 21 GHz**
***NEW* 2755P 50 kHz to 325 GHz**
Programmable Spectrum Analyzers
These *NEW* benchtop spectrum analyzers provide laboratory performance combined with ease of use and advanced signal processing intelligence. A nonvolatile memory stores up to nine waveforms and nine front panel setups. TekSPANS software allows the use with popular controllers, including the IBM PC and compatibles. See page 166.

INTELLIGENT GRAPHICS WORKSTATION

4132 Intelligent Graphics Workstation
The 4132 workstation combines state-of-the-art UTek operating system, microprocessor technology, advanced architectures, and flexible system software. The optional GPIB interface is capable of supporting up to 14 GPIB-compatible instruments, in addition to the 4132 interface itself.

SOFTWARE SUMMARY

Information Display Products

Application	Function/Product	Language	Runs on/with	Page
Graphics Application Systems	Window management for software development and graphics systems; single and multiuser drafting and technical data analysis systems		4120, 4132, 6130 Workstations; 4100A Series Terminals DEC MicroVAX II/MicroVMS	61
CAD	PLOT 10 TekniCAD TCS (Terminal Control System) GKS (Graphical Kernel System) IGL (Interactive Graphics Library)	 FORTRAN/object FORTRAN '77 FORTRAN/object	 4120, 4132, 6130 Workstations; DEC VAX with VMS	66
Artificial Intelligence Systems	R and D applications in expert systems, natural languages, intelligent robotics, auto programming	Smalltalk-80, Tek Common LISP, Franz LISP, Prolog options	4400 AI System	68
CAD conversion of existing drawings	Produces lines, arcs, text, symbols, and layers for insertion into popular CAD systems	FORTRAN IV	4991S1 Workstation	77

Design Automation Products

Application	Function/Product	Language	Runs on/with	Page
CAE Systems Design & analyze complex electronic circuits	Designer's WorkSystem		Apollo Workstations; DEC VAX family	87
VLSI verification and analysis	Gate Array WorkSystem			88
Full custom chip design	Full Custom WorkSystem			88
Structured custom chip design	Structured Custom WorkSystem			89
Printed circuit board design	PCB WorkSystem			89
CASE Tools Analysis—Structured Analysis (SA) Tools	Graphically specify system conceptual requirements		DEC VAX family, Apollo, IBM PC	93
Design—Structured Design (SD) Tools	Graphically specify design requirements		DEC VAX family, Apollo, IBM PC	94
Prototype—Integral C	Rapidly prototype design hypothesis in an integral C programming environment		DEC VAX workstations	95
Code—Language Directed Editors	C and Pascal language-sensitive editors	C, Pascal	DEC VAX family, IBM PC	95
Cross Assemblers	Develop code for all major microprocessors (8, 16, 32-bit)		DEC VAX family, IBM PC	95
Cross C Compilers	C Compilers for major microprocessors (16, 32-bit)	C	DEC VAX family, IBM PC	96
Cross Pascal Compilers	Pascal Compilers for major microprocessors (16-bit)	Pascal	DEC VAX family, IBM PC	96
Test—Emulation Systems	Real Time Emulation for all major microprocessors (8, 16, 32-bit)		DEC VAX family, IBM PC	96
Trigger Trace Analyzers	Captures real time software and hardware events		DEC VAX family, IBM PC	96
High-Level Debug	Debug code at the C/Pascal source level		DEC VAX family	96
Integrate—C-LANDS (C LANguage Development Systems)	Full C Development Systems for 16, 32-bit microprocessors	C	DEC VAX family	96
Pascal LANDS (Pascal LANguage Development Systems)	Full Pascal Development Systems for 16, 32-bit microprocessors	Pascal	DEC VAX family	96
Maintain	All of the above		DEC VAX family, workstations, Apollo, IBM PC	96
Mnemonic Disassemblers	Disassembles data acquired from microprocessor-based system		DAS 9100 1240/1241	115 118
Performance Analysis	Characterizes system performance		1240/1241	118
Semiconductor Testing VLSI LSI	 TEKTEST V TEKTEST	 RSX-11M based	 S-3295 Test System S-3220 Test System	 131 132
Logic Analysis VLSI Verification Software Package	Links DAS 9100 to host for device verification		VAX 7000 Series/UNIX, VAX and IBM PC	133

SOFTWARE SUMMARY

Communication Products

Application	Function/Product	Language	Runs on/with	Page
Automatic Video Measurement	Unattended monitoring of NTSC and/or PAL video signals	Tek ANSWER BASIC	1980 ANSWER System	147
Spectrum Analysis RF Microwave Millimeterwave	S26RF00—General RF Application Software Package • Measurements • Waveform Operation • Filter Tests • Utilities • Signal Search • Remote Access	Tek 4041 BASIC HP BASIC 3.0 IBM Advanced BASIC 2.1	490P Series, 2750P Series, Spectrum Analyzers/ Tek 4041, HP9826, 9836, IBM PC/AT	173
EMI Testing	S26EM00—EMI Prequalification Software FCC/VDE Conducted and Radiated MIL-STD-461B/462 Conducted and Radiated	IBM Compiled BASIC 2.0	490P Series and 2755P Spectrum Analyzers with IBM PC/AT	173

Instruments/Systems Products

Application	Function/Product	Language	Runs on/with	Page
Measurement Software Communication Utilities	TekMAP: S42P101—7854/IBM PC Communication and Control (COMMUTE)	IBM Compiled BASIC	IBM PC/XT/AT	340
Pulse Parameter Analysis	S42H201—7D20/HP Series 200 Time and Amplitude Measurement Software S42H202—7854/HP Series 200 Time and Amplitude Measurement Software S42P201—7D20/IBM PC Time and Amplitude Measurement Software 062-7732-00 7D20/Tek 4041 Time and Amplitude Measurement Software	HP BASIC HP BASIC 4041 BASIC	HP-216, 226, 236, or 236C HP-216, 226, 236, or 236C IBM PC/XT/AT Tek 4041, 4000 Series Terminal	342
Scientific Data Analysis	S42P301 ASYST Scientific Software System/ Graphics/Statistics/Analysis/GPIB Data Acquisition	ASYST	IBM PC/XT/AT or DOS 2.0/2.1/3.0/3.1	342
Semiconductor Testing VLSI Verification Software	Test programs and utilities for device verification	Uniflex, C	10SXX Delta Series VLSI Test System	343
Visual Interactive Access (VIA)	Menu-driven test program editor for ASIC and VLSI device testing	Menu mode	10SXX Delta Series VLSI Test System	343
CAE Link	Links 10SXX Delta Series Testers with CAE Systems, ASIC Design Workstations/10Z280	C	10SXX Delta Series VLSI Test System	343
Signal Processing and Display (SPD) Program Library	Library of over 190 different signal processing and display programs for IBM PC/10Z210 • Fast Fourier Transforms (FFTs) • Pulse Parameters • Correlation • Convolution Functions • FIR Filters	Lattice C, IBM compiled BASIC 1.0, menu mode	IBM PC/XT/AT	343
GPIB Instrumentation Interface	GURU II	IBM PC BASICA	IBM PC (or PC compatible)	358
Measurement Systems	Languages for Instrument Control, Signal Acquisition, Waveform Processing and Graphics	SPS BASIC 4041 BASIC	Micro/PDP-11 4041	373
Single-Shot Acquisition to 500 MHz BW	MS 3101—Waveform Acquisition, Signal Analysis Support for 7912AD	SPS BASIC	Micro/PDP-11 with 7912AD	*1
Single-Shot Acquisition to a 200 MHz Sample Rate	MS 3201—Waveform Acquisition, Signal Analysis Support for 7612D	SPS BASIC	Micro/PDP-11 with 7612D	*1
Single-Shot Acquisition to 500 MHz BW	MP 2101—Waveform Acquisition, Signal Analysis Support for 7912AD	4041 BASIC	4041 with 7912AD	374
Single-Shot Acquisiton to a 200 MHz Sample Rate	MP 2201—Waveform Acquisition, Signal Analysis Support for 7612AD	4041 BASIC	4041 with 7612D	374
Acquisition to 14 GHz BW with Sampling Plug-Ins for Repetitive Signals	MP 2501—Waveform Acquisition, Signal Analysis Support for 7854 including Sampling Applications and TDR	4041 BASIC	4041 with 7854	375
Single-Shot Acquisition to a 100 MHz Sample Rate and to a 150 MHz BW for Repetitive Signals	MP 2601—Portable Measurement Package providing Waveform Acquisition, Signal Analysis for 2430	4041 BASIC	4041 with 2430	376
General-Purpose Instrument Test Development Tool	TEK EZ-TEST	4041 BASIC	4041	358
Audio Test Development Tool	MP 2902—Tek Audio TPG	4041 BASIC	4041	377
Miscellaneous Waveform Acquisition, Signal Processing, etc.	Tekware™ Instrument Software Library	4041 BASIC, IBM BASIC, Turbo Pascal, and others	2220, 2230, 2430, 7D20, 7854, 370, 7612AD, 7912AD, 390AD, and others*1	*1

*1 *Contact your local Sales Engineer.*

COMPONENT DESIGN & PRODUCTION SERVICES

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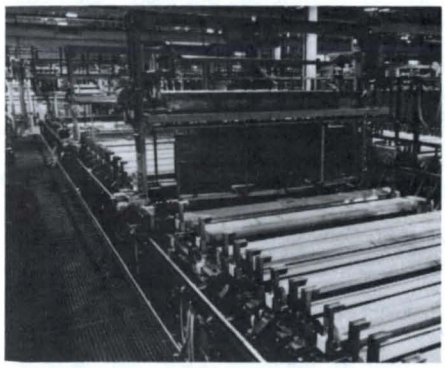
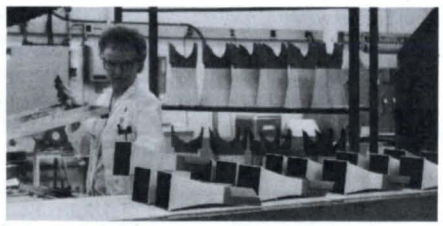
Touch Panels	38
Display Monitors	39

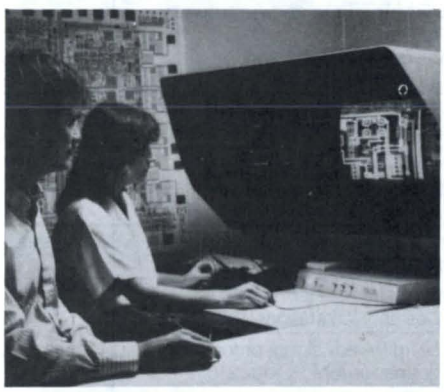
Tek's world class facilities and know-how at your disposal.
We know that your systems can only be as reliable as the components that go into them. For that reason, we place a premium on dependability. We produce products that will keep you and your customers satisfied and your service costs down.

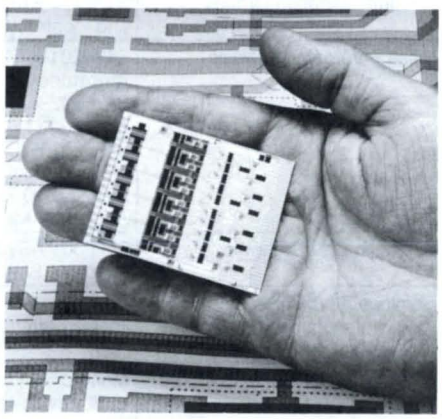
We take your design (or assist you with design) and take the entire process through manufacturing and shipment. Quality control is assured, along with on-time delivery and customer satisfaction. We want to work with you and value you as our customer.

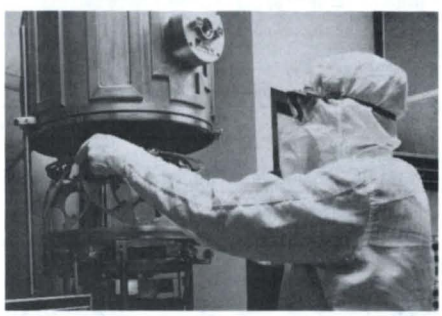
Tek's special application components now available for use in your latest product design.
Now you can increase the productivity of your design team by specifying custom components designed and manufactured by Tektronix. We've made them to our exacting specifications and quality standards. You can depend on it. Contact one of our plants directly.

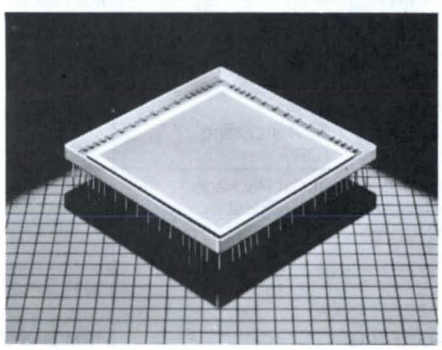


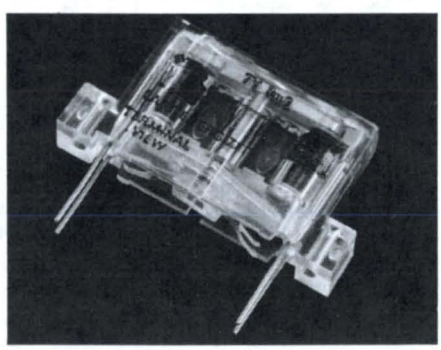




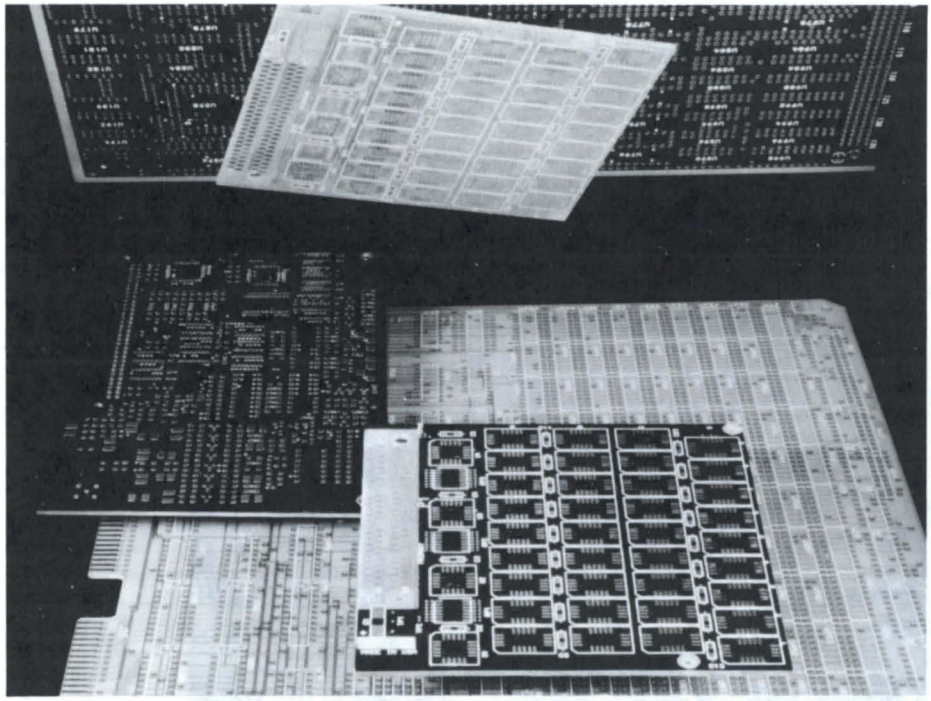








Design, Manufacture, Test, Ship . . . We do it all!



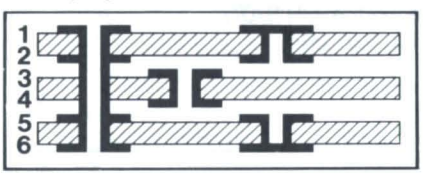
Tektronix state-of-the-art Printed Circuit Board facility in Forest Grove, Oregon serves customers' interconnect needs from design consultation through finished products

Advanced Technology

Quality

Service

Tektronix circuit board manufacturing offers you a competitive advantage in bringing your high-technology products to market and keeping them there.



This illustration shows a 6-layer multilayer with conventional holes, a buried via connection layers 3 and 4, and blind vias connecting layers 1 and 2, and layers 5 and 6. This process, available up to 8 layers, conserves circuit board real estate by allowing only necessary layers to be connected. This process, combined with surface mount technology, can reduce costs per interconnect up to 50% over conventional technology.

TECHNOLOGY

Blind and Buried Vias — These interconnecting vias conserve circuit board real estate by allowing only necessary layers to be connected, which frees space on other layers to be used for circuitry.

High Quality Multilayers — We specialize in high quality multilayers backed by a Tektronix warranty.

Fine-Line Circuits — Our tight tolerances and precise registration accuracy provide high quality fine-line circuits with track widths of 0.006″ and greater.

Hot-Air Leveling — Our state-of-the-art horizontal hot-air leveling system eliminates process variability and ensures component solderability.

Electrical Characteristics — Fabrication and testing of circuitry with impedance control tolerances to ±3%. Consultation in proper lay up and material selection for tightly toleranced 50 Ω and 75 Ω circuitry.

Laser Film Generation — We use customer supplied CAD and N.C. databases to create tooling that provides ultimate feature and registration accuracy and maximum accuracy between laser generated artwork and N.C. drill programs.

Surface Mount — If you are ready to incorporate surface mount technology in your next product, we offer a wide range of technology and support services from design consultation to high quality fine-line or blind and buried via multilayers.

SERVICE

New Product Support — Design consultation, value engineering and prototype support are just some of the services provided by Tektronix circuit board manufacturing which can improve your time-to-market and the cost-effectiveness of your design.

Delivery — Our delivery performance is unequaled in the circuit board industry. Ours is the first Class "A" MRP certified circuit board plant in the world, an accomplishment which assures on-time delivery to our customers.

CAPABILITIES

Number of Layers — Two to ten plus.

Standard Material — FR-4, CEM-3.

Density — 0.006″ conductor width, 0.006″ spacing. Minimum 0.0135″ vias. Denser packaging negotiable on prototype basis.

Finishes — Bright-acid tin, gold, hot-air leveled solder.

Soldermasks — Screen printed, thermal-cured epoxy, photographic dry film.

Panel Size — Maximum 18″ x 24″.

Finished Board Thickness — Maximum 0.125″. Minimum 0.025″.

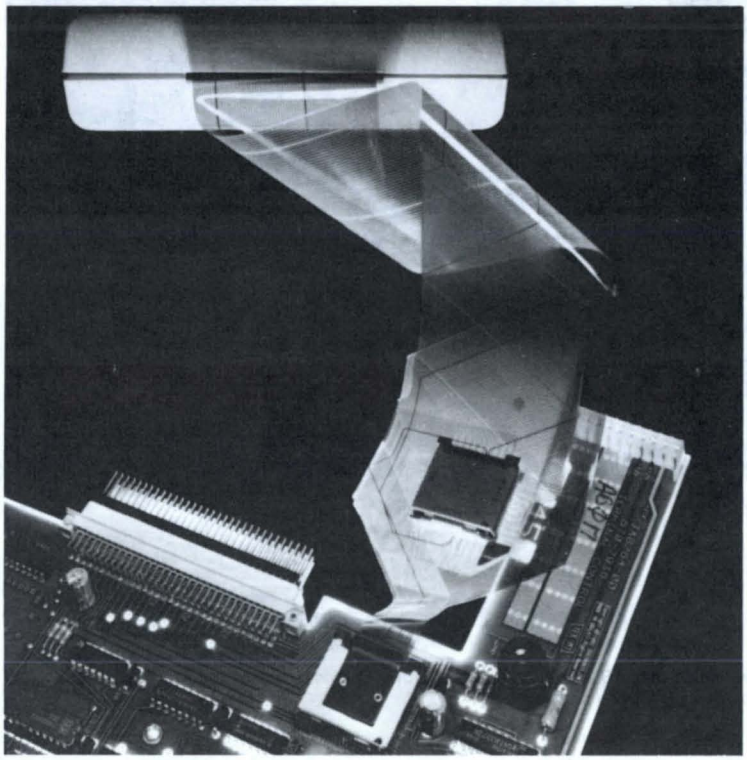
Tooling — Computer aided laser generated film.

Testing and Analysis — Complete in-house electrical, metallurgical and chemical testing.

Customer Support
Circuit Board Manufacturing
Product Marketing Manager or
Customer Representative
Tektronix, Inc.
1521 Poplar Lane, D.S. F1-491
Forest Grove, OR 97116
800-222-2600, Ext. 216

Canada
800-338-8800, Ext. 216

UNIQUE INTERCONNECT SYSTEMS



Shown above is an emulator probe being used in Tektronix logic analyzer instruments. The circuit (PM 202) folds back onto itself, making a two-sided circuit out of a single-sided one. This design allows SMDs to be added directly onto the probe.

Pliable

Versatile

Saves Space and Weight

FLEXIBLE CIRCUITS

Flexible circuits are answering needs in ways never imaginable with wire and cable technology. Generally, flexible circuits are much like printed wiring boards. (PWBs), in that their basic function is to route electrical signals, but this is where the similarity ends! Because flex circuits are pliable (that is, flexible) they are amazingly versatile. This versatility, plus new shielding materials and extreme circuit densities fit flex circuitry for applications that can't be solved with traditional cables and printed wiring boards.

A flexible interconnect is a composite of a metal conductor and a dielectric substrate bonded together by an adhesive. These interconnects can be freely formed without cracking the metal conductor. Flexible interconnects are used to provide an electrical connection between two termination points while saving space and weight. The circuit may serve as a hinge, demanding up to millions of cycles of flexibility.

Mounting SMDs directly on etched circuitry on copper-clad polymide is gaining in popularity due to space and weight savings.

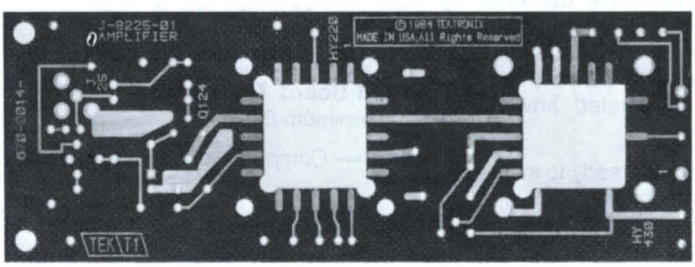
TYPICAL SPECIFICATIONS

Front to Back Registration — ±0.0005″.

Smallest Line Width and Spacing — 0.004″.

Kapton Cover Sheet Registered to Circuit Pattern — ±0.004″.

Customer Support
Tektronix, Inc.
P.O. Box 500, D.S. 38-385
Beaverton, OR 97077
(503) 627-5314



Low Dielectric Constant

Dimensional Stability

Close Tolerances

TEFLON CIRCUIT BOARDS

The utilization of higher frequencies (>10 GHz) in the field of communications and data transmission along with analytical requirements of the test instrumentation for such equipment has accented the need for accurately tuned transmission lines on circuit boards. The low dielectric constant, dimensional stability and close tolerances of raw material make Teflon an attractive selection for circuit board material in these applications.

Circuit elements of precise size and position can be fabricated for this application on glass reinforced Teflon substrates.

Certified by UL for recognized printed wiring board components. Flammability classification 94v-0. We offer complete facilities including:

Graphic Tooling
CAD-CAE N.C. Tooling
Metallurgical Analysis
Chemical Analysis and Control
Electrolytic and Electroless Plating

All critical processes are done in a Clean Room environment.

Our routine production processes are:

Through Hole Plated Teflon Substrates
Laminated Multilayers registered to ±0.004″
Line widths and spacing to ±0.004″
Line width tolerance to ±0.0005″
Front to back registration to ±0.0005″

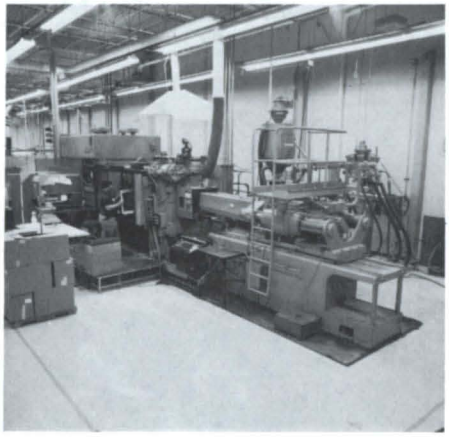
TYPICAL SPECIFICATIONS

Operating Frequencies — >10 GHz.

Dielectric Constant — from 2.17 to 10.6.

Standard Dielectric Thickness — 0.005″ to 0.062″; other thicknesses available.

Customer Support
Tektronix, Inc.
P.O. Box 500, D.S. 38-385
Beaverton, OR 97077
(503) 627-5314



Design Consultation

Prototyping and Mold-Making

Manufacturing

Customer Support

Tektronix Plastic Products (TPP) provides engineering services and high quality components to enable high technology manufacturers to reduce the labor content, number of components, and cost of their products, in order to be competitive in worldwide markets.

Full service capabilities support product design, mold design, prototyping, mold-building, and a complete range of manufacturing capabilities to meet the needs of high technology industries.

State-of-the-art injection molding technology uses thermoplastic resins, and employs multiple finishing and assembly technologies to produce a product of the highest value in terms of price, performance, and reliability.

PROTOTYPING AND ADHESIVES CONSULTATION

Prototyping from models to polyurethane and epoxy components using silicone rubber molds.

Development assistance with jigs, fixtures, masks and protectors using silicone rubber and polyurethane. A typical application might be component masking for application of nickel-loaded acrylic paint for EMI/RFI shielding.

Selection of adhesives and solvents for bonding operations.

CAPABILITIES

Tool Design — TPP uses a full 3D mechanical design package (DDN) plus a graphics applications programming language (GRAPL) for design creation, analysis, and N.C. programming of injection molds. All designs are stored in an integrated data base, which provides easy access to all design data when changing or modifying existing mold designs, or when creating new mold designs. Mold flow analysis programs enable us to help you optimize part design for the required manufacturing process.

Electronic Data Exchange — Tektronix has IGES in/out capability for utilizing CAD-generated data from most systems. (Tooling process time is shortened if your data base is supplied in an electronic format.) We are connected to the Tek Engineering Network, allowing us access to most engineering departments via local area networks (LAN) or Hyperchannel. We can transfer data via phone modem or 1600/6250 BPI mag tape.

Numerically-Controlled Machining — Tektronix has the capability to machine virtually any part or mold cavity configuration including complex shapes and contoured surfaces. By utilizing our CAD database, considerable savings are realized in N.C. programming time. Data is transmitted from the CAD system to the machining centers via DNC (Direct Numerical Control) or punched tape.

EQUIPMENT

TPP has three fully interactive CAD/CAM terminals linked via dedicated line to a company mainframe. We also have a C-size plotter, an N.C. tape punch, and DNC hardware.

Molding equipment includes injection molding machines ranging in clamp tonnage from 13 to 1,000 tons. These machines are capable of processing engineering grades of thermoplastics and structural foam resins. Primary processes are controlled by Maco IV, Scoremaker, and Injectorvisor Systems.

MOLD TYPES

Molds meet standard DME specifications for any custom design you may require.

Some of the more frequent mold types are listed below.

High Volume Molds (Hardened Tool Steels) — Built to produce in excess of 1 million quality parts. We meet or exceed all Society of Plastic Industry mold classification guidelines.

Low Volume Molds (Aluminum) — Primarily built for short runs. Sizes range from 1 in round to structural foam molds 32 in x 40 in.

Prototype Molds, Prototype Model Lab — Prototype tooling and model-making capabilities to aid in the development of our customers' products.

Carrier Systems — 3 in x4 in, 3 in x 4 ½ in, 4 in x 5 in, 6 in x 8 in, and 2 in x 4 in round carriers are available. Carrier systems are designed for quick setups, short runs, and cost savings on mold components and mold construction.

SPECIAL SERVICES

As a part of Tektronix, TPP offers specially-coordinated high technology services not normally available from a plastic parts manufacturer. We provide expert design and materials consultation plus processing capability in the following areas:

Laboratory Testing
- EMC attenuation of conductive or coated plastic systems
- Corrosivity of flame-retardant resin systems
- As-molded part stress analysis
- Surface analysis (scanning electron microscopy)
- UL approved molder C2160

Plastic-Metal Combinations
- Product enclosures
- Functional devices
- Outsert/insert molding operations

Electroless and Electrolytic Plating
- EMC/RFI attenuation
- Electrostatic discharge management
- Corrosion-resistant finishing
- Aesthetic finishing

Conductive Paint
- EMC/RFI attenuation
- ESD management

Automated Painting
- Aesthetic finishing

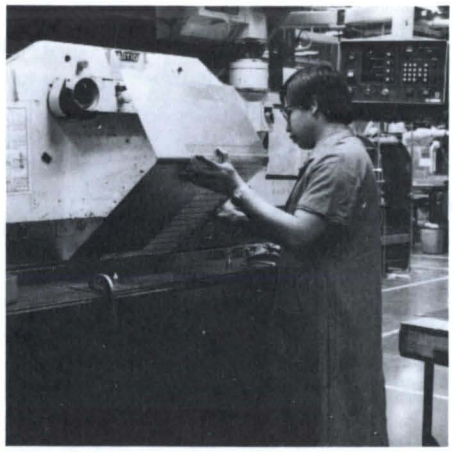
Delivery Systems
- Just-in-Time Kanban
- Matched to Customer Needs

International Tooling
- Consultation
- Mold Design and Build Management

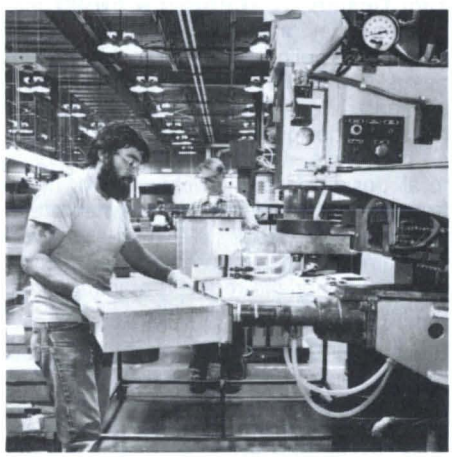
Customer Support
Plastic Products
Tektronix, Inc.
3000 Lewis and Clark Highway, D.S. 08-545
Vancouver, WA 98661
(206) 699-7391

CAD/CAM

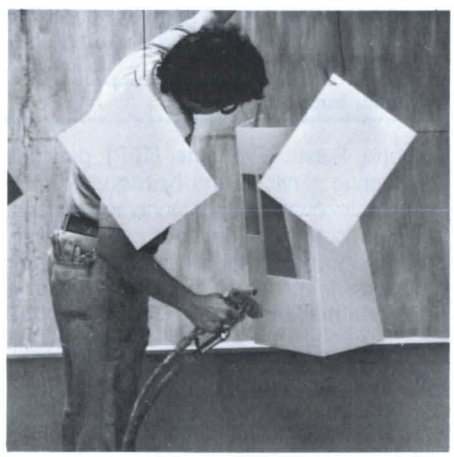
Machining



Sheet Metal



Assembly



Finishing

Metal Products

Tool and Design

Manufacturing

Quality Control

Packaging/Shipping

Tektronix offers complete metal products capabilities from Tool and Design through manufacturing. Quality control is assured and products shipped to customer satisfaction.

MANUFACTURING CAPABILITIES

Tool and Design — Full design and documentation capabilities, with a tool room equipped to build and maintain most types of tooling.

Machining — Screw machines, sawing, and CNC milling with machine-aligned cellular processes.

Sheet Metal — Sanding, blank, pierce, turret punching, shearing, forming, grinding and buffing. Material types include aluminum, copper alloys, brass, and stainless steel.

Programming — Full programming capabilities for sheet metal and machining.

Hardware Assembly — Riveting, hardware insertion, spotwelding, gluing and complete enclosure assemblies.

Finishing — Auto and hand paint; lab for color matching. Etch, lacquer, chromate, silk screening, and printing with full nomenclature capabilities.

Packaging and Shipping — All items packaged and shipped to customer satisfaction.

Quality Control — Fully equipped with latest state of the art equipment and technology.

EQUIPMENT LIST

Quality Control — Programmable measuring system by Brown & Sharpe (0.00025 obtainable measurements)

Programming — MEG 131 Graphic Terminals coupled to VAX 11/780 system.

Production Machining
- CNC screw machines
- CNC milling machines—horizontal/vertical
- CNC bar and chucker
- Automatic screw machines
- Belt sanders
- Vibratory finishers
- NC drillers
- Grinders
- Saws

Sheet Metal
- Shears
- Punch presses, 0-300 ton
- Power brakes, 12-55 ton, automatic back gauges
- Spotwelders, 30 KVA-250 KVA
- Heli-arc welders

Hardware Assembly
- Presses, 2-8 ton
- Auto-press nut machines
- Eyelet machines
- Riveters
- Insertion machines
- Cabinet latch machines

Finishing
- Chromate coat, to MIL-C-5541 (clear & yellow)
- Automated etch line
- Ultra-sonic clean
- Variety chemical baths
- Automated electrostatic paint line (Ransberg Disc)
- Automatic silk screen machines
- Automatic printing press

Tool/Die
- Jig bore
- EDM
- Grinding
- Lathes, mills and drills

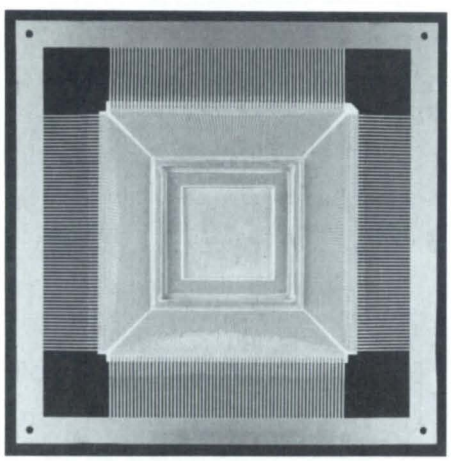
Customer Support
Metal Products
Tektronix, Inc.
P.O. Box 500, D.S. 38-385
Beaverton, OR 97077
(503) 627-5314

Hybrid Circuit Services

For over seventeen years, Tektronix has designed and produced high performance, high reliability hybrid circuits not readily available elsewhere. We have the expertise needed to work closely with you to supply custom hybrids which will help assure your product's success. We offer services ranging from foundry service to full custom design. We have thick-film, thin-film, multilayer ceramic, laser trim, surface mount, and chip-and-wire technologies, plus the latest in CAD systems, all under one roof. Our modern production equipment is augmented by Class "A" MRP-II and Just-In-Time manufacturing. We offer indepth application assistance, complete in-house testing, and strong microelectronics R & D programs.

Thin-Film Hybrids

For microwave, high power, or high precision applications, our thin-film hybrids offer small geometry for increased circuit density and reduced parasitic inductance capacitance. We offer 20 μm line widths ± 1 μm, laser trimmed resistors of up to $\pm 0.05\%$, ratio temperature coefficient of resistance of $+5$ ppm/°C, eutectic die attach, two layers of conductors, and the ability to braze Kovar heat sinks to devices.

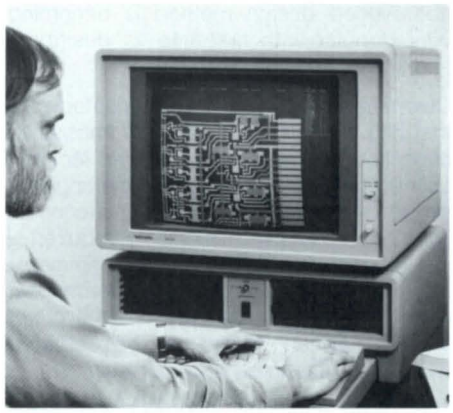


Thick-Film Hybrids

For medium complexity, high resistor count, or special time adjustment applications, our thick-film circuits are a cost effective choice. With care, they can be used up to 2 GHz. We offer multilayer thick-films, passive chip components, surface-mount assembly, and chip-and-wire assembly to achieve typical densities of 25 components per square inch.

Multilayer Ceramic Hybrids

Our multilayer ceramic (MLC) hybrids make use of metalized interconnections screened onto multiple layers of thin ceramic insulation material. The layers are laminated and co-fired to form a hermetic structure with a very high interconnection density as well controlled transmission lines. Electrical isolation among signal layers is provided by interspersed ground or voltage planes. By adding components in chip form to the surface layer, complete circuits can be formed. Our MLC process has been used to build rugged, highpin-count (264 pins and more) VHSIC type chip carriers. Tektronix MLC devices offer 96% Alumina for 50% greater thermal conductivity than the customary 92% Alumina, 4 mil lines and 3 mil spaces, and a unique ability to braze heat sinks and lead frames to a device.

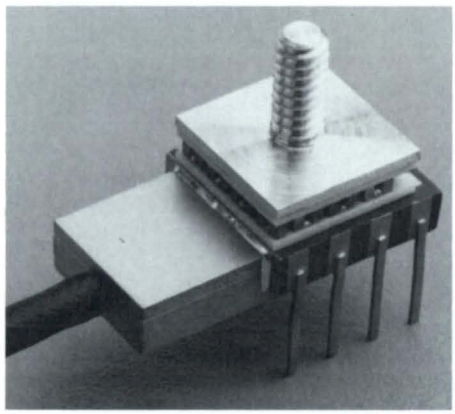


Electro-optic Devices

Tektronix' expertise in hybrid electro-optic devices for communication applications is demonstrated by our LDM 1300 Laser Diode Module. This competitively priced standard product combines Gigabit lightwave transmission, high output power, fast pulse response, and a true hermetic seal with competitive pricing. The LDM 1300's combination of features is not readily available in any other similar device.

Custom Ceramic Parts

Tektronix has over 30 years of experience in the design and production of ceramic components for electronic applications. We can provide you with multilayer ceramic substrates as described above, SLAM packages, custom lids and covers, a wide variety of ceramic insulators, powdered metal parts, powdered metal sputtering targets, and custom ceramic CRT envelopes.



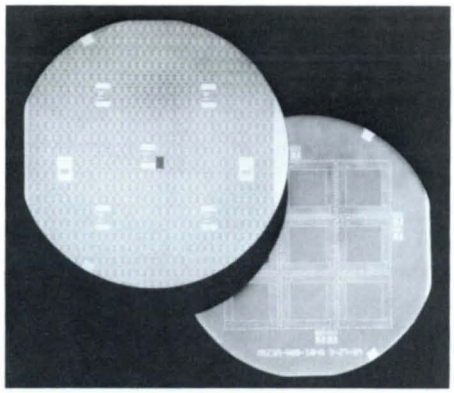
Quality and Reliability

Our Quality and Reliability departments have expertise in standard reliability tests and in highly specialized reliability evaluation procedures. We have complete in-house electrical, mechanical, and environmental test capabilities. All of our hybrids undergo reliability demonstration testing to assure conformance with customer specifications. A variety of our test methods meet or exceed MIL-STD-883C requirements.

Doing Business With Us

We would be happy to discuss your needs for custom or standard hybrid components and to quote on your requirements. We also welcome visits to our plant to consult with our design and production staff and to tour our facilities.

Customer Support
Hybrid Components Operation
Tektronix, Inc.
P.O. Box 500, D.S. 13-810
Beaverton, OR 97077
(503) 627-4220



Bipolar Foundry Services:
- 6.5 GHz Bipolar Analog Processes
- QuickCustom™ ICs
- Full Custom ICs

Microlithography:
- Mask Design and Fabrication

Charge-Coupled Devices:
- Scientific Imagers
- Custom Components

Tektronix Integrated Circuits Operation (ICO) is now marketing its formidable IC design and fabrication capabilities to those who have IC performance requirements but limited resources of their own.

Tek ICO has been supplying ICs with high performance, superior quality, and proven reliability to Tektronix' product divisions since 1967. Our integrated circuits continue to provide important technological and market advantages for many state-of-the-art products. Our foundry services for analog application-specific designs are now available. In addition, a limited number of specialty components for high-performance applications are being offered.

Since we've developed advanced imagers for high-resolution scientific imaging and high-speed signal processing, we can supply you with custom charge-coupled devices (CCDs) for these applications. The development of Tektronix high performance components required development of very sophisticated microlithography, high resolution, fine quality, VLSI mask-making services which are also available.

BIPOLAR ANALOG INTEGRATED CIRCUITS

Two design methods are used for manufacturing custom analog ICs: QuickCustom and full custom.

QuickCustom

A semicustom design approach, QuickCustom, helps reduce your development time and cost. It consists of a series of QuickChip™ design formats and easy-to-understand, time-saving design tools. This abbreviated design method is becoming very popular with first-time IC designers and seasoned IC design engineers.

QuickChips begin with a prefabricated chip that has a basic "core" array of transistors, capacitors and resistors configured for interconnection. Given this impetus, the engineer simply determines the custom interconnections for those circuit elements required—including the specification of laser-trimmable resistors for precise analog applications. Once final designs are determined and approved, finished wafers can be delivered (typically) within three weeks or less.

This "designer-friendly" approach was developed by Tektronix engineers who have many years of analog expertise in IC design. Their mastery of integrated analog circuit design and demonstrated experience have streamlined the design process. Today, ICO engineers are ready to provide you with as much assistance as you require. The "tools" include a complete guide enabling the first-time user to complete a design with minimal one-on-one coaching. We provide you with a library of macro cells (QuickChip 4), and SPICE models for the "core" IC that will predict the performance of your design, and ensure that your QuickCustom circuit works the first time.

We also include a grid-based layout system that specifies where the custom interconnects can be routed, and QuickKic, a graphic layout editor that makes it easy for even the first-time designer to digitize the layout.

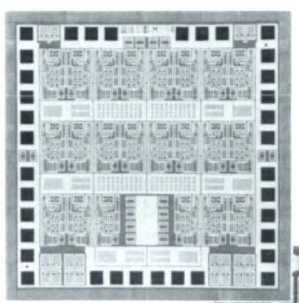
Typical ICO-developed QuickChips are shown in the adjacent photographs (QuickChips 2, 3 and 4).

THE QuickChip FAMILY

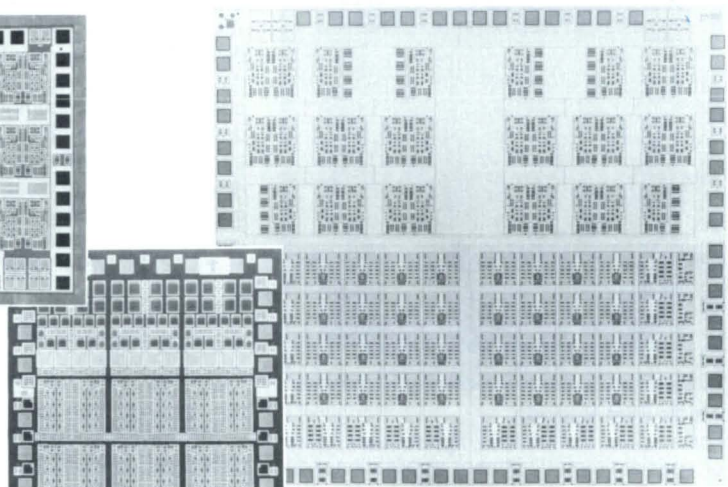
	NPNs*1	f_T	Max V_{CC} to V_{EE}	Resistors	Capacitors	Chip Size	Bonding Pads
QuickChip 2 Family	142-524	6.5 GHz	32 V	2.046 Implanted Thin Film, 10 or 50 Ω/sq*2	≤20 pF	1.98 x 2.49 mm to 4.09 x 4.19 mm	24-70
QuickChip 3	168	2.4 GHz	95 V	684 Implanted Thin Film, 50 Ω/sq*2	≤16 pF	2.97 x 3.05 mm	28
QuickChip 4	294	6.5 GHz <400 ps t_{pd}	32 V	1290 Implanted Thin Film 50 Ω/sq*2	32 Programmable ≤59 pF	4.9 x 4.9 mm (196 mils²)	30A 36D

**1 PNP transistors are also included in QuickChips 3 and 4. The f_T of PNPs is approximately 30 MHz and they are optimized for use as current sources (i.e., low collector capacitance).*

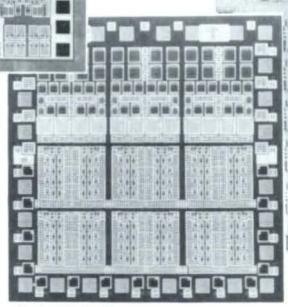
**2 Laser trimmable.*



QuickChip 2



QuickChip 4



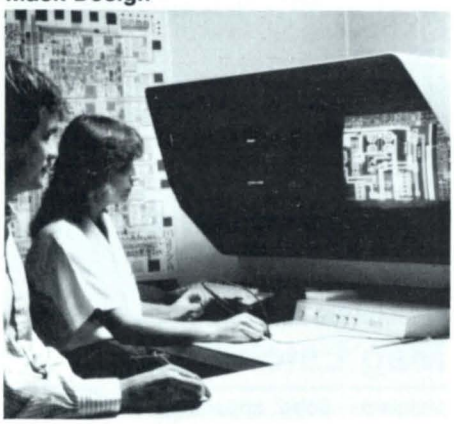
QuickChip 3

Full Custom

If higher performance or lower cost per chip are your requirements, ICO also offers a total custom design approach. One of our experienced applications engineers will be assigned to work with you or your team throughout the entire project. Tektronix-developed CAD/CAE software will be used to assist you through circuit analysis, simulation and layout, greatly improving your confidence in meeting design specifications the first time. Typical delivery of finished wafers is less than eight weeks from approval of design layout.

MICROLITHOGRAPHY PRODUCTS AND DESIGN SERVICES

Mask Design



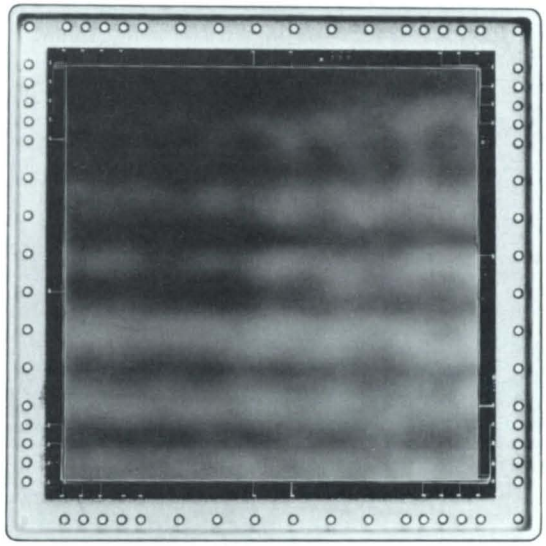
Mask design on a graphic workstation.

From minimally supported system time to full device design, our microlithography facilities are structured to meet your mask design needs. Working from menu-based design technology and grid-based layouts, we provide QuickChip™ and gate array designs plus full custom, application-specific analog and digital ICs. We use mask design tools to support development of non-standard products. Routine efforts include designs for: thick- and thin-film hybrid circuits, multilayer ceramic parts, waveguides, precision mesh components, liquid crystal and electroluminescent panels, graticules, and small chemically milled parts. Also, we are used to accommodating unusual requirements; we can handle yours.

Mask Fabrication

E-Beam pattern data being reviewed prior to generation of a photomask. Class 10 MEBES III write room is at left.

The same commitment to customers' needs is evident in our support of mask tooling. Our state-of-the-art facility can meet all of your photomask needs. Class 10 clean room conditions are constantly maintained in critical manufacturing areas. Our technicians demonstrate the expertise and versatility to support the wide variety of work our Mask Design group creates—from 10X reticles to 1X VLSI wafer scale integration masks. This part of our facility includes both G.C.A./D.W. Mann optical systems and Perkin-Elmer Electron-Beam equipment. Our staff will work with you on an individual basis to determine which design approach will meet your requirements, and still be economical.



TK2048M CCD Scientific Imager (actual size).

Our present capability provides tooling from 2½ by 2½ inch up to 7 by 7 inch glass substrates with a variety of thicknesses. We supply critical feature control from millimeter to submicron sizes, with position accuracy as small as 0.125 microns. Our claim of high quality products is backed by equipment such as Leitz MPV-DC and Nikon MPA-2A measurement systems. A Nikon CM-6 overlay comparator, Quantronix repair station, and KLA and Cambridge mask inspection systems, ensure that we deliver a superior product on time—every time.

CHARGE-COUPLED DEVICES

Charge-coupled devices (CCDs) are MOS integrated circuits that are essentially sampled data, analog delay lines. Used in such diverse applications as ultra-sensitive imaging detectors, transversal filters, tapped analog delay lines, and high-speed samplers/memory buffers, these inherently simple devices have proven to be powerful yet compact signal processing components.

For more than three years the CCD group at Tektronix has been developing a specialized set of devices to incorporate signal processing efficiency into Tektronix instruments. In the process we have developed one of the most advanced CCD technologies in the industry. This technology is available through a line of CCD products and design services.

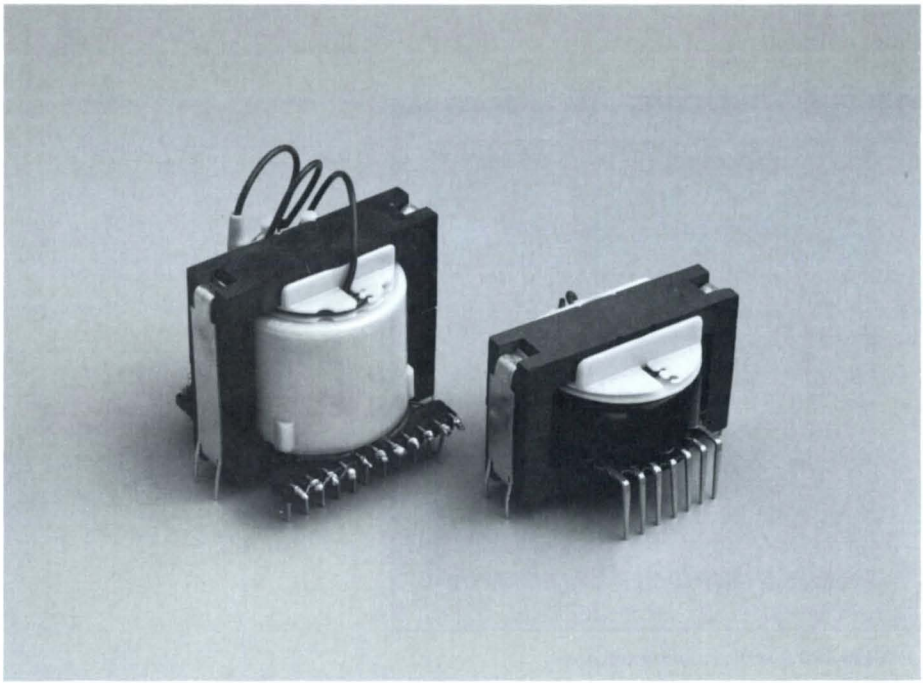
Our CCD imagers are fabricated using a buried channel, three-phase, three-level polysilicon gate process. This approach results in extremely high charge transfer efficiency and low background charge due to dark current. Our wafer-scale integration technology has made large pixel, large imagers a reality. An example is the TK2048M imager, shown above. This imager has approximately 4.2 million picture elements (pixels), each of which is 10 to 100 times more sensitive than conventional high speed photographic film.

Custom Devices

For custom designs our CALMA based, state-of-the-art CAD system, advanced microlithography capability—including wafer-scale E-beam mask making and three- or four-phase CCD processes—make it possible for you to design virtually any type of signal processing device. You can specify nearly any format of serial-parallel-serial CCD structures, optimized either for high speed or wide dynamic range, imaging or nonimaging. We also provide design and fabrication support for certain types of peripheral circuits including wide-band preamplifiers, high speed clock drivers, correlated-double-samplers, and timing/control logic.

If you've already completed a CCD design, Tektronix ICO provides a complete CCD foundry service to fabricate your device(s).

For further information, call:
ICO Marketing
Tektronix, Inc.
P.O. Box 500, D.S. 59-420
Beaverton, OR 97077
(503) 627-2515



Magnetic Components

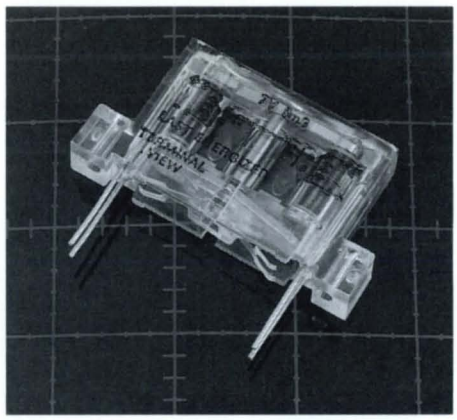
- Fast Prototyping
- Custom Engineering
- Excellent Mechanical Integrity
- Proven High Reliability
- Flow Solderable and Washable Types Available
- Single Packages That Supply Power for Electrostatic CRT Displays in Both Analog and Digital Circuits
- High Voltage Multipliers

TYPICAL APPLICATIONS

CRT Displays
Medical Monitors
Module Power Supplies
Photocopiers and Printers
Test/Measurement Equipment
Electrostatic Precapacitors
Portable Radar and X-Ray Systems

Tektronix Magnetic and Switching Components are designed to meet the stringent reliability specifications of Tektronix, Inc. products. The same components which power over 500,000 TEK instruments are available for your products. Our Transfer Molded High Voltage Transformers and combination High Voltage/Low Voltage Transformers are environmentally sealed, PC mountable and immersion washable. Our High Voltage/Low Voltage Transformers provide big performance in a small package. Up to 12 outputs in combinations from 5 V to 3000 V at output power to 2000 W at 100 kHz with isolated filaments to 10 kV dc in one unit. Their diversity allows many companies to replace several transformers with one. We have the capability to provide custom designs for your specific applications. These features—combined with Just-In-Time delivery, and UL, CSA, IEC compliance—gives you the competitive edge.

Customer Support
Tektronix, Inc.
P.O. Box 500, D.S. 19-013
Beaverton, OR 97077
(503) 627-3233



Mag Latch Relay

- Maintains Good Impedance Matching for Signals up to 1 GHz in 50 Ω Circuit
- High Reliability (Bifurcated Gold Plated BeCu Contacts)
- Space Saving Design
- Single or Dual Coil Drive
- Ceramic or Standard Circuit Boards

The Tektronix Magnetic Latching Relay is designed to offer highly reliable, low level switching without adding significant inductance, capacitance, or resistance to a circuit. It can be mounted directly on a hybrid circuit substrate or on a printed circuit board and consists of two 38 Ω drive coils and a unique open armature-contact system.

The Mag Latch Relay is suitable for input attenuator applications in portable and laboratory test equipment and provides an excellent method for remote low level switching in both manual and automatic instrumentation.

CHARACTERISTICS

Contact Life — (At typical loads) 10^7 cycles dry circuit (<10 mA and <50 mV dc); 10^6 cycles at 250 mA and 30 V dc or peak ac; 10^5 cycles at 250 mA and 250 V dc or ac RMS.

Contact Resistance — 0.1 Ω maximum over life (typically 10 to 30 mΩ), depending on substrate contact material.

Operating Time — 1.0 ms typical, 6.0 ms maximum.

Drive Voltage — Single Coil: 7 V ±1 V (5 ms). Dual Coil: 11 V ±1 V (5 ms).

Coil Resistance (Each) — 38 Ω ±10% at 25°C.

Coil Inductance (Typical) — Magnetic circuit closed, 11 mH.

Coil Operating Temperature — 95°C maximum.

Capacitance (Typical) — Pad-to-pad (contact open) 1.0 pF.

Contact Inductance (Typical) — Closed contact 2.5 pH.

Contact Bounce (Typical) — 200 μs.

Built on 36 years of experience in the design and manufacturing of advanced technology magnetic and electrostatic CRTs

For the first time, Tektronix' proven quality, reliability and performance are available for your CUSTOM CRT needs.

Ultra High Resolution
Photographic Imaging
Medical/Diagnostics
Workstations

High Brightness
Avionic Color
Color Shutters
Air Traffic Control

Ruggedized
Mobile Military
Cockpit Displays
IR Viewers

Avionics Color Cathode Ray Tubes

High Resolution

Sunlight Readable

Breakthrough mechanical design has resulted in a family of high quality shadow-mask color display tubes equally adaptable to both raster-scan and stroke-written modes of operation.

These daylight-bright high resolution ruggedized tubes are intended for electronic flight instrumentation systems (EFIS). The tubes meet or exceed the emerging requirements for EFIS display systems, including MIL-STD-810C for shock and vibration.

The Tektronix Avionics Display organization will quote, upon request, design iterations involving phosphor composition, tube size and shape, and complete assemblies.

For further information call:
Avionic Displays
Tektronix, Inc.
P.O. Box 500, D.S. 48-255
(503) 627-6882
Telex: 151754
TWX (910) 467-8708

Monochrome Cathode Ray Tubes

High Brightness
Proprietary high beam current electron gun design and optimized phosphors provide a unique combination of brightness and resolution. A brightness of 3500 foot lamberts at 768 x 1024 resolution is achievable in a 9 inch display.

A clam shell yoke design and low grid drive capacitance gives low power consumption and high deflection sensitivity.

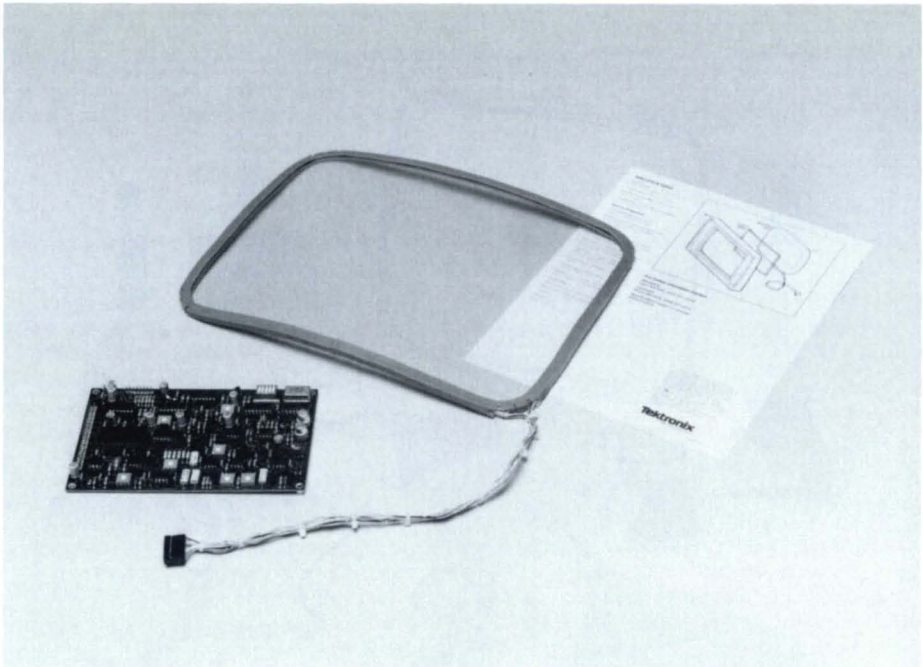
High Resolution Direct View
Our unique electron gun design, dynamic focus and astigmatism correction elements provide optimum resolution over the whole screen.

Resulting spot sizes, 2048 x 2730 addressable pixels, approach the resolving power of the human eye at a viewing distance of 24 inches. Our patented low-capacitance grid structures allow the display designer to utilize this resolution capability.

Ultra High Resolution
Tektronix state of the art capabilities in phosphor formulation and deposition provides the low blemish, high uniformity screens necessary for critical display applications. Spectral output can be optimized for photographic and other requirements.

Our gun designs are capable of achieving spot sizes of less than 0.001 inch in screen sizes up to 9 inches. Internal correction elements maintain a uniform spot size over the entire screen.

Customer Support
Monochrome CRTs
Tektronix, Inc.
P.O. Box 500, D.S. 46-539
(503) 627-6868
Telex: 151754
TWX (910) 467-8708



TekTouch™

Rugged Interactive Panel

High Touch Resolution

High Transmissivity

Rugged and Reliable

Simple Data Link

Low Cost

TYPICAL APPLICATIONS
Process Control
Automatic Teller Machines
Public Information Kiosks
Medical Monitoring
Test and Measurement Instrumentation

Description and Capabilities

What does it do? TekTouch provides simple interactive communication between a human operator and an electronic system. Versatility of the TekTouch communication link allows easy access to even the most complex data input requirements. TekTouch may be easily installed over any monitor or display device or used as a separate input position sensing unit.

How does it work? TekTouch consists of a thin, continuous, transparent layer deposited on a glass panel. The touched position is determined by measuring changes to a small ac signal applied to the touch panel. These changes are due to the added impedance of the operator's body.

High Performance

TekTouch's thin screen construction eliminates many visual distortions commonly found in touch panels that use other technologies. In addition, TekTouch has a touch resolution of 256 x 256 addressable points, and its transmissivity of 85% allows excellent optical clarity.

Low Cost

This technology allows low system cost, as one electronic controller package can process touch position information for most panel sizes.

Use

TekTouch simply mounts under the present CRT/monitor bezel, requiring only about 0.13 inch clearance perpendicular to the display surface. The driver electronics can be mounted on a conventional PC board or integrated into a specially designed hybrid circuit.

Unlimited Uses:

- Menu selection
- Interactive graphics
- Identification of portions of displayed graphics for further manipulation
- Can be used with some gloved operator applications
- Function key replacement on keyboard
- Reprogrammable soft keys for display front panel or as existing keyboard extension

TekTouch does not rely on stationary or rotating light beams, has no moving parts, and is not subject to dust intrusion. It does not extend laterally past existing display tube dimensions.

CHARACTERISTICS

GENERAL

Size range — 5 to 14 inches on a side (flat or curved).

Thickness — 0.125 inch.

Active Touch Area — Within 0.5 inch of bezel edges.

Touch Resolution — 256 x 256 addressable locations.

Weight — 4.5 oz (9 inch panel).

Screen Construction — Continuous transparent film on single glass panel.

OPTICAL PROPERTIES

Transparency — 85% transmissivity at 520 nm (with antiglare-etched surface).

ENVIRONMENTAL

Moisture — Withstands high humidity environments; highly resistant to the corrosive effects of perspiration, beverage spills, etc.

Temperature — Operating: −15° to +55°C. Storage: −62° to +85°C.

Relative Humidity — Operating: 95% at 55°C.

Altitude — Operating: Sea level to 4500 m (15,000 ft). Nonoperating: Sea level to 15 000 m (50,000 ft.)

Vibration — Operating: 0.635 mm (0.025 in) p-p, 10-55 Hz. Nonoperating: 1.27 mm (0.05 in) p-p, 10-55 Hz.

Shock — Operating: 50 g peak acceleration. Nonoperating: 100 g peak acceleration.

Cleaning — Cleanable with commercially available glass cleaners and laboratory solvents.

Abrasion Resistance — Conductive film is harder than glass substrate.

COMMUNICATIONS

RS-232C Interface —
Information Rate: 110 to 19,200 baud.
Data Structure: X,Y,Z; no parity output.
Transmission Code: ASCII asynchronous.

Parallel Interface —
Data Structure: 8-bit data with strobe and ready/busy lines.
Transmission Code: Binary.

Data Transmission Modes —
- Send data on make of touch.
- Send data on break of touch.
- Continuous transmission of data.

Controller —
- Standalone microprocessor-based.
- 20 ms typical response time.

Specifications subject to change without notice.

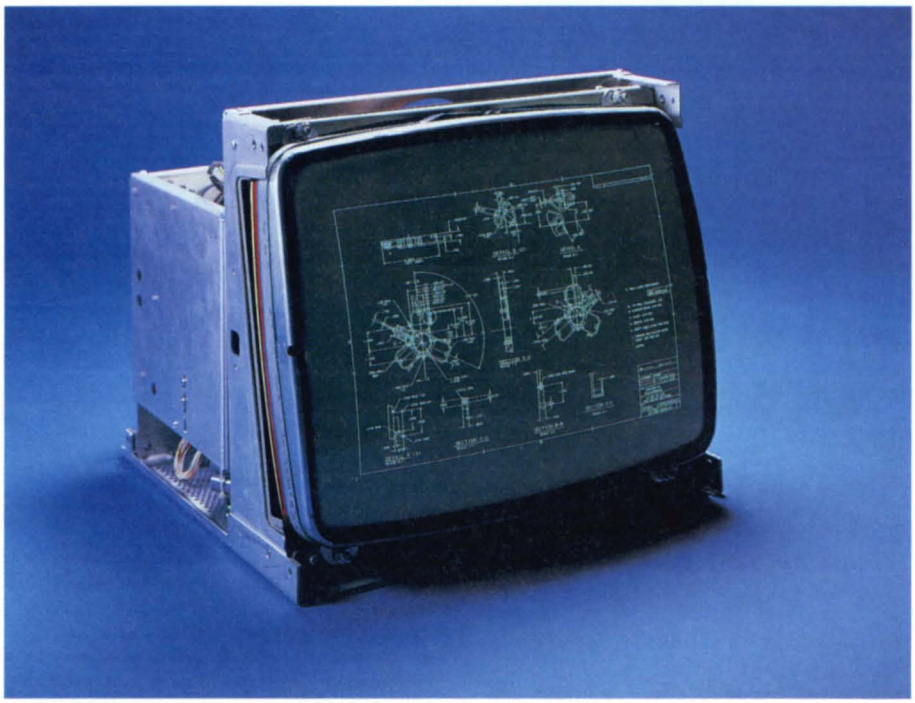
EVALUATION KITS

Standard — Panel with standalone controller and power supply. RS-232C or 8-bit parallel interface.

Custom — For custom shapes, resolution, interface, and specific environmental concerns, consult Tektronix for quotation.

FOR FURTHER INFORMATION

Contact:
Marketing & Sales
Display Devices Operation
Tektronix, Inc.
P.O. Box 500, D.S. 46-539
Beaverton, Oregon 97077
(503) 627-6868



GMA201

Monochrome Raster Display Monitor

High-Resolution Video for the System Builder

Bright, Stable Noninterlaced 60 Hz Refresh

200 MHz Video Amplifier Bandwidth

ROM-Based Dynamic Focus

Modular Construction for Easy Field Service

Unparalleled Raster Scan Video Performance

The GMA201 is an OEM product that is well-suited to system builders in the fields of gray-scale imaging, CAD/CAM, computer-aided publishing, document retrieval, and related technical applications that require extremely high performance.

Key features of the GMA201 monochrome display include 1536 vertical by 2048 horizontal addressable pixels, digitally adjusted focus and astigmatism correction provide a crisp, well focused beam at all points on the screen over the entire range of gray-scale. A patented low capacitance gun structure was developed to address the requirements for small uniform spot size, rugged construction and low power dissipation. The flicker-free 60 Hz (75 Hz optional) noninterlaced refresh rate, high bandwidth 200 MHz amplifier and contrast enhancement panel affords maximum image fidelity. The GMA201 complies with worldwide safety and emissions standards.

We know that your systems can only be as reliable as the components that go into them. For that reason we place a premium on dependability. We produce products that will keep you and your customers satisfied and your service costs down.

Consider the advantages of working with Tektronix—built-in reliability, measureable value, extensive service and support. Your local Tektronix OEM representative will show you how to profit from a partnership with Tektronix.

CHARACTERISTICS

DISPLAY

Addressable Area — 267 mm x 356 mm (10.5 in x 14 in).

Addressable Resolution — Up to 1536 pixels x 2048 pixels at 60 Hz noninterlaced.

Aspect Ratio — 3:4 nominal.

CRT Orientation — Long axis horizontal.

Brightness — 100 cd/m² (30 fL) with installed contrast enhancement filter.

Geometric Distortion — Incremental nonlinearity: ±3% at 25°C. Positional Accuracy: ±1% of image height. Peak-To-Peak Line Variation: ±5%.

Spot Size — 7.5 mils (0.19 mm) center screen (maximum). 9.0 mils (0.23 mm) corners (maximum).

Focus, Astigmatism — Dynamically controlled, digitally adjusted using ROM look-up table.

Phosphor Type — WW (P4).

Compliance — UL, FCC, VDE (with Option 23).

VIDEO AMPLIFIER

Bandwidth — Dc to 200 MHz (−3 dB)

Pulse Response — $T_r \leq 1.75$ ns. $T_f \leq 1.75$ ns.

VIDEO INPUT

Interface — Linear, dc coupled.

Impedance — 50 Ω.

Recommended Input Signal Rise and Fall Time — ≤1 ns.

Level — Black = 0 V, white = +1.0 V.

Maximum Nondestructive Input — +5 V, −2 V.

SYNC INPUTS

Interface — TTL Compatible, falling-edge triggered.

Horizontal Sync — 93.6 kHz, ±2% standard (64 kHz or 78 kHz optional).

Vertical Sync — 60 Hz standard (75 Hz optional).

Vertical Retrace Time — ≤ 250 μs.

Horizontal Retrace Time — ≤2 μs.

AC POWER

Range — 87 V to 128 V, 174 V to 256 V, all at 48 Hz to 63 Hz.

Power Consumption — 150 W maximum.

CONDITION INDICATORS

Scan fail, low-voltage power supply, high voltage power supply.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	447	17.6
Height	389	15.3
Depth	485	19.1
Weight≈	**kg**	**lb**
Net	25.0	55.0

ORDERING INFORMATION

GMA201 Monochrome Raster Display Monitor **$3,695**

Includes: Service manual (070-5079-00).

OPTION

Option 23*1 — Cabinetry and CRT Bezel. **+$870**

Option 30 — 64 kHz Horizontal Sync. **NC**

Option 32 — 78 kHz Horizontal Sync. **NC**

Option 38 — 75 Hz Vertical Sync. **NC**

INTERNATIONAL POWER PLUG OPTIONS

Option A1 — Universal Euro 220 V, 50 Hz.

Option A2 — UK 240 V, 50 Hz.

Option A3 — Australian 240 V, 50 Hz.

Option A4 — North American 240 V, 60 Hz.

Option A5 — Switzerland 220 V, 50 Hz.

**1 Option 23 includes a standard North American 115 V power plug. Option 23 is required to order A1-A5 power plugs.*

Option 23

Special pricing, terms and conditions are available to qualified OEMs. Contact your local Tektronix representative for complete information.

600 Series Monitors

General Purpose, Economical X-Y Displays to Very High Resolution X-Y and Raster Displays for Critical Applications.

606B Monitor

Very High Resolution X-Y Display for Applications Requiring the Most Critically Sharp Photographs and Displays

The critically sharp and detailed imaging provided by the 606B is particularly well suited for photographic recording applications in medical gamma camera systems and multi-imaging systems. It can also provide superior imaging in such applications as electron microscopy, and radiation and thermal scanning systems. When image stability, gray scale performance and brightness uniformity are critical to the quality of measurement or the accuracy of a medical diagnosis, you need the consistent performance and high reliability of the 606B.

608 Monitor

High Resolution with Ambient-Light Viewing

Expansion-Mesh-Halo Suppression

Excellent Gray Scale

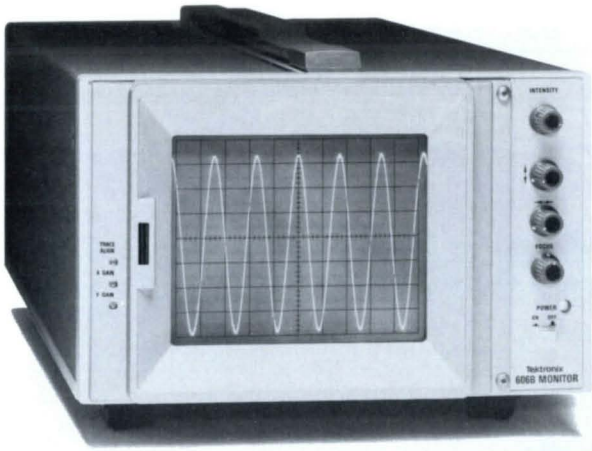
High Brightness

The 608 is a high quality directed beam viewing monitor. It is extremely well suited for high peformance display applications, such as medical and military imaging and electronic instrumentation. The 608's high usable brightness of up to 240 cd/m² (70 fL), 0.26 mm (10 mil) spot size, and a large 9.8 x 12.2 cm screen all combine to give you optimum viewing capability. The 608 produces detailed displays that are easy to read in high ambient light. The crisp high brightness image also yields high quality photographs when an appropriate camera is utilized.

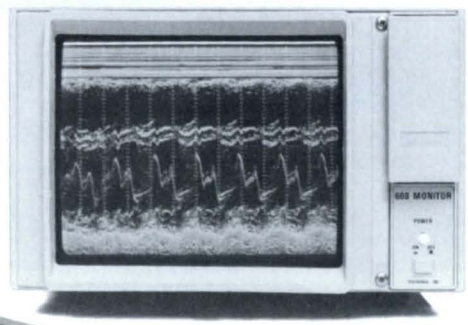
620 Monitor

General Purpose, Economical, X-Y Waveform Display

The 620 can be used in demanding applications requiring an economical, solidly performing X-Y waveform display. Electronic instrumentation applications include pulse height, network, spectrum, logic and signal analyzers and digitizers. The 620 can also be used in mechanical measurement instruments for vibration tests and NDT. In the medical field it can be used for A-mode imaging. The 620 offers a spot size of 0.38 mm (15 mils), a 10 x 12 cm screen, and usable brightness up to 100 cd/m² (30 fL).



606 Option 06



608 Option 23

620 Option 23

KEY SPECIFICATIONS FOR X-Y DISPLAYS

	606B	608	620
Spot Size*1	0.08 mm (3.1 mils)	0.26 mm (10 mils)	<15 mil <25 mil at max drive
Display Size	8 cm x 10 cm	9.8 cm x 12.2 cm	10 cm x 12 cm
Acceleration Potential	5.5 kV	22.5 kV	12.0 kV
Bandwidth, X-Y*2	>3 MHz	⩾5 MHz	⩾2 MHz
Bandwidth, Z*2	5 MHz	⩾10 MHz	⩾5 MHz
Rise Time	<35 ns	⩽35 ns	
Input R and C, X-Y*3	1 MΩ ± 1% or 50 Ω||<47 pF	1 MΩ|| ⩽60 pF	1 MΩ <47 pF
Input R and C, Z*3	1 MΩ or 5 MΩ	1 MΩ ⩽60 pF	1 MΩ <47 pF
X-Y Phase Difference	1° to ⩾500 kHz	⩽1° to 1.5 MHz	⩽1° dc to 500 kHz
Recommended Source Impedance, X-Y and Z	<10 Ω in 1 Ω pos.	⩽10 kΩ	⩽10 kΩ
Temperature Range	0°C to 50°C	0°C to +50°C	0°C to +50°C
Power Requirements*4	75 W	61 W	See footnote*4
Included Accessories		Lined external implosion shield (graticule) for adjustment purposes.	Lined external implosion shield (graticule) for adjustment purposes.
Recommended Cameras	C-30BP, C-5C Opt. 01 C-7 Opt. 01	C-5C Opt. 01, C-7 Opt. 01 C-59A	C-5C, C-5C Opt. 01 C-7 Opt. 01

**1 Measured at 0.5 μA, except for the 606A, measured at 0.1 μA.*

**2 Full spec would read: "dc to . . ." appropriate figure.*

**3 "||<" means "paralleled by less than".*

**4 Line voltage selector allows operation from 100 V, 110 V, 120 V, 200 V, 220 V, and 240 V (±10% on each range). 48 Hz to 440 Hz (except the 624 which excludes 220 V). Number given shows watt max at nominal line voltage. The 620's power requirements are 90 V ac-132 V ac; 48 Hz-440 Hz line frequency, 22 W max, 0.2A at 120 V ac 60 Hz.*

NEW 634/634LC Monitors

High Resolution Video Display for Critical Applications (1400 Lines, Shrinking Raster)

The 634 raster scan monitor delivers extremely high quality video images for both viewing and photography. Applications include: medical diagnostic imaging, military infrared imaging, and automated test systems. The 634 has been specifically designed to deliver the superior performance required to meet those demands.

The 634LC offers an economical version of the raster scan 634. The power supply and user controls have been deleted. The user needs to furnish dc input power (+23, −22, +9 unregulated). All controls are accessible via pin connectors at the rear of the monitor.

KEY SPECIFICATIONS

Video Display		634 634LC	634 Opt. 01 634LC Opt 01
Display Size		9 cm x 12 cm (flat screen)	
Resolution*[1]	Worst Case	1100 line	650 line
	Nominal	1400 line	800 line
Position Accuracy/ Nonlinearity		≤0.5% within 9 cm circle. ≤1% in corners. For Option 01: 1% within 9 cm circle, 2% at corners	
Brightness		515 cd/m² (150 fL) max.	
Brightness, Nonuniformity		Less than ± 10%	
Bandwidth		1 Hz-10 Hz std. 20 MHz Video bandwidth available as Option 14.	
Recommended Cameras		C-5C Opt. 01, C-7 Opt. 01, C-59A.	

[1] Merged raster lines.

Note: Standard 634 accepts the line/field rate of 625/50. Discrete line rates of 675/60 through 1083/60 can be accommodated using Option 15. Option 15 is factory calibrated at 1029/60.

Special pricing terms and conditions are available to qualified OEMs. Contact your local Tektronix representative for complete information.

Tektronix, Inc.
Marketing & Sales
Display Device Operations
P.O. Box 500
Beaverton, OR 97077
(503) 627-6868

634 Option 06

ORDERING INFORMATION

606B Monitor (without handle, feet or covers) **$4,780**
608 Monitor (without handle, feet or covers) **$2,935**
620 Monitor (without handle, feet or covers) **$1,710**
634 Monitor (without handle, feet or covers) **$3,500**
634LC Monitor (without handle, feet or covers) **$2,240**
Recommended Cameras — C-5C Option 01, C-7 Option 01, C-59A.

	606B	608	620	634	634LC	Description	Price
Option 01		✓	✓			Internal Graticule	NC
Option 01				✓		Resolution of 800 Line Nominal, 650 Worst Case	−$150
Option 01					✓	Resolution of 800 Line Nominal, 650 Worst Case	−$155
Option 06			✓			UL 544 (Includes Handles, Feet and Covers)	+$100
Option 06				✓		UL 544 (Includes Handles, Feet and Covers)	+$105
Option 06	✓					UL 544 (Includes Handles, Feet and Covers)	+$125
Option 07	✓					Screwdriver Front Panel Controls	+$30
Option 09	✓	✓	✓	✓		UL 544 Component Recognized	NC
Option 10		✓	✓			25-Pin Remote Program Connector	+$55
Option 12		✓	✓			GM (P7) Phosphor with Internal Graticule	+$65
Option 13				✓		Reverse Video	+$85
Option 14				✓		20 MHz Video Amplifier	+$145
Option 15				✓		Variable Line Rates	+$280
Option 15					✓	Variable Line Rates + 20 MHz Video Amplifier	+$600
Option 16				✓		25-Pin Video Input	+$55
Option 20			✓ (6, 31)*[1]			Ac Delete	−$20
Option 21		✓				Full Differential Inputs	+$60
Option 22		✓				Extended Gain Range	+$45
Option 23		✓ (28)*[1]	✓ (6, 28, 31)*[1]			Handle, Feet and Covers	+$110
Option 24		✓				Linearized Z-axis	+$75
Option 25		✓				TTL Blanking	+$75
Option 25			✓			TTL Blanking	+$50
Option 28	✓ (6)*[1]	✓ (23)*[1]	✓ (6, 23, 31)*[1]			Covers Only	+$90
Option 29		✓				Metal Bezel	+$70
Option 31			✓			Delete all Rear BNC's, Dc Power Connector and Ac Power Supply and Switch	−$25
Option 76		✓	✓			GM (P7) Phosphor	+$65

[1] Not available with these options.

The 4120 Series Color Graphics Workstations provide 2D graphics, 3D wireframe and 3D shaded surface modeling systems.

The 1241 Logic Analyzer's color interface quickly guides your eye to the most relevant information.

TEK Means . . . Getting the Picture

with color enhancement, the power of intelligence, system integration, software and more . . .

Display Technology—An Integral Part of Our Business

For over forty years, Tektronix has designed and manufactured advanced electronic products, starting with cathode-ray oscilloscopes. Our innovative design efforts developed features such as the flat-faced CRT, the direct-view storage tube (DVST), the high-resolution liquid crystal shutter display (shown above), and the microchannel-plate CRT. The latter is incorporated in our 7104 "Gigahertz" oscilloscope, which remains unapproached in bandwidth and performance after six years in the marketplace, and in the R7103 and *NEW* 2467 oscilloscopes.

We're the Leader

We placed affordable graphics in the hands of engineers and scientists in 1971, using our experience in DVST design (in lieu of the then high cost of computer memory). Our PLOT 10 software early on became the *de facto* standard. Today, Tek PLOT 10 is installed on more computers than any other graphics utility library in the world. Our up-to-date graphics line covers a broad spectrum of needs.

Color aids in differentiating dense graphics. Displays with default color tables (and color interfaces to modify colors to your specific application) eliminate viewability problems. Our Imaging Research Lab is developing standards based on human perception and reaction to color.

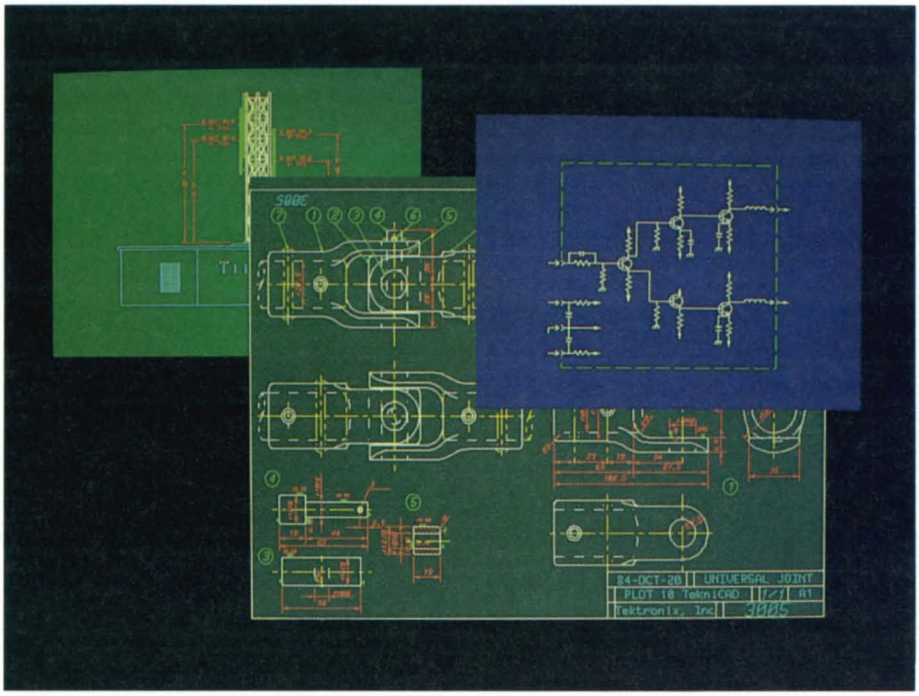
Meeting Expanding Customer Needs

Our products are developed to fill your needs. Tek continues as an industry leader for product line breadth, range of price/performance options, and service support. Tek innovation, reliability and flexibility are built into all our products, which continue to set standards around the world.

Our Products Have a Lot to Display

Computer graphics is no longer constrained to simply drawing pictures or plotting data, but is emerging as an effective, efficient human interface to computers.

The high quality graphics capabilities that were made available to an extensive line of host-based graphic terminals are now avail-



Tektronix PLOT 10® TekniCAD

able in our powerful intelligent workstations. Tedious manual digitization of engineering drawings is eliminated with a Tek graphic input workstation. And, Tek color copiers produce hard copy with resolutions that exceed terminal resolution. Our expanded line of artificial intelligence family increases productivity in many areas of Research and Development including expert systems, natural languages, and automatic programming. Our color terminals enhance operation in a number of areas, such as single keystroke access to the powerful TNIX operating system and Tek's microcomputer design tools. Here, soft-keys simplify command entry and minimize keystrokes. A choice of color terminals is also offered for our acquisition/processing measurement systems. Our newest spectrum analyzer even provides a CRT display of operator "helps," in a choice of plain English, plus optional French, German, or Spanish. This year, more than any other, we've got a lot to display.

Color Perception

The physiological fact behind color's continued success in displays is that the brain has two separate channels for processing visual information: one chromatic, the other achromatic. In many instances, data from both processing channels is used to interpret an image. An achromatic display deprives the operator of one entire visual data channel. Without this chromatic data flow, the brain's processing power is reduced, especially when interpreting complex visual information. The use of color substantially improves the readability of electronic instrument displays.

Color is particularly beneficial when viewing a complex display with high information density.

First, color can be used to organize information into logical groupings. High-priority items can be coded one color and low-priority items another.

Second, color can be used to locate information. This is especially useful when small but important items might be visually lost in a mass of other information.

Third, color can attract attention. Finding a single element in a complex array is easy when a color difference exists. A specific color can be associated with a particular class of events, such as red for warning or yellow for critical information. Color also allows a single instrument to function in different modes with a particular color unambiguously signaling the mode.

Fourth, color definitely has a high aesthetic appeal which reduces the monotony of prolonged display viewing. Although only subjective reports substantiate this aspect, color appears to enhance productivity by reducing boredom and fatigue.

Ergonomics of Color

Through technical improvements and cost reductions, color has now become a potentially powerful tool for improving the instrument/user interface. Yet, the misuse of color can make the interface more difficult instead of easier.

Color is a product of human perception, the result of the eye reacting to "visible" wavelengths of electromagnetic radiation. The optical and sensory mechanics of the eye give color its three basic qualities:

Hue, which identifies the color in relation to other colors in the spectrum, such as red, yellow, green, etc.

Saturation, which defines the "purity" of color. As spectral colors become less pure, they appear more gray or white.

Lightness, which refers to the relative strength of the light coming from the color, as perceived by the observer.

As the wavelengths of visible light change, the eye perceives a changing hue that produces the familiar spectral colors, ranging from deep red through yellow, green, and blue to purple. At any given wavelength, a "pure" color is produced that yields maximum saturation. Pure colors can be desaturated by increasing lightness until the color is "washed out."

Color distribution and saturation play an important part in color perception. Colors widely separated in the spectrum, such as red and green, are much easier to discriminate than neighboring colors. Also, "grayish" colors of low saturation become difficult to separate. On the other hand, highly saturated colors that are also widely separated in hue require the eye to refocus, which can be a source of fatigue. Another important consideration is that the eye's foveal region, which yields maximum visual resolution, is essentially "blind" to the color blue, making it a poor choice for presenting detailed information.

Color Display Characteristics

Image quality and information handling capability are the two broad categories of characteristics that are important to users of color displays. Image quality includes optical characteristics like resolution, edge sharpness, brightness, contrast and color quality. Environmental "noise" can cause undesirable optical characteristics of displays, such as flicker, jaggies, and moire patterns. Information handling capability includes characteristics like display size, number of vectors or pixels, and number of colors.

Resolution

The quality of the image is strongly affected by the resolution of the display system. However, the term resolution is often used synonymously with the number of scan lines (addressability) in discussions of raster displays. Resolution refers to the display's ability to resolve or separate two closely spaced points, lines, or spatial frequencies. Resolution is the essential characteristic that determines image sharpness.

The resolution of a display comprises a combination of elements including spot size, spot profile, dot spacing, number of scan lines and bandwidth. Addressability, on the other hand, refers to the display's ability to position lines or pixels anywhere on the screen. A display may have addressability that exceeds its resolution capability and so will not affect the resolution of the display. However, if the addressability is not high enough, it will affect the resolution of the display in complex images.

Color Display Technology

The CRT is the most important factor in determining characteristics of a color display. Tektronix color display technology produces three basic types of CRTs: the shadowmask CRT, the liquid-crystal (LC) CRT System, and the Direct View Storage Tube (DVST). The choice of CRT and display system is determined by the user's needs and application. For any particular color display application, the user is concerned with image quality and information handling capability relative to that application.

Information Handling Characteristics

- **Size**

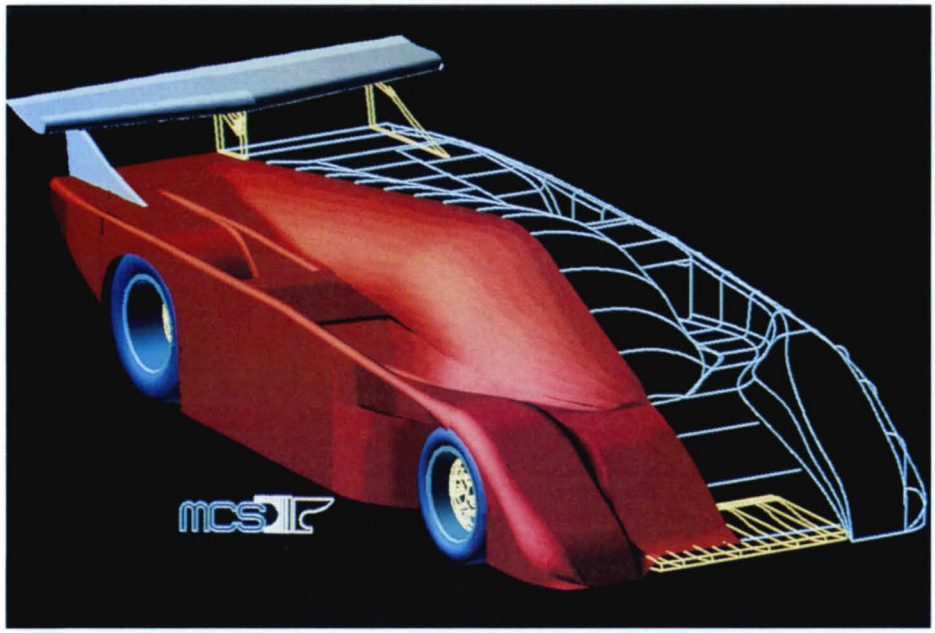
  The ultimate size of color displays using DVSTs and shadow-mask CRTs is about 636 mm (25 inches) diagonally. The DVST can also be made quite small (152 mm or 6 inches) and still provide a large number of vectors because the spot size can be scaled down accordingly. The number of vectors in the color refresh mode is not limited by the resolution, but by the deflection speed required to write the vectors at a flicker-free rate. To display a large number of vectors, the deflection system must have a very high bandwidth, usually at the expense of power. However, the DVST avoids the need for high power with large numbers of stored vectors, though it faces the same trade-off for the refreshed color vectors.

- **Number of Colors**

  The DVST with Color Write Through (CWT) has a maximum of three colors. Only the shadow-mask CRT offers a full range of colors. The color capabilities of a shadow-mask CRT are usually determined by the choice of phosphors for the three primary colors.

  The DVST with CWT is very useful where complex images are to be displayed and color is needed only to highlight areas of the display. The shadow-mask raster display is by far the most prevalent type of color display in use today.

  An attractive feature of a color terminal is its ability to display images in the desired colors. But how does one go about selecting a specific color and describing it to a terminal in meaningful, precise terms? Interactively, the user specifies a color and the terminal displays it. The user evaluates the displayed color and corrects it if necessary.



High resolution graphics to fit today's and tomorrow's needs. The 4120 Series Workstations offer capabilities from 2D and 3D wireframe to 3D shaded surfaces. MCS ANVIL-5000 software is shown being used here.

Direct-View Storage Tube

Both the DVST with CWT and shadow-mask types of color displays reflect and scatter about the same amount of room light, so display contrast is determined by trace brightness. Display contrast can be improved by placing a filter in front of the display screen that will attenuate the emitted light less than the reflected light, which must make a double pass through the filter. Selective filters are also used to absorb room light while transmitting the emitted light from the display. Antiglare screens, which have either a special coating on the front surface or a matte finish to prevent specular reflections, are also used to improve display contrast.

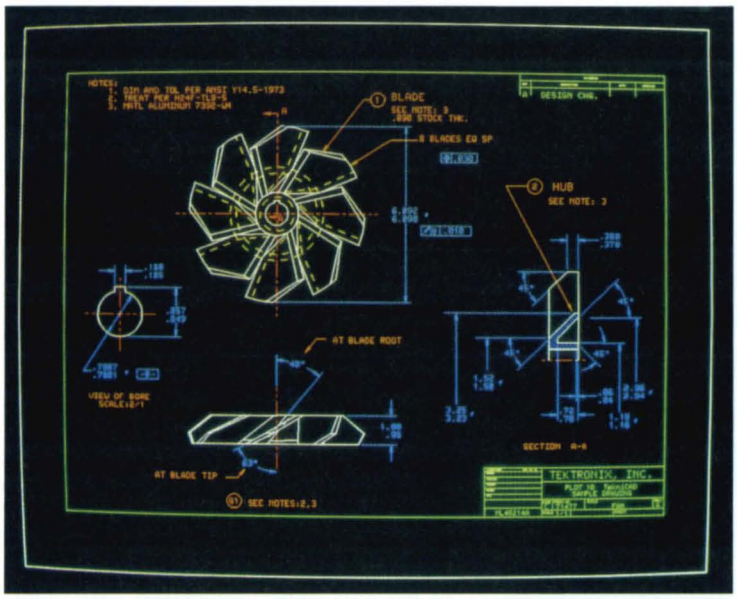
High-Resolution Displays

One of the most important factors in the recent evolution of computer graphics has been the emergence of high-resolution, low cost raster displays. We've overcome the problem of CRT flicker with 60-Hz noninterlaced monitors. Raster technology is pushing the limits of human perception.

In other systems (e.g., home television), an interlaced raster is used. An interlaced display scans every other line in the first pass from top to bottom, then returns to the top and scans the intermediate lines in the next pass. A color image is drawn on the screen by the display system, which determines when each of the three electron guns receives current, and how much, and thereby how much of each color is produced at each point (pixel) on the screen.

When a shadow-mask CRT is used in graphics applications, a bit-map memory is used to store the image. The pixel information from the bit map is read out to the three electron guns in synchronism with the raster pattern of the beams. To produce an image on the CRT screen, the desired vectors and other shapes must first be converted into the proper pixels in the bit map using a scan conversion process. Algorithms are used to code the various shapes into several digital bits, representing the brightness desired at each pixel location on the screen.

Information in the bit map must be read out repeatedly to the CRT at a rate fast enough to avoid flicker. Therefore, the time required to change images on the screen is determined by how fast the scan conversion process can reload the bit map. The larger the bit map, the slower the reloading process; thus, raster images with a large number of pixels must trade off speed of interaction. As the number of pixels increases, so does the rate at which information is clocked out of the bit map. The deflection speed of the CRT beam and the bandwidth of the CRT video amplifier must increase accordingly. Deflection speed and video amplifier bandwidth ultimately limit the number of pixels possible.



Shadow Mask CRT

The shadow-mask CRT is the most commonly used type of CRT for color displays. In fact, the shadow-mask CRT is the type used for home television and for studio television picture monitors. Usually, three electron guns are used to address three primary color phosphor dots or stripes. The dots are spaced close enough so they appear as one. Colors other than the three primary colors result from proportional mixtures of the indivdual dots. A shadow mask is used to make sure that each beam addresses only its assigned color dot. The beams from the red, green, and blue guns must pass through the mask openings at the proper angles to strike their corresponding phosphor dots.

The three beams are deflected together over the phosphor screen in a raster pattern.

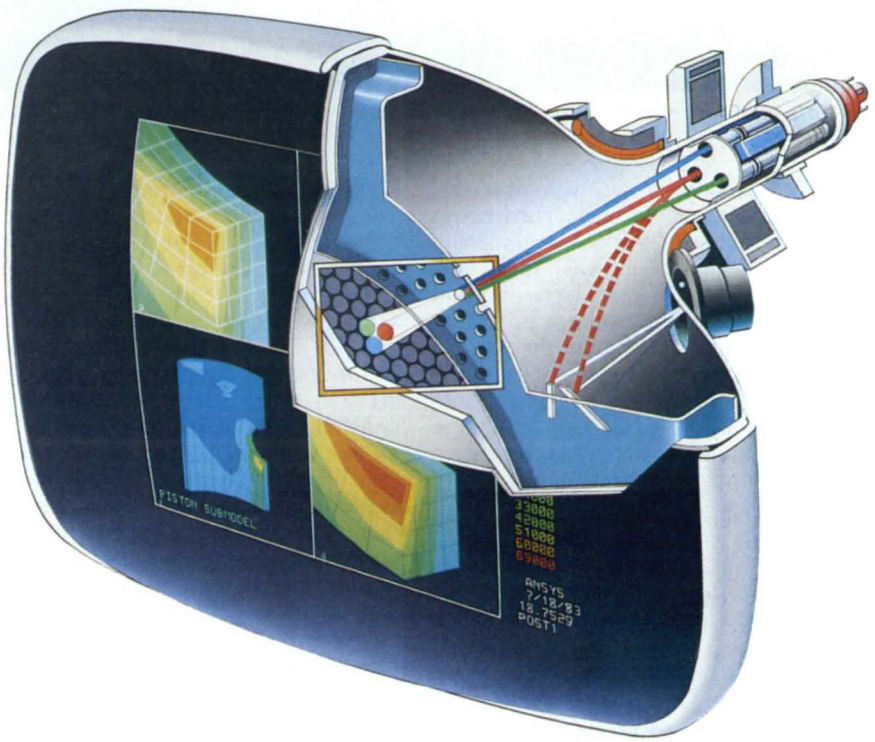
Color Purity and Convergence

Color purity generally refers to the uniformity that a color has over a large area of the display screen. Purity is a measure of whether or not the primary colors selected by the individual beams are spectrally pure. If some electrons meant for the red dot impinge upon the green dot, then the primary color is not pure. Purity is not really much of a problem in shadow-mask CRT displays. Each of the three beams should excite the entire phosphor dot when the beams pass through the shadow-mask holes properly.

High resolution displays introduced another new problem: *misconvergence*. When the display is not properly converged, a line written as yellow, for example, comes up with a red and green fringe on either side. Misconvergence which was simply annoying on the previous new generation of high resolution displays has become a source of potential misinformation on the new generation of high resolution displays. In fact, the convergence specification over the entire active area of the display becomes the effective resolution limit. That is, a 1000 line display is not useable as such unless the convergence specification ensures no detectable misconvergence anywhere on the screen.

Autoconvergence

The 4120 Color Graphic Workstations contains a first-of-its-kind convergence feature that automatically corrects the natural drift occurring in the convergence of the color raster writing beams (shown above). Convergence is controlled to within 0.2 mm over the entire display area, resulting in sharper characters, lines, and colors. Technical skills are not required to maintain optimum convergence.



The 4120's patented AutoConvergence is accomplished by applying non-parallel indexing phosphors at precise angles and positions at the rear of the CRT shadow mask.

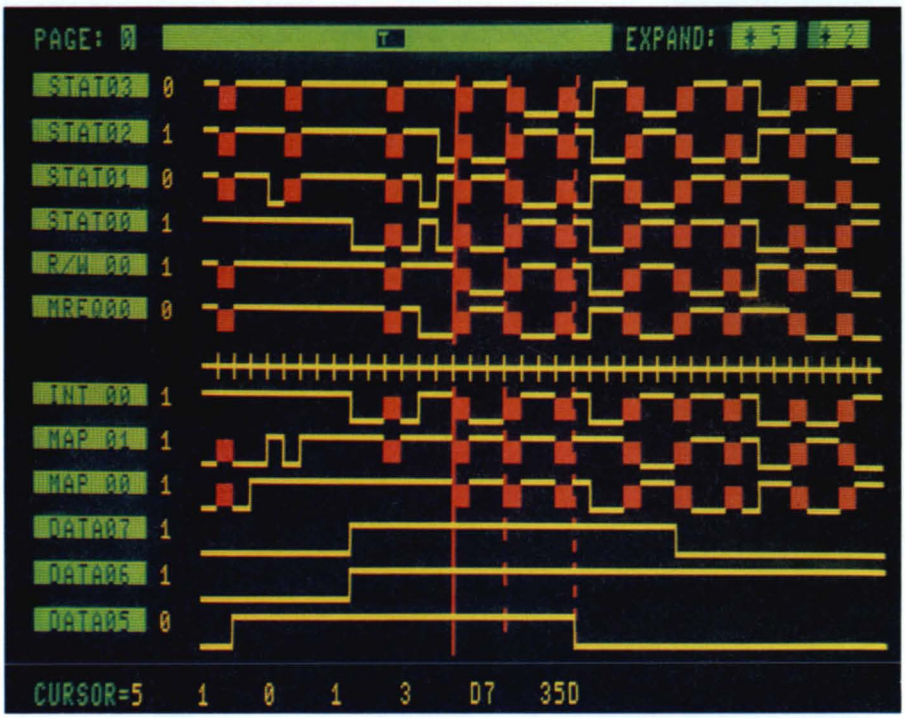
Dynamically Converged Display

Dynamic convergence correction adjusts as the electron beam scans, providing convergence accuracy of 0.3 mm over the entire display area.

Liquid-Crystal Color Display

A method of producing color displays without shadow masks, color-dot phosphors, or any of the other usual techniques has been developed by Tektronix. Based on a combination of liquid-crystal and cathode-ray tube technologies, this LC/CRT system combines a black and white or "monochrome" CRT and a liquid-crystal "color

Liquid-Crystal Color Display (the Color Shutter)



The 1241 Logic Analyzer uses the LC/CRT system to enhance the data display for easier readability and comprehension.

shutter" to produce a very-high-resolution, field-sequential color display. Functioning as a color shutter, this very fast switching device fits in front of the CRT face, thus making it practical to build high-resolution color displays into oscilloscopes and other display instruments. Because no shadow mask or patterned phosphors are used, the resolution can be as high as any monochrome CRT. This is a particular advantage in small display sizes where high-resolution color has not been practical before.

The "monochrome" CRT employed has a simple phosphor with two separate emission peaks that are orange and blue-green. The phosphor does not require any special process steps. However, the true "state-of-the-art" advance represented by the color shutter is the liquid-crystal shutter itself, which provides a three-color display (orange, blue-green, and neutral) of excellent crispness, detail, and color purity. On the 5116 color oscilloscope, the LC shutter is basically a sandwich consisting of a color polarizer, a variable-retardation liquid-crystal cell, and a linear polarizer. The LC shutter consists of two glass plates coated with indium tin oxide for the transparent conductor, a thin layer of silicon dioxide for an insulator, and a special "alignment" layer that causes the director (essentially the major axis of the liquid crystal) to tilt in the same direction on both surfaces.

Field-Sequential System

Previous efforts to produce a field-sequential system have suffered from the lack of a suitably fast color shutter. Earlier attempts at fabricating LC color shutters have used simple twisted nematic (liquid crystal) devices or dual-frequency nematic devices. The simple LC devices generally have relaxation times (essentially the time to switch from one polarization state to another) that are much longer than several milliseconds and are not suitable for fast switching applications. Flicker-free operation of a sequential two-primary-color display requires field rates of 120 Hz, for example, which in turn requires LC shutters capable of millisecond transition times for both the on and off states. Dual-frequency devices can have sufficiently fast response but require the use of drivers that must deliver a high-frequency signal into a large capacitive load.

Employing a field-sequential system with displays having cells switched at a single frequency overcomes the need for high-voltage switching, a drawback of the dual-frequency cell approach. Typical dual-frequency cells are turned on with a low-frequency burst and turned off with a high-frequency signal, while the variable-retardation cell's elements are controlled by a single frequency. As a result, the driving waveforms are simpler and the driver's power requirements are less.

In any one field the information written on the screen appears only in the color selected by the LC shutter. The field-sequential system can provide all possible mixtures of the two primary colors contained in the phosphor. Each color or information field is displayed at a 60-Hz repetition rate.

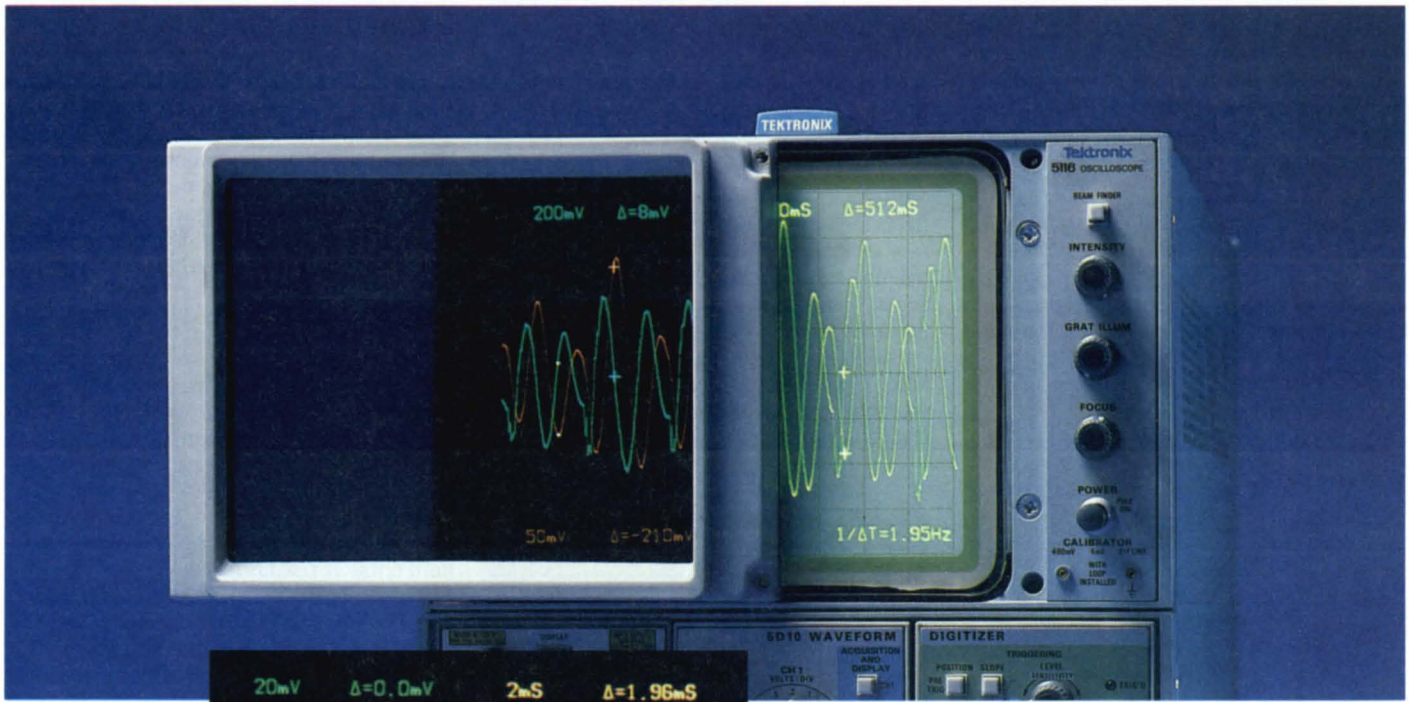
The Pi Cell

The variable-retardation cell (called a pi cell) is sandwiched between a set of red and green color polarizers and a linear polarizer at the output, and its axis is tilted 45° with respect to the polarizers. The color polarizer orthogonally polarizes the orange and blue-green components of the CRT's emission, and the pi cell is used to sequentially rotate the polarized orange and blue-green information into the transmission axis of the linear polarizer. Rotation of the orange and blue-green information is performed in synchronization with the fields of the sequentially addressed CRT. Alternate fields, viewed through different color polarizing filters, are integrated by the eye to give color images. By varying the z-axis modulation, the full range of colors that lie along the line connecting the orange and blue-green peaks of the phosphor's emission spectrum on the chromaticity diagram can be achieved.

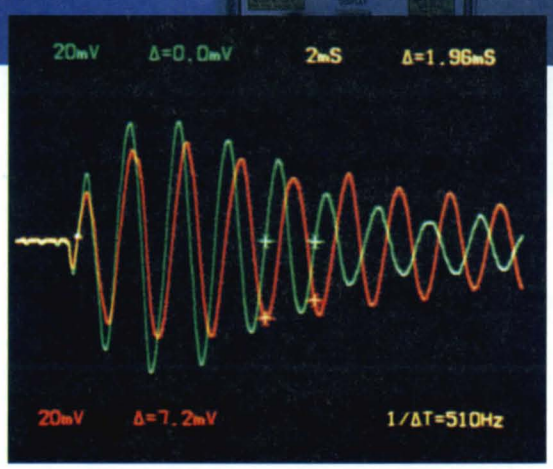
The pi cell derives its name from the pi radian amount of twist it assumes in its quiescent or undriven state. Its features are achieved by speeding the relaxation time of an already fast untwisted birefringent variable-retardation cell, whose liquid-crystal elements are homogeneously aligned.

It is advantageous to keep the cell as thin as possible, since this results in a large angle of view, but narrowing the cell too much prevents achievement of the full half-wave retardation that is required. For LC shutters, such as used in our 5116 Oscilloscope and the 1241 Logic Analyzer, there is no perceptible color shift over the normal viewing angle.

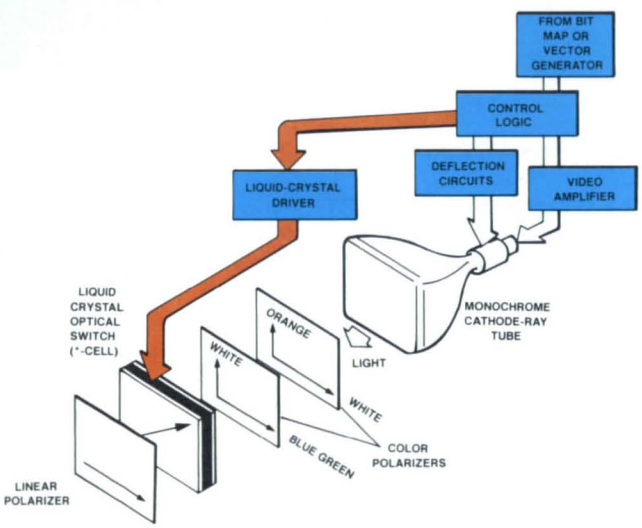
Low Cost, High Resolution, Easily Discernible Multichannel Displays



The 5116 Color Oscilloscope with 5D10 Waveform Digitizer, and the 5A26 Dual Differential Amplifier. See pages 269 and 273.



Control logic drives a liquid-crystal shutter that, by twisting light coming through two filters, lets the linear polarizer filter out emissions from a monochrome CRT. The eye integrates them into orange, blue-green, or an inbetween yellow where the traces overlap, as shown above.



High Resolution, High Contrast

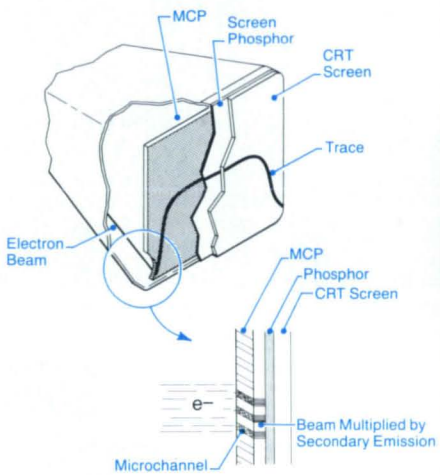
Among the LC/CRT system's advantages are high resolution over a wider range of display sizes, good contrast in high ambient light, and ruggedness, due to the absence of special shadow-mask and phosphor arrangements or complex electron guns. The LC color shutter can be used in either vector or raster displays.

The combination of the color shutter and either a diffusing or an antireflection coated front surface can yield contrast ratios of better than 20:1 in the high ambient lighting normally found in today's offices. Since all screen writing is accomplished by a single electron beam, rather than by three beams as in a shadow-mask display, the LC shutter does not have misconvergence problems. This enhances resolution and produces a very readable display of text and complex graphics.

Bringing Invisible Signals to Light

The 7104 and R7103 Oscilloscopes pioneered Tek's exclusive microchannel plate CRT technology to provide the highest writing rate available today. With the 7104/R7103, any transient signal within the 1 GHz bandwidth can be seen directly on the CRT in average room light. This trace brightness is about 1000 times that of conventional oscilloscopes.

The same technology is now available in the *NEW* 2467, a portable 350 MHz oscilloscope. With a visual writing rate of 4 div/ns, the 2467 is unmatched among portable scopes. Being able to see unexpected transients, even when masked by repetitive events, makes the critical difference in many troubleshooting situations.



Microchannel plate CRT configuration.

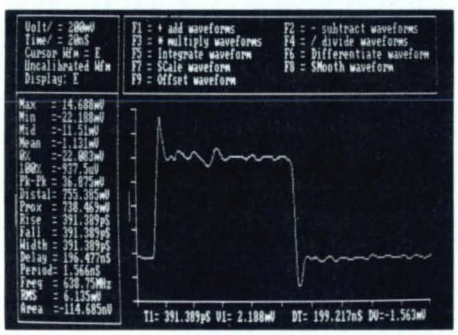
The Microchannel Plate CRT

An oscilloscope CRT based on microchannel plate technology is quite similar to a conventional CRT; the major difference is the microchannel plate (MCP) located just behind the CRT phosphor screen. The accompanying picture shows details of an MCP CRT.

The MCP uses a 0.050-inch glass plate having multiple, closely-spaced holes located directly behind the standard phosphor screen. These holes are offset from the beam axis at a 15° angle and are internally treated to promote the generation of secondary emission electrons.

When the electron beam scans across the MCP, electrons enter the holes and strike the treated sides. This causes secondary emission as it moves down the channel. The amplified electron beam exits the channel and travels the short distance to produce a trace on the phosphor screen.

Because of the channel multiplication of beam electrons, trace brightness is increased, even for extremely fast traces that would otherwise not be visible on the CRT. Individual channels of the MCP saturate in regions of high trace intensity, while maintaining full gain for less intense portions. This feature, called "adaptive" intensity, tends to normalize overall trace intensity between high and low repetition rate signals. Bright traces are limited to a safe viewing level, while the intensity of dim traces is increased for good visibility.



Waveform captured by Digitizing Camera System and displayed on PC monitor.

The World's Fastest Scope Camera

The DCS Digital Camera System combines CCD (Charge-Coupled Device) technology with advances in signal processing hardware and software to bridge the gap between fast oscilloscopes, such as the Tek 7104 and 2467, and processing and analysis tools, like the personal computer (PC).

When used with the Tek 7104 microchannel plate CRT oscilloscope (or R7103), the DCS can acquire and digitize transient (non-repetitive) waveforms at an effective sampling rate of 250 gigasamples per second, or 4 ps per sample.

The light from the scope's screen phosphor is optically coupled to the camera, which captures it on a photosensitive CCD scan-conversion target. This 490 x 384 pixel image is transferred out of the camera at a video rate for conversion by a Frame/Store board slotted in the PC. Because the waveform image is optically coupled into the CCD scan converter—essentially parallel optical sampling—the major bandwidth limit is the scope itself. On the PC, menu-driven software allows easy manipulation of the waveform for display, signal processing and analysis, hard copy output, magnetic storage, or porting to a mainframe via RS-232C or the GPIB.

DCS hardware and software work together to provide exceptional resolution and accuracy. Resolution is derived from three dimensions—a significant advance over traditional two-dimensional, or X-Y, acquisition. The third dimension, the Z axis, measures trace intensity to 8-bit resolution. When combined with the 9-bit vertical and horizontal resolution, the overall nominal resolution of the DCS is 12 bits. This resolution exceeds the resolving power of the unaided human eye by at least 10 times. The Z axis provides exact data as to the center of the trace to a degree never before possible and facilitates the averaging of noisy signals.

Waveforms can be displayed on the PC together with parametric measurements in another window. Cursors can be set along the waveform for extensive automatic waveform measurements. The camera can also be zoomed in between cursors for more detailed waveform viewing. The photo shows a fast squarewave that was captured and digitized by the DCS from a transient waveform displayed on a 7104 oscilloscope. Notice the measurement information provided along with the display and the function-key menu for further operations.

For documenting results, the PC screen can be copied to a dot-matrix printer, or direct copies of video frames or of the PC screen can be made on Tektronix video copiers.

INFORMATION DISPLAY PRODUCTS

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Tektronix has been an industry leader in information display products since it introduced the age of low cost graphics displays with the discovery of the direct-view, bistable storage tube (DVST or Anderson Tube) in 1962. Today, the breadth of the Tektronix product line, its family compatibility, peripheral support, leadership in meeting industry standards, and range of price/performance options, make Tek information display products the best equipped to meet research, engineering, business and manufacturing needs.

Tektronix provides its customers with a full range of graphics processing systems, from color graphics workstations and terminals to graphics applications systems and color printers. Reflecting a commitment to the value of effective communications in today's workplace, Tek is expanding its product line in 1986 and 1987, addressing the emerging graphics needs of our customers. Each new product addresses specific requirements for targeted applications and increased economy and performance.

INFORMATION DISPLAY PRODUCTS

Tektronix offers this combination of new and current graphics processing systems, continuing to meet customer needs for high performance targeted applications and affordable graphics support.

The *NEW* 4132 Graphics Workstation Addresses Technical, Engineering and Business Applications

The high performance 4132 workstation has the power and flexibility to implement a variety of software development, drafting, and technical data analysis applications. In addition, Tek's new window-management software, TekniVIEWS, provides the software developer with extensive windowing functions and software design aids.

4120 Series Enhanced Workstations Protect Customer Investments and Increase Performance

The 4120 Series 2D and 3D Color Graphics Workstations are enhanced to provide higher graphics and communications performance, adding more segment memory, new graphics capabilities, and faster communications.

The *NEW* Protocol Microlink™ Connects Tek Workstations to DEC MicroVAX II Systems

Protocol Microlink creates a flexible and effective communication link between these previously incompatible systems.

The *NEW* 4190 Graphics Projection Package Provides High Resolution Terminal Projection

The 4190 displays 4115B and 4120 Series screens and graphics applications, duplicating terminal resolution on a large, presentation-size projection screen.

The *NEW* 4200 Series Color Graphics Terminals Contribute to Manufacturing Productivity

The Tektronix 4200 Series Color Graphics Terminals contribute to increased productivity in the manufacturing environment with affordable and multipurpose color graphics terminals. They offer extensive software compatibility, advanced local graphics capability, and sturdy construction, for use in a full range of workplace environments.

4696/4692 Color Graphics Output Systems Increase Quality and Productivity

Tek combines its *NEW* 4696 Color Ink-Jet Printer (or the 4692 Color Graphics Copier) with the Color Graphics Rasterizer to provide a cost-effective system for high quality color copies for technical and business users.

A full line of hard copy units and two graphics tablets are offered.

Tek continues the 4100A Series Color Graphics Terminals, providing high performance support for advanced graphics capabilities.

Tek also offers its line of PLOT 10® graphics software and applications, providing complete utilities as well as computer-aided drafting, presentation, and window management systems.

Tek continues the 4400 Series artificial intelligence system and our complete offering of AI languages. The *NEW* 4400 UNIX EMACS Editor and the *NEW* 4944 Mass Storage Unit meet customer needs for program editing and storage facilities.

Finally, as always, we offer a complete range of graphics supplies and support.

Microlink is a trademark of Tektronix, Inc.

4200 Series Terminals.

NEW 4200 Series
Color Graphics Terminals

Multipurpose Terminals With Advanced Alphanumeric and Color Graphics Features

Compatible With Tek 4100A Series Terminals

Tek announces a price breakthrough in color computer graphics terminals with the *NEW* 4200 Series. The 4200 Series replaces the 13-inch screen 4100A terminals, providing Tek graphics standards with advanced features and at more affordable prices. The 4200 Series offers a range of fully compatible color graphics terminals. The 4205 is a low-cost entry point product, with many new features. The 4207 and 4208 are performance leaders in desktop graphics—the 4208 adding even more functionality.

The entire 4200 Series provides Tek quality graphics with extensive user-interface and multipurpose terminal capabilities.

The clean ergonomic design of the 4200 terminals makes them ideal for use in the manufacturing environment, on the shop floor, and on the assembly line, as well as in the office and lab environment.

Available in the IBM 3270 Environment
The CX option to the 4200 Series terminals makes the benefits of Tektronix graphics available in the IBM 3270 environments. The CX option features full plug-compatible IBM 3720 alphanumerics and a familiar IBM-style keyboard.

4200/4100A SERIES TERMINALS SELECTION GUIDE

Applications/Features	4205	4207	4208	4109A	4111
Display size	13-inch	13-inch	13-inch	19-inch	19-inch
Color palette	64	64	64	4096	4096
Displayable colors: Graphics Alphanumeric	16 8	16 8	16 8	16 8	16 8
Pixel resolution	480 x 360	640 x 480	640 x 480	640 x 480	1024 x 768
VT-100 compatible commands	Yes	Yes	Yes	Yes	Yes
Expanded segment support	Yes	Yes	Yes	Yes	Yes
Arc curve commands	Yes	Yes	Yes	Yes	Yes
Pixel operations	Yes	Yes	Yes	Yes	Yes
Two-way peripheral port communications	No	Yes	Yes	Yes	Yes
Enhanced color copier support	Yes	Yes	Yes	Yes	Yes
Fast monochrome copier support	Yes	Yes	Yes	Yes	Yes
4957/4958 Tablet support	No	Yes	Yes	Yes	Yes
Megabytes of memory (optional)	1.0	1.0	1.5	1.0	1.2
Standard system memory installed	128 Kb	256 Kb	512 Kb	256 Kb	256 Kb
4510A support	No	Yes	Yes	Yes	Yes
Page	52	53	53	54	54
Prices begin at	$2,495	$3,995	$4,995	$8,995	$12,950

Note: Each terminal supports the 4644, 4691, 4692 and 4696.

One Megabyte of Memory
No other graphics terminal in this price range offers one megabyte of memory. The 4208 offers an optional 1.5 megabytes of memory, so capacity can expand with application needs.

Software Compatibility
All 4200 terminals accept programs written for Tek 4100A Series terminals. Software support includes the Tektronix PLOT 10® Interactive Graphics Library, PLOT 10 Graphical Kernel System, PLOT 10 Terminal Control System, PLOT 10 TekniCAD™ and TekniCAP™; ISSCO's DISSPLA and TELL-A-GRAPH, SAS Institute's SAS/GRAPH, and many others.

4200 terminals will run DEC VT-100 editors, including the EDT, TV, VI, and EMACS screen editors. The 4200 Series is ANSI 3.64 compatible, and supports standard industry alphanumerics. The 4200 user can define custom character fonts on the host computer to fit specific applications, and then download them for use on a 4200 terminal. A new background copy feature frees the computer for continued use while it makes hard copies.

All 4200 terminals are compatible with the previous 4100A Series and the new, higher performance 4132 graphics workstation. Users can select the right 4200 solution for today, and then allow their applications to grow into higher performance terminals or even off-load applications to less expensive Tek color graphics terminals.

The 4200 Series supports the Tek 4692 Color Graphics Copier and the 4696 Color Ink-Jet Printer. The 4208, with RGB window output, supports the Tek 4632 Copier, the Tek 4644 Dot Matrix Printer and popular low-cost printers, such as the HP Thinkjet, Epson FX-80, and others.

Advanced Intelligent Graphics Capability
Performance and productivity is improved by enhanced segment operations, local zoom and pan, and multiple view functions. Local memory and graphics intelligence allow the user to define primitive elements at the host, save them in the terminal, and then manipulate and edit them locally with only minimum interaction with the host.

True local zoom and pan rescales images using the full resolution of the screen. The user can pan beyond the edge of the screen to view parts of an image that are on the display list but not displayed. The 4200 terminals can magnify the image, substituting graphics intelligence for screen size and resolution to increase productivity at a lower cost and in a smaller physical space.

The 4200 user can display up to 64 views in independent viewports on the screen, allowing comparison of graphic information, simultaneous viewing of different views of one object, or the display of time series data.

Cleaner Display and Use of Surfaces
Surfaces can be made visible or invisible, drawn on independently, and overlaid to create composite and multilevel pictures. Use of surfaces allows easier design and editing because the screen is not cluttered by unnecessary information. In addition, a distinct alphanumeric dialog area separates text and graphics. The 4200 terminals have .31 mm dot pitch CRTs for clear text and images.

Mouse Support
All 4200 terminals support a mouse for graphic input, as well as the 4100A style joydisk. The 4207 and 4208 support the 4957 and 4958 Graphics Tablets.

NEW 4205

Color Graphics Terminal

The Most Affordable Tek Color Graphics Terminal

Includes VT-100 (ANSI 3.64) Alphanumeric Features

Compatible With 4100A Terminal Line and the *NEW* 4207 and 4208

Available in CX IBM Coax Configuration

The 4205 brings higher performance color graphics at a lower price within reach of every computer user. The 4205 offers Tek-standard color graphics and is fully compatible with the new 4200 terminals, as well as the 4100A terminal line. The 4205 offers outstanding general-purpose alphanumerics with high quality color graphics.

The 4205 has a flicker-free, 60 Hz non-interlaced refresh rate, precision in-line gun with fixed convergence, and antiglare etched 13-inch (330 mm) color display screen. The 4205 balanced resolution of 480 x 360 pixels produces distortion free pictures that rival more expensive and higher resolution terminals.

Graphics Features
The 16 graphic and 8 dialog colors, from the palette of 64, offer more than comparably priced products, allowing color differentiation in complex drawings and graphs. Other graphics features include multiple views, multiple surfaces, circular arcs, user definable cursors, and up to one megabyte of RAM for segments.

For ordering information, see next page.

TekniCAD and TekniCAP are trademarks of Tektronix, Inc.

Flexible leasing programs available in the continental U.S.

NEW 4207
Color Graphics Terminal

Desktop Color Graphics Terminal Leader

VT-100 (ANSI 3.64) Compatible Alphanumerics

Compatible With 4100A Terminal Line and the *NEW* 4205 and 4208

Available in CX IBM Coax Configuration

For advanced graphics applications, the sophisticated 4207 is the price/performance leader. With graphics capabilities, such as background copy to a color copier, the 4207 rivals more costly graphics terminals. The 640 x 480 pixel resolution is enhanced by the flicker-free, 60 Hz noninterlaced refresh rate, precision in-line gun with fixed convergence, and anti-glare etched 13-inch (330 mm) display screen. Addressability is 4096 x 4096 points, with true local zoom and pan making effective use of this precision.

Graphics Features
The graphics area supports 16 colors from a palette of 64. Other graphics features include multiple views, multiple surfaces, circular arcs, user definable cursors, tablet support, and up to one megabyte of RAM for segments. Also included are eight predefined line styles, 11 marker types, and 149 predefined solid or dithered patterns for polygon fill. Two styles of graphics text may be scaled, rotated and adjusted in size.

The 4207 supports a wide variety of copiers and printers for both graphics and dialog copies. These include the popular Tektronix 4692 and 4696 Color Graphics Copiers, the Tektronix 4644 monochrome printer, the HP Thinkjet and Laserjet, the Epson FX-80, and many other Epson compatible printers. The 4207 also supports the Tektronix 4957 and 4958 Graphics Tablets.

NEW 4208
Color Graphics Terminal

1.5 Mb of Memory Standard

User-Definable Dialog Characters

Mouse and Improved Joydisk

Laser Printer and Background Copy Support

Compatible With 4100A Terminal Line and the *NEW* 4205 and 4207

Available in CX IBM Coax Configuration

RGB Video Output

The *NEW* 4208 Color Graphics Terminal shares the advanced graphics capabilities and features of the 4207, and adds enhanced functionality.

More Standard Memory
The 4208 has 512K standard system memory to support more demanding applications utilizing Tek intelligent graphics features.

RGB Video Output
RGB video output supports color camera systems, remote monitors and 4630 Series copiers.

Physical Package
The 4208 physical package is built for future flexibility. Cooling vents on the side of the box make the 4208 appropriate for non-office environments, because the terminal is more protected from particles circulating in a manufacturing area.

Input
The 4208 keyboard has the familiar Tek layout. The joydisk for graphic input has three selectable speeds. The optional mouse plugs directly into the keyboard.

New Output Feature Increases Productivity
High quality color copies of 4208 images can be produced on paper or transparency film, using the Tektronix 4690 Series Color Graphics Copiers. A new feature, the Background Copy, allows users to spool graphics copies for minimal terminal interruption. The 4208 is compatible via RGB video output with large screen projectors, and supports color camera output devices. It also supports the HP Laser Jet Printer and the Tek 4957 and 4958 Graphics Tablets.

ORDERING INFORMATION

4205 Color Graphics Terminal **$2,495**
Includes: Power cord (161-0066-09); RS-232 cable (012-0911-00); standard keyboard (119-1989-00); operator manual (070-6279-00); reference guide (070-6046-01).

4207 Color Graphics Terminal **$3,995**
Includes: Same as 4205.

4208 Color Graphics Terminal **$4,995**
Includes: Same as 4205 except operator manual (070-6045-00); programmer reference guide (070-6046-00).

OPTIONS

Option 22 — 1 Mb Memory.	**+$750**
Option 4A — UK Keyboard.	**NC**
Option 4B — French Keyboard.	**NC**
Option 4C — Swedish Keyboard.	**NC**
Option 4F — Danish/Norwegian Keyboard.	**NC**
Option 4G — German Keyboard.	**NC**
Option 4M — Mouse.	**+$150**

IBM Coax Interfaces —
The optional coaxial interface is available with standard accessories and U.S. and international keyboards. Contact your local Sales Representative for ordering information.

INTERNATIONAL POWER PLUG OPTIONS
Option A1 — Universal Euro 220 V, 50 Hz.
Option A2 — UK 240 V, 50 Hz.
Option A3 — Australian 240 V, 50 Hz.
Option A4 — North American 240 V, 60 Hz.
Option A5 — Switzerland 220 V, 50 Hz.

WARRANTY-PLUS SERVICE PLANS
SEE PAGE 496
Contact your local Sales Engineer for prices.
S0 — On-Site Product Installation and Set-Up.
S1 — 1 Year On-Site Service.
S2 — 2 Years On-Site Service.
S3 — 3 Years On-Site Service.

OPTIONAL ACCESSORIES

Programmer Reference Manual —	
(4205/4207) Order 070-6048-01	**$75**
(4208) Order 070-6048-00	**$75**
Field Service Manual —	
(4205/4207) Order 070-6283-00	**$100**
(4208) Order 070-5874-00	**$100**

Workstation Furniture for these products is shown on pages 79 through 82.

Flexible leasing programs available in the continental U.S.

4100A Series
Color Graphics Terminals

VT-100 (ANSI X3.64) Compatible Alphanumerics

Compatible With 4010, 4100A, 4110, 4120, and 4200 Color Graphics Terminals

Available in CX IBM Coax Configuration

RGB Output for External Video Applications

Tektronix is continuing the high end of its 4100A family of terminals by offering high performance 19-inch color graphics terminals. The 4109A and 4111 support advanced firmware and very dense, fine line quality graphics.

Tek Graphics Features Save Time and Money

The segment editing capability allows users to modify existing segments without retransmitting the entire segment—saving CPU transmission time and costs. Segment subroutining defines a graphic primitive in a segment so that it can be called as often as needed. This feature, along with advanced memory algorithms, allows a user to define numerous segments without adding more memory. Arcs and circles can be drawn with one command and a few points, also saving CPU and communications time.

Expanded Peripheral Support

The terminals support the full range of Tektronix color copiers. The 4109A supports the 4644 Dot Matrix Printer and both terminals support popular low cost printers such as the HP Thinkjet, Epson FX-80, and others, in graphics and dialog copiers. They also support Tek 4957 and 4958 Graphics Tablets.

Software Compatibility

The 4100A terminals accept programs written for Tek 4010 terminals and are upward compatible with applications used on the Tek 4110 and 4120 terminals. Some of the software supporting the 4100A terminals include Tektronix PLOT 10® Interactive Graphics Library, PLOT 10 Graphical Kernel System, PLOT 10 Terminal Control System, PLOT 10 TekniCAD™ and TekniCAP™, DISSPLA and TELL-A-GRAPH, SAS/GRAPH, and a host of others. The 4100A line is VT-100 compatible with powerful editing and word processing abilities designed to ANSI X3.64 standards. Each 4100A is designed to facilitate easy transition to higher performance terminals as needs change.

Available in the IBM 3270 Environment

The CX versions of all Tektronix graphics terminals share the features of the Tektronix low-cost, high-performance terminal line, making the benefits of Tektronix graphics available in IBM 3270 environments. All CX terminals feature full plug-compatible IBM 3720 alphanumerics and a familiar IBM-style keyboard.

4109A Color Graphics Terminal

Low Cost, High Performance 19-Inch Color Graphics

For advanced graphics applications requiring a large screen, the cost effective 4109A is the solution. With its advanced graphics abilities, such as segment editing and segment subroutining, advanced pick operations and 2-way peripheral port operations, the 4109A rivals more costly graphics terminals. The 640 x 480 pixel resolution is enhanced by the flicker-free, 60 Hz noninterlaced refresh rate, precision in-line gun with fixed convergence, and 19-inch (483 mm) shadow mask display screen.

Graphics features include multiple views, multiple surfaces, circular arcs, user definable cursors, tablet support, and up to 1 megabyte of RAM for segments. Also included are eight predefined line styles, 11 marker types, and 149 predefined solid or dithered patterns for polygon fill. Two styles of graphics text may be scaled, rotated, and adjusted in size.

4111 Color Graphics Terminal

Advanced Firmware Routines

Four-Bit Planes for Multilayer Graphics

The 4111 is a personalized, high resolution computer display terminal that offers superior price/performance characteristics for 2D ME-CAD and drafting applications, EE-CAD (schematic capture, IC design), cartography, and Technical Data Analysis (TDA). The terminal operates in a 60 Hz, noninterlaced mode that minimizes both flicker and eye strain. An anti-reflection enhancement panel further minimizes user fatigue.

Four-bit planes are standard, allowing the simultaneous display of 16 colors for graphics, eight of which can be used in the dialog area. Each bit plane can be treated as a separate display surface permitting the manipulation of layers of data—a feature that is particularly useful with multilayer drawings such as IC design and printed circuit board design.

An extensive set of graphics functions is available, including windowing, multiple views, segments, surface support, and local zoom and pan. A majority of the 256 Kb of local RAM is available to store picture elements for later use; 1 Mb can be added optionally to bring the total RAM memory up to 1.2 Mb.

Advanced firmware routines aid the applications programmer in developing graphics software with a very interactive operator interface and excellent performance. Included in the 4111's firmware are routines that handle segment editing, segment subroutines, pick operations, host window management, multiple scrolling dialog areas, and pop-up menus.

ORDERING INFORMATION

4109A Color Graphics Terminal **$8,995**
Includes: 8 ft power cord (161-0066-00), 12 ft host port RS-232 cable (012-0911-00), pkg of six keyboard overlays (334-5164-00), An Introduction to Computer Color Graphics (070-5239-00); standard keyboard (119-1592-00), operator manual (070-4981-02), reference guide (070-4892-02).

CX4109A Color Graphics Terminal **$9,995**
Includes: Same as 4109A plus 3270 interface and keyboard.

4111 Color Graphics Terminal **$12,950**
Includes: Power cord (161-0066-00); RS-232C cable (012-0911-00); 4111 operator's manual (070-5683-00); 4110/4120 Series reference guide (070-5142-01); An Introduction to Computer Color Graphics (070-5239-00); function key overlays (package of six) (334-3290-02); standard keyboard (119-2208-00); IDG user's survey card (062-7235-01).

CX4111 Color Graphics Terminal **$13,950**
Includes: Same as 4111 plus 3270 interface and keyboard.

OPTIONS (4109A and CX4109A)

Option 21 — 1 Mb of RAM memory.	**+$1,000**
Option 4A — UK Keyboard.	**NC**
Option 4B — French Keyboard.	**NC**
Option 4C — Swedish Keyboard.	**NC**
Option 4F — Danish/Norwegian Keyboard.	**NC**
Option 4G — German Keyboard.	**NC**
Option 4H — CX System.	**NC**
Option 4I — CX Keyboard.	**NC**

OPTIONS (4111 and CX4111)

Option 2C — Additional 1 Mb of RAM Memory.	**+$1,500**
Option 4M — Mouse.	**+$100**
Option 49 — Rental Identification Tag.	**NC**

INTERNATIONAL POWER PLUG OPTIONS

Option A1 — Universal Euro 220 V, 50 Hz.
Option A2 — UK 240 V, 50 Hz.
Option A3 — Australian 240 V, 50 Hz.
Option A4 — North American 240 V, 60 Hz.
Option A5 — Switzerland 220 V, 50 Hz.

***WARRANTY-PLUS* SERVICE PLANS**
SEE PAGE 496

Contact your local Sales Engineer for prices.

S0 — On-Site Product Installation and Set-Up.
S1 — (4111/CX4111) 1 Year On-Site Service.
S2 — 2 Years On-Site Service.
S3 — 3 Years On-Site Service.

TekniCAD and TekniCAP are trademarks of Tektronix, Inc.

Flexible leasing programs available in the continental U.S.

4120 Series

Newly Enhanced Color Graphics Workstations

A Natural Growth Path From 2D to 3D Wireframe to 3D Shaded Surfaces

Easy Integration Into a Range of Computational Environments

Tektronix has enhanced its line of 2D and 3D Color Graphics Workstations, offering higher performance 4125, 4128, and 4129 terminals with many new features.

MicroVAX II Communications

The new interactive DMA interface and Binary Command Interpreter (BCI) allow high speed communications between a DEC MicroVAX II and the 4120 Series terminals.

The Binary Command Interpreter is designed for high throughput communications interfaces and can be used over current DMA links and the newly developed DMS for the MicroVAX II. Required parameters are formatted directly into 32-bit words and sent in binary form, reducing host computer time. The BCI eliminates the encode/decode process at both ends of the communications line, increasing system throughput and application performance.

The new DMA Interface is implemented as an interactive terminal on the MicroVAX II, eliminating the need for separate RS-232 communications. All communication can be sent over the parallel path. Application performance can be enhanced using this new data path, with no sacrifice of interactivity.

More Segment Memory

All three terminals can incorporate up to 6 Mb of segment memory, allowing users to take full advantage of extensive local segment capabilities.

Easy-to-Use Wide Lines

This new user-selectable line width feature saves large amounts of application code, host computer overhead, and communications traffic. *Pixel-wide lines* are from 1 to 8 pixels wide and can be used with dashed line styles. *Panel-generated lines* may be used when line width relates to a real specification. The line width will adjust as the image is scaled with zooming operations. The wide line feature is standard with the 4128 and 4129, and optional with the 4125.

User-Definable Markers

Users can define up to 117 markers, each within one character cell, in addition to the 11 predefined markers already available.

VT-100 Extensions to ANSI X3.64

This new feature allows the 4120 workstations to be used with DEC standard editors and forms programs and increases 4120 compatibility with the 4100A Series. Double-high, double-wide characters and Answerback mode are included in this set of extensions.

Each member of the 4120 Series is driven by an Intel 80286/80287 processor set and features a color display with Dynamic Convergence; firmware with embedded commands for segment editing, segment subroutines and pick operations; a user interactive keyboard; and 4110 and 4100A Series compatibility.

4120 SERIES SELECTION GUIDE

Applications/Features	4125	4128	4129
3D Wireframe	Optional	Yes	Yes
3D Shaded Surface	Optional	Optional	Yes
Display Size	19-Inch	19-Inch	19-Inch
Viewing Area	13.5 x 10.8 Inch	13.5 x 10.8 Inch	13.5 x 10.8 Inch
Color Palette	16 Million	16 Million	16 Million
Displayable Colors Standard Optional Dialog Areas	 4 16/64/256 64	 16 256 64	 256 4096 (with dithering) 64
Addressable Pixels	1280 x 1024	1280 x 1024	1280 x 1024
VT-100 Compatible Commands	Yes	Yes	Yes
Bit Planes Standard Optional	 2 4/6/8	 4 8	 8 N/A
Windowing; Pan/Zoom	Yes, 2D	Yes, 2D/3D	Yes, 2D/3D
Segments/Subroutines	Yes	Yes	Yes
Memory Standard Optional	 288 Kb Up to 6 Mb	 288 Kb Up to 6 Mb	 288 Kb Up to 6 Mb
Communications Standard Optional	 1 RS-232C I/F Parallel & Serial I/Fs	 1 RS-232C I/F Parallel & Serial I/Fs	 1 RS-232C I/F Parallel & Serial I/Fs
Coordinate Space 32-bit (2D) 24-bit (3D)	 Yes Optional	 Yes Yes	 Yes Yes
4120 Peripheral Support 4692/4696 Copiers 4510A Rasterizer, 4957/4958 Graphics Tablets, 4944 Mass Storage Unit	 Yes, Opt 19 Yes, Opt 10	 Yes, Opt 19 Yes, Opt 10	 Yes, Opt 19 Yes, Opt 10
Page	56	57	57
Prices begin at	**$16,950**	**$19,950**	**$35,000**

Continued Quality 4120 Series Capabilities

The 4120 Series continues to offer a flexible, cost-effective way to integrate one CAD technology into the next. With their powerful 80286/80287 processor sets and sharp, dynamically converged color displays, all three graphics systems are engineered to add performance and reduce project design time.

4120 color workstations are compatible with each other, the 4115B and the 4100A Series Color Graphics Terminals.

The 4120's user-friendly keyboard features numeric keypads, thumbwheels for graphic input, eight dedicated programmable function keys, ports for joystick and mouse, and a complete easy-to-use viewing system implemented from the keyboard.

Coupling this user interactivity with state-of-the-art graphics improves development and execution of design. This results in increased productivity for CAD applications like structural analysis, finite element modeling, thermal and vibrational analysis, schematic capture, integrated circuit design and more.

Up to 64 scrollable dialog areas can be displayed simultaneously, providing valuable new capabilities for host window management. The user can edit one text file while referring to others on the screen at the same time. Because each dialog area has its own text buffer, it may be positioned to overlap others. And even though a dialog area may be partially obscured as a result, it still may be scrolled.

Pop-up menus are also supported. Small areas of screen text and graphics can be stored in local memory and then redisplayed as required. This transient information may be brought on and off the screen at the touch of a key without disturbing the main graphics under development.

Upgrading 4115B and 4120 Workstations to the Enhanced Level

Many upgrade paths are available to 4115B and 4120 customers:

- Upgrade 2D products to 3D capabilities
- Upgrade pre-enhanced products to enhanced products

Owners of the newly enhanced 4120 Series workstations can purchase field-installable upgrade kits to provide additional 3D capability:

- 4125 to 4128: 4115F58 Option 03
- 4128 to 4129: 4100F59

Owners of non-enhanced 4120 Series workstations can purchase field-installable upgrade kits to provide newly enhanced capabilities:

- 4115B to enhanced 4125: 4115F56 and 4100F61
- 4125 to enhanced 4125: 4100F61
- 4125 to enhanced 4128: 4100F61
- 4128 to enhanced 4128: 4100F61
- 4129 to enhanced 4129: 4100F61

The 4100F61 also includes 2 Mb of additional segment memory.

Owners of pre-enhanced level workstations can still upgrade to the 4120 feature set, 3D wireframe, and 3D shaded surface capabilities:

- 4115B to 4125: 4115F55 and 4115F56
- 4115B to 4128: 4115F58 Option 01
- 4125 to 4128: 4115F58 Option 02
- 4128 to 4129: 4100F59

Once a workstation has been upgraded, it can be upgraded further using the appropriate kit for the desired functionality. When upgrading to 3D wireframe or 3D shaded surface capabilities, additional bit planes of display memory may be required to obtain full 4128 or 4129 performance. Consult your local Tek Sales Representative for assistance.

4125 Enhanced High Performance 2D Color Graphics Workstation

80286/80287 Processor Based

Dynamically Converged Display

Fast Draw and Fill

The 4125 Color Graphics Workstation incorporates advanced graphics with local processing power and ultra sharp display qualities to provide CAD developers and users with increased utility and performance. The workstation speeds development and execution of the complex, high density graphics associated with mechanical and electrical engineering, cartography, and other graphics-oriented professions.

Advanced Display

The Tek 4125 employs a 19-inch color raster display operating in a 60 Hz, non-interlaced mode for flicker-free performance. An addressable pixel matrix of 1280 x 1024 ensures crisp, precise resolution of the finest detail in graphics images.

A precision in-line gun CRT is employed for maximum convergence stability. This is supplemented by dynamic convergence correction that adjusts as the electron beam scans, providing convergence accuracy of 0.3 mm over the entire display area.

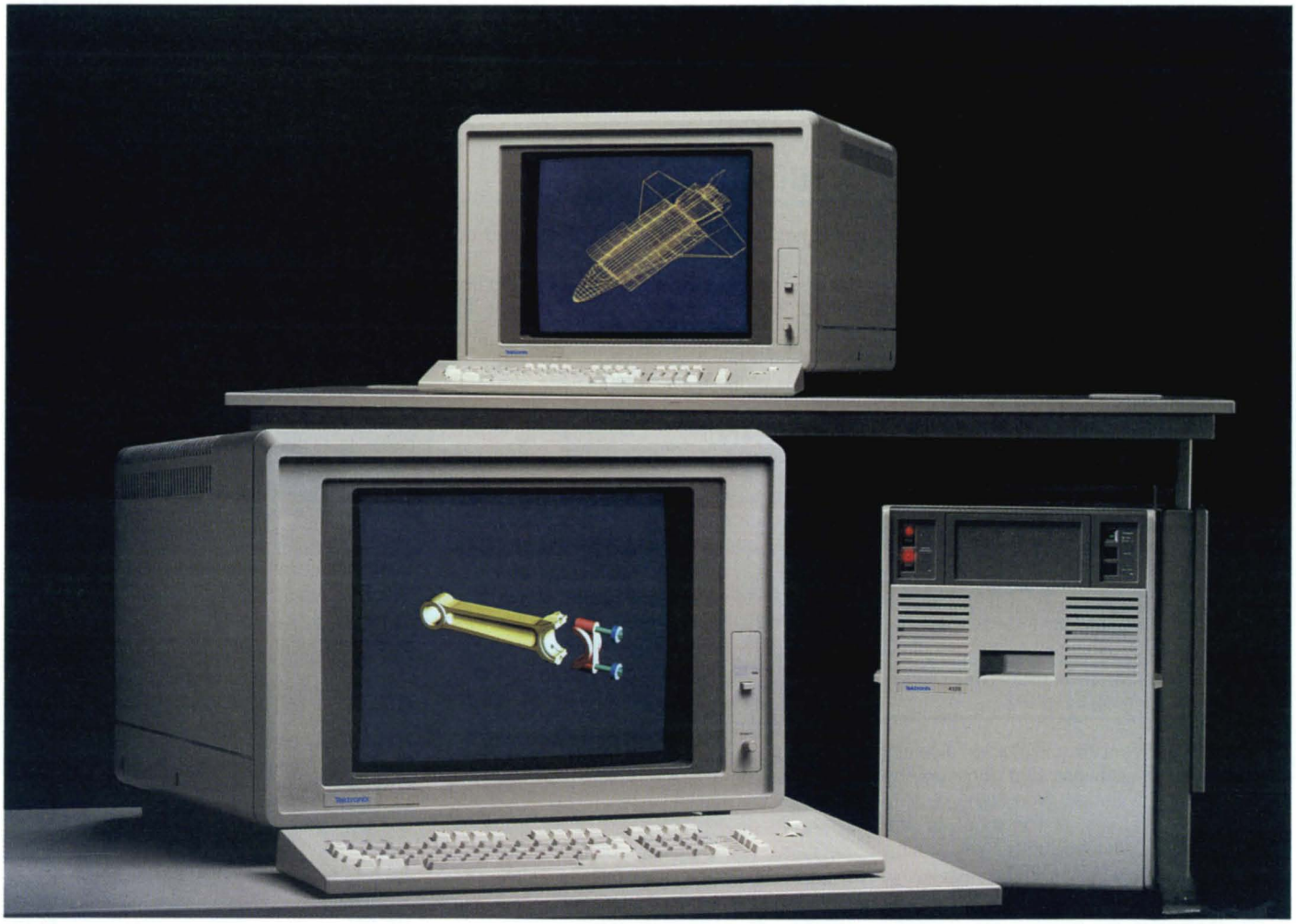
Segments and Local Picture Storage

Embedded in the firmware and microcode of the 4125 are convenient commands for segment editing, segment subroutines, and pick operations that greatly reduce development time and augment productivity.

Enhancements Available

In addition, 4125 owners can upgrade to 4128 and 4129 capabilities with the 4115F58 Option 03 field upgrade kit and the 4100F59 kit, respectively.

For ordering information, see page 58.



4128/4129

Enhanced 3D Color Graphics Workstations

3D Wireframe/Shaded Surface Color Graphics

3D Matrix Transforms

Rapid Data Communication—to 38.4 kbaud

The 4128 and 4129 are members of a family of compatible, high performance computer graphics systems. Both include the same 2D functionality of a 4125, but offer varying levels of 3D performance. Available in modular configurations only, the 4128 and 4129 feature a keyboard that includes a numeric keypad and ports for a joystick and mouse. Both the 4128 and 4129 have 3D wireframe capability built into their firmware and microcode in addition to the standard 4125 2D feature set.

An 80286/80287 processor set drives each unit and provides rapid data communications—at rates up to 38.4 kbaud. Both units come with 288 Kb of RAM, expandable to 6 Mb. The 4128 offers 4-bit planes and the 4129 is equipped with 8-bit planes as standard. Both share a high-resolution 1280 x 1024 in-line gun color display with dynamic convergence.

4129 Special Features

The 4129 also includes hardware enhancements for 3D shaded surfaces. Two additional circuit boards and full 8-bit planes (standard) provide the engineering designer with all the necessary tools for local shading, hidden line removal and hidden surface removal, and the manipulation of surface-image 3D objects.

Sectioning

A useful feature of the 4129 is the ability to section a 3D shaded object. An object may be sliced with two "cuts" or sectioning planes of user defined proportions. These sectioning planes are in addition to the six clipping planes used for viewing operations.

Shading

The 4129 offers three different methods of surface shading—constant, cosine, and Gouraud. The colors used to shade a surface are defined in a contiguous set of color map indices that represent a range of intensities. The local shading is enhanced further by use of a local color dithering algorithm to provide smoothly shaded colors and transitions. The Option 19 Color Copier Interface, used with the 4692 Color Graphics Copier, faithfully reproduces the screen colors, using a Tektronix-developed color matching system.

For ordering information, see next page.

Flexible leasing programs available in the continental U.S.

NEW 4190
Graphics Projection Package

High Resolution, Large Screen Color Projection System Connecting to the Tek 4115B/4120 Series Color Graphics Workstations

Reproduces Terminal Resolution on the Projection Screen

Ideal for Customer Presentations, Design Reviews and Training Sessions

The *NEW* 4190 Graphics Projector displays any application software that runs on the 4115B and 4120 Series Workstations. Projector addressability is identical to the workstation's addressability, producing large-scale images with 1280 x 1024-pixel addressability. The 4190 has the same 60 Hz, noninterlaced refresh rate, producing clear edges and sharp colors as displayed on the workstation screen.

The 4190 employs a 3-CRT, 3-lens projection system that produces high light throughput even when displaying dense, high-resolution images. A sealed liquid cooling system ensures high reliability and high resolution. The concave viewing screen is 80 inches wide and 60 inches high.

A hand-held remote control command module gives the user complete control over image quality. A two-line liquid crystal display on the module prompts for adjustments such as beam centering, convergence, brightness, contrast, black and white balance, and focus.

4120 Series Accessories

Tektronix offers a complete accessories package for the 4125, 4128, and 4129 Workstations.

4100H01 Table

Matches the workstations in styling and color, offering a working surface of 36 x 60 in—enough room for the display, the keyboard, and a tablet. A pedal adjusts the height of the desk's surface, and the electronics module will fit under the table regardless of the table's height.

4100H02 Display Stand

Adjustable electrically by means of a ballscrew actuator. The platform of the display stand fits over the surface of the table and allows the display to be installed in a convenient position by making use of its height adjustment, and its lateral movement capability on its casters.

4100H03 Chair

Offers a five-legged ergonomic design. It completes the accessories package that provides for the optimum in user productivity and comfort.

ORDERING INFORMATION

4125 High Performance 2D Color Graphics Workstation (Modular Configuration) **$16,950**
Includes: Display module and keyboard.

4125P High Performance 2D Color Graphics Workstation (Pedestal Configuration) **$16,950**

4128 3D Wireframe Color Graphics Workstation **$19,950**

4129 3D Shaded Surface Color Graphics Workstation **$35,000**

OPTIONS

Option 01 — Extended Communications Interface. **+$1,000**
Option 05 — IBM 3270 Coax Interface. **+$2,495**
Option 06 — 30 Hz Interlaced Projector Interface. **+$5,100**
Option 10 — Three-Port Peripheral Interface. **+$1,000**
Option 19 — 4690 Series Color Copier Interface. **+$1,000**
Option 2A — Additional 256 Kb ECC RAM. **+$1,500**
Option 2B — Additional 512 Kb ECC RAM. **+$2,500**
Option 2C — Additional 2.0 Mb RAM. **+$2,500**
Option 2D — Additional 4.0 Mb RAM. **+$5,000**
Option 2E — 6.0 Mb RAM Total. **+$6,500**
Option 22 — (4125) Additional 2-bit Planes. **+$2,000**
Option 23 — (4125/4128) Additional 4-bit Planes. **+$4,000**
Option 3A — DMA Interface for DEC, VAX, and PDP-11. **+$5,000**
Option 3B — 30 ft cable for Option 3A. **+$250**
Option 3C — High speed RS-422 Interface to 4132/4133. **+$1,500**
Option 32 — (4125) Wide Lines. **+$200**
Option 4M — Mouse. **+$150**
Option 42 — Single Flexible Disk and Controller. **+$2,000**
Option 43 — Dual Flexible Disk and Controller. **+$2,800**
Option 45 — Mass Storage Controller Interface. **+$1,500**

4190 Graphics Projection Package **$68,995**
Includes: Projector and stand, projector screen and stand, 20-foot coaxial interface cables, and manual. Requires the 4100F07 interface if the 4190 and standard 19-inch display both are connected to the workstation.

4100H01 Table **$1,895**
4100H02 Display Stand **$1,195**
4100H03 Chair **$600**

FIELD KITS

4100F3Q — DMA Interface to DEC Q-Bus (MicroVAX II). **$2,595**
4100F3F*1 — Option 10 Interactive DMA Interface for DEC MicroVAX II.
4100F07 — Camera/Display Interface (required for 4190 Projector). **$1,300**
**1 To order, contact your local Sales Office.*

FIELD UPGRADE KITS

See page 56.

4100F59 **$8,000**
4100F61 **$6,400**
4115F55 **$1,995**
4115F56 **$950**
4115F58 Option 01 **$6,000**
4115F58 Option 02 **$2,100**
4115F58 Option 03 **$2,000**

WARRANTY-PLUS SERVICE PLANS (4125/4125P/4128/4129)

SEE PAGE 496

Contact your local Sales Engineer for prices.
S0 — On-Site Product Installation and Set-Up.
S1 — 1 Year On-Site Service.
S2 — 2 Years On-Site Service.
S3 — 3 Years On-Site Service.

Flexible leasing programs available in the continental U.S.

NEW 4132

Intelligent Graphics Workstation

GPIB IEEE-488 The 4132 Option 3D complies with IEEE Standard 488-1978 and with Tektronix *Standard Codes and Formats.*

Excellent Price/Performance

Variety of Display and Output Options

Flexible Interfacing

Enhanced UNIX Operating System

Integrated LAN With Distributed File System

Extensive Software Support

Compatible With the 6130 Intelligent Graphics Workstation

The 4132 workstation is a high performance, configurable workstation with the power and flexibility to handle a variety of engineering and technical applications.

The 4132 is a powerful, single bus system built around National Semiconductor's NS32016, a 32-bit processor with a 16-bit external data path and 32-bit registers. A 32-bit floating point processor and 32-bit memory management unit augment the 32016 CPU.

The 4132 workstation features include up to 250 Mb internal storage capacity and the UTek™ Operating System with C, FORTRAN, ISO Pascal, and ANSI BASIC languages. Interactive graphics are available through the PLOT 10® library which includes the Terminal Control System (TCS), Interactive Graphics Library (CORE standard) and the Software Terminal Interface.

The 4132 workstation comes standard with:

- 80 Mb hard disk
- 1.2 Mb integrated flexible disk
- 1 Mb of parity RAM
- Small Computer Standard Interface (SCSI)
- 1 RS-232 and 1 RS-232/RS-422 port
- 1 Local Area Network (LAN) port
- 6 backplane expansion slots
- Full UTek Utility Set
- C, FORTRAN 77 and Pascal languages

Display and Output Flexibility

The 4132 supports the full line of Tektronix 4100A and 4200 Color Graphics Terminals and the 4120 Series Color Graphics Workstations—from the entry level 4205 to the shaded surface modeling of the 4129. This wide range of supported displays lets users maximize and protect investment in Tektronix high quality DVST and color raster displays, and in software developed to support those displays. To maintain throughput, the terminals can communicate with the workstation through high speed serial ports. Additional terminals can be added for multi-user support.

The 4132 supports a variety of hard copy output devices. For text and black-and-white graphics output, it supports the Tek 4644 Dot Matrix Printer. For color graphics output, the 4132 supports the Tek 4692 and 4696 color graphics copiers, when driven directly from 4100A, 4120, and 4200 terminals/workstations. With the 4510A Color Graphics Rasterizer, the 4692 can be driven directly from the 4132. The 4132 spools images to the 4510A where they are rasterized at the full resolution of the attached copier, resulting in superior resolution hard copy.

Mass Storage

An 80 Mb internal hard disk is standard on the 4132, with substitute larger capacity hard disks available also. An optional external 45 or 60 Mb cartridge tape provides convenient back-up for mass storage devices. An additional 45 or 90 Mb hard disk is available also with the Tek 4944 Mass Storage Unit.

The Tektronix 4132 Intelligent Graphics Workstation offers several Tek standard features that enhance Tek high performance workstations.

Specific Technical and Engineering Applications

The preconfigured 4132-based Application System brings together the hardware and software needed for specific applications tasks.

Target applications include:

- Schematic editing, drafting and layout
- Software development
- Technical data analysis
- Computer-aided drafting
- Presentation graphics

For more information on these systems, see pages 61–65.

UTek—An Enhanced UNIX

- Comprehensive set of reliable utilities
- Improved program development environment
- Systems Administration Interface
- Distributed File System simplifies network operations
- Hybrid utility set supports both System V and Berkeley 4.2 features
- Interactive tutorials
- Improved on-line help facilities

UTek, a UNIX-enhanced operating system, provides a consistent interface across Tektronix Intelligent Graphics Workstations. UTek helps ensure that programs developed on one workstation will run on any similarly configured workstation.

UTek provides all the capabilities that have led to UNIX' widespread popularity. In addition, UTek's enhancements provide added-value to programmers and end users alike. These enhancements include:

- A virtual memory implementation that allows the efficient execution of very large programs
- A command set, with extensive bug fixes and enhancements to system utilities
- A Multiple Device Queueing System that provides sophisticated queueing capabilities not often found on UNIX-based systems

Another key UTek enhancement is the Distributed File System, which helps you get the maximum possible benefit from being part of a network of workstations linked via LAN. The DFS means that you no longer have to use special commands such as remote login (rlogin) or remote copy (rcp) to access another network node. Instead, you can refer to a file on another network node by simply prefixing the file's regular path name with a double slash and the name of the network node on which the file resides. (The special "remote" commands are still available for users who prefer them.)

Frequently, several organizations within a company will share the same LAN network; however, they may not want to share the same Distributed File System. With the DFS, multiple distributed file systems can coexist and even overlap.

UTek is a trademark of Tektronix, Inc.

Flexible leasing programs available in the continental U.S.

TEK INTELLIGENT GRAPHICS WORKSTATION

UTek includes a number of features designed to give you the advantages of UNIX without the disadvantages. To start with, there's an interactive on-line tutorial, developed expressly for the Tek Intelligent Graphics Workstation that introduces basic UNIX concepts.

The on-line "manual pages" that describe each system command have been revised extensively, and can be accessed through an interactive manual page browser. On-line explanations of system error messages are available also.

Even system administration is easier, thanks to an interactive, menu-based program called "sysadmin." Sysadmin provides help with system administration tasks, such as configuring ports, administering the network, creating user accounts, installing software, and maintaining the file system.

In addition, with the 4200 Series, 4100A Series and 4115B Color Graphics Terminals, and 4120 Series Color Graphics Workstations, the optional Casual User Interface (CUI) creates an alternate, window interface that provides the full power of UTek. With the CUI, you access system functions by using a printing device to select menu items, minimizing the need to know command names and syntax.

The 4132 comes standard with a full implementation of UTek. Portions of UTek that are not needed may be removed from the hard disk and stored on internal media for later use.

Integrated Networking

Local Area Network (LAN) capabilities are standard on the 4132. The 4132's LAN supports the IEEE 802.3 (Ethernet) standard using the TCP/IP protocol. The LAN allows multiple workstations to talk to one another and to host computers, and to share peripherals. Supporting software handles communication services such as the ability to log in to a remote workstation and transfer files between workstations.

Ergonomic Design

The 4132 workstation has been ergonomically designed to ensure high level functionality as well as user comfort and convenience. The system cabinet houses all primary system components and is a compact desktop unit measuring approximately 6 x 17 x 24 inches. The cabinet can be placed unobtrusively on any work surface, providing quick access to the flexible disk drive. Or it may be installed in an optional floor stand and placed underneath or to the side of the desk.

CHARACTERISTICS

HARDWARE SUMMARY

Processors — Standard: NS32016 CPU, NS32081 Floating Point Processor, NS32082 Memory Management Unit.

Memory — Standard: 1 Mb. Optional: 2, 4, or 6 Mb.

Access Method — Demand paged virtual memory (up to 16 Mb).

Storage — Standard: 1.2 Mb diskette, 80 Mb hard disk. Optional: Large capacity hard disk (substitute), 360 Kb diskette, external 45 or 60 Mb cartridge tape, internal cartridge tape, 45 or 90 Mb hard disk.

Interface Ports — Standard: High speed RS-232C/RS-422, Data rate: 110 baud to 38.4 kbaud with flagging; IEEE 802.3 LAN, Protocol: TCP/IP; SCSI. Optional: High speed RS-232C (2); Data rate: 38.4 kbaud with flagging; RS-232C/RS-422, Data rate: Up to 250 kbits/sec; GPIB; dual Centronics, additional SCSI.

Displays — Optional: 4120, 4100A, 4110, 4010 Series.

Peripherals — Optional: 4644 Dot Matrix Printer; 4691, 4692, 4696 Color Graphics Copiers; 4510A Color Graphics Rasterizer; support for line printer, letter-quality printer.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	42.7	16.8
Height	15.5	6.1
Depth	60.7	23.9
Weight≈	**kg**	**lb**
Net	9.1	20.0

ELECTRICAL

Line Voltage — 115 V nominal. 87–132 V, 230 V nominal, 174–264 V at 48–66 Hz.

Power Consumption — 428 W maximum.

ENVIRONMENTAL AND SAFETY

Temperature — Operating: +10°C to +43°C. Nonoperating: −22°C to +47°C.

Humidity — Operating: 20% to 80%, noncondensing.

Altitude — Operating: To 4572 m (15,000 ft). Nonoperating: To 15 240 m (50,000 ft).

Safety — Conforms to UL 478, CSA 154, IEC 435.

Heat Dissipation — 1462 BTU/hr maximum.

ORDERING INFORMATION

4132 Intelligent Graphics Workstation **$10,950**

OPTIONS

Option 2A — 2 Mb Memory Expansion. **+$3,000**
Option 2B — 4 Mb Memory Expansion. **+$6,000**
Option 2C — 6 Mb Memory Expansion. **+$9,000**
Option 3A — Dual High Speed RS-232C Interface. **+$700**
Option 3B — Dual Hard Copy Interface. **+$700**
Option 3C — High Speed RS-232C/RS-422 Interface. **+$700**
Option 3D — High Speed GPIB Interface. **+$700**
Option 3E — Ethernet Network Adaptor. **+$500**
Option 40*1 — Tape Cartridge Expansion Unit.
Option 41*1 — Mass Storage Tape and 45 Mb Disk Expansion Unit.

1 To order, contact your local Sales Office.

INTERNATIONAL POWER PLUG OPTIONS

Option A1 — Universal Euro 220 V, 50 Hz.
Option A2 — UK 240 V, 50 Hz.
Option A3 — Australian 240 V, 50 Hz.

***WARRANTY-PLUS* SERVICE PLANS**
SEE PAGE 496

Contact your local Sales Engineer for prices.
S0 — On-Site Product Installation and Set-Up.
S1 — 1 Year On-Site Service.
S2 — 2 Years On-Site Service.
S3 — 3 Years On-Site Service.

Flexible leasing programs available in the continental U.S.

TekniCAL™ Tools

XED, A Powerful Text Editor and Formatter That Stresses Ease of Use

20/20, A Spreadsheet Modeling Package That Also Helps Prepare Presentation Quality Graphic Displays of Spreadsheet Data

Minitab, An Interactive Data Analysis Package

CUI Mail, A Windowed, Menu-Driven Interface to the UTek Electronic Mail System

CUI, An Interactive, Windowed, Menu-Driven User Interface Providing User Access to the Full Power of the Tek 4132 and 6130 Workstations

Tek offers an economic bundle of general purpose tools for use with the Tek 4000 Family, the 4132, and many ASCII terminals. All the TekniCAL Tools products are leading UNIX-based packages that are widely used throughout the industry. The TekniCAL Tools software is licensed fully and warranted by Tektronix. CUI, XED, Minitab, and 20/20 may be purchased separately also.

ANSI BASIC Compiler

A high performance implementation of the new ANSI standard BASIC (X3.113-1986) for the 4132 Intelligent Graphics Workstation.

ANSI BASIC offers complete modern language structure and program flow control, user-defined functions and subroutines, and extensive built-in math functions. It offers extended GPIB and I/O control and an integrated editing and debugging environment.

The American National Standards Institute (ANSI) has developed a new and powerful ANSI standard for BASIC (X3.113-1986)—the first revision since 1978.

Tek's 64PL30 ANSI BASIC conforms fully to the new standard and includes extensions that are custom-made for scientific and engineering applications

64PL30 ANSI BASIC was designed for the new 4132 workstation and allows full access to UTek capabilities.

ORDERING INFORMATION

64AP20 TekniCAL Tools **$2,995**
Select one of the following options.

64PL30 ANSI BASIC Compiler **NC**
Select one of the following options.

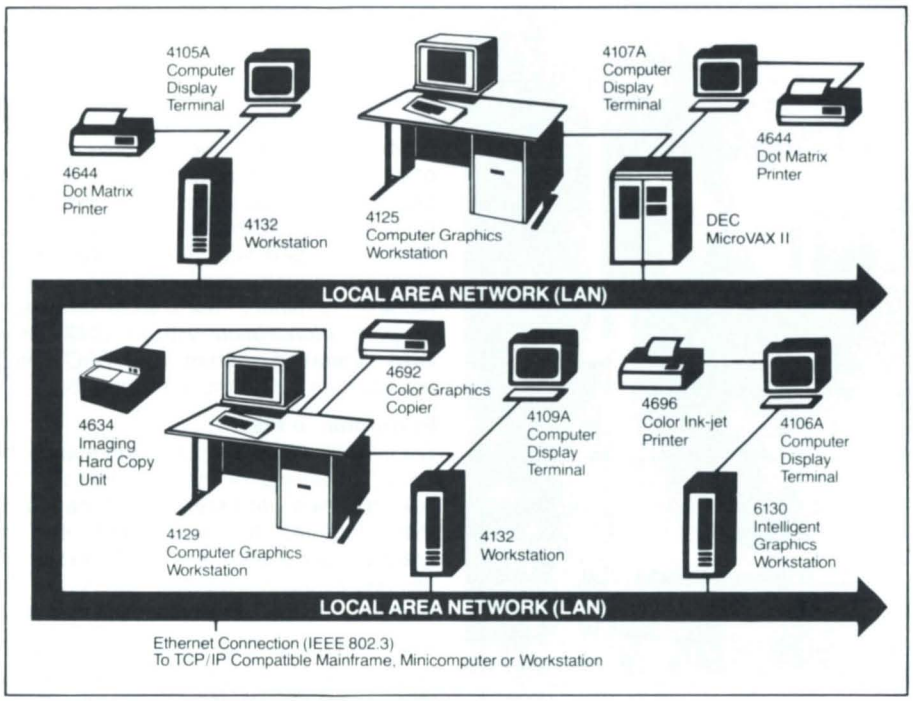
OPTIONS

Option 02 — 5¼ in Flexible Disk. **NC**
Option 03 — (64AP20 only) 9 Track Tape. **NC**
Option 04 — Cartridge Tape. **NC**

***WARRANTY-PLUS* SERVICE PLANS**
SEE PAGE 496

Contact your local Sales Engineer for prices.
S9 — Software Subscription Agreement.

TekniCAL is a trademark of Tektronix, Inc.



The 4132 supports the IEEE 802.3 (Ethernet) Local Area Network.

Graphics Application Systems

Tektronix' Family of Application Systems saves you configuration hassles. We identify the right hardware and software mix for the defined application areas. We integrate and test the equipment and ship a preconfigured system tailored to your specific needs.

Our application systems are selected from our broad product lines and are based on years of experience providing graphics tools to technical, scientific, and now our software development users.

The *NEW* Tektronix 4132 and 6130 Intelligent Graphics Workstations with UNIX-based operating systems, standard interfaces, and multi-user environments, provide the framework for these application systems. Color graphics terminals are chosen from Tek's spectrum of price/performance options. A variety of printers, plotters and color copiers are also available. And the drafting and software development systems are available in a DEC MicroVAX II configuration.

NEW PLOT 10® TekniVIEWS™

Our latest software development tool is PLOT 10 TekniVIEWS, a host-based window management system that combines the flexibility and interactivity of a windowed environment with the full power and sophistication of Tek graphics. See page 62.

Drafting Systems

Our Drafting Application Systems combine the processing power needed for responsive and demanding graphics, high performance graphics terminals, a graphics tablet for input, a plotter for output, and PLOT 10 TekniCAD, a versatile, drafting software tool. See page 64.

Technical Data Analysis and Presentation Systems

Technical Data Analysis (TDA) has less demanding computing and graphics requirements, but still needs additional software to enable users to analyze data and prepare presentations. TDA meets these criteria. See page 65.

UNIX-Based Software Development System

For software development, we've configured a powerful system that includes the development tools a programmer needs to do the job effectively. Software developers require more performance and memory for editing and compiling large programs. Graphics are used more frequently to interface with the system than to draw pictures. Special utilities, standard languages and the ability to easily port programs to other systems are primary needs. UTek supports and enhances all these requirements. See page 63.

4644 Dot Matrix Printer

The 4644 is an economical printer that matches popular interface and software standards and adds capabilities previously found only in more expensive printers. It interfaces readily to the Tek 4132 workstation and can enhance the capabilities of Tek graphics terminals. The 4644 provides general purpose printing for many hosts from other vendors.

Built-In Flexibility

The 4644 provides draft printing at 160 cps and near letter quality printing at 27 cps. A 17-inch wide platen (ideal for spreadsheets), selectable interfaces, U.S., ASCII, and seven international character sets are standard.

User-definable character sets can be downloaded, and character-set combinations and varied print modes are software selectable.

High-Resolution Graphics

The 4644 offers high-density, 8-, 9-, or 16-pin graphics, with six horizontal densities up to 240 dpi, and three vertical densities up to 216 dpi.

ORDERING INFORMATION

4644 Dot Matrix Printer **$1,350**
Includes: 4644 Printer operator manual (070-5433-00) and ribbon cartridge.

INTERNATIONAL POWER PLUG OPTIONS
Option A1 — Universal Euro 220 V, 50 Hz.
Option A2 — UK 240 V, 50 Hz.
Option A3 — Australian 240 V, 50 Hz.
Option A4 — North American 240 V, 60 Hz.
Option A5 — Switzerland 220 V, 50 Hz.

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S0 — On-Site Product Installation and Set-Up.
S1 — 1 Year On-Site Service.
S2 — 2 Years On-Site Service.
S3 — 3 Years On-Site Service.

NEW Protocol Microlink™

Protocol Microlink is a communications data bridge between DEC MicroVAX II systems and the Tektronix workstations network environment. This new Tek product provides a base level of network communications support, linking the MicroVAX II systems with MicroVMS, via a LAN to Tektronix 4132 and 6130 Intelligent Graphics Workstations, and 4400 Artificial Intelligence Systems with Ethernet options. Protocol Microlink also allows communication with VAX 11/7XX Series minicomputers with 4.2 bsd UNIX.

Protocol Microlink and the LAN provide personal control over the user's computing environment, as well as easy communication and data exchange with other users. Other features include multilayered services, Department of Defense Protocol compatibility, Virtual Network (TELNET), and all the following protocols: File transfer (FTP), Address Resolution (ARP), Transmission Control/Internet (TCP/IP), and Ethernet.

ORDERING INFORMATION

41P37 Protocol Microlink **$2,995**
Select one of the following (Option 02 or 04).

OPTIONS
Option 02 — 5¼" Flexible Disk **NC**
Option 04 — Cartridge Tape **NC**
Option 68 — Media Replacement **NC**

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S9 — Software Subscription Agreement.

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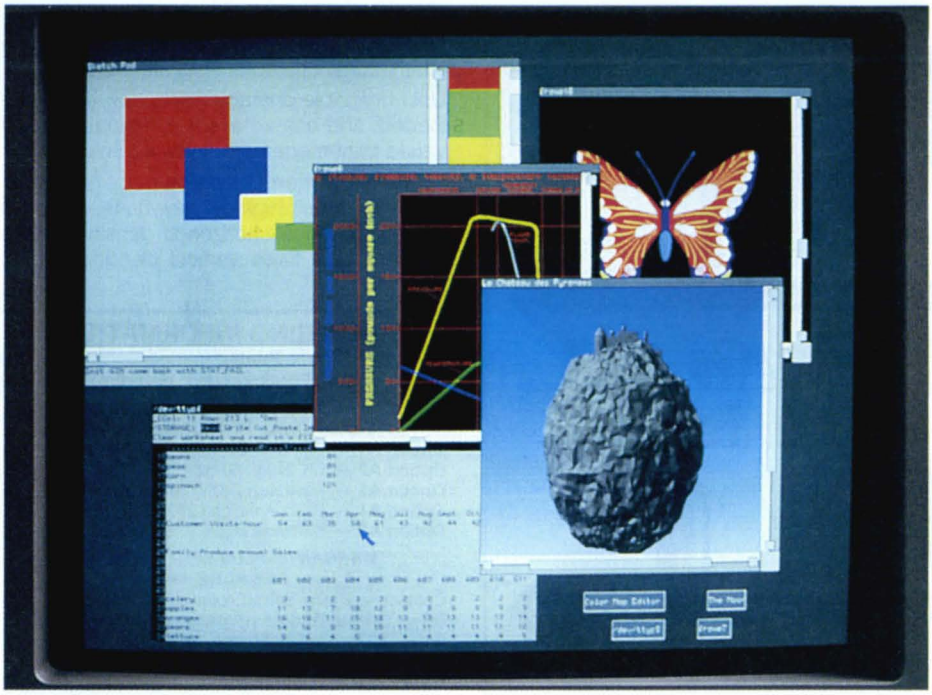
TEK WINDOW MANAGED SOFTWARE DEVELOPMENT SYSTEMS



NEW PLOT 10® TekniVIEWS™

Software for 6130 and 4132 Workstations

A Host-Based Window Management Software System

TekniVIEWS adds the power of windows to Tektronix graphics terminals and workstations. It offers heightened windowing interaction, so the user can monitor the execution of multiple programs, or move between an edited file and data.

- Runs on Tek 6130 and 4132 Intelligent Graphics Workstations, and DEC VMS-based VAX and MicroVAX systems, as part of the Tektronix Workstation Graphics Application Systems.
- Offers a broad range of window-management capabilities and three window types.
- Features more than 140 high level functions for use in porting applications software or developing new window-managed graphics applications.
- Lowers cost-per-seat by connecting several terminals to one host.
- Increases application portability by supporting multiple hosts.

Extensive Windowing Functions

A broad set of windowing functions includes pop-up menus and both vertical and horizontal scroll bars. Windows can be created, buried, uncovered, expanded, moved, reframed, collapsed and deleted. They can be divided into frames, and frames can be zoomed and scrolled separately.

Three types of windows provide extensive flexibility. Users can interact with existing applications through *Alphanumeric Windows* or through the *4014 Plus Color* emulator. No programming is required to use the alphanumeric and 4014 windows. Alphanumeric windows also can be used as personal productivity tools, running text editors, spreadsheets and database management software. 4014 Plus Color emulation windows allow existing 4010 graphics applications to run in their own windows, side by side with alphanumeric and newly-developed Graphics Layer applications.

Users can run new applications on *Graphics Layer Windows*, using TekniVIEW's full-function library of graphics and windowing subroutines. The Graphics Layer provides 120 graphics primitives to create the graphics that run within the windows created and managed by the 26 primitives in the Window Layer. Graphics Layer features include support for lines, polylines, graph text, graphic input and output attributes, the color map, segments and segment editing.

Host-Based Multiple Terminal Support

TekniVIEWS is a host-based software product that can support multiple terminals from a single workstation or host. Multiple terminal support provides added management flexibility and may lower the cost-per-seat of each windowed system. It also adds portability, and protects previous investment in workstations, terminals and hosts. Applications developed with TekniVIEWS run on standard industry platforms and support multiple terminals: Tek's 6130 Intelligent Graphics Workstation, with its UNIX-based UTek operating system, and DEC's VAX and MicroVAX systems running VMS.

Performance Plus

TekniVIEWS achieves full performance by taking advantage of the capabilities in the Tek graphics workstations. Because of these features, the host is not used for graphics processing, and windowing activities and interaction are fast—even over the standard RS-232C terminal-to-host interface.

TekniVIEWS uses the Tek terminals' Direct-Memory-Access Interface to transfer text and complex graphics images between the host and the terminal. No extra programming is required, because TekniVIEWS integrates the DMA interfacing.

TekniVIEWS supports all 2D graphics functions, except pixel operations, surfaces, multiple dialog areas and viewports. TekniVIEWS can provide each of these functions (except pixel operations): viewports are handled through panes and windows, and multiple dialog areas are handled through multiple text panes.

ORDERING INFORMATION

41P30 PLOT 10 TekniVIEWS, for Tek Workstation	**$295**
41P31 PLOT 10 TekniVIEWS, for Host	**$595**

OPTIONS

Option 0F — (41P30) 6130/UTek, Flexible Disk, 48 tpi.	**NC**
Option 0H — (41P30) 6130/UTek, Cartridge Tape.	**NC**
Option 0K — (41P31) DEC VAX/VMS, 9 Track Tape, 1600 bpi.	**NC**
Option 0L — (41P30) DEC MicroVAX/VMS, Flexible Disk, 96 tpi.	**NC**
Option 0M — (41P30) DEC MicroVAX/VMS, Cartridge Tape.	**NC**

The product is supplied as precompiled C object code requiring approximately 1.1 Mb of hard disk space. The run time module will use approximately 300 Kb when executing. User-level documentation and installation instructions are provided.

Software Marketer Licenses are available, in addition to standard end-user agreements.

CUSTOMER SOFTWARE SERVICES

A Software Update Service is available to keep your PLOT 10 TekniVIEWS current.

TekniVIEWS is a trademark of Tektronix, Inc.

NEW 4132S65

Window Managed Software Development System

Superior Graphics Performance

Powerful Local Intelligence That Offloads the Host Processor

Window Management Software Developed by the Graphics Experts

A Family of Compatible, Expandable Graphics Systems

A Broad Base of Applications Software From Industry-Leading Vendors

Offered With UTek, FORTRAN, C and Pascal

TekniVIEWS: Cost-Effective Window Management

The *NEW* 4132S65 is a software development package based on the Tek 4132 Workstation, with the 4111 Color Graphics Terminal or 4125 Color Graphics Workstation, and the *NEW* PLOT 10 TekniVIEWS.

Specifically designed for software development applications, the 4132S65 System includes an internal cartridge tape subsystem and standard high speed RS-232 ports. The standard hard disk capacity for the 4132 is 80 Mb.

TekniVIEWS is Tek's new, high performance window management software package that takes full advantage of the extensive intelligence in the Tek graphics subsystems. Users can construct graphics images as segments and perform zoom and pan functions—all of which can be stored locally in the terminal. A single command transforms the standard 4111 or 4125 terminal into a window managed display, and existing VT-100 applications can run in an interactive, windowed environment with no programming.

NEW 4130S1

Entry Level Window Managed Graphics System Based on DEC MicroVAX

Superior Graphics Performance

Powerful Local Intelligence That Offloads the Host Processor

Window Management Software Developed by the Graphics Experts

A Family of Compatible, Expandable Graphics Systems

A Broad Base of Applications Software From Industry-Leading Vendors

The 4130S1 offers the same type of features as the Tek 4132S65 System for the DEC MicroVAX environment.

The *NEW* 4130S1 is a graphics system package based on DEC's VMS-based MicroVAX II and the *NEW* PLOT 10 TekniVIEWS, with options for the Tek 4111 Color Graphics Terminal or 4125 Color Graphics Workstation.

The entry level system is a cost-effective configuration with a VMS license for one to two users, using the pedestal (BA23) cabinet, and providing 2 Mb of RAM, four serial ports, and a hard disk and cartridge tape. Networking is handled through DEC's DEQNA Ethernet connection, which is standard, and Tektronix' TCP/IP software.

NEW 4130S2

Multi-User/Expandable Window Managed Graphics System Based on DEC MicroVAX

The 4130S2 multi-user/expandable system includes all the features of the 4130S1 but adds a license for one to eight users. It features 5 Mb of RAM, eight serial ports, a 71 Mb hard disk, and cartridge tape drive plus excellent controller, all housed in the BA123 ("World Box") enclosure.

ORDERING INFORMATION

4132S65 Window Managed Software Development System **$16,540**

Includes: Intelligent Graphics Workstation with 80 Mb disk and cartridge tape subsystem and 3 Mb memory; UTek auxiliary utilities (64WP05); UTek programming support package (64WP06); Pascal (64PL31); C (64WP32); FORTRAN (64WP33); TekniVIEWS (41P30); configured software back-up (64WPS62).

4130S1 Window Managed Graphics System **$26,995**

Includes: MicroVAX II configuration (BA23 cabinet, MicroVMS 1-2 user license, 2 Mb RAM, 71 Mb hard disk, cartridge tape, 4 serial ports, Ethernet interface); cartridge tape (DEC) with preconfigured MicroVMS/TekniVIEWS plus overview manual (tape is disk-image, installable by customer); MicroVMS tape (back-up) and manuals; TekniVIEWS tape (backup), license and manuals.

4130S2 Window Managed Graphics System **$37,995**

Includes: Same as 4130S1 except 8 serial ports instead of 4, BA123 cabinet, MicroVMS 1-8 user license, and 5 Mb RAM.

OPTIONS

Option 1D — (4132S65 only) 4644 Dot Matrix Printer and parallel interface (61KP01) **+$2,150**

Option 14 — 4111 screen terminal with expanded memory, Options 2C, 4M, N1. **+$16,150**

Option 15 — 4125 high resolution terminal, Options 2B, 22, 10, 4M, N1. **+$30,640**

Option 30 — MicroVAX FORTRAN compiler, license, cartridge tape, manuals. (4130S1 and S2 only) **+$3,600**

Option 31 — MicroVAX C Programming language, license, cartridge tape, manuals. (4130S1 and S2 only) **+$3,350**

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TEK PRECONFIGURED WORKSTATION APPLICATION SYSTEMS

NEW 4132S11
Single-User Drafting System

Drafters want the power of color graphics without spending hours learning the complexities of an operating system or a new command language to get a program to work. Our application software addresses those requirements.

The single-user drafting system is based on the *NEW* Tektronix 4132 Workstation, a low-cost but powerful 32-bit system with the UNIX-enhanced UTek operating system.

The drafting software is PLOT 10® TekniCAD™, an easy-to-use, versatile program that works the way a drafter works. It also has a menu-driven interface and uses English prompts—again, no foreign commands to learn.

TekniCAD lets you create drawings easily by combining stored images or with free-form input. Special functions let you edit and update your work quickly. You can, for instance, COPY drawings or segments, automatically CHECK the accuracy of your data, and even have the system archive your drawings.

The Casual User Interface (CUI) lets you access this powerful computer and the features of the operating system through menu selections instead of cryptic commands.

Specifically designed for drafting applications, the 4132S11 system includes an internal cartridge tape subsystem with standard high speed RS-232 ports and hard disk capacity of 80 Mb.

Different types of drafting applications demand different levels of graphics performance, so a choice of optional display terminals is available. The Tek 4107A Color Graphics Terminal features a 13-inch screen, 640 x 480 pixel resolution, and a selection of 16 colors from a 64-color palette. The Tek 4109A offers the same additional performance with a 19-inch screen for complex drawings. The 4111 High Resolution Color Graphics Display Terminal is available. For the finest detail, the 4125 Color Graphics Workstation has a color 19-inch screen with 1280 x 1024 resolution. The 4125 is easily expanded to produce 3D wireframe and 3D shaded surface graphics.

The menu-picking device for the 4132S11 Single-User Drafting System is the optional Tek 4957 Graphics Tablet for use with the 4107A, 4109A, or 4125.

The Calcomp 1043 plotter has the capability to produce E-size drawings and is available as an option to meet hard copy needs.

NEW 4132S12
Two-User Drafting System

The 4132 also supports the two-user drafting system, adding a high speed dual RS-232 port and interface, additional 2 Mb of memory for a system total of 3 Mb, and a 150 Mb disk in place of the standard 80 Mb disk. The configuration includes two terminals and two graphics tablets. The optional displays and software available are the same as for the single-user system.

NEW 4130S11
Entry-Level 2D Drafting System

The 4130S11 Entry-Level Drafting System is built around the DEC MicroVAX II and runs DEC's MicroVMS operating system and PLOT 10 TekniCAD drafting software. The system supports one or two users, and houses 2 Mb of RAM, a 71 Mb hard disk, a cartridge tape, and four serial ports and Ethernet controller.

A choice of two high-performance graphics terminals or two low cost terminals is offered for the 4130S11: the 4111 Color Graphics Terminal and the 4125 Color Graphics Workstation, or two 4107A Color Graphics Terminals. Both the 4111 and 4125 provide 19-inch screens and 32-bit virtual address space for superior image quality. The 4125 has 1280 x 1024 addressable points, offering the finest detail for the most complex drawings. The 4125 also can be expanded to handle 3D wireframe and 3D shaded surface image display. The 4111 has 1024 x 768 addressable points. Both terminals display 64 colors from a palette of more than 16 million shades on the 4125, or 4096 shades on the 4111. Terminals can be added singly or in pairs. The Calcomp 1043 plotter is available as an option.

To support communication needs, DEC's Ethernet hardware interface is standard and compatible with Tek 41P37 TCP/IP software. Both 6130 and 4132 workstations and MicroVAX systems can communicate over the LAN, ensuring a high degree of flexibility.

NEW 4130S12
Multi-User/Expandable Drafting System

The 4130S12 is an expandable system that can handle multiple users. The MicroVAX comes with 5 Mb of RAM and eight serial ports, in addition to the same hard disk and cartridge tape in the entry-level system. Graphics terminals, input and output devices, and networking options are identical to those of the entry-level system.

ORDERING INFORMATION

4132S11 Single-User Drafting System **$14,110**
Includes: Intelligent Graphics Workstation with 80 Mb disk and cartridge tape subsystem; casual user interface (64AP19); PLOT 10 TekniCAD drafting software (4100P35); floor stand (016-0804-00); configured software back-up (64WPS11).

4132S12 Two-User Drafting System **$20,375**
Includes: Intelligent Graphics Workstation with 80 Mb disk and cartridge tape subsystem; 3 Mb memory; high speed dual RS-232 port (61KR01); casual user interface (64AP19); PLOT 10 TekniCAD drafting software (4100P35); floor stand (016-0804-00); configured software back-up (64WPS12).

4130S11 Drafting System **$31,995**
Includes: MicroVAX II configuration (BA23 cabinet, MicroVMS 1-2 user license, 2 Mb RAM, 71 Mb hard disk, cartridge tape, 4 serial ports, Ethernet interface); cartridge tape (DEC) with preconfigured MicroVMS and TekniCAD (4100P35) plus manual; MicroVMS tape (back-up) and manuals; TekniCAD tape (back-up); license and manuals.

4130S12 Drafting System **$42,995**
Includes: MicroVAX II configuration (BA23 cabinet, MicroVMS 1-8 user license, 5 Mb RAM, 71 Mb hard disk, cartridge tape, 8 serial ports, Ethernet interface); cartridge tape (DEC) with preconfigured MicroVMS and TekniCAD (4100P35) plus manual VMS tape (hook-up) and manuals; TekniCAD tape (back-up); license and manuals.

OPTIONS (4132S11/4132S12)

Option 10 — Calcomp 1043 Plotter. 61KR01 High Speed RS-232 Interface (4132S12). **+$10,800**

Option 12 — 4107A Color Graphics Terminal. **+$6,995**

Option 14 — 4111 High Resolution Color Graphics Terminal, Options 2C, 1 Mb RAM, N1. **+$16,050**

Option 15 — 4125 High Performance Graphics Workstation, Options 2B, 10, 22, N1, includes 4 bit planes and 768 Kb RAM. **+$30,490**

OPTIONS (4130S11/4130S12)

Option 10 — Calcomp 1043 plotter, supplies, service agreement. **+$10,800**

Option 14 — 4111 High Resolution Color Graphics Terminal, Options 2C, N1. **+$16,050**

Option 15 — 4125 High Performance Graphics Workstation, Options 2B, 22, 10, N1. **+$30,490**

Option 22 — Two 4107A low cost terminals. **+$13,990**

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TekniCAD is a trademark of Tektronix, Inc.

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The 4132 Technical Data Analysis and Presentation System is displayed on the Tek 4107A terminal, with hard copies produced by the Tek 4696 Color Ink-Jet Printer.

NEW 4132S71

Technical Data Analysis System

GPIB IEEE-488 The 4132S71 complies with IEEE Standard 488-1978 and with Tektronix *Standard Codes and Formats.*

The Technical Data Analysis System is based on the 4132 Intelligent Graphics Workstation, a low-cost, powerful 32-bit system with the UTek™ Operating System.

The system includes the Minitab Statistics Package, a general-purpose package that facilitates data analysis and produces graphs of analyzed data. Capabilities include: regression analysis, residual analysis and stepwise procedures, analysis of variance, nonparametric methods, time series analysis, and matrix operations.

For those users with 4050 Desktop Computers who want to expand their system capability, we are providing TBASIC. Based on the proposed ANSI standard, it allows you to recompile 4050 BASIC programs with a minimum of changes. TBASIC also offers excellent color graphics and GPIB support.

Software was chosen to make the analyst's job easier. For example, the Casual User Interface (CUI) lets the user access the features of the operating system through menu selections instead of computer commands.

The system includes an internal cartridge tape subsystem, a standard high speed communications board, and an 80 Mb hard disk.

We're offering several optional display terminals to accommodate various graphing needs. The 4105A Color Graphics Terminal features a 13-inch screen, 480 x 360 pixel resolution, and a selection of eight colors from a 64-color palette. The 4109A offers 640 x 480 pixel resolution with a 19-inch display that is more appropriate for dense graphics. It features 16 colors from a palette of 4096 for greater differentiation of data.

For archival purposes, we've selected the 4696 Color Ink-Jet Printer (page 73), a color ink-jet printer with the capability to produce color copies and transparencies.

NEW 4132S73 Technical Data Analysis and Presentation System

GPIB IEEE-488 The 4132S73 complies with IEEE Standard 488-1978 and with Tektronix *Standard Codes and Formats.*

Our Technical Data Analysis and Presentation System is based on TekniCAP™ software (see page 66) running on the 4132.

An important requirement of many TDA applications is the ability to present the results of the analysis. PLOT 10® TekniCAP software automates the creation and production of color presentation graphics. This menu-driven program lets users create professional-looking graphics quickly and easily.

Special enhancements of UTek let scientists and researchers get up to speed fast and take advantage of the powerful features of the UNIX-based operating system. The Auxiliary Utilities provide on-line documentation for the operating system, as well as text processing utilities.

As with the 4132S71 Technical Data Analysis System, this system includes TBASIC which allows you to recompile 4050 BASIC programs with a minimum of changes. TBASIC also offers excellent color graphics and GPIB support.

Besides the 4696 ink-jet printer, the 4692 Color Graphics Copier (page 73) is optionally available. This high resolution copier (154 dots per inch) produces graphics with precise registration and rich, saturated hues. It also produces transparencies as well as copies. The 4510A Color Graphics Rasterizer (page 73) can be used with the 4692 to further improve the resolution and to expand the color palette to over 274,000 selectable colors.

Analyze the Results for Yourself

With either of these application solutions, you have the flexibility to expand your system and to add other application software to keep pace with your needs.

ORDERING INFORMATION

4132S71 Technical Data Analysis System **$13,495**

Includes: Intelligent Graphics Workstation with 80 Mb disk and cartridge tape subsystem; TransEra TBASIC (TBASIC); casual user interface (64AP19); Minitab Statistics package (64AP22); configured software backup (64WPS71).

4132S73 Technical Data Analysis and Presentation System **$14,185**

Includes: Intelligent Graphics Workstation with 80 Mb disk and cartridge tape subsystem; TransEra TBASIC (TBASIC); casual user interface (64AP19); UTek Auxiliary utilities (64WP05); PLOT 10 TekniCAP presentation software (4000P60); configured software backup (64WPS73).

OPTIONS

Option 1C — 4696 Color Ink-Jet Printer. **+$1,795**

Option 1E — 4510A Color Graphics Rasterizer, Option 31, 512 Kb Memory, 4692 Color Graphics Copier. **+$13,790**

Option 11 — (4132S71 only) 4105A Color Graphics Terminal. **+$3,495**

Option 12 — (4132S73 only) 4107A Color Graphics Terminal. **+$6,995**

Option 13 — 4109A Large Screen Color Graphics Terminal. **+$8,995**

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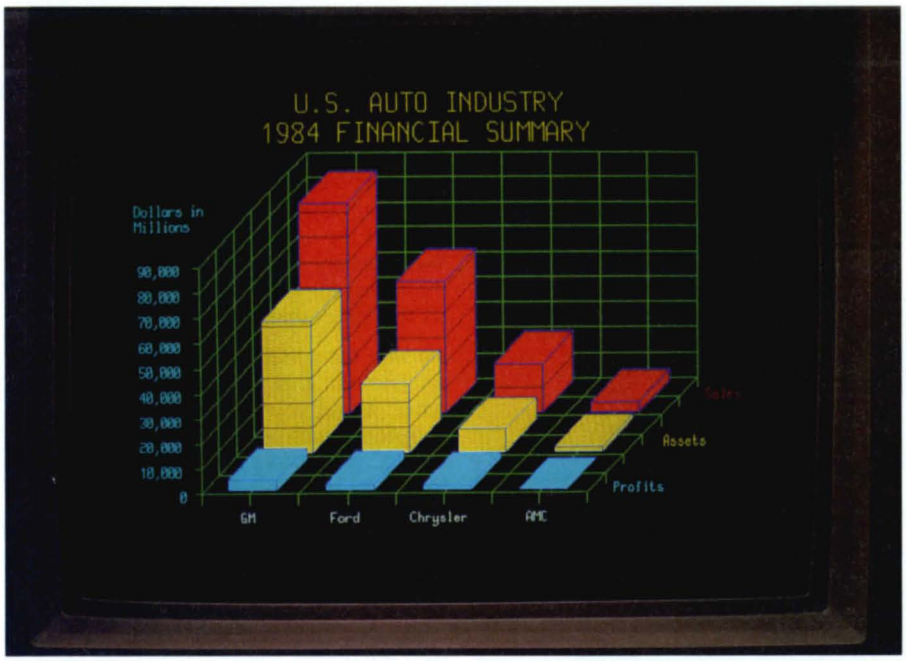


PLOT 10 GDI.

PLOT 10®

Graphics Software for 4100/4100A/4200 and 4110/4120 Series Terminals

Tektronix has been setting graphics standards for over a decade. Our products reflect the implementation of the evolving international standards and the concepts that underlie those standards—software portability and device independence. The goal is to protect your software investment and provide a hardware growth path, and Tek software is designed to meet your changing needs.

Tektronix offers PLOT 10 products to make that goal a reality. PLOT 10 software takes advantage of the graphic capabilities of the 4010, 4100, 4100A, 4200, 4110, and 4120 Series computer display terminals together with our color copiers and tablets.

PLOT 10 includes applications software as well as powerful tools to build applications to suit your specific needs.

Software Support

When you buy Tektronix software, you are also investing in the people and services behind the product. A Software Update Agreement provides current releases of Tek licensed software products, updates to the documentation, along with additional information on applications and enhancements. The TAS (Technical Assistance Services) are designed to supplement your own resources and to provide training as well as short-term consulting during your software implementation. These combined programs help you get maximum benefit from your Tektronix software products.

Peripheral Support for Device-Independent Graphics

PLOT 10 products are packaged with device drivers for graphics hardware products. Applications can be written without concern for the physical attributes of a device because the specifics reside in these device-dependent software modules. Many non-Tektronix products are advertising PLOT 10 compatibility; a special driver may not even be needed. PLOT 10 GKS includes drivers for Tektronix terminals and digitizing tablets as well as selected DEC and IBM graphics terminals. In addition, a device driver model and its documentation are provided offering the professional programmer a tool to develop drivers for non-Tek devices. PLOT 10 IGL and GKS also include a full complement of device drivers to support the entire 4100/4100A/4200 and 4110/4120 lines, and selected DEC and IBM graphics terminals.

Software Portability

Portability has always been the ultimate goal of the graphics standards efforts. Now it is not only possible to transport applications to a variety of host computers, but it is also possible to move applications to workstations.

Existing applications on the host can be downloaded to workstations and run locally, thereby increasing interactivity and saving storage costs.

Product overviews and specification data follow. We invite you to ask your local Tektronix Sales Engineer for a demonstration.

PLOT 10 APPLICATIONS SOFTWARE

PLOT 10 application software has been built to take full advantage of the powerful features included in the 4100/4100A/4200 and 4110/4120 terminals.

PLOT 10 TekniCAD™ (Computer-Aided Drafting)

PLOT 10 TekniCAD is a complete computer-aided drafting system for producing and maintaining design documentation. It is an interactive system that enables you to construct geometry, create and store specialized symbols, and annotate and dimension drawings quickly, simply, and accurately.

TekniCAD performs standard drafting functions through a highly responsive user interface. This allows drafters, engineers, scientists and technical illustrators to create high quality drawings without extensive training or knowledge of complex command languages.

TekniCAD adheres to both ANSI Y14 and ISO drafting standards, and is still flexible enough to be easily adapted to individualized drafting standards.

Tektronix PLOT 10 CADDport, a related product, provides a link between TekniCAD and computer-aided design packages of other vendors. This allows TekniCAD to function as the drafting component of a complete CAD/CAM system.

PLOT 10 TekniCAP™ (Computer-Aided Presentations)

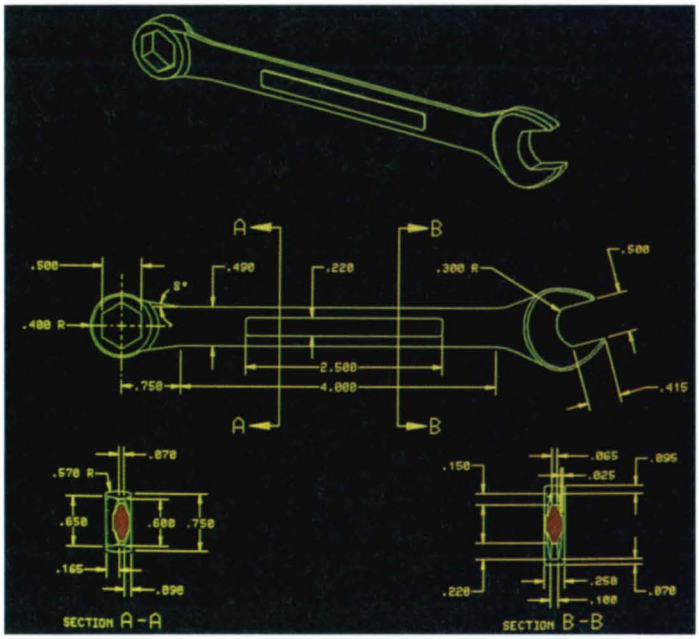
PLOT 10 TekniCAP is designed especially for the production of high-quality graphics for business and technical presentations. TekniCAP makes it easy to show the results of data analysis programs, to prepare overhead transparencies and 35 mm slides, and to create illustrations and designs for color graphics applications.

The TekniCAP package includes a data graphing module that lets you create line graphs, bar graphs, and pie graphs, either from data entered at the keyboard or from an existing data file. But TekniCAP is much more than a graphing package. It includes nine separate *modules*, each designed to facilitate the production process. These modules help you prepare formatted lists with bulleted or numbered items, create standard data graphs, place multiple graphs or pictures on a single display, and even schedule a series of displays for automatic output to a color hard copy device. And the menu system and defaults built into all TekniCAP modules make it easy to learn and to use.

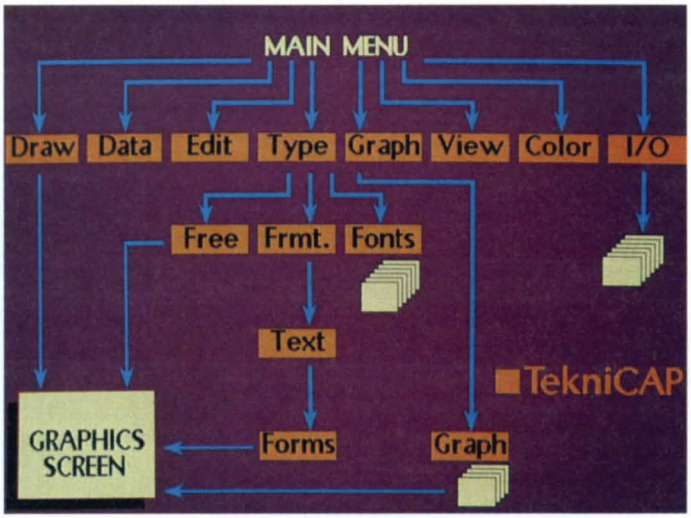
Color is a major part of presentation graphics, and TekniCAP makes it easy to select just the colors you want. Palettes are defined and optimized for various hardware configurations and requirements. Or you can define your own colors, using any color from the terminal's color palette.

Additional key features include the ability to bring in outside graphics files and annotate them for presentations. Spooling to output devices is included also.

TekniCAD and TekniCAP are trademarks of Tektronix, Inc.



PLOT 10 TekniCAD



PLOT 10 TekniCAP

PLOT 10 STANDARD TOOLS

PLOT 10 Standard Tools consist of seven software packages, each optimized for different graphics applications: Graphic Spooler Interface, TekniVIEWS Graphical Kernel System, Interactive Graphics Library, Terminal Control System, Software Terminal Interface, and Graphic Display Interface.

NEW PLOT 10 TekniVIEWS

PLOT 10 TekniVIEWS brings host-based window management software to the software developer. TekniVIEWS runs on Tek 4132 and 6130 workstations, and provides a broad range of window-management capabilities and more than 140 functions for porting applications software. See page 62 for more information.

NEW PLOT 10 Graphic Spooler Interface (GSI)

The NEW PLOT 10 GSI provides a user-friendly method of sending IBM GDDM-based graphics to the Tek CX4692S and CX4696S Color Graphics Output Systems, which consist of the CX4510A Color Graphics Rasterizer, bundled with the CX4692 Color Graphics Copier or the *NEW* CX4696 Color Ink-Jet Printer. The Graphic Spooler Interface allows the user to make presentation-quality color hard copies independent of the terminal used to create the image. The PLOT 10 GSI converts ADMGDF graphics primitives into a format that can be spooled to the CX4692S or CX4696S. The same high quality color copies can be produced from PLOT 10 IGL and PLOT 10 GKS applications that produce ADMGDF output files.

The PLOT 10 GSI uses IBM concepts to offer interfacing versatility. It also provides the flexibility to specify the number of copies to be made, paper or transparency copies, color map information, and more. GSI recreates the 16 default patterns and colors available with GDDM. Panels can be filled with solid colors instead of patterns with no impact to copy times. Support for GDDM programmed symbol cells is provided through a simple modification to GDDM symbol set libraries, identical to that required for support of IBM plotters.

PLOT 10 Graphical Kernel System (GKS)

PLOT 10 GKS is a FORTRAN '77 subroutine library certified as conforming to the GKS International Standard ISO/IS 7942, Level 2B and ANSI/ANS X3.124 1985. PLOT 10 GKS extensively supports the engineering and scientific workstation environment for a variety of technical data analysis and CAD/CAM applications. Capabilities include 2D graphics, color control, workstation control, text manipulation and fonts, segments, and separate window-viewport control of interconnected devices.

PLOT 10 Interactive Graphics Library (IGL)

PLOT 10 IGL is a library of FORTRAN '77 subroutines based on the SIGGRAPH Core proposal, designed for use in the development of application programs requiring 2D and 3D graphics output. The approach used is independent of display technology and provides full control of color displays, line smoothing and contouring algorithms, and high-resolution graphics text fonts. Both simple and intelligent terminals are supported, including emulation of many features for device independence as well as model input/output routines.

PLOT 10 Terminal Control System (TCS)

PLOT 10 TCS is a FORTRAN '66 subroutine library designed to aid the graphics application programmer. The system is designed specifically for the Tektronix 4010 Series terminals and the 4105A terminal. TCS modules include graphing routines, software character fonts, and graphics tablet support.

PLOT 10 Software Terminal Interface (STI)

PLOT 10 STI is a FORTRAN '77 subroutine library for device driver development designed for the Tektronix 4200, 4100, 4110, and 4120 Series terminals. Working at a low level and directly accessing terminal firmware features, STI is intended to be used by experienced graphics applications programmers and system programmers.

PLOT 10 Graphic Display Interface (GDI)

PLOT 10 GDI is a FORTRAN '77 program which allows graphics applications developed with IBM GDDM to display on Tektronix coax terminals. This is accomplished by translating ADMGDF (Graphics Data Format) file primitives produced by GDDM into Tektronix 4100 display format. Existing GDDM applications, such as the Interactive Chart Utility, are easily displayed on Tektronix coax devices. This allows the user to enjoy the high performance and interactivity of the Tektronix terminals without sacrificing the ability to use existing GDDM applications.

ORDERING INFORMATION

Please contact your local Sales Engineer.

Artificial Intelligence: A Productivity Tool
Building on the 4404 AI System, Tek now broadens its AI family to include the 4405 with increased processing power and the 4406 with its high speed 16 MHz Motorola 68020 32-bit microprocessor and 68881 co-processor. The Tek AI family offers a powerful range of capabilities for application developers, researchers, software engineers, and computer scientists at prices well below the industry norm.

The 4400's advanced languages make it an excellent exploratory programming and software prototyping tool.

All the major AI languages in use today are represented on the 4400 including Tek Common LISP, Smalltalk-80, Prolog and Franz LISP. This offers AI researchers and developers a clear choice of programming environments—all accessible from a single desktop device, all fully compatible with the entire 4400 Series Artificial Intelligence Systems.

A quick review of the specifications (see box) clearly shows the performance of the 4406 and 4405 is comparable to systems that cost significantly more. AIM expects these new AI systems, based on optimized architecture and powerful, low-cost, general-purpose components, to capture a major portion of the emerging AI market because of their outstanding price/performance.

4400 SERIES SELECTION GUIDE

Features	4404	4405	4406
Architecture	68010 @ 10 MHz 32081 Floating point co-processor	68020 @ 16 MHz 68881 Floating point co-processor	68020 @ 16 MHz 68881 Floating point co-processor
Display			
Size	13 inch monochrome	13 inch monochrome	19 inch monochrome
Viewable Points	640 x 480	640 x 480	1376 x 1024
Addressable Points	1024 x 1024	1376 x 1024	1376 x 1024
Input Devices	Joydisk, mouse	Joydisk, mouse	Joydisk, mouse
Software			
Operating System	UNIX-like OS with 8 Mb Virtual memory address space	UNIX-like OS with 32 Mb Virtual memory address space	UNIX-like OS with 32 Mb Virtual memory address space
Languages			
Standard	Smalltalk-80	Smalltalk-80	Smalltalk-80
Optional	Tek Common LISP® Franz LISP Prolog	Tek Common LISP Franz LISP Prolog	Tek Common LISP Franz LISP Prolog
Memory			
Standard	1 Mb dynamic RAM	1 Mb dynamic RAM	2 Mb dynamic RAM
Optional	Additional 3 Mb	Additional 4 Mb	Additional 4 Mb
Communications			
Standard	RS-232C Centronics parallel SCSI ANSI X3.64 emulation	RS-232C Centronics parallel SCSI ANSI X3.64 emulation	RS-232C Centronics parallel SCSI ANSI X3.64 emulation
Optional	IEEE Ethernet	IEEE Ethernet	IEEE Ethernet
Mass Storage			
Standard	45 Mb hard disk 5¼ inch, 320 Kb flexible	45 Mb hard disk 5¼ inch, 320 Kb flexible	90 Mb hard disk 5¼ inch, 320 Kb flexible
Optional	90 Mb hard disk & streaming tape drive	90 Mb hard disk & streaming tape drive	90 Mb hard disk & streaming tape drive
Page	69	69	69
Prices Begin At	**$11,950**	**$14,950**	**$23,950**

Artificial Intelligence Systems

- Smalltalk-80 Programming Environment
- 32-Bit CPU
- Floating Point Co-Processor
- Large Dynamic RAM
- Multitasking, Hierarchical File System
- C Compiler With Standard I/O Library
- Several Programming Language Options
- Large Hard Disk, Floppy
- High Resolution Display
- Virtual Memory Operating System
- Three-Button Mouse
- Low Profile Detached Keyboard; 14-Key Numeric Keypad; Four Special, Eight Dedicated Programmable Function Keys; Key Roll-Over and Joydisk
- Programmable Sound Generator
- Crystal-Controlled Clock/Calendar With Battery Backup
- ROM/EPROM Expansion Sockets

4404 AI System

The Tektronix 4404 Artificial Intelligence System provides a powerful, highly interactive environment for AI research and development. A low-cost desktop system, the 4404 sets a new price/performance standard for AI applications such as expert systems, natural languages, vision systems, theorem proving, intelligent robotics and automatic programming.

The 4404 comes standard with a high speed, proprietary implementation of Smalltalk-80, an extensible, object-oriented language which supports rapid prototyping and exploratory programming. Smalltalk-80, in conjunction with the 4404 display capabilities, offers the most sophisticated user interface available for AI program development.

A bit-mapped graphics display with mouse input is closely coupled to the processor for a state-of-the-art user-interface. The 13-inch monochrome display has a 640 x 480 pixel resolution and operates at 60 Hz, noninterlaced. It functions as a window into a 1024 x 1024 bit-map memory with smooth panning whenever the cursor reaches a physical display edge. The bit-mapped display facilitates advanced concepts such as overlapping windows, "pop-up" menus and pointing with the mouse. Graphics performance makes screen animation possible. The full keyboard provides programmable function keys and a joydisk.

4405 AI System

The Tektronix 4405 Artificial Intelligence System joins the Tek 4404 and 4406 to offer a complete family of AI application development tools and delivery systems. The Tek 4405 offers a complete, state-of-the-art, personal AI development system that rivals units costing much more.

Delivering significantly more processing power than the 4404, the 4405 is ideally suited for larger AI efforts. It provides all the software and hardware capabilities needed for developing major artificial intelligence programs.

As with the 4404, the Smalltalk-80 programming environment is included standard with the 4405.

4406 AI System

The Tektronix 4406 Artificial Intelligence System is the highest performance member in the compatible 4400 Series AI Systems. The 4406 has the power and memory to handle even the most complex AI programs with speed and efficiency. The system includes a 32 Mb virtual memory address space, a full 2 Mb of dynamic RAM (expandable to 6 Mb) and a 90 Mb hard disk. The optional 4944 Mass Storage Unit further enhances 4406 performance by providing incremental 90 Mb hard disk back-up. The 4406 inherits the innovative design and advanced manufacturing techniques pioneered by the 4404. Employing VLSI architecture and 32-bit data paths, the 4406 is nearly twice as powerful as the 4404. It is equally appropriate for AI research, application development, or as a cost effective delivery system.

AI Programming Environments

The 4406 supports all the popular AI programming languages in use today. Smalltalk-80, Tek Common LISP, Prolog, and Franz LISP all run on the 4406. Programs developed on the Tektronix 4404 and 4405 are upwardly compatible with the 4406.

CHARACTERISTICS

Size — 4404/4405:330 mm (13 in). 4406: 482.6 mm (19 in).
Viewing Area — 4404/4405: 241 mm x 178 mm (9.5 in x 7 in). 4406: 356 mm x 267 mm (14.0 in x 10.5 in).
CPU — 4405/4406: Motorola 68020. 4404: 68010.
Floating Point Co-Processor — 4405/4406: Motorola 68881. 4404: National Semiconductor 32081.
Dynamic RAM — 4404/4405: 1 Mb. 4406: 2 Mb.
Terminal Emulation — ANSI X3.64; 80 characters x 32 lines.
Viewable Points — 4404/4405: 640 x 480. 4406: 1376 x 1024.
Addressable Points — 4404: 1024 x 1024. 4405/4406: 1376 x 1024.
Max Baud Rate — 9600 baud.
Flexible Disk Capacity — 320 Kb.
Hard Disk Capacity — 4404/4405: 45.0 Mb. 4406: 90.0 Mb.
Communications Interfaces — SCSI, RS-232C, Hard Copy.
Line Voltage Ranges — 87 V ac to 128 V ac, 174 V ac to 250 V ac.
Line Frequency — 48 Hz to 66 Hz.
Operating Power — < 200 W.

PHYSICAL CHARACTERISTICS 4400 CPU MODULES

	4404, 4405		4406		Mass Storage (All)	
Dimensions	**mm**	**in**	**mm**	**in**	**mm**	**in**
Width	419	16.5	553.7	21.8	368.3	14.50
Height	353	13.9	429.3	16.9	127.6	5.03
Depth	495	19.5	566.4	22.3	433.1	17.05
Weights ≈	**kg**	**lb**	**kg**	**lb**	**kg**	**lb**
Net	20.0	44.0	31.8	70.0	6.35	14.0

Ordering Information—see next page.

ORDERING INFORMATION

4404 Artificial Intelligence System	**$11,950**
4405 Artificial Intelligence System	**$14,950**
4406 Artificial Intelligence System	**$23,950**

HARDWARE OPTIONS

Option 01 — (4404 only) 1 Mb additional memory.	**+$1,750**
Option 02 — (4405, 4406 only) 2 Mb additional memory.	**+$3,500**
Option 03 — (4404 only) 3 Mb additional memory.	**+$5,250**
Option 04 — (4405, 4406 only) 4 Mb additional memory.	**+$7,000**
Option 10 — Ethernet Interface.	**+$2,000**
Option 21 — (4404, 4405 only) 90 Mb Hard Disk.	**+$2,500**

INTERNATIONAL POWER PLUG OPTIONS

Option A1 — Universal Euro 220 V, 50 Hz.
Option A2 — UK 240 V, 50 Hz.
Option A3 — Australian 240 V, 50 Hz.
Option A4 — North American 240 V, 60 Hz.
Option A5 — Switzerland 220 V, 50 Hz.

Smalltalk-80

Extensible, Object-Oriented Programming

Bit-Mapped Graphics User Interface

Designed for Exploratory Programming

Smalltalk-80 combines an object-oriented programming language with the most advanced user-interface available. Pioneered at Xerox PARC, Smalltalk-80 permits exploratory programming through rapid prototyping and experimentation. Smalltalk-80 provides an interactive approach to solving complex problems.

High Performance Implementation

Tektronix' implementation of Smalltalk-80, combined with the powerful hardware architecture of the 4400 Series, provides graphic response fast enough to support screen animation under direct control of Smalltalk-80.

Smalltalk-80 satisfies the needs of programmers in the AI field and is ideal for AI research and development. Smalltalk-80 can be extended by defining new instances of an object class (each with its own internal state) or by defining an entirely new object class with a distinct set of rules and default behavior. The class structure of Smalltalk-80 provides both multiple inheritance and hierarchical inheritance mechanisms. Over 200 predefined classes support the data and control abstractions most commonly used in AI applications development.

Original Windowing System

Bit-mapped graphics and window management were originally developed for Smalltalk-80. The Smalltalk-80 *Model-View-Controller* window-based manager supports the creation of new window-based applications. Multiple processes are supported with a virtually unlimited number of overlapping windows.

Smalltalk-80 supports primitive graphic functions such as scaling, translation, rotation, logical combination of pixels and text attribute modification through its integral "BitBlt" operator.

Virtually any activity—text editing, file manipulation, compilation, execution, debugging—can be performed at any time, regardless of the current state. The user simply "opens" another window and proceeds with the new operation. Smalltalk-80 allows immediate access to any of its subsystems, whether user-defined or predefined, for inspection or modification.

PROLOG

Configured for 4400 Series AI Systems

Interactive Development Support

Modular Development Capability

PROLOG, as implemented on the 4400 Series, is a unique language that allows programmers to solve problems by specifying what answers are needed rather than describing a detailed solution procedure. PROLOG is non-procedural, based entirely on logical relationships or rules, among an assortment of facts.

PROLOG operates on the principle of "controlled deduction." The programmer creates a network of facts and rules that describe the known relationships between the elements of a problem. Once the logical network is defined, PROLOG makes logical inferences from the relationships when queried by the programmer. These characteristics make PROLOG ideal for many AI applications including expert systems, natural language processing, data base query languages and automatic programming systems.

Performance for Complex Problems

PROLOG makes complex problems easier to solve and reduces program development time. The inherent efficiency of PROLOG is enhanced by the power of the 4400 Series hardware. The PROLOG system is an ideal vehicle for both software development and end-user AI applications. PROLOG is one of the acknowledged languages in artificial intelligence technology. Now, Tektronix adds the programmer productivity and application development tools needed to move AI into the marketplace.

Ordering Information—See Next Page.

TEK® Common LISP

A Full Common LISP Implementation

Optimized for 4400 Systems

Rapid Prototyping of AI Concepts

Run Time Compiler for Optimized Machine Code

TEK Common LISP has been specifically optimized and enhanced for the Tektronix 4400 Series. It provides AI researchers and software developers with a personal LISP programming environment previously available only on dedicated LISP machines.

Common LISP was conceived by a large committee of academicians and AI researchers as a language that would incorporate the very best features of other LISP dialects. Tek Common LISP is a full implementation of this language (as specified in "Common LISP, the Language" by Guy Steele). It offers a much richer set of data types and more complex program structures than other LISP dialects currently in use.

A New Standard

Common LISP is considered by many artificial intelligence experts to be a new industry standard for AI programming environments. This consensus is reflected in the general parameters established for the language:

Commonality: Common LISP focuses the features of several different implementations of LISP into a common dialect.

Portability: Applications written in Common LISP are easily ported to any Common LISP implementation.

Expressiveness: Common LISP is a very rich language that employs the most valuable constructs from other LISP dialects.

Efficiency: Common LISP has features designed to facilitate the production of fast, high-quality compiled code.

Compatibility: Since Common LISP is derived from a number of popular dialects, code from other LISP dialects should readily map into Common LISP.

Additional Tek Common LISP Features

Additional features include a powerful optimizing compiler with built-in debugging features; lexically scoped interpreter and compiler; full featured package system for symbol name differentiation; rich collection of numerical primitives and built-in functions; built-in garbage collector and dynamic storage management; complete implementation of arrays, vectors and strings; flexible interactive user interface; flexible debugging aids; powerful facilities for structures and macros; lexical closures; built-in user-extensible data type facility; and built-in user-extensible parser and hash-table facility.

The rich set of primitives available in Common LISP makes the language an appropriate candidate for expert systems, natural language interfaces, and all types of symbolic programming. Tek Common LISP goes beyond the specifications of the language to provide online documentation; a user-definable error handler; powerful and robust foreign function interfaces to C and FORTRAN programs and a built-in Flavors system for object-oriented programming.

Ordering Information—See Next Page.

TEK Common LISP is a registered trademark of Tektronix, Inc.

Franz LISP

Configured for 4400 AI Systems

Full-Featured Development Language

Optimizing Compiler Generates 4400 Series Machine Code

A commercial derivative of the MacLISP language from MIT, Franz LISP is the long-time favorite for AI programming because of its uniqueness as a high-level machine language for symbolic processing. Many natural languages and expert systems have been built using the recursive programming facilities of LISP. Traditionally, LISP has resided only on expensive mainframe computers. Now, Franz LISP is available on the 4400 Series Artificial Intelligence Systems.

A Powerful AI Programming Environment

4400 Series LISP is a programming environment that includes many tools to enhance research and development. Besides the popular language primitives, functions and data types, LISP contains a powerful macro facility, and allows programs written in other languages to be called. The system supports separately compiled functions, UNIX-like file accessing, and I/O redirection.

The language provides dynamic storage allocation and garbage collection. It provides operators for creation, accessing, and manipulation of data types, data type determination, and structure comparison. Users may create their own data types out of vectors and specify how standard system functions, like *print*, should handle them.

Franz LISP provides simple arithmetic functions, arithmetic predicates, trigonometric functions, "bignum" functions and a host of conversion and special purpose arithmetic functions. It includes a set of operators to allow dynamic error indication and recovery, with nonstandard control flows, through the powerful *catch*, *throw* and *errset* functions.

Franz LISP in the 4400 Series environment provides many functions for communicating with I/O devices, including I/O redirection to and from files. It supports UNIX-like disk file operations such as direct file access with the *fseek* function, allowing reading or writing at random locations within a file.

Many system functions allow interaction with internal components of LISP and the operating system. These include new process generation from within a program with the process and signal functions.

ORDERING INFORMATION

4400P31 PROLOG Programming Language	**$3,000**
4400P33 Tek Common LISP Programming Language	**$3,500**
4400P30 Franz LISP Programming Language	**$3,000**

OPTIONS

Option 02 — (Franz LISP) 5¼ Floppy Media.	**NC**
Option 04 — 4404	**NC**
Option 05 — 4405	**NC**
Option 06 — 4406	**NC**

NEW 4400 UNIX EMACS Editor

An extensible display editor used for typing and modifying documents, programs, or other kinds of text, the EMACS uses a display to interact with the user, keeping an accurate representation of what is happening in the text visible on the screen. EMACS interacts with the user through several windows and a line at the bottom of the terminal screen for messages and questions from EMACS.

Extensibility

This is the feature that distinguishes EMACS from most other editors, allowing the user to tailor EMACS to individual requirements and design.

Interactive Help Menus

The detailed menus ensure smooth operation and understanding of EMACS help areas, commands, and key functions.

Buffers and Windows

The EMACS user views the buffer—the section of text being edited—through a window. A buffer may be viewed in several windows, so the user can work on or examine several different areas of a file at the same time. Similarly, two different buffers can be viewed in two different windows simultaneously.

Other EMACS features include definable macros to identify and facilitate working with blocks of program or text, an interpreter for a language similar to LISP, debugging tools, program structure commands, and the ability to handle multiple interactive subprocesses.

ORDERING INFORMATION

4400P32 UNIX EMACS Editor	**$500**

OPTIONS

Option 01 — 4404	**NC**
Option 02 — 4405	**NC**
Option 03 — 4406	**NC**

NEW 4944 Mass Storage Unit

Compatible With Tek 4400 Artificial Intelligence Systems, 4132 and 6130 Intelligent Graphics Workstations, and 4120 Color Graphics Workstation

Removable 45 or 60 Mb Streamer Tape

Standard SCSI Interface

45 or 90 Mb Disk Drives

To satisfy a variety of customer requirements, this mass storage unit offers a flexible combination of streamer tape, hard disk, and floppy disk drives.

Options

- Two 45 Mb and 90 Mb capacity high performance, Winchester disk drives, with seek time of less than 30 μsec and track to track access time of less than 6 μsec.
- Dual 5.25 inch double density, single- or double-sided, flexible disks, with average access time of 93 ms and formatted capacity of 327 Kb.
- 4944 streamer tape drive operating at 90 inches per second and transferring data at a maximum rate of 86.7 Kb per second, making it ideal for quick back-up and restoring information stored on hard disks.

4944 options have been tailored for use with a variety of Tektronix host computers and terminals: 4400 Series Artificial Intelligence Systems, 4132/6130 Intelligent Graphics Workstation, and 4120 Color Graphics Workstations.

ORDERING INFORMATION

4944 Mass Storage Unit **$1,000**

Includes: Power cord (161-0066-00); two meter SCSI cable (012-1117-00); instruction manual (070-5978-00); SCSI terminator (011-0090-00); DC300XL tape cartridge (119-0680-00).

OPTIONS (4400 Series)

Option 01 — 60 Mb streamer tape.	**+$2,500**
Option 02 — 90 Mb disk.	**+$5,500**
Option 03 — 60 Mb streamer tape/90 Mb disk.	**+$8,000**

OPTIONS (4132/6130 Series)

Option 11 — 60 Mb streamer tape.	**+$2,500**
Option 12 — 90 Mb disk.	**+$5,500**
Option 14 — 60 Mb streamer tape/45 Mb disk.	**+$6,000**
Option 15 — 60 Mb streamer tape/90 Mb disk.	**+$8,000**

OPTIONS (4120 Series)

Option 21 — 45 Mb disk.	**+$3,200**
Option 22 — 45 Mb disk/dual floppies.	**+$4,500**

FIELD INSTALLED KITS

4944F01 — 60 Mb streamer tape.	**$2,750**
4944F02 — 90 Mb fixed hard disk.	**$5,750**

INTERNATIONAL POWER PLUG OPTIONS

Option A1 — Universal Euro 220 V, 50 Hz.
Option A2 — UK 240 V, 50 Hz.
Option A3 — Australian 240 V, 50 Hz.
Option A4 — North American 240 V, 60 Hz.
Option A5 — Switzerland 220 V, 50 Hz.

***WARRANTY-PLUS* SERVICE PLANS**
SEE PAGE 496

Contact your local Sales Engineer for prices.
S0 — On-Site Product Installation and Set-Up.
S1 — 1 Year On-Site Service.
S2 — 2 Years On-Site Service.
S3 — 3 Years On-Site Service.
S9 — Software Subscription Agreement.

OPTIONAL ACCESSORIES

SCSI Cables —
(25 inch) 4944 to 4944 or 4926 or 61TC01. Order 012-1178-00 **$150**
(2 m) 4944 to 4400 or 4120. Order 012-1117-02 **$250**
(2 m) 4944 to 4132/6130. Order 012-1146-00 **$140**

SCSI Interface — For 4132/6130. Order 61KP04 **$800**

DC600A Tape Cartridge — Order 119-1463-00 **$47**

PROLOG and Common LISP are registered trademarks of Tektronix, Inc.

Tek 4696 Color Ink Jet Printer (left), 4510A Color Graphics Rasterizer (center), and 4692 Color Graphics Copier.

TEKTRONIX COLOR OUTPUT SOLUTIONS

The Tektronix 4690 Series ink-jet printers offer high quality output on paper or transparency material. The *NEW* 4696 Ink-Jet Printer is a personal printer for producing screen copies or plots. The 4692 Color Graphics Copier handles higher volume printing applications.

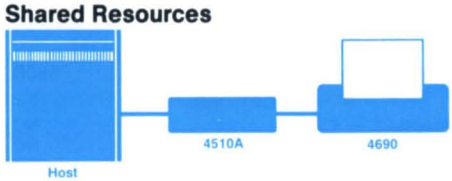
The 4510A Rasterizer enhances 4690 Series quality and speed, while making it possible to connect the 4692 and 4696 directly to a host computer or other data source. The 4510A, in conjunction with the 4690 Series, forms cost-effective color output systems with considerable configuration flexibility.

Screen Copying

The 4690 Series color printers can attach directly as screen copiers to the full range of Tektronix color display terminals and workstations. Screen copying provides a simple, cost-effective method for producing hardcopy. In this mode, no additional printer hardware or software is required to drive the attached printers. The terminal acts as a printer/controller, minimizing impact on the host computer and eliminating the need for printer driver software on the host.

The Tektronix 4692 Color Graphics Copier has an optional multiplexer allowing up to four terminals to share it as a color output resource, and reducing the cost per user. The Tektronix 4696 Ink-Jet Printer is ideally suited and affordably priced for use as a personal screen copier.

Shared Resources



The 4510A Rasterizer connects 4690 Series color printers directly to host computers via standard RS-232 interfaces. All system users can share the resource of high quality color output while freeing the terminals during output. The CX4510A brings the same capability to users in IBM 3270 environments.

The 4690 Series connection to a host is supported by leading host-based graphics application software packages from Tektronix and other vendors. This connection provides the color output at maximum resolution and color selection, regardless of the terminals used.

Full Resolution Copies

The 4510A Rasterizer controls 4690 Series color printers to form a color output system which can be used as a local resource by users of Tektronix terminals equipped with peripheral port interfaces.

This connection offers maximum resolution output with a wide range of colors, not limited to the resolution of the computer display terminal. This type of connection is ideal for providing local user control in 2D vector applications.

Direct Host Connection

The 4690 Series color printers use an 8-bit parallel interface to connect directly to host computers for certain applications. For example, the 4696 Color Ink-Jet Printer is compatible with a large number of graphics applications which run on personal computers. This connection is a very cost-effective method for producing excellent quality color output from leading personal computer software packages.

Configuration Flexibility

Many simultaneous 4510A and 4690 Series combinations are possible, providing maximum flexibility to configure color output systems which match application demands.

4696 Color Ink-Jet Printer.

NEW 4696 Color Ink-Jet Printer

Support From Many PC Application Packages

High Quality Graphics

Easy Installation and Maintenance

Handy Front Panel Controls

Roll, Sheet, or Transparency Capability

Quiet, .47 sq in-per-Second Printing

Complete Supplies Start-Up Kit

The Tek 4696 Color Ink-Jet Printer combines low-cost, excellent image quality and quiet performance in a compact design. It produces vivid color graphics with addressability of 120 dots-per-inch.

Reliability and Maintenance

Inks specially formulated for the 4696 provide excellent color saturation and brilliance. A separate black cartridge ensures a true black that is unobtainable from other systems that mix dyes. The larger ink volume of the 4696 allows longer periods of output before replacement—approximately 100 copies per cartridge, depending on the image.

The 4696 generates copies in 8 x 6 portrait format or 10.6 x 8 inch landscape format (depending on the terminal employed), by program command or simply pushing a button on the terminal keyboard. Continuous images are produced using roll paper or roll transparency.

Special Features and Versatility

An eight-bit parallel interface with a standard Amphenol 36-pin connector offers direct connection to a variety of Tek terminals, workstations and to other devices, such as PCs. Conversion of existing driver routines is accomplished easily, and prewritten drivers are available for popular graphics applications.

4692 Color Graphics Copier

Superior Image Quality and Excellent Color Saturation

Unique Ink Transient Suppressor for Reliable Operation

Adjustable for A and A4 Size

Horizontal and Vertical Formats

Four-Channel Multiplexer I/F Option

Variable Image Density and Copy Time

216 On-Board Colors

Complete Supplies Start-Up Kit

Auto-Handling of Paper and Transparencies

The 4692 represents a standard in color ink-jet reliability. The high performance air-assist drop-on-demand technology provides resolution of up to 1536 x 1152 dots in an A-size image. Specially matched paper and transparency media and inks provide highly saturated colors, including vivid black.

CHARACTERISTICS

Addressability — Fixed Mode Vertical and Horizontal: 6 dots/mm (154 dots/in). Variable "preview" mode vertical and horizontal 128 dots/in to 158 dots/in.

Copy Time — One minute to three minutes.

Page and Image Format — A and A4 output sizes. Landscape and portrait format selectable under program control.

Image Sizes — Variable depending on orientation and image source (for A-size output; A4-size output slighty smaller to maintain adequate margins).

Compatibility — 4104A/5A/6A/7A/9A/11/CX, 4205/7/8/CX, 4113B/15B Option 19, 4125/8/9 Option 19 Color Graphics Workstations, 4510A/CX Color Graphics Rasterizer.

Interface — Eight-bit parallel.

Data Rate — Up to 400 Kbytes (burst mode).

ORDERING INFORMATION

4696 Color Ink-Jet Printer	**$1,795**
4692 Color Graphics Copier	**$7,795**

The 4692 must be ordered with Installation Option S0.

OPTIONS

Option 01 — (4692) Set-up for A4 Size Media.	**NC**
Option 02 — (4692) Four-Channel Multiplexer.	**+$995**

INTERNATIONAL POWER PLUG OPTIONS

Option A1 — Universal Euro 220 V, 50 Hz.
Option A2 — UK 240 V, 50 Hz.
Option A3 — Australian 240 V, 50 Hz.
Option A4 — North American 240 V, 60 Hz.
Option A5 — Switzerland 220 V, 50 Hz.

***WARRANTY-PLUS* SERVICE PLANS**
SEE PAGE 496

Contact your local Sales Engineer for prices.
S0 — On-Site Product Installation and Set-Up.
S1 — 1 Year On-Site Service.
S2 — 2 Years On-Site Service.
S3 — 3 Years On-Site Service.

4510A Color Graphics Rasterizer

Provides Maximum Resolution Output to Tek 4691, 4692, 4695, and 4696 Color Graphics Printers

A Shared System Resource

More Than 130,000 Colors Available

Available With IBM 3287-Style Coaxial Interface (CX4510A)

Compatible With 4100, 4200, 4110, and 4120 Series Color Graphics Terminals (2D Vector Data)

Available as a Bundled System With the Tek 4692 or 4696

The 4510A Color Graphics Rasterizer facilitates a direct host connection of the 4691, 4692, 4695, and 4696 color graphics printers, creating shared system resources.

The 4510A accepts 4100A-style graphics data serially and drives an attached color graphics printer at its maximum potential for color and resolution. Even complex images are clear and jagged lines smooth when processed by the 4510A.

When equipped with the optional IBM style coaxial interface, the 4510A can be connected simultaneously to an IBM and a non-IBM host computer.

The 4510A is supported by leading host-based graphics software packages.

ORDERING INFORMATION

4510A Color Graphics Rasterizer	**$5,995**
CX4510A IBM Color Graphics Rasterizer	**$7,995**

OPTION

Option 32 — 2 Mb Memory Total.	**+$1,995**

***WARRANTY-PLUS* SERVICE PLANS**
SEE PAGE 496

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S0 — On-Site Product Installation and Set-Up.
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S3 — 3 Years On-Site Service.

Flexible leasing programs available in the continental U.S.

NEW 4696S Color Output System

Includes 4510A Rasterizer and 4696 Color Ink-Jet Printer

Brilliant Color Plots in Three Minutes

Image Area Up to 8.5 in x 11.4 in

Portrait and Landscape Mode Output

Easy Connection to Host Computers, Including IBM (CX4696S)

The 4696S Color Output System is a cost-effective combination of the 4510A Color Graphics Rasterizer and the 4696 Color Ink-Jet Printer. As a system, it connects to as many as four RS-232 data sources, including host computers or Tektronix terminals with peripheral ports, reducing the cost per user.

The 4696S uses 10 inch wide roll paper stock and produces images which entirely fill standard 8.5 x 11 inch paper. This makes it ideally suited for producing graphics output for public posting, CAD preview, and mapping applications. Specially formulated transparency film produces brilliant presentation materials in moderate volumes.

The 4696S is compatible with applications which support the 4692S, making it an excellent low-cost companion product for supplemental output requirements.

The CX4696S offers a simple connection to IBM 3270 environments and is compatible with it.

NEW 4692S Color Output System

Cost-Effective Bundling of the 4510A and 4692

Fast, High Quality Color Output in A and A4 Sizes

Available With IBM Coaxial Interface (CX4692S)

Shared Resource for Host-Based Graphics Applications

The 4692S Color Output System produces brilliant, high resolution color copies on paper or transparency material. Its four-channel RS-232 interface connects to multiple data sources simultaneously, including host computers and Tektronix graphics display terminals.

The 4692S is ideal for generating hard copy from CAD, mapping, and data analysis applications. Its transparency output provides excellent presentation material directly from any application supporting it.

The 4692S uses pre-cut paper and transparency media. In combination with its large capacity ink cartridges, it can be shared by a number of users with minimal operator attendance.

The CX4692S combines all the benefits of the 4692S, replacing two of the serial input ports with an IBM compatible coaxial interface. Two serial ports are available for simultaneous connection to non-IBM hosts or Tektronix terminals.

ORDERING INFORMATION

4696S Color Output System	**$6,995**
CX4696S IBM Color Output System	**$8,995**
4692S Color Output System	**$12,995**
CX4692S IBM Color Output System	**$14,995**

OPTIONS

Option 01 — (4692S/CX4692S) Set-up for A4 output.	**NC**
Option 02 — (4692S/CX4692S) 4 channel multiplexer 4692.	**+$995**
Option 1A — PLOT 10® GSI (MVS). (CX4696S/CX4692S)	**+$1,995**
Option 1C — PLOT 10 GSI (VM). (CX4696S/CX4692S)	**+$1,995**
Option 32 — (4510A/CX4510A) 2 Mb Memory.	**+$1,995**

***WARRANTY-PLUS* SERVICE PLANS**
SEE PAGE 496

Contact your local Sales Engineer for prices.

S0 — On-Site Product Installation and Set-Up.
S1 — Plus 1 Year On-Site Service.
S2 — Plus 2 Years On-Site Service.
S3 — Plus 3 Years On-Site Service.

Flexible leasing programs available in the continental U.S.

4631 Hard Copy Unit

High Image Quality, Copies in Seconds

Fiber Optic Process

Storage Tube Compatible

The 4631 Hard Copy Unit provides superior quality copies of any graphic and alphanumeric information displayed on a storage tube display. The 4631's fiber optic process uses Dry Silver paper for the fine detail and photographic quality image.

CHARACTERISTICS

Addressability — Normal Scan: Vertical is 79 dots/cm (200/in). Horizontal is 67 dots/cm (170/in). Slow Scan: Vertical is 118 dots/cm (300/in). Horizontal is 134 dots/cm (340/in).

Copy Time — Normal Scan: 18 s first copy; 9 s subsequent. Slow Scan: 36 s first copy; 16 s subsequent.

Image Size — Vertical: 180 mm x 137 mm (7.1 in x 5.4 in). Horizontal: 225 mm x 170 mm (8.85 in x 6.7 in). Option 31: 163 mm x 190 mm (6.4 in x 7.5 in).

Paper Size — 216 mm x 277 mm (8.5 in x 11 in).

Paper Type — Std Dry Silver (500 ft roll).

Warm-Up Time — 10 minutes.

AC POWER

Line Voltage Range — 104 V ac to 126 V ac.

Strappable — Low Range: 90 V ac to 126 V ac. High Range: 108 V ac to 132 V ac.

Warm-Up — 620 W nominal; 750 W on high range.

Copy Process — 200 W nominal; 240 W on high range.

For Ordering Information, see next page.

4632 Video Hard Copy Unit

Copies in Seconds

Gray Scale Capability

Copies Many Color Displays

Video Source Compatible

The 4632 provides very fast, photographic quality hard copies from color raster scan terminals such as the Tektronix 4109A and 4120 Series. First copies are produced in 18 seconds regardless of the complexity of the screen image. Copies feature a minimum of six continuous shades of gray.

CHARACTERISTICS

Addressability — Incoming signal dependent.

Copy Time — 18 s first copy; 9 s subsequent copies.

Image Size — 203 mm x 152 mm (8 in x 6 in).

Gray Shades — Six minimum (8 with Option 06).

Paper Size — 216 mm x 277 mm (8.5 in x 11 in).

Paper Type — Standard Dry Silver (500 ft roll).

Warm-Up Time — 10 minutes.

AC POWER

Line Voltage Range — 104 V ac to 126 V ac.

Strappable — Low Range: 90 V ac to 110 V ac. High Range: 108 V ac to 132 V ac.

Warm-Up — 620 W nominal; 240 W maximum.

Copy Process — 200 W nominal; 240 W maximum.

Idle — 120 W nominal, 185 W maximum.

For Ordering Information, see next page.

4634 Imaging Hard Copy Unit

Fast, High Resolution Copier for Tek and Other Terminals and Workstations

Excellent Gray Scale

The 4634 provides fast, photographic quality hard copies from both Tektronix color graphics terminals and other TV video sources, both analog and digital. First copies are produced in 26 seconds, successive copies in 12 seconds, regardless of the complexity of the screen image. Hard copies feature a minimum of 12 continuous shades of gray when made with high performance paper. The 4634 is particularly suited for solids modeling and other CAD applications.

CHARACTERISTICS

Resolution — At least 4.92 lines/mm (125 lines/in) with high performance (7772) paper; at least 3.94 lines/mm (100/lines/in) with standard (7770) paper.

Copy Time — 26 s first copy; 12 s subsequent copies.

Image Size — Horizontal: 203 mm x 152 mm (8 in x 6 in) for 50 Hz field. 203 mm to 127 mm (8 in to 5 in) for 60 Hz field rate. Vertical: Adjusts for correct aspect ratio.

Gray Shades — (12 minimum with high performance paper) 6 minimum with standard paper.

Paper Size — 216 mm x 152 mm (8.5 in x 11 in).

Paper Type — Dry Silver (500 ft roll); Tektronix' High Performance (7772) or switch selectable to Tektronix' Standard (7770).

Warm-Up Time — 20 minutes.

AC POWER

Line Voltage Range (±10%) — Jumper selectable for 100 V ac, 120 V ac, 220 V ac, 230 V ac, and 240 V ac.

Line Frequency — 48 Hz to 62 Hz.

For Ordering Information, see next page.

Flexible leasing programs available in the continental U.S.

ORDERING INFORMATION

4631 Hard Copy Unit **$7,150**
4632 Video Hard Copy Unit **$6,800**
4634 Imaging Hard Copy Unit **$8,300**

OPTIONS

Option 01 — (4631 and 4632 only) Resettable Copy Counter. **+$200**
Option 02 — Four Channel Multiplexer. **+$990**
Option 03 — (4632 only) Set-Up for 625 Line/ 50 Hz. **NC**
Option 04 — (4632 only) Set-Up for 1029 Line/ 60 Hz. **NC**
Option 05 — (4632 only) Set-Up for Tektronix 4023 Terminal. **NC**
Option 06 — (4632 only) Enhanced Gray Scale. **+$970**
Option 07 — (4632 only) Compatible with HP 2640 Series Terminal. **+$150**
Option 08 — (4632 only) Compatible with DEC MINC Systems. **+$150**
Option 09 — (4632 only) Set-Up for AT&T GEMINI 100 Systems. **+$150**
Option 09 — (4634 only) Set-Up for Tek 4109A. **NC**
Option 10 — (4632 only) Set-Up for Tek 4109A. **NC**
Option 11 — (4634 only) Set-Up for Tektronix 4111 Terminal. **+$100**
Option 12 — (4634 only) Combines Options 02 and 11. **+$1,090**
Option 13 — (4634 only) Set-Up for IBM 5080 50 Hz. **NC**
Option 14 — (4634 only) Combines Options 02 and 13. **+$990**
Option 15 — (4632 and 4634 only) Set-Up for Tek 4120 Series. **NC**
Option 23 — (4634 only) Set-Up for IBM 5080 60 Hz. **NC**
Option 24 — (4634 only) Combines Options 02 and 23. **+$990**
Option 30 — (4634 only) Delete Rackmount Hardware. **−$85**
Option 31 — (4631 only) Compatible with Tektronix 4025 and 4025A Terminals. **NC**
Option 45 — (4634 only) End-User Configuration. **NC**

INTERNATIONAL POWER PLUG OPTIONS

Option A1 — Universal Euro 220 V, 50 Hz.
Option A2 — UK 240 V, 50 Hz.
Option A3 — Australian 240 V, 50 Hz.
Option A4 — North American 240 V, 60 Hz.
Option A5 — (4632 and 4634 only) Switzerland 220 V, 50 Hz.

***WARRANTY-PLUS* SERVICE PLANS**
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S0 — On-Site Product Installation and Set-Up.
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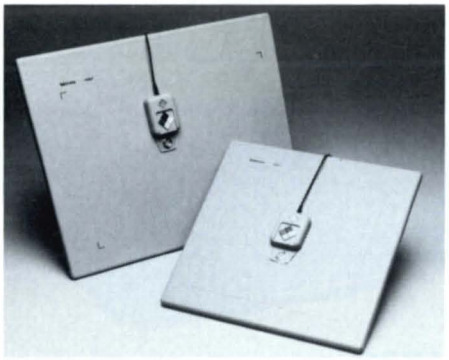
S2 — 2 Years On-Site Service.
S3 — 3 Years On-Site Service.

OPTIONAL ACCESSORY

RGB Mixer — (4632/4634) Order 016-0596-06 **$425**



4957 Graphics Tablet

Graphic Input Capabilities for 4100A, 4110, 4120 and 4200 Color Graphics Terminals, and RS-232C Based Computer

Simple Four-Button Cursor Control

To use the 4957, merely touch the four-button cursor-puck or stylus (optional accessory) to the tablet's active area. The tablet calculates the coordinates and relays them to the host computer for storage or manipulation.

Applications Fit

The 4957 can augment a terminal keyboard as a menu selection device, move a cursor around a display screen, or help transfer data from paper to a computerized data base.

Compatibility

The 4957 is compatible with the Tek 4106A, 4107A, 4109A, 4110A, 4120 and 4200 Series color graphics terminals.

CHARACTERISTICS

Size — 419 mm x 394 mm (16.5 in x 15.5 in).
Active Writing Area — 297 mm x 297 mm (11.7 in x 11.7 in).
Resolution*1 — User selectable up to 1000 points/inch.
Speed*1 — User selectable up to 90 coordinates/second.
Accuracy — ± .625 mm (0.025 in).
Repeatability — ± .250 mm (0.010 in).

**1 Maximum specs may not be accessible from various terminals.*

ORDERING INFORMATION

4957 Graphics Tablet **$955**
Includes: Power supply and cord (119-1748-00); four-button cursor (119-1775-00); operator manual (070-4784-00).

OPTION

Option 02 — 305 mm x 456 mm (12 in x 18 in). **+$740**

INTERNATIONAL POWER PLUG OPTIONS

Option A1 — Universal Euro 220 V, 50 Hz.
Option A2 — UK 240 V, 50 Hz.
Option A3 — Australian 240 V, 50 Hz.
Option A5 — Switzerland 220 V, 50 Hz.

***WARRANTY-PLUS* SERVICE PLANS**
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4958 Graphics Tablet

Highly Precise, Easy-to-Use Graphic Input Capabilities for the 4110, 4120, and 4200 Series and Color Graphics Terminals, and RS-232 Based Computers

Desktop or Pedestal Configurations

The 4958 is available in either 17 x 24 inch desktop, 36 x 48 inch pedestal-compatible, or 44 x 60 inch pedestal-compatible configurations. The *NEW* 4900H01 Tablet Pedestal is available for pedestal-compatible surfaces.

Simple, Flexible Input

The 4958 reads graphic coordinate data via a multi-button cursor or a stylus (optional). When either is touched to the tablet surface, the tablet calculates the coordinates and relays them to the host computer/terminal for further processing.

Programmability

The tablet cursor is available with 4 or 16 buttons, with a fine cross-hair lens for accurate point selection. The cursor serves as a programmable hand-held keyboard from which the user can perform user-defined functions.

Precision Duplication

The 4958 offers up to 1,000-points-per-inch resolution with 0.010 inch accuracy.

ORDERING INFORMATION

4958 Graphics Tablet **$500**
Includes: Power supply and cord (119-1748-00); four-button cursor (119-1775-00); and user's manual.

OPTIONS

Option 03 — (17 x 24 in). **+$4,000**
Option 05 — (36 x 48 in). **+$6,450**
Option 06 — (44 x 60 in). **+$8,750**
4900H01 Tablet Pedestal **$1,500**
Includes: Power cord and data sheet (062-8975-00).

INTERNATIONAL POWER PLUG OPTIONS

Option A1 — Universal Euro 220 V, 50 Hz.
Option A2 — UK 240 V, 50 Hz.
Option A3 — Australian 240 V, 50 Hz.
Option A4 — North American 240 V, 60 Hz.
Option A5 — Switzerland 220 V, 50 Hz.

***WARRANTY-PLUS* SERVICE PLANS**
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S0 — On-Site Product Installation and Set-Up.
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S2 — 2 Years On-Site Service.
S3 — 3 Years On-Site Service.

4991S1 Graphic Input Workstation

A Complete Graphic Input Solution

Five-Fold Productivity Increase Over Manual Digitizing or On-Screen Redesign

Transfers Hard-Copy Into CAD Systems

Automatic Scanning and Vectorizing

Interactive Software Produces Graphics Entities

The Tektronix 4991S1 quickly and accurately transforms existing documents into a useful data base for CAD systems. It supports many applications in mechanical engineering, architecture, mapping, and electrical engineering.

The 4991S1 supplies useful data with minimum impact on host CAD system resources. The 4991S1 interfaces directly to three leading CAD systems: ComputerVision, CADAM, and TekniCAD™. The direct interface ensures rapid, accurate data transfer. Because scanning and structuring processes are performed locally, CAD system resources are not tied up with time consuming input tasks.

The interactive Graphic Structuring Software gives the user maximum flexibility and control in preparing the most usable data base for any given application. The structuring software supports a variety of entities (e.g., lines, arcs, text, symbols), standard attributes (e.g., line width, line style), and user-definable attributes.

A straightforward user interface simplifies scanning and structuring by allowing the operator to control most functions from on-screen menus, using the graphics tablet and stylus. A clear, accurate, and complete documentation package, including an on-line tutorial, makes the workstation surprisingly easy to learn and use.

CHARACTERISTICS

SYSTEM POWER REQUIREMENTS

Total Power Consumption — 1381 Watts. (4991: 275 W. 4991WS Electronics Module: 872 W. 4991WS Display Module: 230 W. 4957: 4 W.)

Line Voltage Ranges — 87 V ac to 128 V ac or 174 V ac to 250 V ac.

Line Frequency — 50 Hz or 60 Hz nominal (±2 Hz).

PHYSICAL CHARACTERISTICS

	4991		4991WS w/Display & Table	
Dimensions	**mm**	**in**	**mm**	**in**
Width	1219	48.0	1505	59.3
Height	1283	50.5	1118	44.0
Depth	787	31.0	914	36.0
Weights≈	**kg**	**lb**	**kg**	**lb**
Net	150.0	330.0	152.1	335.0
Shipping	225.0	495.0	258.1	546.0

PERFORMANCE

Scanning Technology — Precision drum scanner; halogen lamp illumination and Charge Coupled Device Array detector.

Maximum Scan Area — 885 mm x 1200 mm (34.8 in x 47.2 in).

Resolution — 12 samples/mm (304.8 samples/in).

Typical Media — Black graphite lead or black ink on vellum; black plastic lead or black ink on drafting film; photographic line art; bluelines.

Minimum Line Detected — (with contrast >0.5) 0.254 mm (0.010 in).

Programmable Features — User-definable scan area; dot and void removal; edge smoothing, line fitting accuracy; digitizing threshold; document rotation; mirror image.

Output Capabilities — Hardware: RS-232C, 19.2 kbaud. Protocol: KERMIT-type communications protocol. Modes: Freeman code data, polynode data, interconnect data, combined data. User-selectable output data files: polylines, short vectors, and filled areas.

Media — Nine-track magnetic tape (1600 bpi).

Format — Block 80 x 10, standard label EBCDIC and unlabeled ASCII.

Data Transmission — RS-232C, 19.2 kbaud.

Memory — 2.0 Mb RAM with ECC; 20 Mb internal hard disk.

Display — 483 mm (19 in) diagonal color raster; 60 Hz, noninterlaced.

Graphics — 1024 x 1280 pixels.

Capacity — 98,000 nodes (larger drawings are managed by structuring smaller sections of the original file).

GRAPHIC STRUCTURING SOFTWARE
Functional Structuring Capabilities

Graphics Entities Supported — Lines, polylines, arcs, circles, text, symbols, ellipses, arrows, dimensions, splines.

Attributes Supported — Layer number, pen number, color, line width, line style, text font, character slant, arrow style, user-definable attributes.

Transformation Operations — N-point alignment, snap-to-grid.

Viewing Capabilities — Zoom, pan, previous view, original view, nodes.

Local Calculations — Position, distance, user-defined units.

Host Control and Interfacing — KERMIT-type communications protocol.

HOST INTERFACING SOFTWARE

Data Communications — KERMIT-type protocol.

Data Conversion — 4991S1 to IBM CADAM Version 19.2.4 or later (MVS/TSO and CM/VMS). 4991S1 to ComputerVision CADDS 4X. 4991S1 to Tektronix PLOT 10® Computer-Aided Drafting (TekniCAD) Version 7.3 or later.

Data Checking — Unrecognized or illegal host system commands or data reported on the 4991WS display for immediate correction.

Configuration — Host-system resident.

Language — FORTRAN IV (license required).

ORDERING INFORMATION

4991S1 Graphic Input Workstation **$150,000**
Includes: 4991WS (4125 Color Graphics Workstation); 4100P01 with Option 01 and Option 11: CP/M-86 +DTI: 4100H01 Workstation table; 4957 Graphics Tablet; 4991 Auto Vectorizer; 4991P01 Graphic structuring software.

OPTIONS

Option 01 — 4991P02, CADAM HIS. **+$12,000**
Option 02 — 4991P03, ComputerVision HIS. **+$12,000**
Option 05 — Add Option 05 to 4991WS. **+$2,195**

INTERNATIONAL POWER PLUG OPTIONS

Option A1 — Universal Euro 220 V, 50 Hz.
Order 020-0859-00.

Option A2 — UK 240 V, 50 Hz.
Order 020-0860-00.

Option A3 — Australian 240 V, 50 Hz.
Order 020-0861-00.

Option A4 — North American 240 V, 60 Hz.
Order 020-0862-00.

Option A5 — Switzerland 220 V, 50 Hz.
Order 020-0863-00.

***WARRANTY-PLUS* SERVICE PLANS**
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S2 — 2 Years On-Site Service.
S3 — 3 Years On-Site Service.

OEM terms available on this product.

TekniCAD is a trademark of Tektronix, Inc.

Flexible leasing programs available in the continental U.S.

INTRODUCTION

Now you can rely on Tektronix as your single supply source for all media, pens and ink for your Tektronix copiers, plotters, printers and storage devices. By using Tektronix brand supplies, you can be assured of getting the best output quality from your Tek peripherals.

For further information U.S. customers may call toll free to the *NEW* Direct Order Desk. Supplies Specialists can answer any of your questions on use and availability of supplies listed below. Direct Order Desk for supplies is open 6 am to 5 pm PST. In the U.S., call 1-800-TEK-6100 (Oregon and Alaska, call collect 503-642-8000). Overseas customers, call your Tektronix Sales Office.

INK JET SUPPLIES

4691 Ink Cartridges		
200 ml Each		
Cyan	016-0713-01	**$90**
Black	016-0714-01	**$90**
Yellow	016-0715-01	**$90**
Magenta	016-0716-02	**$90**
4691 Ink Jet Copy Paper		
500 Sheets Per Package		
216 x 279 mm (8.5 x 11 in) A Size	016-0712-00	**$32**
279 x 432 mm (11 x 17 in) B Size	016-0711-00	**$41**
210 x 297 mm (4691 Option 01 only)		
A4 Size	016-0709-00	**$32**
297 x 420 mm (4691 Option 01 only)		
A3 Size	016-0710-00	**$41**
4691 Transparency Film		
100 Sheets Per Package		
A Size	016-0765-00	**$95**
A4 Size	016-0766-00	**$95**
4691 Drum Adaptors		
Package of 3 for use with		
A or A4 size	118-2593-00	**$16.75**
4692 Ink Cartridges		
200 ml Each		
Cyan	016-0713-01	**$90**
Black	016-0714-01	**$90**
Yellow	016-0715-01	**$90**
Magenta	016-0716-02	**$90**
4692 Ink Jet Copy Paper		
500 Sheets Per Package		
216 x 279 mm (8.5 x 11 in) A Size	016-0793-00	**$36**
210 x 297 mm A4 Size	016-0794-00	**$36**
4692 Transparency Film		
100 Sheets Per Package		
A Size	016-0765-02	**$95**
A4 Size	016-0766-02	**$95**
4692 Maintenance Cartridge		
250 ml	016-0770-02	**$33**
4695 Ink Cartridge Packages		
2.5 cc Each, 16 Per Package		
Yellow	016-0734-02	**$9.00**
Magenta	016-0735-02	**$9.00**
Cyan	016-0736-02	**$9.00**
Black	016-0737-02	**$9.00**
4695 Ink Jet Copy Paper		
50 m Each 6 Rolls Per Box		
Roll Paper	016-0743-00	**$75**
4695 Ink Jet Copy Paper		
500 Sheets Per Package		
A Size	016-0739-00	**$25**
A4 Size	016-0740-00	**$25**
4695 Transparency Film		
100 Sheets Per Package	016-0480-00	**$90**
Roll Format (10″x100′)	016-0836-00	**$90**
4695 Liquids		
Maintenance Liquid (200 cc)	016-0732-00	**$10.50**
Print Head Protect Liquid (10 cc)	016-0733-00	**$3.00**
Lubricant (5 cc)	016-0742-00	**$2.00**
Syringe to Wash Printhead	118-3406-00	**$8.25**
4696 Ink Cartridges		
5 cc Each, 2 Per Package		
Black	016-0839-00	**$9.00**
Cyan	016-0840-00	**$9.00**
Magenta	016-0841-00	**$9.00**
Yellow	016-0842-00	**$9.00**
4696 Copy Paper–Roll Format		
254 mm x 50 m Each Roll		
Box of six rolls	016-0743-00	**$75**
4696 Copy Paper–Sheet Format		
500 Sheets Per Package		
A Size	016-0739-00	**$25**
A4 Size	016-0740-00	**$25**
4696 Transparency Film		
100 Sheets Per Package	016-0480-00	**$90**
Roll Format (10″x100′)	016-0836-00	**$90**
4696 Maintenance Cartridge		
175 cc		
Maintenance Cartridge	016-0838-00	**$15**
4696 Lubricant		
5 cc		
Lubricant	016-0742-00	**$2.00**

PLOTTER PENS AND SUPPLIES

For plotter pens and supplies, ask your local Tektronix office for an IDG Computer Graphics Supplies Catalog.

MONOCHROME COPIER PAPER

4631, 4632		
Tektronix Standard Dry Silver Paper		
216 mm x 152 m (8.5 in x 500 ft)		
Single Roll	006-1603-00	**$95**
4 Roll Carton	006-1603-01	**$325**
Quantity Discounts:		
4 to 9 Cartons (5% Savings per Carton)		
10 to 19 Cartons (10% Savings per Carton)		
20 or More Cartons (15% Savings per Carton)		
4633A, 4634 and 4635		
Tektronix High Performance Dry Silver Paper		
216 mm x 152 m (8.5 in x 500 ft)		
Single Roll	006-2432-00	**$235**
4 Roll Carton	006-2432-01	**$810**
Quantity Discounts:		
4 to 9 Cartons (5% Savings per Carton)		
10 to 19 Cartons (10% Savings per Carton)		
20 or More Cartons (15% Savings per Carton)		
4611/4612 Dielectric Hard Copy Paper		
216 mm x 152 m (8.5 in x 500 ft)		
2 Roll Package	006-2838-00	**$43**
4611/4612 Tektronix Dry Copy Toner		
4.9 oz Bottle	006-2990-00	**$28**

PRINTER PAPER AND RIBBONS

4641 Printer Ribbon		
Box of 12	119-0820-00	**$185**
4642 Printer		
Paper-Tab Stock, Fan Fold,		
270 mm x 279 mm (10.6 x 11 in)		
2500 Sheets/Carton	002-0262-01	**$65**
Paper Roll Box of 12	002-1084-01	**$80**
Ribbons Package of 4	002-1451-01	**$70**
4643 Printer Ribbon		
Cassette	118-1314-00	**$26**
4644 Printer Ribbon		
Box of 6	118-3876-00	**$140**

MAGNETIC MEDIA

4110 Series 8 inch Flexible Magnetic Disk		
512 Kb Formatted Capacity		
Box of 10	119-1376-01	**$115**
4170; 4925; and 4926 Option 25 Flexible 5¼ inch Disk		
650 Kb Formatted Capacity		
Box of 10	119-1583-01	**$36**
4404; 6130; 4132, Option 11 Flexible 5¼ inch Disk		
650 Kb Formatted Capacity		
Box of 10	119-1583-01	**$36**
4905 Options 31 & 32 Flexible 8 inch Magnetic Disk		
315 Kb Formatted Capacity		
Package of 10	119-0848-01	**$115**
4907 Flexible 8 inch Magnetic Disk		
630 Kb Formatted Capacity		
Package of 10	119-1011-01	**$155**
4905 Options 33 and 34		
Hard Disk Pack Formatted Capacity		
5 Mb	119-0855-00	**$250**
4909 Disk Cartridge		
Formatted Capacity		
13 Mb	119-1462-00	**$360**
4050 Series, 4923 and 4924		
Certified Data Cartridge (300 ft)		
Each Cartridge	119-0680-00	**$30**
Package of 5	119-0680-01	**$125**
Certified Data Cartridge (450 ft)		
Each cartridge	119-1439-00	**$35**
Package of 5	119-1439-01	**$280**
Certified Data Cartridge (4050 Series Only)		
600 ft Cartridge	119-1463-00	**$47**
4944 Option 11, Option 14, Option 15; 61TC01; 6130 Option 40, Option 41, Option 42; 4132 Option 40, Option 41		
450 feet:		
Each cartridge	119-2408-00	**$40**
Package of 5	119-2408-01	**$180**
600 feet:		
Each Cartridge	119-1463-00	**$50**
Package of 5	119-1463-01	**$200**

TEKTRONIX QUALITY LIVES ON THROUGH RE-MANUFACTURE

Tektronix IDG instruments returned from Demo and Lease are brought up to latest specifications and sold at reduced prices carrying new product warranty. Quantity discounts apply to current as well as discontinued products. Shipment is typically four weeks after receipt of the order. Your Tektronix IDG Customer Sales Representative or Sales Engineer can provide you with information on products, prices and availability.

In the U.S., call IDG Reconditioned Products Marketing, 1-503-685-2023. Overseas customers, call your Tektronix Sales Office.

NEW

AnthroArm GT

Holds up to 200 lbs

Rotates 360°

Cast Aluminum Construction

Five Year Warranty

The AnthroArm GT is the space saving armature designed to hold substantial loads—up to 200 lbs. You can float your heavy 19 inch terminal above your workspace, and have plenty of room to spread out underneath.

Now you can easily move your terminal around. Push the AnthroArm back to store your monitor out of the way. Pull it towards you for better viewing. Swivel it 360° to get rid of screen glare, or to see your terminal if you're on the phone or sharing with others.

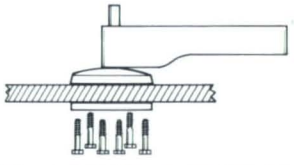
Choose between three different models, depending on the reach you want (how much depth you have on your work surface) and how high you want your terminal (the compound arm raises your terminal higher than the single arms).

The AnthroArm GT. The only arm strong enough to give you back your workspace.

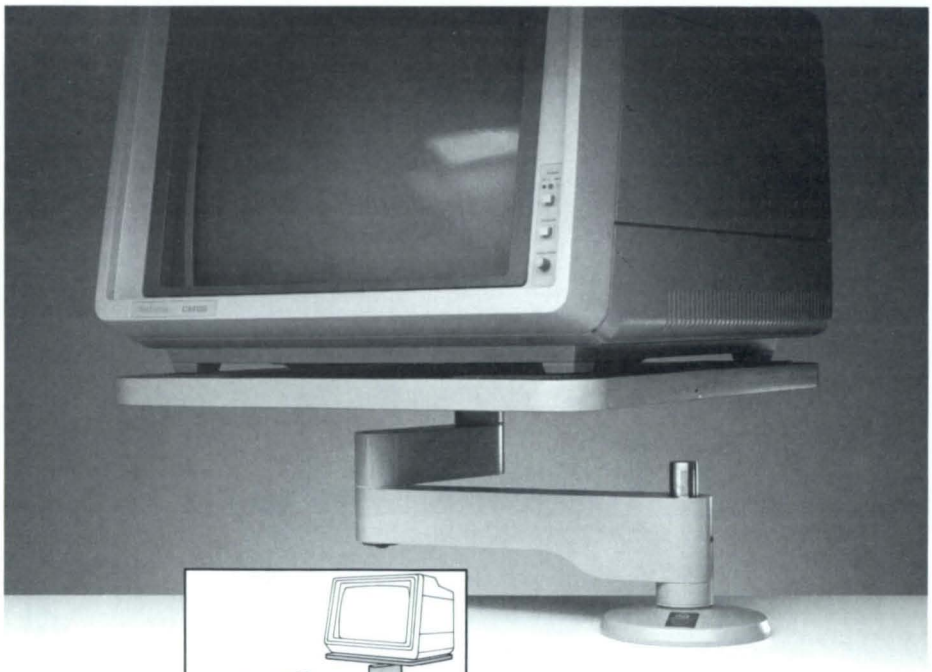
CHARACTERISTICS

- Arm, base plate and mounting plate are thick-wall aviation grade casted aluminum, hardened to T6. The parts have a baked-on powder coated smoke tan finish.
- The main pivots are 1 inch ID needle bearings. Other pivots are oil light brass bushings.
- Mounting posts are hardened ground steel.
- The 45 lb. density, 21½ inch x 21½ shelf is 1 inch thick with vinyl t-molding edges. Its surface is high pressure laminate with non-skid pads for additional safety.
- Two stacking lugs (⅞ inch each) are included for height adjustment.

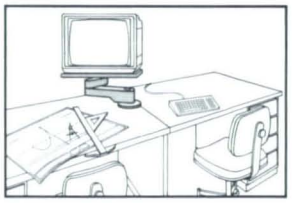
INSTALLATION



Your 19 inch terminal is very heavy, so your worktable must be sturdy enough to support the AnthroArm. The Arm is recommended for installation on engineering tables and large drafting tables which are at least 2 inches thick. The Arm is installed by drilling through the work surface and mounting using the 6 supplied bolts.



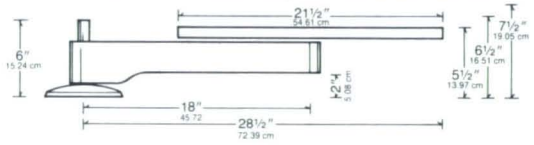
The AnthroArm clears your worksurface so you have more space.



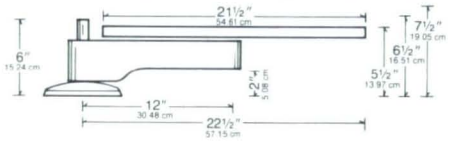
With the AnthroArm, you can share terminals between stations.

Soon to be available:
AnthroArm GT with tilt option,
and AnthroArm GT wall mount option.
Call for availability update.

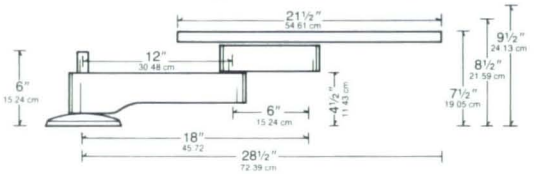
AnthroArm GT 18 Inch Single Arm. Order 550-SA **$449**



AnthroArm GT 12 Inch Single Arm. Order 551-SA **$425**



AnthroArm GT Compound Arm. Order 550-CA **$475**



ANTHRO™

Anthro Corporation
Technology Furniture
3221 NW Yeon St.
Portland, OR 97210
To order: 1-800-325-3841
503-241-7113

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The AnthroCart Deluxe Model, left, and the Standard model, right, are available in a variety of configurations.

AnthroCart™

Mobile

Compact

Rugged Steel Base

Stacks Vertically in 5 1/2 sq ft of Area

Holds up to 68 kg (150 lbs)

Five Year Warranty

Configure your AnthroCart to suit your application. Holes in 1 inch increments on the legs mean you can move your shelves up or down to fit both your equipment and your body. Then, customize your cart with any of the options listed on page 82.

Choose between two depths of carts. The AnthroCart Compact is 30 inches deep for space savings. The AnthroCart Full-Size is 36 inches deep for bigger equipment.

And choose between two heights of carts. The PC model is 35 inches high for typical "monitor on top/CPU on bottom" applications. The GT model is 28 inches high with the bigger shelf on top for large graphic terminals, or systems like the Macintosh.

Four inch castors, too. That's the AnthroCart 4 x 4.

AnthroCart™ Deluxe

Includes: Two shelves; three legs; a base tube; four 2 3/8 castors (two locking); document holder; four inch storage basket; wire base shelf; six-outlet surge protector; three cord management clips; and tools for assembly. Available in slate gray or golden oak color.

AnthroCart™ Standard

Includes: Two shelves; three legs; a base tube; four 2 3/8 castors (two locking); three cord management clips; and tools for assembly. Available in slate gray or golden oak color.

AnthroCart SELECTION GUIDE

(When ordering, indicate slate gray or golden oak color)

Model	Compact 30" Depth	Full Size 36" Depth	PC Models 35" High	GT Model 28" High	Deluxe	Standard	4" Castors	Price
PC02-DX	✓		✓		✓			$495
GT02-DX	✓			✓	✓			$495
PC07-DX		✓	✓		✓			$495
GT07-DX		✓		✓	✓			$495
PC04-DX	✓		✓		✓		✓	$549
GT04-DX	✓			✓	✓		✓	$549
PC10-DX		✓	✓		✓		✓	$549
GT10-DX		✓		✓	✓		✓	$549
PC03-ST	✓		✓			✓		$299
GT03-ST	✓			✓		✓		$299
PC09-ST		✓	✓			✓		$299
GT09-ST		✓		✓		✓		$299
PC05-ST	✓		✓			✓	✓	$349
GT05-ST	✓			✓		✓	✓	$349
PC11-ST		✓	✓			✓	✓	$349
GT11-ST		✓		✓		✓	✓	$349

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NEW

TECHNOLOGY FURNITURE

TECHNOLOGY FURNITURE

TECHNOLOGY FURNITURE

TECHNOLOGY FURNITURE

AnthroCart™ Combinations

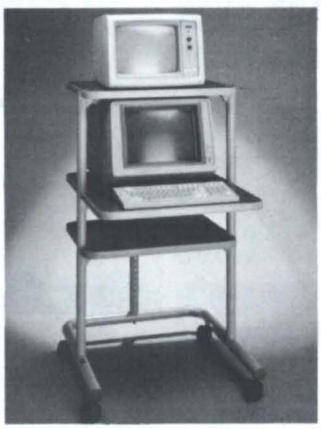
The AnthroCart. High-tech furniture for high-tech equipment. Use your imagination. Move shelves around. Try different options. Configure the AnthroCart so your equipment is easy and comfortable to use.

AnthroCart Compact PC with options, including Printer Basket option and Slide-Out Shelf option.

AnthroCart Compact PC with options, including SideCar option.

AnthroCart Compact GT with options, including Printer Basket option.

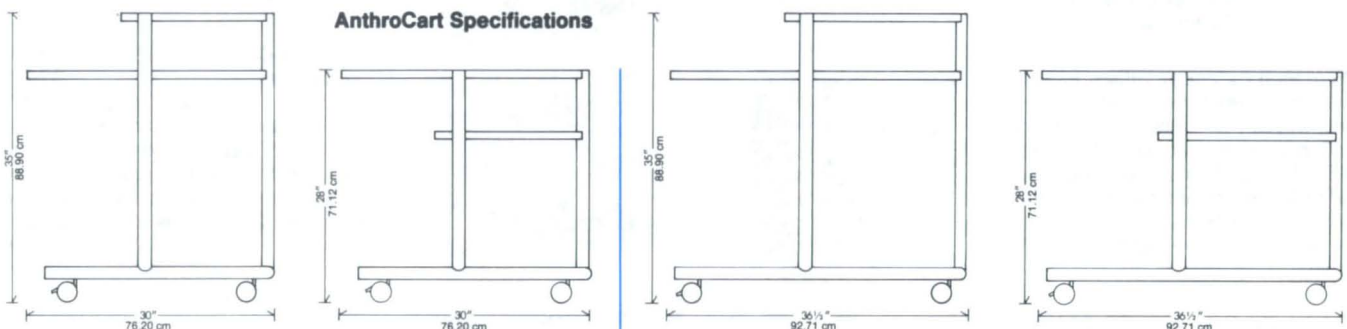
AnthroCart Full-Size GT with Extension Shelf Kit option.

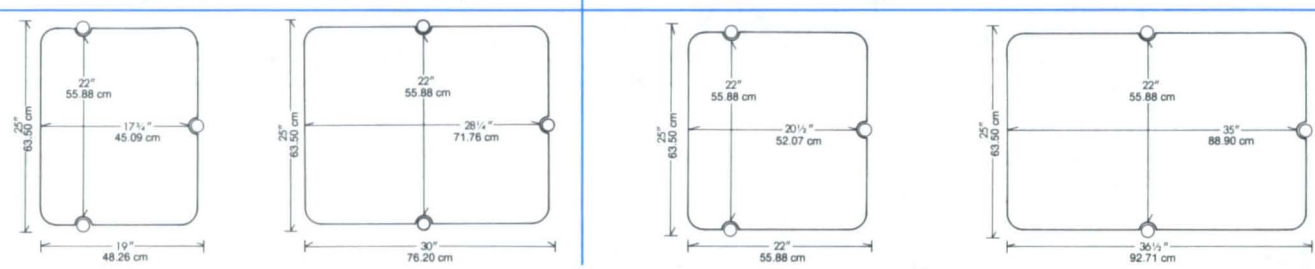


AnthroCart Compact GT with Extension Shelf Kit option.

AnthroCart Compact 4 x 4 GT with options.

AnthroCart Specifications





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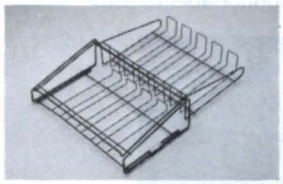
AnthroCart Optional Accessories

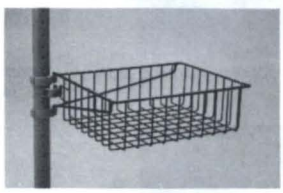
(1) Paper Feed and Catch $79.95
Handles your printer paper flow. Generally used atop Extension Shelf Kit option. Wire frame holds either 80 or 132 column printers. Paper feed holds up to 5 inches paper. Measures 18¼ inches wide x 12 inches deep x 5 inches high.


1

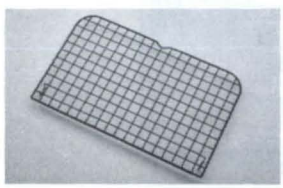
(2) Slide-Out Shelf $89.95
Acts as extra work surface. Use it for a mouse, documentation, or a digitizer pad (11 inch or 12 inch). Attaches under your keyboard shelf and slides out to the left or to the right. Measures 11¼ x 11¼ inches. Supports up to 20 lbs. Available in slate gray color.

2

(3) Four Inch Storage Basket $54.95
Use it for extra storage room. Different from Printer Basket option (#7). Black wire basket swings under cart and locks in place. Measures 13 inches x 10½ inches x 4 inches. Specify for either right or left side.


3

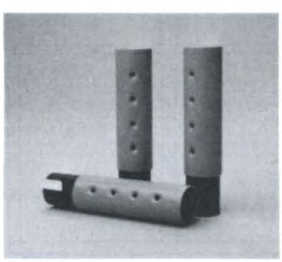
(4) Wire Base Shelf $44.95
Designed for books, storage or can be used as a foot rest. Black wire shelf pops onto base tube. Specify whether for Compact or Full size model.


4

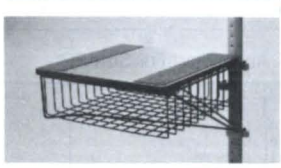
(5) Extension Shelf Kit $119.95
Adds one more level to your cart. Can be used for printers, plotters, monitors, or any hardware add-ons. Extension tubes are 15 inches high and pop into legs of cart. Shelf is the small monitor size shelf. Shelf available in slate gray or golden oak color. Specify whether for Compact or Full Size model.

5

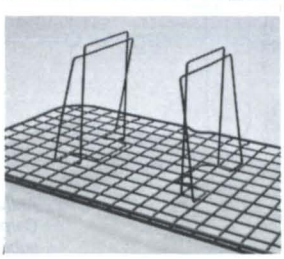
(6) Five Inch Extender Tubes $39.95
Gives height flexibility by adding five inches to your cart. Pops into legs of cart. Can also be used with the Extension Shelf Kit so total of 20 inches can be added. Like any AnthroCart legs, the extensions have holes in 1 inch increments so you can move your shelves up or down.

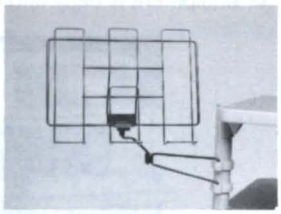

6

(7) Printer Basket $119.95
Specifically for 80 column printers. Use Extension Shelf Kit or SideCar options for 132 column printers. Black wire basket holds up to 20 lbs and 3½ inches of paper. Nonskid surface holds printer securely in place. Swings under cart and locks in place. Includes cord management clips. Measures 14½ inches x 13½ inches x 4½ inches. Available for either right or left side.


7

(8) Bookends $29.95
Keeps your books and manuals in place. Black wire pieces pop into Wire Base Shelf option.

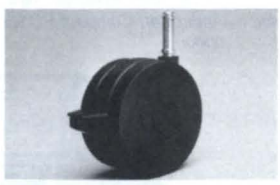

8


9

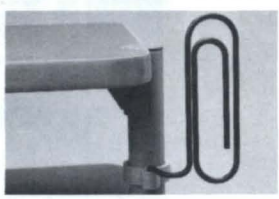
(9) Document Holder $29.95
Holds your papers at a comfortable reading angle. The black wire moves back and forth, and tilts to three positions. Can be mounted to either the left or right side. Measures 13 inches x 10 inches. Specify whether for PC or GT model.

10

(10) Surge Protector $116.95
Takes all your cords and plugs them into one strip. Six outlets, UL approved, series 9 conditioned strip. Rated 15 A, 125 V, 60 Hz, 1875 W continuous duty. Can be screwed underneath shelf or attached to a leg.


11

(11) Four Inch Castors $74.95
Provides easy maneuverability across uneven surfaces. Cart can be purchased with four inch castors (see page 80) or four inch castors can be added as an option. The four castors are soft rubber, two of which are locking.


12

(12) AnthroClip $9.95
Cleans up your papers and keeps everything neat and tidy in one spot. Black wire piece can be mounted either to the left or right side. Measures 6½ inches high.

13

(13) Additional Small Shelf $59.95
Adds more space for more equipment. Can be added anywhere onto cart, either above or below existing shelves. Available in slate gray or golden oak color. Specify whether for Compact or Full Size model.

14

(14) SideCar $199.95
and Rover $29.95
Holds your 132 column printer. Supports up to 80 lbs and accommodates an entire box of paper or forms. Paper can be fed from front, rear, or center. Swings under cart and locks in place. Measures 21½ inches x 15¼ inches x 15¾ inches. Comes with two castors (one locking). Available also with Rover option, which turns SideCar into standalone mobile unit by adding two additional castors.

15

(15) Anthro PrinterCart $299.00
An AnthroCart designed specifically for large printers. Roll your printer from PC to PC. And adjust the shelves to fit your paper flow. A slotted top shelf feeds paper from the second shelf, and cord management clips keep your cords in order. Measures 22½ inches x 25 inches x 20¾ inches. Available in slate gray or golden oak color.

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DESIGN AUTOMATION PRODUCTS

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Tektronix Design Automation products provide a comprehensive array of tools intended for engineering, production, and service applications throughout the electronics industry. As the electronics industry demands ever-increasing front-end design automation via computer-aided processes, Tektronix' Design Automation tools respond with computer-aided software engineering systems and with test and measurement linkages to CAE and CASE Systems. In applications ranging from VLSI prototype verification and computer servicing, to microcomputer software development, to production semiconductor testing, products from the Design Automation Group have set the industry standard for versatility, innovativeness, and performance.

Computer Aided Engineering
Tektronix now has a comprehensive set of tools for electronic product design and test. Integrating CAE products from the CAE Systems Division with its traditional test and measurement and software development products, Tek now offers a broad range of CAE solutions. See page 84.

Computer Aided Software Engineering
The Computer-Aided Software Engineering (CASE) Division provides integrated software and hardware products and services for the analysis, design, prototyping, coding, test, integration and maintenance phases of the software development life cycle. CASE Division products meet the needs of software engineers in both private industry and government markets.

These design solutions are integrated in the CASE Division lifecycle software tools and automate the transition from one software development phase to the next. Our total CASE product offering has been named the "Integral CASE Software Factory." Current key products include: Structured Analysis (SA) Tools, Structured Design (SD) Tools, LANguage Development Systems (LANDS), and Multi-V Systems—new 32-bit microprocessor development systems for the Motorola 68020 and the Intel 80286.

CASE's products and services facilitate software specification, design, implementation, documentation, and maintenance on popular host computers and engineering workstations—as well as the integration of software in a prototype hardware environment. See page 90.

Logic Analyzers
The Logic Analyzer Division provides instrumentation for testing and measuring digital hardware and software throughout the entire cycle of design, manufacture, and service. This instrumentation includes data acquisition, pattern generation and data analysis capabilities.

The breadth and modularity of the Logic Analyzer product line ensures powerful, cost-effective solutions for applications ranging from testing VLSI devices to troubleshooting failing equipment remotely over telephone lines. See page 105.

Semiconductor Test Systems
The Semiconductor Test Systems (STS) Division furnishes integrated circuit manufacturers and users with computer-controlled automated IC test systems ranging from compact production testers to full scale characterization machines.

Every STS system includes a complete package of the functional, ac parametric, and dc parametric test features required for thorough integrated circuit testing at any level. STS systems are often called upon to do device characterization during the first shift, and to analyze results and generate reports during the third. STS products are designed to serve customers who demand precision and accuracy combined with cost-effectiveness. See page 128.

Computer Based Instrumentation Products
The Computer Based Instrumentation (CBI) Division provides customers the *NEW* Delta Series family of compact, modular VLSI Test Systems. The Delta Series may be used by design engineers to verify the functionality and timing margins of custom or semi-custom VLSI devices and by test engineers for low-cost production testing of SSI to VLSI devices.

In the design engineering environment, the Delta System allows designers to interactively test a prototype device during development and to compare actual device performance against design expectations. Test programming is simplified through the use of menu-driven Visual Interactive Access (VIA) software. Alternatively, test programs can be written directly in C.

In the production test environment, the Delta System allows test engineers to test the functional and timing performance of manufactured SSI to VLSI devices. Application areas include incoming inspection of parts, production, and "lot sample" QC testing. The modularity inherent in the Delta Series offers customers flexibility in configuring a system to meet their current needs as well as a growth path for the future to accommodate changing production test requirements. See page 133.

COMPUTER AIDED ENGINEERING

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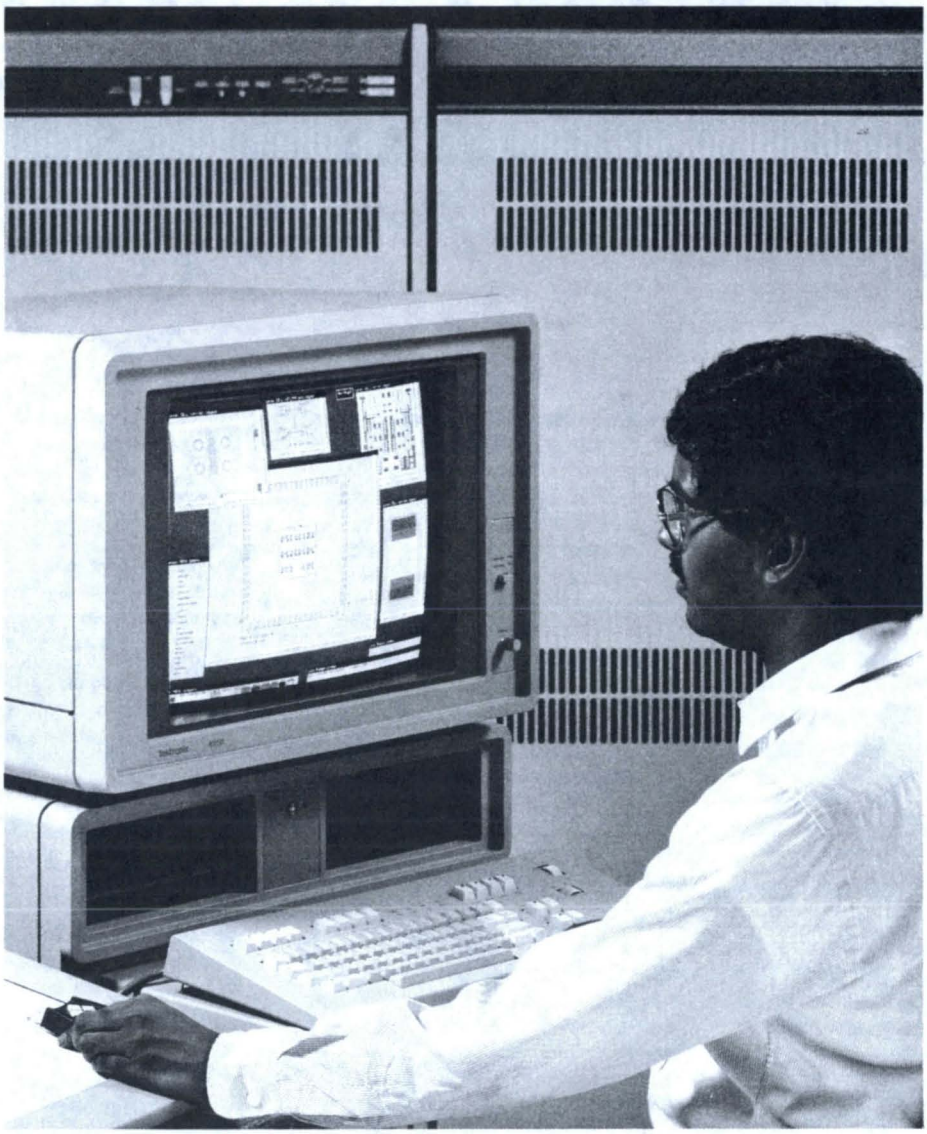


Tek/CAE WorkSystems, featuring Designer's Database and Schematic Capture, simulation products and (shown above) special IC layout tools such as LEIA (Layout Editor) on a Digital VAX 11/780 with a Tek terminal support a full family of electronic automation and design applications.

TEKTRONIX AIDED ENGINEERING AND THE WorkSystem

Tektronix and CAE

Tektronix' entry into the CAE market extends the company's commitment to providing the best available engineering tools. The broadened product line includes leading edge CAE tools. These products provide Tektronix with the ability to couple state-of-the-art instrumentation to the CAE design process.

Tektronix, the long standing leader in the verification and test areas of the product development cycle, expanded our technology base to include front end CAE design tools through CAE Systems Division, headquartered in Santa Clara, California. Development and support centers are located in Boston, Massachusetts; Austin, Texas; Beaverton, Oregon; and London, England. Thus, Tektronix extends the utility of CAE by integrating hardware design tools with software development, including integration tools, instrumentation, production test systems, and mechanical CAD capabilities.

The Demand for Productivity

The most difficult problem faced by electronics manufacturers today is how to get better, more complex products to market more quickly. Computer Aided Engineering (CAE) technology reduces development time. Better tools improve the efficiency and accuracy of designs and get a product to market more quickly. The current demand for productivity, coupled with the opportunity offered by computer technology, has led to a new era of engineering. Today, computer assistance is required not just to speed the design process, but, indeed, to make complex projects possible. The state of the art has surpassed the engineer's ability to cope with design complexity without the aid of computers.

CAE workstations speed up the engineering process by allowing the designer to evaluate ideas before committing to expen-

sive prototype fabrication. Many of the detailed design tasks previously performed manually are now done by software. Design errors are eliminated by simulating and verifying the operation of a circuit on the workstation.

CAE Users Demand More
As CAE tools become available for larger and more complex projects, users are developing new requirements. For example, the need has emerged for an efficient facility for communication and administration of the total design database.

In the past, emphasis has been on the performance of individual tools. But systems that emphasize individual tools tend to be application-driven. The architecture assumes a defined order in the use of tools and provides for communication only at predefined intersections. It is difficult to provide concurrent access. As products increase in complexity, the need for such access to a single design database has become critical.

For this reason, the trend is toward "data-driven" CAE tools that view data as the hub of a tool assortment, each with direct access to the entire database. Under this organization, the CAE environment is seen as a flexible set of compatible tools that may be used in the order and combination appropriate to the specific design task.

The Next Phase
An important new development in CAE is the movement toward increased integration, better and more consistent user interfaces, and standardized data interfaces among tools. The focus is shifting from the performance of individual workstations and application programs to the effectiveness of the overall design process. Users are demanding new CAE tools that are compatible with existing hardware and software resources and that provide links to existing design, manufacturing, and test tools.

Open Systems
Tektronix CAE Systems Divisions design and test solutions are based on an "open systems" philosophy that combines a wide range of functionality with standard interfaces to fit into existing design environments. To promote compatibility among tools, the Division actively supports industry-wide standards in the design of its products and through participation in industry standards efforts. Compatible interfaces allow users to configure the engineering environment, broaden equipment and applications software choices, and protect a substantial CAE investment against obsolescence.

Multiple Hardware Platforms
Tektronix' CAE tools are available on a variety of computer systems and workstations.

VAXstation II—Using Tektronix' electronic design software, DEC's VAXstation II engineering workstation is one of the most powerful and flexible systems available.

Users have a broad choice of hardware platforms including the Apollo workstations, and Digital's VAX family of products ranging from the MicroVAX II-based workstations to the powerful 8800.

The multiple hardware platforms approach is an integral part of the Tektronix long term strategy and will remain an important advantage of Tektronix solutions. Such broad hardware support is critical to users with a large investment in computing equipment and also to users who need extra freedom to choose an optimum configuration. Evolving and improving CAE tools must be able to fit into an existing environment gracefully. Multiple hardware platforms complement the open systems philosophy by providing the greatest number of options to CAE users.

Team Engineering
To work efficiently, engineering teams must be able to work in parallel, which requires good communications on all levels. Tektronix CAE tools are built around the distributed database concept, which gives every engineer instant access to the latest design information. With both hierarchical and relational capabilities, the database manager allows distributed access to circuit design at several levels of abstraction and in multiple representations. The Tektronix design environment also provides facilities for networking and documentation, and will soon provide full project data management and project tracking capabilities.

Instrumentation
Tektronix instrumentation continues to lead the industry in performance and reliability, and we are firmly committed to the pursuit of advanced measurement technology. Many Tektronix instruments already possess the intelligence to perform either in standalone mode or as a subsystem in a larger CAE environment. A major Tektronix objective is to extend the available linkages among instruments and systems, allowing the user to select the level of integration appropriate for a particular task.

The Tektronix CAE Solution
Tektronix thus offers a comprehensive set of tools for electronic product design and test through integrating products from CAE Systems Division with traditional Tek test and measurement and software development products. To understand how the full complement of Tektronix CAE tools work together in the design engineering environment, consider what is required to implement a complex electronic product containing standard devices, special purpose ICs, microprocessors, and custom firmware. The Tektronix CAE product line addresses each of the following points in the total design process.

System Definition
To aid in overall system definition and requirements specifications, Structured Analysis (SA) tools provide a structured, graphic approach to high level architectural specifications, for both software and hardware, using data flow diagrams, data dictionaries, and minispecifications. SA tools allow the designer to specify and analyze what a system will do before dealing with implementation details, and provide a convenient, interactive graphics interface that automated most of the clerical chores associated with creating consistent specifications.

Software Development
The LANguage Development System (LANDS) provides a complete development tool kit for popular languages and target processors. LANDS automates the software development process with language-directed editors that check for syntax errors and eliminate many time consuming mistakes that would otherwise be present at compile time. Symbolic debuggers (SBD) allow the software engineer to follow program execution using high level symbolic names and control structures. The Integration Control System (ICS) automates the process of configuring software for a specific hardware environment. The 8540 Microcomputer Integration Unit provides a simulated execution environment with memory and I/O in addition to the target processor.

Electrical Hardware Design
- A concurrent, multi-engineer design environment with a flexible, hierarchical, distributed database.
- Multiple design representation at each level of the design hierarchy with user-defined block diagram, logic, and circuit descriptions.
- Interactive "what if" analysis of designs.
- One-button interfaces to industry standard CAE tools running locally or on host computers.
- Capability for easy user interface with in-house tools.
- A LAN with electronic mail to allow multi-engineer communication and data transfer.

The MultiSim family of simulator products includes an interactive, multilevel simulator. MultiSim provides function simulation, and an interactive software logic analyzer for probing and waveform display during simulation.

The functional modeling language option, a part of MultiSim, allows the user to build functional models of selected portions of a system to describe and simulate a design before all of the circuit details are known. The behavioral model can be incorporated as part of an overall simulation that alsoincludes logic and circuit descriptions.

The Statistical Fault Analyzer (SFA) allows designers to determine the effectiveness of a specified set of stimulus test vectors in detecting electrical faults which may occur in digital circuits.

To speed analysis of complex designs, the Tektronix electronic design system interfaces to the Zycad hardware logic simulator to execute simulations at more than one million events per second. For simulation of complex components without software models, the HICHIP hardware modeling system allows an IC or PCB to be coupled with a simulation on the workstation to evaluate the combined system.

Physical design is aided by the MERLYN-P package for board layout or MERLYN-G for gate array layout. Performing both interactive and automatic placement and routing, and design rule checking, CALMA GDS/II files are automatically generated for IC mask fabrication.

For custom ICs, Tektronix offers its Structured Custom WorkSystem, which includes:

- Module generation
- Layout editing with the Tektronix custom layout editor (LEIA)
- Layout verification by ECAD's Dracula II

Tektronix electronic design system software provides interfaces to other popular layout programs such as:

- MEDS, GARDS, CAL-MP, and BOLT for IC layout
- SCICARDS, CALAY, and REDAC for PCB layout

A comprehensive, up-to-date library system is essential for rapid design implementation. Through the CONNECTIONS joint marketing program, Tektronix has partnerships with selected IC vendors to provide the widest possible range of foundry libraries.

Verification and Test
The Delta Series VLSI Test System family offers users the capability of testing ICs ranging from 24 I/O pins to 96 I/O pins (48 to 192 total pins). ICs and PCBs can be verified at the engineer's bench with the DAS 9100 Digital Analysis System, which provides test pattern excitation from dc to 50 MHz. DASLink software allows automatically generated test patterns to be downloaded to the DAS from a Designer's Database and Schematic Capture System. The acquired results are returned for direct comparison with simulation by displaying actual data through the virtual logic analyzer "roving probe" interface on the workstation.

Documentation
As products increase in complexity and development cycles become shorter, the need to properly document a design becomes acute. Documentation is a valuable resource that allows engineers to reuse designs and also aids in manufacturing, value engineering, and product customization. The Tek/CAE electronic design system incorporates the powerful, screen-oriented TekWriter publications software for engineering documentation. TekWriter allows descriptive text to be entered and formatted at the workstation and combined with waveform graphics and tabular information generated by other CAE tools.

The Tektronix Difference
Tektronix CAE tools span the product development process from concept through production and provide both flexibility in design style and compatibility with the existing environment. A common design database integrates these tools into an effective data-driven, team-oriented engineering environment. Since Tektronix offers proven test and measurement capability coupled with front end design, users can incorporate state-of-the-art instrumentation while realizing the benefits of control and analysis through the consistent CAE workstation interface.

Tektronix internal resources provide a large degree of vertical integration, which enables cost reduction and performance advances. The Electronic and Mechanical Component Group maintains eight state-of-the-art engineering and manufacturing facilities for custom silicon and gallium arsenide integrated circuits, analog and analog/digital hybrids, and high-density PCBs. Major in-house software efforts often yield new software development tools to enhance the productivity of all Tektronix product development groups.

Since Tektronix is a major component and system manufacturer, it is a model for evaluating the evolving CAE environment. Internal programs exist to make Tektronix CAE products available to all engineers and to promote rapid feedback to the product development groups. Tektronix believes that the same process of internal evaluation that has made Tektronix oscilloscopes and other instrumentation unsurpassed in the industry can also be applied to CAE tools. Tektronix calls it the "next bench effect"—a product designed by one engineer is likely to be used by the engineer at the next bench.

Tektronix' large R&D resources prove increasingly important as the frontiers of CAE move into areas such as artificial intelligence, computer-aided software engineering, and high speed signal processing. For example, instrumentation is currently reaching the limits afforded by silicon technology. Advances in speed requires more exotic materials such as gallium arsenide (GaAs)—an eventuality anticipated by Tektronix in advanced research that has resulted in state-of-the-art GaAs design and foundry capability.

Tektronix has a large base of traditional engineering customers. This provides knowledge of and direct contact with CAE users of the future. A worldwide sales and service organization and a reputation for quality products and responsive support give Tektronix a credible presence in the evolving CAE market.

Summary

Computer-aided engineering is based on more than a single turnkey solution. It is a systems integration approach to maximizing engineering productivity by applying computer power. It is a set of flexible, evolutionary solutions that will continue to expand in many dimensions.

Tektronix is one of the first Fortune 500 companies with a comprehensive set of CAE solutions. Users now have a large, reliable vendor source for a broad range of CAE products. Tektronix is establishing the trend toward an open systems architecture, industry standards, and a flexible tool kit approach to CAE.

Data management is becoming a dominant issue for CAE users. Tektronix' electronic design environment will set the direction for future CAE database systems. It provides a new level of system integration that includes hardware, software, test and measurement, and project management coupled through a global design database.

The WorkSystems

The WorkSystems, designed by Tektronix CAE Systems Division, integrate a complete family of electronic design and test tools with a distributed designer's database.

Each WorkSystem is a vertically integrated set of computer-aided engineering tools and addresses a specific area of a design cycle, or can be combined to do multiple tasks. The WorkSystem family is comprised of the following:

Designer's WorkSystem™
Gate Array WorkSystem™
Full Custom WorkSystem™
Structured Custom WorkSystem™
PCB WorkSystem™

Together, the WorkSystems give you all the tools for your entire development process, including design capture, documentation, verification, test and measurement, PCB and IC layout, and production test.

All WorkSystems feature open architecture so that new tools may be added. Each WorkSystem also works with DEC VAX and Apollo workstations.

Designer's WorkSystem™

Designer's Database and Schematic Capture System (DDSC)—Complete Environment for Capturing and Managing Designs

MultiSim Family

SPICE Analog Simulator

HILO Software for Logic and Fault Simulation of Standard Parts, Microprocessors and Custom ICs

Libraries: Standard Parts

Librarian System for Modifying or Augmenting Existing Libraries

TekWriter™ Engineering Documentation and Publication Software

Integrating design capture and verification tools with a database, this WorkSystem is a complete environment for conceptual design and analysis.

The Designer's WorkSystem helps you find simple answers to difficult problems by integrating design capture and verification tools. You can even test ideas while they're still only ideas with the MultiSim simulator family.

Designer's Database and Schematic Capture

The Designer's Database and Schematic Capture system offers a completely integrated, hierarchically structured software system for the design of complex electronic circuits. The software runs UNIX operating system.

Design information in the database can be defined and accessed along two dimensions. Vertically, the user defines hierarchical levels from the most general and abstract (the functional level) to the most detailed (gate or transistor level). Horizontally, design at each level may appear as a behavioral description, in logical symbols, or as a circuit diagram. A one-button "push" command brings any level into view on the screen. The vertical hierarchy permits review and analysis to focus on details such as fanout and loading, when appropriate. Horizontally, the hierarchical structure encourages "what if" and trade-off analysis.

The critical difference in the Tektronix Designer's Database and Schematic Capture software lies in the nature and design of the database. This proprietary, hierarchically organized database allows the designer to work in his most comfortable style, at any level from top-down to bottom-up, or in any combination. In the same design, an engineer may define and display some blocks at the functional level, others at the logic level, and others at the circuit level. Since the user defines his own hierarchy, existing design practices need not be altered.

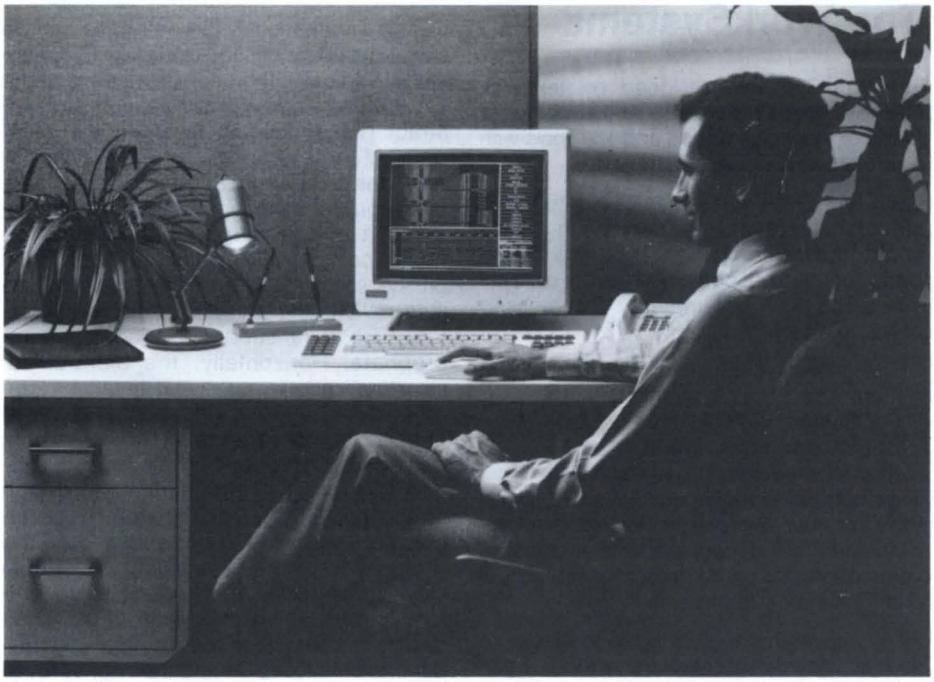
With the Tektronix WorkSystems, concurrent design is at your fingertips. Teams of engineers can work simultaneously on different levels. All team members have access to the entire design as it progresses. Because data entered at any design level instantly updates the database, communication among team members is automatic. Analysis and simulation results are available to all team members. The project manager can view the progress of the entire team and check interfaces for compatibility and compliance with specifications. No copying of files or other special integration procedures are required—the design is always integrated. This total concurrent Team Engineering concept is unique to the Division. In addition, the networked database is integrated with other tools within the WorkSystems to protect your design data investment.

TekWriter

TekWriter Publications Software is based on Interleaf's Workstation Publishing Software for engineering documentation.

Design graphics and text can be mixed within documents. TekWriter allows engineers to accelerate, improve and simplify the development of documentation associated with the design of integrated circuits and printed circuit boards.

TekWriter also enables the user to edit and format documents, as well as illustrate production quality technical publications. Users can select from various type faces and sizes.



Tektronix' CAE tools are available on a variety of computer systems and workstations such as the Apollo DN 3000 shown above.

MultiSim Family
MultiSim is an integrated, modular family of design simulation and verification software tools.

The MultiSim family is composed of the following:

- A choice of different modeling methods: physical modeling (HICHIP); C modeling; functional (gate and switch level) modeling
- HILO-3 (5-state, industry standard simulator)
- IDEAL Logic Simulator (12-state, interactive multilevel simulation kernel)
- Interfaces to Tektronix' standard Computer-Aided Engineering Software (CASE) Products (MicroLink) and Design Automation Systems (DASLink)

Logic Libraries
To reduce design time, Tektronix offers access to a library of over 3000 standard parts, including those for TTL, FAST, CMOS, ECL, and MICRO-P.

Systems and IC designers have a wide variety of state-of-the-art implementations for their electrical designs. The libraries provide primitive elements from simple gates to complex functions such as I/O buffers, multiplexers and memories.

Gate Array WorkSystem™

MERLYN-G Automatic Gate Array Placement and Routing System

Libraries: Foundry, Logical, and Physical Gate Array Libraries

DDSC

MultiSim Family

Offering complete electrical and physical design system for gate array VLSI layout, verification and analysis, the Gate Array WorkSystem also provides 100 percent fully automated placement and routing, as well as access to extensive parts libraries.

The Gate Array WorkSystem from Tektronix brings all the power of the Designer's WorkSystem plus the proven Merlyn-G gate array layout tools. Modules are included within the WorkSystem to provide the user with automatic place and route. Logic Libraries are also part of the Gate Array WorkSystem.

Full Custom WorkSystem™

LEIA Interactive Layout Editor for Custom ICs

Dracula II Layout Verifier

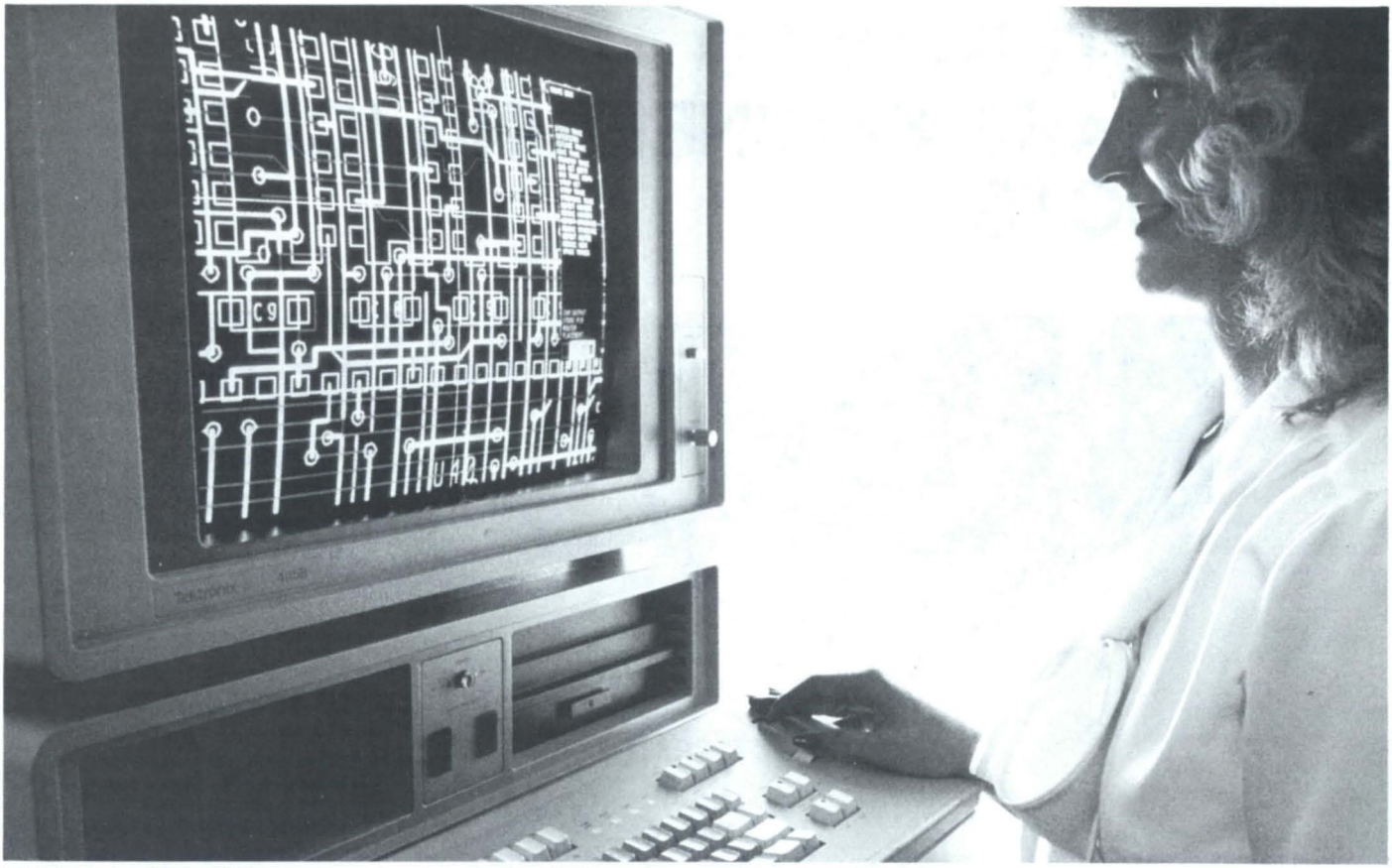
DDSC

MultiSim Family

This WorkSystem provides full custom chip design including design capture, simulation and an interactive full custom layout editor.

In addition to the full Designer's WorkSystem features, the Tektronix Full Custom WorkSystem includes LEIA layout editor, which allows IC designers to create layouts for custom and semicustom ICs. LEIA is also Calma GDS/II STREAM compatible, and interfaces with the Dracula II layout software.

Dracula II, from ECAD, Inc. of Santa Clara, California, provides users with a tool to verify the accuracy of integrated circuit layout data. The program includes a design rule checker, electrical rule checker, layout parameter extractor (LPE), layout schematic and layout versus layout comparators, interactive post processor of LPE database and a Versatec plotter interface.



PCB WorkSystem features 100 percent automatic routing and verification for printed circuit board design and layout.

Structured Custom WorkSystem™

Chip Compiler

DDSC

MultiSim Family

Coupled with Designer's WorkSystem, complete electrical and physical design capture, verification and layout is provided for structured custom ICs.

The Structured Custom WorkSystem combines all the features of the Designer's WorkSystem along with the Concorde Chip Compiler. Logic Libraries complete the structured custom design system.

The chip compiler manages and simplifies digital design, geometry generation, placement, routing and packaging. This gives electrical engineers who are not IC design specialists the ability to develop their own application-specific chips.

PCB WorkSystem™

MERLYN-P Automatic PCB Design System

Foundry, Logical and Physical Standard Parts Libraries

DDSC

MultiSim Family

Board-level design capture, verification and layout, as well as extensive parts libraries, are included in this WorkSystem.

The PCB WorkSystem combines the features of the Designer's WorkSystem along with the powerful features of the Merlyn-P automated printed circuit design system, and Parts Library.

For further information about the WorkSystem products and configurations as they apply to your particular design needs, contact:

Tektronix
CAE Systems Division
5302 Betsy Ross Drive
Santa Clara, CA 95052-8137
Phone: (408) 727-1234
Telex: 821378 CAESYSTEMS

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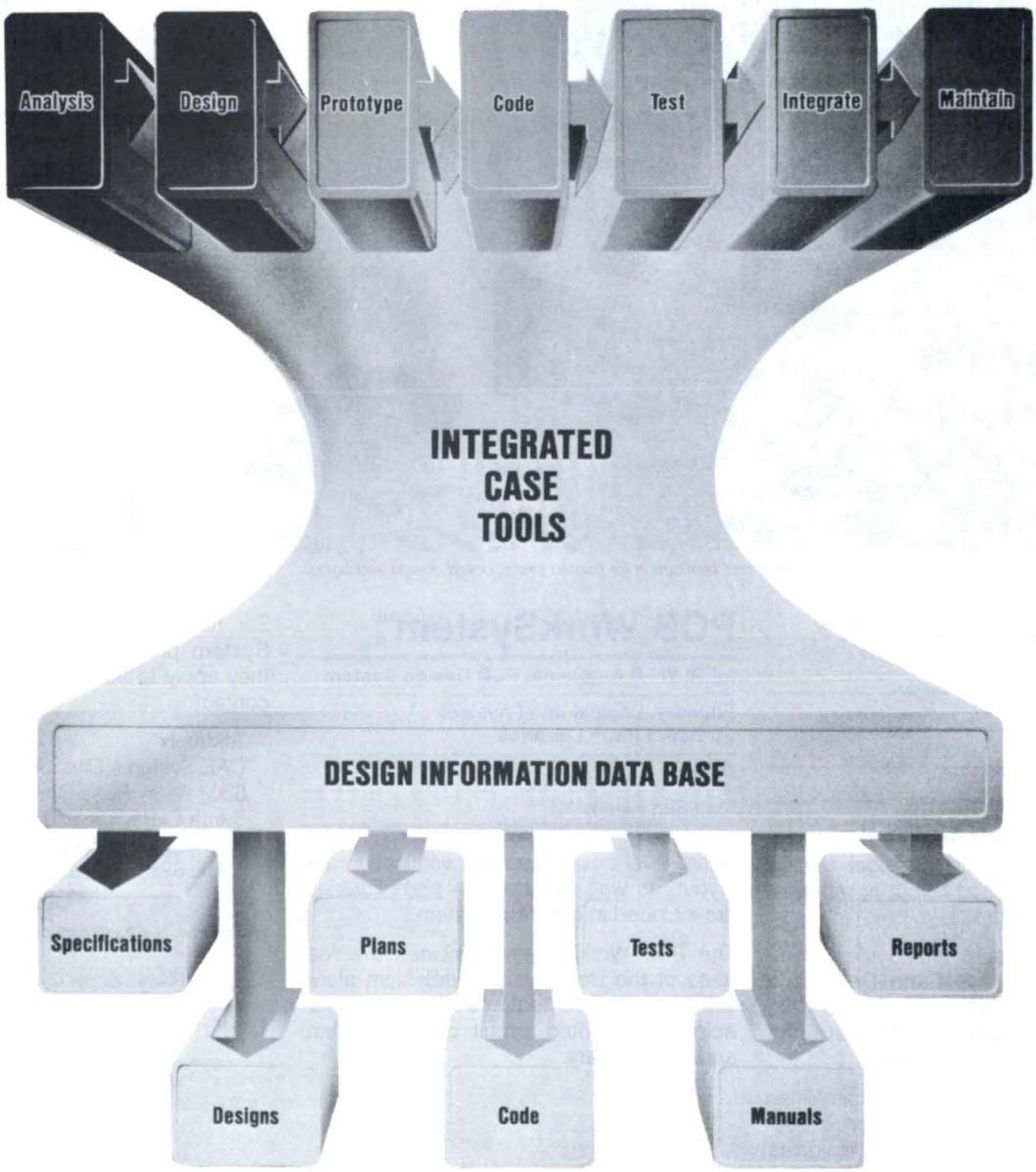
COMPUTER-AIDED SOFTWARE ENGINEERING (CASE) PRODUCTS



Software Development Products Division was recently renamed the Computer-Aided Software Engineering (CASE) Division. This name change reflects Tek's accelerating participation in the rapidly developing computer-aided software engineering (CASE) market.

Tek's commitment to the emerging CASE marketplace makes the name change a logical fit for our expertise. Our goal is to provide a functional and integrated tool set for software design engineers—life-cycle management from concept to completion to maintenance.

These design solutions are integrated in CASE's life-cycle software tools and automate the transformation from one software development phase to another. Our total CASE product offering has been named the "Integral CASE Software Factory." Current key products include: Structured Analysis (SA) Tools, Structure Design (SD) Tools, Language Development Systems (LANDS), and Multi-V Systems—new 32-bit microprocessor development systems for the Motorola 68020 and the Intel 80286.

CASE products provide you with a carefully configured and integrated system of automated tools applied to the software life-cycle. CASE's tool set is comprised of seven support stages geared around the software life-cycle:

1. Analysis
2. Design
3. Prototype
4. Code
5. Test
6. Integrate
7. Maintain

The integrated CASE tool set, when linked to the user's design information database, enable the software designer to rapidly and proficiently develop specifications, designs, plans, code, manuals, and reports.

The CASE Division is continuing to evolve its CASE solutions by more tightly integrating the phases, extending the capability of its automated tools, adding new alternative tools, and by expanding into software development on engineering workstations.

To support the analysis and design phase of the software life-cycle, the Tektronix CASE strategy is to make SA and SD Tools available in the most common computer environments. Now, in addition to running on VAX and MicroVAX systems, SA Tools are also available on Apollo DOMAIN and IBM PC.

Tek's CASE offering continues with code development and debug tools with the high-level Language Development System (LANDS). This integrated set of language development tools, originally released by Tektronix in 1982, include a Language Directed Editor (LDE), C or Pascal compiler, integration control systems, a high-level debugger, and an assembler/linker for popular 8-, 16-, 32-bit microprocessors.

Since 1946, Tektronix has been a leader in test and measurement—enriched with the latest software technology. For 10 years, Tektronix has dedicated one division to providing software tools for embedded microprocessor software development.

Our close working relation with Tektronix Laboratories links us with a major software research and development facility, and we have the technological and financial resources needed to be a premier CASE vendor. We are committed to helping software designers who need the total support only a firm like Tektronix can provide.

The "Integral CASE Software Factory" culminates this effort. Its tools are powerful proof of Tektronix' software leadership. Meeting your needs through integrated, automated solutions to manage the software life-cycle—this is CASE Division's mission.

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SOFTWARE LIFE CYCLE PHASES

1. Analysis

In the analysis phase, the software engineer specifies what a software system must do to meet its user's requirements. Data flow diagrams and process descriptions define how data flows, and is transformed. A data dictionary describes how data is structured. These components comprise a specification for the software system upon which a design is based.

2. Design

In the design phase, the specifications from the analysis phase are transformed into a software module design. Logic modules and algorithms are created so solution prototyping can begin.

3. Prototype

In the prototype phase, prototyping tools allow the software engineer to test the hypotheses posed in the analysis and design phases. The detailed design of the solution to be implemented can be tested and refined during this phase.

4. Code

In the code phase, the software engineer needs tools to produce executable code on a computer or workstation in a particular language. If the software is being developed for an embedded microprocessor, the coding tools on the development computer require cross-development tools to produce code that will execute on the target microprocessor.

5. Test

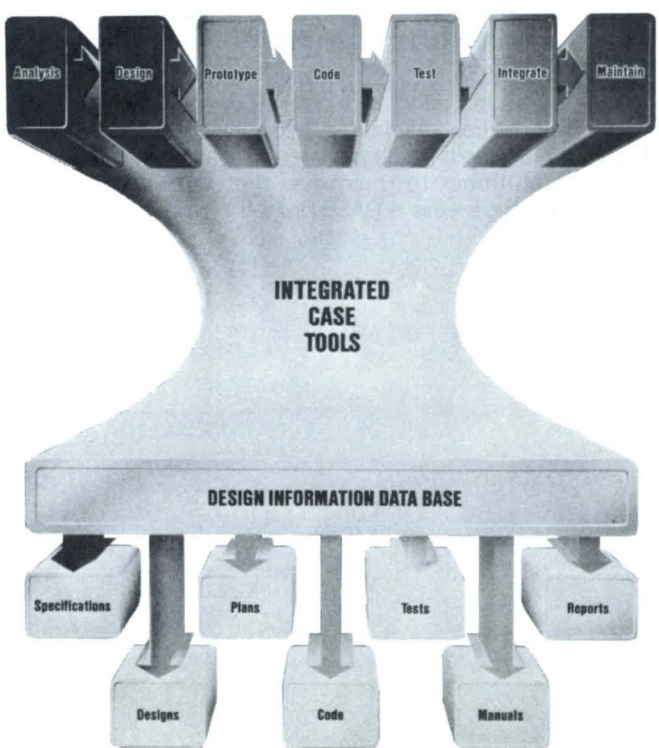
In the test phase, an interactive source level (or symbolic) debugger assists the software engineer in testing the software in accordance with the requirements and specifications defined in the analysis and design phases. The debugger should allow the user the ability to test a program on both the development computer and the target system.

6. Integrate

In the integration phase, the final testing and verification of the software must be performed where the software is actually used. Software/hardware integration is performed using symbolic debuggers if the software is to execute on a traditional computer or workstation, or using a symbolic debugger linked to a software/hardware integration unit and emulator for embedded microprocessor targets. In addition, test cases resulting from the analysis and design phases are used to ensure the software meets its requirements.

7. Maintain

In the maintenance phase (after the software is developed), tools used in the previous six phases can be put to work making changes, or detecting and correcting defects in the software. Another traditional task may include installing customer requested enhancements, identifying and resolving problems, or assisting customers in the proper usage of the software. The maintenance phase is required documentation that defines what software product was developed, how the software product was developed, what can be changed, and how to make the change.



Structured Analysis (SA) Tools

Specify System Requirements Graphically

Automatically Check Completeness and Consistency

Improve Product Quality

Reduce Development Time and Cost

STRUCTURED ANALYSIS TOOLS: CRITICAL SYSTEM DEFINITION

A specification that inadequately defines system requirements can jeopardize a project's success.

SA Tools help define the system accurately from the very beginning—so you can build the right system to meet your goals. By defining *WHAT* to build before you design it, SA Tools define the system before you decide how to implement it in software and in hardware.

The vivid graphics and rigorous descriptions used to build this logical system model make it easier to study the specification and to verify that the proposed system will actually meet requirements.

Creating Accurate Specifications

Structured Analysis Tools support easy modifications that are consistent, complete, and well-structured, allowing developers to improve and adapt the specification throughout its development, and to reach final agreement on the specification.

Based on this verified specification, the software designer can reliably create a Structured Design for the software.

SA TOOLS FUNCTIONS

Tektronix SA Tools support the SA method described in *Structured Analysis and System Specification*, by Tom De Marco. SA is a systematic, graphic, top-down way to describe what a system does.

SA Tools support the SA methodology by automating the routine tasks of specifying a system: drawing diagrams, organizing documents, checking details, preserving consistency, and making copies.

Editing

A special-purpose interactive graphics editor lets designers create and modify Data Flow Diagrams (DFD) on-line. With the editor, designers can create, label, move, change and delete each type of symbol in a DFD.

The graphics editor lets designers move through the SA specification creating child DFDs and Mini-Specifications (MS). New DFDs are created with parent information automatically included.

The Data Dictionary (DD) and MSs are edited with any text editor, allowing designers to use the editors they prefer.

Evaluation

The evaluation tool verifies consistency, completeness, and structure in the SA specification. It identifies inconsistencies between documents and evaluates the specification for adherence to SA guidelines.

Correction

The correction tool helps preserve consistency in the SA specification between DFDs and the DD.

Display

The display tool allows designers to show SA documents on-line or to produce DFD hard copies. Copies can be full or half size, and in color or black and white.

Auxiliary Tools

Auxiliary Tools support system analysis by performing tasks such as sorting the DD, and extracting information from the SA specification.

Combined Tool Use

SA Tools can be easily combined with one another and with standard operating system commands to perform more complex tasks.

ColorKey+ User Interface

The Tektronix ColorKey+ user interface makes SA Tools easy to learn and use. Designers can use SA features by pressing function keys or by entering a command directly. Refer to page 101 for more information on ColorKey+.

Real-Time

A recent enhancement to SA Tools has added the capability to include control information in the SA model:

- Control Flow Diagrams to show the flow of control signals among processes.
- Control Specifications to show the state changes of processes and what actions result.
- Control Flow Definitions in the Data Dictionary to define the structure of control signals.

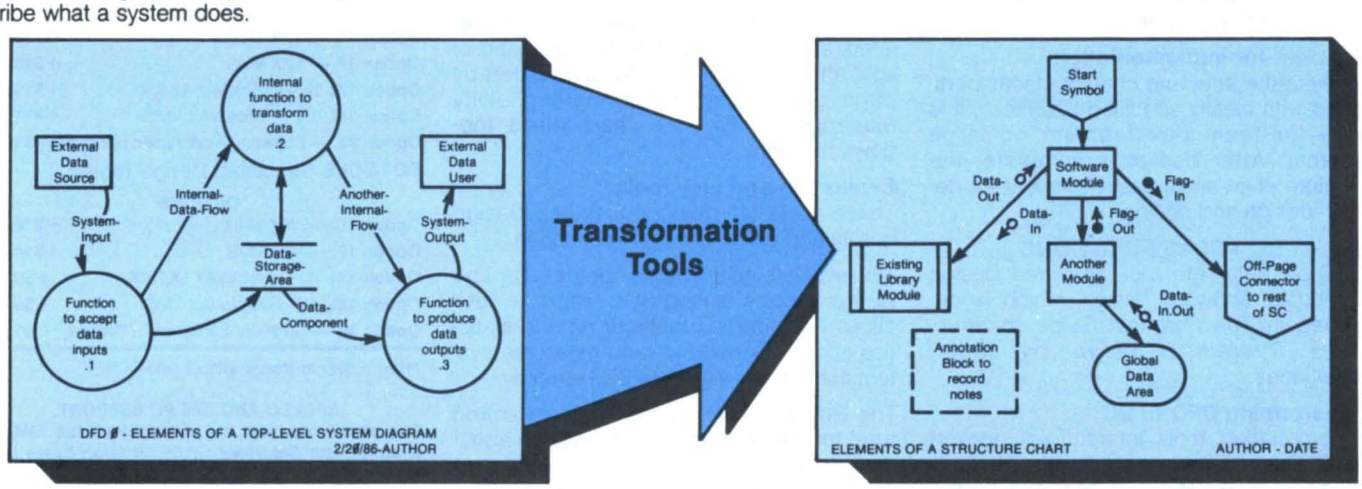
The method for real-time SA, an extension of standard SA, is described in *Strategies for Real-Time and General System Development* by Derek Hatley and Imtiaz Pirbah.

Now, system and software engineers can better apply the proven method of Structured Analysis to the broad class of real-time applications.

Host Support

SA Tools run on VAX and MicroVAX computers under the VMS, UNIX, and ULTRIX operating systems, and on other popular workstations, VAXstations, Apollo, and IBM PC.

With DEC systems, SA Tools work with both Tektronix and DEC peripherals.



Structured Analysis Tools create a set of interrelated data flow diagrams and descriptions that show the active functions of the system and its interfaces.

Structured Design Tools create a structure chart that graphically depicts the software architecture, with symbols showing modules and their controlling and communicating relationships.

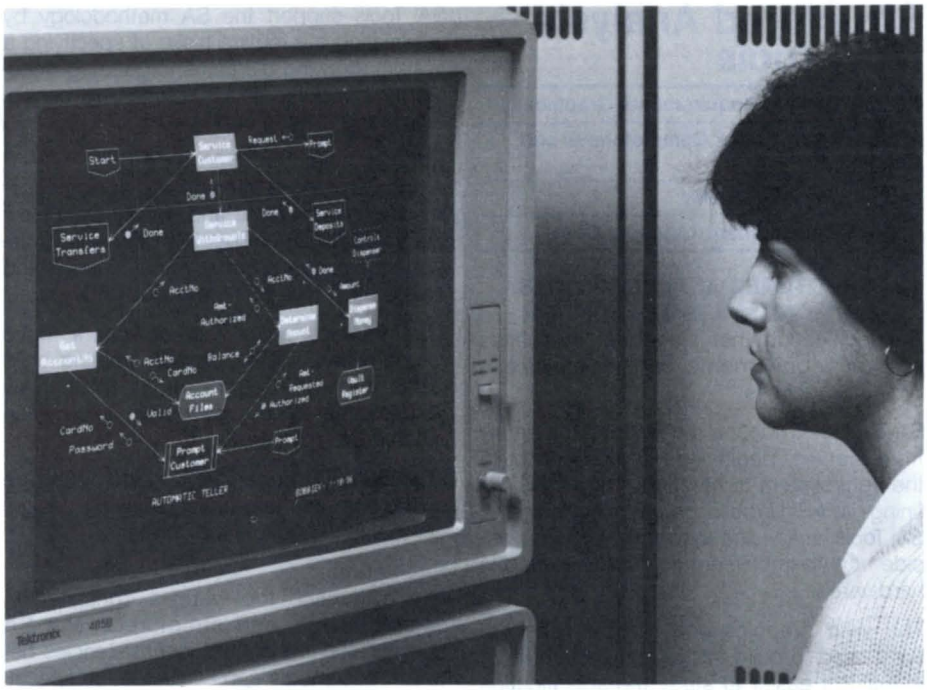
Structured Design (SD) Tools

Transition From Analysis to Design

Design Software Systems Architecture

Foundation for Detailed Design and Coding

Structured Maintenance of Existing Code



TRANSFORMATION TOOLS: BRIDGING ANALYSIS AND DESIGN

Tektronix SA/SD Tools are integrated to guarantee that specification information is automatically preserved in the design process.

Transformation utilities convert system specification diagrams into software design charts that include the same function and data specified during analysis.

Interactive transformation tools allow rapid "What-If" designs that encourage innovation and creative problem solving. Designers can then continue the creation of optimal designs using other, interactive Structured Design Tools.

PLANNING SUCCESSFUL SOFTWARE

Structured Design Tools help you build your software the right way—the first time—by supporting disciplined planning of software implementation.

The output of SD Tools is a set of diagrams for the entire software architecture which rigorously defines HOW the software is to be implemented.

Finding the Best Design

SD develops a structure chart (SC) which graphically illustrates the partitioning of a system into modules, showing their hierarchy, organization, and interfaces. The graphic nature of the structure chart conveys complex architecture quickly.

An interactive editor and evaluation tools for these software design charts enable designers to produce the best plan for implementing the software.

Blueprint for Implementation

Because the structure chart is strictly partitioned with clearly specified interfaces, it is ideal for team development on large projects. After design is complete, the structure chart serves as a blueprint for detailed design and coding.

SD TOOLS FUNCTIONS

SD Tools automate the Structured Design method of software design, which is described in *The Practical Guide to Structured Systems Design* by Meilir Page-Jones.

Transforming DFD to SC

Transformation tools interactively convert the DFDs that are created with SA Tools into a structure chart. In preparation for this conversion, associated DFDs may be merged into a single DFD.

To transform the merged DFD into a structured chart, the designer designates one process as the controlling module, an operation known as "pick a boss," where software execution will start.

Each primitive process in the merged DFD is converted to a modue in the SC. Transformation also moves and renames the mini-specification associated with each primitive process. The renamed mini-specifications can then be used as the basis for module specifications.

Editing Structure Charts

A special purpose, interactive graphics editor lets designers create and modify structure charts on-line. With this editor, designers can create, label, move, and delete each type of symbol in the chart.

Groups of symbols can be moved or deleted, and structure charts can be joined or split off into related SC files associated by page connectors. A reformatting utility rearranges a structure chart into a top-down hierarchy.

Evaluation and List Tools

These tools let designers check design quality and extract design information.

The evaluate tool checks for defects and inconsistencies among SCs, warns of deviations from the SD method, reports statistics about SC modules, and measures system complexity within the SC hierarchy.

The list tool provides the "module calling tree" for the SC files, and information about data item references, modules called, data item locations and parameter usage. This output is produced in a form specified by a user-defined configuration file.

Structured Maintenance

Designers can also use SD Tools to enhance existing software. A set of utilities automatically convert source code (the language C is initially supported) into structured charts. This view of existing architecture improves maintenance projects.

Host Support

SA Tools run on VAX and MicroVAX computers under the VMS, UNIX, and ULTRIX operating systems, and on other popular workstations, including Apollo and IBM PC.

With DEC systems, SA Tools work with both Tektronix and DEC peripherals.

ORDERING INFORMATION

STRUCTA Structured Analysis Tools	**$10**
OPTIONS	
Option 1C — VAX UNIX.	**+$16,490**
Option 1F — VAX VMS.	**+$16,490**
Option 1K, 1L — MicroVAX ULTRIX.	**+$11,990**
Option 1M, 1N — MicroVAX VMS.	**+$11,990**
Option 3S — Software Subscription Service.	**+$1,400**
SDTOOLS Structured Design Tools	**$10**
OPTIONS	
Option 1C — VAX UNIX.	**+$14,490**
Option 1F — VAX VMS.	**+$14,490**
Option 1K, 1L — MicroVAX ULTRIX.	**+$9,490**
Option 1M, 1N — MicroVAX VMS.	**+$9,490**
Option 3S — Software Subscription Service.	**+$1,000**

Prices subject to change without notice.

APOLLO AND IBM PC SUPPORT

The above products are available on the IBM PC. Contact your Tektronix CASE Division Sales Representative for additional information.

NEW Integral C

An Integrated C Programming Environment

Incremental Compiler Technology

Validating Design Assumption

Producing Functional Software Prototypes

Once a design has been completed, the next phase of the development cycle consists of constructing a software prototype. Tektronix offers Integral C, a completely integrated programming environment which replaces the functionality of a conventional editor, compiler, linker, and debugger.

Incremental Compiler Technology

The entire Integral C system is based on an incremental technology that greatly speeds the turnaround time between editing and debugging. Changes made in the source code are automatically compiled and linked, making the target program ready for execution and debug at any time. Since this process is accomplished on a function by function basis, it is unnecessary to wait for the compiler to rebuild a large software system after making small changes in the source code.

Windowed User Interface

Integral C provides a multi-window user interface, with access to different functions provided by various types of browse windows. The project browser is the window used by the developer to monitor and control the programming environment. Code browsers are available for editing source code, data browsers for monitoring the internal data structures of an executing C program and, finally, workspace browsers are available for viewing and modifying your debug routines.

Source-Level Debugging

The environment can find and diagnose several classes of compile-time and run-time errors that conventional systems fail to detect, such as pointer and array memory violations. In addition, Integral C provides a fast, reliable method of incorporating debugging code into a program without modifying the program itself. Workspaces are separate windows containing user-defined C code that can be attached to important events in the target program. When the event occurs, the workspace code is executed.

Software Prototype

Integral C is the first highly interactive development tool to bring the full power of today's computer performance together with advanced software technology to focus on the specific needs of the C programmer. Using Integral C, developers can quickly validate design assumptions and produce a functional software prototype that can be used as input to the implementation phase of the product development cycle.

LANDS I

16-Bit Language Development Systems

Complete C/Pascal Code Generation Systems

Integrated Set of Software Development Tools

Tightly Linked With V-16 Emulation Systems

After using SA Tools to develop your system specifications and SD Tools to design your software modules, you're now ready to develop and debug your code. Tektronix' Language Development Systems (LANDS I and LANDS II) offer a comprehensive set of tools for the development, debug, and integration of your software modules.

LANDS I

Using a high-level language to generate code for microprocessors has advantages over assembly language programming since programs are easier to understand and maintain and programmer productivity is higher. To support this, Tektronix CASE offers a language-oriented development system for C or Pascal called LANDS I. The LANDS I package is an integrated set of 16-bit language development tools consisting of a Language Directed Editor (LDE), a compiler (C or Pascal), an Integration Control System (ICS), a high-level language symbolic debugger, and a 16-bit macro assembler and linker. These products allow you to work through the software development and debug cycle in the same high level language from code entry through debugging.

Language Directed Editors

The Language Directed Editor included in the LANDS I package is an editor that understands C or Pascal syntax. LDE flags any syntax errors in the source code while you are still in the editor, so that the errors can be corrected immediately. LDE is also an excellent general purpose screen-oriented editor.

Compilers—C and Pascal

For high-level language programming, the LANDS I C and Pascal cross-compilers contain many enhancements for microprocessor programming.

These enhancements include interrupt handling, bit-level data manipulation, assignment of variables to specific hardware addresses, and direct access to I/O ports without having to resort to assembly language code. The LANDS I C compiler supports Kernighan and Ritchie's standard C and the proposed ANSI C standard and includes an implementation of the standard I/O libraries.

Integration Control System (ICS)

One major task associated with microcomputer design is to correctly interface the software with the specifics of the prototype hardware.

LANDS I includes a unique tool for implementing the hardware/software interface called the Integration Control System. The user fills in a brief source file with parameters defining the software modules and hardware configuration. From this source file, ICS automatically handles the details and generates the necessary code and command files to execute code in the target system.

High-Level Debug—C and Pascal

Program debugging is a tedious and time consuming task. Tek's LANDS I debug system increases your productivity by enabling you to debug code at the source code level.

Breakpoints can be set on statement numbers, procedure and function names, or on variables to halt program execution. Values can be returned to calling functions. This completely eliminates the time-consuming requirements of translating assembly-level debug information into its high-level counterpart.

In addition, your program and variables can be displayed in high-level source form, which speeds the analysis.

8- and 16-Bit Assemblers and Linkers

Tek assembler packages consist of an assembler for the specific microprocessor, a sophisticated linker for locating code, and a library generator for creating source code for object modules and reusing object modules previously created. Tektronix' assemblers and linkers include many features that are normally only associated with high-level coding.

ORDERING INFORMATION

LANGUAGE DEVELOPMENT SOFTWARE

C and Pascal LANDS I

Includes: HLL compiler, assembler, LDE, ICS, HLL debug.

CLAN68K C Support for 68000/08/10 — **$10**

CLAN86 C Support for 8086/8088/186/188/286 — **$10**

PLAN68K Pascal Support for 68000/08/10 — **$10**

PLAN86 Pascal Support for 8086/8088/186/188 — **$10**

OPTIONS

Option 1C — VAX/ULTRIX. **+$9,990**
Option 1F — VAX/VMS. **+$9,990**
Option 1K, 1L — MicroVAX ULTRIX. **+$8,490**
Option 1M, 1N — MicroVAX VMS. **+$8,490**
Option 3S — Software Subscription Service. **+$1,000**

ASSEMBLERS

ASMZ80 Z80/NSC800 Assembler — **$10**
ASM8085 8085 Assembler — **$10**
ASM6809 6809 Assembler — **$10**
ASM1750 1750 Assembler — **$10**
ASM68K 68000/08/10 Assembler — **$10**
ASM8086 8086/8088/186/188 Assembler — **$10**

OPTIONS

Option 1C — VAX/ULTRIX. **+$2,490**
Option 1F — VAX/VMS. **+$2,490**
Option 1K, 1L — MicroVAX ULTRIX. **+$2,990**
Option 1M, 1N — MicroVAX VMS. **+$2,990**
Option 3S — Software Subscription Service. **+$350**

EDITORS

CLDEDIT C-Language Directed Editor — **$10**
PLDEDIT Pascal Language Directed Editor — **$10**

OPTIONS

Option 1C — VAX/ULTRIX. **+$1,490**
Option 1F — VAX/VMS. **+$1,490**
Option 1K, 1L — MicroVAX ULTRIX. **+$1,490**
Option 1M, 1N — MicroVAX VMS. **+$1,490**
Option 3S — Software Subscription Service. **+$150**

COMPILERS AND ICS

CCC68K C Compiler for 68000/08/10 — **$10**
CCC8086 C Compiler for 8086/8088/186/188/286 — **$10**
PAS68K Pascal Compiler for 68000/08/10 — **$10**
PAS8086 Pascal Compiler for 8086/8088/186/188 — **$10**

OPTIONS

Option 1C — VAX/ULTRIX. **+$3,990**
Option 1F — VAX/VMS. **+$3,990**
Option 1K, 1L — MicroVAX ULTRIX. **+$3,490**
Option 1M, 1N — MicroVAX VMS. **+$3,490**
Option 3S — Software Subscription Service. **+$400**

HIGH LEVEL LANGUAGE DEBUG

CDB68K C Debug 68000/08/10 — **$10**
CDB8086 C Debug 8086/8088/186/188 — **$10**
PDB68K Pascal Debug 68000/08/10 — **$10**
PDB8086 Pascal Debug 8086/8088/186/188 — **$10**

OPTIONS

Option 1C — VAX/ULTRIX. **+$3,990**
Option 1F — VAX/VMS. **+$3,990**
Option 1K, 1L — MicroVAX ULTRIX. **+$3,490**
Option 1M, 1N — MicroVAX VMS. **+$3,490**
Option 3S — Software Subscription Service. **+$400**

COMMUNICATIONS

ICOM40A Integrated Communications System for V Systems — **$10**

OPTIONS

Option 1C — VAX/ULTRIX. **+$1,990**
Option 1F — VAX/VMS. **+$1,990**
Option 1K, 1L — MicroVAX ULTRIX. **+$1,490**
Option 1M, 1N — MicroVAX VMS. **+$1,490**
Option 3S — Software Subscription Service. **+$200**

IBM PC SUPPORT

Many of the above products are available on the IBM PC. Contact your Tektronix CASE Division Sales Representative for additional information.

Prices subject to change without notice.

NEW LANDS II

32-Bit C Language Development System

32-Bit C Optimizing Compilers

Kernighan and Ritchie/ANSI C Compatibility

32-Bit Assembler and Linker

32-bit microprocessors have advanced microprocessor technology to the point where mainframe applications can now run on microprocessor-based systems. A corresponding advancement in software tools technology is needed to take advantage of these new microprocessors.

Using all the knowledge gained in the highly successful LANDS I products, the LANDS II product was developed specifically for large applications programs running on 32-bit microprocessors. LANDS II products are true 32-bit products including the assembler, compiler and linker. The first product in the *NEW* LANDS II product line is a 68020 C Language Development System.

68020 C-LANDS II

Included in LANDS II are:

- C Language Directed Editor (CLDE)
- 68020 32-bit C Compiler
- Integration Control System (ICS)
- 68020 32-bit Assembler
- 32-bit Linker
- Powerful TekDB HLL Debug System

C Language Directed Editor

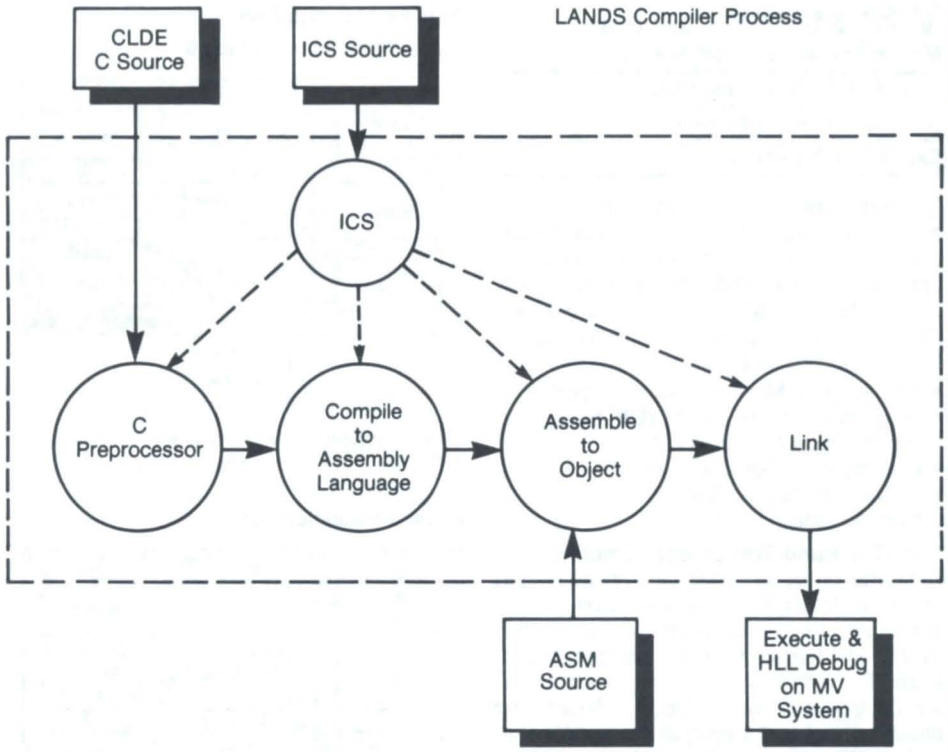
The CLDE is the same editor included in LANDS I products. New enhancements to CLDE include ANSI C compatibility.

68020 32-Bit Optimizing C Compiler

The 68020 C compiler is a true 32-bit compiler optimized to take advantage of the 68020 performance features including all the 68020's memory spaces and addressing modes. Key features of the 68020 C LANDS II compiler are:

- Kernighan and Ritchie Compatible
- ANSI C Standard (Proposed)
- Multi-tasking Support
- Complete C Library Support
- Sophisticated Optimization Techniques

Through sophisticated optimization techniques, generated code is compact and fast. For increased portability the additional features of the proposed ANSI C standards have been included in addition to supporting the "de facto" Kernighan and Ritchie standard.



Integration Control System (ICS)

ICS was introduced as a unique tool in Tek's LANDS I product. The concept of an automated software/hardware integration tool is even more important in large applications. ICS has been enhanced, making it more powerful and more convenient. Once set up, it runs continuously in the background controlling the compilation, assembly, and linking processes.

Assembler and Linker

The 68020 assembler and linker are designed to support large program development. Key features with the assembler and linker include:

- Optimizes instructions and addressing modes
- Motorola compatible
- Recognizes all 68020/68881 instructions
- Nested plus recursive macros
- Conditional assembler
- Handles large programs

TekDB™—HLL Debug

The LANDS I system includes a C Debug program called CDB for doing source level debugging with the V8 and V16 microprocessor development systems. The LANDS II source level debugger called TekDB is integrated with the Multi-V 32-bit development systems. The LANDS II compiler and assembler generate all the information required for source level symbolic debugging. TekDB uses this information to provide the users of the Multi-V Systems with a fast and powerful debugging system. TekDB is a standard feature of the Multi-V Systems.

ORDERING INFORMATION

CLA6820 68020 C Development System **$10**
C compiler, assembler, linker, ICS, CLDE

OPTIONS

Option 1C — VAX/ULTRIX.	**+$9,990**
Option 1F — VAX/VMS.	**+$9,990**
Option 1K, 1L — MicroVAX ULTRIX.	**+$8,490**
Option 1M, 1N — MicroVAX VMS.	**+$8,490**
Option 3S — Software Subscription Service.	**+$1,000**

ASM6820 68020 Assembler, Linker, ICS **$10**

OPTIONS

Option 1C — VAX/ULTRIX.	**+$3,490**
Option 1F — VAX/VMS.	**+$3,490**
Option 1K, 1L — MicroVAX ULTRIX.	**+$2,990**
Option 1M, 1N — MicroVAX VMS.	**+$2,990**
Option 3S — Software Subscription Service.	**+$350**

Prices subject to change without notice.

V Systems 8- and 16-Bit Microprocessor Support Systems

8- and 16-Bit Real Time Emulation

Modular Universal System

Expansion Capability

To support the test and integration phases of a user's project, Tek offers V Systems—the complete 8- and 16-bit microprocessor development systems. Modularity and universality are key features of the V Systems enabling them to be configured to meet your needs. Modular options include:

- Full Range of Microprocessor Support
- Program Memory—64K to 768K bytes
- Trigger Trace Analyzer (TTA)
- Memory Allocation Controller
- PROM Programmer Support
- Communication Options

Real-Time and Transparent Emulation

Real-time emulation, standard on all 8- and 16-bit emulators, is accomplished by executing code on a processor identical in function to the one targeted for the prototype hardware. The emulator processor is run under the control of powerful debug software that allows control and tracing of the code's execution. This debug software does not need to be linked into your code or use any of your memory or interrupt lines. Tek's superior emulators allow your code to execute in real time, with no wait states inserted or clock pulses stretched. This means the emulator is fully transparent to the user; therefore, you do not spend time "working around" the development system.

TTA Captures Real-Time Events (standard with V Systems)

A powerful option to Tek emulators is the Trigger Trace Analyzer (TTA), which uses a high-speed trace buffer to capture real-time software and hardware logic events, with the prototype running at the design's full specified operating speed. Multiple-word recognizers allow you to define sophisticated triggers when tracing code execution. And data qualification allows you to capture only the data you wish to see.

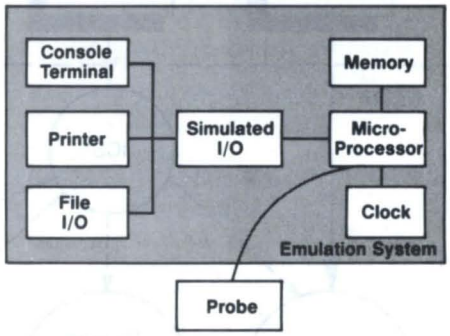
Three Modes of Emulation

The V-Systems enable you to incrementally integrate your prototype software and hardware. Starting with mode 0, you can do a majority of your software design without a prototype. Using Supervisor Calls (SVCs) to simulate I/O, mode 0 debug can begin long before actual hardware is available.

Once prototype hardware is available, designers gradually move from using emulation system resources to using prototype resources (mode 1). The final step is to use all of the prototype resources (mode 2) to execute the program. Because of the transparent nature of Tek emulators, your prototype will reliably perform in mode 2 as it will in actual operation with the emulator disconnected.

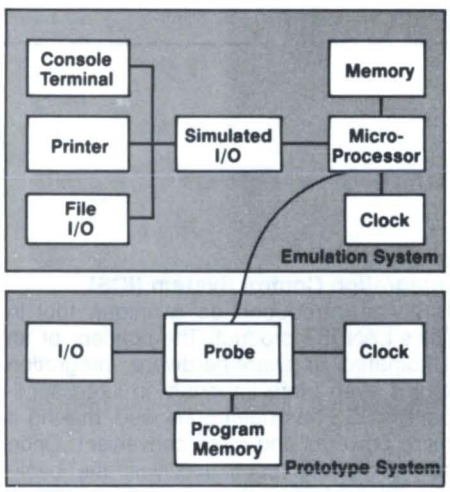
Modes of Emulation

Phased Emulation—Mode 0



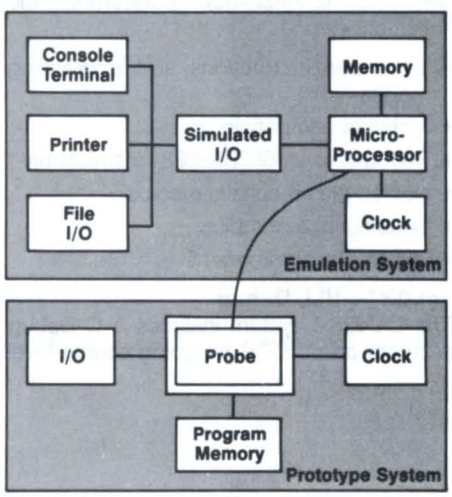
- No prototype hardware required
- Prototype I/O interactions are simulated

Phased Emulation—Mode 1



- Start software and hardware integration
- Program is transferred to prototype memory in steps

Phased Emulation—Mode 2



- Final test of software and hardware

ORDERING INFORMATION

V SYSTEMS

The V Systems are configured to integrate with an existing host computer, a VAX or MicroVAX computer or IBM PC AT/XT.

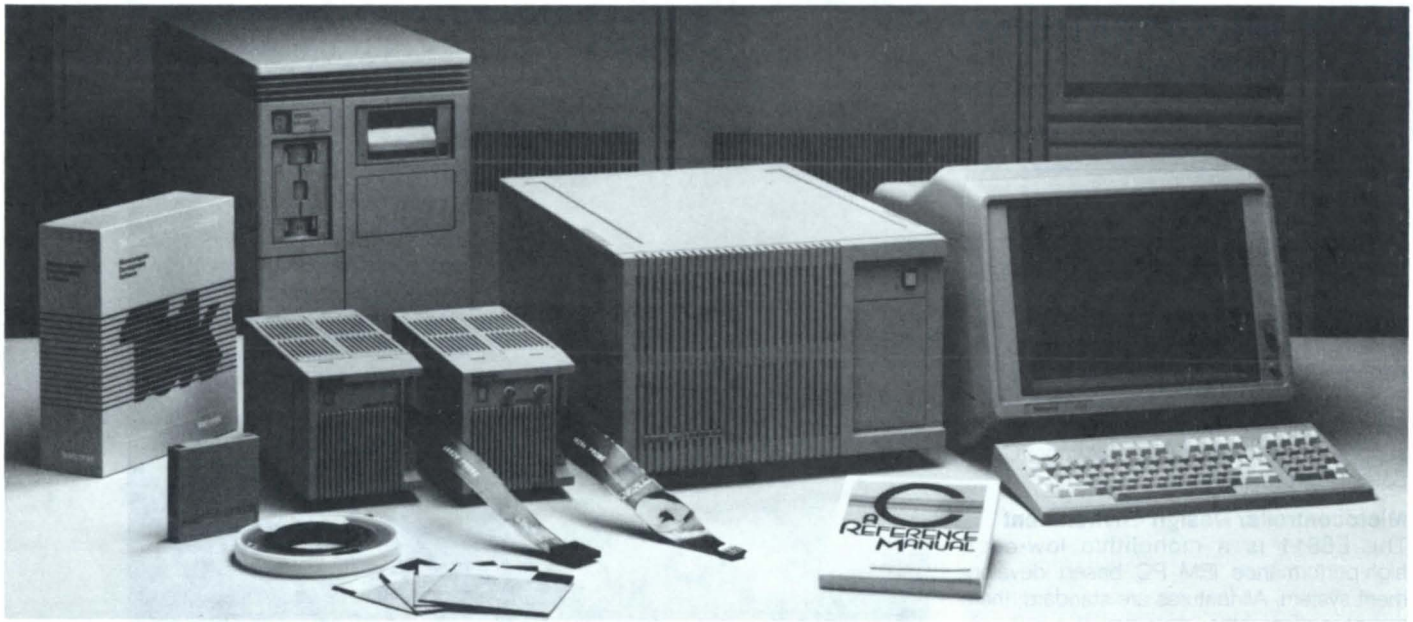
Included with the V Systems are Tektronix' 8540A Integration Unit, 16-bit emulation support (emulator and probe) with 128K byte memory or 8-bit emulation support with 64K byte memory and Trigger Trace Analyzer.

VZ80 Emulation Support	**$9,500**
V68000A Emulation Support	**$24,900**
V68008 Emulation Support	**$24,900**
V68010 Emulation Support	**$24,900**
V6809 Emulation Support	**$9,500**
V80186 Emulation Support	**$24,900**
V80188 Emulation Support	**$24,900**
V8085 Emulation Support	**$9,500**
V8086 Emulation Support	**$24,900**
V8088 Emulation Support	**$24,900**

OPTIONS

Option 02 — (V68000A/V68008/V68010) Memory Allocation Controller.	**+$2,500**
Option 03 — TTA 8-Bit External LA Probe.	**+$1,000**
Option 04 — Comm I/F for 8540A.	**+$400**

Prices subject to change without notice.



NEW 32-Bit Multi-V Systems

32-Bit Real-Time Emulation

32-Bit Software Executers

TekDB HLL Debug System

32-bit microprocessors, like Motorola's 68020 and Intel's 16-bit 80286, present a level of complexity to the software and hardware designers not encountered in previous 8- or 16-bit designs. New problems require new solutions. To address these problems, Tektronix uses its experience in language tools and emulation systems to design the *NEW* Multi-V Systems. The Multi-V Systems sets the industry standard for 32-bit development systems.

New Generation of Microprocessor Support

The Multi-V Systems consist of a family of tools to support software development through software/hardware integration and test. The Multi-V's unique architecture provides the industry's first true multi-user microprocessor development system enabling several emulators to reside in a single mainframe. Multiple emulators can be controlled by a single user in a multiple microprocessor based application or each emulator can be controlled independently by multiple users.

Other unique features of the Multi-V Systems are the Software Executer, an execution environment for software development before prototypes are available; a memory system capable of up to 9 Mb; a high-speed industry standard local area network; TekDB, the most powerful microprocessor debug system available today; and C-LANDS II, a C Language Development System that enables you to take advantage of the full power of 32-bit microprocessors (68020 only).

Software Executers

The Software Executer is a new tool providing a cost effective environment for early debug of software before prototypes are available. Code developed on the host computer is downloaded into the Multi-V's program memory system (up to 9 Mb) where it runs on the target microprocessor and FPU (68020/68881 or 80286/80287). Your program can then be verified with TekDB. If required, the Software Executers can be upgraded to full emulation by adding an emulator pod.

TekDB—State-of-the-Art Debug

As programs get larger and more complex, more powerful tools are needed for efficient program debug and verification. TekDB, a standard feature of the Multi-V Systems, is an enhanced version of the LANDS I HLL debugger. Key features of TekDB include virtually unlimited numbers of software breakpoints, complex breakpoint qualification, source code tracing, and complete control of display information. TekDB's powerful breakpoint qualification allows events to be described in such a level of detail that you need not set up other breakpoints to "zero in" on the desired event.

68020 and 80286 Emulation

Software/hardware integration has always been a complex task. Advanced microprocessors, like the 68020, running at a speed greater than 16 MHz add another level of complexity to the integration task.

Tektronix designed the 68020/68881 and 80286/80287 emulator system for the needs of large design teams developing large complex applications. For in-prototype testing of your software, real-time emulation provides the testing capability required for real-time application.

Local Area Networking Improves Flexibility and Performance

The Multi-V System's LAN Option enables your development systems to be connected directly to your network and allows large amounts of code to be downloaded quickly and reliably. The industry standard LAN is used: IEEE 802.3 electrical and mechanical connections, Ethernet frame formats and TCP/IP software protocol.

Support for the VAX Environment

The Multi-V Systems have been tightly integrated into the VAX environment. Support for the entire VAX line from the MicroVAX to the VAX 8600, running on VMS or ULTRIX operating systems is offered.

ORDERING INFORMATION

MV6820 68020/68881 Support Systems	**$6,900**
MV286 80286/80287 Support Systems	**$6,900**
OPTIONS	
Option 06 — Software Executer.	**+$6,400**
Option 08 — Emulator.	**+$13,500**
Option 15 — 1 Mb Memory.	**+$3,000**
Option 16 — 2 Mb Memory.	**+$4,600**
Option 17 — 3 Mb Memory.	**+$6,200**
Option 18 — LAN plus Transceiver.	**+$2,000**
TekDB CONTROL SOFTWARE	
Option 1C — VAX/ULTRIX.	**NC**
Option 1F — VAX/VMS.	**NC**
Option 1K, 1L — MicroVAX ULTRIX.	**NC**
Option 1M, 1N — MicroVAX VMS.	**NC**
Option 3S — Software Subscription Service.	**+$300**

Prices subject to change without notice.

NEW Microcontroller E Systems 68HC11

8-Bit Microcontroller Emulation

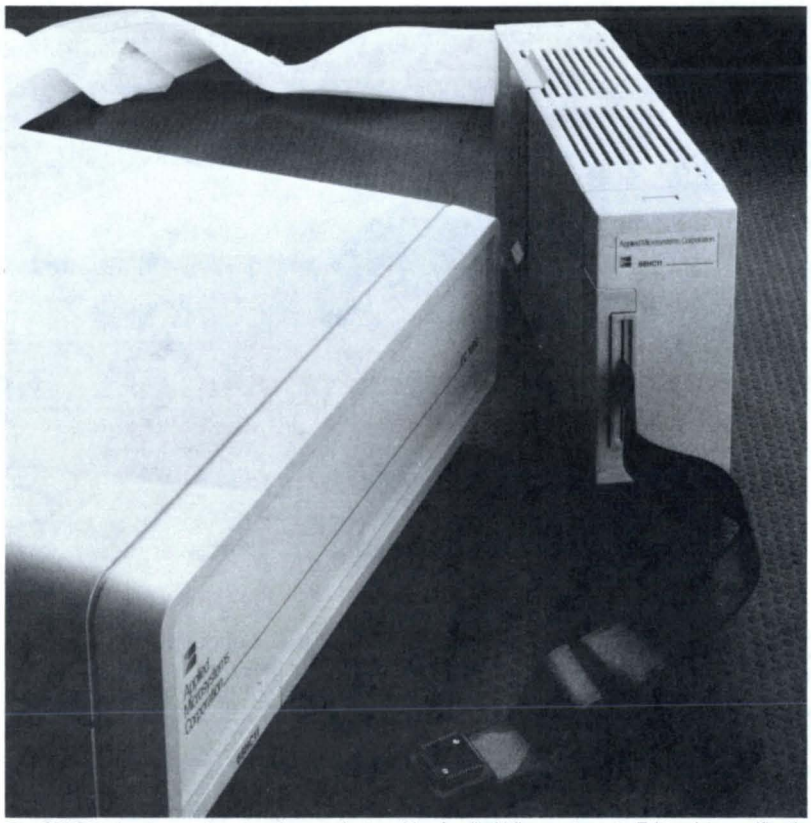
High Performance—Low Cost

Easy to Use

Microcontroller chips are becoming more and more important in today's designs. These chips are used as the main CPU for small real-time systems. Tektronix' E Systems is a new product line designed for the support of microcontroller chips. The first microcontroller supported is Motorola's 68HC11 family. For future microcontroller support, contact your local Tektronix CASE Sales Representative.

Microcontroller Design Environment

The E6811 is a monolithic low-cost, high-performance IBM PC based development system. All features are standard; there are no options other than power supply options. Based on Motorola's 68HC11 bond-out chip, full emulation support is available. The bond-out chip preserves the 68HC11's counter/timer registers while the emulator is handling its own internal routines. The bond-out chip also makes it possible to trace, break, or store on internal reads or writes.



The 68HC11 development system is manufactured by Applied Microsystems to Tektronix' specifications.

KEY FEATURES

- Supports single chip, expanded, bootstrap and test modes
- Break, trace/store capability on internal reads/writes
- Counter/Timer preservation during emulation
- Support for several 68HC11 family members

EMULATOR FEATURES

64K no-wait state memory
Selective tracing
Register tracing
16 hardware breakpoints
No hardware add-ons required
Power-up diagnostics

SOFTWARE SUPPORT

Assembler
In-line assembler
Linker/Librarian
TekHex format
Motorola Object format

EASE OF USE

Push button user interface
Extensive documentation
New user tutorial
On-line Help features

ANALYSIS FEATURES

Real-time bus acquisition
  Non-stop execution
  1024 line buffer
Symbolic debug
Disassembler
External trigger In/Out lines

HOST SUPPORT

IBM PC XT/AT (MS-DOS)
IBM PC XT/AT compatible

ORDERING INFORMATION

E6811 68HC11 Emulation System	**$9,600**
Option 1Y IBM PC Control Software	**NC**
ASP6800 68HC11 Assembler	**$600**
Option 1Y IBM PC Floppy	**NC**

Prices are subject to change without notice.

Design Environments

Multiple Hardware Platforms

ULTRIX/VMS/PC DOS Support

Integrated Communications Packages

To support your engineering environment, Tektronix has tailored tools for working in many different environments. By supporting the VAX family from MicroVAX through VAX 8600 on both VMS and ULTRIX, and the IBM PC, you can choose the environment that best fits your needs.

Tek/DEC Software Compatibility

Tek offers powerful high-level language tools, both C and Pascal LANDS packages, and many popular assemblers on Digital Equipment Corporation's VAX series of computers using the VMS or ULTRIX based operating systems. This Tek/DEC combination gives you a powerful series of options when configuring your design environment.

You can run Tek software development tools on the VAX to produce executable object code, and easily download the code to a V8, V16, or Multi-V Development Systems to perform emulation/debug tasks. Tek supplies you with the software needed to make your VAX/Development System function as a turn-key system.

ColorKey+ User Interface

ColorKey+ and the Tek color graphics terminals work together to give simple single key stroke access to the DEC VAX/VMS or ULTRIX operating system and Tek's microcomputer design tools.

The color coding and graphically defined soft-keys guide you through the system with a minimum of effort or knowledge.

The use of color and soft-keys minimize the time it takes you to learn the operating system, and emulation/debugging system. Soft-keys simplify command entry and minimize key strokes.

Soft-key labels appear on the bottom of the screen and change as different operations are performed. Functions are arranged in a hierarchical manner, from major tools down to specific options for selected commands.

ColorKey+ is an intelligent interface. Parameters entered by the user are remembered and can be displayed as soft-key options later. Previous commands can also be recalled, modified, and reissued.

As soft-key commands are entered, ColorKey+ displays the actual commands required to perform the operation. When you learn most of the system commands, you can directly issue commands to the system instead of using the soft-keys.

	SOFTWARE SUPPORT			EMULATION SUPPORT		
	VAX/VMS	VAX ULTRIX/UNIX	IBM PC	V Systems	MV Systems	E Systems
68020/68881	Assembler, C-LANDS II	Assembler, C-LANDS II			✓	
80286/80287	Assembler, C-LANDS I	Assembler, C-LANDS I			✓	
68HC11			Assembler			✓
68000	Assembler, C-LANDS I, Pascal LANDS I	Assembler, C-LANDS I, Pascal LANDS I	Assembler, C Compiler	✓		
68008	Assembler, C-LANDS I, Pascal LANDS I	Assembler, C-LANDS I, Pascal LANDS I	Assembler, C Compiler	✓		
68010	Assembler, C-LANDS I, Pascal LANDS I	Assembler, C-LANDS I, Pascal LANDS I	Assembler, C Compiler	✓		
8086	Assembler, C-LANDS I, Pascal LANDS I, PL/M	Assembler, C-LANDS I, Pascal LANDS I	Assembler, PL/M Compiler	✓		
8088	Assembler, C-LANDS I, Pascal LANDS I, PL/M	Assembler, C-LANDS I, Pascal LANDS I	Assembler, PL/M Compiler	✓		
80186	Assembler, C-LANDS I, Pascal LANDS I, PL/M	Assembler, C-LANDS I, Pascal LANDS I	Assembler, PL/M Compiler	✓		
80188	Assembler, C-LANDS I, Pascal LANDS I, PL/M	Assembler, C-LANDS I, Pascal LANDS I	Assembler, PL/M Compiler	✓		
1750A	Assembler			✓		
Z80	Assembler	Assembler	Assembler, C & Pascal Compilers	✓		
8085	Assembler	Assembler	Assembler, Pascal Compiler	✓		
6809	Assembler	Assembler	Assembler	✓		
NSC800	Assembler	Assembler	Assembler, C & Pascal Compilers	✓		
Z8001/2	Assembler		Assembler	✓		

Support for Aerospace/Defense Applications

Real-Time Software Testing in the Target System
High Order Language Development Systems; Ada
VAX, MicroVAX Host Support
Worldwide Service and Support

The use of microprocessors in military applications has mushroomed in the past few years. Military applications usually have strict reliability and environmental requirements that prevent the use of commercially popular microprocessors. Tektronix is addressing the need to support microprocessors used in military applications by offering support for the following processors: Z8000 including the Z8001B and Z8002B, SBP9989, SBR9000 and MIL-STD 1750A processors including the F9450, MDC281, and PAC1750.

A complete software integration environment from Tektronix. Products shown from left: V1750A Software Integration Systems, 86M1750 Software Execution Unit, 4105 Color Graphics Terminal, and 8575X MicroVAX II host processor.

MIL-STD 1750A Background

In an effort to control the spiraling cost of developing software, the military community has instituted several standardization programs. One of these, MIL-STD 1750A, was developed for the United States Air Force and defines the standard 16-bit processor to be used in all embedded weapons systems. MIL-STD 1750A standard specifies the Instruction Set Architecture (ISA) but not the physical, electrical or performance characteristics of the processor. This allows processors to be implemented as several boards, a single board or a microprocessor chip. Since the ISA is the same however, application software can be transported from one processor to another without modification.

MIL-STD 1750A Support System

The Tektronix 1750A support system includes tools for developing and debugging software for embedded applications. The package includes a Tektronix assembler/linker system for software development and a full function emulation system for testing the software with or without the target system.

The 1750A assembler/linker package provides all of the functions to support machine level program development. The assembler supports either the MIL-STD 1750A instruction mnemonics or the IEEE version. The package can be hosted on the DEC VAX and MicroVAX Series with VMS.

For embedded applications requiring a real time operating kernel, Tektronix is offering the Hunter-Ready VRTX/1750 and VMX/1750 R & D packages. VRTX and VMX are off-the-shelf software components that can be used directly in the embedded system to coordinate real-time tasks. These systems are available in EPROM and computer media to be used directly in the target environment.

The MIL-STD 1750A emulator supports the unique requirements for integrating software into the target environment. The emulation system can be used to test software written in assembly, or in a high-order language such as Ada, JOVIAL or CMS-II. A series of probe adaptors are available for connection into the target processor environment including an in-circuit probe for the F9450 microprocessor. These probe adaptors can be used to connect the emulator to a chip socket (F9450), a board, a bus or to the CPU's mechanical enclosure.

NEW McDonnell Douglas MDC281 Processor Support

Tektronix has expanded its MIL-STD 1750A program by announcing V1750A Software Integration System support for the McDonnell Douglas MDC281 processor. Verification testing with the V1750A and the MDC281 was conducted at the McDonnell Douglas Microelectronics Center in St. Louis, Missouri.

The Tektronix V1750A Software Integration System provides the mechanism to transfer the run-time software from the mainframe into the MDC281 target system. This allows the software to be executed in real time, right in the target environment. The V1750A provides control and monitoring capability, while execution is progressing in real time. Both the 15 MHz and 20 MHz versions of the MDC281 are supported in real time.

Other MIL-STD 1750A Processors

In addition to the MDC281, the V1750A also supports the Fairchild F9450, Delco M-372, Mikros MKS1750, and the Tracor RH1750.

1750A Software Execution Unit

If the target processor isn't available, Software Execution Unit (SEU) can be used in its place. The Mikros SEU provides a MIL-STD 1750A compliant environment for testing and debugging software. Programs can be loaded and tested on the SEU processor before they are transferred to the target environment. This frees the host from time consuming (and slow) simulations.

It also provides a more consistent and reliable testing environment.

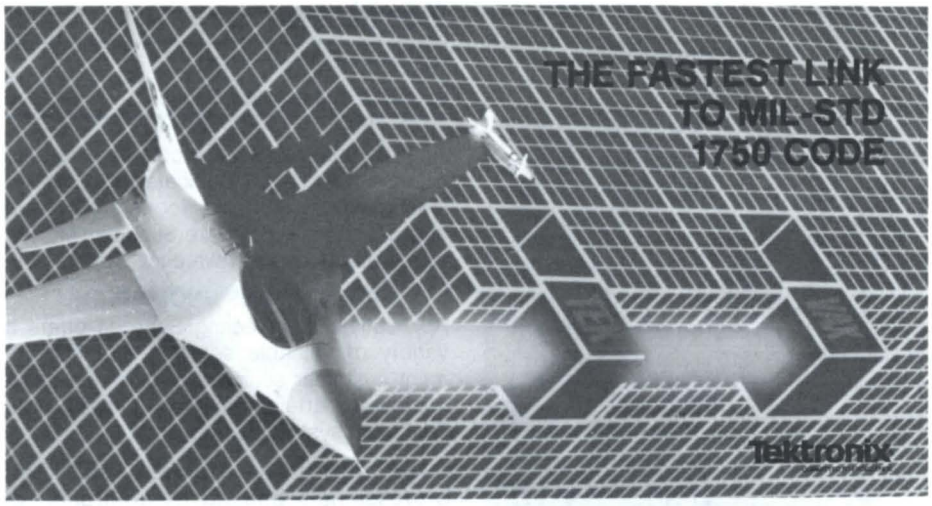
The 86M1750 software execution unit interfaces to the Tektronix V1750A Emulation System via the 8300P53 Probe. The 86M1750 supports MIL-STD 1750A expanded memory addressing. Software is downloaded from the host system into the 1 Megaword Memory contained in the 86M1750.

Z8000 Support Systems
Z8000 processors are used in a wide variety of military applications, and are currently available to meet military reliability requirements like MIL-STD 883 screening.

Tektronix supports both the Z8001 segmented version, and the Z8002 nonsegmented versions of the processor. An assembler/linker system is available to support machine language programming requirements. Both of these software systems are supported on the VAX and MicroVAX hosts.

The emulator supports in-circuit probes for either the Z8001 or Z8002 microprocessors. Both the 10 MHz Z8001B and Z8002B are supported in real-time with no-wait states. The emulator system provides trace, breakpoint and memory substitution in the actual target environment.

9900 Support Systems
9900 Series processors are used in aerospace applications where radiation tolerance is a requirement. The Tektronix 9900 support package includes emulation support for the SBP9989 and software support for the TMS9900, SBP9900 and SBR9000. The 9900 assembler/linker package supports machine-level programming requirements. This system is hosted on the Tektronix 856X Series. Symbol tables are available to the emulation system to support fully symbolic control during the debugging process.



The Fastest Link to Embedded Software

MIL-STD 1815A (Ada) Support
Ada has been mandated by the Department of Defense to be used as the single High Order Language (HOL) used in all mission critical applications. The effect of this mandate is to reduce the escalating cost of developing and maintaining software for military applications. These software costs are currently estimated at $10 billion, and by 1990, they will triple to $30 billion. Ada is also being used for commercial applications, especially in the European electronics industry.

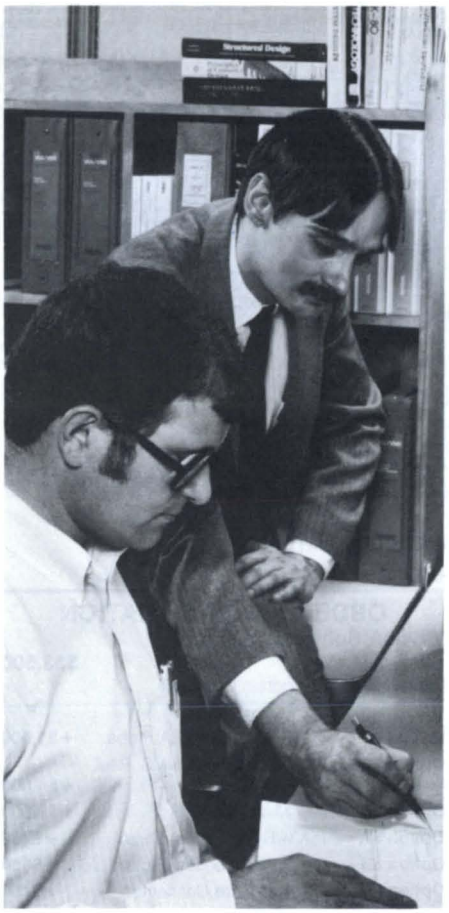
Ada is not just another programming language and incorporates many characteristics that support modern software engineering principles. Tektronix is making a significant commitment to developing Ada support for its customers. This support is being modeled after the LANDS programming environment that was developed for commercial users. These LANDS systems are based on C and Pascal.

An Ada language system will be available soon to support MIL-STD 1750A applications. This system is being modeled after the Tektronix LANDS software development environment explained on page 96. Your Tektronix CASE Sales Representative can give you the details.

ORDERING INFORMATION

V1750A Software Integration System **Includes:** 64 kw Program Language.	**$33,500**
OPTIONS	
Option 03 — TTA 8-Bit External LA Probe.	**+$1,000**
Option 1F — Assembler, VAX VMS Reel Mag Tape.	**+$4,000**
Option 1M, 1N — MicroVAX VMS	**+$3,000**
Option 3A — PIA w/Flying Leads, Clips.	**+$750**
Option 3B — PIA w/Flying Leads, Pigtail.	**+$650**
Option 3C — PIA Euro-Card Connector.	**+$750**
Option 3D — PIA, F9450 Probe without expanded memory.	**+$1,500**
Option 3E — PIA, F9450 Probe with expanded memory.	**+$2,000**
86M1750 Software Execution Unit	**$19,500**

Prices subject to change without notice.



Services

Applications Engineering

Software Subscription Service

After purchasing CASE products, extensive support is available. Dedicated engineering resources are available for many custom applications and Software Subscription Service protects your software investment.

APPLICATIONS ENGINEERING

Applications Engineering Services offers a variety of valuable services that supplement customer sources. This service helps customers attain maximum benefit from Tek CASE system components.

CASE applications engineers are skilled professionals backed by Tektronix resources and experience.

Applications Engineering Services (AES) is only available for customers using Tektronix computer-aided software engineering products.

On-site consultive services are available to assist customers with development programs. This consultation is valuable for meeting critical program schedules. AES consultation optimizes the operation of Tek CASE software and hardware.

Application engineers can help trace and debug problems within a software/hardware system or problems encountered during software/hardware integration.

Tektronix can assist you with unusual interfacing challenges requiring in-depth knowledge of Tek software and hardware.

Applications engineers can also give you expert consultation in software/hardware design and integration using Tek computer-aided software engineering products. AES-01 price quotes are available by the hour, day or week.

SOFTWARE SUBSCRIPTION SERVICE

The Tektronix Software Subscription Service (SSS) automatically provides new releases of CASE licensed software products as well as associated updates to software documentation.

Product Updates

New software releases are sent out as product updates occur. This program allows customers to maintain their equipment at the latest software revision level.

Applications and Information

Customers must identify a person or department responsible for receiving software updates and for maintaining the software's integrity.

SSS should be purchased for all CASE software because of product interaction.

SOFTWARE SUBSCRIPTION SERVICE
Software Subscription Service is available on most software items.

***WARRANTY-PLUS* SERVICE PLANS**
WARRANTY-PLUS is available on most hardware items.

CASE Division has provided you with a partial listing of available products. For information concerning other configurations, options, peripherals, and available software, contact your local Tektronix CASE Sales Representative.

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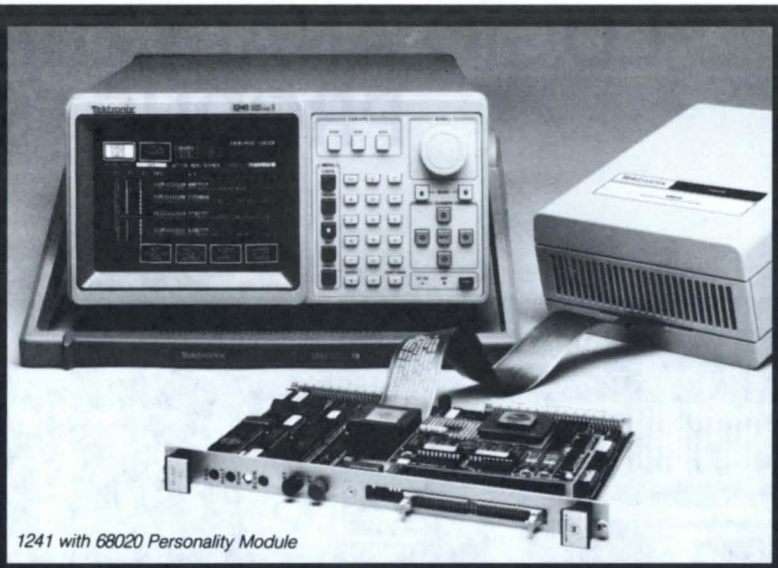
LOGIC ANALYZER PRODUCTS

The Tektronix Logic Analyzer Family includes the DAS 9200, DAS 9100, the 1240/1241, the 338, and the 318 Logic Analyzers.



1241 with 68020 Personality Module

DAS 9100

DAS 9200

SELECTION GUIDE

For more information on a specific model, refer to the description on the following pages, or contact your Tektronix Sales Engineer.

Application/Feature	DAS 9200	DAS 9100	1240/1241	318	338
Hardware Analysis					
Asynchronous acquisition rate, in MHz	20,200 2,000	10, 25, 100, 660 2,000	50, 100	50	20
Color Display	✓	✓	✓		
Trigger on simple program execution	✓	✓	✓	✓	✓
Measure event time/state count	✓	✓	✓		
Trigger on event time/state count	✓		✓		
Clock qualification	✓	✓	✓	✓	✓
Simultaneous state/timing acquisition	✓	✓	✓		
Glitch capture	✓	✓	✓	✓	✓
Edge Recognition	✓		✓		
Easily transportable storage media	Floppy	Tape	Pack		
Trigger input and output	✓	✓	✓	✓	✓
Screen hard copy capability	✓	✓	✓	✓	✓
Software Analysis					
Synchronous acquisition rate, in MHz	20,200	10, 25 100, 330	50	50	20
Trigger on complex program flow	✓	✓	✓	✓	✓
Measure execution time/state count	✓	✓	✓		
Trigger on execution time/state count	✓		✓		
Data qualification	✓	✓	✓		
Microprocessor mnemonics	✓	✓	✓		
Multiple microprocessor support	✓				
Register deduction	✓				
Stack simulation	✓				
Time Stamp	✓				
User-definable mnemonics		✓			
Performance Analysis	✓		✓		
Analyze serial data to 19.2 kbaud				✓	✓
Hardware/Software Integration					
Multiple synchronous time bases	✓		✓		
Trigger arming	✓	✓	✓		
Time-aligned state and timing displays	✓	✓	✓		
Graph Display	✓				
Multiple Display Windows	✓				
Demultiplexing	✓	✓	✓		
ASIC Verification	✓	✓			
Circuit Board Functional Test	✓	✓			
Programmable via RS-232C	✓	✓	✓	✓	✓
Programmable via GPIB	✓	✓	✓		
Pattern generation and acquisition	✓	✓			
Acquisition/reference memory compare	✓	✓	✓	✓	✓
Remote control via master/slave		✓	✓		
Page	108	115	118	122	122
Prices Begin at:	8,970	13,470	4,500/6,000	5,300	5,800

DAS 9200

The Digital Analysis System 9200 provides more channel width, greater speed, far deeper memory, and decidedly better trigger capability than has ever been possible before. Add up to 28 acquisition and pattern generation modules. Build incrementally to as many as 540 acquisition channels at 20 MHz, 384 channels at 200 MHz, or 160 channels at a full 2 GHz. Or apply up to 1008 pattern generation channels at 50 MHz. A hard disk drive and a floppy disk drive are standard equipment

DAS 9100

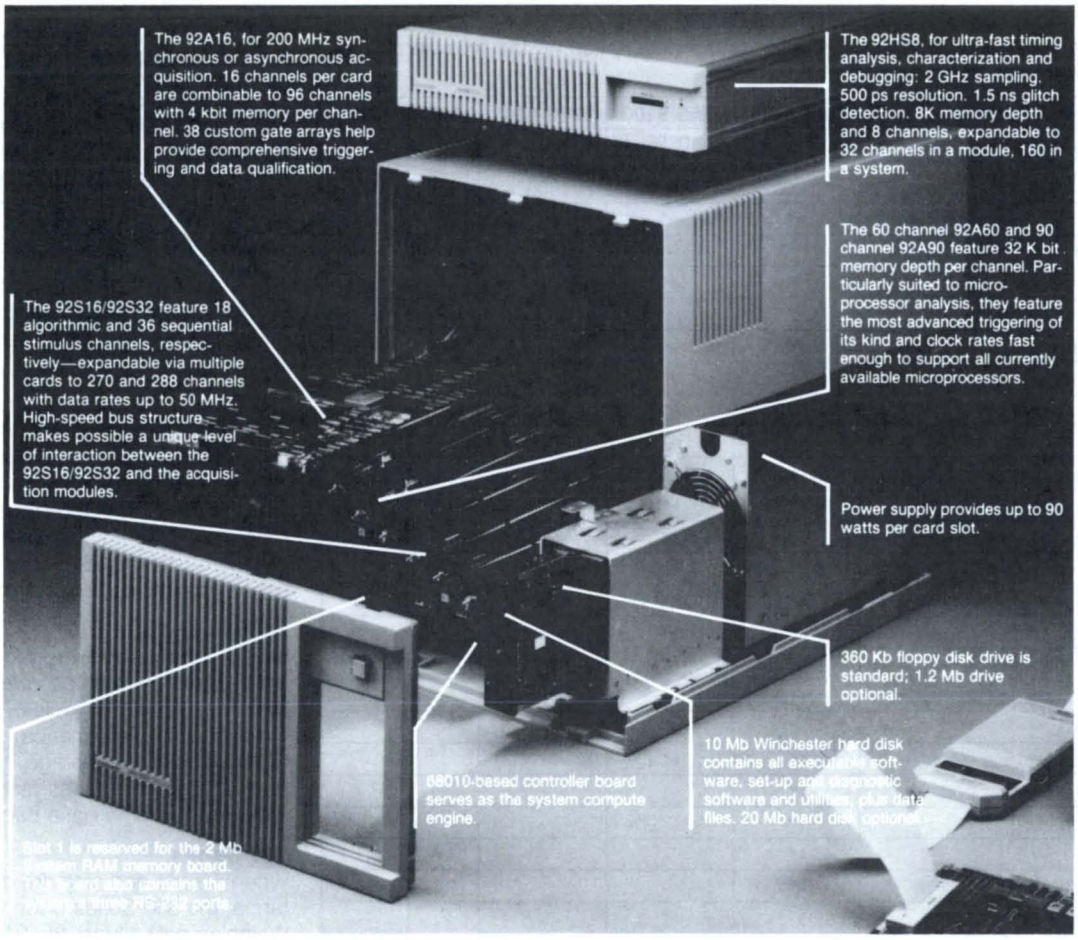
The Digital Analysis System 9100 offers three mainframes, seven different data acquisition modules, four different pattern generation modules, tape cassette mass storage, systems interfaces, and microprocessor mnemonics. For high-speed applications, the DAS offers 2 GHz sample speed for timing resolution of 500 ps.

1200 Series

Easily portable and rugged, the 1240 and color 1241 mainframes offer two types of data acquisition modules, microprocessor mnemonics, performance analysis, RAM/ROM pack mass storage, modular COMM pack system interfaces, and the industry's first true dual-time base capability.

300 Series

When weight and size are of utmost importance, the 300 Series offers ultra-portability. Weighing only 11 lbs, the 318 and 338 each offer state, timing, and serial analysis.



DAS 9200 Series

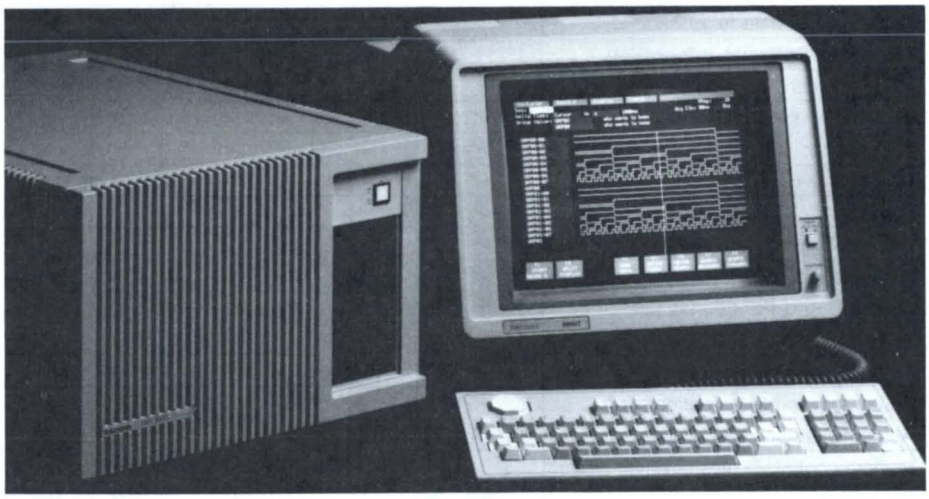
Digital Analysis System

GPIB IEEE-488

The Tek 9200 communication modules 92C01 and 92C02 (mainframe options 1C and 2C) comply with IEEE Standard 488-1978 and with Tektronix *Standard Codes and Formats.*

The DAS 9200 expands on all the best features of the proven DAS 9100 line of digital analysis tools. Its modern architecture allows you to install only those data acquisition and pattern generation modules you need today, and then upgrade and expand as your needs grow. The high resolution color display and a menu-driven interface make the instrument easy to learn and use.

A variety of data acquisition and pattern generation modules are available. You choose the module type based on the number of channels, operating speeds and analysis features required. Most modules allow you to increase channel width by adding expansion circuit boards. Depending on the module type, you can define a module to be up to 8 circuit boards wide. Refer to the DAS 9200 Performance Summary for an overview.



The DAS 9219 mainframe and 9200T color display form the conerstone of the 9200 Series. The mainframe supplies the 68010 CPU, 2 Mbyte system RAM, 10 Mbyte hard disk, 360 Kbyte floppy disk, three RS-232 ports, and 750 watt power supply.

Any combination of data acquisition and pattern generation can be installed in the same mainframe. Modules can be set up to interact in real-time. For instance, two acquisition modules can be set up to run at different clock rates and still display time-correlated data. With 92A60/92A90 modules, this feature lets you debug multiple-microprocessor systems.

Multitasking

The DAS 9200 allows you to define clusters of modules. A cluster is a set of modules designed to function independently of any other modules in the mainframe. If you define two clusters, you effectively have two analyzers; they can run simultaneously and independently. For example, if you are babysitting a prototype while looking for an intermittent failure, you can define one cluster of modules to monitor the prototype and use the remaining modules in the DAS 9200 for other problems.

Expansion

Up to three expansion mainframes (DAS92E9) can be connected to the DAS 9219 for a total of 28 slots. The DAS 92E9 expansion mainframe has eight card slots, a 750 watt power supply, a backplane board, and an expansion slave board in slot 0. It has no CPU, disks, system memory, or display. Up to three expansion mainframes can be connected in daisy-chain fashion.

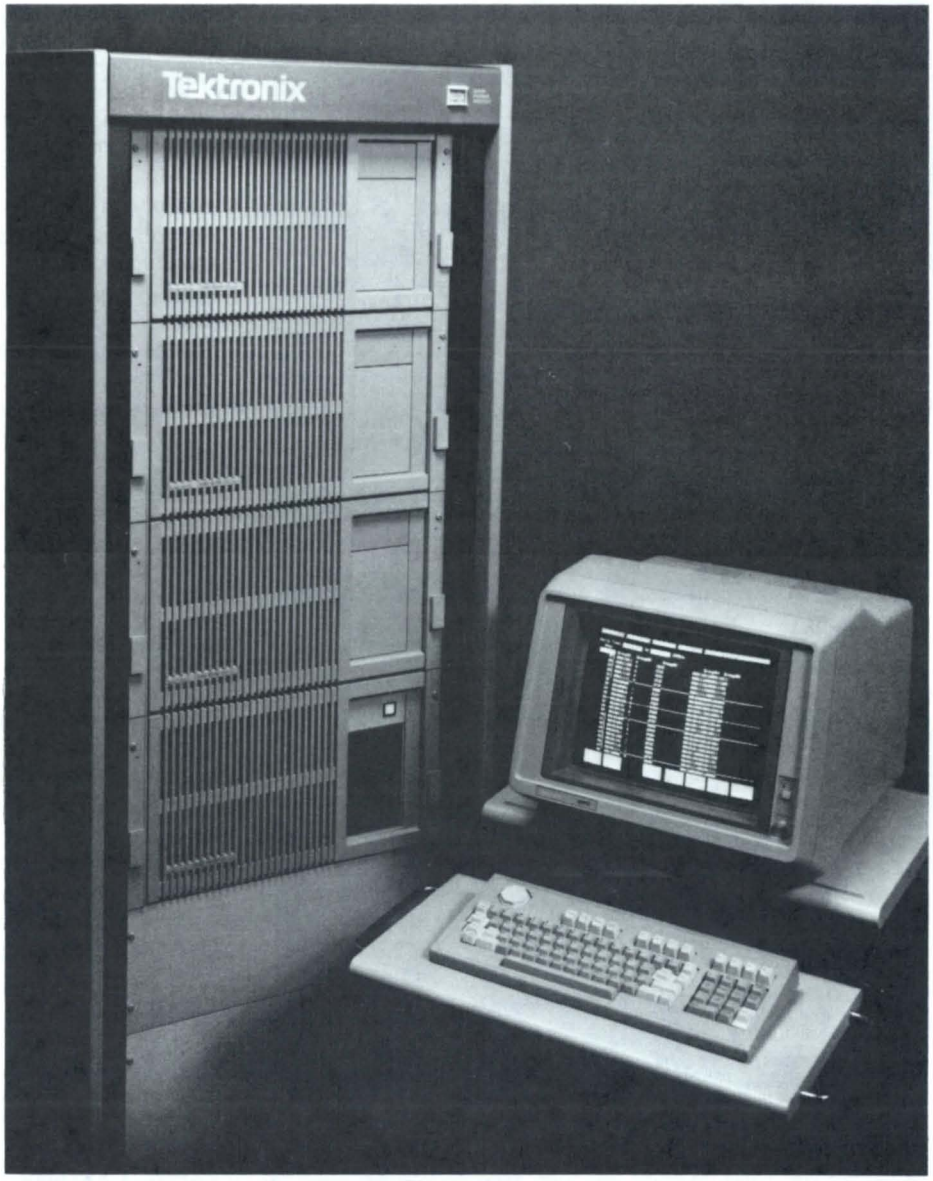
To connect an expansion mainframe to the DAS 9219 or to another expansion, the top slot of the lower mainframe (slot 8) must contain an Expansion module or combination Expansion/GPIB module. This module connects with cables to the slave board in slot 0 of the expansion mainframe.

The maximum configuration yields 28 card slots: six slots in the base mainframe; seven slots each in the first and second expansions, and eight slots in the third expansion mainframe. DAS 9200 systems with two or more expansion mainframes must be rack-mounted.

Ease of Use

The power of the DAS 9200 doesn't come at the expense of ease-of-use. All operations are menu-controlled via a high resolution color display. Menus are grouped into Setup, Display, and Utility functions, thus keeping logical operations together. Throughout the menu structure, a field-specific, on-line help system is available to guide your selections and keep you focused on the problems instead of the tool.

In an Automated Test Environment, the DAS 9200 can be set up and controlled over either RS-232 or GPIB interfaces.

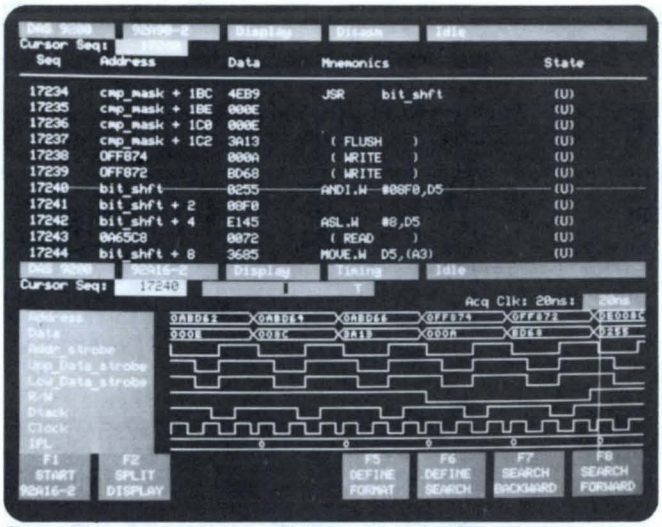


Up to three expansion mainframes can be connected to the DAS 9219 mainframe, in daisy-chain fashion, for a total of 28 slots.

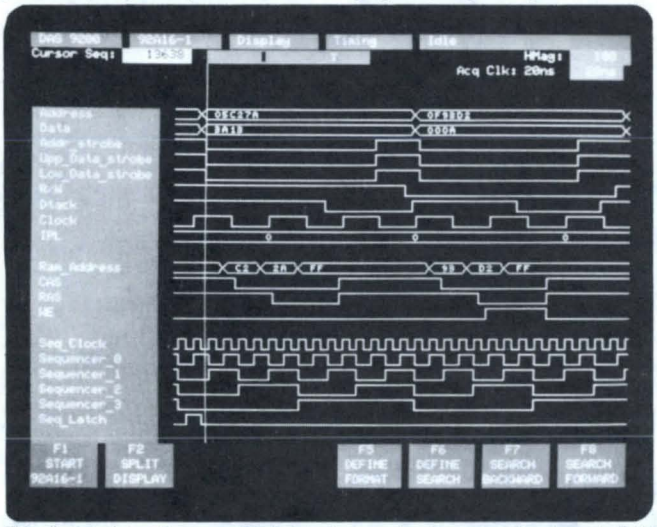
DAS 9200 PERFORMANCE SUMMARY

Card Name	Type	Speed	Maximum Channels per Card	Maximum Channels per Module	Maximum Channels per System	Memory Depth	M/F Slots Req'd
92A16/92A16E	Acquisition	200 MHz	16	96	384	4K	1
92A60	Acquisition	20 MHz	60	60	360	32K	2
92A90	Acquisition	20 MHz	90	90	540	32K	2
92HS8/92HS8E	Acquisition	2 GHz	8	32	160	8K	2 2/32 ch
92S16	Pattern Generator (algorithmic)	50 MHz	18	270*1	936*1	1K	1
92S32	Pattern Generator (sequential)	50 MHz	36	288	1008	8K	1

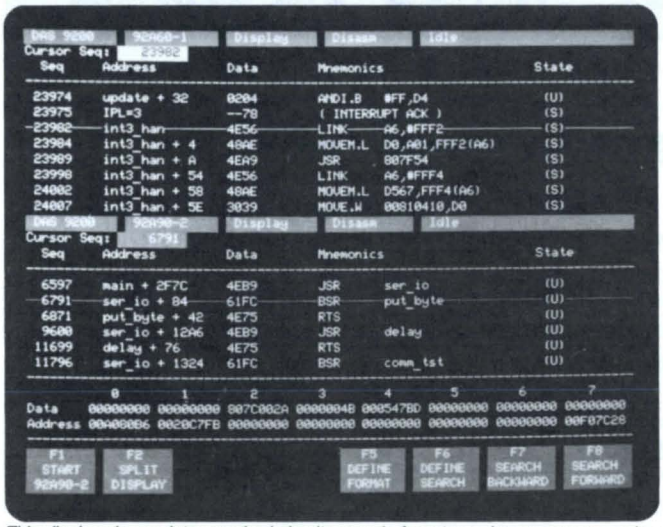
*1 *92S16 controlling multiple 92S32s.*



This split-screen display shows data acquired simultaneously from a microprocessor (using 92A90), and from bus timing signals (using 92A16).



This display shows time-correlated data from a microprocessor, the dynamic RAM controller, and high-speed logic independent of the microprocessor bus.



This display shows data acquired simultaneously from two microprocessors, using separate 92A60/92A90 modules. The display in the lower window includes register deduction.

Hardware Timing Analysis

Configured with 92A16 Data Acquisition Modules, the DAS 9200 makes an unbeatable tool for timing analysis and hardware integration. With the bus values display that lets you monitor the activity on dozens of channels, and the ability to display correlated timing diagrams of nonsynchronized circuit elements, you can perform tasks like these:

- Monitor a state machine synchronously
- Monitor a state machine synchronously and surrounding circuits asynchronously
- Synchronously acquire transactions on both sides of dual-ported RAM
- Sample data from different parts of a circuit at different synchronous rates
- Identify which functional block is central to a problem

Hardware/Software Integration

Configured with both 92A16 and 92A60/90 modules, the DAS 9200 helps you evaluate the complex interactions between hardware and software. It lets you display disassembled microprocessor activity on the same screen as high-resolution timing information, with true time-correlation of all data. You can use the acquisition modules to:

- Pinpoint logic timing problems that occur relative to specific software events
- Evaluate dynamic memory and peripheral timing under a variety of conditions
- Perform high-resolution timing measurements of any circuitry interfaced to a microprocessor

Software Analysis

Configured with 92A60 and 92A90 Data Acquisition Modules, the DAS 9200 lets you monitor up to six microprocessors at once and offers the following features:

- Multi-phase clocking handles the most complex microprocessor clocking schemes
- State-driven triggering lets you define and branch to any of 16 states for precise trigger placement
- Exceptionally deep (32K bits/channel) memory lets you see and solve your problem with a single acquisition
- High resolution timestamp accurately time correlates data from multiple microprocessors

NEW

GPIB

LOGIC ANALYZERS

Performance Analysis

Both 92A16 and 92A60/90 Data Acquisition Modules provide the DAS 9200 with Performance Analysis capabilities that let you monitor software activity in real time without the delays and compromises of breakpoints, wait states, or debug code. And to put it all together, the graphical display makes the information easy to access and easy to interpret.

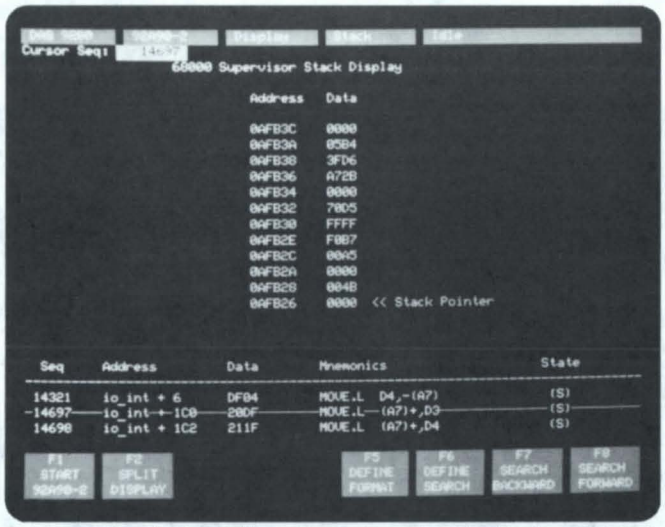
Microprocessor Support

The 92DM family of microprocessor support products provides display and setup software and single-connection probe adaptors for most popular microprocessor packages. See page 124 for ordering information.

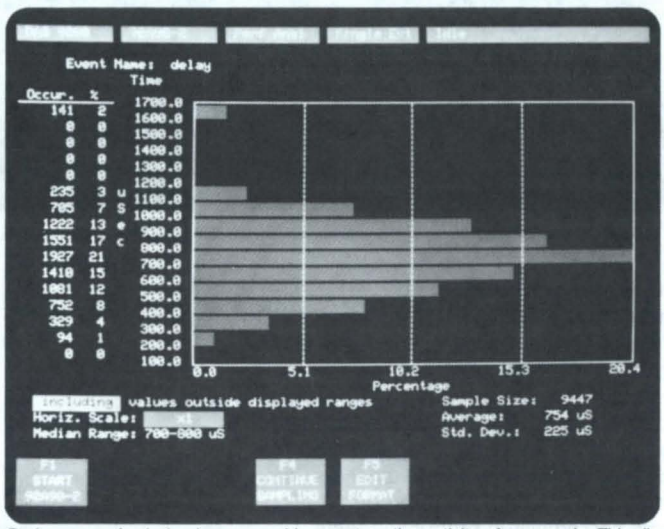
The 92DM support on the DAS 9200:

- Lets you integrate multiple microprocessors by acquiring all bus transactions simultaneously and displaying time-correlated disassembly of any two micros on the screen
- Deduces register contents from acquired data and displays registers simultaneously with disassembly
- Simulates stack contents in a Stack display that is continually updated as you scroll through disassembly
- Outlines program flow with Subroutine Trace Mode
- Offers symbolic debug by using address symbols for display and triggering

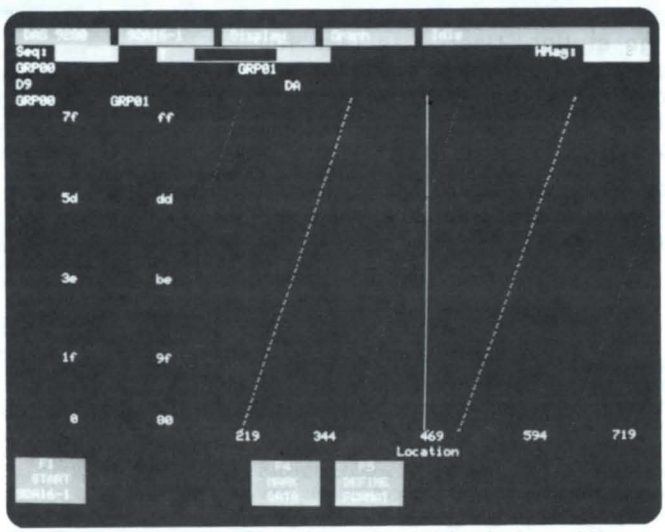
Disk-based mnemonics and single-connection probe adaptors make DAS 9200 microprocessor support versatile and easy to use. Refer to page 124.



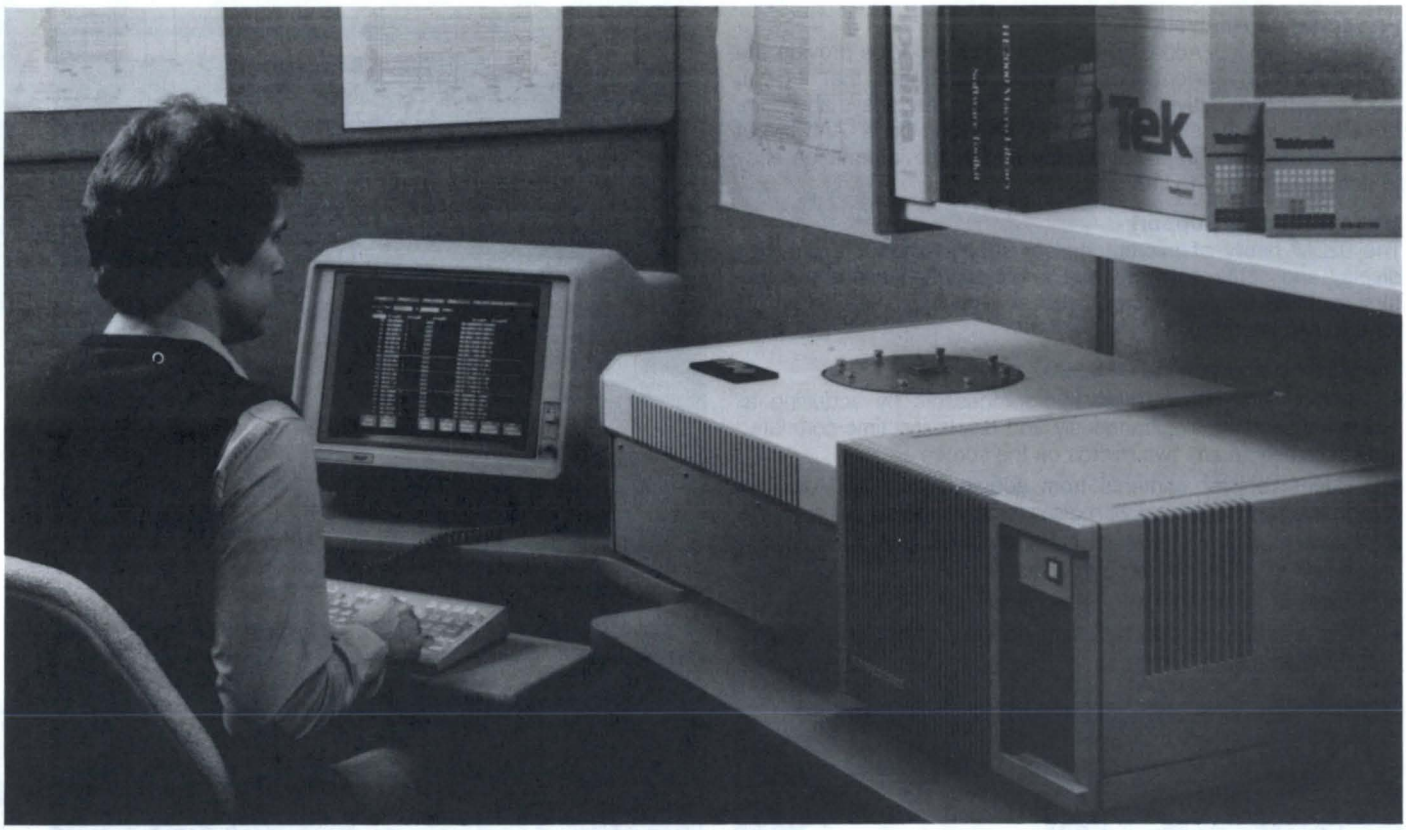
Stack simulation display. Problems like stack overflow of subroutines that don't correctly restore the stack pointer can be quickly identified by watching a continually updated stack model as you scroll through disassembly.



Performance Analysis gives a graphic report on the activity of your code. This display shows the distribution of execution times of the "delay" subroutine.



Graph display plots acquired data values against their location in acquisition memory to create a "fingerprint" of an acquisition.



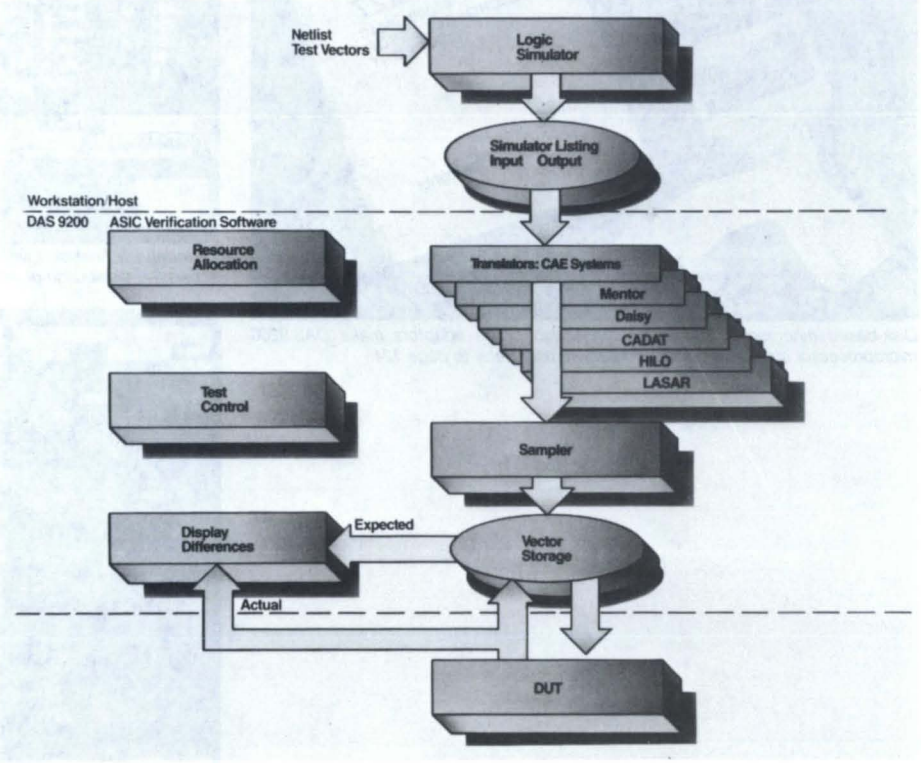
The DAS 9200 personal verification system supports application specific IC (ASIC) functional verification, analysis, and debugging.

ASIC Prototype Verification

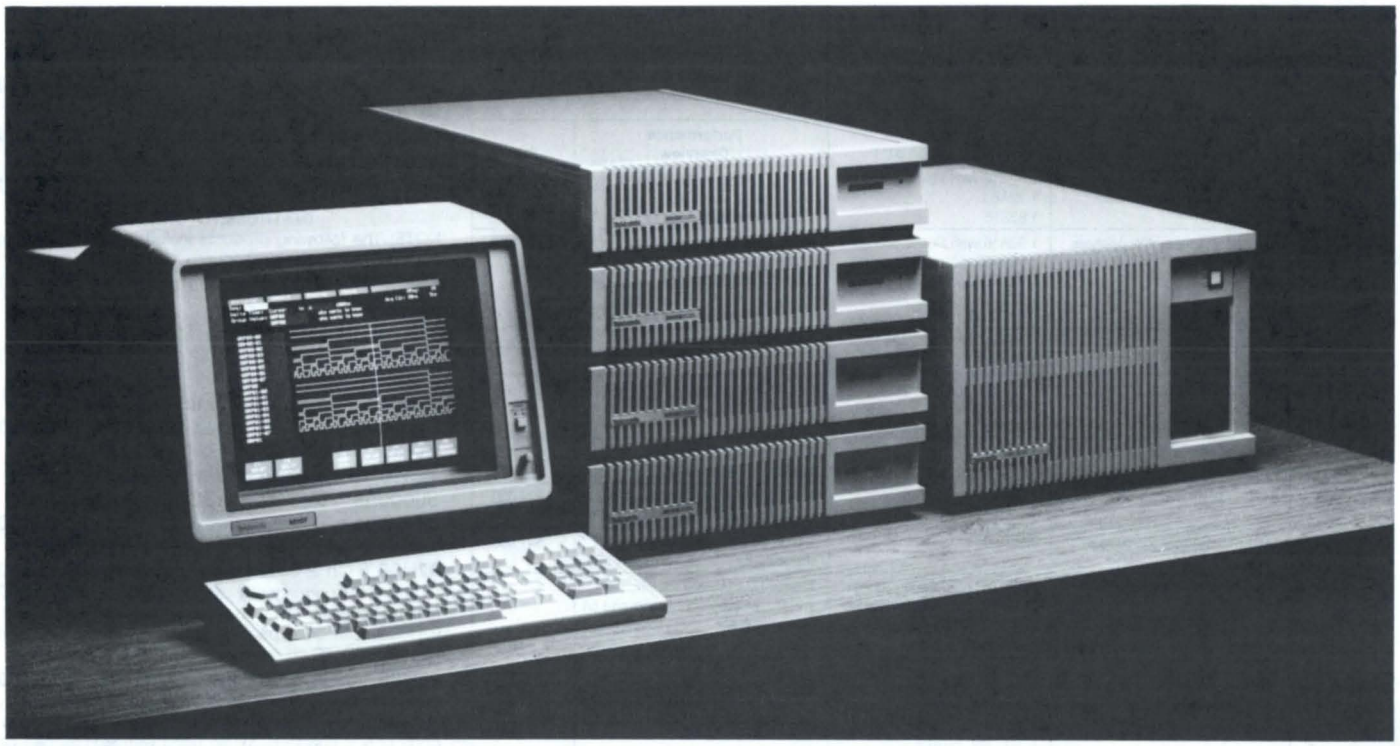
Tektronix has developed a personal ASIC verification system around the DAS 9200. Featuring 50 MHz pattern generation speed, 8K bit vector depth, 1 ns edge placement and 2.5 ns/0 ns setup/hold times, it is a cost-effective alternative in functional verification, failure analysis, timing characterizations, wafer probe functional tests and small-run production tests.

The software resides on the DAS 9200 and supports download of test vectors from the design station. Users can take full advanatage of the system's excellent signal quality. They can utilize powerful analysis features like split-screen display and graphical presentation of results.

A test fixture is available that uses interchangeable adapter cards to minimize set-up times.



In a standard application, the host downloads circuit simulation data into the 9200 via the latter's RS-232 or GPIB port. Simulator-specific translation software on the 9200 converts the data into a standard Tektronix format. The 9200 samples event data at fixed points in the clock period. It further evaluates the vectors to accommodate the setup/hold times of the specific stimulus and acquisition modules. This process creates final stimulus vectors and expected results.



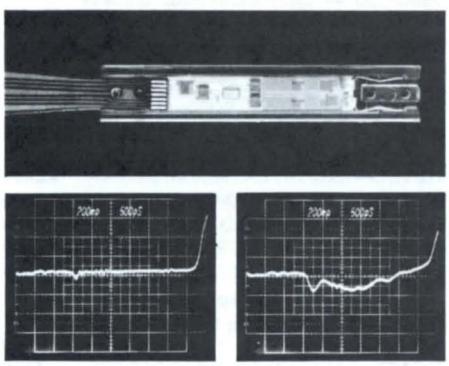
92HS8s can be formed into modules of 8 to 32 channels for wide parallel applications. A fully expanded DAS 9200 system supports five sets of 32-channel 92HS8s, for a total of 160 channels at 2 GHz.

Fastest Analyzer in the World

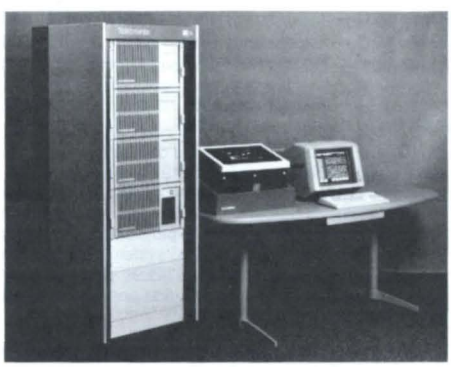
The 92HS8 acquisition module provides up to 32 channels at 2 GHz asynchronous sampling rates (500 ps sampling period). The 92HS8 combines the timing resolution of an oscilloscope with the flexible triggering, glitch detection, memory depth, and channel width of a logic analyzer. It uses a new generation of high-performance probes with custom ICs in the probe tips. These probes provide high-impedance differential inputs and input capacitance of less than 1 pF to eliminate common-mode noise and circuit loading.

Circuit Board Functional Test

The variety of acquisition and stimulus modules available on the DAS 9200 make it an ideal tool for circuit board functional testing. Local mass storage and high speed 9200-host communications help minimize upload/download time and overall test time. Time-correlated module interactions let you use data acquired by one module to change the activity of another for more realistic conditional testing.



Comparison of the line distortion of the 92HS8 probe attached to a nominal 50 Ω test point on an ECL-based circuit (left), versus that of a typical 100 MHz probe (right). Less distortion means more accurate high-speed acquisition.



Operable as a standalone device or under the control of a host, the DAS 9200 can move from engineering to manufacturing with no loss of functionality.

ORDERING INFORMATION

NOTE: All DAS 9200 products (including standard configurations, mainframes, and modules) include an extended warranty providing one year of on-site service.

STANDARD CONFIGURATIONS

Model Number	Recommended Application	Composed of*1	Performance Overview	Price
DAS 9230	General purpose H/W analysis with 8-, 16-bit microprocessor support	1 92A16 with P6460 probes 1 92A60 1 92S16	16 ch 200 MHz async/100 MHz sync 8-, 16-bit μP support 18 ch, 50 MHz stimulus	$36,930
DAS 9232	General purpose H/W analysis with 8-, 16-, 32-bit microprocessor support	1 92A16 with P6460 probes 1 92A16E with P6460 probes 1 92A90 1 92S16 1 92S32 with P6465 probes	32 ch 200 MHz async/100 MHz sync 8-, 16-, 32-bit μP support 50 ch 50 MHz stimulus	$60,280
DAS 9240	Timing Analysis	1 92A16 1 92A16E	32 ch 200 MHz async/sync	$30,400
DAS 9242	High-speed Timing	1 92HS8 1 92A16 1 92A16E	8 ch 2 GHz async 32 ch 200 MHz async/sync	$55,940
DAS 9250	8-, 16-bit microprocessor support	1 92A60	60 ch 20 MHz async/sync supports one 8-, 16-bit μP	$22,420
DAS 9252	8-, 16-, 32-bit microprocessor support	1 92A90	90 ch 20 MHz async/sync supports one 8-, 16-, or 32-bit μP	$26,030
DAS 9254	Dual microprocessor support	2 92A90	180 ch 20 MHz async/sync supports two 8-, 16-, or 32-bit μPs	$41,050
DAS 9260*2	ASIC Prototype Verification	1 92A16 with P6460 probes 3 92A16E with P6460 probes 2 92S32 with P6465 probes TF100 Test Fixture 92DV Software	128-pin 50 MHz ASIC verification system: 64 pins acquisition and 64 pins stimulus	$70,110
DAS 9262*2	ASIC Prototype Verification	1 92A16 with P6460 probes 5 92A16E with P6460 probes 3 92S32 with P6465 probes TF100 Test Fixture 92DV Software DAS 92E9 Expansion M/F 92C02 Expansion/GPIB	192-pin 50 MHz ASIC verification system: 96 pins acquisition and 96 pins stimulus	$109,850
DAS 9270*2	Circuit Board Functional Test	1 92A16 with P6460 probes 5 92A16E with P6460 probes 3 92S32 DAS 92E9 Expansion M/F 92C02 Expansion/GPIB	192-pin 50 MHz test system: 96 pins acquisition and 96 pins stimulus	$97,120
DAS 9272*2	Circuit Board Functional Test	2 92A16 with P6460 probes 6 92A16E with P6460 probes 4 92S32 DAS 92E9 Expansion M/F 92C02 Expansion/GPIB	256-pin 50 MHz test system: 128 pins acquisition and 128 pins stimulus	$122,890
DAS 9274	Circuit Board Functional Test	2 92A90 6 92S32 DAS 92E9 Expansion M/F 92C02 Expansion/GPIB	360-pin 20 MHz test system: 180 pins acquisition and 192 pins stimulus	$113,920
DAS 9276*3	Circuit Board Functional Test	3 92A90 8 92S32 DAS 92E9 Expansion M/F 92C02 Expansion/GPIB	512-pin 20 MHz test system: 270 pins acquisition and 256 pins stimulus	$150,480

*1 *All configurations include a DAS 9219 mainframe and 9200T color display.*

*2 *Includes mainframe Option 1A (15 A power cord).*

*3 *Includes mainframe Option 1B (3 phase power supply).*

MAINFRAMES

DAS 9219 Mainframe only **$8,970**
Includes: Mainframe chassis with 8 slots, backplane board, controller board, 2 Mb memory board (resides in slot 1), 10 Mb hard disk drive, 360 Kb floppy disk drive, power supply, 3 RS-232 ports, system software.

DAS 9229 Mainframe and Color Display **$11,420**
Includes: DAS 9219 (see above) and 9200T high-resolution color display.

DAS 92E9 Expansion Mainframe **$6,205**
Includes: Mainframe chassis with 8 slots, backplane board, expansion slave board, power supply. Contains no mass storage or external communications.

OPTIONS

Option 04 — Mainframe EMI shielding (meets VDE 0871, Class B). Requires 220 V input voltage. **+$700**
Option 05 — Rackmount hardware. **+$400**
Option 1A — 115 V/15 A power cord.*1 **NC**
Option 1B — 125/208 V 3-phase power supply.*1 **+$180**
Option 1C — GPIB board.*2*3 **+$1,650**
Option 10 — 1.2 Mb floppy disk drive.*3 **+$250**
Option 12 — 20 Mb hard disk drive.*3 **+$350**
Option 2C — GPIB/Expansion board.*2*3 **+$1,950**
Option 3C — Expansion board. **+$1,350**
Option 88 — Factory configuration and test. **NC**

*1 *Cannot be ordered with DAS 9276.*
*2 *Cannot be ordered with DAS 9262, 9270, 9272, 9274, 9276.*
*3 *Cannot be ordered with DAS 92E9.*

Up to three expansion mainframes can be connected, in daisy-chain fashion, to a DAS 9219. To connect an expansion mainframe, slot 8 of the previous mainframe must contain an Expansion/GPIB card or Expansion card. This card connects to the expansion slave board in the DAS 92E9. The maximum 9200 system configuration of one DAS 9219 and three DAS 92E9s yields 28 card slots: 6 in the DAS 9219, 7 in the first and second DAS 92E9s, and 8 in the third DAS 92E9.

9200T High Resolution Color Display **$3,635**

INTERNATIONAL POWER PLUG OPTIONS (Standard Configurations/Mainframes/Display)

Option A1 — Universal Euro 220 V, 50 Hz.
Option A2 — UK 240 V, 50 Hz.
Option A3 — Australian 240 V, 50 Hz.
Option A4 — North American 240 V, 60 Hz.
Option A5 — Switzerland 220 V, 50 Hz.

MAINFRAME FIELD-INSTALLABLE OPTIONS

92C01 GPIB Board (same as mainframe Option 1C) **$1,650**
92C02 Expansion/GPIB board (same as mainframe Option 2C) **$1,950**
92C03 Expansion board (same as mainframe Option 3C) **$1,350**

INSTRUMENT CARDS

NOTE: The following products include probes. Refer to page 125 for probe descriptions.

92A16 16 Ch 200 MHz Data Acq **$9,750**
Includes: Two P6461 probes.

92A16E 16 Ch 200 MHz Acquisition Expander **$9,340**
Includes: Two P6461E probes.

92A60 60 Ch 20 MHz Data Acquisition Supports 8-, 16-bit microprocessors **$11,860**
Includes: Buffer probe and general purpose leadset.

92A90 90 Ch 20 MHz Data Acquisition Supports 8-, 16-, 32-bit microprocessors **$15,470**
Includes: Buffer probe and general purpose leadset.

92HS8 8 Ch 2 GHz Data Acquisition **$25,980**
Includes: 9 permanently attached probes. Requires 2 mainframe slots. Can be expanded to 16 ch with 92HS8C. Can be expanded to 32 ch with 92HS8E and two 92HS8C; 32 ch requires only 2 slots.

92HS8E 8 Ch 2 GHz Acq. Expander **$25,980**
Includes: 9 permanently attached probes. Requires only 1 mainframe slot. Can operate without 92HS8 but supports only 8 channels. When used with 92HS8, can be expanded to 16 channels with 92HS8C.

92HS8C 8 Ch 2 GHz Acq. Cabinet **$24,940**
Includes: 9 permanently attached probes. Expands 92HS8/92HS8E from 8 to 16 channels without using additional slots. Cannot operate alone; requires 92HS8/92HS8E.

92S16 18 Ch 50 MHz Algorithmic Pattern Generator **$7,290**
Includes: Two P6464 probes.

92S32 36 Ch 50 MHz Sequential Pattern Generator **$10,930**
Includes: Four P6464 probes.

APPLICATION SOFTWARE

Microprocessor Support — See page 124.

92DV ASIC Prototype Verification Software **$5,000**
Includes: Link to CAE Systems simulators.

OPTIONS

Option 3F — Mentor-to-DAS 9200 simulator link. **+$2,000**
Option 3G — Daisy-to-DAS 9200 simulator link. **+$2,000**
Option 3H — Hilo-to-DAS 9200 simulator link. **+$2,000**
Option 3J — CADAT-to-DAS 9200 simulator link. **+$2,000**
Option 3K — LASAR-to-DAS 9200 simulator link. **+$2,000**

Simulator links may be ordered separately as:
92DVL2 — Mentor-to-DAS 9200 simulator link. **$2,000**
92DVL3 — Daisy-to-DAS 9200 simulator link. **$2,000**
92DVL4 — Hilo-to-DAS 9200 simulator link. **$2,000**
92DVL5 — CADAT-to-DAS 9200 simulator link. **$2,000**
92DVL6 — LASAR-to-DAS 9200 simulator link. **$2,000**

OTHER PRODUCTS

TF100 — ASIC Verification Test Fixture. 320 pins, 50 MHz. **$5,000**
92CART — Mobile AnthroCart for DAS 9200 **$355**

DAS 9100 Series

Digital Analysis System

GPIB IEEE-488

The DAS 9100 Series Option 06 complies with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats*.

Color Display Enhances Ease-of-Use and Increases Productivity

Acquisition Speeds to 2 GHz (500 ps)

Data Widths to 104 Channels

Pattern Generation Up to 192 Channels at 50 MHz

91DVS Software Links DAS 9100 to IBM PC for Bench-Top VLSI Functional Testing

TF100 Test Fixture Supports Devices to 320 Pins at 50 MHz

VAXBI Bus Simulation and Debug

Disassembly Support for Over 30 Microprocessors and Buses

Memory Depths From 512 to 8032 Bits per Channel

Disassembly Support for Proprietary Processors and Buses

Triggering to 16 Levels

Patented Time Correlation of High-Speed and Low-Speed Data

Separate Glitch Memory

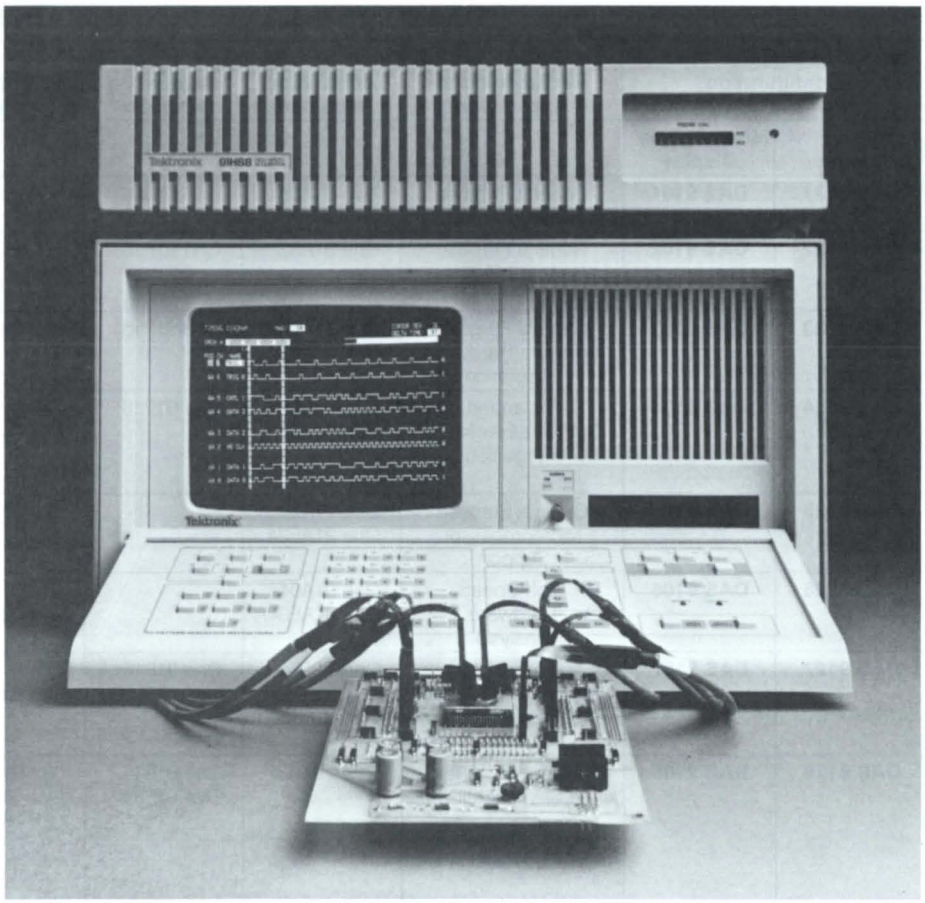
State-Table and Timing Diagrams Displayed for All Channels

Pattern Generation to Simulate Hardware or Software

Supports GPIB, RS-232, Hard-Copy Units and Serial Line Printers

Tape Drive Stores Patterns and Instrument Set-Ups for Future Use

Thirteen Standard Application Configurations Available or Custom Design Your Own System



The Industry Standard

The DAS 9100 Series Digital Analysis System has set the industry standard for virtually all aspects of logic analysis. Its modular mainframe accepts a wide assortment of both data acquisition and pattern generation modules to fit your application needs.

High Speed

The 91HS8 acquisition module provides up to 32 channels at a 2 GHz asynchronous sample rate (500 picosecond sample interval). The 91HS8 combines the time resolution of an oscilloscope with the flexible triggering, glitch detection, memory depth, and channel width of a logic analyzer.

Ease of Use

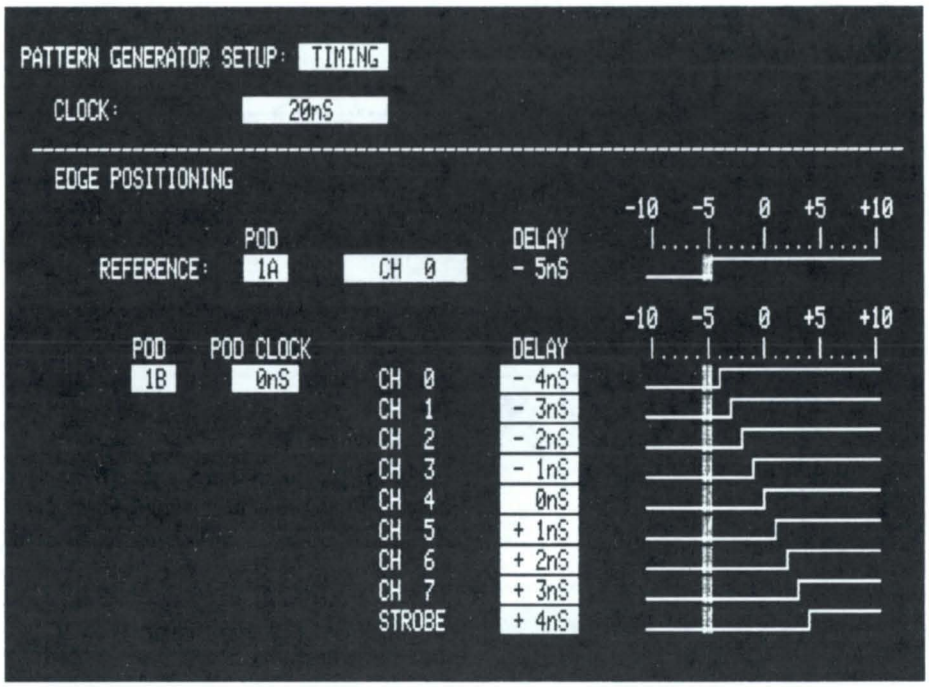
Besides color, the DAS 9100 Series includes many other important human engineering features. Its menu-driven user interface is easy to learn and self-documenting. There is a color-coded keyboard organized specifically to enhance user programming. All keys are arranged into logical groups that correspond to the display elements.

DAS 9100 PERFORMANCE SUMMARY

Module Name	Type	Channels	Maximum Channels	Memory Depth	Speed	Application
91HS8/91HSE8	Acquisition	8	32	8000	2 GHz	Ultra High-Speed Hardware Analysis
91A04A/91AE04A	Acquisition	2/4	16	4096/2048	660/330 MHz	High-Speed Hardware Analysis
91A08	Acquisition	8	32	512	100 MHz	Hardware Analysis
91A32	Acquisition	32	96	512	25 MHz	Hardware/Software Analysis
91A24/91AE24	Acquisition	24	96	1024	10 MHz	Sophisticated Software Analysis
91S16	Pattern Generator (Algorithmic)	16	176 with five 91S32	1024	50 MHz	High-Speed HW/SW Simulation
91S32	Pattern Generator (Stored-Pattern)	32	192	2048	50 MHz	High-Speed HW/SW Simulation
91P16/91P32	Pattern Generator (Algorithmic)	16/32	80	254	25 MHz	Hardware/Software Simulation

DAS 9100 STANDARD CONFIGURATIONS

Standard Configuration Model Number		Recommended Application	Acquisition Modules	Pattern Generation Modules	Options Included	Performance Features
Color Display	Monochrome Display					
DAS 9121	**DAS 9101**	General Purpose Hardware Analysis	Two 91A08			16 Channel 100 MHz Data Acquisition
DAS 9122	**DAS 9102**	General Purpose Acquisition With Stimulus	One 91A32	One 91P16		32 Channel 25 MHz Data Acquisition 16 Channel 25 MHz Pattern Generation
DAS 9123	**DAS 9103**	General Purpose Software/Hardware Integration	One 91A32 One 91A08	One 91P16	Opt 03 Power	32 Channel 25 MHz Data Acquisition 8 Channel 100 MHz Data Acquisition 16 Channel 25 MHz Pattern Generation
DAS 9124	**DAS 9104**	Expanded Software/Hardware Integration	Two 91A32 Two 91A08	One 91P16	Opt 01 Tape Opt 04 Power	64 Channel 25 MHz Data Acquisition 16 Channel 100 MHz Data Acquisition 16 Channel 25 MHz Pattern Generation DC-100 Tape Mass Storage
DAS 9125	**DAS 9105**	General Purpose Microprocessor Support	One 91A24 One 91AE24		Opt 01 Tape	48 Channel 10 MHz Data Acquisition DC-100 Tape Mass Storage
DAS 9126	**DAS 9106**	High Speed Hardware Analysis	One 91A04A One 91AE04A		Opt 01 Tape Opt 03 Power	4 Channel 660 MHz or 8 Channel 330 MHz Data Acquisition DC-100 Tape Mass Storage
DAS 9127	**DAS 9107**	Microprocessor Software/Hardware Integration	One 91A24 One 91AE24 One 91A08	One 91P16	Opt 01 Tape Opt 03 Power	48 Channel 10 MHz Data Acquisition 8 Channel 100 MHz Data Acquisition 16 Channel 25 MHz Pattern Generation DC-100 Tape Mass Storage
DAS 9128	**DAS 9108**	Interactive ATE: VLSI Verification	Three 91A32	One 91P16 Two 91P32	Opt 01 Tape Opt 04 Power Opt 06 Comm	96 Channel 25 MHz Data Acquisition 80 Channel 25 MHz Pattern Generation DC-100 Tape Mass Storage GPIB/RS-232 Communications Interface Serial Line Printer Port Display Video Output
DAS 9130		Ultra High-Speed Hardware Analysis	One 91HS8 Three 91HSE8		Opt 01 Tape Opt 03 Power Opt 06 Comm	32 Channel 2 GHz Data Acquisition DC-100 Tape Mass Storage GPIB/RS-232 Communications Interface Serial Line Printer Port Display Video Out
DAS 9131		General Purpose Acquisition With Stimulus	One 91A32 One 91A04A	One 91S32	Opt 01 Tape Opt 04 Power Opt 06 Comm	32 Channel 25 MHz Data Acquisition 4 Channel 330 MHz Data Acquisition 32 Channel 50 MHz Pattern Generation
DAS 9132		General Purpose Acquisition With Stimulus	One 91A32 One 91A08	One 91S16 One 91S32	Opt 01 Tape Opt 04 Power Opt 06 Comm	32 Channel 25 MHz Data Acquisition 8 Channel 100 MHz Data Acquisition 48 Channel 50 MHz Pattern Generation
DAS 91VB		VAXBI Bus Simulation and Debug	One 91A24 Three 91AE24	One 91P16 One 91P32	Opt 01 Tape Opt 04 Power Opt 06 Comm	96 Channel 10 MHz Data Acquisition 48 Channel 25 MHz Pattern Generation VB100 VAXBI Support Package
DAS 9118 With DAS 9119 ATE mainframe		Remote Only Operation; Display and Keyboard not Included	Three 91A32	One 91P16 Two 91P32	Opt 04 Power Opt 06 Comm	96 Channel 25 MHz Data Acquisiton 80 Channel 25 MHz Pattern Generation CRT and Keyboard Deleted GPIB/RS-232 Communications Interface Serial Line Printer Port Display Video Output



The 91S16/91S32 50 MHz pattern generator modules let you adjust the timing relationships between output clocks and data channels in 1 ns increments.

Pattern Generation

The DAS 9100 is the first logic analyzer with both acquisition and pattern generation in the same instrument. Pattern generation makes it possible to start debugging hardware before the software, or all of the hardware, is available. You can also use pattern generation to test VLSI devices. VLSI test software (91DVS) and a 320-pin VLSI test fixture are available.

Microprocessor Support

The widest selection of microprocessor support packages in the industry is listed on page 124.

VAXBI Bus Simulation and Debug

The DAS 91VB, a configured DAS 9100 system, supports the 32-bit VAXBI bus from Digital Equipment Corporation. Developed in cooperation with DEC, the DAS 91VB is a complete VAXBI test system that can fully monitor and simulate the VAXBI bus. The DAS 91VB can be used stand alone or from a VAX-connected terminal. Special control software installed on the VAX automatically performs all VAX-DAS 91VB communications and translations.

DAS 9100 ORDERING INFORMATION

STANDARD CONFIGURATIONS

DAS 9121	**$16,370**	**DAS 91VB**	**$51,930**
DAS 9122	**$17,380**	**DAS 9101**	**$13,470**
DAS 9123	**$22,165**	**DAS 9102**	**$14,480**
DAS 9124	**$33,390**	**DAS 9103**	**$19,265**
DAS 9125	**$19,540**	**DAS 9104**	**$30,490**
DAS 9126	**$24,550**	**DAS 9105**	**$16,640**
DAS 9127	**$28,315**	**DAS 9106**	**$21,650**
DAS 9128	**$45,760**	**DAS 9107**	**$25,415**
DAS 9130	**$108,000**	**DAS 9108**	**$42,860**
DAS 9131	**$32,840**	**DAS 9118**	**$40,710**
DAS 9132	**$48,250**		

MAINFRAME ONLY

DAS 9109 Monochrome Mainframe **$5,500**
Includes: P6452 probe; P6454 external clock probe; ejector tool (214-3154-00); operators manual (062-5847-09); workshop workbook (062-7596-00).

DAS 9119 ATE Mainframe (Deletes CRT and Keyboard; Adds Option 06) **$6,350**
Includes: Same as above.

DAS 9129 Color Mainframe **$8,970**
Includes: Same as above.

MAINFRAME OPTIONS

Option 01 — DC-100 Tape Drive. **+$1,450**
Option 03 — One Additional Power Supply. **+$800**
Option 04 — Two Additional Power Supplies. **+$1,600**
Option 05 — Rackmount Hardware. **+$200**
Option 06 — GPIB, RS-232, Line Printer Port. **+$1,550**
Option 88 — Mainframe shipped with modules installed and checked as part of the mainframe. **NC**

INTERNATIONAL POWER PLUG OPTIONS

Option A1 — Universal Euro 220 V, 50 Hz.
Option A2 — UK 240 V, 50 Hz.
Option A3 — Australian 240 V, 50 Hz.
Option A4 — North American 240 V, 60 Hz.
Option A5 — Switzerland 220 V, 50 Hz.

MAINFRAME FIELD INSTALLABLE OPTIONS

DAS 91F1 — Field Installed Option 01 (Includes Installation in Service Center). **+$1,700**
DAS 91F3 — Field Installed Additional Power Supply. **+$800**
DAS 91F6 — Field Installed Option 06 (For Mainframes Above S/N B020100). **+$1,700**

MAINFRAME MODULES

The following modules include probes. See Probe Selection Guide on page 125 for more information. Maximum of six modules per mainframe, 104 data acquisition channels, 80 pattern generator channels when using 91P16/91P32, or 192 pattern generator channels when using 91S16/91S32.

91AE04A — Data Acquisition, Expander **$5,950**
91AE24 — Data Acquisition, Expander **$4,700**
91A04A — Data Acquisition, 660/330 MHz **$7,950**
91A08 — Data Acquisition, 100 MHz **$3,985**
91A24 — Data Acquisition, 10 MHz **$4,990**
91A32 — Data Acquisition, 25 MHz **$4,990**
91HS8 — Data Acquisition, 2 GHz **$25,000**
91HSE8 — Data Acquisition, Expander **$25,000**
91P16 — Pattern Generator, 25 MHz **$3,990**
91P32 — Pattern Generator, 25 MHz **$6,900**
91S16 — Pattern Generator, 50 MHz **$6,900**
91S32 — Pattern Generator, 50 MHz **$10,400**

Note: When adding modules, check that the correct number of power supplies is also selected. The mainframe includes sufficient power for two modules. One additional power supply (Option 03) is required for three or four modules. Two additional power supplies (Option 04) are required for a total of five or six modules.

MICROPROCESSOR/BUS SUPPORT
For ordering information please see page 124.

PROBES

P6452 — 8-Channel Data Acquisition Probe. **$730**
P6453 — 4-Channel Data Acquisition Probe. **$1,560**
P6454 — External Clock Probe For 91A08 Modules. (Only one required, included with each DAS 9100 Mainframe.) **$265**
P6455 — 8-Channel TTL/MOS Pattern Generator Probe. **$575**
P6456 — 8-Channel ECL Pattern Generator Probe. **$575**
P6457 — 4-Channel Tri-State Pattern Generator Probe. **$575**
P6460 — 8-Channel Data Acquisition Probe. **$700**
P6462 — 8-Channel TTL Only Data Acquisition Probe. **$340**
P6464 — 8-Channel TTL/ECL Pattern Generator Probe. **$1,350**

OTHER PRODUCTS

91DVS IBM PC XT/AT-DAS 9100 Device Verification Support Package **$5,000**
TF100 VLSI Device Test Fixture, 320 pins, 50 MHz **$5,000**
VB100 VAXBI Bus Support Package **$8,950**

1240/1241

GPIB IEEE-488 The 1240/1241 comply with IEEE Standard 488-1978, and with Tektronix *Standard Code and Formats.*

Total Design Support: Hardware, Software, and Integration

1241's Color Display Enhances User Interface

Up to 72 Acquisition Channels

Acquisition Speeds to 100 MHz Async, 50 MHz Sync

14 Levels of Triggering With Conditional Branching

Dual Time Base Triggering, Acquisition and Display

Simple Menu Operation With On-Screen Soft Keys

Transfers Easily Into Manufacturing and Service

Expanded 1241 Timing Diagram With Glitches.

TOTAL PERFORMANCE

With the 1240/1241 Logic Analyzers, the key phrase is **total performance.** These instruments provide complete support for all aspects of the design task, including hardware analysis, software analysis, and integration.

The 1241 color mainframe with its LCCS (Liquid Crystal Color Shutter) and 1240 monochrome mainframe provide rapid set-up and operation. Use of either instrument is made simple through a straightforward menu oriented approach, combined with multi level operation and touch-screen soft keys. Multi level operation allows the user to select from one of four levels best matched to the user's skill level and the task at hand. Touch-screen soft keys provide high-level commands at a keystroke, keeping operator selections simple and well labeled.

Hardware Analysis

For hardware analysis, the 1240/1241 offer up to 36 channels of acquisition at sampling rates of 100 MHz asynchronous and 50 MHz synchronous. 6 ns glitch detection is also available.

Standard memory depth is 512 bits per channel, and this can be extended to a maximum of 2048 bits per channel by using a special memory chaining feature. This feature allows you to chain one card's memory to another, trading channel width for memory depth.

Superior hardware triggering capabilities include data and glitch triggering for isolating the problem area; clocked and unclocked triggering for capturing events that might not coincide with sample points; and counters, timers, and duration filters for triggering on the characteristics of a signal as well as its occurrence.

Auto-run capability allows you to track intermittents through continuous acquisitions and change parameters on the system under test and dynamically monitor their effects.

Software Analysis

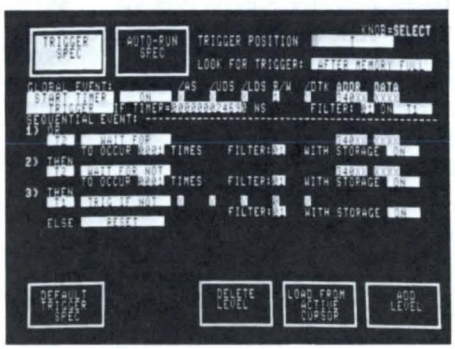
Software analysis is supported by up to 72 data channels at sampling rates of 50 MHz synchronous/asynchronous. A flexible clocking scheme includes data demultiplexing without double-probing.

Powerful software triggering capabilities are provided so you can track program flow. Included are 14 trigger levels, conditional branching, counters, timers, and both program flow and data flow qualification. These functions are implemented in two independent event recognizers.

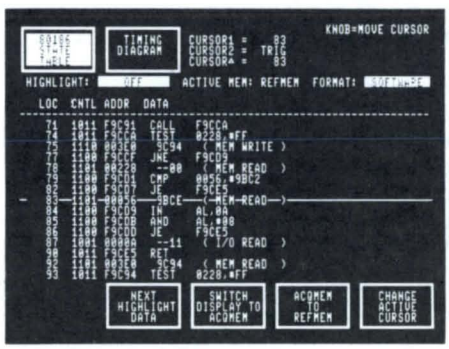
Other features that assist in software analysis are flexible channel groupings for display, standard display radices (including ASCII and EBCDIC), and an eight-level pattern search and memory compare with highlighting.

Hardware/Software Integration

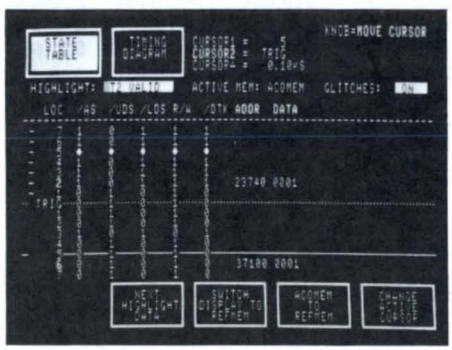
The 1240/1241 offer a dual time base system that integrates all the hardware and software analysis capabilities. The dual time base system greatly speeds the hardware/software integration process by tying together the acquisition, triggering, and display of two independent time bases. You can fully monitor the interaction between hardware and software, or the relationship of two interdependent systems. All data



Trigger Specification Menu.



80186 Software Format



State Table Display With Dual Time-base Acquisition.

displays are time-aligned and completely correlated. The dual time base allows you to integrate functional modules, an increasingly important design task.

FLEXIBILITY NOW AND IN THE FUTURE

The power of the 1240/1241 stems from the configurable architecture of the mainframes. You can select features that meet your current application needs, then later upgrade the mainframe to increased performance.

Selectable Acquisition Cards

Each mainframe has four card slots which accommodate any combination of 9 channel (1240D1) and 18 channel (1240D2) data acquisition cards, with a maximum of 72 channels.

ROM Packs for Data Processing

Data processing capabilities can be added by inserting ROM packs into the ROM port on the side of the mainframe. These ROM packs provide the capability to capture data which is very specific to your problem at hand and assist in analyzing that data, by processing it and presenting it to you in the most useful manner. Currently, there are ROM Packs supporting performance analysis (12R01) and (12RMXX) mnemonic disassembly of popular microprocessors. Special communications applications, such as printer support (12RC01) and master/slave (12RC02), require both a ROM Pack and COMM Pack.

COMM Packs for External Communications

Communication capabilities can be added by inserting COMM Packs into a communications port on the rear of the mainframe. These COMM Packs act as adaptors, allowing the 1240/1241 to function in different communication environments. The 1200C01 supports RS-232C, the 1200C02 supports GPIB, and the 1200C11 supports the parallel printer interface.

EASE OF USE

In line with Tek's goal of easy-to-use logic analyzers, the 1240/1241 human interface has been designed to facilitate the user's operation of the instrument.

Menu Operation and Soft Keys

Ease of use starts with the 1240/1241's menu operating system. Straightforward menu displays and on-screen soft keys allow you to make set-up choices on the screen where your attention is already directed. You are not distracted by the need to look elsewhere on the instrument.

Multiple Operation Levels

Another major feature of the menu operating system is user-selected operation levels. The 1240/1241 provide four operation levels, ranging from basic operation for simple applications to full operation for complex applications. The sophistication of system features increases with the operation levels.

Configurable From the Front Panel

The 1240/1241 are completely configurable from the front panel, thus eliminating the need to switch boards and reconnect probes when changing from hardware to software applications. Probe connections are on the side of the instrument so they can be easily accessed. The keyboard has a simple layout, with single function keys. Also, a knob is included on the keyboard for data scrolling. This knob, along with the extreme smoothness of the data scrolling, make the 1240/1241 displays easier to read and manipulate.

Automatic Nonvolatile Storage

A battery backed CMOS memory stores two complete instrument set-ups, including the last set-up used before the 1240 or 1241 is powered down. This facilitates quick instrument start-up when returning to work, and eliminates the problem of losing a set-up as a result of power system interruptions.

Scroll Knob

IDEALLY SUITED FOR ENGINEERING, MANUFACTURING, AND SERVICE

In addition to its usefulness in the engineering environment, the 1240/1241 is well suited for manufacturing and service tasks. It transfers easily from one environment to another and helps facilitate communications between the different groups through its portability, remote control, mass storage and teleservicing capabilities.

Portability

The 1241 weighs 12.7 kg (28.0 lb) and meets environmental Class 5 specifications. The 1240 weighs 12.0 kg (26.5 lb) and meets environmental Class 3 specifications.

Remote Control

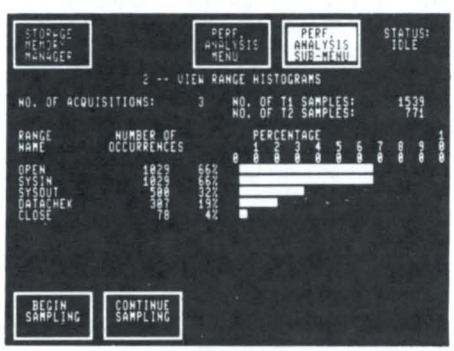
The 1200C01 RS-232C and 1200C02 GPIB COMM Packs are ideally suited to automated test environments and remote control.

Mass Storage

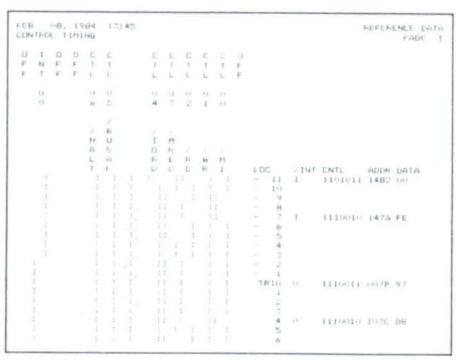
Mass storage of set-ups, acquisition memories, and reference memories is achieved through RAM and EPROM Packs.

Storage and retrieval of information from the 12RS01 8K RAM Pack and the 12RS02 64K RAM Pack is accomplished via menu soft keys. The 12RS11 32K EPROM Pack (no EPROMs included) and the 12RS12 32K EPROM Pack (EPROMs included) provide a permanent storage medium for set-ups and

Personality Module with COMM Packs and ROM Packs.



View Range Histograms Menu.



Combined Format Print-out.

memories. To store files on these EPROM Packs, the set-ups and memories are uploaded from the 1240/1241 to a host computer via GPIB or RS-232C and then burned into EPROMs. Menu soft keys are used to retrieve files.

Teleservicing

Master-Slave capability allows one 1240/1241 to remotely control another over a telephone line. This greatly eases the higher levels of service troubleshooting, as service specialists can get to the problem via the telephone rather than having to physically travel to the problem site. The 1240/1241 supports master/slave operation with the following configuration at each end of the phone line: 12RC02 Master/Slave ROM Pack, a 1200C01 RS-232C COMM Pack and a modem.

CHARACTERISTICS

Characteristics are common to the 1240/1241 unless otherwise indicated.

OPERATING LEVELS

Level 0 — Basic Operation.
Level 1 — Advanced timing analysis (includes basic state analysis).
Level 2 — Advanced state analysis (includes basic timing analysis).
Level 3 — Full operation.

TIME BASES

Two per Instrument — Assignable by probe. Time Base 1: Asynchronous or Synchronous. Time Base 2: Synchronous or Demultiplex.

INPUTS

Clocks — C1, C2, . . . Cn. Where n = number of probes = number of channels/9. Minimum Pulse Width: 8 ns. Specifiable as rising, falling, or either edge.

Qualifiers — Q1, Q2, . . . Qn. Where n = number of probes = number of channels/9. Set-up Time, Hold Time: = (P6460) 11 ns, 0 ns; (P6462) 17 ns, 6 ns. Specifiable as high or low level.

Asynchronous — Rate: 1240D1: 10 ns to 1 s, (1240D2: 20 ns to 1 s). Specification: (1-2-5 sequence) • (Q1 • Q2 • . . . • Qn). Accuracy: 0.01%. Channel-to-Channel Skew: ±3 ns. Glitch Detection: (1240D1 only) 6 ns.

Synchronous — Rate: Dc to 50 MHz. Set-up Time, Hold Time: On 1240D1 is (P6460) 7 ns, 2 ns; (P6462) 12 ns, 7 ns. On 1240D2 is (P6460) 12 ns, 0 ns; (P6462) 17 ns, 5 ns. Specification: (C1 + C2 + . . . + Cn) • (Q1 • Q2 • . . . • Qn). Minimum Delay After Previous Clock: 20 ns.

Demultiplex — Rate: Dc to 50 MHz. Set-up Time, Hold Time: On 1240D1 is (P6460) 7 ns, 2 ns; (P6462) 12 ns, 7 ns. On 1240D2 is (P6460) 12 ns, 0 ns; (P6462) 17 ns, 5 ns. Specification: First Phase Clock (Latch Data) (C1 + C2 + . . . + Cn) • (Q1 • Q2 • . . . • Qn). Minimum Delay After Last Phase Clock: 20 ns. Last Phase Clock (Store Data): (C1 + C2 + . . . + Cn) • (Q1 • Q2 • . . . • Qn). Minimum Delay After First Phase Clock: 10 ns.

DATA ACQUISITION CARDS

Two types of acquisition cards: 1240D1, 1240D2. Maximum of four cards per 1240/1241, in any combination.

	1240D1	1240D2*2
Number of Channels	9	18
Max Asynchronous Rate With Glitches	100 MHz 50 MHz*1	50 MHz N/A
Max Synchronous Rate	50 MHz	50 MHz
Memory Depth (Bits/Channel With Glitches)	 512 256	 512 N/A
Max Depth via Chaining	2048	2048

*1 *Glitch capture available on all channels.*
*2 *Supports single probe demultiplexing.*

Depth vs Channels — Tradeoffs possible between data acquisition cards of same type. Maximum depth is 2048 (with four 1240D1 or four 1240D2).

DATA ACQUISITION PROBES

Two Types of Acquistion Probes: P6460, P6462. One probe required per 1240D1, two per 1240D2.

	P6460	P6462
Signal Input Data Channels Clock/ Clock Qualifier Lines	 9 1	 9 1
Impedance Nominal Threshold Range Increments Accuracy Threshold Assignment Polarity Assignment	 1 MΩ, 5 pF −6.35 V to +6.35 V 0.05 V ±0.5% ±0.065 V By acquisition card By channel	 ≈1 LTTL +1.4 V — ±.25 V +.055 V/ (0°C −25°C) N/A By channel
Maximum Input Voltage Peak Channel to Channel	 ±40 V ±60 V	 −2 to +7 V No restriction

NOTE: All system specifications are based upon P6460 probes, for specifications based upon P6462 probes, please refer to the 1240/1241 Data Sheet.

TRIGGER DEFINITION (TWO EVENT RECOGNIZERS)

Global Event Recognizer (Event Recognizer #1) — One level. Event Recognition specified by: Word recognizer—data (data or glitch on 1240D1). Duration filter—1 to 16 consecutive samples or 10 ns to 160 ns. Commands: Store On (Not), Trigger On (Not), Reset On (Not), Start Timer On (Not), Time While On (Not), Increment Counter On (Not), or Off. Counter/timer: Clock interval is 10 ns. Range is 0 to 99,999,999,999 (either counts or 10 ns increments) Counter/timer value may be used to cause trigger or reset.

Sequential Event Recognizer (Event Recognizer #2) — 14 levels. Event Recognition on Each Level Specified By: Time Base: Which time base to monitor for event. Word Recognizer: Data (data or glitch on 1240D1). Iteration Counter: 1 to 9999 occurrences. Duration Filter: 1 to 16 consecutive samples. Selective Storage on Each Level Specifiable: With Storage On or with Storage Off. Commands on Each Level: Wait For (Not), Trigger If (Not), Reset If (Not), Jump If (Not) or Delay (up to 9999). Commands at End of Sequence: Trigger, Reset or Do Nothing.

External Trigger Out — TTL level output whenever trigger attempted.

External Trigger In — TTL level input can be required for enabling trigger.

AUTORUN

Four Modes of Operation

Compare Acquisition Memory to Reference Memory — Specifiable which channels to compare, specifiable starting and ending memory locations of comparison. Specifiable result of Comparison Outcome: Display and reacquire, discard and reacquire, or display and stop. Specifiable Minimum Display Time: 0 s to 99 s.

Continuous Trigger Out — Data is not stored. 1240/1241 acts as trigger source.

Trigger In — Requires Trigger In signal to enable trigger. Enables two 1240/1241s to work in parallel.

Store After Trigger — Data at last trigger is available after stopping 1240/1241. Time between storages is minimum.

DISPLAY FORMATS

State Table — Acquisition or reference memory. Data displayed in binary, octal, hex, ASCII, EBCDIC. Glitch display can be turned on or off.

Timing Diagram — Acquisition or Reference Memory. Horizontal Expansion: *1, *2, *5, *10, *20. Vertical Expansion: (1241 only): *1, *2.

Distance Between Cursors — Value displayed as absolute time for unqualified asynchronous measurement, as number of memory locations for qualified or synchronous measurement.

Highlighting Modes — Memory comparison differences, glitches, search pattern occurrences, time base 1 occurrences, time base 2 occurrences.

Search Pattern — Length: 1 to 8 contiguous locations.

STORAGE

Internal (Standard)

Nonvolatile Memory (NVM) — Size: Contains two set-ups, including status at power down, lithium iodide battery.

Volatile Memory (RAM) — Size: Contains two set-ups.

Memory Types

Set-Up — Stored in NVM, RAM, or Pack, contains all data pertinent to making an acquisition.

Reference Memory — Stored in Pack, reference memory is editable in Edit Reference Memory menu.

ENVIRONMENTAL

Temperature — Operating: (1240 only) −10°C to +55°C; (1241 only) 0°C to 50°C. Nonoperating: −62°C to +85°C.

Altitude — Operating: To 4600 m (15,000 ft). Nonoperating: To 15 000 m (50,000 ft).

Vibration — 0.025 inch displacement. 10 Hz to 55 Hz frequency range.

Shock — 30 g.

OTHER CHARACTERISTICS

Diagnostics — At power-up, the 1240/1241 perform processor, ROM, RAM and board checks. A test pattern generator located on the side provides stimulus for verifying probes and acquisition system operation. Complete system verification and extended diagnostics are available with an optional ROM Pack.

Rear Panel Connections — Trigger In: TTL compatible. Trigger Out: TTL compatible. Video Out: (1240 only) Conforms with RS-170 (composite video).

Power — 90 V to 132 V or 180 V to 250 V, 48 Hz to 63 Hz.

NOTE: 48 Hz to 440 Hz operation with addition of safety ground strap.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	368	14.5
Height	197	7.8
Depth	498	19.6
Weight≈	**kg**	**lb**
1240 Without Accessories	12.0	26.5
1241 Without Accessories	12.7	28.0

ROM Packs

Analysis

12R01 (Performance Analysis) — State Overview: 1 to 11 ranges. Ranges can be different groups and different timebases. Ability to halt and resume measurement. Display in count, percentage, and histogram. Event Measurement: 1 to 11 distribution intervals. 1 to 4 events. 10 ns resolution. Five measurement types (measure total time, count cycles, count occurrences, time occurrence, accumulate time). Display in distribution, min, mean, max, and histogram.

Communication Support

12RC01 (Printer Support) — Requires: 1200C01 for serial interface or 1200C11 for parallel interface. Output: Menus, search pattern, acquisition and reference memory. Memory Format: State table, timing diagram, and combined.

12RC02 (Master/Slave) — Requires: 1200C01 and modem. With Option 01: Auto-answer, autodial, voice-data switching, nonvolatile storage of four phone numbers, 300 baud and 1200 baud. Diagnostics: Local 1240/1241 with COMM Pack and RS-232 cable, modem, and link between local and remote 1240/1241.

External Storage (Optional)

12RS01 (8K RAM Pack) — Size: Contains 8 Kbytes with Lithium Iodide battery.

12RS02 (64K RAM Pack) — Size: Contains 64 Kbytes with Lithium Iodide battery.

12RS11 (32K EPROM Pack) — Size: Contains 32 Kbytes (no EPROMs included). Requires four 68764s or 68766s.

12RS12 (32K EPROM Pack) — Size: Contains 32 Kbytes. Comes with four 68764s or 68766s.

Microprocessor Support

12RMXX (Mnemonic Disassembly) — Formats: State, Absolute, Hardware, Software. Provides printer support for all four display formats when 1200C01 (for serial printer interface) or 1200C11 (for parallel printer interface) is installed.

COMM Packs

1200C01 (RS-232C) — Baud Rate: 110 to 9600. Bits/Character: Eight, including parity bit. Protocol: Asynchronous full duplex. Compatibility: Stand alone with host for remote control, with 12RC01 for printers with serial interface, with 12RC02 and 12RC02 Option 01 for master/slave, with 12RMXX for printers with serial interface.

1200C02 (GPIB) — Full listener/talker capabilities. Meets IEEE Standard 488-1978. Compatibility: Stand alone with host for remote control.

1200C11 (Parallel Printer) — Compatibility: With 12RC01 for printers with parallel interface, with 12RMXX for printers with parallel interface.

ORDERING INFORMATION

1240 Logic Analyzer Mainframe **$4,500**
Includes: Accessory pouch (016-0707-00); front panel cover (200-2780-00); operator manual (070-4340-01); reference guides (070-4641-01).

1241 Color Logic Analyzer Mainframe **$6,000**
Includes: Same as above.

Option 05 — Rackmount Adaptor. **+$400**

INTERNATIONAL POWER PLUG OPTIONS

Option A1 — Universal Euro 220 V, 50 Hz.
Option A2 — UK 240 V, 50 Hz.
Option A3 — Australian 240 V, 50 Hz.
Option A4 — North American 240 V, 60 Hz.
Option A5 — Switzerland 220 V, 50 Hz.

STANDARD SYSTEM CONFIGURATIONS

8-BIT

1240N08 — 8-Bit Microprocessor Analysis System **$12,400**
Includes: 1240 Logic Analyzer with two 1240D2 modules with four P6460 probes, 12RS02 RAM Pack.

1241N08 — 8-Bit Microprocessor Analysis System **$13,900**
Includes: Same as above except the 1241 Logic Analyzer.

OPTIONS

Options 01 thru 09 — Microprocessor Specific Support (Includes: 12RMXX Microprocessor Disassembly ROM Pack, 12RMXX Option 01 Configured Probe Interface).
Option 01 — Specific Support for 8080. **+$600**
Option 02 — Specific Support for 8085. **+$600**
Option 03 — Specific Support for 6800. **+$600**
Option 04 — Specific Support for 6802. **+$600**
Option 05 — Specific Support for 6808. **+$600**
Option 06 — Specific Support for 6809. **+$600**
Option 07 — Specific Support for Z80. **+$600**
Option 08 — Specific Support for 6502. **+$600**
Option 09 — Specific Support for NSC800. **+$600**

16-BIT

1240N16 — 16-Bit Microprocessor Analysis System **$12,600**
Includes: 1240 Logic Analyzer with three 1240D2 Option 1D modules without probes, P6460 probe, 12RS02 RAM Pack.

1241N16 — 16-Bit Microprocessor Analysis System **$14,100**
Includes: Same as above except the 1241 Logic Analyzer.

OPTIONS

Options 01 thru 09 — Microprocessor Specific Support (Includes: 12RMXX Microprocessor Disassembly ROM Pack, 12RMXX Option 02 or Option 04 Personality Module).
Option 01 — Specific Support for 8086. **+$2,500**
Option 02 — Specific Support for 8088. **+$2,500**
Option 03 — Specific Support for 80186. **+$2,500**
Option 04 — Specific Support for 80188. **+$2,500**
Option 05 — Specific Support for 68000 (DIP). **+$2,500**
Option 06 — Specific Support for 68000 (PGA). **+$2,500**
Option 07 — Specific Support for 68008. **+$2,500**
Option 08 — Specific Support for 68010 (DIP). **+$2,500**
Option 09 — Specific Support for 68010 (PGA). **+$2,500**

GENERAL PURPOSE

1240NGP — General Purpose Analysis System **$15,350**
Includes: 1240 Logic Analyzer with 1240D1 module with P6460 probe, two 1240D2 modules with four P6460 probes, 12RS02 RAM Pack.

1241NGP — General Purpose Analysis System **$16,850**
Includes: Same as above except the 1241 Logic Analyzer.

BUS ANALYSIS

1240NBA — Bus Analysis System **$19,800**
Includes: 1240 Logic Analyzer with four 1240D2 modules with eight P6460 probes, 12RS02 RAM Pack.

1241NBA — Bus Analysis System **$21,300**
Includes: Same as above except the 1241 Logic Analyzer.

HIGH SPEED ANALYSIS

1240NHS — High Speed Analysis System **$16,800**
Includes: 1240 Logic Analyzer with four 1240D1 modules with four P6460 probes, 12RS02 RAM Pack.

1241NHS — High Speed Analysis System **$18,300**
Includes: Same as above except the 1241 Logic Analyzer.

OPTIONAL ACCESSORIES

ACQUISITION CARDS

1240D1 — 9-Channel Data Acquisition Card, 100 MHz, includes one P6460 Data Acquisition Probe. **$2,950**
Option 1D — Deletes one P6460 Data Acquisition Probe. **−$700**
1240D2 — 18-Channel Data Acquisition Card, 50 MHz, includes two P6460 Data Acquisition Probes. **$3,700**
Option 1D — Deletes two P6460 Data Acquisition Probes. **−$1,400**
Option 2S — Substitutes two P6462 Data Acquisition Probes for two P6460 Data Acquisition Probes. **−$720**

DATA ACQUISITION PROBES

P6460 — 9-Channel Data Acquisiton Probe. **$700**
P6462 — 9-Channel Data Acquisiton Probe, fixed threshold TTL. **$340**

COMMUNICATION INTERFACES (COMM PACKS)

1200C01 — RS-232C COMM Pack. **$750**
1200C02 — GPIB COMM Pack. **$850**
1200C11 — Parallel Printer COMM Pack. **$500**
Note: To order cables for these COMM Packs, see the Logic Analyzer Accessories Section.

ROM PACKS

Analysis
12R01 — Performance Analysis ROM Pack. **$800**

Communication Functions
12RC01 — Printer Support ROM Pack. **$300**
12RC02 — Master/Slave ROM Pack. **$500**
Option 01 — Modem. **+$600**

Microprocessor Mnemonic Disassembly
12RMXX — See pages 124-125 or ordering information.

Storage
12RS01 — 8K RAM Pack. **$300**
12RS02 — 64K RAM Pack. **$500**
12RS11 — 32K EPROM PACK (Empty). **$85**
12RS12 — 32K EPROM PACK. **$300**

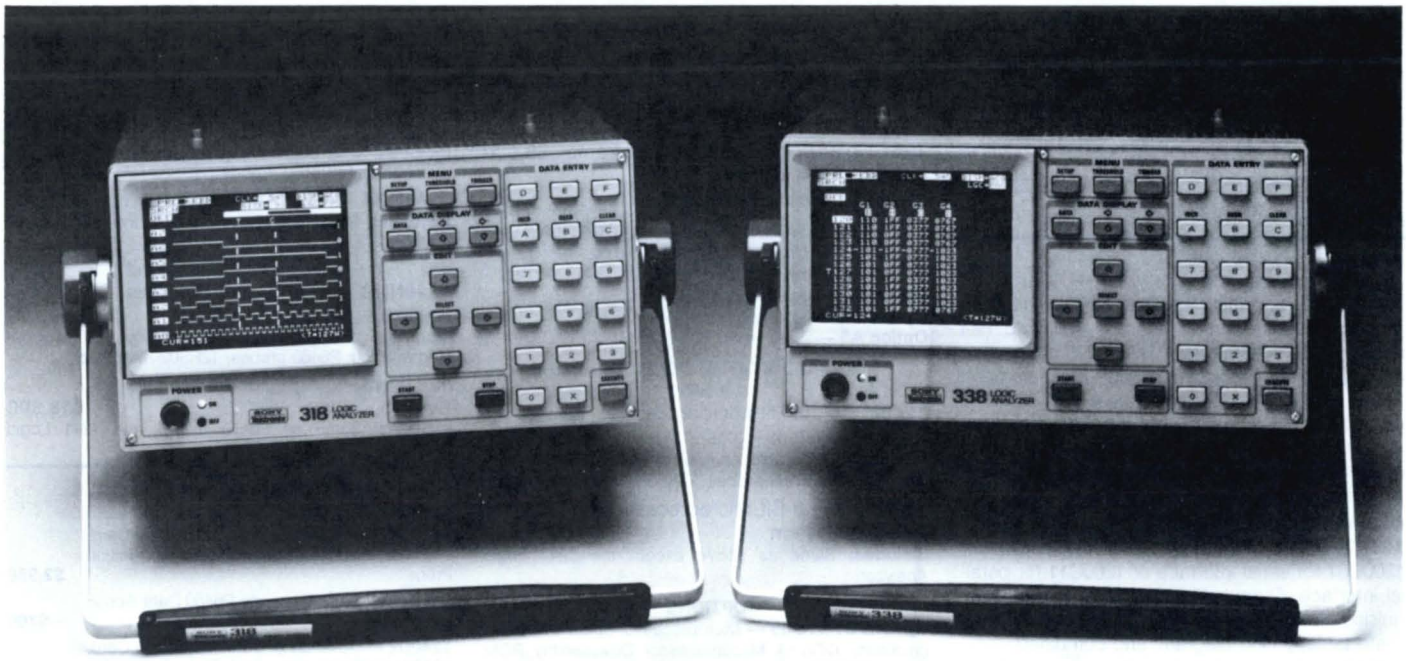
SERVICE ACCESSORIES

12RD01 — Diagnostic ROM Pack. **$1,500**
Diagnostic Lead Set — Order 012-0556-00 **$60**
Extender Card — Order 670-7539-02 **$455**
Service Manual — Order 062-7124-02 **$150**
Service Maintenance Kit — Includes the above service accessories. Order 067-1103-02*[1] **$**

CART

Portable Instrument Cart — For on-site portability. Order K212. See page 461 for complete description. **$330**

[1] To order, contact your local Tektronix Sales Office.



318/338 Logic Analyzers

Parallel and Serial Data Acquisition

State and Timing Displays

32 Channels up to 20 MHz
16 Channels up to 50 MHz
Serial Acquisition up to 19,200 bits/sec

Multilevel Triggering

Easy-to-Use Menu-Driven Interface

RS-232 Remote Control Interface

Internal Nonvolatile Memory for Set-Ups and Reference Data

Ultra-Portable and Rugged

Weighing only 7 kg (15 lb) each, including accessories, these instruments incorporate proprietary LSI circuitry to provide an array of features usually associated with much larger logic analyzers. Both the 318 and 338 include parallel and serial data acquisition capabilities and powerful multilevel triggering. Each instrument can also be controlled remotely via an RS-232 interface, an extremely useful feature in first-line service applications. Also, nonvolatile memory allows both set-up information and reference data to be retained and transported from site to site.

The 318 and 338 Logic Analyzers are built around the same basic feature set. The 338, targeted more toward software applications, allows 32 channels of data acquisition at speeds up to 20 MHz. The 318 includes 16 channels of acquisition at up to 50 MHz, and is a better fit for timing applications. The basic 318 and 338 include parallel data acquisition, state and timing displays, reference memory, glitch acquisition and glitch triggering capabilities. The S1 configurations add serial acquisition, an RS-232 remote control interface, and nonvolatile memory.

Parallel Data Acquisition

The 318 and 338 contain powerful 3-level triggering, allowing the user to specify and capture complex event sequences. The trigger allows definition of three separate events. Up to 65,000 occurrences can be required for the first event. The next two events can be defined to follow immediately or at any time later. The third event can be used to RESET the trigger sequence. In addition, the events can be OR'd together.

Once acquired, parallel information can be displayed as a state table in the radix selected (hex, binary, octal or decimal) or as a timing diagram. The data can be searched for occurrences of a specified event, or the acquired data can be compared to the data in the reference memory, with differences highlighted on the screen.

In the timing diagram up to eight channels of data can be displayed. Each channel can be assigned a label chosen by the user. For increased ease of use, the delta measurement feature displays the difference between locations of two cursors.

All data channels can be clocked either asynchronously (internal analyzer clock) or synchronously (from the clock of the unit under test). Thus, no reprobing is necessary if the user wishes to select a different clocking mode.

Glitches are recognized and stored. They can also be used as trigger conditions.

Serial Data Acquisition

The S1 configurations include serial data acquisition. Data can be acquired synchronously or asynchronously at up to 19,200 bits per second, with 5 to 9 bits per character. Two-level triggering is available both synchronously and asynchronously. In addition, in synchronous mode, SYNC and HUNT words can be specified.

Serial data can be displayed in state table or character format. State table radices include binary, octal, hex, ASCII and EBCDIC. The character format can be decoded as ASCII or EBCDIC. Data can be searched for specific events, or the acquired data may be compared with data stored in reference memory.

RS-232 Interface for Remote Control

The S1 configurations also include an RS-232 interface which allows complete control of the instrument from a remote processor or terminal. The connection may be made locally or via modems and telephone lines. The remote interface parameters are programmable and can be set easily from the menu interface.

Nonvolatile Memory

The nonvolatile memory feature is part of the S1 configurations. This internal nonvolatile memory can store instrument set-ups and reference data. Such storage is useful for rapid and accurate restoration of set-ups and reference data under a variety of conditions. It is especially useful at remote service sites where a less skilled technician can configure the instrument quickly and easily, and compare acquired data to expected (reference) data.

CHARACTERISTICS

PARALLEL ANALYZER FUNCTION

DATA INPUT

Channels — 318: 16 channels; glitch data is detected on all 16 channels. 338: 32 channels; glitch data is detected on 8 channels (POD A).

Minimum Logic Swing — 500 mV p-p; centered on threshold voltage.

Maximum Logic Swing — Threshold voltage plus 10 V to threshold voltage minus 15 V.

Glitch Data Width — 5 ns minimum with 350 mV overdrive from threshold.

Threshold Voltage — TTL: +1.4 V. V 1: −10 V to +10 V. V 2: −10 V to +10 V. V 3: = (V 1 +V 2)/2.

SAMPLING

External Clock Mode	318	338
Data set-up time	13 ns max	14 ns max
Data hold time	0 ns max	0 ns max
Clock period	20 ns min	50 ns min

Clock Pulse Width — High-Logic level: 15 ns min. Low-Logic Level: 15 ns.

Clock Polarity — + or −edge.

INTERNAL CLOCK MODE

Sample Interval — 318: 20 ns to 500 ms/sample in 1-2-5 sequence. 338: 50 ns to 500 ms/sample in 1-2-5 sequence.

Data Memory Depth	318	338
Acquisition Memory	16 x 256 bits	32 x 256 bits
Reference Memory	16 x 256 bits	32 x 256 bits
Glitch Memory	16 x 256 bits	8 x 256 bits

TRIGGERING

Internal Trigger

Word Recognizer — Three words: A, B, and C; selected channels are AND'd together.

Input — All data input channels from P6451 data acquisition probes.

Glitch Trigger — Selected channels are OR'ed together.

Trigger Position — Begin, Center, End, Delay up to 65,000 clock cycles.

External Trigger

Input — Mini-jack connector on side panel, TTL compatible.

Threshold — 1.4 V nominal (TTL level).

Polarity — + or −edge.

Pulse Width — 20 ns minimum.

Trigger Output — Initiated high when an internal trigger sequence, glitch trigger or external trigger is detected. Reset on next acquisition start.

Output Level — TTL.

Current Max — High-Logic Level: 1 mA. Low-Logic Level: 2 mA.

DATA DISPLAY

Timing Diagram Mode — Maximum of eight channels (one page) present on screen at one time. The 318 has two pages; the 338 has four pages. Glitch Display: Displays glitches on timing diagram as a bit width transition edge. Search: Searches for glitches or user defined word.

ΔT — Movable cursor for calculating the number of clocks and temporal distance between two events.

State Table Mode — Hex, decimal, octal, or binary radix format. Search: Searches for glitches or user defined word. Compare: Compares acquisition memory to reference memory and displays mismatched characters in reverse video.

SERIAL STATE ANALYZER FUNCTION

DATA INPUT

Data Timing — Synchronous or asynchronous.

Bits/Character — 5, 6, 7, 8 or 9 bits (includes parity bit if parity is active).

SAMPLING

Internal Clock for Asynchronous Mode — 50, 75, 110, 134.5, 150, 200, 300, 600, 1200, 1800, 2400, 4800, 9600, and 19,200 bits/second.

External Clock for Both Synchronous and Asynchronous Modes — Up to 19,200 bits/second.

Parity Control — Odd, even, or none.

TRIGGER SOURCE

Internal or external.

DATA DISPLAY

State Table Mode — Hex, binary, octal, ASCII, EBCDIC radix. Search: Searches for parity errors or user defined word. Compare: Compares acquisition memory to reference memory and displays mismatched characters in reverse video.

Character Table Mode — All 256 bits of memory displayed in either ASCII or EBCDIC radix. Search: Searches for parity errors or user defined word. Compare: Compares acquisition memory to reference memory and displays mismatched characters in reverse video.

RS-232 INTERFACE

Data Transmission Type — Asynchronous only.

Communication Mode — Full Duplex.

Bits/Character — Eight bits with parity.

Parity — Even.

Data Transfer Rate — 110, 150, 300, 600, 1200, 2400, 4800, 9600 bps.

Signal Characteristics — Meets RS-232C standard.

I/O Connector — 25 pin standard connector.

NONVOLATILE MEMORY

Memory Size — Three set-ups (serial or parallel) and one memory acquisition or reference.

Nonvolatile Period — Approximately five years at room temperature.

POWER REQUIREMENTS

Line Voltage Range — 90 V to 132 V ac, 180 V to 250 V ac.

Line Frequency — 48 Hz to 440 Hz.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width with handle	237	9.3
Height with accessory pouch	174	6.8
Height without accessory pouch	120	4.7
Depth, handle not extended	409	16.1
Depth, handle extended	492	19.4
Weight≈	**kg**	**lb**
Net without accessories	5.1	11.5
318S1 with accessories	6.7	14.7
338S1 with accessories	7.2	15.7

ORDERING INFORMATION

318 Logic Analyzer **$5,300**
Includes: Power cord (161-0104-00); accessory pouch (016-0697-00); P6107 Probe (1 additional with the S1 configuration) (010-6107-03); P6451 probe, two with the 318, four with the 338 (010-6451-07); workbook; reference guide; operator's manual.

318S1 Logic Analyzer With Serial Analysis, RS-232 and Nonvolatile Memory **$6,500**

318F1 Field Installed Serial Analysis, RS-232 and Nonvolatile Memory **$1,500**

338 Logic Analyzer **$5,800**

338S1 Logic Analyzer With Serial Analysis, RS-232 and Nonvolatile Memory **$7,000**

338F1 Field Installed Serial Analysis, RS-232 and Nonvolatile Memory **$1,500**

INTERNATIONAL POWER PLUG OPTIONS

Option A1 — Universal Euro 220 V, 50 Hz.
Option A2 — UK 240 V, 50 Hz.
Option A3 — Australian 240 V, 50 Hz.
Option A4 — North American 240 V, 60 Hz.
Option A5 — Switzerland 220 V, 50 Hz.

OPTIONAL ACCESSORIES

Service Manual*1

RS-232 Cable — Order 012-0757-00 **$170**

Service Maintenance Kit — Order 067-1159-01 **$950**

Null Modem Cable — Order 012-0530-00 **$90**

*1 *To order, contact your local Tektronix Sales Office.*

The SONY®/TEKTRONIX® 300 Series is manufactured and marketed in Japan by Sony/Tektronix Corporation, Tokyo Japan. Outside of Japan, the 300 Series is available from Tektronix, Inc., its marketing subsidiaries and distributors.

300 SERIES COMPARISON SELECTION GUIDE

Characteristics	318	318S1	338	338S1
Number of Parallel Data Channels	16	16	32	32
Maximum Asynchronous Sample Rate	50 MHz	50 MHz	20 MHz	20 MHz
Maximum Synchronous Sample Rate	50 MHz	50 MHz	20 MHz	20 MHz
Number of Trigger Levels	3	3	3	3
Acquisition Memory Depth (Bits/Channel)	256	256	256	256
Reference Memory Depth (Bits/Channel)	256	256	256	256
Glitch Capture (Channels)	16	16	8	8
Glitch Trigger (Channels)	16	16	8	8
Serial Data Acquisition	No	Yes	No	Yes
RS-232 Remote Control Interface	No	Yes	No	Yes
Nonvolatile Memory	No	Yes	No	Yes
Video Output	Yes	Yes	Yes	Yes

Microprocessor and Bus Support

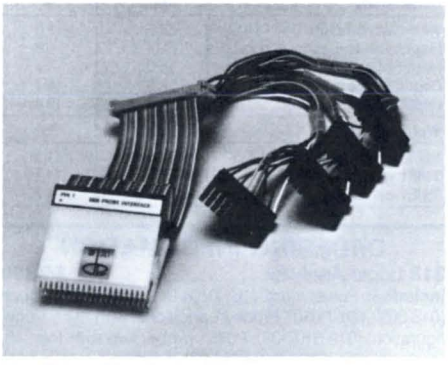
Single-Connection Probe Adaptors for Ease of Use and Reliability

Ready-to-Use Mnemonics on Disk, Tape, or ROM Pack

DAS 9200 Support Includes Register Deduction, Stack Simulation, Subroutine Trace and Data Variable Displays

This table summarizes the microprocessor and bus support products offered by the DAS 9200, DAS 9100, and 1240/1241.

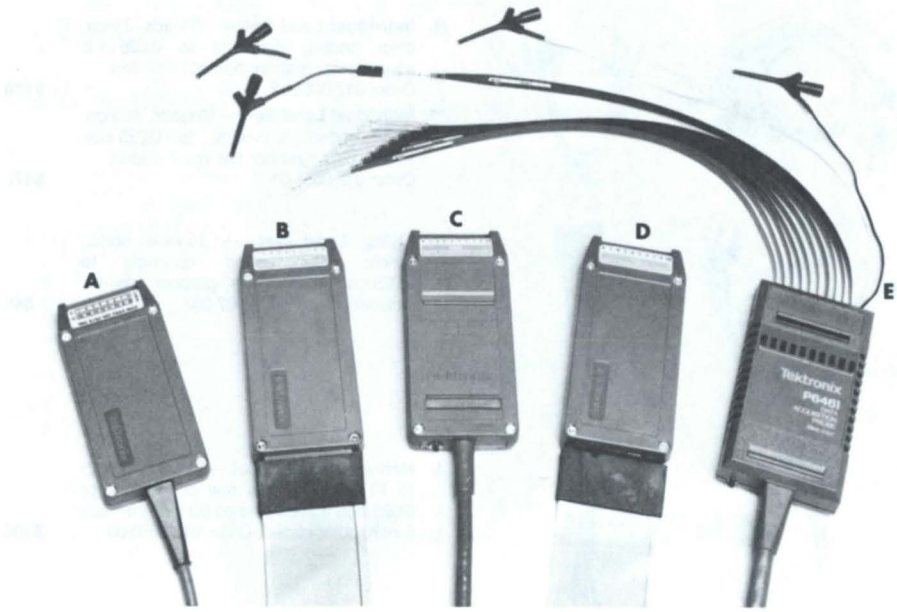
For custom microprocessors, or microprocessors not listed, Tektronix offers support through EDM (Extended Define Mnemonics) on the DAS 9100. Also the Universal Probe Interface Kit (UPIK40) on page 127 is a general-purpose, single-connection probe adaptor.



The Option 01 probe interface works with the mnemonics files on tape or ROM pack to support disassembly on the DAS 9100 and the 1240/1241.

Micro-processor	Logic Analyzer Family	For Software ORDER	For Probe Adaptor ORDER	Acq. Boards Required	Acq. Probes Required	Fastest Clock Rate Supported	Price*1
8080	DAS 9100 1240/41	91TM01 12RM01	Opt 01 Opt 01	2*2 2*4	4*9 4*9	Max Max	$550 $600
8031	DAS 9100 1240/41	91TM07 12RM99 (Opt 03)	Opt 01 UPIK40	2*2 2*4	4*7 4*7	Max Max	$550 $400
8039	DAS 9100	91TM10	Opt 01	1*3	3*7	Max	$550
8085	DAS 9200 DAS 9100 1240/41	92DM02 91TM02 12RM02	92DM02 Opt 01 Opt 01	*5 2*2 2*4	None 4*9 4*9	Max Max Max	$900 $550 $600
8086 (DIP)	DAS 9200 DAS 9100 1240/41	92DM03 91TM03 12RM03	92DM03 Opt 02*10 Opt 02*10	*5 2*2 3*4	None None None	Max 8.0 MHz 8.0 MHz	$1,250 $2,450 $2,500
8088 (DIP)	DAS 9200 DAS 9100 1240/41	92DM04 91TM04 12RM04	92DM04 Opt 02*10 Opt 02*10	*5 2*2 3*4	None None None	Max 8.0 MHz 8.0 MHz	$1,250 $2,450 $2,500
80186 (LCC/PGA)	DAS 9200 DAS 9100 1240/41	92DM05 91TM05 12RM05	92DM05 Opt 02*10 Opt 02*10	*5 2*2 3*4	None None None	Max 8.0 MHz 8.0 MHz	$1,250 $2,450 $2,500
80188 (LCC/PGA)	DAS 9200 DAS 9100 1240/41	92DM06 91TM06 12RM06	92DM06 Opt 02*10 Opt 02*10	*5 2*2 3*4	None None None	Max 8.0 MHz 8.0 MHz	$1,250 $2,450 $2,500
80286 (LCC/PGA)	DAS 9200 1240/41	92DM08 12RM08	92DM08 Opt 02*10	*5 3*4	None None	Max 10.0 MHz	$1,600 $2,500
6301/3	1240/41	12RM99 (Opt 09)	UPIK40	2*4	4*9	Max	$400
GM ECM	1240/41	12RM99 (Opt 01)	UPIK40	2*4	4*9	Max	$700
6800	DAS 9100 1240/41	91TM21 12RM21	Opt 01 Opt 01	2*2 2*4	4*9 4*9	Max Max	$550 $600
6801	DAS 9100 1240/41	91TM28 12RM99 (Opt 05)	Opt 01 UPIK40	2*2 2*4	4*9 4*9	Max Max	$550 $400
6802	DAS 9100 1240/41	91TM22 12RM22	Opt 01 Opt 01	2*2 2*4	4*9 4*9	Max Max	$550 $600
6803	DAS 9100	91TM29	Opt 01	2*2	4*9	Max	$550
6805E2 6805E2 6805E3	DAS 9100 1240/41 1240/41	91TM30 12RM99 (Opt 06) 12RM99 (Opt 07)	Opt 01 UPIK40 UPIK40	2*2 2*4 2*4	2*7 2*7 3*7	Max Max Max	$550 $400 $400
6808	DAS 9100 1240/41	91TM23 12RM23	Opt 01 Opt 01	2*2 2*4	4*9 4*9	Max Max	$550 $600
6809	DAS 9200 DAS 9100 1240/41	92DM24 91TM24 12RM24	92DM24 Opt 01 Opt 01	*5 2*2 2*4	None 4*9 4*9	Max Max Max	$900 $550 $600
6809E	DAS 9200 DAS 9100 1240/41	92DM24 91TM24 12RM24	N/A*13 Opt 01 Opt 01	*5 2*2 2*4	None 4*9 4*9	Max Max Max	$900 $550 $600
68HC11	1240/41	12RM99 (Opt 08)	N/A*11	2*4	3*7	Max	$400
68121	DAS 9100	91TM32	N/A*11	2*2	4*9	Max	$550
68000 (DIP)	DAS 9200 DAS 9100 1240/41	92DM25 91TM25 12RM25	92DM25 Opt 02*10 Opt 02*10	*5 2*2 3*4	None None None	Max 12.5 MHz 12.5 MHz	*18 $2,450 $2,500
68000 (PGA)	DAS 9200 DAS 9100 1240/41	91TM27 91TM25 12RM25	Opt 2S*17 Opt 04*10 Opt 04*10	*5 2*2 3*4	None None None	Max 12.5 MHz 12.5 MHz	$2,100 $2,450 $2,450
68008 (DIP)	DAS 9100 1240/41	91TM26 12RM26	Opt 02*2 Opt 02*10	2*2 3*4	None None	8.0 MHz 8.0 MHz	$2,450 $2,500
68010 (DIP)	DAS 9200 DAS 9100 1240/41	92DM27 91TM27 12RM27	92DM27 Opt 02*10 Opt 02*10	*5 2*2 3*4	None None None	Max 12.5 MHz 12.5 MHz	$1,250 $2,450 $2,500
68010 (PGA)	DAS 9200 DAS 9100 1240/41	91TM27 91TM27 12RM27	Opt 2S*17 Opt 04*10 Opt 04*10	*5 2*2 3*4	None None None	Max 12.5 MHz 12.5 MHz	$2,100 $2,450 $2,500
68020	DAS 9200 1240/41	92DM31 12RM31	92DM31 Opt 02*10	*6 3*4	None None	Max 20.0 MHz	$1,900 $2,500
Z80	DAS 9200 DAS 9100 1240/41	92DM41 91TM41 12RM41	92DM41 Opt 01 Opt 01	*5 2*2 2*4	None 4*7 4*7	Max Max Max	$900 $550 $600
Z8001/3	DAS 9100 1240/41	91TM42 12RM42	N/A*11 N/A*11	2*2 3*4	4*9 4*9	Max Max	$350 $400
Z8002/4	DAS 9100 1240/41	91TM43 12RM43	Opt 01 Opt 01	2*2 3*4	3*9 3*9	Max Max	$550 $600
6502/C02	DAS 9100 1240/41	91TM63 12RM63	Opt 01 Opt 01	2*2 2*4	4*8 4*8	Max Max	$550 $600
1802	DAS 9100	91TM61	Opt 01	2*2	4*7	Max	$550
1805C/6C	DAS 9100	91TM65	Opt 01	2*2	4*7	Max	$550
1802/4/5/6/ (A/C/AC/BC)	1240/41	12RM99 (Opt 02)	UPIK40	2*4	3*7	Max	$400
F9450	DAS 9200 DAS 9100 1240/41	92DM64 91TM62 12RM62A	*15 N/A*11 N/A*11	*5 2*2 3*4	None 3*9 3*9	Max Max Max	$900 $350 $400
1750A	DAS 9200 DAS 9100	92DM64 91TM64	*14 N/A*11	*5 2*2	None *16	20.0 MHz 10.0 MHz	$900 $350
NSC800	DAS 9100 1240/41	91TM71 12RM71	Opt 01 Opt 01	2*2 2*4	4*7 4*7	Max Max	$550 $600
UNIBUS	DAS 9100	91TM51	N/A*11	2*2	4*9	Max	$350
Q-BUS	DAS 9100	91TM52	N/A*11	2*2	4*9	Max	$350
GPIB; ASCII; EBCDIC	DAS 9100	91TM53	Opt 01	1*3	2*9	Max	$380
GPIB	1240/41	12RM99 (Opt 04)	*12	2*4	2*9	Max	$400

**1 Price for Software and Probe Adaptor (if available) — probes and boards not included.*
**2 Requires one 91A24 and one 91AE24.*
**3 Requires one 91A24.*
**4 1240D2 boards.*
**5 Works with 92A60 and 92A90.*
**6 Requires 92A90.*
**7 P6460s are always required.*
**8 P6460s are required for CMOS versions.*
**9 Can be used with P6460s or P6462s.*
**10 PM200 personality module required.*
**11 No configured probe interface available.*
**12 Uses GPIB lead set (103-0209-00).*
**13 Use 92A60/90 General purpose lead set (standard with 92A60 or 92A90) and a 003-0801-00 IC clip. Order Option 1D to delete 6809 probe adaptor.*
**14 Comes with adaptor for Emulator PIAs (8300P53 options).*
**15 Use 92DM64 Probe Adaptor and order PIA 010-6606-00 (for non-MMU applications) or 010-6607-00 (for MMU-based applications).*
**16 Depends on 1750A implementation.*
**17 Substitutes a PGA probe adaptor.*
**18 Contact your local Tektronix Sales Engineer.*



A. P6451 8-Channel Data Acquisition Probe — For use with 7D01, 7D01F, 7D01F2. Order P6451 (010-6451-03) **$545**

P6451 — For use with 300 Series instruments (right-angle connector to analyzer). Order P6451 (010-6451-07) **$545**

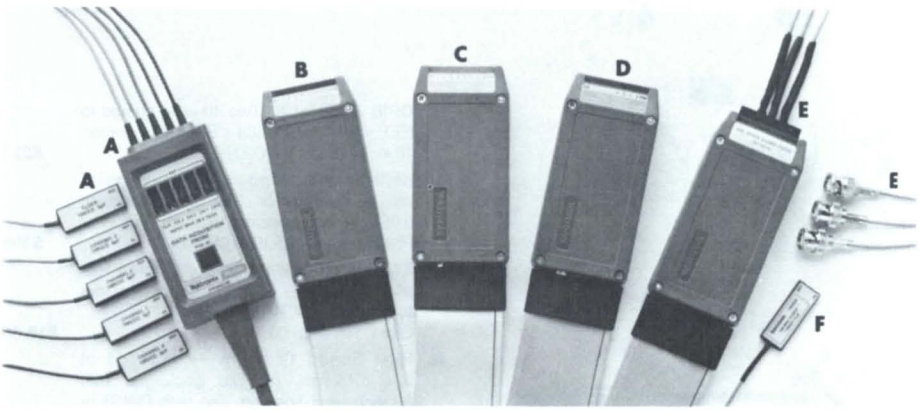
B. P6452 8-Channel Data Acquisition Probe — For use with DAS 9100 mainframes, DAS 91A32/91A08. Order P6452 **$730**

C. P6460 8/9-Channel Data Acquisition Probe — For use with 1240D1, 1240D2, DAS 91A24/91AE24. Order P6460 **$700**

D. P6462 8/9-Channel TTL Only Data Acquisition Probe — For use with 1240D2, DAS 91A24/91AE24/91A32. Order P6462 **$340**

All probes include lead sets.

E. P6461/P6461E 8 Channel Data Acquisition Probe — For use with DAS 92A16/92A16E (P6461E has no clock or Qualifier Channels). Order P6461 or P6461E **$1,570**



A. P6453 4-Channel Data Acquisition Probe — High-speed probe for DAS 91A04A/91AE04A. Order P6453 **$1,560**

B. P6455 TTL/MOS Pattern Generator Probe 8-Channels — For use with DAS 91P16/91P32. Order P6455 **$575**

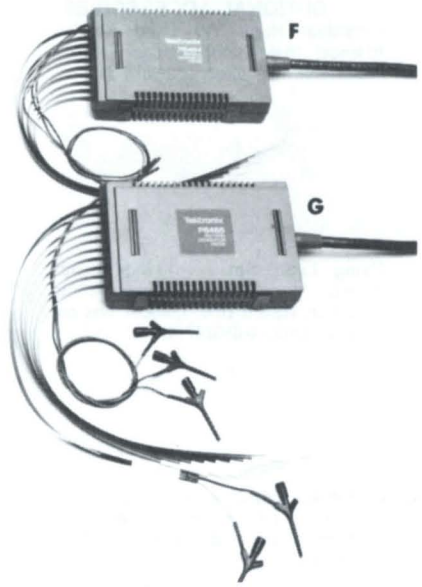
C. P6456 ECL Pattern Generator Probe 8-Channels — For use with DAS 91P16/91P32 modules. Order P6456 **$575**

D. P6457 TTL/MOS Pattern Generator Probe, 4-Channels, Individually Tri-Stateable — For use with DAS 91P16/91P32. Order P6457 **$575**

E. State Stamp Probe — For use with DAS 9100 system in Digital Design Lab (DDL) Configuration. Order 021-0366-01 **$1,200**

F. P6454 100 MHz Clock Probe — For use with DAS 91A08 (max of one P6454 per DAS system). Order P6454 **$265**

All probes include lead sets.



F. P6464 50 MHz Pattern Generator Probe — For use with DAS 91S16/92S32. Order P6464 **$1,350**

G. P6465 50 MHz Pattern Generator Probe — 8 Data Channels 1 clock and 1 Rz R1 strobe for use with DAS 92S16/92S32. Order P6465 **$1,680**

H. Controlled-Width Probelet — Use with DAS 91S16/91S32 to create programmable pulses. Requires two P6464 channels to create one programmable channel. Order 020-1392-00 **$150**

* **P6041 Passive Probe** — Used as Sync out cable, 50 Ω Termination. Order P6041 **$60**

* *Not shown.*

PROBE APPLICATION MATRIX

PRODUCT	P6451	P6452	P6453	P6454	P6455	P6456	P6457	P6460	P6461/E	P6462	P6464	P6465
92A16, 92A16E									✓			
92S16, 92S32											✓	✓
91A24, 91AE24								✓		✓		
91A32		✓								✓		
91A08		✓		✓								
91A04A, 91AE04A			✓									
91P16, 91P32					✓	✓	✓					
91S16, 91S32											✓	
1240D1								✓				
1240D2								✓		✓		
338, 318	✓											

OPTIONAL ACCESSORIES

A. Individual Hook Tip Lead Set — 10 leads, 16 inch, color coded with E-Z Micro Hook Tips. Order 012-0670-00 **$80**

B. Flying Lead Set — 10 wide comb, 10 inch, color coded, connects to 0.025 inch square pins, grabber tips not included. Order 012-0747-00 **$60**

C. Harmonica Lead Set — 10 wide comb to 10 position single row connector, for 0.025 inch square pins on 0.1 inch centers, 10 inch, color coded. Order 012-0800-00 **$34**

D. Pattern Generator Lead Set — 10 + 2 wide comb, 9 inch, twisted pairs, color coded, connects to 0.025 inch square pins, grabber tips not included. Used with P6455, P6456, P6457 pattern generator probes. Order 012-0926-00 **$150**

E. High Speed Pattern Generator Lead Set — 10 + 2 wide comb to 20 position double row connector, for 0.025 inch square pins on 0.15 inch centers, 5 inch, color coded. Used with P6455, P6456, P6457 pattern generator probes. Order 012-0551-00 **$125**

*1 **Diagnostic Lead Set, DAS 9100** — 10 wide comb to 10 wide comb, and two wide ground jumper, 10 inch, for connecting pattern generator probes to data acquisition probes. Order 012-1000-00 **$75**

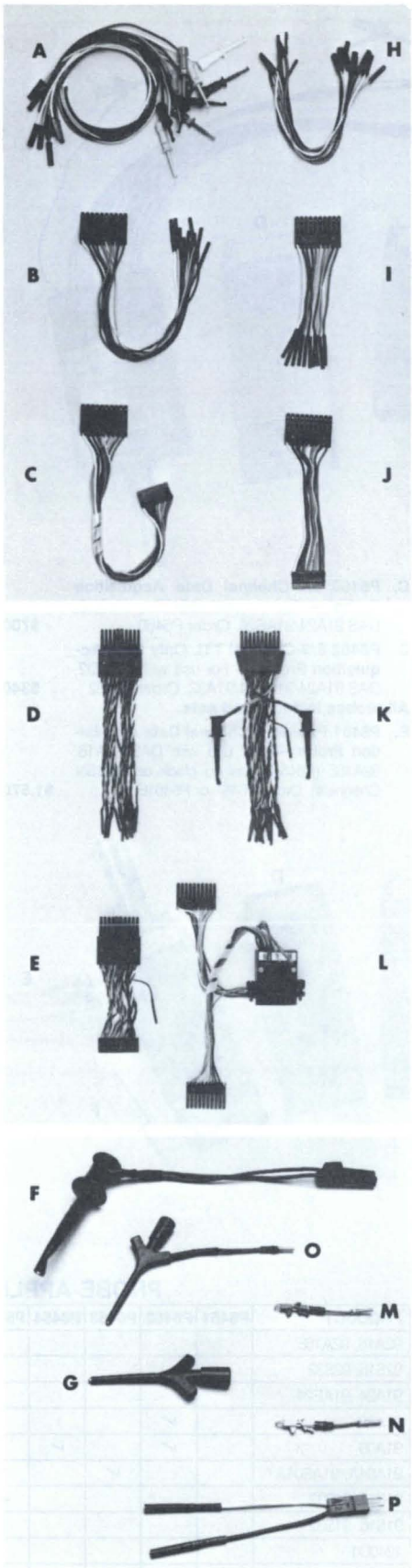
*1 **Diagnostic Lead Set, 1240/1241** — 10 wide comb with 2 wide ground to 12 position double row connector, for 0.025 inch square pins on 0.1 inch centers, 10 inch, color coded. Order 012-0556-00 **$60**

F. Sense Leads — Package of ten, 2 wide comb to Pomona Hook Tip, 5 inch, black for ground or VL. Order 012-0989-01 **$110**

G. Grabber Tip — Package of 12, for general purpose probing with various lead sets.
(Single-sided grabber tips)
Order 020-1386-00 **$40**
(Double-sided grabber tips)
Order 020-1456-00 **$85**

*1 **Sense Leads** — Package of ten, 2 wide comb to Pomona Hook Tip, 5 inch, green for ground or VH. Order 012-0990-01 **$175**

*1 *Not shown.*



H. Individual Lead Set — 10 leads, 8 inch, color coded, connects to 0.025 inch square pins, grabber tips not included. Order 012-0655-02 **$170**

*1 **Individual Lead Set** — 10 leads, 16 inch, color coded, connects to 0.025 inch square pins, grabber tips not included. Order 012-0655-01 **$170**

I. Flying Lead Set — 10 wide comb, 5 inch, color coded, connects to 0.025 inch square pins, grabber tips not included. Order 012-0987-00 **$45**

J. Harmonica Lead Set — 10 wide comb to 10 position single row connector, for 0.025 inch square pins on 0.1 inch centers, 5 inch, color coded. Order 012-0968-00 **$100**

K. Pattern Generator Lead Set — 10 + 6 wide comb with VH and VL Pomona Hook Tips, 9 inch, twisted pairs, color coded, connects to 0.025 inch square pins, grabber tips not included. Used with P6455, P6456, P6457 pattern generator probes. Order 012-1053-00 **$110**

L. GPIB Adaptor — Two 10 wide combs to IEEE Standard 488 Bus Connector, 10 inch. Order 103-0209-00 **$220**

M. High Speed Grippers — Package of ten, 1.75 inch, for flat packages with 0.05 inch lead spacing, use with P6453 or P6454. Order 195-1943-06 **$105**

*1 **91AE04A Coaxial Jumper Cables Replacements** — 3 inch, SMA connectors to connect 91A04A to 91AE04A. Order 175-6425-00 **$18.50**

N. High Speed Grippers — Package of ten, 1.75 inch, for Dip packages with 0.1 inch lead spacing, use with P6453 or P6454. Order 195-2234-06 **$105**

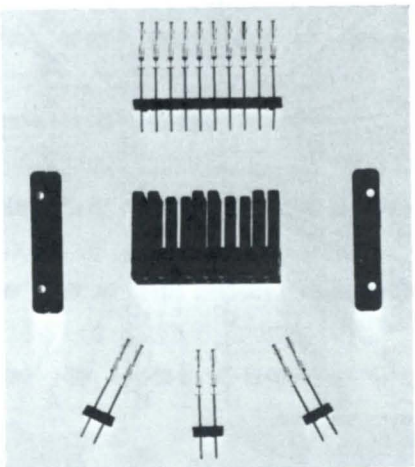
*1 **High Speed Lead Connectors** — Package of ten, gold plated contact pins that interface to podlet lead receptacles on P6453 or P6454. Order 131-2729-02 **$30**

O. High Speed Clock Lead — With grabber tip, package of two, for use with P6453 or P6454. Order 195-3659-02 **$15.75**

P. Lead Set — For use with Podlets.
Acquisition probes P6461/E and HS8.
Order 196-3047-00 **$14**
Pattern generator probes P6464/P6465.
Order 196-2963-00 **$9.50**

- **UPIK 40, Universal Probe Interface Kit** — For 40 pin dip packages. Allows user to configure interconnect from 6 probes or less to a clothespin style 40 pin IC clip. Order UPIK 40 — **$175**
- **RS-232 Cable** — Male-to-female, 20 inch, wires: 1-1, 2-2, 3-3, 4-4, 5-5, 6-6, 7-7, 8-8, 11-11, 12-12, 15-15, 17-17, 19-19, 20-20, 22-22. Used with 1200C01 modem interface DAS 9200 mainframe to terminal or DAS 9100 line printer and communications interface. Order 012-0911-00 — **$100**
- **RS-232 Cable** — Male-to-female, 2 meter, 25 wires: 1-1, 2-2, 3-3, thru 25-25. General purpose. Order 012-0815-00 — **$70**
- **Null Modem Cable** — Female-to-female, 60 inch, wires: 1-1, 2-3, 3-2, 4-5, 5-4, 7-7, 8-20, 11-11, 12-12, 19-19, 20-8. General purpose. Order 012-0820-00 — **$405**
- **Null Modem Cable** — Female-to-female, 60 inch, wires: 1-1, 2-3, 3-2, 4-8, 5-8, 6-20, 7-7, 8-4, 8-5, 20-6. Used with 1200C01 Serial Printer interface. Order 012-0530-00 — **$90**
- **Parallel Interface Cable** — Two meter, used with 1200C11 Parallel Printer COMM Pack for Centronix type printer interface. Order 012-0997-00 — **$65**
- **GPIB Cable** — Two meter. Order 012-0630-01 — **$90**
- **75 Ω Coaxial Cable** — BNC to BNC, 42 inch, used with video hard copy interface. Order 012-0074-00 — **$19**
- **75 Ω Coaxial Cable** — BNC to BNC, 120 inch, used with video hard copy interface. Order 175-2753-00 — **$27**
- **Low Profile Dip Clip** — 40 pin dip to 40 position double row connector, for 0.025 inch square pins on 0.1 inch centers, 4 inch (requires male adaptor below). Order 015-0339-02 — **$49**
- **Low Profile Dip Clip** — 40 pin, same as above except 12 inch. Order 015-0339-00 — **$49**
- **40 Pin Male Adaptor** — 40 position double row header with 0.025 inch square pins on 0.1 inch centers, interfaces the PM 101 or flying lead sets to low profile dip clip above. Order 380-0560-05 — **$16.50**
- **40 Pin Dip Socket Female Adaptor** — 40 position double row head with 0.025 inch square pins on 0.1 inch centers to 40 pin dip socket, for interfacing 40 pin low profile dip clips to PM 100 series probes. Order 380-0647-01 — **$40**
- **IC Clip** — 16 pin dip, clothespin style. Order 003-0709-00 — **$14.50**
- **IC Clip** — 24 pin dip, clothespin style. Order 003-0823-00 — **$33**
- **IC Clip** — 40 pin dip, clothespin style. Order 003-0801-00 — **$50**
- **Circuit Board Ejector Tool** — For removing DAS 9100 module cards. Order 214-3154-00 — **$5.75**
- **Retainer Clamps** — Kit of 4. (P6461/E) Order 020-1483-00 — **$35**
(P6460/P6464/P6465, DAS 9200) Order 020-1484-00 — **$35**

A. LCC (Leadless Chip Carrier) to PGA (Pin Grid Array) Adapter — 68 pin package, for adapting 80286 (LCC) packages to 80286 (PGA) package.
To order 015-0494-00 contact your local Sales Office.



B. Circuit Board Mounted Probe Connector Kit — 10 + 6 wide comb to 0.025 inch square pins on 0.15 inch centers, with mounting tabs, for PC mounting, mounting hole dimensions 0.80 inch wide X0.95 inch long. Interfaces to the following probes: P6452, P6455, P6456, P6457, P6460, and P6462. Seven piece kit. Order 020-1027-00 — **$35**

- **DAS 9100 Service Maintenance Kit** — Includes board and cable extenders for DAS modules, power supplies, CRT, and keyboard. Order 067-0980-01 — **$1,375**
- **DAS 9100 Set-Up and Hold Time Test Fixture** — Order 067-1037-00 — **$1,275**
- **DAS 9100 High Speed Acquisition Test Fixture** — For verification of DAS 91A04, DAS 91AE04, DAS 91A04A, and DAS 91AE04A modules. Order 067-1139-00 — **$250**
- **Low Profile Dip Clip** — 16 pin dip to 16 position double row header with 0.025 inch square pins on 0.1 inch centers, 12 inch. Order 015-0330-00 — **$40**
- **Flat Cable Mounts** — Adhesive Back for securing and organizing probes with flat ribbon cables. Order 343-1048-00 — **$.95**
- **Sync Out Cable** — Miniature Phone Plug to BNC, 79 inch, for 91A24 sync output. Order 175-8165-00 — **$35**
- **91AE24 Jumper Cable Replacements** — Package of seven, twisted pair, 2 position connectors, 3 inch. Order 175-8167-00 — **$4.80**
- **Probe Extender Cable** — Male to Female 34 position double row connectors compatible with P6452, P6455, P6456, P6462, 6 feet. Order 012-1012-01 — **$125**

MEDIA
For DAS 9200, DAS 9100 and 1240/1241.

- **Flexible Disk** — 360K, 5.25 inch 48 TPI, package of 10. Order 119-1583-01 — **$36**
- **Tape Cartridges, DC-100 Type** — Package of five used on DAS 9100 Option 01. Order 119-1350-01 — **$180**
- **Mnemonic Conversion Tape, DAS 9100** — Converts mnemonic and all type files from DAS firmware versions 1.05 and 1.07 to compatibility with DAS firmware versions 1.09 or 1.11. Order 062-6705-00 — **$75**
- **8K RAM Pack** — With lithium iodide battery back-up, used with 1240/1241. Order 12RS01 — **$300**
- **64K RAM Pack** — Lithium iodide battery back-up, used with 1240/1241. Must have firmware version 5-2 or higher. Order 12RS02 — **$500**
- **32K EPROM Pack** — Used with 1240/1241, EPROMs not included. Order 12RS11 — **$85**
- **32K EPROM Pack** — Used with 1240/1241, four 68764 or 68766 EPROMs included. Order 12RS12 — **$300**

RECOMMENDED CARTS
For DAS 9200, DAS 9100 and 1240/1241.

- **92 Cart** — AnthroCart for DAS 9200. Order 92 Cart — **$355**
- **K217 Cart** — See page 462 for complete description. — **$495**
- **Tilt Bail** — For DAS 9100. Order 348-0727-01 — **$36**
- **Rackmount Kit** — For DAS 9100. Order 016-0463-00 — **$200**
- **Rackmount Kit** — For DAS 9200. Order 016-0845-00 — **$450**
- **Rackmount Kit** — For 1240/1241. Order 016-0789-00 — **$400**

Accessory Pouch — Convenient for carrying manuals, and other accessories for 1240/1241 and DAS 9100 logic analyzers. Order 016-0707-00. — **$60**

** Not shown.*

SEMICONDUCTOR TEST SYSTEMS

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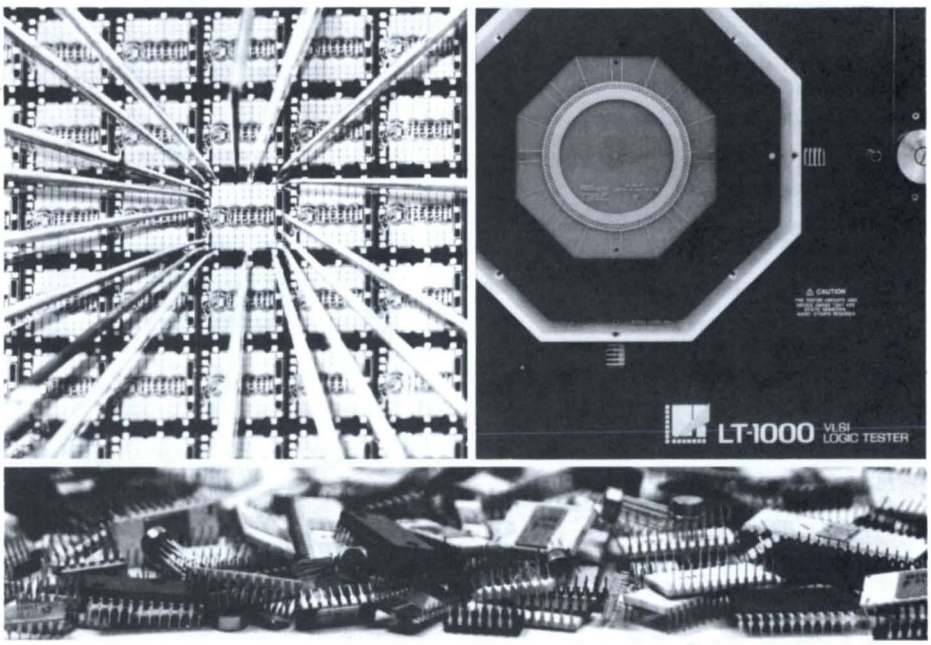


With the introduction of the LT-1000 VLSI Logic Test System, Tektronix Semiconductor Test Systems Division initiates a new era of cost-effective production testing of high speed, high pin count VLSI circuits. With all new hardware and software designed "from the ground up," this is the first system from Tektronix developed specifically with production priorities uppermost in the minds of the designers.

Tektronix test systems are known throughout the electronics industry for their innovative solutions to the latest testing challenges. Each successive generation of semiconductor devices boasts higher speed, more pins, more functions per chip, and more complex testing requirements. With the LT-1000, Tektronix STS again meets the new challenges of the industry with a new approach to the complexities of production test. Backed by the same commitment to excellence as other Tektronix products, this new system offers time saving features in such critical areas as program development, device handling and test, system calibration, and maintenance while lowering capital equipment costs through creative economy of design.

While the LT-1000 marks a dramatic departure from the architecture of the previous Tektronix systems in the S-3200 product line, it also represents a new chapter in a continuing effort to anticipate and fill the needs of the evolving device-testing market.

In the beginning, our first generation automated semiconductor tester was designed to test the largest LSI devices in use at the time (four- and eight-bit microprocessors, 1K memories, and peripheral chips). Later systems offered improved device characterization and were designed for quality control in production test environments. Next we tackled the challenge of testing high speed logic and solving the unique problems associated with subnanosecond technologies. Then, we offered a full range of production-oriented enhancements to truly put Tek quality into production. And now, with the LT-1000, Tektronix offers a cost-performance breakthrough in the testing of high speed, high pin count, application-specific ICs.

Tektronix provides the hardware, software, training, and applications engineering support to solve today's testing problems, and tomorrow's as well. New and unusual device parameters are viewed as a challenge to our resources, not as insurmountable problems.

Every Tektronix system, whether it's one of the field-proven S-3200 products or the innovative new LT-1000, is designed with the user in mind. The S-3200 Series testers use TEKTEST® software, an easily learned and manipulated language with many powerful capabilities for easy test program generation and debugging. The LT-1000 software is a powerful, menu-driven language set that can interface directly with CAE design sources and runs on hardware independent of the tester and devoted exclusively to program development.

All Tektronix systems feature highly sophisticated data reduction and graphics, which make the test results manageable and easy to understand.

We offer analog and digital capability to meet the new test requirements presented by new and increasingly complex devices. In fact, many "captive" device manufacturing facilities use Tektronix systems for just this reason. Tektronix is also a device manufacturer and has been testing its own ICs and hybrids for years. As a company, we have developed expertise and in-depth understanding of complex testing.

At Tektronix, we've built on our past experience and knowledge about device testing and tester design to create products that can help you meet your testing challenges—today and in the future.

NEW LT-1000

VLSI Logic Test System

Optimized for High Speed, High Pin Count ASIC Devices

Reduced Production Cost-Per-Test

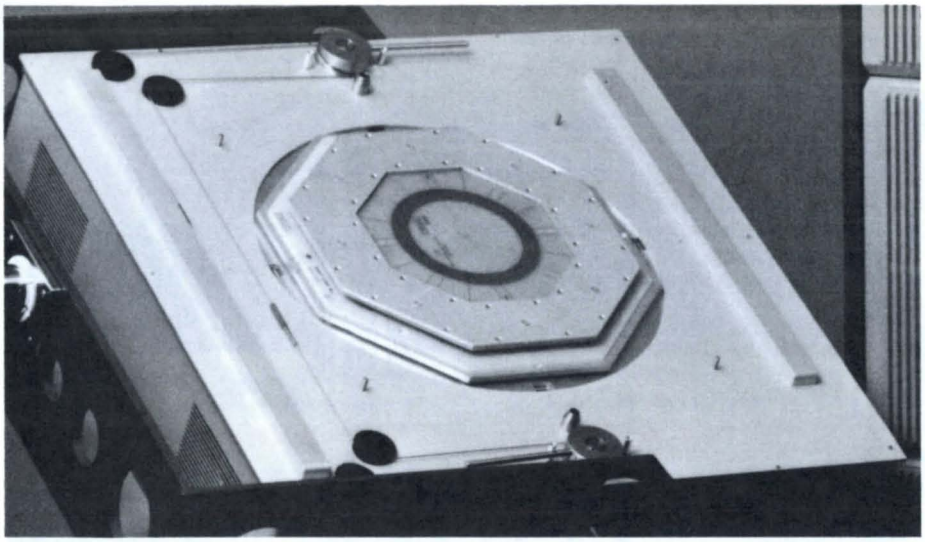
Independent Auto-Calibration

Rapid Off-Line Program Development

The LT-1000 VLSI Logic Test System represents a price performance breakthrough for high-speed, high pin count ASIC device testing in the production environment. Each component, hardware and software, was designed for maximum efficiency and reduced cost per test. By balancing the tester per pin and shared resource requirements in the system's integrated pin electronics, the cost and size of hardware in the LT-1000 is kept at a minimum. Test head fixturing and interfacing capabilities are designed for maximum throughput.

Unique approaches to system calibration and program development using system-independent support units maximize the utility of those units and eliminate costly redundancy. All of these features translate into savings in all of the critical production test cost areas: initial capital investment, device handling and testing time, program development time, and set-up time between runs, as well as routine and unscheduled maintenance.

TEK VLSI LOGIC TEST SYSTEM



The innovative system architecture and software of the Tektronix LT-1000 VLSI Logic Test System, along with the system's unique support units, were strategically designed for high volume testing of application specific VLSI circuits. The LT-1000 meets all the production testing and incoming inspection requirements for gate arrays, standard cell IC's, custom and semicustom devices, at a price substantially lower than the general purpose testers commonly used in these applications.

The LT-1000 VLSI Logic Test System is capable of testing the ac, dc, and functional performance of VLSI circuits with up to 256 pins at speeds up to 50 MHz. The system was optimized for the demands of CMOS technology, but with sufficient flexibility to be adapted to other processes as well.

The LT-1000 VLSI Logic Test System is made up of the LT-1000 Test Station, supported by the LT-PDS Program Development Station and the LT-ACS Auto-Calibration Station. The PDS is used to access data from design databases and to write and debug test programs. The ACS uses external instrumentation to quickly and accurately perform system verification and calibration routines. A key to the system's economy is the sharing of system's support units' capabilities among a number of Test Stations.

The LT-1000 Test Station design is based on a 'mixed" architecture that combines the strengths of both tester-per-pin and shared resource architectures. The DUT interface circuitry required at each device pin (including drivers, comparators, timing generators, and data formatters) is condensed into two custom CMOS monolithic integrated circuits. This approach requires less hardware which, in turn, results in a more compact, more maneuverable test head, lower hardware costs, and higher reliability.

Dc parametric test times are reduced by making simultaneous parametric measurements on multiple pins. Up to 32 Parallel Parametric Measurement Units may be configured in each test head, one for every 8 DUT pin channels.

The modular test head contains up to 256 I/O channels that may be split into four 64-pin segments for testing four devices in parallel. For applications where multiple test heads are required, a second test head is available as a system option.

The compact design of the test head allows positioning on any axis for mounting to commercial manipulators or adaptation for manual insertion. The test head interfaces to a variety of wafer probers and automatic device handlers for high throughput, and fixturing can be changed quickly and easily to save time between production runs. Positioning keys and locking devices make such changes virtually error-free and ensure high integrity signal transmission.

The test head is linked to a double-width, short-frame system support rack that houses the system controller and the shared-resource components, which provide the signals, voltages, and instructions to the DUT through the test head pin electronics. Each function provided by the rack was designed for maximum economy and maximum throughput. For example, throughput is enhanced by 256K pattern memory which is loaded through a fast direct memory access (DMA) channel to a MicroVAX II (TM) computer. The MicroVAX II is configured with 2 MBytes of memory, a 31 MByte hard disk, and GPIB and Ethernet interfaces.

LT-PDS Program Development Station

The LT-PDS is an advanced programming workstation that links directly to the design workstation. An automatic test program generator running on the PDS converts test vectors and other data extracted from CAE design databases. These are combined with user inputs into a test program using predefined test program skeletons and rules specific to the process technology being tested.

A highly interactive, multiwindow, bit-mapped environment allows the test engineer to fine tune programs quickly and efficiently using intelligent editors and graphical debugging aids such as timing diagrams. These programming tools reduce test development time to a matter of hours instead of days or weeks, which results in dramatic time and cost savings. And, to ensure maximum utilization, a single PDS may be used to write and debug programs for several test stations.

LT-HOST

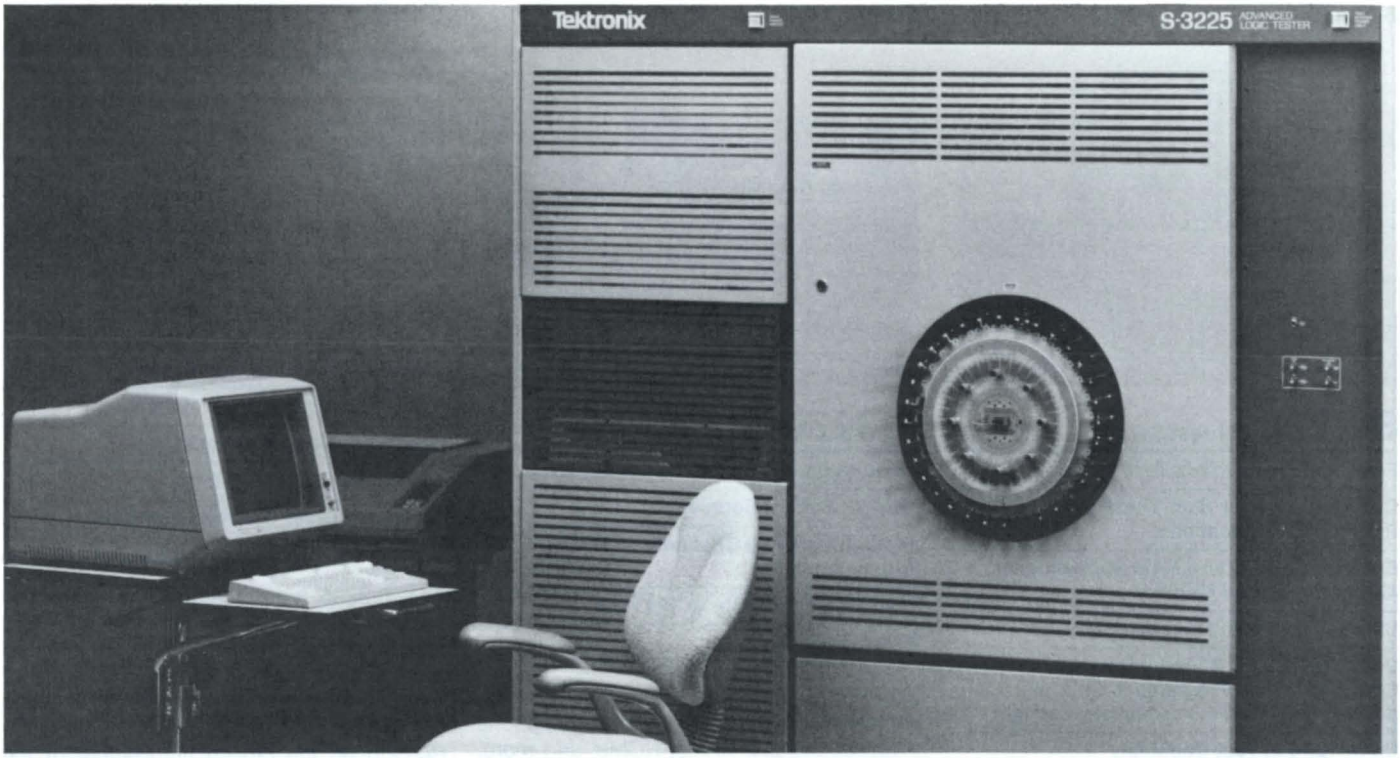
An optional system host called LT-HOST may be added to the Ethernet network which links the Program Development Stations and LT-1000 Test Stations. The LT-HOST provides centralized data storage, and test data analysis, data reduction and test floor management software, all running on a VAX/VMS CPU.

LT-ACS Auto-Calibration Station

The LT-1000 ACS provides microprocessor-controlled external instrumentation for fast and accurate system calibration. Physically linked to the test head during calibration, the ACS uses a single, retractable probe and one signal path to measure system timing, skew, and dc parametric performance. The ACS is controlled by the LT-1000 central processor during calibration and communicates tabulated data back to the system for interpolation and error correction.

A system verification procedure examines the system for gross failures and deviations from published specifications. A fully automatic calibration procedure brings the system up to specified performance levels without manual service adjustments. The ACS is capable of probing the actual DUT fixture, ensuring a fully corrected signal path to the DUT pin.

The accurate, efficient verification and calibration procedures of the LT-ACS save valuable production test time and result in higher yields. And, as with the PDS, a single ACS unit can service many LT-1000 testers for additional hardware cost savings.



S-3225

Advanced Logic Tester

Specifically Designed for Advanced Schottky-TTL and HCMOS Technologies

High Speed Driver Features 1 V/ns Slew Rate

Seven-Phase Programmable Clock With 125 ps Edge Placement

External Fixturing Site Offers a High-Fidelity Interface Point for Handlers and Probers

The S-3225 Advanced Logic Tester is a production test system designed to provide the full range of capabilities required for thorough Advanced Schottky TTL and High Speed CMOS device testing. This versatile system encourages a test strategy based on accurate and exhaustive production testing, in the belief that superior accuracy produces higher yields. The S-3225 can perform thorough device tests that eliminate the risk of passing marginal parts while ensuring that all passing devices meet very tight guardband tolerances. Although the S-3225 is aimed at high-throughput applications, such as production QC and receiving inspection, its high performance meets the stringent demands of the engineering characterization lab.

The standard system package consists of a vertical test station mated to an integral rack bay that houses the system controller and stimulus equipment. The "carousel" within the test station accommodates up to 64 D25 pin electronics cards, each supporting a single DUT I/O pin. The new D25 is the "front end" of the S-3225, since it interfaces directly to the DUT and provides the exacting electrical performance required by the emerging families of high-speed logic—AS-TTL and HCMOS. The D25's high slew rate (greater than 1 V/ns) and its wide dynamic range (−2 V to +8 V programmable range) are capabilities essential to meaningful testing of high-speed devices.

The system's seven-phase (14 phases optional) timing generator has 125 ps edge placement programming increments, placing the S-3225 at the top of its class in timing accuracy. Other standard features yield not only accuracy, but also outstanding throughput performance. The Parallel Parametric Unit, for example, implements dc measurements on all DUT pins simultaneously. And the Single-Shot Time Measurement System allows ac measurements such as *propagation delay, access time,* and *set-up/hold time* to be made in a single pass, saving time-consuming "iterated-strobe" measurement steps while enhancing accuracy (the resolution of measurements made with the S-STMS is 50 ps).

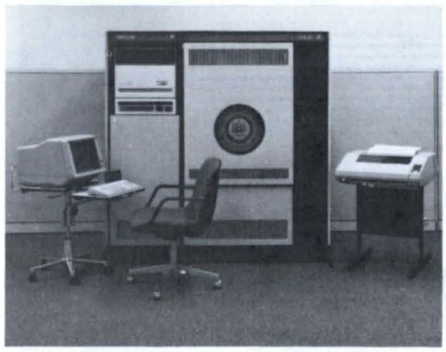
Special provisions for efficient interfacing to automatic device handlers and wafer probers are fundamental to the S-3225's production test capability. The system has a production-optimized *External Fixturing Site* that allows fast and easy fixturing changeovers and preserves the integrity of the critical driver/comparator signal path. This is accomplished by extending the controlled-impedance portion of that path outside the system housing, so that it directly mates various automated device handlers. Interface cabling to these external devices is minimized or eliminated. Conventional (horizontally-oriented) wafer probers that require a cable interface to the S-3225 also benefit from the system's ability to provide full-spec driver/comparator performance into cable interfaces as long as 18 inches.

For those applications requiring full clock rate device testing at speeds up to 200 MHz, the Fmax Test Option furnishes a separate, high-quality 50 ohm path to route signals to and from external GPIB-controlled instrumentation. This path is used to connect chosen DUT pins to pulse generators, counters, and sampling equipment to allow those pins to be monitored at their full functional speed. The Fmax Test Option is another unique attribute that makes the S-3225 a superior production test system.

The S-3225 uses the familiar TEKTEST III Operating System/Test Language that provides self explanatory high-level test constructs, enabling users to come quickly "up to speed" with their device test programming skills. Of course, programs written in TEKTEST III can be transported easily between all Tektronix S-3200 Series systems, with only minor hardware-related modifications required for most applications.

With speed and accuracy that meet the challenge of the fastest Advanced Schottky-TTL and High Speed CMOS devices, and high-throughput features for volume testing, the S-3225 has the right mix of features for a tough testing job. From any perspective, the S-3225 is a unique solution to high-performance production testing.

S-3220



S-3220 LSI Test System

Full Capability 20 MHz Test System

Cost-Effective for High-Throughput Production Applications

Enhanced 1K Pattern RAM Supplements 4K per Pin Stored Memory

Single-Shot Timing Measurement

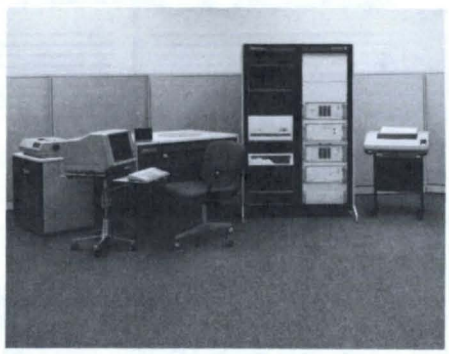
Uses TEKTEST®, Allowing Device Characterization Programs to be Condensed and Used in Production Testing

Up to 128-Pin Test Capability

The S-3220 is offered as a production-oriented complement to the Tektronix S-3270 Test System. Since the S-3220 uses the TEKTEST control software used in all S-3200 systems, programs originally developed for engineering use can easily be condensed and employed in a high volume production or incoming inspection environment. The essential test related features of the larger systems are retained in the S-3220, allowing (with no loss in speed or accuracy) functional or pattern testing as well as dc parametric and single-pass ac parametric testing.

The S-3220 is configured with a vertical pin-electronics package that is integrated with the control/stimulus equipment rack. This feature eases prober/handler mechanical interface and reduces floor space requirements—an important consideration in most production areas.

S-3270



S-3270 LSI Test System

Uninterrupted Error Storage at 20 MHz

Multiple Pattern Sources

14 Programmable Channels of Timing Information

Test Devices with Up to 128 Pins

Single-Shot Timing

The S-3270 System tests LSI, microprocessors, analog and digital hybrids, peripheral interface circuits, RAMs, ROMs, and more. Designed to deliver test results on the devices you see everyday, it is also built to deliver results when new devices appear.

With the S-3270, you can perform functional tests at speeds up to 20 MHz. When you must test a microprocessor at its optimum speed, you need the S-3270.

When testing one of the new, fast devices with the S-3270, you will not have to stop the test to log an error. The S-3270 keeps right on testing while it catches the error and records its location. Input/Output switching may also be performed at a clock rate of 20 MHz.

The system has 64 pin electronic cards, each with input and output capability, so you can test a device with up to 128 pins. The 14-phase clock gives you many programmable channels of timing information, to properly and effectively test devices. For total flexibility, the S-3270 features independent control of logic level definition at each driver and receiver. You set the logic level on every input and output channel, so you are not bound by the limits of the system.

The unique Single-Shot Time Measurement technique allows you to make a measurement with 50 ps resolution in one iteration. Dynamic measurements can also be made by moving strobes (iteration) or by using the optional waveform digitizer.

S-3295

S-3295 VLSI Test System

High Precision for Characterization

High Throughput for Production

256 Channels, 128 I/O Pins

Advanced Color Graphics and Data Reduction

The S-3295 was designed to meet the needs of the user who demands precision, reliability, and efficiency in an automated test system. The S-3295 offers a range of features for applications in the engineering lab as well as on the production test floor. Building on the proven architecture of the S-3200 series, the S-3295 incorporates significant advances in the areas of real time pattern generation, timing flexibility and accuracy, resolution, and functional test capability.

Subsystems within the S-3295 include the pattern processor, a powerful dedicated pattern computer; the multiset timing generator, which provides 16 sets of 16 timing phases, accurate 125 picosecond timing resolution, and split-cycle operation at all clock speeds; and the 1809 V test station that houses up to 64 D95 pin electronics cards with 2 input and 2 output pins on each.

D95 pin electronics cards contain the critical DUT testing capabilities of the S-3295. The signal drivers feature programmable rise time, low inhibit leakage, low aberrations, and wide bandwidth and are complemented by comparators of equal performance. These I/O pairs are backed up by 128K of local memory. Driver, comparator, and inhibit phases are automatically deskewed. Drivers can be multiplexed for an effective clock rate of 40 MHz for testing high speed devices. Programmable output loads eliminate the need for complex external load boards.

In the production environment, the S-3295's exceptional accuracy permits the use of narrow guardbands, thereby improving yields.

NEW

COMPUTER BASED INSTRUMENTATION

The Delta Series system occupies a minimum amount of floor space. Here, a user tests an application-specific IC (ASIC) using Tek-developed Visual Interactive Access (VIA) Software.

Delta Series VLSI Test Systems

24 to 96 I/O Pins Available to Test up to 196 Pins

Link to CAE Systems Simulators

Modular, VME-Based Architecture

20 MHz Data Rate

Provides Timing Margin Tests With 100 ps Resolution

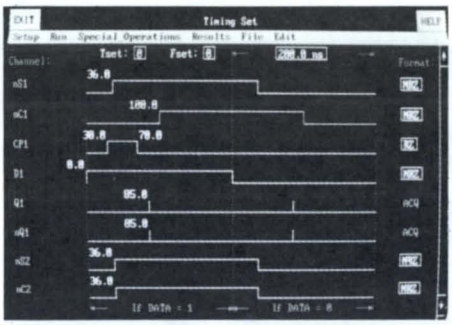
The Tektronix Delta Series has incorporated state-of-the-art instrumentation into modular, plug-in cards, each with its own on-board computer, and integrated them within a compact, low-cost system compatible with major hosts and workstations.

The Delta Series allows the design engineer to test and verify semicustom VLSI prototypes personally, interactively, using the same resources and user interface as in the design process itself.

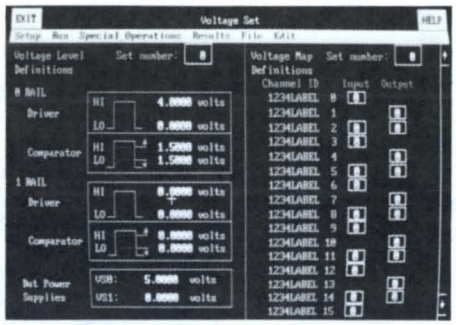
By downloading test vectors from the data base and by utilizing levels of accuracy never previously achievable at the workbench level, designers can conduct *functional tests* (to determine the existence and origin of chip failure) and *timing margin tests* (to evaluate how well the device works and how well it integrates within the larger system).

The Delta Series' Device-Under-Test (DUT) interface is easily reconfigurable to accommodate common IC packaging formats.

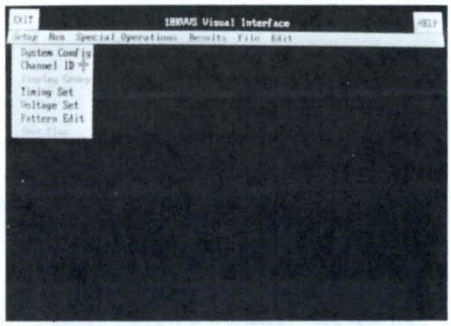
NEW



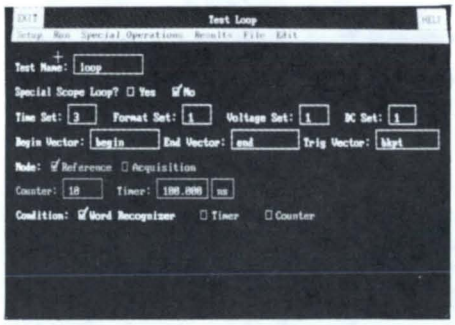
With the Timing Setup Screen, the user can define format and clock edges associated with pattern generator/signal conditioner, force, compare and clock signals.



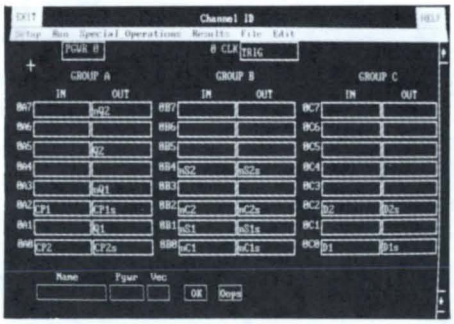
The Voltage Setup Screen is used to specify voltage levels of the programmable power supply and to make DUT-to-power supply rail assignments.



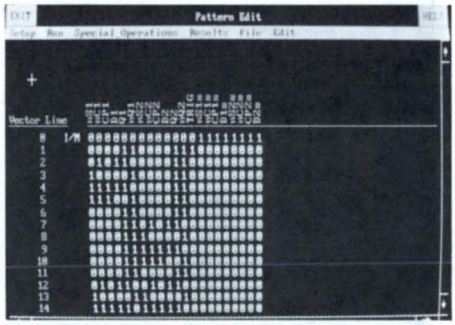
From the Main Menu, the user can select the modes of operation: SETUP, RUN, SPECIAL OPERATIONS, RESULTS, FILE and EDIT. Multiple drop-down menus are used to implement specific functions. Pop-up message windows provide help or indicate status.



The Test Loop Screen is used to build a simple loop test through the VIA interface. It allows the user to implement a common DUT test without having to write a VME-based C test program.



The Channel ID Setup Screen in used to assign logical DUT pin names to physical hardware test channels.



The Pattern Edit Screen is used to view and modify the .vec file found within the VME test data base. Because the test program can select specific ranges of vectors for loops, single pass programs, etc., the .vec file does not necessarily correspond to the vector loaded at test execution. This screen is aimed specifically at modifying the .vec test setup file.

VLSI TEST SYSTEMS

System Description

The Delta Series VLSI Test System was designed for ASIC and commodity test requirements.

Coupled with an ASIC Design Workstation, (such as from CAE Systems Division of Tektronix), the Delta Series can be used to cost-effectively verify performance of ASICs after fabrication by the foundry. Time-saving and effective software, such as CAELink, allow the user to utilize the simulator files developed on the Design Workstation to generate test vectors for the IC.

In the commodity IC application area, the Delta Series can be configured with industry-standard Test Head manipulators, and interfaced with many different device handlers.

Both types of testing can take advantage of the Delta Series concept of modularity, expandability and ease-of-use.

Modularity

The Delta Series was developed with a modular hardware and software approach. The hardware modules include the Test Head and Device-Under-Test (DUT) electronics, the signal conditioning section, instrument modules and VME-based system controller.

The software modules include the Unix-like Uniflex operating system, C Compiler, Test Program Utilities, and VIA (Visual Interactive Access) software.

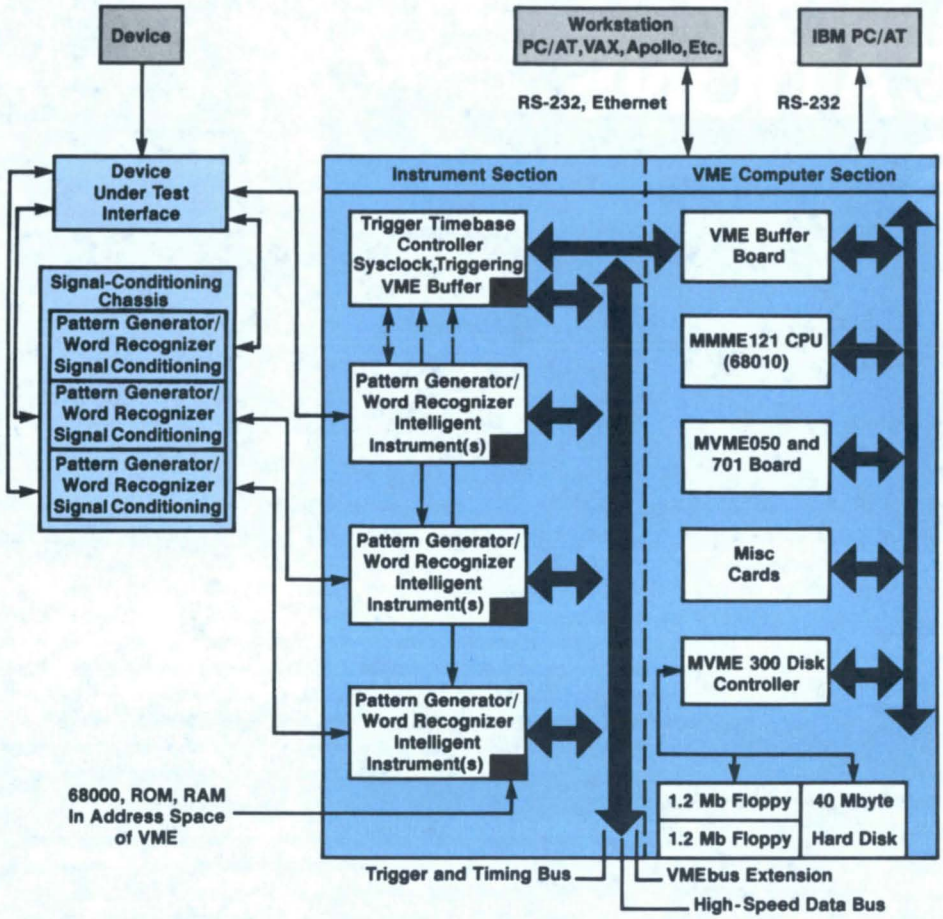
Expandability

Because the Delta Series is modular, it offers the user the capability of upgrading the system later as new technology and interfaces become available. Additionally, as test requirements change, the system may be upgraded to test a high number of pins (up to 192 pins—96 I/O) with upgrade kits available from Tektronix.

Ease-of-Use

The Delta Series is a high-powered, sophisticated tester designed by Tektronix to be easy and quick to learn and used by technical personnel. This is made possible by a unique Tektronix-developed software program called VIA (Visual Interactive Access).

NEW



CBI ATE systems that are designed to test very large-scale integration (VLSI) components require human interface solely at the system keyboard. All computer control passes through the VMEbus. The high-speed data bus handles communicatons between IOCs. The trigger and timing bus controls synchronization between the IOCs. The 6800 microprocessor included with each instrument function is powerful enough to allow users to attach a dumb terminal and run each instrument function separately.

CAE Systems Translator Software (10Z280)

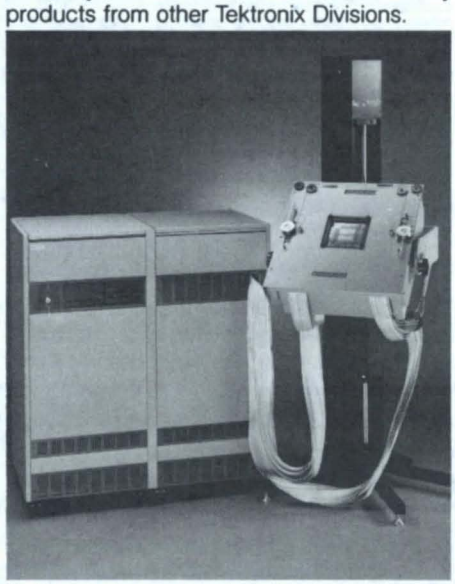
The 10Z280 CAELink is designed to link the simulator data base with the Delta Series Tester. It runs on the VME System controller in the Delta Tester and accesses the files from the system disk storage unit. The design data base may be transferred over RS-232, or for greater speed, via the optional Ethernet network interface.

Easy to Learn, Easy to Use

The design engineer simply transfers the design data file into the Delta system, starts the CAELink translator software and begins generating the test program. The user interface is the Delta System's user interface on the IBM PC/AT. The VIA is a menu-driven, graphics-oriented, mouse based software which greatly speeds test program generation and execution.

Fits the Data to the Tester

The translator will convert the user's vector file into an events-driven format, which is then sampled with tester specific constraints, into a sampled format. During this conversion the time period of the vectors is fit into the constraints of the tester as closely as possible. Any incompatibilities between the simulator vectors and the capabilities of the tester are flagged and processed by the user. The formats defined by the CAELink are also used by products from other Tektronix Divisions.



System can be configured to interface with device handlers.

Device Handlers and Positioners

Tektronix, through the modular design approach, offers a Delta Version compatible with industry-standard device handlers and positioners. This version is suitable for applications where maximum device throughput is important. Contact Tektronix for complete information.

ORDERING INFORMATION

VLSI Test System

10S24 24 I/O Pins	**$60,000**
10S48 48 I/O Pins	**$90,000**
10S72 72 I/O Pins	**$120,000**
10S96 96 I/O Pins	**$150,000**

OPTIONS

Option 05 — GPIB Interface.	**+$2,500**
Option 06 — Ethernet Interface.	**+$6,000**
Option 07 — Additional 1 Mb of RAM.	**+$1,500**
Option 09 — Streaming Tape.	**+$2,500**
Option 10 — 140 Mb Hard Disk.	**+$5,000**

SOFTWARE

10Z280 CAELink	**$4,000**

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Communications Products are quality instruments designed to test, time, measure and monitor a variety of television, RF, fiber optic, and data communications network signals.

Electronic communications continue to impact mankind through newer and better equipment and applications. We are proud to be at the leading edge of these new technological opportunities. Here are a few examples:

Spectrum Analyzers
In the last year, the Tektronix Frequency Domain Instrumentation (FDI) division introduced nine new spectrum analyzers and added EMI testing capability to the TekSPANS® software line.

The communications industry demands high performance analysis both in the lab and in the field. To meet the needs of the industry, we offer the 490 and 2750 Series covering baseband frequencies through 325 GHz. Just introduced, the low cost, portable 2710 offers unprecedented measurement convenience and covers frequencies from 10 kHz to 1.8 GHz.

To meet the needs for system automation and remote site control, we offer GRASP, first in TekSPANS' family of spectrum analyzer software. GRASP improves the accuracy, repeatability and the speed of the 490 and 2750 Series spectrum analyzer measurements and supports a variety of popular controllers. EMI software, also used with the 490 Series and 2755P Spectrum Analyzers, economically automates VDE, FCC, and MIL-STD tests.

Because of your need for measurement versatility, we offer the 7000 Series spectrum analyzer plug-ins. These easy-to-use plug-in models cover 20 Hz to 2.5 GHz, with individual ranges appropriate for applications from audio/baseband to microwave measurements. A variety of features let you select the capability you need. They share the versatility that is basic to the Tektronix plug-in concept—there are over 30 other test and measurement plug-ins.

To meet your demand for high performance millimeter applications, we offer the WM 490 Series of waveguide mixers. Calibrated amplitude and frequency measurements from 18 GHz to 325 GHz are made possible when coupled with the 490 Series and the 2755/2755P spectrum analyzer.

Television
The Television Products Division continues to meet the market's needs for high performance and low cost test, measurement, and monitoring equipment. Introduced this year, the 1720 Vectorscope and 1730 Waveform Monitor offer more performance than the products they replaced or the competitive products on the market, and at a lower price. See page 138. Also in the high performance/low price arena is the newly introduced TSG-170A Test Signal Generator and the SPG-170A Sync Generator. See page 143.

More and more television stations are broadcasting programs with stereo audio. Helping them achieve and maintain audio quality are the 751 BTSC Aural Modulation Monitor/Decoder, the 760 Stereo Audio Monitor, and the AVC-20 Audio Vector Converter. See pages 145 and 146.

Component television technology continues to impact the television industry. Fulfilling the needs of this emerging technology are three new component products from Tektronix. The WFM-300 Component Analog Waveform Monitor, with its innovative "Lightning" display (see page 142), the TSG-300 Component Analog test signal generator featuring the unique Bowtie gain and timing test signal (page 142), and the 650HR-C Component Picture Monitor (page 149) are all presented in this catalog.

Communication Network Analyzers
The new 836TV Analyzer provides a cost-effective, time-efficient tool for installing, testing, and maintaining equipment that uses the EBU/SMPTE interface recommendation developed jointly by the European Broadcast Union (EBU) and the Society of Motion Picture and Television Engineers (SMPTE) to define and standardize a remote-control system for television production equipment such as video tape recorders, audio tape recorders, production switchers, editing systems, etc. See page 153.

TELEVISION PRODUCTS

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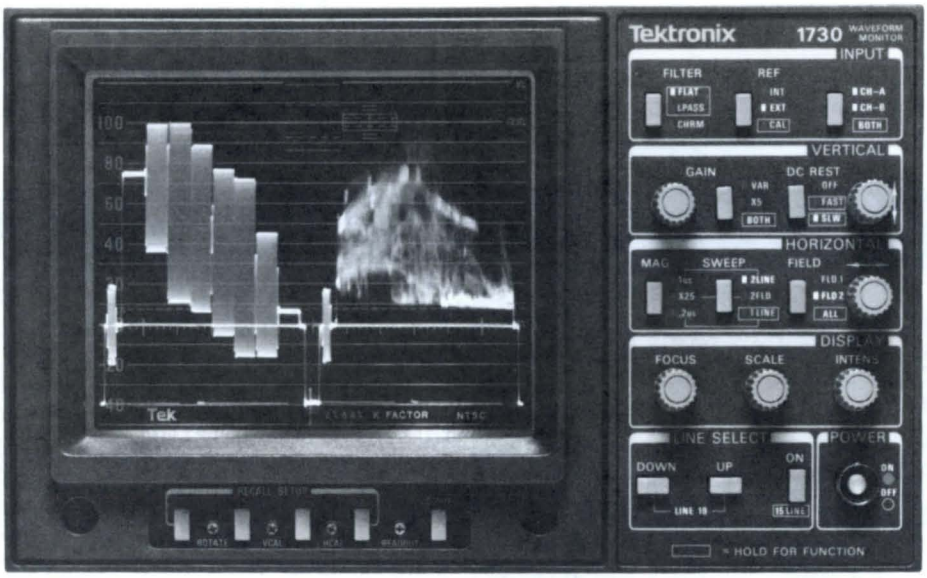


1730 Waveform Monitor—Simultaneous Channel A and B Display.

NEW 1720/1730

- Performance and Economy
- Complete Line Select
- Simultaneous Channel A and B Display
- Dual Filter Display
- One Button Front Panel Recall
- Differential Phase and Gain Measurement
- Stereo Audio Phase Measurement
- RGB/YRGB Display Capability
- Vector Center Dot Clamping
- Parallax-Free Internal Graticules
- Portable Dc Power and Battery Available
- Remote Control Capability
- Available in NTSC and PAL Standards

The Tektronix 1730 Series Waveform Monitors and 1720 Series Vectorscopes provide a new dimension in television signal monitoring for both NTSC and PAL applications. These versatile new instruments are lightweight, half-rack width, and have bright CRTs for comprehensive video signal monitoring. Both instruments exceed normal monitoring capabilities. Their unique features make them even more powerful when operated in tandem. Each monitor has its own advanced feature set and the proven 1700 Series family performance to provide more monitor for the money. These new monitors do the job faster, better, and easier at a new low price.

Complete Line Select

The 1730 Series Waveform Monitor has full frame line select, with alphanumeric readout that can be tracked by the 1720 Series Vectorscope when in Auxiliary mode. Any one or two lines of the entire frame can be selected and displayed, or the same line(s) in both fields can be viewed at one time. An intensified zone in the two-field sweep and on the picture monitor output signal indicates the location of the line selection. In addition, any successive 15 lines can be overlayed for camera and VTR adjustments.

Simultaneous Channel A and B Display

These new instruments have state-of-the-art microprocessor front panel control. They are operator friendly and provide new features in half-rack waveform monitors or vectorscopes. Both the 1730 Series Waveform Monitor and the 1720 Series Vectorscope have dual channel display capability, allowing both input channels to be displayed on the CRT simultaneously.

Dual Filter Display

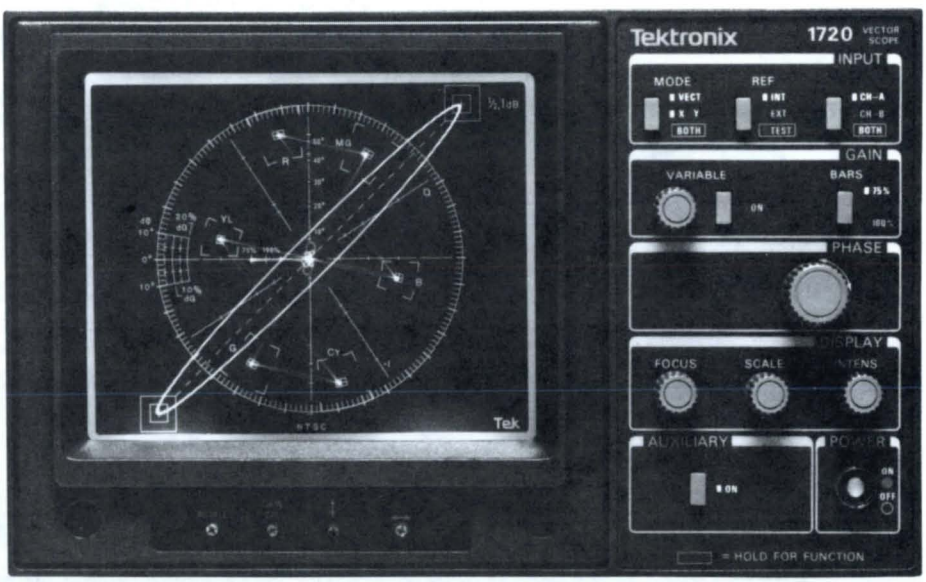
The 1730 (NTSC) and the 1731 (PAL) Waveform Monitor include dual filter display, which provides low pass and flat information in the same display. The 2-Field and 2-Line Display Modes have the Low Pass Filter applied to the left half of the trace. In the 1-Line Mode, the two signals are overlayed. These filter modes can also be used independently. Both versions of the 1730 Series have chroma filters centered around the subcarrier frequency.

One-Button Front Panel Recall

Once the front panel has been set up in a frequently used mode, the configuration can be stored for later one-button recall. In addition, when the 1720 is used in tandem with the 1730, it will respond to this Store/Recall operation. Up to four operator-selected front panel configurations can be stored from the front panel. Four other front panel configurations are factory-programmed settings and are accessible from the Remote Control interface.

Differential Phase and Gain Measurements

The 1720 Series Vectorscope graticule has scales for measuring Differential Phase and Gain. The Differential Phase scale has markings at 2° intervals. The Differential Gain scale has markings at 5% intervals. For even greater precision, the 1720 and 1730 Series can be coupled for using the field or line sweep on the 1730 Series Waveform Monitor. The Waveform Chroma filter can be used for differential gain measurements.



1720 Vectorscope—Vector and Stereo Audio Dual Display Mode.

Stereo Audio Phase Measurements
Balanced inputs for the X-Y mode are available on the 1720 Series Vectorscope through a separate input connector. This mode is particularly useful for evaluation of stereo audio using a special X-Y graticule scale for both amplitude and phase measurements. X-Y measurements can be displayed individually or in combination with a vector display. This input can also be used for other applications where X-Y monitoring is useful.

RGB-YRGB
The Waveform Monitor can display RGB or YRGB staircase. The RGB/YRGB staircase input is through a rear panel connector.

Vector Center Dot Clamping
These new vectorscopes employ center dot clamping in Vector mode for easy detection of residual subcarrier on the signal. In addition, with no signal present, the center dot automatically dims, prolonging the CRT life.

Parallax-Free Internal Graticules
Both instruments utilize post-accelerated, mesh-type CRTs equipped with internal graticules to provide parallax-free displays. Variable, evenly-illuminated scales, along with molded bezels, make waveform photography a snap.

Portable Dc Power
In addition to being ideal for camera control units and video tape recorders, these instruments can be equipped with cabinet and field upgrades allowing them to operate from a 12 V dc source for portable operation. They can be used with the Tektronix BP1 or other 12 V supply. Coupling this dc operation with their light weight (about 9 pounds, including cabinet), low power consumption, and compact size make these instruments well suited for use on a portable production cart.

Remote Control
Internal front panel presets, RGB/YRGB enable, along with front panel recall/setup can be accessed through the Waveform Monitor Remote connector.

Available in NTSC and PAL
Both the 1730 Series and the 1720 Series are available in either NTSC or PAL versions. The 1721 Vectorscope and the 1731 Waveform Monitor are the PAL versions. The 1735 Waveform monitor provides PAL/NTSC Dual Standard Monitoring. Pal-M instruments are available as a modified product.

ORDERING INFORMATION

When ordering, please use exact nomenclature given here. **The standard instruments are shipped without a case or handle.** If your application is for bench or portable use, please order the appropriate enclosure from the optional accessories list. The 1720, 1721, 1730 and 1731 are UL-recognized components and meet the requirements for listing when used in the appropriate enclosure.

1720 Vectorscope (NTSC System Applications) **$2,250**

1721 Vectorscope (PAL System Applications) **$2,250**

1730 Waveform Monitor (NTSC System Applications) **$2,250**

1731 Waveform Monitor (PAL System Applications) **$2,250**

Portable Dc Powered Applications 17XX (from above) plus 1700F10 Dc Power Converter Kit, 1700F02 Portable Cabinet and BP1 Battery Pack

OPTIONAL ACCESSORIES

See 1710B Optional Accessories below.

For complete Television Product information, request the Television Products Catalog.

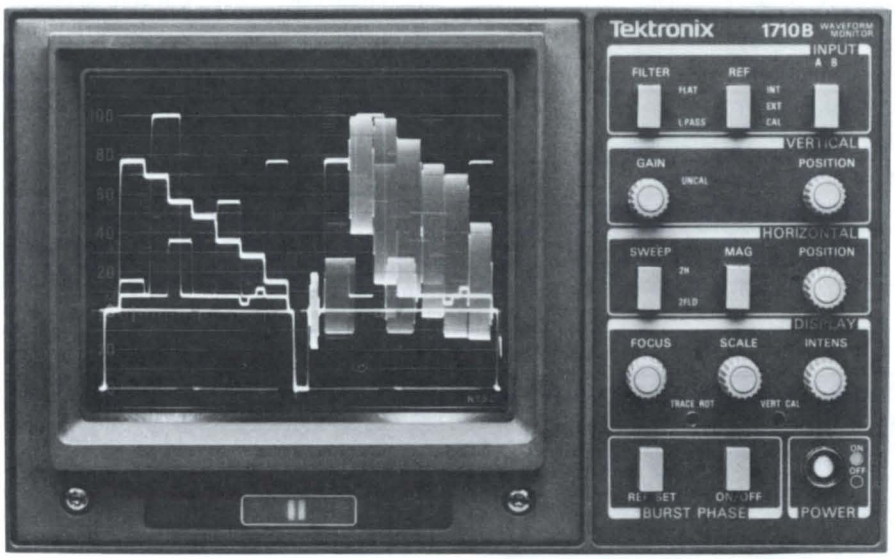
1710B Series Waveform Monitors

Cost Effective
Easy Operation
Burst Phase Indicator
Dual Filter Display
Half Rack Width
Bright CRT Display
Internal Graticule
Light Weight
Low Power Consumption
Dc Operation
Available in NTSC and PAL Standards

The 1710B Series waveform monitors provide all of the commonly used display modes. In addition, the 1710B Series adds relative burst phase indication and dual filter display. All of this in a cost effective package for the user who wants high quality at a low price. These monitors are mechanically compatible and retrofit into an existing system that uses half rack width, 5¼ inch waveform monitors.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	133	5.2
Height	214	8.4
Depth	429	16.9
Weight≈	**kg**	**lb**
Net	3.6	8.0



1710B Waveform Monitor—Dual Filter Display.

ORDERING INFORMATION

These instruments are configured for rackmounting and are shipped without cases or covers. Order appropriate optional accessories to configure for rack, bench or portable use.

1710B Waveform Monitor (NTSC System Applications) **$1,745**

1711B Waveform Monitor (PAL System Applications) **$1,745**

OPTIONAL ACCESSORIES 1710/1720/1730 SERIES

Cabinets —
(Plain) Order 1700F00 **$60**
(Portable) Order 1700F02 **$85**

Side-By-Side Rack Mount — For mounting two half-racks (1750, 528A, etc.) in a standard 19 inch rack. Order 1700F05 **$180**

Blank Panel Adaptor — For the side-by-side rackmount. Order 1700F06 **$60**

Viewing Hood — For high ambient light environments. Order 016-0475-00 **$10**

Cameras —
(Regular) C-5C Option 02. **$465**
(Automatic) C-7 Option 03. **$565**

Battery Pack — Requires 1700F02 case and 1700F10 dc operation kit. Order BP1 **$600**

Dc Operation Kit — 12 V dc. Order 1700F10 **$200**

For complete Television Product information, request the Television Products Catalog.

1740 Waveform/Vector Monitors with optional carrying case and battery pack.

1740 Series Waveform/Vector Monitors

Two Instruments in One
Optional Dc Power Capability
Bright CRT Display
R-Y (V-Axis) Mode
VITS Monitoring
RGB/YRGB Display Capability
Remote Control Capability
Available in NTSC, PAL, and PAL-M

Similar to the 528A and 1420 Series products, the 1740 Series provides all the basic waveform monitoring and vectorscope functions, but in a single, compact package. In addition, the 1740 Series adds dc power operation (optionally), single line vertical interval display which is internally preset, an R-Y/ sweep mode for differential phase measurements, and remote control of waveform/vector mode and most of the front panel sweep and vertical amplifier response functions.

The 1740's half rackwidth package allows easy installation where space and power requirements are important considerations. The 1740 is mechanically compatible with the 528A, 1710B, 1420 and 1750 Series instruments.

Typical applications include video signal monitoring in VTR bridges, camera control units, production switcher consoles, and in mobile vans and field productions.

ORDERING INFORMATION

These instruments are configured for rackmounting and are shipped without cases or covers. Order appropriate options or optional accessories to configure for bench or portable use. **Option 06 is recommended.**

1740 Option 01 Waveform/Vector Monitor (NTSC Applications) **$4,000**

1741 Option 01 Waveform/Vector Monitor (PAL Applications) **$4,000**

1742 Option 01 Waveform/Vector Monitor (PAL-M Applications) **$4,400**

OPTIONS

Option 06 — Composite internal graticule, waveform and vector. **+$30**

Option 07 — Adds dc power operation capability, must be installed during manufacture. **+$60**

Option 11 — Portable carrying case, dc power operation, and a BP1 Battery Pack. **+$650**

OPTIONAL ACCESSORIES

Cabinets —
(Plain) Order 1700F00 **$60**
(Portable) Order 1700F02 **$85**

Side-by-Side Rackmount — For mounting two half-racks (1740, 528A, etc.) in a standard 19 inch rack. Order 1700F05 **$180**

Blank Panel — For one half of the side-by-side rackmount. Order 1700F06 **$60**

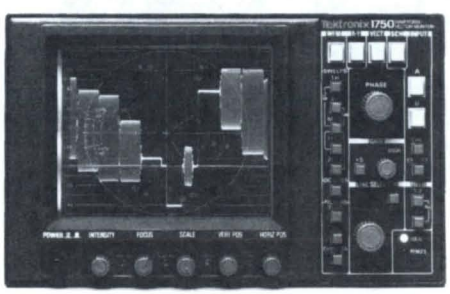
Snap-On Front Cover — High impact plastic. Order 200-1566-00 **$22**

Viewing Hood — For high ambient light environments. Order 016-0475-00 **$10**

Cameras — Use C-30 Option 01 with adaptor 016-0269-03, C-5C Option 02 or 04, or standard C-4 (see Camera Section of this catalog).

Battery Pack — (1740) Order BP1 **$600**

For complete Television product information, request the Television Products Catalog.



1750 Waveform/Vector Monitor—Dual Filter/ Simultaneous Display.

1750 Series Waveform/Vector Monitors

Two Instruments in One
SCH Phase and Color Framing
R-Y (V-Axis) Mode
RGB/YRGB Mode
Remote Control Capability

The Tektronix 1750 Series offers comprehensive monitoring and measurement of television signals, including SCH phase and color framing, in one compact unit. While similar in appearance to the 1740 instruments, the 1750 has enhanced performance in each of its operating modes.

The unique SCH phase display presents horizontal sync timing relative to reference subcarrier (burst) for verification of signal format and color framing. This mode enables easy analysis and monitoring of these important characteristics of the television signal; a task which previously required complex techniques, highly skilled operators and/or additional instrumentation. The 1750's SCH phase and color frame displays are derived from the standard composite signals. No extra pulses or added signal details are required.

The 1750's SCH capability makes it particularly valuable in production and editing environments where maintenance of SCH phase and color frame are critical considerations. Applications include VTR bridges, camera control units, switcher consoles, master control, mobile and field production units, and in maintenance operations supporting any of these areas.

The 1750's half-rack package allows easy installation in environments where space and power requirements are important considerations. The 1750 is mechanically compatible with 528A, 1710B, 1420, and 1740 Series Tektronix instruments.

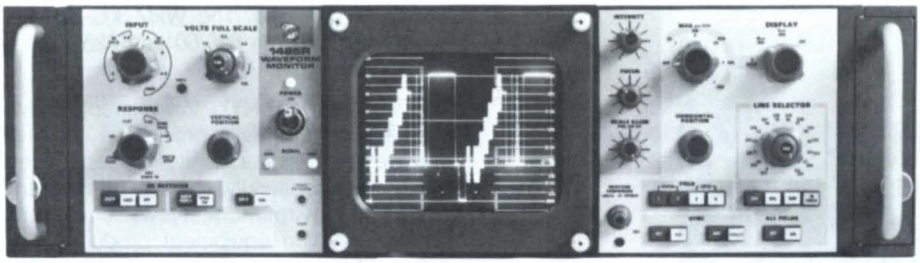
ORDERING INFORMATION

These instruments are configured for rackmounting and are shipped without cases or covers. Order appropriate optional accessories above to configure for rack, bench or portable use.

1750 Waveform/Vector Monitor (NTSC) **$6,050**

1751 Waveform/Vector Monitor (PAL) **$5,900**

For complete Television product information, request the Television Products Catalog.



1485R Option 01 PAL/NTSC Dual Standard Waveform Monitor (Rackmount).

1480 Series Waveform Monitors

Bright CRT Especially Suitable for Vertical Interval Testing

Advanced Measurement Modes

Amplitude Measurement Accuracy Approaching 0.2%

Digital Selection of Line and Field

Probe Input Option

15-Line Display for VTR Applications

Full feature capability for demanding video measurements in a range of applications

The 1480 Series was designed to meet the monitoring needs of CCU, VTR, control room, transmission facilities, transmitter and special systems with optimum accuracy, precision and performance. It features a variety of advanced measurement modes, amplitude measurement accuracy approaching 0.2%, plus an exceptionally bright CRT that's especially suitable for vertical interval testing . . . bright enough for one vertical interval test signal selected out of four fields to be seen with ease even in a well lit area. Digital selection of line and field assures positive identification of displayed information.

In addition to a 0.2% amplitude standard, the 1480 Series provides superior resolving power through calibrated five-times expansion of the vertical display, plus offset comparison and fine CRT spot size for making highly accurate amplitude measurements.

A unique overlay mode makes it possible to superimpose portions of waveform displays for exact, side-by-side comparison of levels.

Among many additional features are a probe input option, AFC sweep synchronization, selectable filters and 15-line display for VTR applications.

The 1480 Series is available in NTSC, PAL, PAL-M and NTSC/PAL Dual Standard versions.

PHYSICAL CHARACTERISTICS

	1480C		1480R	
Dimensions	**mm**	**in**	**mm**	**in**
Width	216	8.5	482	19.0
Height	210	8.3	133	5.3
Depth	430	16.9	457	18.0
Weights≈	**kg**	**lb**	**kg**	**lb**
Net	9.8	21.5	11.2	24.6
Shipping	24.1	53.1	24.1	53.1

ORDERING INFORMATION

1480C NTSC Waveform Monitor	**$6,300**
1480R NTSC Waveform Monitor	**$6,300**
1481C PAL Waveform Monitor*1	**$6,090**
1481R PAL Waveform Monitor*1	**$6,090**
1482R PAL-M Waveform Monitor	**$6,790**
1485C PAL/NTSC Dual Standard Waveform Monitor*1	**$6,300**
1485R PAL/NTSC Dual Standard Waveform Monitor*1	**$6,300**

OPTIONS

Option 01 — 1 MΩ, 20 pF Probe Input (not available with Option 06, probe not included). **+$300**
Suggested Probe: P6108A 10X, 2 m Probe; or 3 m Opt. 03 **$75**

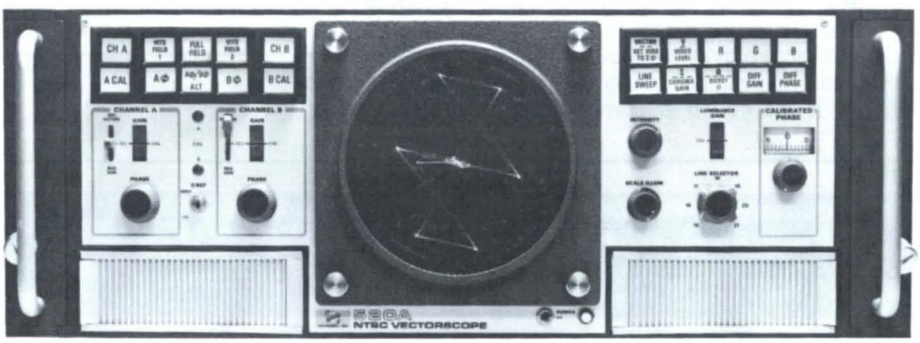
Option 06 — (1480R only) 124 Ω WECO Style Inputs. **+$2,075**

Option 07 — Slow Sweep*2 (Option 07 performance included with Option 06. Do not order with Option 06). **+$510**

Option 08 — (1481C, 1481R, 1485C and 1485R only) SECAM Field Identification. **+$315**

**1 1481C/R, 1485C/R meets European Broadcast Union Tech. 3221-E, Guiding Principles for design of Television Waveform Monitors.*

**2 Option 07 satisfies EBA Tech 3321-E § 3.2.2.*



R520A NTSC Vectorscope.

R520A Series Vectorscopes

Luminance Amplitude

Chrominance Amplitude and Phase

Precision Differential Gain and Phase

Outstanding accuracy and versatility in a video measurement vectorscope

The 520A Series offers advanced capability that enables measurements of the chrominance signal and distortions thereof to be made with a high degree of precision. It effectively complements the 1480 Series in applications requiring highly accurate measurements of luminance amplitude, chrominance amplitude and phase, differential gain, differential phase and other distortions.

The 520A Series provides polar coordinate displays with which to easily detect errors in color encoding, videotape recording and playback, or transmission processes that interfere with phase and/or amplitude relationships and lead to color errors in a television picture. Large phase shifts can be read from the parallax-free vector graticule, and a precision calibrated phase shifter is provided for measuring small phase shifts.

Differential gain and differential phase measurements can be made with accuracy to better than 1% or 1°. Using a trace overlay provides excellent resolution for measuring very small phase errors.

Other features include a voltage step-up termination option, VITS observation from front panel selected lines and dual vector display.

The 520A Series is available in NTSC, PAL and PAL-M versions.

PHYSICAL CHARACTERISTICS

Dimensions	**mm**	**in**
Width	483	19.0
Height	178	7.0
Depth	483	19.8
Weights≈	**kg**	**lb**
Net	15.0	33.0
Shipping	27.7	61.0

ORDERING INFORMATION

R520A NTSC Vectorscope	**$8,525**
R521A PAL Vectorscope	**$8,360**
R522A PAL-M Vectorscope	**$9,540**

For complete Television product information, request the Television Products Catalog.

TEK COMPONENT TELEVISION MONITOR AND GENERATOR

WFM-300 Component Television Waveform Monitor with Vector Display.

NEW WFM-300

Component Television Waveform Monitor

Electronic Graticule

Parade and Waveform Overlay Display

Vector Display

Bow Tie Timing Display

Color Gamut Limit Indication

Linearity Measurements

Y,P_b,P_r; Y,B-Y,R-Y; G,B,R; Y,Q,I Input Options

Lightning Display

625/50 and 525/60 Selectable

GBR Picture Monitor Output

A vector display of the color difference signals provides the traditional color bar vector display. The new Bowtie timing test signal from the TSG-300 component television test signal generator allows precise timing of three wire component television systems. This utilizes a channel 1 minus channel 2 and 3 mode to provide a side-by-side differential comparison (1–2, 1–3) of all three channels.

The input signal can be color difference or GBR, with optional accommodation for several color difference formats. All of these signal types are converted to GBR for a dedicated picture monitor output. The valid GBR gamut limit is monitored to ensure the operator is warned if a combination of signals is not valid. The WFM-300 can be configured for both 525/60 and 625/50 signal standards.

The versatile WFM-300 Component Television Waveform Monitor provides a comprehensive set of signal monitoring capabilities designed specifically for the component television environment. New component based television equipment produces signals quite different from the composite television signals, and the WFM-300 provides new monitoring capabilities to meet this challenge. An innovative new Lightning display provides amplitude and timing information for all three channels simultaneously, allowing the operator to set up equipment accurately and efficiently. The traditional parade display of three signals provides side-by-side comparison of all signals. In addition, any combination of the three signals can be overlayed for accurate comparisons. Both horizontal and vertical magnification can be applied for detailed inspection of the signal being observed.

ORDERING INFORMATION

When ordering, please use exact nomenclature given here. **The standard instruments are shipped without a case or handle.** If your application is for bench or portable use, please order the appropriate enclosure from the optional accessories list. The WFM-300 is a UL recognized component and meets the requirements for listing when used in the appropriate enclosure.

WFM-300 Component Television Waveform Monitor (525/60 operation) **$4,900**

OPTIONS

Option 01 — For 625/50 operation. **NC**

Option 10 — For BetaCam transducer. **+$120**

Option 12 — For YQI transcoder. **+$120**

TSG-300 Component Television Generator.

TSG-300

Component Television Generator

Multiple Formats Including RGB, SMPTE Parallel, Betacam, M

No Need for Test Signal Transcoding

Test Signal Complement Tailored to Component Systems

10-Bit, 13.5 MHz Digital Signal Generation

Compatible With 525/60 and 625/50 Systems

The versatile TSG-300 Component Television Generator provides direct digital test signal generation in a wide range of commonly used formats, without need for format transcoders. This flexibility, combined with simple operation and Tektronix signal quality, makes the TSG-300 the ideal choice for applications ranging from research and development to routine maintenance of new component-based ENG equipment. The TSG-300 test signal complement includes color bars, linearity, pulse and bar, and multiburst, as well as new component test signals.

ORDERING INFORMATION

TSG-300 Component Television Generator **$8,850**

For complete Television product information, request the Television Products Catalog.

NEW

SPG-170A NTSC Sync Generator.

NEW SPG-170A

NTSC Sync Generator

Digitally Generated RS-170A Black Burst

Digital Genlock

High Stability Subcarrier

Flexible Pulse Outputs

Pulse Timing Independent of Black

Remote Control Timing Presets

Remote Control ID Presets

Optional SMPTE Bars, ID, and Audio Tone

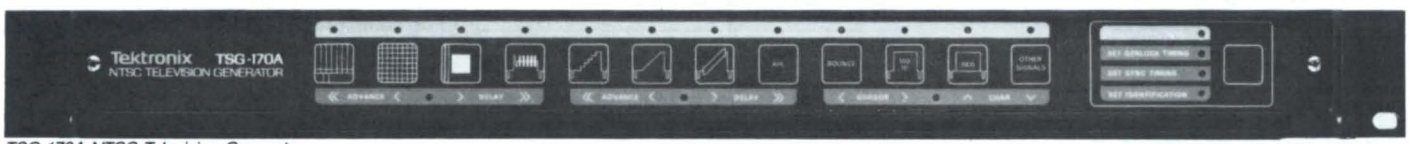
The SPG-170A sync generator offers all the features expected in a sync generator, plus the advantages of digital accuracy and system flexibility. Ideal for either master or slave generator operation, the SPG-170A features stable RS-170A performance and a rugged 1¾ inch package. The SPG-170A Option 01 provides even more versatility by adding SMPTE bars with programmable identification and audio tone.

ORDERING INFORMATION

SPG-170A NTSC Sync Generator **$3,300**

OPTION

Option 01 — SMPTE Bars with ID and Audio Tone Output **+$1,000**



TSG-170A NTSC Television Generator.

TSG-170A

NTSC Television Generator

Simple, Effective Test Signal Complement

RS-170A Sync Pulse Generator With Digital Genlock

Separate Timing Controls for Sync and Test Signals

Separate SMPTE Bars Output With Programmable ID (Option 01)

Audio Tone Output (Option 01)

Tape Leader Countdown

The Tektronix TSG-170A NTSC Television Generator offers you the test signals you need plus the advantages of master and genlock sync capability. It provides true 10-bit digital signal accuracy with a full complement of test signals and a stable RS-170A sync generator.

The rugged, compact TSG-170A is designed to support both operational and maintenance requirements. The TSG-170A Option 01 provides even more versatility by adding a separate SMPTE bar generator, programmable identification, and audio tone output.

FEATURES

- SMPTE Bars
- Convergence
- Pulse and Bar with Window
- Multiburst
- 5-Step Luminance Staircase
- Luminance Ramp
- Modulated Ramp
- Selectable 10% or 90% APL
- Bounce
- 10 and 100 IRE Flat Fields
- Red Field
- Multibars
- NTC7 Composite
- System Test Matrix
- Monitor Set-up Matrix
- 5 MHz Line Sweep
- Multipulse
- DAC Calibration Signals

ORDERING INFORMATION

TSG-170A NTSC Television Generator **$4,800**

OPTION

Option 01 — Adds separate SMPTE Bars output with 12 Character ID, Audio Tone Output and Tape Leader Countdown. **+$1,000**

ECO-170A Synchronous Changeover.

NEW ECO-170A

Synchronous Changeover

Automatic Sync Changeover

Clean Electronic Switching

Unique Fault Detection System

8 Channels

Manual Override

Remote Control With Fault Indicators

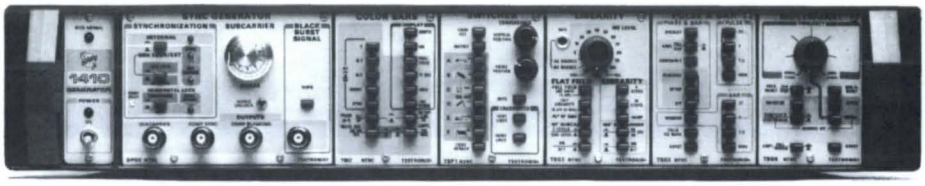
Compatible With NTSC and PAL Systems

The ECO-170A Synchronous Changeover provides transparent, automatic selection of sync sources. Front panel controls allow simple access to changeover functions. A two level front panel lockout protects these controls in critical master sync systems.

ORDERING INFORMATION

ECO-170A Synchronous Changeover **$2,000**

GENERATORS/CHANGEOVER



1410R Option 04 Test Signal Generator.

1410R/1411R/1412R

NTSC, PAL, and PAL-M Generators

- **Five Test Signal Generators and One Switcher**
- **Conforms to EIA Standard RS-170A (1410R)**
- **Sync to Subcarrier Phasing Maintained or Corrected**
- **Color Frame Reference Output**
- **Genlock to Composite Video**
- **Lock to External References**
- **Adjustable Blanking Widths**
- **Adjustable Sync Delays (H and V)**
- **Parallel Test Signal Outputs**

Three different models are available. The 1410R is for NTSC applications, the 1411R for PAL and the 1412R is for PAL-M applications.

ORDERING INFORMATION

1410R NTSC PACKAGES
STANDARD CONFIGURATIONS

	Option 03	Option 04
TSG2 Convergence	x	
TSG3 Linearity	x	x
TSG5 Pulse and Bar		x
TSG6 Multiburst		x
TSG7 Color Bars	x	x
TSP1 Switcher		x

1410R NTSC Mainframe and SPG2A **$4,200**

OPTIONS

Option 03*1 — NTSC Package Installed and Tested Together. **+$3,460**

Option 04*1 — NTSC Package Installed and Tested Together. **+$8,280**

1411R PAL PACKAGES
STANDARD CONFIGURATIONS

	Option 03	Option 04
TSG11 Color Bars	x	x
TSG12 Convergence	x	
TSG13 Linearity	x	x
TSG15 Pulse and Bars		x
TSG16 Multiburst		x
TSP11 Switcher		x

1411R PAL Mainframe and SPG12 **$4,200**

OPTIONS

Option 03*1 — PAL Package Installed and Tested Together. **+$3,000**

Option 04*1 — PAL Package Installed and Tested Together. **+$7,500**

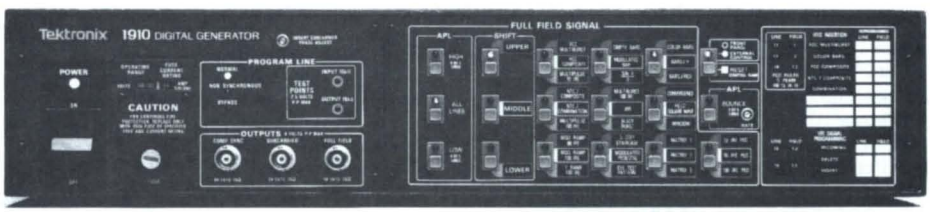
**1Cannot be combined with any other option.*

PAL-M PACKAGES

1412R PAL-M Mainframe and SPG22, TSG21 **$7,415**

Option 05 — Adds TSG23/TSG25/TSG26/TSP21 Installed. **+$8,795**

For complete Television Product information, request the Television Products catalog.



1910 NTSC Digital Generator/Inserter.

1910 Digital Generator

- **Four External VITS Inputs for Insertion of Teletext, Closed Captioning, Source ID, etc.**
- **Nonvolatile Memory to Maintain Selected VITS and Full Field Signal Configuration After Power Interruption**
- **Signal Stored in Replaceable PROMS so Your 1910 Won't Become Obsolete**
- **The Accuracy and Stability of an all-Digital 10-Bit Sync and Signal Generation (RS-170A)**
- **User Friendly RS-232C Control Port for Added Versatility**
- **New Signals (Eye Test Pattern, Special Multipulse, Color Multipulse), New Functions (VITS Sequence, Field Sequence and More)**

The 1910 Digital Generator is a state-of-the-art test signal generator designed for performance testing of NTSC video systems and equipment. The 1910 is especially suited where high accuracy and stability are required. It is also a VITS inserter (internal and external) with a full complement of signals that allow testing in studio, transmitter, production or research environments. Four external VITS inputs permit insertion of signals such as teletext, closed captioning, source ID, and other similar sources. These four inputs may be converted to four pulse outputs for use in a production environment.

External interfacing of the 1910 is controlled by an internal microprocessor and its nonvolatile memory. Test signals are stored as 10-bit digital words and converted to analog form by a 10-bit precision DAC (with deglitching to reduce differential gain and differential phase) to ensure signal accuracy as well as long term stability and repeatability.

Since all signals are stored in replaceable EPROMs, changing needs and industry standards will not cause obsolescence.

Control and versatility of the 1910 are greatly enhanced by the use of its RS-232 control port. Most functions of the 1910 can be controlled, reconfigured and saved. This includes VITS and full field signal selection, matrix signal creation, sequences and other features.

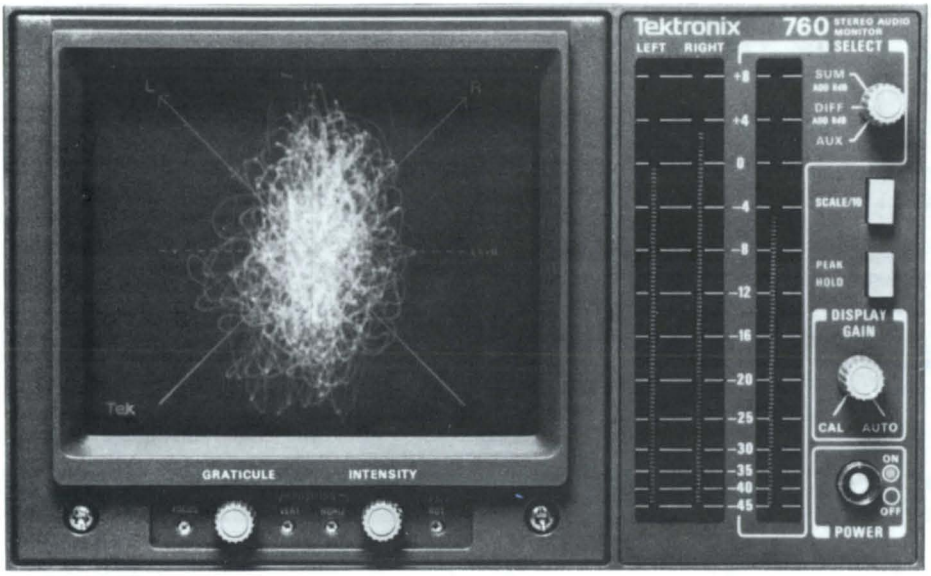
ORDERING INFORMATION

1910 Digital Generator **$9,990**

OPTION

Option 03 — CBC Test Signals. **NC**

For complete Television Product information, request the Television Products Catalog.



760 Stereo Audio Monitor.

NEW 760 Stereo Audio Monitor

Graphic CRT Display of Stereo Audio Signal

AGC for Continuously Viewable Pattern

Bar Graph for Quick Setups and Accurate Peak Indication

Third Bar Indicates Mono Compatibility When Set to SUM

Suitable for Phase and Amplitude Measurements

With Tektronix' *NEW* 760 Stereo Audio Monitor, the audio engineer can analyze a pattern display of the stereo audio signal. This display, along with a high resolution bar graph, provides accurate monitoring and measurement capabilities. Used in both operation and setup, the instrument provides immediate feed-back of the audio signal for creative or technical correction. With the appropriate test signals, the unit can also be used for accurate phase and amplitude measurements. On the CRT and adjacent bar graph, you can observe amplitude information, stereo separation, and phase correlation between the Left and Right channels. Also of great importance, you can see monaural amplitudes resulting from the stereo channels.

Your choice of automatic or manual gain control provides flexible control of the pattern size. With no input signal, the display will dim to prolong CRT life.

Two calibrated bars are dedicated to the Left and Right channels. The input to a third bar is selectable from Sum, Difference (both internally derived), and an Auxiliary input on the rear panel. These give the operator accurate level indicators featuring a three second "peak hold" that makes level monitoring easier than ever.

The 760 is ideally suited for use in editing suites, master control, transmission, and any other locations where monitoring the stereo audio signal is a must.

ORDERING INFORMATION

The standard instrument is shipped without a case or handle. If your application is for bench or portable use, please order the appropriate enclosure from the optional accessories list. The 760 is a UL recognized component and meets the requirements for listing when used in the appropriate enclosure.

760 Stereo Audio Monitor **$1,990**

Portable Dc Powered Applications
760 Stereo Audio Monitor plus 1700F10 Dc Power Converter, 1700F02 Portable Cabinet, and BP1 Battery Pack.

AVC-20 Audio Vector Converter.

NEW AVC-20
Audio Vector Converter

Use With Any NTSC Vectorscope

Balanced Line Level Inputs

Time Code or Third Channel Input
—Field Locked for Time Code Phase

User Selectable Display Formats
—Lissajous Pattern with Calibrated Amplitude
—Lissajous Pattern and Sweep Displays of Both Channels

Time Versus Amplitude Sweep Display
—Selectable Between All Three Inputs
—Left Plus Right Sweep

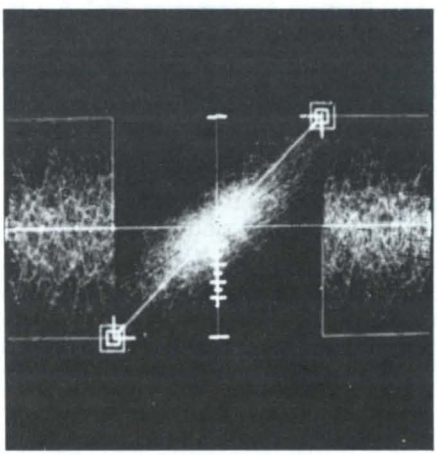
Low Power Consumption

Cost Effective

No Front Panel Space Required

Simple Remote Control

The *NEW* AVC-20 provides stereo audio monitoring capability when installed with an NTSC vectorscope. Complete audio monitoring can be added to VTR bridges, master control consoles and other locations requiring stereo audio monitoring without modifying the vectorscope and without using front panel space. Stereo phase, individual signal amplitudes and audio distortions can be observed by simply using the B input to an existing vectorscope. A third audio input channel and a field locked sweep are available for monitoring time code or a second language program.



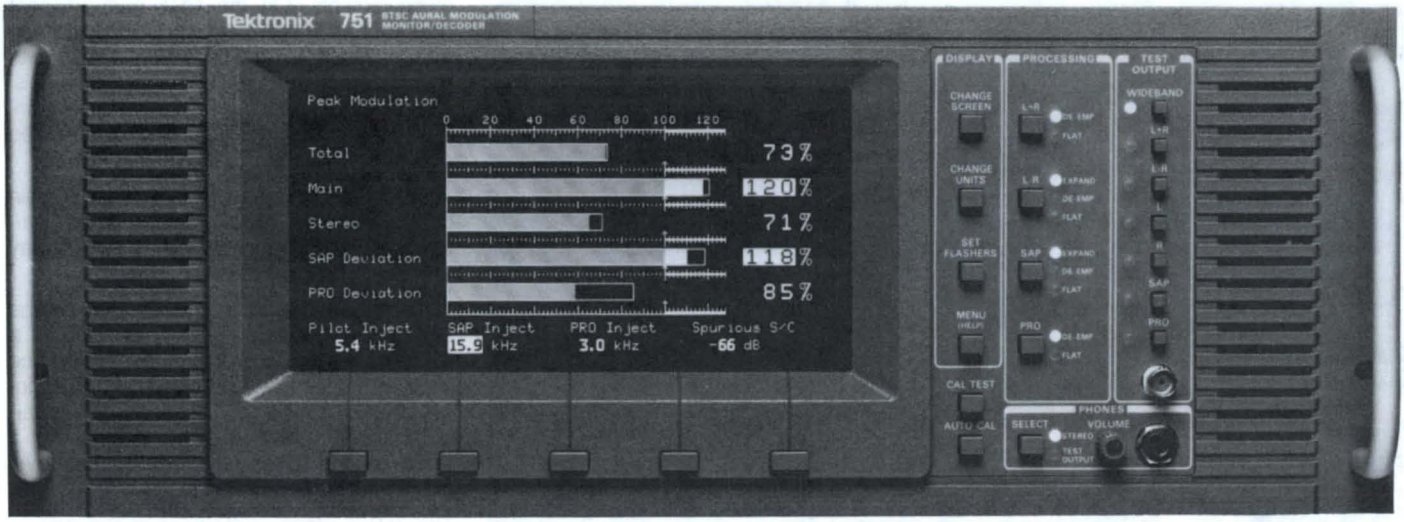
Live audio, left and right channels, time versus amplitude sweep display, and Lissajous pattern (center) with correct stereo phase.

The Tektronix AVC-20 is easy to operate, install and afford. It's an excellent choice for stereo television facilities.

ORDERING INFORMATION

AVC-20 Audio Vector Converter **$790**

TEK BTSC AURAL MODULATION MONITOR/DECODER



751 BTSC Aural Modulation Monitor/Decoder.

NEW 751 BTSC
Aural Modulation Monitor/Decoder

Precision Modulation Monitor for Entire BTSC Sound Channel

Simultaneously Displays All Components Necessary to Ensure Modulation Remains Within Legal Limits

Alternate Display of Processed Audio Levels for Left, Right, Sum, Difference, SAP and PRO

Electroluminescent Bar Graph With Precisely Controlled Dynamics

Bars Feature Peak Indicators With Timed Peak Hold and Easily Set Peak Limits

Digital Readout Accompanies Each Bar for Accurate Setups

Internal Auto-Calibrator Ensures Accurate Modulation Measurements

The *NEW* 751 BTSC Aural Modulation Monitor/Decoder provides accurate modulation monitoring and measurement of the BTSC encoded TV sound channel.

The 751 comes ready to monitor the entire BTSC sound channel, including SAP and PRO. Should the needs of your station change, a simple "soft-keys" controlled menu can add or delete SAP or PRO from the display.

Two sets of parameters can be alternately displayed by a simple front panel selection. Similarly, bar graph and digital readout units of measure can be changed from % of maximum to kHz deviation and dB, with the simple push of a button.

Also displayed are injection levels for SAP, PRO, and Stereo Pilot, as well as Spurious Stereo Subcarrier.

Instantaneous peak values as well as "held" peak values are displayed as calibrated bars. Each bar is accompanied by a digital readout that corresponds to the "held" peak value. The bar and readout both indicate when an easily set peak limit has been exceeded.

Processing is front panel selected from Expand, De-emphasis, and Flat. A monitor output is provided on both the front and rear panels for external measurements of the Left and Right stereo channels, SUM, DIFF, SAP, and PRO. A switchable headphone output is also located on the front panel.

Precisely decoded Left and Right stereo channels, SAP, and PRO 600 Ω balanced line outputs are provided on the rear panel through XLR connectors.

Remote alarm contact closures for Pilot Unlocked (from horizontal sync) and Stereo Channels Out of Phase are provided on the rear panel through a 9 pin D connector. Alarm conditions are also indicated on the display. H sync for measuring Pilot Phase Lock is obtained via the rear panel Composite Video loop-through connector.

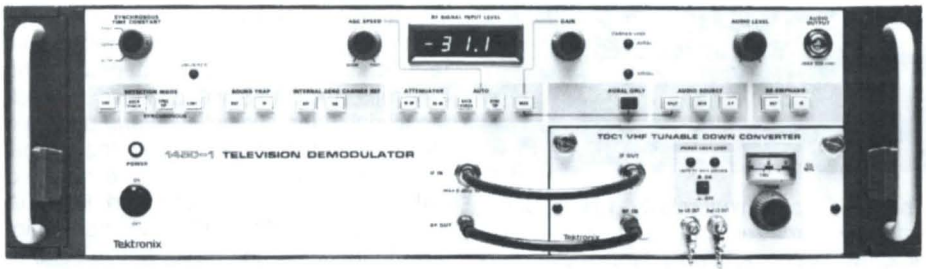
Automatic calibration of the display is accomplished by internally generating a calibration signal routed through the 1450-1 TV Demodulator, which provides a calibrated 1450-1 Deviation Out signal. This operation, as well as a calibration test, is software controlled.

The 751 is a 178 mm (7 inch) high, full rack width instrument that weighs approximately 13.5 kg (30 lb).

ORDERING INFORMATION

751 BTSC Aural Modulation Monitor/Decoder **$12,000**

For complete Television product information, request the Television Products Catalog



The 1450-1 is compatible with System M Television Transmission, the 1450-2 is compatible with System B/G, and the 1450-3 is compatible with System I.

1450-1/1450-2/1450-3

Television Demodulators

Measurement-Quality Performance for Negligible Distortion

Synchronous Detection Eliminates Quadrature Distortion

Envelope Detection for Accurately Determined Differential Phase

Surface Acoustic Wave Filter Provides Precise Nyquist Slope; Excellent Long and Short-Term Stability

Digital Readout of Input Power Level for Easy, Accurate Field Strength Readings

Constant-Bandpass Characteristics Over Wide Dynamic Range

Any Single VHF or UHF Channel Operation

UHF and VHF Tunable Down Converters

The 1450-1 (System M), 1450-2 (System B/G) and 1450-3 (System I) demodulator mainframes are combined with a Tektronix Television Down Converter (TDC) to provide an accurate link between your transmitter's RF signals and video baseband measuring equipment. Unique components work together to identify and eliminate any possible dedemodulation distortion in reproduced signal characteristics. You see a transparent picture of your transmitter's performance and signal output.

ORDERING INFORMATION

SYSTEM M

1450-1 Television Demodulator (Order one Vision IF option) **$14,900**

OPTIONS

Option 01 — 37 MHz Vision IF. **NC**
Option 02 — 38.9 MHz Vision IF. **NC**
Option 03 — 45.75 MHz Vision IF. **NC**

For demodulation of RF signals, one of the following three down converters must be plugged into the 1450-1 mainframe. Order one Vision IF option and either Option 11 or Option 14.

TDC — Fixed Channel Down Converter. Stipulate channel number when ordering. **$4,100**
TDC-1 — Tunable Down Converter VHF Band. **$7,660**
TDC-2 — Tunable Down Converter UHF Band. **$7,660**
Option 01 — 37 MHz Vision IF. **NC**
Option 02 — 38.9 MHz Vision IF. **NC**
Option 03 — 45.75 MHz Vision IF. **NC**
Option 11 — System M Countries.* **NC**
Option 14 — Japan and Okinawa. **NC**

FIELD UPGRADE KIT

For upgrading 1450-1 and 1450 (S/N BO19999 and below) to provide a wide band audio output suitable for use with BTSC System multichannel sound in the U.S. and with stereo sound in Japan.

1450F20 — Field Upgrade Kit **$2,150**

** Except Japan and Okinawa.*

ORDERING INFORMATION

SYSTEM B/G

1450-2 Television Demodulator (Order both Option 02 and Option 09) **$13,145**

OPTIONS

Option 02 — 38.9 MHz Vision IF. **NC**
Option 09 — +90ns/170 ns Group Delay. **NC**

For demodulation of RF signals, one of the following three down converters must be plugged into the 1450-2 mainframe. Order both Option 02 and Option 12.

TDC — Fixed Channel Down Converter. Stipulate channel number when ordering. **$4,100**
TDC-1 — Tunable Down Converter VHF Band. **$7,660**
TDC-2 — Tunable Down Converter UHF Band. **$7,660**
Option 02 — 38.9 MHz Vision IF. **NC**
Option 12 — System B/G/I countries. **NC**

ORDERING INFORMATION

SYSTEM I

1450-3 Television Demodulator (Order Option 02) **$13,145**

OPTION

Option 02 — 38.9 MHz Vision IF. **NC**

For demodulation of RF signals, one of the following three down converters must be plugged into the 1450-3 mainframe. Order both Option 02 and Option 12.

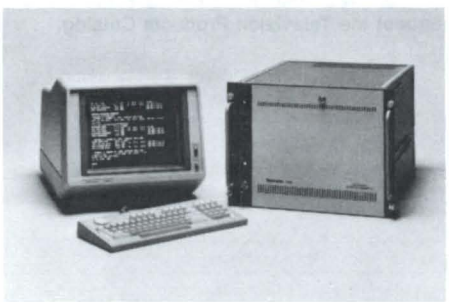
TDC — Fixed Channel Down Converter. Stipulate channel number when ordering. **$4,100**
TDC-1 — Tunable Down Converter VHF Band. **$7,600**
TDC-2 — Tunable Down Converter UHF Band. **$7,600**
Option 02 — 38.9 MHz Vision IF. **NC**
Option 12 — System B/G/I Countries. **NC**

ORDERING INFORMATION

SYSTEMS D AND K

1450 Series Television Demodulators and Down Converters with modifications. Contact Tektronix for quote.

For complete Television product information, request the Television Products Catalog.



1980

ANSWER With Measurement Software

Unattended Monitoring of Video Signals From Studios, STLs, Earth Stations, and Transmitters

Full Spectrum of Timing, Frequency Response, Amplitude, Phase, and Noise Measurements

Waveform Plots for Analysis and Documentation

Remote Operation

Automatic Logging

User Definable Measurement Limits

Operator Initiated Individual Measurement

Vertical Interval Scan for Test Signal Locations

User-Defined Measurement Groups

ORDERING INFORMATION

For Base Unit plus software, order:

1980 ANSWER with Option 01, NTSC Applications Software **$28,450**
1980 ANSWER with Option 04, NTSC Monitoring Software **$28,150**
1980 ANSWER with Option 05, PAL Monitoring Software **$28,150**
1980 ANSWER Monitoring with Option 06, PAL/NTSC Software **$30,990**

OPTION

Option 12 — Automatic Call Equipment Interface **+$600**

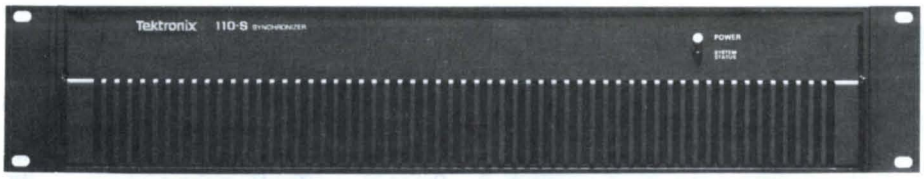
For Software only, order:

1980 F04 **$6,300**
1980 F05 **$6,300**
1980 F06 **$9,140**

OPTIONAL ACCESSORY

Service Kit — Order 067-1115-01 **$3,705**

For complete Television Product information, request the Television Products Catalog.



110-S Video Synchronizer/TBC

True 10-Bit Accuracy and Resolution

Tracks Signals into the Noise

Optional Four-Field Memory for the Highest Picture Quality

Adaptive Decoding—Minimizes Picture Shifts While Preserving Horizontal and Vertical Detail, Provides Exceptionally High Quality Picture Freeze

Adaptive Clamping—Minimizes Streaking on Noisy Signals

Digitally Precise RS-170A Sync and Burst Insertion

Passes the Vertical Interval

Processing Amplifier

Precalibrated Boards in Modular Design

Heterodyne Color Processing

Auto VTR Signal Recognition

Infinite Window Correction Range

The 110-S is a high quality 10-bit, 4X fsc video synchronizer. The 10-bit architecture, adaptive decoding, and adaptive clamping combine to provide a synchronizer that performs well on noisy signals, minimizes horizontal picture shifts, and is virtually transparent to the processed signal.

10-Bit Precision

A Tektronix-designed 10-bit digitizer and a sampling rate of four times the subcarrier frequency result in negligible quantizing errors, low differential gain and phase, and a flat frequency response. Compared to 8-bit synchronizers, the 110-S has four times the accuracy and resolution. The resulting transparency to the video signal allows cascading of 110-S synchronizers in the signal path with minimum signal degradation.

Tracking Into Noise

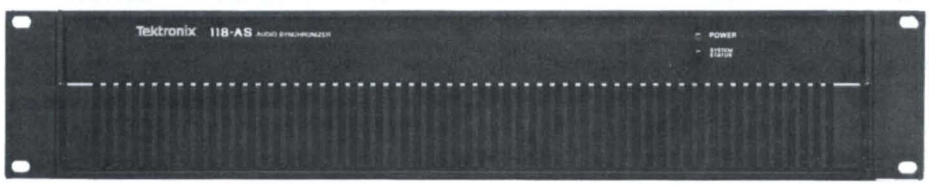
When noise from a fading ENG microwave feed or static interference degrades the S/N ratio, the 110-S will continue to track the signal. If the original sync and burst are clean, they may be passed with the original signal. Noisy sync and burst are replaced with precise, digitally generated RS-170A sync and burst. The 110-S can be configured to track into the noise, freeze field, or go to black upon loss of the incoming signal. As noise increases, an adaptive clamp slows down to prevent horizontal streaking while still responding quickly to hot switches.

The 110-S TBC option adds time base correction for heterodyne color VTRs to the 110-S Synchronizer.

ORDERING INFORMATION

110-S Video Synchronizer	**$14,975**
OPTIONS	
Option 10 — Four-Field Memory Adaptive Decoder.	**+$1,500**
Option 20 — Adds time base correction for heterodyne color VTRs	**+$2,000**
110-RC Remote Control Unit	**$500**

For complete Television Product information, request the Television Products Catalog.



118-AS Audio Synchronizer

Automatic or Manual Control of Audio to Video Timing

Simple One-Wire Interface to 110-S Video Synchronizer

118-F02 Option Provides Interface to Other Video Synchronizers

Expandable to Three Channels for Stereo and Auxiliary Channel

Compensates for up to Ten Fields of Video Delay

93.75 kHz Sampling Provides Accurate Stereo Phasing and Flat Frequency Response

18-Bit Floating Point Code for Wide Dynamic Range

Built-In Diagnostics and Easy Module Access for Service

The Tektronix 118-AS Audio Synchronizer provides automatic and/or manual control of audio delay to maintain proper audio to video timing. With 18-bit floating point code and 93.75 kHz sampling, the Tektronix 118-AS brings to audio synchronization the same high standards established for video synchronization by the Tektronix 110-S.

The 118-AS Audio Synchronizer automatically tracks the 110-S Video Synchronizer using a simple one-wire digital interface. The 118-F02 video interface board allows the 118-AS to automatically track the delay of other video equipment. Additional fixed audio delay may be added manually to compensate for audio to video timing errors present on an incoming signal.

The standard 118-AS is a single channel audio synchronizer, which may be expanded to two or three channels for stereo or second language applications.

ORDERING INFORMATION

118-AS Single Channel Audio Synchronizer	**$6,500**
118-F01 Audio Channel Kit (adds one channel)	**$2,700**
118-F02 Video Interface Kit	**$1,400**
118-RC Remote Control Unit	**$1,400**

For complete Television Product information, request the Television Products Catalog.

650HR-C Series Component/Composite Picture Monitor.

650HR Series Color Picture Monitors

High Resolution Display Plus Capability for Critical Signal Analysis

0.25 mm Triad Pitch High Resolution Trinitron® CRT

Variable Aperture Correction

Precise Color Tracking Over Full Signal Range

Two Video Inputs With Differential (A-B) Capability

Video Inputs Isolated from Ground for Hum Rejection

Optional Parallel Component Inputs—Internally Selected Format

NTSC, PAL, SECAM and Multistandard Versions Available

Precise Decoders With Outputs to Provide Vector Display on External X, Y Monitor

Unique Monochrome (White) Display of Decoded Blue Signal for Critical Analysis of Color Noise

The Tektronix 650HR Series color picture monitors are designed for exacting applications where picture quality and signal quality analysis are particularly important.

The decoders have sufficient chroma channel bandwidth to pass all of the information in standard signals.

The unique blue only mode feeds the decoded blue video signal to the red, green, and blue channels simultaneously. This produces a monochrome display with a high subjective sensitivity to chroma noise, allowing better analysis of video quality.

Circuits in the Tektronix 650HR Series are designed for color stability and consistency. Outputs are provided from the precision decoders and may be used to drive an X,Y monitor for a vector display. The regulated high voltage supply is not affected by extreme changes in APL even when calibrated brightness, at peak white, is set at 30 fL. Raster size is held within 1%, while excellent clamping maintains a stable black level with a 0% to 100% range of APL.

In 650HR Series color monitors, you can shift the picture either horizontally or vertically, or both (pulse cross). This lets you monitor sync, burst, blanking, vertical interval test, and reference signals. Expansion of the vertical scan is provided in the pulse cross and vertical delay modes, so you can view individual lines in the vertical blanking interval.

Versions of the 650HR are available for certain combinations of NTSC, PAL, SECAM and parallel components. (See ordering information chart.)

The optional "-C" versions directly display 3-wire parallel component signals. Internal selection for SMPTE Parallel (Y, Pb, Pr), BetaCam (Y, B-Y, R-Y), M (Y, Q, I), or G, B, R formats offer a wide range of applications. Front panel switching between component and composite inputs allows easy comparison of non-encoded and encoded signals.

The following special features are included in the SECAM version: Color sequencing from field identification signals or line burst. Reduced chrominance line crawl. Color sequence error indicater.

The 650HR Series monitors can be used in rack installations or separately in their own cabinets. (See separate TV Division catalog for detailed specifications.)

PHYSICAL CHARACTERISTICS

	Cabinet		Rackmount	
Dimensions	**mm**	**in**	**mm**	**in**
Width	426	16.8	483	19.0
Height	279	11.0	266	10.5
Depth	419	16.5	464*[1]	18.3*[1]
Weights≈	**kg**	**lb**	**kg**	**lb**
Net	22.7	50.0	23.5	52.0
Domestic Shipping	28.5	65.0	30.4	67.0
Export Shipping	36.3	80.0	37.2	82.0

[1] With handles.

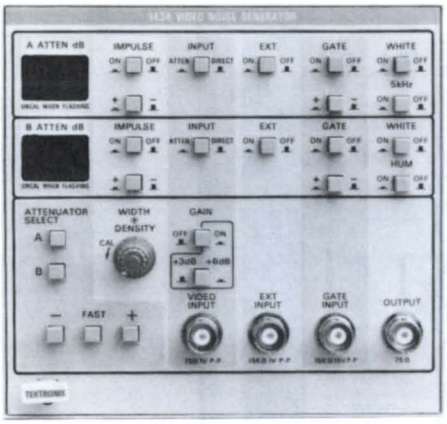
ORDERING INFORMATION

All 650HR Monitors are shipped with rackmounting hardware. Cabinet version hardware is also included.

Model Number	NTSC	PAL	SECAM	Component	Price
650HR	•				**$4,950**
650HR-C	•			•	**$5,300**
651HR		•			**$5,165**
651HR-C		•		•	**$5,515**
652HR-1		M		*	**$5,875**
655HR-C	•	•		•	**$6,100**
656HR-1		•	•	*	**$6,750**

** G,B,R format only.*

For complete Television Product information, request the Television Products Catalog.



1430 Random Noise Measuring Set

1440 Automatic Video Corrector

1434 Video Noise Generator

- Calibrated Noise Levels
- White Noise
- Impulse Noise With Selectable Polarity, and Variable Width and Density
- Hum—50 Hz or 60 Hz
- 5 kHz Sinewave
- Noise Gating
- Calibrated Video Attenuation
- Works With NTSC, PAL, PAL-M, and SECAM

ORDERING INFORMATION

1434 Video Noise Generator **$5,500**

1430 Random Noise Measuring Set

- Conforms to CCIR Recommendation 568
- In-Service Testing
- Out-of-Service Testing
- Program Material Protected by Fail-Safe Provisions
- 525/60 or 625/50 Standards

ORDERING INFORMATION

1430 Random Noise Measuring Set (525/60) **$4,115**

Option 01 — Random Noise Measuring Set (625/50). **+$85**

1440 Automatic Video Corrector

- Reduces Operating Costs
- Extends Transmitter Tube Life and Reduces Maintenance Costs
- Maintains Consistent High Quality Color Pictures
- Automates Transmitter Modulation Level Control
- Maintains Correct Sync-To-Video Ratios During Line Voltage Fluctuations
- Automatic VIRS Referenced Correction of:
  - Overall Video Signal Amplitude
  - Chrominance to Luminance Gain Ratio
  - Black Level
  - Chrominance Phase
  - Burst Gain
  - Sync Gain
- Optional Closed Loop Capabilities for Greater Efficiency and Economy in Transmitter and VTR Operations

ORDERING INFORMATION

1440 NTSC Automatic Video Corrector **$6,325**

OPTIONAL ACCESSORIES

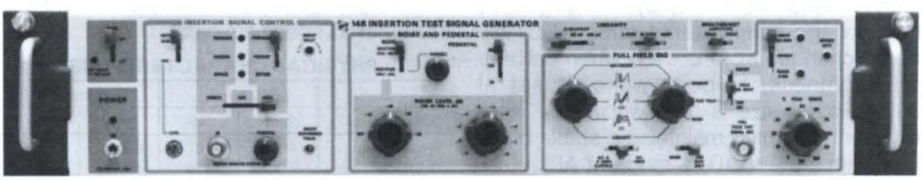
Remote Control Unit for 1440 — Includes two connectors. Order 015-0240-00 **$1,020**

Remote Monitor Unit for 1440 — Includes one connector. Order 015-0239-00 **$1,080**

Six Foot Extender Cable — With connectors for use between the 1440 and Remote Control Unit or Remote Monitor Unit. Order 012-0131-00 **$400**

Three Foot Extender Cable — With connectors for use between the 1440 chassis and the rear rackmounting section. Order 012-0637-00 **$405**

For complete Television Product information, request the Television Products Catalog.



R148/R148-M

Test Signal Generators

- Insertion Test Signals (Per EBU, CCIR Recommendation 473-2, Annex 1)
- Full-Field Test Signals (Per CCIR Recommendation 567)
- Easily Reprogrammable
- Safe In-Service ITS Insertion (Per EBU Specifications)
- Noise Measurement
- APL Bounce Signal
- Source Identification Code
- Operates With Sound In Syncs
- Locks With Mixed Sync (Per EBU Homologation Specifications for ITS Generators) Subcarrier, PAL Pulse, Burst Flag, Comp Sync

ORDERING INFORMATION

R148 PAL Test Signal Generator **$5,540**

R148-M PAL-M Test Signal Generator **$8,700**

OPTIONAL ACCESSORIES

Noise Measurement Filters — External filters are required with the 148 Generator when making noise measurements.

Low Pass 6.0 MHz 625/50 — Order 015-0220-00 **$130**

Noise Weighting 5.0 MHz 625/50 — Order 015-0215-00. **$100**

Low Pass 4.2 MHz 525/60 — Order 015-0212-00 **$155**

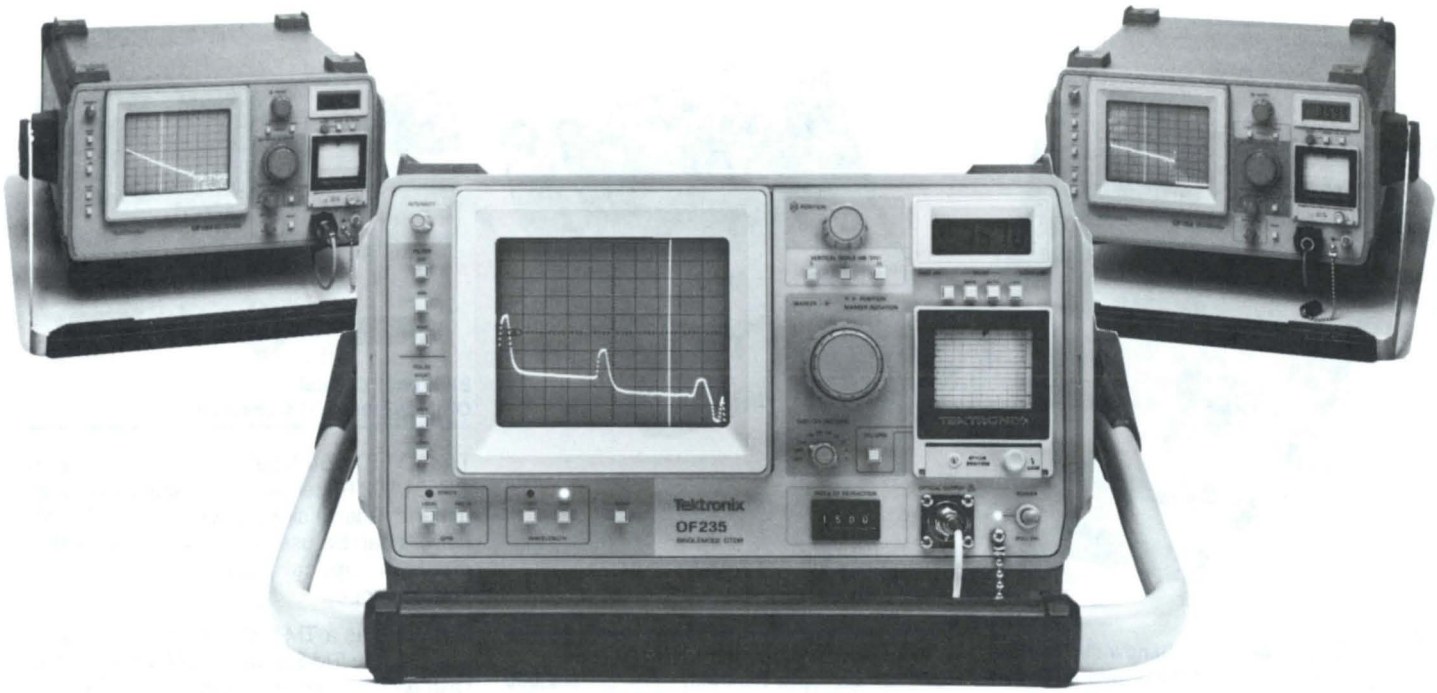
Noise Weighting 4.2 MHz 525/60 — Order 015-0214-00 **$100**

CCIR recommendation 568 provides for measuring signal-to-weighted random noise on all international transmissions (both 525/60 and 625/50) with a 5.0 MHz low pass filter and a unified noise weighting filter.

Low Pass 5.0 MHz — Order 015-0213-00 **$150**

Unified Noise Weighting Network — Order 015-0283-00 **$85**

Rackmount to Cabinet Conversion Kit — Order 040-0573-00 **$100**



Fiber Optic Cable Testers

Singlemode and Multimode Environments

825 nm to 1550 nm

LCD Readout

Accurate, Repeatable Measurements

Optional Chart Recorder, Optional Recorder Output

Digital Storage With Easy-To-View Waveform and Noise Reduction

Selectable Pulse Widths

Rugged and Portable—Operates From 12 Volt Vehicle System or Battery Pack

OF235 Fiber Optic TDR

GPIB (IEEE-488)

The OF235 complies with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats.*

Dual Wavelength

1300 nm/1550 nm Switchable GPIB

3 Loss Measurement Modes

Connectors Available: AT&T Biconic, FC, NEC, Diamond 3.5, Diamond 2.5, Radiall

0.25 dB/Div Vertical Scale

1 Meter Distance Resolution

TEKTRONIX PORTABLE FIBER OPTIC INSTRUMENTS

Instrument Type	Type	Wavelength	Fiber
OF235	OTDR	1300 nm/1550 nm	Singlemode
OF235 Option 07	OTDR	1300 nm	Singlemode
OF152	OTDR	1300 nm	Multimode
OF150	OTDR	825 nm or 850 nm	Multimode
OF192	Bandwidth Test Set	825 nm/850 nm/1300 nm	Multimode

ORDERING INFORMATION

OF235 Fiber Optic Time Domain Reflectometer **$29,500**

OF152 Fiber Optic Time Domain Reflectometer **$18,500**

OF150 Fiber Optic Time Domain Reflectometer **$13,500**

OPTIONS

Option 01 — XY1 Output Module. **+$300**
Option 04 — Chart Recorder. **+$1,050**
Option 05 — (OF150) 850 nm (Nominal). **NC**
Option 07 — (OF235) Delete 1550 nm. **−$7,000**
Option 08 — (OF235) Delete 1300 nm. **−$4,000**
Option 20 — AT&T Biconic Connector. **NC**
Option 22 — (OF235) FC Connector. **NC**
Option 23 — (OF235) NEC Connector. **NC**
Option 24 — (OF235) Diamond 2.5 mm Connector. **NC**
Option 25 — (OF235) Radiall Connector. **NC**

INTERNATIONAL POWER PLUG OPTIONS

Option A1 — Universal Euro 220 V, 50 Hz.
Option A2 — UK 240 V, 50 Hz.
Option A3 — Australian 240 V, 50 Hz.
Option A4 — North American 240 V, 60 Hz.
Option A5 — Switzerland 220 V, 50 Hz.

OPTIONAL ACCESSORIES (OF235, OF152, OF150)

Fiber Adaptors
FA-1 — Deutsch-Multimode Fiber. **$695**
FA-2 — AT&T Biconic-Multimode Fiber. **$695**
FA-3 — Diamond (3.5)-Singlemode Fiber. **$695**
FA-4 — FC-Singlemode Fiber. **$695**
FA-5 — AT&T Biconic-Singlemode Fiber. **$695**
FA-9 — (NEC-D4-Singlemode) **$695**
FA-10 — (Radiall-Singlemode) **$695**
FA-11 — (Diamond 2.5-Singlemode) **$695**
C-5C — Camera. **$495**
C-7 — Camera. **$595**
Hard Case — Transit. Order 016-0658-00 **$750**
Soft Case — Order 016-0659-00 **$105**
Receptacle Connector, Optical — Ten each. Order 013-0207-02 **$425**
Chart Paper —
(One Roll) Order 006-3618-00 **$9.25**
(25 Rolls) Order 006-3618-01 **$225**
(100 Rolls) Order 006-3618-02 **$710**
Accessory Kit — Deutsch Tools and Plugs. Order 015-0474-00 **$850**
Sun Visor — Order 016-0653-00 **$34**
XY1 Output Module **$350**
Chart Recorder — Order 016-0506-07 **$1,100**
Cable Assemblies —
(Diamond to AT&T Biconic) Order 175-9708-00 **$560**
(Diamond to FC) Order 175-9707-00 **$560**
(Diamond to Diamond) Order 175-9695-00 **$560**

ADDITIONAL INFORMATION

OF150 Series Brochure — 22-W-5847
OF235 Brochure — 22-W-5987-2

OF192 Fiber Optic Bandwidth Test Set

GPIB IEEE-488

The OF192 complies with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats.*

Frequency Range (Automatic)
1 MHz to 1450 MHz

Attenuation Measurement Accuracy ±1.5 dB

Connectors: AT&T Biconic, FC, Diamond

Temperature Operating Range
0°C to +50°C

ORDERING INFORMATION

OF192 Fiber Optic Bandwidth Test Set $32,000
Includes: Two ac power cords (161-0118-00); two calibration jumper cables; AT&T connector (174-0043-00); Diamond connector (174-0045-00); FC connector (174-0047-00); operator handbook (070-5744-00).

OPTIONS

Option 05 — 850 nm TX Module.	**+$3,000**
Option 06 — 825 nm TX Module.	**+$3,000**
Option 07 — 1300 nm TX Module.	**+$7,500**
Option 20 — AT&T Biconic Connector.	**NC**
Option 21 — Diamond Connector.	**NC**
Option 22 — FC Connector.	**NC**

INTERNATIONAL POWER PLUG OPTIONS

Option A1 — Universal Euro 220 V, 50 Hz.
Option A2 — UK 240 V, 50 Hz.
Option A3 — Australian 240 V, 50 Hz.
Option A4 — North American 240 V, 60 Hz.
Option A5 — Switzerland 220 V, 50 Hz.

OPTIONAL ACCESSORIES

Fiber Adaptors

FA-2 — (AT&T Biconic)	**$695**
FA-6 — (FC)	**$695**
FA-8 — (Diamond)	**$695**

Electrical/Optical Optical/Electrical Converters

The OT501/502/503 Transmitters and OR501/502 Receivers are designed to transmit and receive signals across fiber. The receivers can be used to convert most instruments to optical instruments (e.g., the optical scope).

Designed as a TM 500 plug-in, they may be used in any TM 500 or TM 5000 mainframe. Diamond 3.5 mm connector is standard.

OT501/502/503 Transmitters

	OT501	OT502	OT503
Wavelength	825 ±15 nm	850 ±10 nm	1300 ±25 nm
FWHM*	<2 nm		<4 nm
Output Power, Dc	+3 dBm		0 dBm
Mod Input	50 Ω		
Mod Input Level Max w/100% Mod	+20 dBm <0 dBm		
Mod Freq Response	.03 to 1700 MHz		.03 to 1500 MHz
Mod Flatness	±1 dB (.05 to 1000 MHz)		
	±2 dB (.03 to 1700 MHz)		±5 dB (.03 to 1500 MHz)

OR501/502 Receivers

	OR501	OR502
Wavelength	700 to 1500 nm	
Photo Element	Ge-APD	
Max Linear Input	−20 dBm	+10 dBm
Frequency Response	.03 to 1500 MHz ±2 dB .05 to 1000 MHz ±1 dB	
Noise Floor	≤ −110 dBm/Hz	
Output 50 Ω	−15 dBm typical for −20 dBm optical input	−12 dBm typical −20 dBm optical input
Optical Attenuator	N/A N/A	2.5 dB/step (Nom) 37.5 dB (Max)

** Full width half maximum.*

ORDERING INFORMATION

OT501 825 nm E/O Converter	**$5,900**
OT502 850 nm E/O Converter	**$5,900**
OT503 1300 nm E/O Converter	**$9,500**
OR501 O/E Converter	**$4,300**
OR502 O/E Converter	**$6,500**

OPTIONS

Option 01 — Diamond to SMA Cable.	**NC**
Option 20 — AT&T Biconic Connector.	**NC**
Option 22 — FC Connector.	**NC**

DATA COMMUNICATIONS ANALYZERS FROM TEKTRONIX: SOLVING PROBLEMS IN A COMPLEX NETWORK WORLD

834/835/836

Multiple Triggers. Trigger on Selected Control Line Changes, Error Conditions or Character Strings, Both Masked and Unmasked.

The ROM Development Aid (830RDA/834RDA) Gives Users the Ability to Automate and Extend Capabilities.

Other Application ROM Packs Contain Software to Expand the Analyzers and Preprogrammed Test Routines Dedicated to Specific Applications.

Three Year Warranty

835/836

Upload/Download
Uploads Data, Downloads Programs Between Analyzer and Host or Analyzer to Analyzer.

Nonvolatile Memory
Automatically Retains All Programs, Set-Ups and Captured Data

Application RAM and ROM Packs
The 830M Series Memory Packs Provide Mass Storage (RAM) of Data and Programs Plus Application Programs (ROM). The 830L Series Library Packs Allow Multiple Selection of Application Programs Through User-Selectable ROM Banks.

Products Are Rackmountable, Standard Instruments Are Lightweight, Rugged and Portable.

836

High Speed, Up to 72 kbps, All Modes.

Data Compression
Prevents Buffer From Filling Up With Idle Frames in HDLC.

ORDERING INFORMATION

The Tektronix three-year warranty applies to these products.

836 Programmable Data Communications Analyzer — **$4,650**
R836 Rackmount Version — **$4,950**
835 Programmable Data Communications Analyzer — **$3,350**
R835 Rackmount Version — **$3,650**
834 Programmable Data Communications Analyzer — **$2,450**

INTERFACE OPTIONS

Option 02 — Current Loop Interface. +$325
Option 03 — RS-449 (RS-422/RS-423) Interface. +$750
Option 04 — MIL-STD-188C Interface. +$350
Option 05 — Two Wire Direct Interface. +$395
Option 06 — V.35 Interface. +$800
Option 07 — (835/836 only) X.21 Interface (A6745/830R12) +$950
Option 09 — X.21 Physical Interface (A6747) +$450

TV ANALYZERS

836TV Television Production Protocol Analyzer — **6,500**
Includes: 836L18; A6746; case.

836L18 Television Production Library Pack — **$1,700**
Includes: TV software (Ampex, Sony BVU-800/BVH-2000, GVG, EBU/SMPTE).

A6746 EBU/SMPTE Bus Interface — **$800**

ROM PACKS

834RDA — ROM Development Aid — **$450**
830RDA — ROM Development Aid — **$450**
834R01 — Asynchronous ROM Pack — **$280**
830R01 — Asynchronous ROM Pack — **$280**
834R02A — Bisynchronous (EBCDIC) ROM Pack — **$350**
834R03A — Link Test ROM Pack — **$370**
830R03 — Link Test ROM Pack — **$370**
834R04 — HDLC/X.25 ROM Pack — **$450**
834R05 — Extended Instruction ROM Pack — **$175**
834R06 — Bisynchronous (ASCII) ROM Pack — **$350**
834R07 — PARS/IPARS ROM Pack — **$375**
830R07 — PARS/IPARS ROM Pack — **$375**
834R10 — SDLC/SNA (FID2) ROM Pack — **$450**
830R10 — SDLC/SNA (FID2) ROM Pack — **$450**
834R11 — Extended Monitor ROM Pack — **$425**
830R12 — X.21 ROM Pack — **$300**
834R13 — SDLC/SNA (FID3) ROM Pack — **$450**
830R13 — SDLC/SNA (FID3) ROM Pack — **$450**
Option 12 — (834R02A, 834R06, 830R10, 834R10, 830R13, 834R13 ROM Packs only) Download with ATT Application +$60

LIBRARY PACKS (835/836 only)

The library and memory packs may be specified to contain one software option for each 16K ROM bank.

Product	Memory	Banks	Price
830L01	16K	2	$255
830L02	64K	4	$400
830L03	128K	8	$550

MEMORY PACKS (835/836 only)

Product	RAM	Banks	ROM	Banks	Price
830M01	16K	1			$350
830M02	16K	1	16K	1	$400
830M03	16K	1	64K	4	$600
830M04	32K	2			$380
830M05	32K	2	16K	1	$450
830M06	32K	2	64K	4	$700
830M07	48K	3			$450
830M08	48K	3	16K	1	$500
830M09	48K	3	64K	4	$750

SOFTWARE OPTIONS (Memory & Library Packs)

Option 01 — 830S01 Asynchronous. +$140
Option 02 — 830S02 Bisync (EBCDIC). +$175
Option 03 — 830S03 Link Test. +$195
Option 04 — 830S04 HDLC/X.25. +$275
Option 06 — 830S06 Bisync (ASCII). +$175
Option 1A — 830SDA ROM Development Aid. +$275
Option 10 — 830S10 SDLC/SNA (FID2). +$275
Option 11 — 830S11 Extended Monitor. +$250
Option 12 — 830S12 X.21*[1]
Option 13 — 830S13 SDLC/SNA (FID3). +$275
Option 2A — 830SDA with Option 01. +$275

TV SOFTWARE OPTIONS

Option 19 — Ampex VPR3/VPR6. +$325
Option 20 — Sony BVU-800/BVH-2000. +$325
Option 21 — GVG 100/300. +$325
Option 22 — EBU/SMPTE (ESbus). +$325

INTERNATIONAL POWER PLUG OPTIONS

Option A1 — Universal Euro 220 V, 50 Hz.
Option A2 — UK 240 V, 50 Hz.
Option A3 — Australian 240 V, 50 Hz.
Option A4 — North American 240 V, 60 Hz.
Option A5 — Switzerland 220 V, 50 Hz.

OPTIONAL ACCESSORIES

Service Manual — Order 070-5600-00 — **$100**
Carrying Case — Order 016-0672-00 — **$80**
Large Carrying Case — Order 016-0812-00 — **$100**
Shielded "T" Cable — Order 175-9709-00 — **$75**
RS-232 V.24 Tri-State Break-Out Box — Order A6743 — **$265**
Interface Adaptors —
(RS-449) Interface. Order A6741 — **$750**
(Two-Wire) Order A6742 — **$395**
(V.35) Order A6744 — **$800**
(Current Loop) Order 015-0361-00 — **$430**
(X.21) Order A6745*[1]
(X.21) Physical Interface. Order A6747 — **$450**
(Coax) Order A6770*[1]

New accessories continually being introduced. Please check with Sales Engineer at local Sales Office.

ADDITIONAL INFORMATION

830 Series Brochure — Request 22-W-5910
830 Series Selection Guide — Request 22-W-5901
Essentials of Data Communications — Request 062-8101-00
Getting Started with Your Data Communications Analyzers — Request 22-W-6243
A variety of training accessories are also available including workbooks, videotapes, etc.

LOGISTICS INFORMATION

For logistics data, see Tektronix Logistics Data Book.

[1] To order, contact your local Tektronix Sales Office.

TEKTRONIX METALLIC CABLE TESTERS: ACCURATE TIME DOMAIN REFLECTOMETRY FOR FIELD MAINTENANCE, LONG-RANGE AND SHORT-RANGE

1502/1503

Portable. Battery-Powered, Self-Contained, Lightweight

Rugged. Meets MIL-T-28800, Type III, Class 3, Style A

Versatile. Tests Any Type Paired-Conductor and Coax Cable

Easy to Use. Produces Results With Minimal Operator Training

The 1502 is appropriate for testing coax and other cables in aircraft, ships, radar sites, etc. It uses a step-pulse and provides fault resolution to 0.6 inch on short cables. The 1502 performs to a maximum of 2000 feet.

The 1503 tests long runs of coax or twisted pair cables in telephone and other communications applications. It provides high-energy, ½-sine-shaped pulses. Range of the 1503, dependent upon cable type, is up to 50,000 feet.

ORDERING INFORMATION

1502 Short Range TDR Cable Tester	**$6,200**
1503 Long Range TDR Cable Tester	**$5,200**

OPTIONS

Option 01 — (1503 Only) Distance Cal.	**+$375**
Option 02 — (1502 Only) With Static Suppressor.	**+$150**
Option 04 — With Cable Tester Recorder.	**+$1,050**
Option 05 — With Cable Tester Metric Version.	**NC**
Option 76 — GM (P7) Phosphor.	**+$35**

INTERNATIONAL POWER PLUG OPTIONS

Option A1 — Universal Euro 220 V, 50 Hz.
Option A2 — UK 240 V, 50 Hz.
Option A3 — Australian 240 V, 50 Hz.
Option A4 — North American 240 V, 60 Hz.
Option A5 — Switzerland 220 V, 50 Hz.

OPTIONAL ACCESSORIES (1502)

Chart Recorder — Order 016-0506-04	**$1,100**
Chart Paper —	
(One Roll) Order 006-1658-01	**$7.25**
(100 Roll Case) Order 006-1658-02	**$575**
Accessory Pouch — Order 016-0351-00	**$31**
Impedance Adaptors —	
(50/75 Ω) Order 017-0091-00*[1]	**$195**
(50/93 Ω) Order 017-0092-00*[1]	**$195**
(50/125 Ω) Order 017-0090-00*[1]	**$195**

[1] Should be purchased with the following connectors.

Connectors —	
(BNC Female-to-GR) Order 017-0063-00	**$50**
(BNC Male-to-GR) Order 017-0064-00	**$90**

OPTIONAL ACCESSORIES (1503)

Chart Recorder — Order 016-0506-06	**$1,100**
Chart Paper —	
(One Roll) Order 006-1658-01	**$7.25**
(100 Roll Case) Order 006-1658-02	**$575**
Isolation Network — (For balanced line). Order 013-0169-00	**$275**
Adaptor Cables (BNC-to-Clips) —	
(Nine foot) Order 012-0671-02	**$80**
(30 foot) Order 012-0671-03	**$90**
Direct Current Adaptor With Filter — 25 foot cord (for use with standard 12 V automobile lighter plug with negative ground). Order 015-0327-00	**$260**
Pulse Inverter — Order 015-0495-00	**$75**

ADDITIONAL INFORMATION

1500 Series TDR Cable Testers Brochure — Order 27-AX-3004-4.

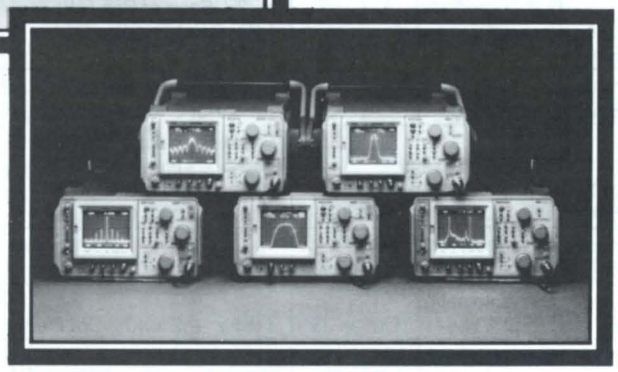
A variety of training accessories are also available including workbooks, videotapes, etc.

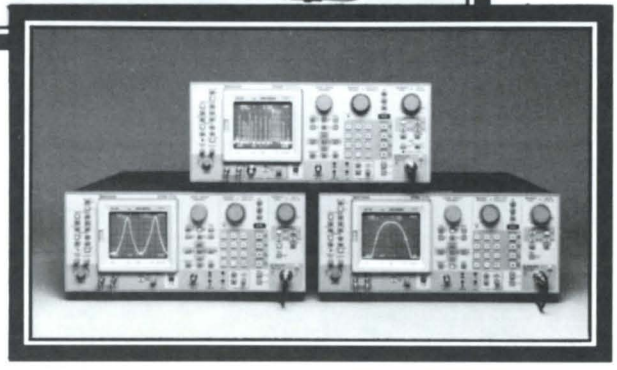
Prices, terms and conditions may change without notice.

LOGISTICS INFORMATION

For logistics data, see Tektronix Logistics Data Book.

SPECTRUM ANALYZERS, SWEPT FREQUENCY SYSTEMS AND IBM PC BASED MEASUREMENT PACKAGES





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SPECTRUM ANALYZER PRODUCT SELECTION GUIDE

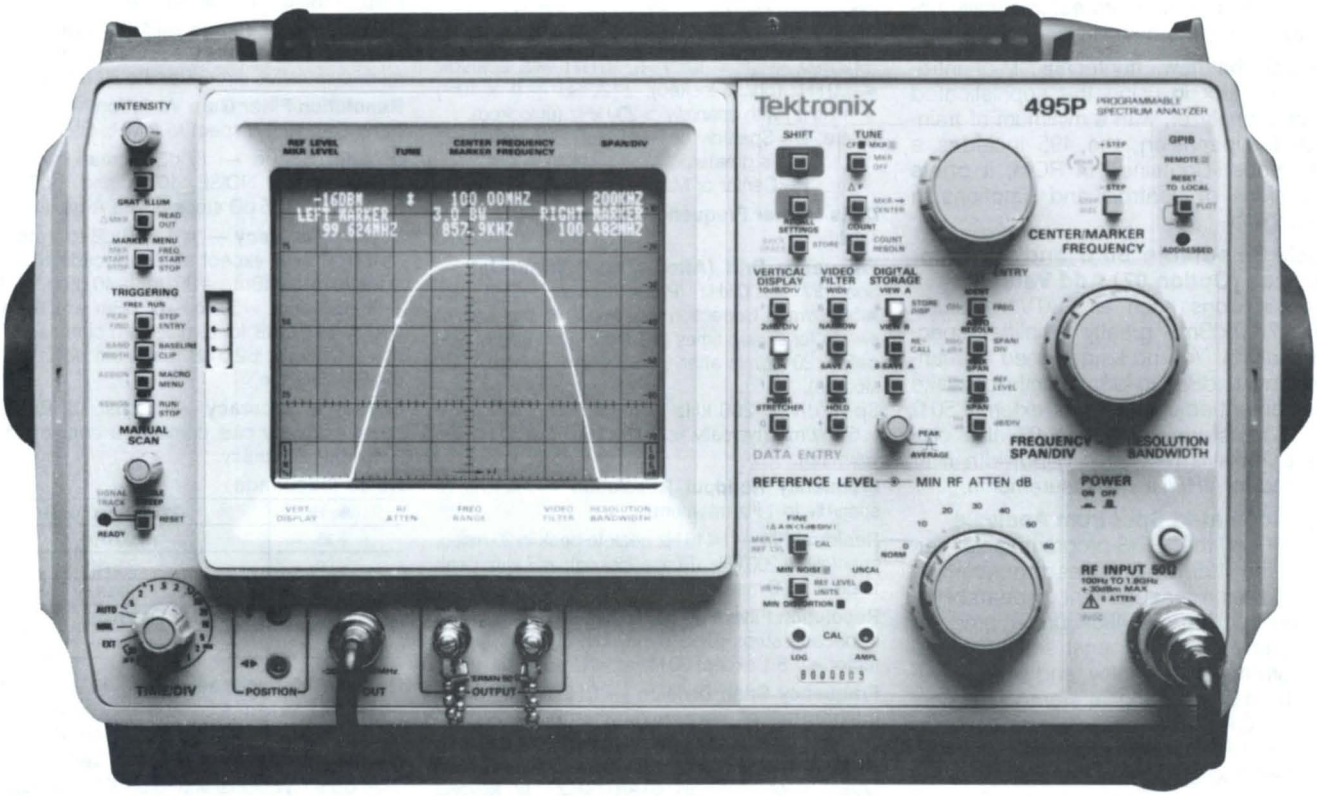
Choose among a large selection of capabilities: Unprecedented measurement convenience in the low cost, portable 2710 Spectrum Analyzer; top RF performance, portability and full programmability in the 490 Series and the 2750 Series; versatility and high performance economy in the 7000 Series plug-ins—from baseband through millimeter-wave.

Enhance your productivity, measurement repeatability and utility with TekSPANS—the *NEW* Family of Spectrum Analyzer Applications Software—available for IBM PC, Tek or HP controllers. Automate your FCC, VDE, and MIL-STD tests with the new EMI prequalification software.

Model	Frequency Range	Minimum Resolution	Average Noise Level (Minimum BW)	Amplitude Measurement Range	GPIB Capability	Tracking Generator	Frequency Accuracy	Page	Prices Begin At
NEW **2754**	50 kHz to 21 GHz	1 kHz	−115 dBm	+30 dBm to −115 dBm	Direct Plot	TR 503	±[(20% Span/Div or Resolution BW)	168	$22,995
NEW **2754P**	50 kHz to 21 GHz	1 kHz	−115 dBm	+30 dBm to −115 dBm	Full	TR 503	+(Center or Marker Frequency) X10^{-5}] Hz	168	$27,995
NEW **2755**	50 kHz to 325 GHz	100 Hz	−125 dBm	+30 dBm to −125 dBm	Direct Plot	TR 503	±[(20% Span/Div or Resolution BW)	166	$26,050
NEW **2755P**	50 kHz to 325 GHz	100 Hz	−125 dBm	+30 dBm to −125 dBm	Full	TR 503	+(Center or Marker Frequency) X10^{-5}] Hz	166	$31,050
NEW **492A**	50 kHz to 325 GHz	100 Hz	−125 dBm	+30 dBm to −125 dBm	Direct Plot	TR 503	±[(20% Span/Div or Resolution BW)	161	$27,290
NEW **492AP**	50 kHz to 325 GHz	100 Hz	−125 dBm	+30 dBm to −125 dBm	Full	TR 503	+(Center or Marker Frequency) X10^{-5}] Hz	161	$33,590
494	10 kHz to 325 GHz	30 Hz	−121 dBm	+30 dBm to −121 dBm		TR 503	±[(2% Span or Res BW) +(CF x Ref Error) +(2N + 25 Hz)]	163	$40,425
494P	10 kHz to 325 GHz	30 Hz	−121 dBm	+30 dBm to −121 dBm	Full	TR 503	±[(2% Span or Res BW) +(CF x Ref Error) +(2N + 25 Hz)]	163	$45,245
NEW **495**	100 Hz to 1.8 GHz	30 Hz	−130 dBm	+ 30 dBm to −130 dBm	Direct Plot	TR 503	±[(2% Span or Res BW) +(F x Ref Error) +15 Hz]	157	$26,250
NEW **495P**	100 Hz to 1.8 GHz	30 Hz	−130 dBm	+ 30 dBm to −130 dBm	Full	TR 503	Where: F=Center or Marker Frequency Ref Error=10^{-5} Standard 10^{-9} Option 05	157	$29,950
496	1 kHz to 1.8 GHz	30 Hz	−126 dBm	+30 dBm to −126 dBm		TR 503 (to 1.8 GHz)	±(5 MHz + 2% Span)	*3	$25,250
7L5	20 Hz to 5 MHz	10 Hz	−148 dBV	+8 dBV to −148 dBV	Semiautomatic with 7854	Option 25	±(5 Hz + 2 x 10^{-6} Dot Freq)	176	*1
7L12	100 kHz to 1.8 GHz	300 Hz	−115 dBm	+30 dBm to −115 dBm	Semiautomatic with 7854	TR 502	±(8 MHz +1% of Dial)	175	*1
7L12 Option 39	100 kHz to 2.5 GHz	300 Hz	−115 dBm	+30 dBm to −115 dBm	Semiautomatic with 7854	TR 502 (to 1.8 GHz)	±(8 MHz +1% of Dial)	175	*1
7L14	10 kHz to 1.8 GHz	30 Hz	−130 dBm	+30 dBm to −130 dBm	Semiautomatic with 7854	TR 502	±(5 MHz + 2% Span)	174	*1
7L14 Option 39	1 kHz to 2.5 GHz	30 Hz	−130 dBm	+30 dBm to −130 dBm	Semiautomatic with 7854	TR 502 (to 1.8 GHz)	±(5 MHz + 2% Span)	174	*1
NEW **2710**	10 kHz to 1.8 GHz	3 kHz 300 Hz*2	−120 dBm −130 dBm*2	+20 dBm to −130 dBm			CF x 10^{-5} CF(5 x 10^{-7})*2	171	Low $8,250

*1 *Dependent on 7000 Series mainframes. See page 218.*
*2 *With Option 01.*
*3 *Contact your local Sales Office for information.*

NO COMPROMISE PERFORMANCE IN THE 495/495P PORTABLE SPECTRUM ANALYZERS



NEW 495/495P

Portable Spectrum Analyzers

GPIB IEEE-488

The 495P complies with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats.*

Covers 100 Hz to 1.8 GHz With −130 dBm Sensitivity and ±1 dB Frequency Response

10^{-9} Marker and Center Frequency Accuracy, Built-In Signal Counter, External Reference Input With Option 05: 10^{-5} Frequency Accuracy With the Standard 495/495P

Front Panel Execution of Downloaded Programs With the 495P Option 05

Intelligent Markers With Signal Processing Functions

Pushbutton Occupied Bandwidth and Noise Normalization Functions

Switch Selectable 50 Ω and 75 Ω Impedances (Option 07) for IF, CATV and Local Area Network Applications

Nonvolatile Memory for Up to Nine Waveforms and Nine Front Panel Settings

Direct Keypad Entry of Control Parameters

HELP Mode Explains Front Panel Controls and Signal Processing Functions at the Touch of a Button

Optional MATE/CIIL Compatibility for Military System Integration

Lab Quality Performance Made Fully Portable and Easy to Use

The Tektronix 495 Spectrum Analyzer offers features essential for lab grade measurements in a lightweight, portable package. Offering frequency coverage from 100 Hz to 1.8 GHz, with an impressive −130 dBm sensitivity and advanced, intelligent markers with exclusive signal processing capabilities, the 495 is optimized for use in baseband through UHF measurements, where ability to identify and process weak signals is critical.

Option 05 Offers Macro Programming, 10^{-9} Frequency Accuracy, Signal Counting and System Clock Compatibility

Downloadable programming capability (495P only) lets you execute frequently used measurement routines from the spectrum analyzer's nonvolatile memory. An internal high stability reference provides 10^{-9} marker or center frequency accuracy for added confidence in measurements. A built-in signal counter with 140 dB dynamic range means you can determine the exact frequency of marked signals only 30 Hz apart, or count the exact delta frequency between two marked signals, even with greatly differing amplitudes.

With Option 05 you also have the flexibility of coupling to a system clock, using the instrument's external reference lock capacity.

Nonvolatile memory lets you store up to nine front panel settings and nine waveforms, simplifying setup and making field operation easier. A permanent record of CRT displays can be obtained at the push of a button, without a controller, using the direct plot capability.

Menu-Selected, Intelligent Markers and Signal Processing

New dynamic markers automatically update frequency and amplitude data with every sweep. In conjunction with the 495's powerful signal processing intelligence, you can use PULSE mode to mark the peak of a main lobe and peaks of side lobes at the push of a button. CW mode locates signals exhibiting CW characteristics and ignores all other signals. SPUR mode marks signals that meet user-definable or automatic threshold criteria. Threshold criteria are available for all signal processing modes.

The 495 also offers hands-off convenience for measuring the bandwidths of filters, amplifiers and other networks. Simply enter the desired bandwidth point, select Bandwidth mode, and markers automatically update to display the new value.

To assist the new, nontechnical, or infrequent operator in using this sophisticated spectrum analyzer, with a minimum of training and supervision, the 495 includes a HELP mode. Contained in ROM, it offers descriptions of controls and functions in plain English.

Switch Selectable 50 Ω and 75 Ω Impedances (Option 07) Add Versatility

For applications such as CATV measurements, 75 Ω/dBmV greatly simplifies spectrum analysis. You no longer need to manually convert dBm to dBmV units or make measurement adjustments for external 50 Ω to 75 Ω transformers. Option 07 also provides a 300 kHz resolution bandwidth filter optimized for VHF/UHF measurements.

Fully Automated Spectrum Analysis

The 495P is the GPIB-programmable version of the 495. It simplifies programming and ensures measurement repeatability. You can operate the 495P under program control, change front panel settings, read data from the CRT display, and send waveforms from internal digital storage memory to other GPIB devices. Tek's *Standard Codes and Formats* keep commands clear, consistent and universally understood.

You can increase programming flexibility and power with the 495P's MATE/CIIL language extension (Option 45). It provides direct memory access for high speed data transmission, a requirement for MATE/CIIL compliance.

To meet budget constraints or future applications, you can add full programmability to a standard 495 at any time. Your Tek Service Center is eager to assist when you are ready to convert.

There are many other time-saving and accuracy enhancing capabilities. See the summary of signal processing and marker functions on page 160 for a more complete idea of the 495 measurement benefits. Talk to your Tektronix Spectrum Analyzer Sales Engineer for complete details.

Tektronix Automated Spectrum Analyzer Packages

Convenient to order, these packages are configured around the IBM PC and Tek laboratory quality programmable 490P Series spectrum analyzers. Coupling the PC to the analyzer via the IEEE-488 bus enables the user to take advantage of the PC's capability, as well as the power and versatility of Tek's spectrum analyzers. A highly versatile General RF Applications Software Package (GRASP) offers many different applications and utility routines which are selected through easy, menu driven operation.

CHARACTERISTICS

The following characteristics apply after a 30 minute warm-up period unless otherwise noted.

FREQUENCY RELATED

Frequency Range — 100 Hz to 1.8 GHz.

Center and Marker Frequency Accuracy*1 — ±[20%D + (F x 10^{-5}) + 15 Hz] with span/div ≤200 kHz (phase locked); ±[20%D + (F x 10^{-5}) + 15 kHz] with span/div >200 kHz (unlocked).
Where: D=Span/div or Resolution BW, whichever is greater.
F=Center or Marker Frequency.

Delta Marker Frequency Accuracy — ±1% of Total Span.

Frequency Drift (After 1 Hour Warm-Up) — Span/div ≤200 kHz (Phase Locked): Drift rate ≤50 Hz/min. Correction will occur at the end of sweep for sweep times ≥5 s/div. (Drift rate is typically <20 Hz/min after 1 hour warm-up from 25°C storage).
Span/div >200 kHz (unlocked): Drift rate <5 kHz/min (typically <25 kHz/min after 30 minute warm-up).

Frequency Readout Resolution — ≤10% of span/div to 1 Hz minimum.

Residual FM — ≤10 Hz peak-to-peak in 20 msec, span/div ≤200 kHz (Phase locked); ≤7 kHz peak to peak in 20 msec, span/div >200 kHz (unlocked).

Resolution Filters — 30 Hz then 100 Hz to 1 MHz in decade steps (6 db bandwidth ±20%); Shape factor ≤7.5:1 except 30 Hz at ≤12:1 (60 dB/6 dB).

Frequency Span/Division — 0 Hz (ZERO SPAN pushbutton or keypad data entry); 20 Hz to 100 MHz (in a 1-2-5 sequence) via span/div knob; 20 Hz to 170 Hz (to two significant digits) via FREQUENCY or MARKER START/STOP, or keypad data entry; 180 MHz via power-up, RESET, or MAX SPAN pushbuttons; accuracy ±5%.

Frequency Response — ±1.0 dB (measured with 10 dB RF attenuation).

Zero Frequency Spur — −24 dBm maximum measured into 50 Ω and open circuit with 0 dB RF attenuation; −35 dBm typical.

AMPLITUDE RELATED

Vertical Display Modes — 10 dB/div, 2 dB/div and linear via pushbutton; any integer from 1 to 15 dB/div via Data Entry keypad.

Display Dynamic Range — 80 dB Log mode; 8 divisions Linear mode.

Reference Level Range — Log Mode : −117 to +40 dBm (+30 dBm maximum); −130 to +27 dBV (+17 dBV maximum); −70 to +87 dBmV (+77 dBmV maximum); −10 to +147 dBμV (+137 dBμV maximum).
Linear Mode: 39.6 nV/div to 2.8 V/div (1 W or 10 V peak maximum).

Reference Level Steps — 10 dB coarse, 1 dB fine in 10 dB log; 1 dB coarse, 0.25 dB fine in 2 dB log; 1-2-5 sequence coarse, 1 dB equivalent fine in linear; coarse step=Log/div (except 1 dB for 2 dB/div), fine is 1 dB for ≥5 dB or 0.25 dB for ≤4 dB/div, set via Data Entry keypad.

Reference Level Accuracy — Accuracy is dependent on a combination of RF Attenuator Accuracy, IF Gain Accuracy, Resolution Bandwidth, Display Mode, Calibrator Accuracy, Frequency Response and Temperature Change. (±0.15 dB/°C maximum.)

**1 Reference Oscillator Accuracy: ±1.5 kHz over the temperature extremes of −15°C to +55°C.*

Display Amplitude Accuracy — ±1.0 dB/10 dB to a maximum error of ±2.0 dB over 80 dB range (10 dB/div Log); ±0.4 dB/2.0 dB to a maximum error of ±1.0 dB over 16 dB range (2 dB/div Log); ±5% of full scale in Linear.

RF Attenuator Range and Accuracy — 0 to 60 dB in 10 dB steps; 0.5 dB/10 dB, 1.0 dB maximum cumulative error over the 60 dB range.

Resolution Filter Gain Variation — <±0.4 dB (after CAL with respect to 1 MHz filter).

IF Gain Range — 87 dB increase, 10 dB decrease in MIN NOISE, 10 dB and 1 dB steps; 57.75 dB in 0.25 dB steps (Delta A mode).

IF Gain Accuracy — ≤0.2 dB/dB to a maximum of 0.5 dB/9 dB except at the decade transitions −29 to −30 dBm, −39 to −40 dBm, −49 to −50 dBm and −59 to −60 dBm which add an additional 0.5 dB for a maximum cumulative error of 1 dB/10 dB; ±2.0 dB maximum deviation over the 97 dB range.

Marker/s Accuracy — Equal to Reference Level Accuracy plus cumulative error of Display Amplitude Accuracy.

Noise Sidebands

dBc/Hz	Offset From Carrier
−85	900 Hz
−90	3 kHz
−105	30 kHz
−115	300 kHz
−125	3 MHz

Residual Responses — ≤−100 dBm with input terminated and 0 dB RF attenuation (≤−95 dBm for Rackmount Option 31).

Harmonic Distortion — ≤−60 dBc for a −30 dBm CW signal with 0 dB RF Attenuation in MIN DISTORTION mode.

Third Order Intermodulation Distortion — ≤−70 dBc for any two on-screen CW signals within any frequency span in MIN DISTORTION mode.

Sensitivity (Equivalent Input Noise)

Sensitivity dBm	Resolution
−130	30 Hz
−125	100 Hz
−115	1000 Hz
−105	10 kHz
−95	100 kHz
−85	1 MHz

LO Emissions — ≤−70 dBm with 0 dB RF attenuation.

INPUT SIGNAL

RF Input — Type "N" female, 50 Ω nominal impedance.

VSWR — 1.3:1 maximum, 1.2:1 typical, with 10 dB or more RF attenuation; 2.0:1 maximum, 1.9:1 typical, with 0 dB attenuation.

Maximum Safe Input (0 dB RF Attenuation) — +30 dBm (1 W) continuous, 75 W peak, 1 μsec pulse width, 0.001 duty; 0 Vdc.

1 dB Gain Compression — −10 dBm with 0 dB RF attenuation in MIN NOISE; −20 dBm with 0 dB RF Attenuation in MIN DISTORTION; (No gain compression can be observed on screen).

OUTPUT SIGNALS

Calibrator (Cal Out) — −20 dBm ±0.3 dB at 100 MHz ± 10 PPM.

1st and 2nd LO — Provides access to the output of the respective local oscillators. 1st LO output range +6 dBm to +15 dBm; 2nd LO output range −10 dBm to +15 dBm; these ports must be terminated in 50 Ω at all times.

Vertical Output — Provides 0.5 V ±5% of signal/div of video above and below the CRT centerline; 1 kΩ source impedance.

Horizontal Output — Provides 0.5 V either side of the CRT centerline. Full range ±2.5 V ±10%.

Pen Lift — TTL compatible, +5 V nominal to lift pen.

10 MHz IF Output — Output level is −5 dBm for a full screen signal at −30 dBm reference level; 50 Ω nominal impedance.

110 MHz IF Output (Option 42) — Center frequency from 108.5 MHz to 111.5 MHz; 3 dB bandwidth >5 MHz; Bandpass ripple ≤0.5 dB; power out with −30 dBm reference level and a full screen signal ≤0 dBm; 1 dB compression at ≥0 dBm output, MIN DISTORTION; 50 Ω nominal impedance.

Probe Power — Provides operating voltages for active probes. Pin 1: +5 V at 100 mA maximum. Pin 2: Ground. Pin 3: −15 V at 100 mA maximum. Pin 4: +15 V at 100 mA maximum.

IEEE Standard 488-1978 Interface Function Subsets Implemented — 495P Version: In accordance with IEEE Std 488-1978 implemented as SH1, AH1, T5, L3, SR1, RL1, PP1, DC1, DT1, and CØ. 495 Non-P Version (Plotter Output): Implemented as SH1, AHØ, T3, LØ, SRØ, RLØ, PPØ, DCØ, DTØ, and CØ.

DISPLAY CHARACTERISTICS

CRT — 8 cm x 10 cm, GH (P31) phosphor.

CRT Readout — Displays: Reference level, center frequency, marker frequency and amplitude, frequency range, vertical display mode, frequency span/div, resolution bandwidth, RF attenuation, video filter, and text.

Video Filter Range — 0.3 Hz to 30 kHz (coupled to resolution filter by front panel pushbuttons).

Sweep — Triggered, auto, manual, single sweep, and external.

Sweep Time — 20 μs to 5 s/div (10 s/div in Auto) in a 1-2-5 sequence; accuracy ±5%.

Triggering — Internal, External, Line, and Free Run; Internal Trigger Level ≥2 div of signal; external level ≥1 V peak, 15 Hz to 1 MHz, 50 V maximum (dc + ac peak).

Digital Storage — 1000 points Horizontal, 250 points Vertical; A and B Views; Save A; Max Hold; B to Save A; digital averaging (Peak/Average); Pulse Stretcher.

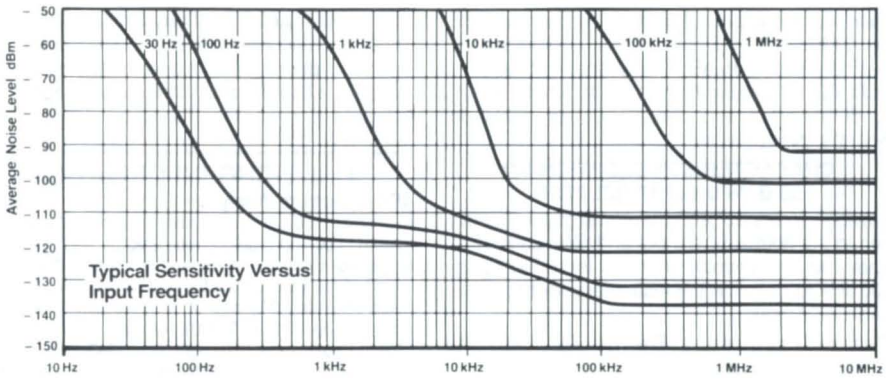
Nonvolatile Display Memory — Store and recall up to 9 full waveforms complete with CRT readouts.

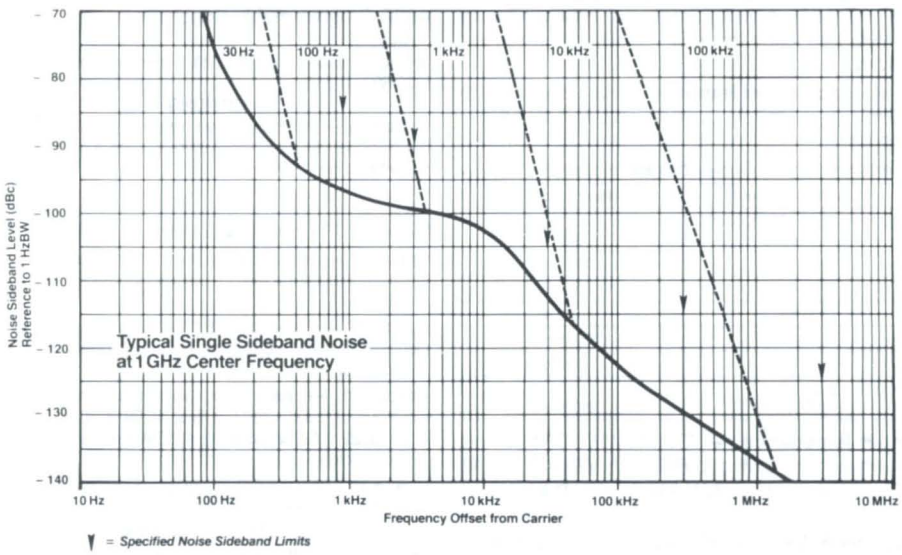
GENERAL CHARACTERISTICS

Input Voltage — 90 to 132 V ac or 180 to 250 V ac, 48 to 440 Hz.

Power — 210 W maximum with all options, at 115 V and 60 Hz.

Configuration — (Portable) 19.1 kg (42 lb) including cover and included accessories. Option 05 adds .4 kg (.9 lb). Option 07 adds .2 kg (.4 lb); 175 mm x 327 mm x 499 mm (6.9 in x 12.9 in x 29.6 in).





ENVIRONMENTAL

Meets MIL-T-28800C, Type III, Class 3, Style C specifications as follows:

Temperature — Operating: −15°C to +55°C. Nonoperating: −62°C to +85°C.

Altitude — Operating: 15,000 feet (tested to 25,000 feet). Nonoperating: 40,000 feet (50,000).

Vibration — Operating: 15 Hz to 55 Hz at 4 g maximum per MIL-STD-810D, Method 514, Procedure I (modified).

Humidity — Operating: 95% (+5%, −0%). Nonoperating: Five cycles (120 hours) in accordance with MIL-STD-810D Procedure 3 (modified).

Shock — Operating and Nonoperating: 30 g, one-half sine, 11 ms (tested to 50 g).

Transit Drop — Free fall, 12 inches, one per each of six faces and eight corners.

Electromagnetic Compatibility — Meets requirements of MIL-STD-461B Part 4 tested as follows:
Conducted Emissions: CE01, 1 kHz to 15 kHz only; CE03, 15 kHz to 50 kHz relaxed by 15 dB.
Conducted Susceptibility: CS01; CS02; CS06.
Radiated Emissions: RE01, Relaxed by 10 dB for fundamental to the 10th harmonic of power line (exceptioned, 30 kHz to 36 kHz); RE02.
Radiated Susceptibility: RS01; RS02, to 5A only; RS03, up to 1 GHz.

CHARACTERISTICS (OPTION 05)

Provides precision internal reference, signal counter, external reference input, and Macro (495P only) down-loadable programming capabilities.

Center and Marker Frequency Accuracy — ±[20%D + (F x Ref. Freq. Error) + 15 Hz] with span/div ≤200 kHz (Phase locked); ±[20%D + (F x Ref. Freq. Error) + 15 kHz] with span/div >200 kHz (unlocked).
Where: D=Span/div or Resolution BW, whichever is greater.
F=Center or Marker Frequency.

Reference Frequency Error (Internal) — ≤1 x 10^{-9} per day; ≤1 x 10^{-7} in the first six months, ≤1 x 10^{-7} year thereafter; Accuracy 30 minutes after power on within 5 x 10^{-8} of the frequency after 24 hours; Within 2 x 10^{-8} over the temperature range of −15°C to +55°C.

Signal Counter Accuracy — ±[(F x Ref. Freq. Error) + 12 Hz + 1 LSD]
Where: F=Center, Marker, or Delta Marker Frequency
LSD=Least Significant Digit

Counter Sensitivity — Signal level must be ≤20 dB above the average noise level and within 60 dB of the reference level.

Counter Readout Resolution — Selectable from 1 Hz to 100 MHz in decade steps.

TEK 100 Hz to 1.8 GHz PORTABLE SPECTRUM ANALYZERS

External Reference Input — Frequency: 1,2,5, or 10 MHz with ⩽5 ppm stability. Power Range: −15 dBm to +15 dBm. Waveshape: Sinewave, ECL, TTL (Allowable Duty cycle symmetry is 40% to 60%). Input Impedance: 50 Ω ac, 500 Ω dc; Rear-panel BNC input.

CHARACTERISTICS (OPTION 07) 50 Ω/75 Ω INPUT RELATED

Provides 75 Ω input and dBmV calibration in addition to the normal 50 Ω input and dBm calibration. The 100 kHz resolution filter is replaced by 300 kHz to optimize the instrument for broadcast and CATV uses.

Center Frequency Range — 1 MHz to 1000 MHz.

Frequency Response — ±2.0 dB from 5 MHz to 1000 MHz; typical response for the 1 MHz to 5 MHz frequency range is <3 dB down from the 5 MHz response.

Reference Level Range — −68 dBmV to +79 dBmV (+89 dBmV is achievable in MIN NOISE mode).

Sensitivity (Equivalent Input Noise)

Sensitivity dBmV	Resolution
75 Ω Input 5 MHz to 1000 MHz	
−81	30 Hz
−76	100 Hz
−66	1000 Hz
−56	10 kHz
−41	300 kHz
−36	1 MHz
50 Ω RF Input	
−90 (dBm)	300 kHz

Input Impedance — 75 Ω; VSWR 1.35:1 (17 dB RL) maximum, 5 MHz to 800 MHz; VSWR 1.6:1 (13 dB RL) maximum, 800 MHz to 1000 MHz; BNC female.

Maximum Input Level — With 0 dB attenuation: +78 dBmV. With attenuation ⩾20 dB: +78 dBmV, 100 V maximum (dc + ac peak).

Calibrator (Cal Out) — +20 dBmV ±0.5 dB; 75 Ω impedance nominal.

CHARACTERISTICS (OPTIONS 30 AND 31) RACKMOUNT

These options provide rackmount configurations with accessories drawer that mount in standard EIA 19 inch racks. Option 31 additionally provides rear-panel input/output connectors. These rackmounts affect the 495/495P electrical and environmental characteristics as follows:

Environmental — Meets MIL-T-28800C, Type III, Class 5, Style F.

Residual FM — May increase according to the rack frame environment; typically by a factor of two.

Electrical — (Option 31) Frequency Response: ±1.5 dB measured at the rear panel RF input. Residual Spurious Response: <−95 dBm.

Size — 8.75 x 16.89 x 25.00 inches (222 x 429 x 635 mm).

Weight — Adds 20 lbs. (9.1 kg) to the weight of the instrument.

PORTABLE TO RACK ADAPTOR

Those needing the utility of a rackmounted instrument and desiring easy convertibility to a rugged portable should order the rack adaptor P/N 016-0844-00 rather than the Option 30 or 31.

ORDERING INFORMATION

495 Spectrum Analyzer **$26,250**

Includes: 50 Ω coax cable, N to N Conn, 6 ft (012-0114-00); 50 Ω coax cable, BNC to BNC Conn, 18 in (012-0076-00); operator manual, Vol. 2 (070-5085-00); N male to BNC female adaptor (103-0045-00); 4A fast blow fuses (159-0017-00); power cord (161-0104-00); power cord clamp (343-0170-00); amber CRT light filter (378-0115-01); gray CRT light filter (343-0115-02); CRT mesh filter, (378-0887-01); Rear Connector Shield (337-3274-00).

495P Programmable Spectrum Analyzer **$29,950**

Includes: Same as 495 plus programmer's manual (070-5086-00).

OPTIONS

Option 05 — Adds precision frequency reference, signal counter, external reference lock, and macro programming.
(495) **+$2,500**
(495P) **+$3,000**
Includes: CRT mesh filter (378-0227-01).

Option 07 — Adds 75 Ω input and dBmV calibrator to the normal 50 Ω input and dBm calibrator. **+$750**

Option 30 — Rackmount; 8.75 x 16.89 x 25.0 inches (222 x 429 x 635 mm); fits EIA standard 19 inch rack. **+$790**

Option 31 — Rackmount with rear-panel input/output connectors; 8.75 x 16.89 x 25.0 inches (222 x 429 x 635 mm); fits EIA standard 19 inch rack. **+$840**

Option 39 — Replaces Lithium with Silver batteries for instrument memory. **+$50**

Option 42 — 110 MHz, >5 MHz bandwidth, IF Output suitable for broadband receiver measurements. **+$1,500**

Option 45 — MATE/CIIL language interface (495P only). **+$4,975**

Option 52*1 — North American 220 V configuration with standard power cord.

**1 To order, contact your local Tektronix Sales Office.*

INTERNATIONAL POWER PLUG OPTIONS

Option A1 — Universal Euro 220 V, 50 Hz.
Option A2 — UK 240 V, 50 Hz.
Option A3 — Australian 240 V, 50 Hz.
Option A4 — North American 240 V, 60 Hz.
Option A5 — Switzerland 220 V, 50 Hz.

WARRANTY-PLUS SERVICE PLANS

SEE PAGE 497

M1 — (495) 2 Calibrations. **+$1,735**
M1 — (495P) 2 Calibrations. **+$1,810**
M2 — (495) 2 Years Service. **+$2,875**
M2 — (495P) 2 Years Service. **+$3,015**
M3 — (495) 2 Years Service and 4 Calibrations. **+$3,470**
M3 — (495P) 2 Years Service and 4 Calibrations. **+$3,620**

SUMMARY OF SIGNAL PROCESSING AND MARKER FUNCTIONS

Assign Menu Functions — Marker functions that are assignable to nonvolatile front-panel pushbuttons ASSIGN 1 and ASSIGN 2 listed as follows:

RIGHT NEXT: Moves marker to the right next signal defined by "SIGNAL TYPE" in frequency.

LEFT NEXT: Moves marker to the left next signal defined by "SIGNAL TYPE" in frequency.

NEXT LOWER: Moves marker to the next lower signal defined by "SIGNAL TYPE" in amplitude.

NEXT HIGHER: Moves marker to the next higher signal defined by "SIGNAL TYPE" in amplitude.

MOVE RIGHT "X" dB: Moves marker to the right "X" dB (X can be + or −) in signal amplitude from its current position.

MOVE LEFT "X" dB: Moves marker to the left "X" dB (X can be + or −) in signal amplitude from its current position.

FIND PEAK AND CENTER: Marks the highest displayed signal and moves it to the center of the CRT screen.

Signal Type Menu — Sets the signal processor pattern recognition from a selection of three routines (chosen signal type remains in memory until overwritten by new selection, RESET, which defaults to CW, or power-down):

CW: Recognizes signals with CW characteristics and ignores all others (instrument selects this mode at power-up).

PULSE: Recognizes pulsed RF lobe patterns for line and dense spectrums and places marker at peaks for easy location of carrier spectral line.

SPUR: Recognizes ALL signals including impulses above the assigned Threshold.

Noise Normalization (dB/Hz) — Normalizes the noise measured at the marked position to 1 Hz; simplifies Phase Noise and Signal/Noise Ratio tests.

Signal Track — Locates, marks, and centers on the highest signal on screen above the Threshold. If track is lost, or if the signal drops below Threshold value, "SIGNAL TRACK IDLE" will be displayed on the CRT below the last "tracked" frequency and the instrument will "idle" there until track is regained.

Peak Find — Locates and marks the highest displayed signal on the CRT.

Bandwidth — Places markers the assigned number (from memory) of dB below, left and right of desired signal peak automatically after each sweep.

Marker to Reference Level — Changes reference level to the marker amplitude value.

Marker to Center — Changes center frequency to equal marker frequency.

Marker Start/Stop — Frequency start/stop sweep is matched to the current delta marker positions.

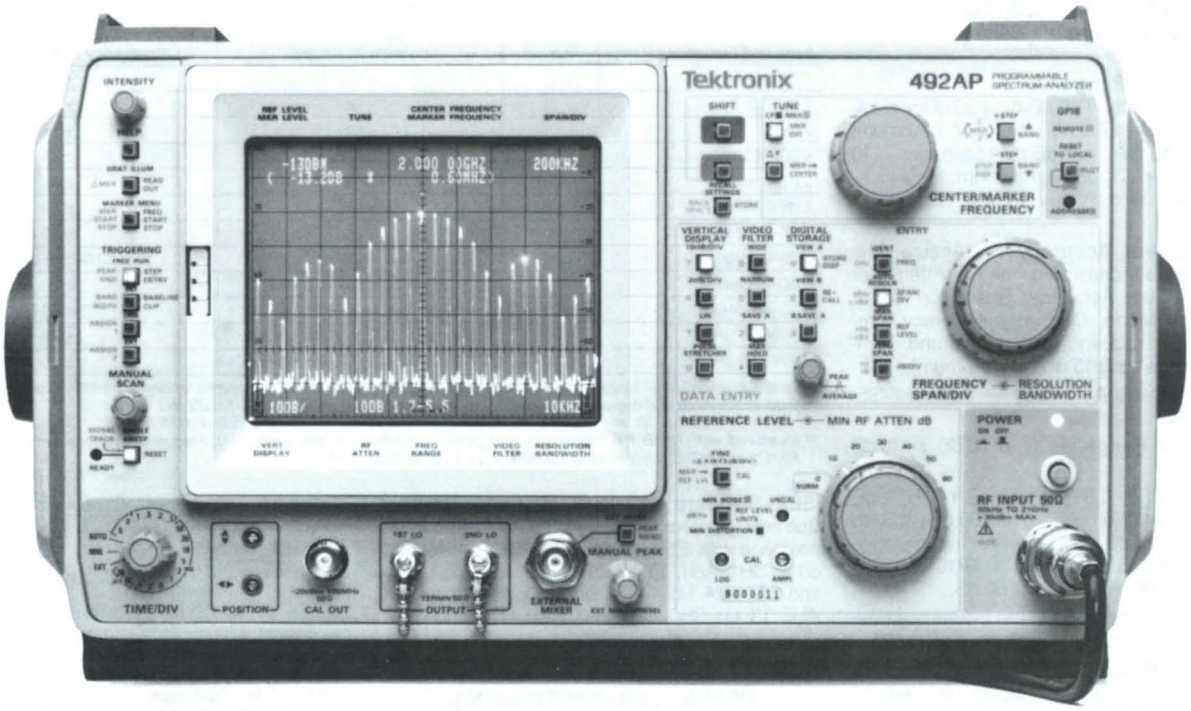
Step Size — Assigns either the center, marker, or delta marker frequency to the ±STEP frequency functions.

Macro Menu (495P Option 05 only) — Allows the selection from up to seven stored user-defined programs to be executed.

Run/Stop (495P Option 05 only) — Starts and stops execution of the selected Macro program.

Settings Store/Recall — Allows up to nine full front panel set-ups, plus a power-down last instrument state, to be stored and recalled from nonvolatile memory.

Zoom (495P only) — Moves the marked signal to center screen and decrements the span.



NEW 492A/492AP

Spectrum Analyzers

GPIB IEEE-488 The 492AP complies with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats.*

Dot Markers Accurate in Frequency to 10^{-5}

Frequency Range From 50 kHz to 325 GHz

CW, Pulse and Spurious Signal Processing Modes

Occupied Bandwidth Function
—dBm, dBV, dBmV and dBμV Alternate Reference Units
—Signal Tracking
—Noise Normalization

Keypad Entry of Frequency, Span/Div, Reference Level and Vertical Scale Factors

Environmentalized per MIL-T-28800C Type III, Class 3, Style C

Convenience, Accuracy, Intelligence and Value

The 492A and the fully programmable 492AP represent a new benchmark for spectrum analyzers with built-in signal processing intelligence. These spectrum analyzers are designed to offer power to the experienced user, yet offer convenience to the novice, in field environments and in the lab. These lightweight, portable form factor spectrum analyzers deliver maximum utility and benefits at a reasonable cost.

Counter Center Frequency Accuracy, Near Zero Long Term Drift, Superior Range and Resolution All in One Package

The 492A offers calibrated amplitude and frequency coverage from 50 kHz to 21 GHz in coax, and to 325 GHz using Tek's WM 490 Series high performance waveguide mixers.

Center frequency accuracy is excellent; typically 1 kHz at 100 MHz, 10 kHz at 10 GHz and 40 kHz at 40 GHz. Negligible long term frequency drift ensures measurement repeatability.

You get 100 Hz resolution bandwidth to 220 GHz and 1 kHz resolution to 325 GHz with high sensitivity and low phase noise—plus built-in preselection to 21 GHz (Option 01).

With Its Built-In Marker Intelligence You Can Rely on the 492A as a Decision-Making Tool

Menu-Selectable Signal Processing

Enables the analyzer to mark the peak of a main lobe and the peaks of side lobes at the push of a button—using the pulsed RF signal processing mode in conjunction with other marker functions like Peak Find, Right Next and Left Next. The CW mode will mark only signals exhibiting CW characteristics with regard to span and resolution, ignoring all other signals. The spur mode will locate all signals that meet user-definable or automatic threshold criteria. Threshold criteria is available for all signal processing.

CHARACTERISTICS

The following characteristics apply after a 30 minute warm-up period unless otherwise noted.

FREQUENCY RELATED

Frequency Range — 50 kHz to 21 GHz coaxial input; 50 kHz to 325 GHz external mixer input (amplitude specified from 18 GHz to 325 GHz with Tektronix WM 490 Series Waveguide Mixers).

Center and Marker Frequency Accuracy*[1] — Phase Locked: $\pm[20\%D + (Fx10^{-5})]$ Hz. Bands 1 and 5–12 with span/div ≤200 kHz, and Bands 2–4 with span/div ≤100 kHz. Unlocked: $\pm[20\%D + (Fx10^{-5}) + (15\ kHz)N]$ Hz.
Where: D=Span/div or Res BW, whichever is greater.
F=Center or Marker Frequency
N=Harmonic Mixing Number

Center Frequency Drift (After 1 Hour Warm-Up) — Bands 1 and 5–12 with span/div ≤200 kHz, and band 2–4 with span/div ≤100 kHz. Phase locked: ≤50 Hz per minute of sweep time corrected at least every 30 seconds. Unlocked: ≤(5 kHz) N per minute of sweep time.

Frequency Readout Resolution — ≤10% span/div to 1 kHz minimum (100 Hz in Delta Marker Mode).

Residual FM — Phase Locked: ≤(10 +2N) Hz peak-to-peak in 20 ms, Bands 1 and 5–12 with span/div ≤200 kHz, and Bands 2–4 with span/div ≤100 kHz. Unlocked: ≤(7 kHz) N peak-to-peak in 20 ms.

Noise Sidebands

dBc/Hz	Offset From Carrier
≤−95	3 kHz
≤−105	30 kHz
≤−115	300 kHz

Resolution Filters — 100 Hz to 1 MHz (6 dB bandwidth ±20%) in decade steps. Shape factor ≤7.5:1 (60 dB/6 dB).

Frequency Span/Div — 0 Hz (ZERO SPAN pushbutton or keypad data entry); 200 Hz to 10 GHz (in a 1-2-5 sequence) via span/div knob; 200 Hz to 15 GHz (to two significant digits) via keypad or start/stop data entry, or marker start/stop; full band via MAX SPAN pushbutton (12 bands). Accuracy ±5% of selected span/div.

*[1] *Over the operating temperature extremes of −15°C to +55°C, 1.5 x 10^{-5}*

TEK 50 kHz to 325 GHz PORTABLE SPECTRUM ANALYZERS

AMPLITUDE RELATED

Vertical Display Modes — Same as 495. See page 158.

Reference Level Range —
Log Mode: −117 to +40 dBm, +30 dBm maximum; −130 to +27 dBV, +17 dBV maximum; −70 to +87 dBmV, +77 dBmV maximum; −10 to +147 dBμV, +137 dBμV maximum.
Linear Mode: 39.6 nV/div to 2.8 V/div, 1 W maximum.

Reference Level Accuracy — Accuracy is dependent on a combination of RF Attenuator Accuracy, IF Gain Accuracy, Resolution Bandwidth, Display Mode, Calibrator Accuracy, Frequency Band, Frequency Response and Temperature Change (±0.15 dB/°C maximum).

Display Amplitude Accuracy — Same as 495. See page 158.

RF Attenuator Range — 0 to 60 dB in 10 dB steps.

Accuracy — Dc to 1.8 GHz: 0.5 dB/10 dB, 1 dB maximum cumulative error over 60 dB. 1.8 to 18 GHz: 1.5 dB/10 dB, 3 dB maximum cumulative error over 60 dB. 18 to 21 GHz: 3 dB/10 dB, 6 dB maximum cumulative error over 60 dB.

Marker/s Accuracy — Equal to Reference Level Accuracy plus Display Amplitude Accuracy.

SPURIOUS RESPONSES

Residual — ⩽−100 dBm. Rackmount Options 30 and 31: ⩽−90 dBm.

Harmonic Distortion — ⩽−60 dBc for a −40 dBm input 50 kHz to 21 GHz in MIN Distortion mode. Not discernible above the noise (typically −100 dBc) for preselected bands (Option 01 only).

LO Emissions — ⩽−10 dBm. Option 01: ⩽−70 dBm.

Third Order Intermodulation Distortion — ⩽−70 dBc for CW signal (MIN Distortion Mode) Any two on-screen signals within any frequency span (50 kHz to 21 GHz); ⩽−100 dBc for signals spaced ⩾100 MHz for preselected bands (Option 01 only).

INPUT SIGNAL

RF Input — Type "N" female 50 Ω nominal impedance.

VSWR

Frequency	0 dB Attenuation (Typical)	10 dB Attenuation
50 kHz to 2.5 GHz	1.9:1	1.3:1 Max; 1.2:1 Typical
2.5 to 6.0 GHz	1.9:1	1.7:1 Max; 1.5:1 Typical
6.0 to 18 GHz	2.3:1	2.3:1 Max; 1.9:1 Typical
18 to 21 GHz	3.0:1	3.5:1 Max; 2.7:1 Typical

Measured at ±3 MHz of preselector peak for Option 01.

Maximum Safe Input — +30 dBm CW with ⩾20 dB attenuation; +13 dBm CW with 0 dB attenuation; 0 V dc. Option 01 preselector: +30 dBm (1 W) CW; 75 W peak, 1 μs Pulse width, 0.001 duty; 0 dB attenuation. Do not apply dc.

1 dB Gain Compression — ⩾−18 dBm in MIN Distortion Mode.

OUTPUT SIGNAL

Same as the 495 (see page 158) except for the following:

Calibrator (Cal Out) — −20 dBm ±0.3 dB at 100 MHz ±1.0 kHz

1st and 2nd LO — Provides access to the output of the respective local oscillators (1st LO + 7.5 dBm minimum to a maximum of +15 dBm; 2nd LO −22 dBm minimum to maximum of +15 dBm). These ports must be terminated in 50 Ω at all times.

Table 1: SENSITIVITY AND FREQUENCY RESPONSE

Band and Frequency Range	Harmonic Number	Sensitivity at (dBm) Minimum Resolution	Frequency Response (dB)*3
1 (50 kHz–4.2 GHz)*1	1	−125	±1.5
2 (1.7–5.5 GHz)*1	1	−125	±1.5
3 (3.0–7.1 GHz)*1	1	−125	±1.5
4 (5.4–18 GHz)*1	3	−110	±2.5
5 (15–21 GHz)*1	3	−105	±3.5
6 (18–27 GHz)	6	−108	±2.0
7 (26–40 GHz)	10	−103	±2.0
8 (33–60 GHz)	10	−103	±2.2 33 to 50 GHz; ±2.5 40 to 60 GHz
9 (50–90 GHz)*2	15	−105 at 50 GHz; −95 at 90 GHz	±3.0
10 (75–140 GHz)*2	23	−100 at 75 GHz; −85 at 140 GHz	±3.0
11 (110–220 GHz)*2	37	−90 at 110 GHz; −75 at 220 GHz	±3.0
12 (170–325 GHz)*2	56	−70 at 170 GHz; −55 at 325 GHz	±3.0

**1 Band 1 is limited to 50 kHz to 1.8 GHz for preselected (Option 01) units. The preselector degrades minimum sensitivity by 5 dB (6 dB in BAND 3) and degrades frequency response by ±1.0 dB to 18 GHz; ±1.5 dB to 21 GHz.*
**2 Frequency response for any 5 GHz band. Response is within ±6 dB referenced to 100 MHz.*
**3 Measured with 10 dB RF Attenuation and peaking optimized (when applicable). Frequency response within ±3.5 dB from 50 kHz to 18 GHz referenced to 100 MHz (±4.5 dB for Option 01).*

IEEE Standard 488-1978 Interface Function Subsets Implemented — 492AP Version: In accordance with IEEE Standard 488-1978, implemented as SH1, AH1, T5, L3, SR1, RL1, PP1, DC1, DT1, and C0. 492A Non-P Version: Implemented as SH1, AH0, T3, L0, SR0, RL0, PP0, DC0, DT0, and C0.

DISPLAY

Same as the 495 (see page 159).

GENERAL CHARACTERISTICS

Same as the 495 (see page 159) except as noted.

Configuration — (Portable) 20 kg (44 lb), all options; 17.5 x 32.7 x 49.9 cm (6.9 x 12.9 x 19.7 in) without handle or cover.

Environmental — Per MIL-T-28800C Type III, Class 3, Style C. Same as 495 (see page 159).

ORDERING INFORMATION

492A Spectrum Analyzer **$29,040**
Includes: 50 Ω coax cable, N to N connector, 6 ft (012-0114-00); 50 Ω coax cable, BNC to BNC connector, 18 in (012-0076-00); service manual Vol. 1 (070-5565-00); service manual Vol. 2 (070-5566-00); operator's manual (070-5562-00); N male to BNC female adapter (103-0045-00); 2 Fast-Blo 4A fuses (159-0017-00); power cord (161-0104-00); power cord clamp (343-0170-00); amber CRT light filter (378-0115-01); gray CRT light filter (378-0115-02); CRT mesh filter (378-0887-01).

492AP Programmable Spectrum Analyzer **$35,340**
Includes: Same as 492A plus programmer's manual (070-5564-00).

OPTIONS*1

Option 01 — Adds preselection for the 1.7 GHz to 21 GHz band and limiter for 1st mixer below 1.8 GHz. **+$3,995**

Option 07 — 75 Ω dBmV input and calibration in addition to 50 Ω dBm input and calibration. **+$750**
Includes: BNC male to female adaptor connector (013-0126-00); 75 Ω coax cable, BNC to BNC connector, 42 in (012-0074-00).

Option 08 — Deletes external mixer capability. Frequency range limited to 50 kHz to 21 GHz (not combinable with options 07, 21, 22). **−$1,750**

Option 21 — High Performance 18 to 40 GHz Waveguide Mixer Set includes two mixers (18 to 26.5 GHz, and 26.5 GHz to 40 GHz). **+$2,525**
Includes: Diplexer assembly (015-0385-00); BNC to SMA adaptor (015-0388-00); semirigid cable (015-1055-00); SMA to SMA cable (012-0649-00).

Option 22 — High Performance 18 to 60 GHz Waveguide Mixer Set includes three mixers (18 to 26.5 GHz, 26.5 to 40 GHz, 40 to 60 GHz). **+$4,250**
Includes: Same as Option 21.

Option 30 — Rackmount 19″ rack width. **+$790**
Includes: Rack slides (351-0623-00).

**1 Options 07, 08, 21, and 22 are not combinable in any form.*

Option 31 — Rackmount 19″ rack width with rear panel input/output capability. **+$840**
Includes: Same as Option 30.

Option 39 — Non-Lithium (Silver) batteries for battery-powered memory. **+$50**

Option 41 — Digital Microwave Radio Enhancement. **+$450**
Includes: Wider bandwidth preselector for better signal symmetry in digital radio bands; Narrow video filter (app. 1/3000th resolution bandwidth); Improved frequency span/div accuracy at 5 MHz/div span.

Option 42 — Replaces MARKER/VIDEO input port on the rear panel with a 110 MHz IF output port which provides a signal with a 3 dB bandwidth ⩾5 MHz and makes the 492A suitable for broadband, swept-receiver measurements. **+$1,500**

Option 45 — (492AP) MATE CIIL language. **+$4,975**

Option 52*1 — North American 220 V configuration with standard power cord. Fuses are replaced with 2A slo-blo.

WARRANTY-PLUS SERVICE PLANS SEE PAGE 497

M1 — (492A) 2 Calibrations. **+$1,995**
M1 — (492AP) 2 Calibrations. **+$2,025**
M2 — (492A) 2 Years Service. **+$3,380**
M2 — (492AP) 2 Years Service. **+$3,510**
M3 — (492A) 2 Years Service & 4 Calibrations. **+$3,995**
M3 — (492AP) 2 Years Service & 4 Calibrations. **+$4,045**

OPTIONAL ACCESSORIES

GPIB Interconnect Cable*1 — Order 012-0630-00

Operator's Handbook — Order 070-5563-00 **$10**

CRT Visor — Order 016-0653-00 **$34**

External Waveguide Mixers —
(18 to 26.5 GHz) Order WM 490K **$1,250**
(26.5 to 40 GHz) Order WM 490A **$1,250**
(33 to 50 GHz) Order WM 490Q **$1,450**
(40 to 60 GHz) Order WM 490U **$1,720**
(50 to 75 GHz) Order WM 490V **$1,950**
(60 to 90 GHz) Order WM 490E **$2,120**
(75 to 110 GHz) Order WM 490W **$2,175**
(90 to 140 GHz) Order WM 490F **$2,330**
(110 to 170 GHz) Order WM 490D **$3,250**
(140 to 220 GHz) Order WM 490G **$3,325**

Tapered Transition — (Used with WM 490G) 220 to 325 GHz. Order 119-1728-00 **$1,200**

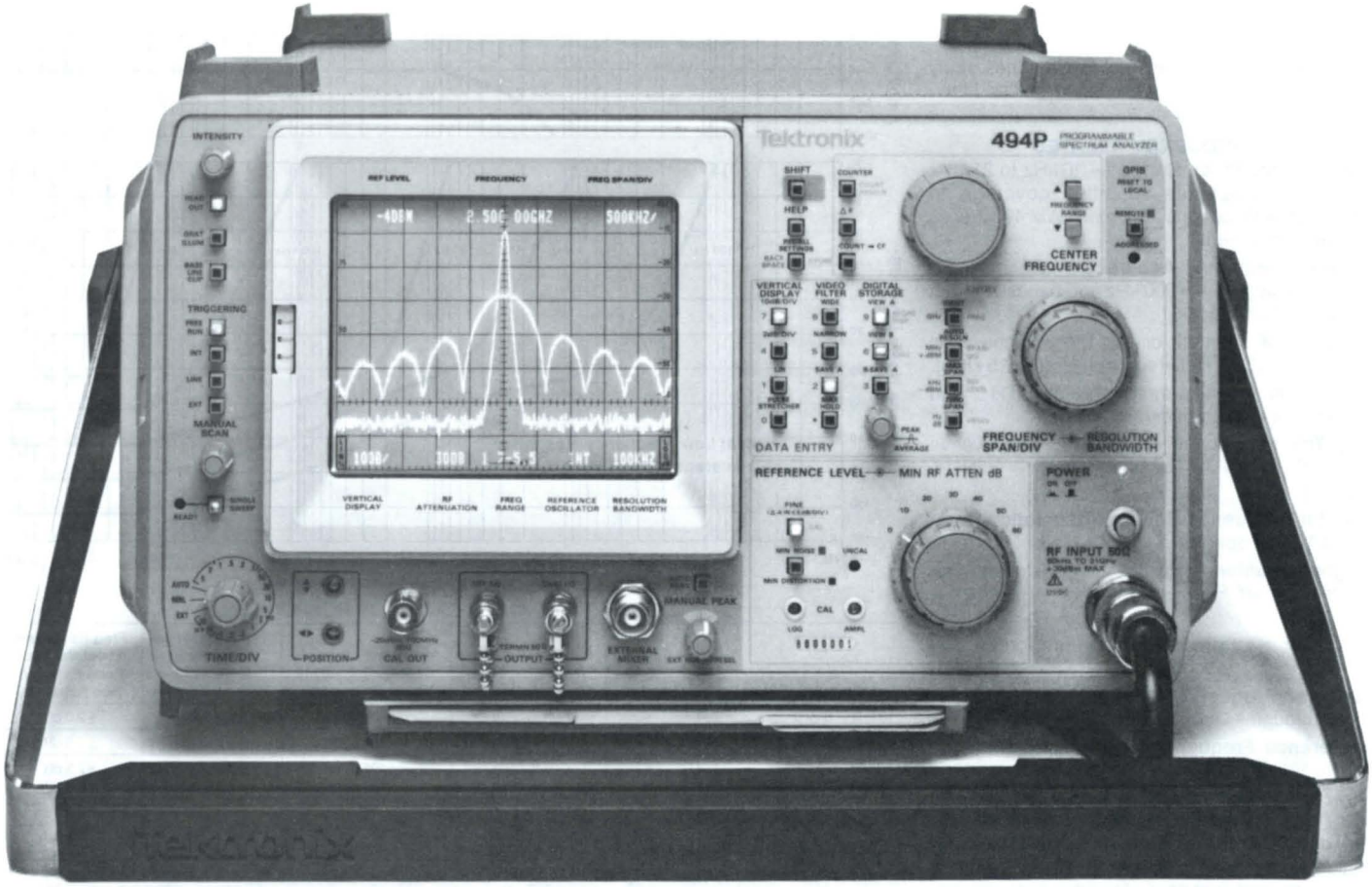
Microwave Comb Generator — TM 500 Series compatible. Order 067-0885-00 **$1,800**

1405 Option 02 — TV Sideband Analyzer Adapter (525/60 markers) **$5,780**

TR 503 — Tracking Generator, 100 kHz to 1.8 GHz **$6,620**

Rack Adaptor Kit — (Cradle Mount). Order 016-0844-00 **$625**

**1 To order, contact your local Tektronix Sales Office.*



494/494P

GPIB IEEE-488 The 494P complies with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats.*

Built-In Frequency Counter to 325 GHz

HELP Manual in ROM

Nonvolatile Memory Storage

Keypad Data Entry

Direct Plot Capability

Alternate Language Options

GPIB/Fully Programmable (494P)

Full Three Year Warranty

The TEK 494 and fully programmable 494P offer portability, ease of use, and the widest amplitude calibrated frequency range of any spectrum analyzers available—10 kHz to 21 GHz in coax, and 18 GHz to 325 GHz using one or more of ten WM 490 Series waveguide mixers.

Counter Center Frequency Accuracy, Zero Long-Term Drift, Superior Range and Resolution in a Compact, Portable Package

A 4 GHz signal can be measured to within 41 Hz with 1 Hz readout resolution 30 minutes after turn on. And the 494's zero drift will ensure long term measurement repeatability on that frequency.

You get 30 Hz resolution bandwidth to 60 GHz, 100 Hz resolution bandwidth to 220 GHz and 1 kHz bandwidth to 325 GHz with excellent sensitivity and low phase noise. Popular features common to other 490 Series spectrum analyzers are standard on the 494, including digital storage, manual to programmable convertibility, and environmentalization per MIL-T-28800C, Type III, Class 3, Style C.

An exclusive pushbutton *HELP* mode makes the 494 accessible to operators of widely varying skills and experience. At the touch of a button or twist of a knob the 494 tells you what to expect from nearly every control—in plain English. Plus optional French, German, or Spanish. Pull-out reference cards supply an additional level of detail. Having answers available at your fingertips minimizes training time and reduces complexity.

Center Frequency, Span/Division, Amplitude Scaling and Reference Level Selected Either by μP-Aided Three Knob Operation or Direct Pushbutton Entry

In pushbutton mode, variables can be set to nonstandard values, i.e., 7 dB/div vertical mode or 9.2 kHz/div frequency span.

Nonvolatile memory retains up to ten setups and nine displays—for rapid measurements and easy data comparison. One memory location stores on-screen settings to quickly bring the analyzer back if power is turned off.

The fully programmable 494P provides easy-to-implement automated measurements. The 494P is straightforward to interface to our GPIB controllers . . . or yours. If you want to free your controller but still get graphics output, a convenient front panel *PLOT* button will send display data to a plotter.

Now increase your ATE capabilities with the TekSPANS general RF applications software in IBM PC, HP or Tek controller versions. Automate your EMI verification testing with the *NEW* TekSPANS EMI software. See page 173.

In strong testimony of the incomparable reliability of the 494 and 494P, Tek offers the first spectrum analyzer three year warranty. Beyond the first three years of warranty coverage, Tek will extend your service coverage for two years, providing all your calibration and maintenance needs for the first five years.

The following characteristics and features apply after a 30-minute warm-up period unless otherwise noted.

FREQUENCY RELATED

Center Frequency Range — 10 kHz to 21 GHz standard; amplitude specified coverage to 325 GHz with optional Tektronix WM 490 Series Waveguide Mixers.

Center Frequency Accuracy — Bands 1 and 5–12 with span/div >200 kHz and bands 2–4 with span/div >100 kHz.

±[(20% of span/div or res BW, whichever is greater) + (CF x Ref Freq Error) + (N x 15 kHz)].

Bands 1 and 5–12 with span/div ≤200 kHz and Bands 2–4 with span/div ≤100 kHz.

±[(20% of span/div or res BW, whichever is greater) + (CF x Ref Freq Error) + (2N + 25 Hz)].

Center Frequency Readout Resolution — At least 10% of span/div.

Signal Counter Accuracy — ±[(Counter Frequency x Ref Freq Error) + (10 + 2N) Hz + 1 LSD)].

Counter Sensitivity — Center Screen S/N ≥20 dB.

Counter Frequency Readout Resolution — 1 Hz through 1 GHz.

Reference Frequency Error (Aging Rate) — 1 x 10^{-9}/day, 1 x 10^{-7}/year.

Frequency Span/Division Range — 50 Hz/div to 500 MHz/div in coaxial bands (10 kHz through 21 GHz) and 50 Hz/div to 10 GHz/div in waveguide bands (18 GHz through 325 GHz), plus zero span and maximum span. Any span to two significant digits (within 50 Hz and up to 10 GHz) can also be selected with the Data Entry Keyboard.

Frequency Span/Division Accuracy — Within 5% of the selected span/div over the center eight divisions of the ten division CRT display.

Resolution Bandwidth (6 dB) — 30 Hz then 100 Hz to 1 MHz in decade steps plus auto. Accuracy: Within 20%.

Resolution Shape Factor (60 dB/6 dB) — 7.5:1 or less, 100 Hz through 1 MHz and 15:1 or less for 30 Hz.

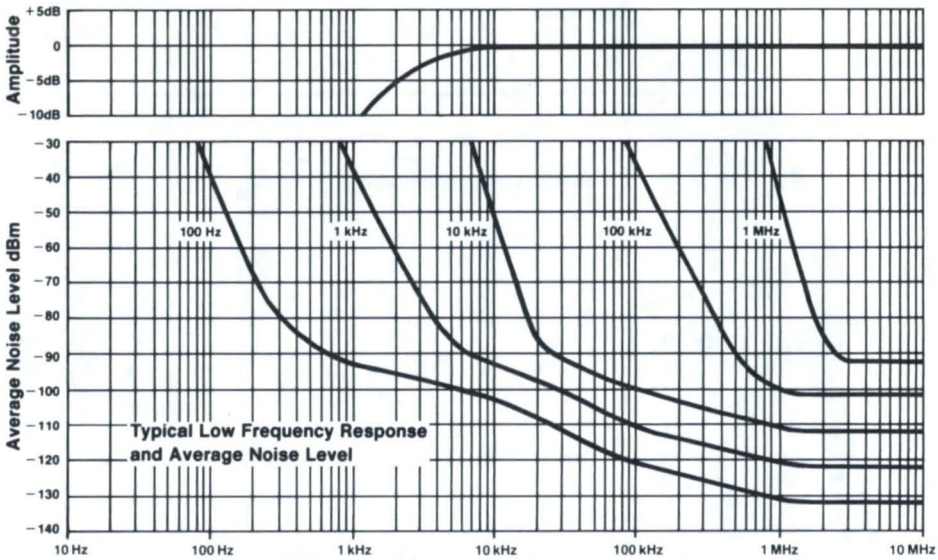
Residual FM (After One Hour Warm-Up) — Bands 1 and 5–12 with span/div >200 kHz, and bands 2–4 with span/div >100 kHz: ≤(7 kHz) N total excursion in 20 ms.

Bands 1 and 5–12 with span/div ≤200 kHz, and bands 2–4 with span/div ≤100 kHz: ≤(10 + 2N) Hz total excursion in 20 ms.

Long Term Drift (at Constant Temperature and Fixed Center Frequency and After One-Hour Warm-Up) — Bands 1 and 5–12 with span/div >200 kHz, and bands 2–4 with span/div >100 kHz: ≤(5 kHz) N per minute of sweep time.

Bands 1 and 5–12 with span/div ≤200 kHz, and Bands 2–4 with span/div ≤100 kHz: ≤50 Hz per minute of sweep time.

Noise Sidebands — At least −75 dBc at 30 times the resolution bandwidth offset from the center frequency (−70 dBc for 100 Hz resolution bandwidth or less).



SENSITIVITY AND FREQUENCY RESPONSE

Frequency Range	LO Harmonic Number	Ave Noise Level for 1 kHz Res BW	Minimum Frequency Counter Sensitivity Minimum Res BW	Freq Response Referenced to 100 MHz With 10 dB Attn	Freq Response About the Mid-Point Between Two Extremes
10 kHz–1.8 GHz	1	−110 dBm	−101 dBm	±3.0 dB	±2.0 dB
50 kHz–1.8 GHz	1	−110 dBm	−101 dBm	±2.5 dB	±1.5 dB
1.7 GHz–5.5 GHz	1	−110 dBm	−101 dBm	±3.5 dB	±2.5 dB
3.0 GHz–7.1 GHz	1	−110 dBm	−101 dBm	±3.5 dB	±2.5 dB
5.4 GHz–18.0 GHz	3			±4.5 dB	±3.5 dB
5.4 GHz–12 GHz		−95 dBm	−86 dBm		
12 GHz–18 GHz		−90 dBm	−81 dBm		
15.0 GHz–21.0 GHz	3	−85 dBm	−76 dBm	±6.5 dB	±5.0 dB

WITH TEKTRONIX OPTIONAL HIGH PERFORMANCE WM 490 SERIES WAVEGUIDE MIXERS

Frequency Range	LO Harmonic Number	Ave Noise Level for 1 kHz Res BW	Minimum Frequency Counter Sensitivity Minimum Res BW	Freq Response Referenced to 100 MHz With 10 dB Attn	Freq Response About the Mid-Point Between Two Extremes
18.0 GHz–26.5 GHz **WM 490K**	6	−100 dBm	−91 dBm	±6.0 dB	±2.0 dB
26.5 GHz–40 GHz **WM 490A**	10	−95 dBm	−86 dBm	±6.0 dB	±2.0 dB
33 GHz–50 GHz **WM 490Q**	10	−95 dBm	−86 dBm	±6.0 dB	±2.0 dB
40 GHz–60 GHz **WM 490U**	10	−95 dBm	−86 dBm	±6.0 dB	±2.5 dB
50 GHz–75 GHz* **WM 490V**	15			±6.0 dB	±3.0 dB
@ 50 GHz		−95 dBm	−86 dBm		
@ 75 GHz		−90 dBm	−81 dBm		
60 GHz–90 GHz* **WM 490E**	15			±6.0 dB	±3.0 dB
@ 60 GHz		−95 dBm	−89 dBm		
@ 90 GHz		−85 dBm	−79 dBm		
75 GHz–110 GHz* **WM 490W**	23			±6.0 dB	±3.0 dB
@ 75 GHz		−90 dBm	−84 dBm		
@ 110 GHz		−80 dBm	−74 dBm		
90 GHz–140 GHz* **WM 490F**	23			±6.0 dB	±3.0 dB
@ 90 GHz		−85 dBm	−79 dBm		
@ 140 GHz		−75 dBm	−69 dBm		
110 GHz–170 GHz* **WM 490D**	37			±6.0 dB	±3.0 dB
@ 110 GHz		−80 dBm	−74 dBm		
@ 170 GHz		−70 dBm	−64 dBm		
140 GHz–220 GHz* **WM 490G**	37			±6.0 dB	±3.0 dB
@ 140 GHz		−75 dBm	−69 dBm		
@ 220 GHz		−65 dBm	−59 dBm		
220 GHz–325 GHz* **119-1728-00**	56			±6.0 dB	±3.0 dB
@ 220 GHz		−65 dBm	−50 dBm		
@ 325 GHz		−50 dBm	−35 dBm		

** Typical values and with frequency response indicated over any 5 GHz range.*

AMPLITUDE RELATED

Reference Level Range (Full Screen, Top of Graticule) — −117 dBm to +40 dBm (+40 dBm includes maximum safe input of +30 dBm and 10 dB gain of IF gain reduction) for 10 dB/div and 2 dB/div log modes. 1 W maximum safe input in the linear mode.

Reference Level Accuracy — Accuracy is a function of the characteristics listed below.

Calibrator: (Cal out) See output signal characteristics on page 158.

Input Attenuator Accuracy: Dc to 1.8 GHz: 0.5 dB/10 dB, 1 dB max accumulative. 1.8 GHz to 18 GHz: 1.5 dB/10 dB, 3 dB max accumulative. 18 GHz to 21 GHz: 3.0 dB/10 dB, 6 dB max accumulative.

Frequency Response: See Frequency Response Table on page 164.

Display Amplitude Accuracy, Resolution Bandwidth Gain Variation and IF Gain Variation — Same as 495 (see page 158).

SPURIOUS RESPONSES

Residual (No Input Signal Referenced to Mixer Input) — −100 dBm or less. Fundamental mixing Bands 1-3.

Harmonic Distortion (CW Signal Minimum Distortion Mode) — Typically −60 dBc for −40 dBm signal in the minimum distortion mode to 21 GHz. At least −100 dBc for preselected bands 1.7 GHz to 21 GHz.

Third-Order Intermodulation Distortion (Minimum Distortion Mode) — At least 70 dB down from two full screen signals within any frequency span. At least 100 dB down for two signals spaced more than 100 MHz apart from 1.7 GHz to 21 GHz for preselected bands.

LO Emissions (No RF Attenuation) — −70 dBm maximum to 21 GHz.

INPUT SIGNAL

RF Input — Type N female connector.

Input Impedance — 50 Ω.

Maximum VSWR*1 With ≥10 dB Attenuation

Frequency Range	Typical	Specified Maximum
Dc to 2.5 GHz	1.2:1	1.3:1
2.5 GHz to 6.0 GHz	1.5:1	1.7:1
6.0 GHz to 18 GHz	1.9:1	2.3:1
18 GHz to 21 GHz	2.7:1	3.5:1
50 kHz to 2.5 GHz	1.9:1	
2.5 GHz to 6.0 GHz	1.9:1	
6.0 GHz to 18.0 GHz	2.3:1	
18.0 GHz to 21.0 GHz	3.0:1	

**1 At Type N female connector to internal mixer.*

Input Level (Optimum Mixer Level for Minimum Distortion Linear Operation) — −30 dBm (minimum distortion control setting); 1 dB gain compression −23 dBm.

Optimum Mixer Level for Minimum Noise Display Dynamic Range Enhanced Operation — −20 dBm (minimum noise control setting); 1 dB gain compression −18 dBm.

External Reference Frequency — 1 MHz, 2 MHz, 5 MHz or 10 MHz ±5 ppm (minimum). Waveshape: Sinewave, ECL, TTL duty cycle 40%-60%. Input Impedance: 50 Ω ac, 500 Ω dc. Power: −15 dBm to +15 dBm.

Maximum Safe Input Level (RF Attenuation at Zero dB) — +30 dBm (1 W) continuous, 75 W peak for 1 μs or less pulse width and 0.001 maximum duty factor (attenuation limit). Dc must never be applied to RF input.

OUTPUT SIGNAL

For details see page 158.

IEEE Standard 488-1978 Interface Function Subsets Implemented — (494P) Source Handshake: SH1. Acceptor Handshake: AH1. Talker: T5. Listener: L3. Service Request: SR1. Remote/Local: RL1. Parallel Poll: PP1. Device Clear: DC1. Device Trigger: DT1. Controller: C0.

GENERAL CHARACTERISTICS

For details see page 159.

ENVIRONMENTAL

Per MIL-T-28800C Type III, Class 3, Style C. For Details, see page 159.

ORDERING INFORMATION

494 Spectrum Analyzer **$42,175**

Includes: Diplexer assembly (015-0385-00); 6 ft N to N connector 50 Ω coax cable (012-0114-00); N male to BNC female adaptor (103-0045-00); 18 in BNC to BNC connector, 50 Ω coax cable (012-0076-00); CRT mesh filter (378-0726-01); two 4 A fast blow fuse (159-0017-00); 115 V power cord (161-0118-00); cord clamp (343-0170-00); CRT visor (016-0653-00); amber CRT light filter (378-0115-01); gray CRT light filter (378-0115-02); blue CRT light filter (378-0115-00); operator manual (070-4418-00); operator handbook (070-4419-00); service manual, volume 1 (070-4416-00); service manual, volume 2 (070-4417-00).

494P Programmable Spectrum Analyzer **$46,995**

Includes: In addition to the above a 2 m, double shielded GPIB cable (012-0630-03); programmer manual (070-4415-00).

OPTIONS (494/494P)

Option 08 — Delete External Mixer Capability. Deletes internal switching, front panel connector and external diplexer to connect and use external waveguide mixers. Limits frequency range to 10 kHz to 21 GHz (coaxial input). **−$1,750**

Option 12 — Help Mode Text. CRT prompts selectable between German and English. Pull-out reference cards in German.
(494) **+$200**
(494P) **+$500**

Option 13 — Help Mode Text. CRT prompts selectable between French and English. Pull-out reference cards in French.
(494) **+$200**
(494P) **+$500**

Option 14 — Help Mode Text. CRT prompts selectable between Spanish and English. Pull-out reference cards in Spanish.
(494) **+$200**
(494P) **+$500**

Option 20 — General Purpose 12.4 GHz to 40 GHz Waveguide Mixer Set. (12.4 GHz to 18 GHz, 18 GHz to 26.5 GHz, and 26.5 GHz to 40 GHz) and hardware. **+$900**

Option 21 — High Performance 18 GHz to 40 GHz Waveguide Mixer Set. (18 GHz to 26.5 GHz and 26.5 GHz to 40 GHz) and hardware. **+$2,525**

Option 22 — High Performance 18 GHz to 60 GHz Waveguide Mixer Set. (18 GHz to 26.5 GHz, 26.5 GHz to 40 GHz, and 40 GHz to 60 GHz) and hardware. **+$4,250**

Option 30 — Rackmount. 19 inch rack width with front panel input/outputs. See page 160. **+$790**

Option 31 — Rackmount. 19 inch rack width with rear panel input/output capability. See page 160. **+$840**

Option 32 — Benchmount. Adds side and top panels, carrying handles and feet for a stackable bench top configuration. **+$940**

Option 41 — Digital Radio. Provides wider bandwidth preselector, 30 Hz video filter with 100 kHz resolution bandwidth and 5 MHz span/div optimized for 6 GHz and 11 GHz D/R. **+$450**

Option 42 — 110 MHz IF Output. Provides 5 MHz bandwidth at 6 dB points. **+$1,500**

Option 45*1 — (494P only) MATE/CIIL.

CONVERSION KIT

494 to 494P — Conversions are made by your nearest Tektronix Service Center. Order 040-1140-01 **$5,300**

INTERNATIONAL POWER PLUG OPTIONS

Option A1 — Universal Euro 220 V, 50 Hz.
Option A2 — UK 240 V, 50 Hz.
Option A3 — Australian 240 V, 50 Hz.
Option A4 — North American 240 V, 60 Hz.
Option A5 — Switzerland 220 V, 50 Hz.

WARRANTY-PLUS SERVICE PLANS

SEE PAGE 497

M1 — (494) 2 Calibrations. **+$695**
M1 — (494P) 2 Calibrations. **+$715**
M2 — (494) 2 Years Service. **+$1,330**
M2 — (494P) 2 Years Service. **+$1,350**
M3 — (494) 2 Years Service & 4 Calibrations. **+$2,725**
M3 — (494P) 2 Years Service & 4 Calibrations. **+$2,785**
M4 — (494) 5 Calibrations. **+$1,590**
M4 — (494P) 5 Calibrations. **+$1,630**
M5 — (494) 9 Calibrations + 2 Years Service. **+$4,145**
M5 — (494P) 9 Calibrations + 2 Years Service. **+$4,240**

OPTIONAL ACCESSORIES

TR 503 Tracking Generator — See page 178. **$6,620**

Microwave Comb Generator — TM 500 Series compatible. Order 067-0885-00 **$1,800**

75 Ω to 50 Ω Minimum Loss Pad — Order 011-0112-00 **$70**

Dc Block N to N — Order 015-0509-00 **$250**

P6201 — FET Probe to 900 MHz. **$1,220**

1405 TV Sideband Adaptor — 525/60 Markers. See page 179. **$5,780**

TV Trigger Synchronizer — Order 015-0261-01 **$450**

Hard Case (Transit) — Order 016-0658-00 **$750**

Soft Case — Order 016-0659-00 **$105**

Rear Panel Protective Cover — Order 337-3274-00 **$5.00**

Lab Cart — K213. (See page 462.) **$595**

Camera — C-5C. (See page 445.) **$495**

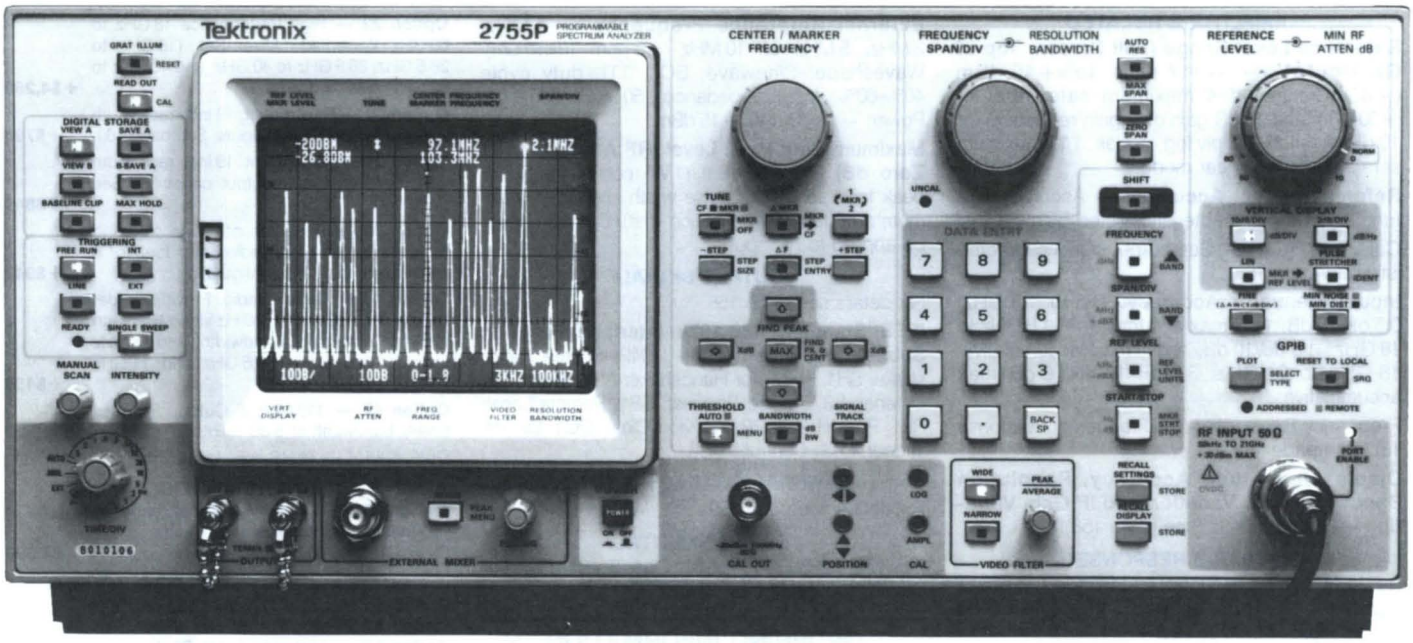
Note: 490 Series spectrum analyzers are compatible with all Tektronix C-50 Series cameras.

PERIPHERAL PRODUCTS FOR 494P SPECTRUM ANALYZER

4041 — System Controller (see page 355). **$4,950**

4207 — Color Graphics Terminal (see page 53). **$3,995**

TEK 50 kHz to 325 GHz SPECTRUM ANALYZERS



NEW 2755/2755P

GPIB IEEE-488

The 2755P complies with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats*.

Lab Performance Packaged for Engineering and Manufacturing Productivity

50 kHz to 21 GHz Coverage in Coax and to 325 GHz Using Tek Waveguide Mixers

Marker and Center Frequency Accuracy of One Part in 10^5

Built-In Marker Intelligence
—Exclusive Occupied Bandwidth Mode
—Menu-Selectable Signal Processing
—Signal Search Functions
—Noise Normalization to 1 Hz
—Alternate Reference Units

Large, Easy-to-Use Controls

Nonvolatile Memory for Up to Nine Waveforms and Nine Front Panel Displays

Direct Keypad Entry of Control Parameters

Direct Plot Capability (All Versions)

GPIB/Fully Programmable (2755P)

Optional Preselector

Now There is a Tek Spectrum Analyzer Especially for the Laboratory

The Tektronix 2755 is a benchtop instrument that combines cost-effective lab performance and ease of use, with a new dimension in spectrum analyzer processing intelligence. Packaged for enhanced engineering productivity, it reduces operator interface requirements and risk of human error. You'll make measurements faster and more accurately than ever before. All with the high standard of Tektronix quality and reliability.

Decision-Making Power at the Touch of a Button

Tek exclusives include signal processing intelligence that can discriminate and sort among continuous wave (CW), pulse and spurious signals. Hands-off convenience for measuring the bandwidth of filters, amplifiers and channelized spectrum occupancy is provided by Tek's new BANDWIDTH mode. For a summary of signal processing functions, see page 160.

Tedious, time-consuming calculations are eliminated with automatic noise normalization to 1 Hz and alternate reference units such as dBm, dBmV, dBμV and dBV.

Feature for feature, the 2755 is optimized for straightforward operation and outstanding ease of use—from the ergonomically designed front panel and larger controls to direct keypad entry of important control factors.

Millimeter Wave Capability

Using Tek's high performance waveguide mixers, you get calibrated amplitude and frequency coverage from 18 GHz to 325 GHz. Real signals are determined in two sweeps with Tek's accurate millimeter wave identification mode. No costly L.O. amp is needed—just some simple connections and you're ready to measure.

Use as a Systems Component

The 2755P is the GPIB-programmable version of the 2755. Featuring Tek *Codes and Formats*, programming easy to implement with English-like commands. With TekSPANS® software you can use the 2755P with popular controllers including the IBM PC and PC compatibles.

As an option, you can also rackmount the 2755 for use in the manufacturing or test environment not requiring instrument mobility.

CHARACTERISTICS

The following characteristics apply after a 30 minute warm-up period unless otherwise noted.

FREQUENCY RELATED

Frequency Range — 50 kHz to 21 GHz coaxial input; 50 kHz to 325 GHz external mixer input (amplitude specified from 18 GHz to 325 GHz with Tektronix WM 490 Series Waveguide Mixers).

Center and Marker Frequency Accuracy*[1] — Phase Locked: $\pm[20\%D + (Fx10^{-5})]$ Hz
Bands 1 and 5–12 with span/div ≤200 kHz, and Bands 2–4 with span/div ≤100 kHz. Unlocked: $\pm[20\%D + (Fx10^{-5}) + 15$ NkHz].
Where: D=Span/div or Res BW, whichever is greater.
F=Center or Marker Frequency
N=Harmonic Mixing Number

Delta Marker Frequency Accuracy — 1% of total span.

Center Frequency Drift (After 1 Hour Warm-Up) — Phase Locked: ≤50 Hz per minute of sweep time corrected at least every 30 seconds. Bands 1 and 5–12 with span/div ≤200 kHz, and bands 2–4 with span/div ≤100 kHz. Unlocked: ≤(5 kHz) N per minute of sweep time.

Frequency Readout Resolution — ≤10% span/div to 1 kHz minimum. (100 Hz in Delta Marker Mode).

Residual FM — Phase Locked: ≤(10 +2N) Hz p-p in 20 ms, Bands 1 and 5–12 with span/div ≤200 kHz, and Bands 2–4 with span/div ≤100 kHz. Unlocked: ≤(7 kHz) N p-p in 20 ms.

Noise Sidebands

dBc/Hz	Offset From Carrier
≤−95	3 kHz
≤−105	30 kHz
≤−115	300 kHz

Resolution Filters — 100 Hz to 1 MHz (6 dB bandwidth ±20%) in decade steps. Shape factor ≤7.5: 1 (60 dB/6 dB).

Video Filter Range — 0.3 Hz to 30 kHz (coupled to resolution filter by front panel pushbuttons).

Frequency Span/Division — 0 Hz (zero span pushbutton or data entry keypad); 200 Hz to 10 GHz (in a 1-2-5 sequence) via span/div knob; 200 Hz to 15 GHz (to two significant digits) via keypad or start/stop data entry, or marker start/stop; full band via MAX SPAN pushbutton (12 bands). Accuracy ±5% of selected span/div.

AMPLITUDE RELATED

Vertical Display Modes — 10 dB, 2 dB and linear via pushbutton; any integer from 1 to 15 dB/div via Data Entry keypad.

[1] Over the operating temperature extremes of 0°C to +50°C, 1.5 x 10^{-5}.

Display Dynamic Range — 80 dB log mode; 8 divisions linear.

Reference Level Range — Log Mode: −117 to +40 dBm, +30 dBm maximum input level; −130 to +27 dBV, +17 dBV maximum input level; −70 to +87 dBmV, +77 dBmV maximum input level; −10 to +147 dBμV, +137 dBμV maximum input level. Linear Mode: 39.6 nV/div to 2.8 V/div, 1 W maximum input level.

Reference Level Steps — 10 dB coarse, 1 dB fine in 10 dB log; 1 dB coarse, 0.25 dB fine in 2 dB log. 1-2-5 sequence coarse, 1 dB equivalent fine in linear; coarse step=log/div, fine is 1 dB for 5 dB/div or greater, 0.25 dB for 4 dB/div or less set via Data Entry keypad.

Reference Level Accuracy — Accuracy is dependent on a combination of RF Attenuator Accuracy, IF Gain Accuracy, Resolution Bandwidth, Display Mode, Calibrator Accuracy, Frequency Band, Frequency Response and Temperature Change (±0.15 dB/°C maximum).

Frequency Response and Sensitivity — Refer to Table 1, page 162.

Display Amplitude Accuracy — ±1.0 dB/10 dB to a maximum of ±2 dB over 80 dB (10 dB Log); ±0.4 dB/2 dB to a maximum of ±1.0 dB over 16 dB (2 dB Log); ±5% of full scale in linear mode.

RF Attenuator Range — 0 to 60 dB in 10 dB steps.

Attenuator Accuracy — Dc to 1.8 GHz: 0.5 dB/10 dB, 1 dB maximum cumulative error over 60 dB. 1.8 to 18 GHz: 1.5 dB/10 dB, 3 dB maximum cumulative error over 60 dB. 18 to 21 GHz: 3 dB/10 dB, 6 dB maximum cumulative error over 60 dB.

Resolution Bandwidth Gain Variation — ±0.4 dB (after CAL with respect to 1 MHz filter).

IF Gain Range — 87 dB increase; 10 dB decrease in MIN NOISE; 10 dB and 1 dB steps.

IF Gain Accuracy — ⩽0.2 dB/dB to maximum of 0.5 dB/9 dB except at the decade transitions: −19 to −20 dBm, −29 to −30 dBm; −39 to −40 dBm, −49 to −50 dBm, −59 to −60 dBm. An additional ⩽0.5 dB for a maximum cumulative error of 1 dB over 10 dB; ±2 dB maximum deviation over the 97 dB range.

Marker/s Accuracy — Equal to Reference Level Accuracy plus Display Amplitude Accuracy.

Third Order Intermodulation Distortion — ⩽−70 dBc for CW signal (MIN Distortion Mode) Any two on-screen signals within any frequency span (50 kHz to 21 GHz); ⩽−100 dBc for signals spaced ⩾100 MHz for preselector bands (Option 01 only).

Harmonic Distortion — ⩽−60 dBc for a −40 dBm input 50 kHz to 21 GHz in MIN Distortion mode. Not discernible above the noise (typically −100 dBc) for preselected bands (Option 01 only).

LO Emissions — ⩽−10 dBm. Option 01: ⩽−70 dBm.

Spurious Responses (Residual) — ⩽−100 dBm.

INPUT SIGNAL

RF Input — Type "N" female 50 Ω nominal impedance. Refer to page 160 for 75 Ω input (Option 07) characteristics.

Maximum Safe Input — +30 dBm CW with ⩾20 dB attenuation; +13 dBm CW with 0 dB attenuation; 0 V dc. Option 01: +30 dBm (1 W) CW; 75 W peak, 1 μs Pulse width, 0.001 duty; 0 dB attenuation. Do not apply dc.

1 dB Gain Compression — ⩾−18 dBm in MIN Distortion Mode.

VSWR

Frequency	10 dB Attenuation	(Typical) 0 dB Attenuation
50 kHz to 2.5 GHz	1.3:1 Max; 1.2:1 Typical	1.9:1
2.5 to 6.0 GHz	1.7:1 Max; 1.5:1 Typical	1.9:1
6.0 to 18 GHz	2.3:1 Max; 1.9:1 Typical	2.3:1
18 to 21 GHz	3.5:1 Max; 2.7:1 Typical	3.0:1

Measured at ±3 MHz of preselector peak for Option 01.

OUTPUT SIGNAL

Calibrator (Cal Out) — −20 dBm ±0.3 dB at 100 MHz ±1.0 kHz

1st and 2nd LO — Provides access to the output of the respective local oscillators (1st LO + 7.5 dBm minimum to a maximum of +15 dBm, 2nd LO −22 dBm minimum to maximum of +15 dBm). These ports must be terminated in 50 Ω at all times.

Vertical Out — Provides 0.5 V ±5% of signal/div of video above and below the centerline.

Horizontal Out — Provides 0.5 V either side of center. Full range −2.5 V to +2.5 V ±10%.

Pen Lift — TTL, 5 V nominal to lift pen.

IF Out — Output of the 10 MHz IF. Level is approximately −5 dBm for a full screen signal at −30 dBm input reference level. Nominal impedance 50 Ω.

IEEE Standard 488-1978 Interface Function Subsets Implemented — **2755P**: SH1, AH1, T5, L3, SR1, RL1, PP1, DC1, DT1 and CØ. **2755** (Direct Plot only): SH1, AHØ, T3, LØ, SRØ, RLØ, PPØ, DTØ and CØ.

GENERAL CHARACTERISTICS

Sweep Time — 20 μs to 5 s/div (10 s/div in auto) in 1-2-5 sequence.

CRT Readout — Displays: Reference level, center frequency, frequency range, vertical display mode, frequency span/div, resolution bandwidth, RF attenuation and video filter.

CRT — 8 x 10 cm, P31 Phosphor.

Power — 210 W max with all options, at 115 V and 60 Hz.

Input Voltage — 90 to 132 V ac or 180 to 250 V ac, 48 to 440 Hz.

Configuration — (Bench/Rackmount) 27 kg (60 lb), 177.8 mm x 431.8 mm x 609.6 mm (7 in x 17 in x 24 in).

ENVIRONMENTAL

Per MIL-T-28800C Type III, Class 5, Style E.

Temperature — Operating: 0°C to +50°C. Nonoperating: −40°C to +75°C.

Altitude — Operating: 10,000 feet. Nonoperating: 40,000 feet.

Humidity — 95% below +30°C; 75% above +30°C; 45% above +40°C.

Electromagnetic Compatibility — Meets MIL-STD-461B requirements, operating from 48 Hz to 440 Hz power sources with the exceptions shown below.

Conducted Emissions: CE01, 15 dB relaxation for first 10 harmonics of power line frequency; CE03 (Narrowband), full limits; CE03 (Broadband), 15 dB relaxation from 15 kHz to 50 kHz.

Conducted Susceptibility: CS01, full limits; CS02, full limits; CS06, full limits.

Radiated Emissions: RE01, 10 dB relaxation for first 10 harmonics of power line frequency, and exceptioned from 30 kHz to 36 kHz; RE02, full limits.

Radiated Susceptibility: RS01, full limits; RS02-1, full limits; RS02-2, to 5 amps only; RS03, up to 1 GHz only.

ORDERING INFORMATION

2755 Spectrum Analyzer **$27,800**
Includes: 50 Ω coax cable, N to N connector, 6 ft (012-0114-00); 50 Ω coax cable, BNC to BNC connector, 18 in (012-0076-00); service manual Vol. 1 (070-6032-00); service manual Vol. 2 (070-6033-00); operator's manual (070-6031-00); N male to BNC female adaptor; 2 Fast-Blo, 4A fuses; power cord (161-0104-00); power cord clamp (343-0170-00); CRT amber light filter (378-0115-01); gray CRT light filter (378-0115-02); CRT mesh filter (378-0887-00).

2755P Programmable Spectrum Analyzer **$32,800**
Includes: Same as 2755 plus programmer's manual (070-6034-00).

OPTIONS

Option 01 — Adds preselection for the 1.7 GHz to 21 GHz band and limiter for 1st mixer below 1.8 GHz. **+$3,995**

Option 07 — 75 Ω dBmV input and calibration in addition to 50 Ω dBm input and calibration. **Includes:** BNC male to female adaptor connector (013-0126-00); 42 inch BNC to BNC connector, 75 Ω coax cable (012-0074-00). **+$750**

Option 08 — Deletes external mixer capability. Frequency range limited to 50 kHz to 21 GHz. (Not combinable with Options 07, 21, 22) **−$1,750**

Option 21 — High Performance 18 to 40 GHz Waveguide Mixer Set includes two mixers (18 to 26.5 GHz, and 26.5 GHz to 40 GHz). **Includes:** Diplexer assembly (015-0385-00); BNC to SMA adaptor (015-0388-00); semirigid cable (015-1055-00); SMA to SMA cable (012-0649-00). **+$2,525**

Option 22 — High Performance 18 to 60 GHz Waveguide Mixer Set includes three mixers (18 to 26.5 GHz, 26.5 to 40 GHz, 40 to 60 GHz). **Includes:** Same as Option 21. **+$4,250**

Option 30 — Rackmount 19 in rack width. **Includes:** Rack slides (351-0623-00). **+$250**

Option 31 — Rackmount 19 in rack width with rear panel input/output capability (no front panel inputs). **Includes:** Same as Option 30. **+$450**

Option 39 — Non-Lithium (Silver) batteries for battery-powered memory. **+$50**

Option 41 — Digital Microwave Radio Enhancement. Including: 1) Wider bandwidth preselector for better signal symmetry in digital radio bands. 2) Narrow video filter (approximate 1/3000th resolution bandwidth). 3) Improved frequency span/div accuracy at 5 MHz/div span. **+$450**

Option 42 — Replaces MARKER/VIDEO input port on the rear panel with a 110 MHz IF output port which provides a signal with a 3 dB bandwidth ⩾5 MHz and makes the 2755 suitable for broadband, swept-receiver measurements. **+$1,500**

Option 45 — (2755P) MATE/CIIL language. **+$4,975**

Option 52*[1] — North American 220 V configuration with standard power cord. Fuses are replaced with 2 A slo-blo.

OPTIONAL ACCESSORIES

External Waveguide Mixers —

(18 to 26.5 GHz) Order WM 490K	$1,250
(26.5 to 40 GHz) Order WM 490A	$1,250
(33 to 50 GHz) Order WM 490Q	$1,450
(40 to 60 GHz) Order WM 490U	$1,720
(50 to 75 GHz) Order WM 490V	$1,950
(60 to 90 GHz) Order WM 490E	$2,120
(75 to 110 GHz) Order WM 490W	$2,175
(90 to 140 GHz) Order WM 490F	$2,330
(110 to 170 GHz) Order WM 490D	$3,250
(140 to 220 GHz) Order WM 490G	$3,325

Tapered Transition — Used with WM 490G, 220 to 325 GHz. Order 119-1728-00 **$1,200**

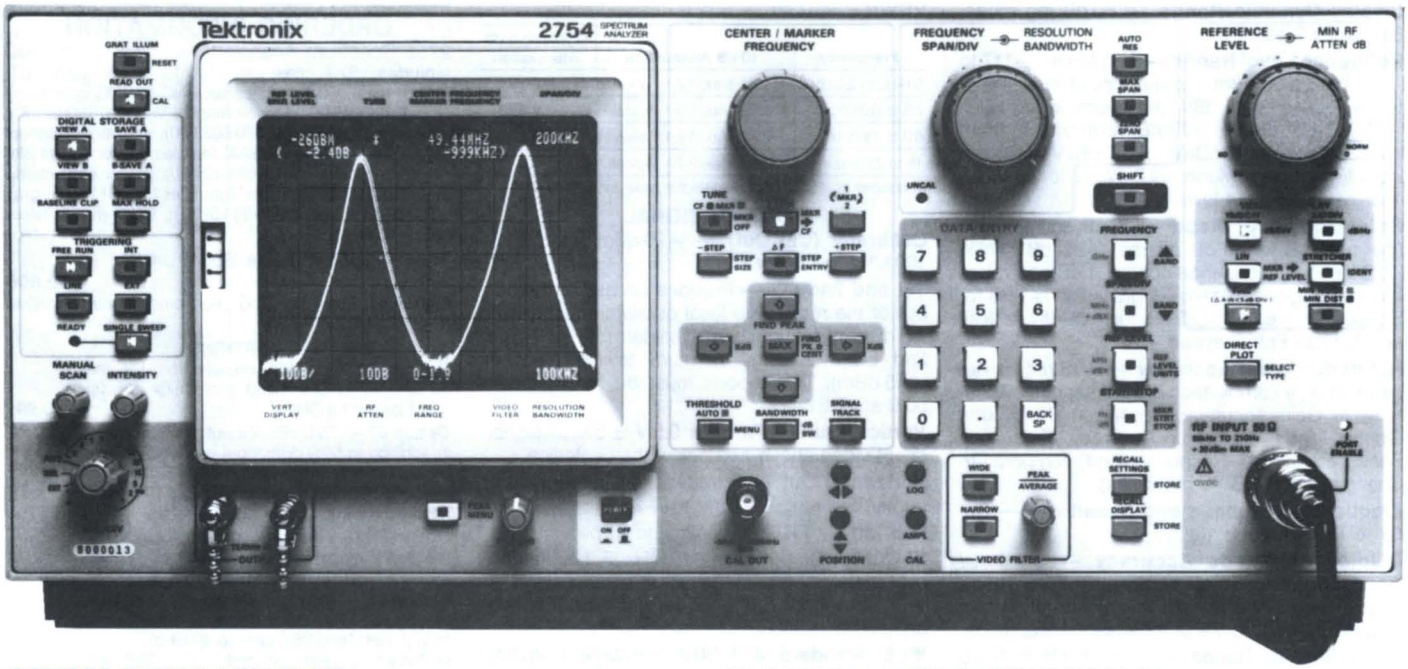
Microwave Comb Generator — TM 500 Series compatible. Order 067-0885-00 **$1,800**

1405 TV Sideband Analyzer Adaptor — 525/60 markers (Opt 02 required for 275X & 49X). **$5,780**

TR 503 Tracking Generator — 100 kHz to 1.8 GHz. **$6,620**

**[1] To order, contact your local Tektronix Sales Office.*

TEK 50 kHz to 21 GHz SPECTRUM ANALYZERS



NEW 2754/2754P

GPIB IEEE-488

The 2754P complies with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats*.

Rackmountable for Engineering and Manufacturing System Productivity

Marker and Center Frequency Accuracy of One Part in 10^5

Built-In Signal Processing Intelligence
—Search, Sort and Mark CW, Pulse or Spurious Signals
—Exclusive Occupied Bandwidth Mode
—Signal Tracking
—Noise Normalization to 1 Hz

Nonvolatile Memory for Storage of Up to Nine Waveforms and Nine Front Panel Displays

Direct Keypad Entry of Control Parameters

Large, Easy-to-Use Controls

Direct Plot Capability (All Versions)

1 kHz Resolution Bandwidth

Optional Preselector

Now There is a Tek Spectrum Analyzer Especially for the Engineering Labs and Manufacturing Systems

The Tektronix 2754 Spectrum Analyzer combines cost-effective lab performance and ease of use with a new dimension in Spectrum Analyzer signal processing intelligence. Packaged for enhanced productivity, it reduces operator interface requirements and risk of human error. You'll make measurements faster and more accurately than ever before. All with the high standard of Tektronix quality and reliability.

Decision-Making Power at the Touch of a Button

Tek exclusives include marker signal processing intelligence that can discriminate and sort among continuous wave (CW), pulse and spurious signals. Hands-off convenience for measuring the bandwidth of filters, amplifiers and channelized spectrum occupancy is provided by Tek's new BANDWIDTH mode. For a summary of signal processing functions, see page 160.

Tedious, time-consuming calculations are eliminated with automatic noise normalization to 1 Hz and alternate reference units such as dBm, dBmV, dBμV and dBV.

Value Packed

Feature for feature, the 2754 is optimized for straightforward operation and outstanding ease of use—from the ergonomically designed front panel and larger controls to direct keypad entry of important control factors.

Use as a Systems Component

The 2754P is the GPIB-programmable version of the 2754 and features Tek *Standard Codes and Formats*, making programming easy to implement with English-like commands. With TekSPANS® software you can use the 2754P with popular controllers including the IBM PC and PC compatibles.

As an option, you can quickly and easily rackmount the 2754 for use in the manufacturing or test environment not requiring instrument mobility.

SENSITIVITY AND FREQUENCY RESPONSE

Band and Frequency Range	Harmonic Number	Sensitivity at (dBm) Minimum Resolution	Frequency Response (dB)*2
1 (50 kHz–4.2 GHz)*1	1	−115	±1.5
2 (1.7–5.5 GHz)*1	1	−115	±1.5
3 (3.0–7.1 GHz)*1	1	−115	±1.5
4 (5.4–18 GHz)*1	3	−100	±2.5
(12–18 GHz)	3	−95	±2.5
5 (15–21 GHz)*1	3	−95	±3.5

*1 Band 1 is limited to 50 kHz to 1.8 GHz for preselected (Option 01) units. The preselector degrades minimum sensitivity by 5 dB (6 dB in BAND 3) and degrades frequency response by ±1.0 dB to 18 GHz; ±1.5 dB to 21 GHz.
*2 Measured with 10 dB RF Attenuation and peaking optimized (when applicable). Frequency response within ±3.5 dB from 50 kHz to 18 GHz referenced to 100 MHz (±4.5 dB for Option 01).

CHARACTERISTICS

The following characteristics apply after a 30 minute warm-up period unless otherwise noted.

FREQUENCY RELATED

Frequency Range — 50 kHz to 21 GHz coaxial input.

Center and Marker Frequency Accuracy*1 — Phase Locked: ±[20%D + (Fx10^{-5})] Hz; Bands 1 and 5 with span/div; ≤200 kHz, and Bands 2–4 with span/div ≤100 kHz. Unlocked: ±[20%D + (Fx10^{-5}) + 15 NkHz].
Where: D=Span/div or Res BW, whichever is greater.
F=Center or Marker Frequency
N=Harmonic Mixing Number

Delta Marker Frequency Accuracy — 1% of total span.

Center Frequency Drift (After 1 Hour Warm-Up) — ≤50 Hz per minute of sweep time corrected at least every 30 seconds. Phase Locked: Bands 1 and 5 with span/div ≤200 kHz, and band 2–4 with span/div ≤100 kHz. Locked: ≤(5 kHz) N per minute of sweep time.

Frequency Readout Resolution — ≤10% span/div to 1 kHz minimum. (100 Hz in Delta Marker Mode).

Residual FM — Phase Locked: ≤(10 +2N) Hz peak-to-peak in 20 ms, Bands 1 and 5 with span/div ≤200 kHz, and Bands 2–4 with span/div ≤100 kHz. Unlocked: ≤(7 kHz) N peak-to-peak in 20 ms.

1 Over the operating temperature extremes of 0°C to +50°C, 1.5 x 10^{-5}

Noise Sidebands

dBc/Hz	Offset From Carrier
≤ −105	30 kHz
≤ −115	300 kHz

Resolution Filters — 1 kHz to 1 MHz (6 dB bandwidth ±20%) in decade steps. Shape factor ≤7.5: 1 (60 dB/6 dB).

Video Filter Range — 3 Hz to 30 kHz (coupled to resolution filter by front panel pushbuttons).

Frequency Span/Division — 0 Hz (zero span pushbutton or data entry keypad); 200 Hz to 1 GHz (in a 1-2-5 sequence) via span/div knob; 200 Hz to 1.2 GHz (to two significant digits) via keypad or start/stop data entry, or marker start/stop; full band via MAX SPAN pushbutton (5 bands). Accuracy ±5% of selected span/div.

AMPLITUDE RELATED

Vertical Display Modes — 10 dB, 2 dB and linear via pushbutton; any integer from 1 to 15 dB/div via Data Entry keypad.

Display Dynamic Range — 80 dB log mode; 8 divisions linear.

Reference Level Range — Log Mode: −117 to +40 dBm, +30 dBm maximum input level; −130 to +27 dBV, +17 dBV maximum input level; −70 to +87 dBmV, +77 dBmV maximum input level; −10 to +147 dBμV, +137 dBμV maximum input level. Linear Mode: 39.6 nV/div to 2.8 V/div, 1 W maximum input level.

Reference Level Steps — 10 dB coarse, 1 dB fine in 10 dB log; 1 dB coarse, 0.25 dB fine in 2 dB log. 1-2-5 sequence coarse, 1 dB equivalent fine in linear; coarse step=log/div, fine is 1 dB for 5 dB/div or greater, 0.25 dB for 4 dB/div or less set via Data Entry keypad.

Reference Level Accuracy — Accuracy is dependent on a combination of RF Attenuator Accuracy, IF Gain Accuracy, Resolution Bandwidth, Display Mode, Calibrator Accuracy, Frequency Band, Frequency Response and Temperature Change (±0.15 dB/°C maximum).

Display Amplitude Accuracy — ±1.0 dB/10 dB to a maximum of ±2 dB over 80 dB (10 dB Log); ±0.4 dB/2 dB to a maximum of ±1.0 dB over 16 dB (2 dB Log); ±5% of full scale in linear mode.

RF Attenuator Range — 0 to 60 dB in 10 dB steps.

Attenuator Level Accuracy — Dc to 1.8 GHz: 0.5 dB/10 dB, 1 dB maximum cumulative error over 60 dB. 1.8 to 18 GHz: 1.5 dB/10 dB, 3 dB maximum cumulative error over 60 dB. 18 to 21 GHz: 3 dB/10 dB, 6 dB maximum cumulative error over 60 dB.

Resolution Bandwidth Gain Variation — ±0.4 dB (after CAL with respect to 1 MHz filter).

IF Gain Range — 87 dB increase; 10 dB decrease in MIN NOISE; 10 dB and 1 dB steps.

IF Gain Accuracy — ≤0.2 dB/dB to maximum of 0.5 dB/9 dB except at the decade transitions: −19 to −20 dBm, −29 to −30 dBm; −39 to −40 dBm, −49 to −50 dBm, −59 to −60 dBm. An additional ≤0.5 dB for a maximum cumulative error of 1 dB over 10 dB; ±2 dB maximum deviation over the 97 dB range.

Marker/s Accuracy — Equal to Reference Level Accuracy plus Display Amplitude Accuracy.

Third Order Intermodulation Distortion — (Option 01 only) ≤−70 dBc for CW signal (MIN Distortion Mode) Any two on-screen signals within any frequency span (50 kHz to 21 GHz); ≤−100 dBc for signals spaced ≥100 MHz for preselector bands.

Harmonic Distortion — (Option 01 only) ≤−60 dBc for a −40 dBm input 50 kHz to 21 GHz in MIN Distortion mode. Not discernible above the noise (typically −100 dBc) for preselected bands.

LO Emissions — ≤−10 dBm. Option 01: ≤−70 dBm.

Spurious Responses (Residual) — ≤−100 dBm.

INPUT SIGNAL

RF Input — Type "N" female 50 Ω nominal impedance.

Maximum Safe Input — +30 dBm CW with ≥20 dB attenuation; +13 dBm CW with 0 dB attenuation; 0 V dc.

Option 01: +30 dBm (1 W) CW; 75 W peak, 1μs pulse width, 0.001 duty; 0 dB attenuation. Do not apply dc.

1 dB Gain Compression — −10 dBm with 0 dB RF Attenuation in MIN NOISE; −20 dBm with 0 dB RF Attenuation in MIN DISTORTION (No gain compression can be observed on screen).

VSWR

Frequency	10 dB Attenuation	(Typical) 0 dB Attenuation
50 kHz to 2.5 GHz	1.3:1 Max; 1.2:1 Typical	1.9:1
2.5 to 6.0 GHz	1.7:1 Max; 1.5:1 Typical	1.9:1
6.0 to 18 GHz	2.3:1 Max; 1.9:1 Typical	2.3:1
18 to 21 GHz	3.5:1 Max; 2.7:1 Typical	3.0:1

Measured at ±3 MHz of preselector peak for Option 01.

CHARACTERISTICS (OPTION 07) 50 Ω/75 Ω INPUT RELATED

Same as 495. See page 160.

OUTPUT SIGNAL

Calibrator (Cal Out) — −20 dBm ±0.3 dB at 100 MHz ±1.0 kHz

1st and 2nd LO — Provides access to the output of the respective local oscillators (1st LO + 7.5 dBm minimum to a maximum of +15 dBm, 2nd LO −22 dBm minimum to maximum of +15 dBm). These ports must be terminated in 50 Ω at all times.

Vertical Out — Provides 0.5 V ±5% of signal per division of video above and below the centerline.

Horizontal Out — Provides 0.5 V either side of center. Full range −2.5 V to +2.5 V ±10%.

Pen Lift — TTL, 5 V nominal to lift pen.

IF Out — Output of the 10 MHz IF. Level is approximately −5 dBm for a full screen signal at −30 dBm input reference level. Nominal impedance 50 Ω.

IEEE Standard 488-1978 Interface Function Subsets Implemented — **2754P:** SH1, AH1, T5, L3, SR1, RL1, PP1, DC1, DT1 and CØ. **2754 (Direct Plot only):** SH1, AHØ, T3, LØ, SRØ, RLØ, PPØ, DTØ and CØ.

GENERAL CHARACTERISTICS

Sweep Time — 20 μs to 5 s/div (10 s/div in auto) in 1-2-5 sequence.

CRT Readout — Displays: Reference level, center frequency, frequency range, vertical display mode, frequency span/div, resolution bandwidth, RF attenuation and video filter.

CRT — 8 x 10 cm, (GH) P31 Phosphor.

Power — 210 W max with all options, at 115 V and 60 Hz.

Input Voltage — 90 to 132 V ac or 180 to 250 V ac, 48 to 440 Hz.

Configuration — (Bench/Rackmount) 24.5 kg (54 lb), 177.8 mm x 431.8 mm x 609.6 mm (7 in x 17 in x 24 in).

ENVIRONMENTAL

Per MIL-T-28800C Type III, Class 5, Style E.

Temperature — Operating: 0°C to +50°C; Nonoperating: −40°C to +75°C.

Humidity — 95% below +30°C, 75% above +30°C, 45% above +40°C.

Altitude — 10,000 feet operating; 40,000 feet nonoperating.

Electromagnetic Compatibility — The 2754 and 2754P Spectrum Analyzers meet the requirements of MIL-STD-461B, operating from 48 Hz to 440 Hz power sources with the exceptions shown below.

Conducted Emissions — CE01: 15 dB relaxation for first 10 harmonics of power line frequency. CE03 (Narrowband): Full limits. CE03 (Broadband): 15 dB relaxation from 15 kHz to 50 kHz.

Conducted Susceptibility — CS01: Full limits. CS02: Full limits. CS06: Full limits.

Radiated Emissions — RE01: 10 dB relaxation for first 10 harmonics of power line frequency, and exceptioned from 30 kHz to 36 kHz, RE02: Full limits.

Radiated Susceptibility — RS01: Full limits. RS02-1: Full limits. RS02-2: To 5 amps only. RS03: Up to 1 GHz only.

ORDERING INFORMATION

2754 Spectrum Analyzer **$22,995**

Includes: 50 Ω coax cable, N to N connector, 6 ft; (012-0114-00); 50 Ω coax cable, BNC to BNC connector, 18 in (012-0076-00); service manual Vol. 1 (070-6097-00); service manual Vol. 2 (070-6098-00); operator's manual (070-6096-00); N male to BNC female adaptor; 2 Fast-Blo, 4A fuses; power cord (161-0104-00); power cord clamp (343-0170-00); amber CRT light filter (378-0115-01); gray CRT light filter (378-0115-02); CRT mesh filter (378-0887-00).

2754P Programmable Spectrum Analyzer **$27,995**

Includes: Same as 2754 plus programmer's manual (070-6099-00).

OPTIONS

Option 01 — Adds preselection for the 1.7 GHz to 21 GHz band and limiter for 1st mixer below 1.8 GHz. **+$3,995**

Option 07 — 75 Ω dBmV input and calibration in addition to normal 50 Ω dBm input and calibration. **+$750**

Includes: BNC male to female adaptor connector (013-0126-00); 42 inch BNC to BNC connector 75 Ω coax cable (012-0074-00).

Option 30 — Rackmount 19 inch rack width. **+$250**

Includes: Rack slides (351-0623-00).

Option 31 — Rackmount 19 inch rack width with rear panel input/output capability (no front panel inputs). **+$450**

Includes: Same as Option 30.

Option 52*[1] — North American 220 V configuration with standard power cord. Fuses are replaced with 2A slo-blo.

***WARRANTY-PLUS* SERVICE PLANS**

SEE PAGE 497

M1 — (2754) 2 Calibrations. **+$1,995**

M1 — (2754P) 2 Calibrations. **+$2,025**

M2 — (2754) 2 Years Service. **+$3,380**

M2 — (2754P) 2 Years Service. **+$3,510**

M3 — (2754) 2 Years Service and 4 Calibrations. **+$3,995**

M3 — (2754P) 2 Years Service and 4 Calibrations. **+$4,045**

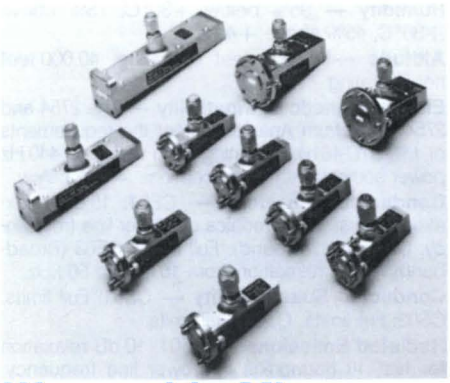
OPTIONAL ACCESSORIES

Microwave Comb Generator — TM 500 Series compatible. Order 067-0885-00 **$1,800**

1405 TV Sideband Analyzer Adaptor — 525/60 markers (Option 02 required for 275X and 49X). **$5,780**

TR 503 Tracking Generator — 100 kHz to 1.8 GHz. **$6,620**

[1] To order, contact your local Tektronix Sales Office.



Waveguide Mixers

490/2750 Series

Tektronix Waveguide Mixers cover from 18 GHz to 325 GHz with optimum sensitivity. They are designed specifically for use with the Tektronix 490 and 2750 Series Spectrum Analyzers.

Two microwave mixers, with field replaceable diodes, cover ranges 18 GHz to 26.5 GHz and 26.5 GHz to 40 GHz. When used with the 490 and 2750 Series, the frequency response is ±2 dB.

Eight millimeter-wave mixers cover the 33 GHz to 220 GHz range in the standard Mil-spec band ranges. J to G band flange transition (119-1728-00) converts the WM 490G mixer to cover the 220 GHz to 325 GHz range.

All mixers are gold plated brass, conforming to MIL-G-45204 Class I, Type 1 specifications and will withstand harsh environments. Mixer sets come complete with a container for spare diodes, a 28-inch cable, an instruction manual and a wood storage box with foam cutout storage locations for five mixers.

CHARACTERISTICS

For All Waveguide Mixers — Maximum CW RF Input Level: +20 dBm (100 mW).

Maximum PULSED RF Input Level — 1 W peak with 0.001 maximum duty factor and 1 μs maximum pulse width.

LO Requirement — +7 dBm minimum, +15 dBm maximum, +10 dBm typical.

Bias Requirement — −2.0 V to +0.5 V with respect to the mixer body through a current limiting resistor, to provide 0 mV to 20 mA of bias current.

1 dB Compression Point — +13 dBm typical.

Amplitude Accuracy — ±6 dB maximum reference level error with respect to the internal calibrator.

INDIVIDUAL MIXER ELECTRICAL CHARACTERISTICS

Frequency Range (GHz)	Tektronix Model	Band Designation	Sensitivity (dBm)*1	Frequency Response*2	Conversion Loss*3 Typical
18 to 26.5	WM 490K	K	−100	±2 dB	−30 dB
26.5 to 40	WM 490A	A	−95	±2 dB	−30 dB
33 to 50	WM 490Q	Q	−95	±2 dB	−30 dB
40 to 60	WM 490U	U	−95	±2.5 dB	−30 dB
50 to 75	WM 490V	V	−95 at 50 GHz −90 at 75 GHz typical	±3 dB typical*4	−30 dB at 50 GHz −35 dB at 75 GHz
60 to 90	WM 490E	E	−95 at 60 GHz −85 at 90 GHz typical	±3 dB typical*4	−30 dB at 60 GHz −40 dB at 90 GHz
75 to 110	WM 490W	W	−90 at 75 GHz −80 at 110 GHz typical	±3 dB typical*4	−35 dB at 75 GHz −45 dB at 110 GHz
90 to 140	WM 490F	F	−85 at 90 GHz −75 at 140 GHz typical	±3 dB typical*4	−40 dB at 90 GHz −50 dB at 140 GHz
110 to 170	WM 490D	D	−80 at 110 GHz −70 at 170 GHz typical	±3 dB typical*4	−45 dB at 110 GHz −55 dB at 170 GHz
140 to 220	WM 490G	G	−75 at 140 GHz −65 at 220 GHz typical	±3 dB typical*4	−50 dB at 140 GHz −60 dB at 220 GHz
220 to 325	119-1728-00*6	J	−65 at 220 GHz −50 at 325 GHz typical*5	±3 dB typical*4	−60 dB at 220 GHz −70 dB at 325 GHz

*1 *Equivalent average noise level at 1 kHz bandwidth.*
*2 *Maximum amplitude variation across each waveguide mixer band (with peaking control optimized at each frequency in response to a −30 dBm CW input signal to the mixer).*
*3 *490 LO drive +10 dBm peaking control optimized.*
*4 *Over any 5 GHz bandwidth for millimeter wave mixers above 60 GHz.*
*5 *Value estimated at 325 GHz.*
*6 *Tapered waveguide transition allowing WM 490G to cover this range.*

INDIVIDUAL MIXER MECHANICAL CHARACTERISTICS

Frequency Range (GHz)	Tektronix Model*3	Waveguide (EIA)	Flange (JAN)	Length	Width*1	Height*1	Weight
18 to 26.5	WM 490K	WR-42	UG-595/U	8.97 cm (3.53 in)	2.22 cm (.875 in)	3.68 cm (1.45 in)	180 g (6.5 oz)
26.5 to 40	WM 490A	WR-28	UG-599/U	6.93 cm (2.73 in)	1.90 cm (0.750 in)	3.35 cm (1.32 in)	100 g (3.7 oz)
33 to 50	WM 490Q	WR-22	UG-383/U	5.37 cm (2.125 in)	1.84 cm (0.725 in)	2.82 cm (1.110 in)	90 g (3.3 oz)
40 to 60	WM 490U	WR-19	UG-383/U-M	4.52 cm (1.78 in)	1.84 cm*1 (0.725 in)	2.45 cm (0.980 in)	80 g (2.9 oz)
50 to 75	WM 490V	WR-15	UG-385/U	4.31 cm (1.70 in)	0.89 cm (0.350 in)	2.29 cm (0.900 in)	40 g (1.5 oz)
60 to 90	WM 490E	WR-12	UG-387/U	4.31 cm (1.70 in)	0.89 cm (0.350 in)	2.29 cm (0.900 in)	40 g (1.5 oz)
75 to 110	WM 490W	WR-10	UG-387/U-M	4.31 cm (1.70 in)	0.89 cm (0.350 in)	2.29 cm (0.900 in)	40 g (1.5 oz)
90 to 140	WM 490F	WR-08	UG-387/U-M*2	4.31 cm (1.70 in)	0.89 cm (0.350 in)	2.29 cm (0.900 in)	40 g (1.5 oz)
110 to 170	WM 490D	WR-06	UG-387/U-M*2	4.31 cm (1.70 in)	0.89 cm (0.350 in)	2.29 cm (0.900 in)	40 g (1.5 oz)
140 to 220	WM 490G	WR-05	UG-387/U-M*2	4.31 cm (1.70 in)	0.89 cm (0.350 in)	2.29 cm (0.900 in)	40 g (1.5 oz)
220 to 325	119-1728-00 G-J Band flange transition	WR-05 WR-03	74-003 74-005	—	—	—	—

*1 *Physical dimensions exclude contribution due to the diameter of round waveguide flanges in U, V, E, W, F, D and G bands.*
*2 *All mixers are equipped with standard UG-XXX/U type flanges as indicated. Flange adaptors to standard MIL-F-3022 type flanges are provided in F, D, and G bands at no additional charge.*
*3 *All mixers include a protective flange cover, an LO/IF port protective shorting cap, and two captive flange screws for round flange mixers.*

ORDERING INFORMATION

PERFORMANCE SPECIFIED MIXERS AND SETS

18 GHz to 26.5 GHz — Order WM 490K **$1,250**

26.5 GHz to 40 GHz — Order WM 490A **$1,250**

33 GHz to 50 GHz — Order WM 490Q **$1,450**

40 GHz to 60 GHz — Order WM 490U **$1,720**

50 GHz to 75 GHz — Order WM 490V **$1,950**

60 GHz to 90 GHz — Order WM 490E **$2,120**

75 GHz to 110 GHz — Order WM 490W **$2,175**

90 GHz to 140 GHz — Order WM 490F **$2,330**

110 GHz to 170 GHz — Order WM 490D **$3,250**

140 GHz to 220 GHz — Order WM 490G **$3,325**

220 GHz to 325 GHz — Order 119-1728-00 **$1,200**

18 GHz to 40 GHz Set — Order WM 4902 **$2,550**
Includes: WM 490K, WM 490A.

18 GHz to 60 GHz Set — Order WM 4903 **$4,300**
Includes: WM 490K, WM 490A, WM 490U.

18 GHz to 90 GHz Set — Order WM 4904 **$6,420**
Includes: WM 490K, WM 490A, WM 490U, WM 490E.

18 GHz to 140 GHz Set — Order WM 4905 **$8,750**
Includes: WM 490K, WM 490A, WM 490U, WM 490E, WM 490F.

Cable — Order 012-0649-00 **$32**

Case — Order 016-0465-01 **$30**

140 GHz to 220 GHz — Tapered transition 119-1729-00 used with WM 490F waveguide mixer. **$550**

GENERAL PURPOSE WAVEGUIDE MIXERS AND SET

12.5 GHz to 18 GHz — Order 119-0097-01 **$250**

18 GHz to 26.5 GHz — Order 119-0098-01 **$300**

26.5 GHz to 40 GHz — Order 119-0099-01 **$500**

Cable — Order 012-0748-00 **$60**

Case — Order 016-0465-01 **$30**

12.5 GHz to 40 GHz Set — Order 016-0640-00 **$1,275**
Includes: 119-0097-01, 119-0098-01, 119-0099-01.

NEW 2710

More Performance, Lower Price

Frequency Accuracy of ±10 kHz at 1 GHz Center Frequency

Faster Measurements With Full Marker/ Delta Marker Capabilities

More Convenience With Four-Trace Digital Storage, Automatic Measurements

High Stability Package (Option 01)
- **300 Hz Resolution/Phase Lock**
- **5 x 10^{-7} Frequency Accuracy**
- **Frequency Counter**

Excellent for installation, service, manufacturing and other test applications, the under-20-pound, portable 2710 provides 10 kHz to 1.8 GHz coverage with center frequency accuracy of 10^{-5}. Resolution bandwidth ranges from 3 kHz to an unprecedented wide resolution of 5 MHz to examine wideband signals with minimum measurement distortion. A high stability package, Option 01, provides an additional level of performance: 300 Hz resolution bandwidth/phaselock stabilization and frequency accuracy of 5 x 10^{-7}, ±500 Hz at 1 GHz CF. This frequency accuracy is available at wide spans and with readout resolution to the nearest hertz with an optional built-in frequency counter.

The 2710 includes 80 dB display dynamic range and 1, 5 and 10 dB/div vertical scale log modes. Sensitivity is −130 dBm at 300 Hz RBW. A built-in 18 dB preamp improves sensitivity to −143 dBm (at 300 Hz RBW); it boosts low level signals for accurate measurement without degradation due to front-end losses of measurement equipment.

The Tek 2710 marker/delta marker capability includes front panel controls for peak find, right next and left next signals, and marker to center. Using the FREQ/MKR menu, next highest and next lowest signal marker maneuvers may be made. Markers function in both the frequency and time domain and include off-screen measurement capability.

Four-trace digital storage display greatly improves signal comparison. A, B, and C displays may be stored and viewed with the D display always remaining current. Digital processing includes MAX HOLD and DISPLAY minus SAVE A functions. By pressing SAVE and D keys, a waterfall or time series display mode is implemented.

The Tek 2710 features a comprehensive time domain capability that has particular value in making communications measurements. Included are one microsecond to 2 sec/div sweep in a 1-2-5 sequence for maximum flexibility in expanding the display, analog display for gray scale enhancement, and 5 MHz system bandwidth (including CRT) that minimizes amplitude measurement distortion. AM/FM detectors with audio amplifier, speaker and headphone jack permit evaluation of demodulated audio. A new, optional video monitor mode permit viewing the demodulated, rasterized video on the CRT of the spectrum analyzer.

Additional time-saving and accuracy enhancing features include automatic calibration, selectable reference level units (dBm, dBmV, dBμV, dBV, dBμW, dBμV/m), selectable 50 Ω/dBm or 75 Ω/dBmV operation, signal track, bandwidth characterization mode, noise normalization mode and much more!

The Tek 2710 capabilities are accessed via easy-to-read and logically grouped controls on the front panel or over the IEEE-488 interface bus with GPIB/full programmability option.*[1] Secondary functions are implemented by selecting from clearly marked pushbutton menus. Ease of use is further enhanced by auto sweep, auto resolution and auto min RF attenuation modes. A user-definable key accesses pushbutton measurements programmed from the front panel and stored in nonvolatile memory. And start/stop, center frequency, span/div and other control parameters can be directly entered through a front panel keyboard.

*[1] *Not available at product announcement date. Contact your Tektronix Sales Engineer for more information.*

ORDERING INFORMATION

2710 Portable Spectrum Analyzer*[2] **$8,250**

OPTIONS

Option 01 — 300 Hz resolution bandwidth/ phase lock/5 x 10^{-7} frequency accuracy. **+$750**

Option 02 — Internal frequency counter. **+$400**

Option 06 — Battery power option. **Includes:** Tek 1106 Battery Pack; 1107 dc Inverter; mounting hardware. **+$1,710**

Option 09 — Centronix interface. **+$300**

Option 10 — Video Monitor mode. **+$200**

Option 11 — Nonvolatile RAM storage for setups, displays, and user-definable key sequences. **NC**

Option 30 — Rackmount. **+$750**

INTERNATIONAL POWER PLUG OPTIONS

Option A1 — Universal Euro 220 V, 50 Hz.
Option A2 — UK 240 V, 50 Hz.
Option A3 — Australian 240 V, 50 Hz.
Option A4 — North American 240 V, 60 Hz.
Option A5 — Switzerland 220 V, 50 Hz.

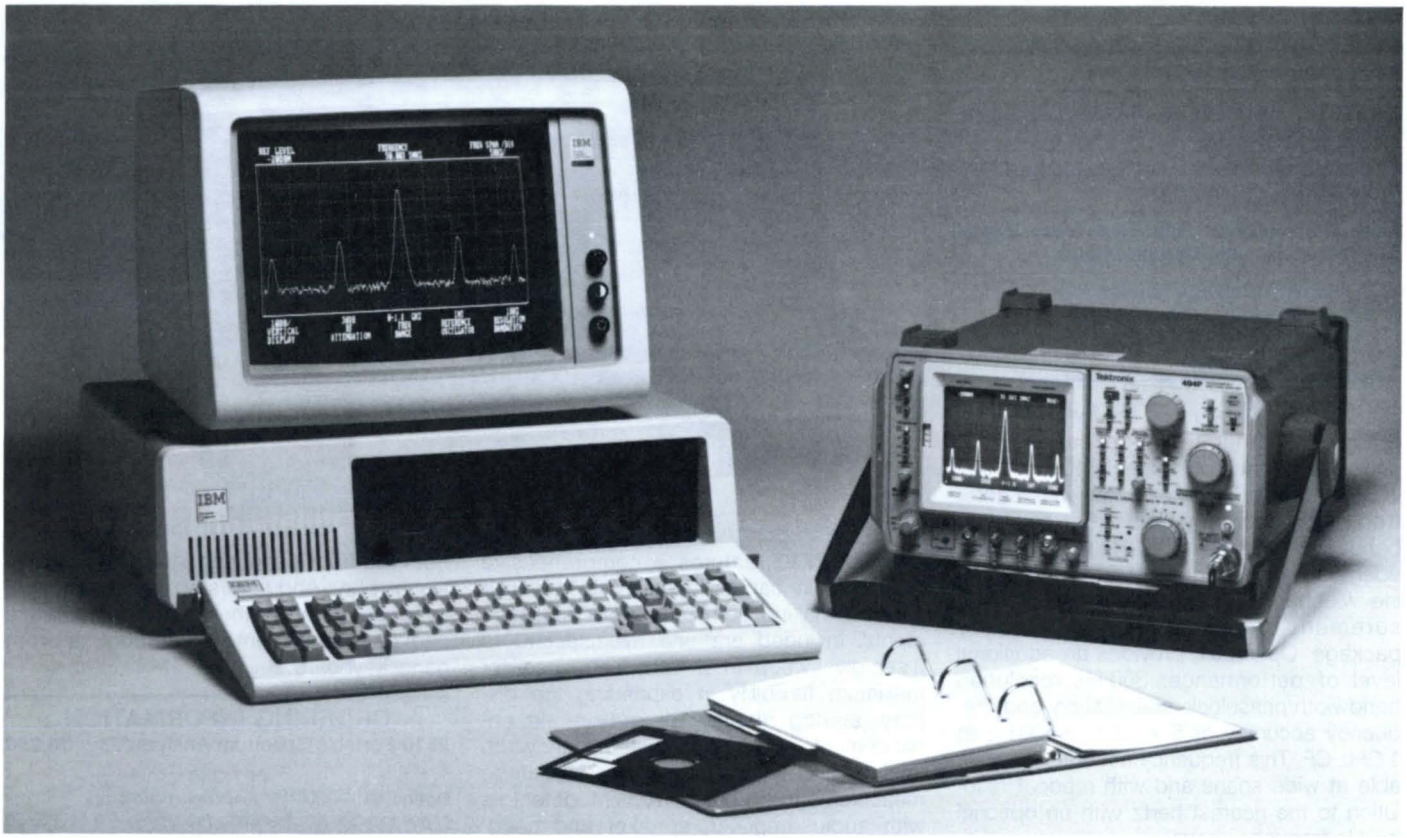
***WARRANTY-PLUS* SERVICE PLANS**
SEE PAGE 497

M1 — 2 Calibrations. **+$710**
M2 — 2 Years Service. **+$1,190**
M3 — 2 Years Service and 4 Calibrations. **+$1,430**

*[2] Contact your nearest Tektronix Sales Office for complete details and ordering information on the Tek 2710 Spectrum Analyzer. Or write to:

Tektronix, Inc.
P.O. Box 500
Delivery Station 58-070
Beaverton, Oregon 97077

TEK SPECTRUM ANALYZER PACKAGES



NEW Spectrum Analyzer Packages

GPIB IEEE-488

The Tektronix Spectrum Analyzer Packages comply with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats.*

Packages Include Tek's High Performance Spectrum Analyzers, an IBM PC XT/AT and GRASP Software

Powerful GRASP Software Aids in Acquiring, Processing, Storing, and Displaying Spectral Data

Each Package is Ordered as an Option to a Spectrum Analyzer

Tektronix spectrum analyzer packages are configured around IBM's popular PC and Tektronix' laboratory quality, programmable spectrum analyzers. Coupling the PC to the analyzer via the IEEE-488 bus enables the user to take advantage of the power and versatility of Tektronix spectrum analyzers. An IEEE-488 interface (National Instruments PC2A card) is included in each package.

A highly versatile General RF Applications Software Package (GRASP) offers routines for several types of Measurements, Filter Tests, Signal Searches, Waveform Operations, and Utilities. Each routine is selected through easy, menu-driven operation.

Tek's spectrum analyzer packages are ordered as standard options for the 492AP, 494P, 495P, 2754P and 2755P. Packages are not available in all countries. Contact your local Sales Engineer for availability.

Option 23 is intended for the user who already has an IBM PC or PC-compatible. Options 24 through 28 are turnkey systems designed for R&D, manufacturing test, and general RF automated testing.

Tektronix can also provide Technical Assistance Services for users requiring custom programming or applications assistance. Contact your Tektronix Sales Engineer for details.

ORDERING INFORMATION

Tek's spectrum analyzer packages are ordered as standard options to the following analyzers—492AP, 494P, 495P, 2754P and 2755P.

When ordering, please specify the model number and desired options of the spectrum analyzer plus one of the following package options.

OPTIONS

Option 23 — GRASP and GPIB Interface. **+$1,750**
Includes: GRASP software, National's PC2A (GPIB) card, and GPIB cable.

Option 24 — IBM XT-3 Package. **+$7,250**
Includes: GRASP, PC2A, GPIB cable, IBM PC/XT-3, 10 Mb hard disk, 360 Kb floppy drive, 256 Kb memory, enhanced color display, and AST SixPakPlus.

Option 25 — IBM XT-1 Package. **+$6,250**
Includes: GRASP, PC2A, GPIB cable, IBM PC/XT-1, 2 ea. 360 Kb floppy drives, 256 Kb memory, enhanced color display, and AST SixPakPlus.

Option 26 — IBM PC/AT Enhanced Package. **+$9,250**
Includes: GRASP, PC2A, GPIB cable, IBM PC/AT Enhanced Model, 20 Mb hard disk, 1.2 Mb floppy, 360 Kb floppy, 512 Kb memory, enhanced color display, and serial/parallel interface.

Option 28 — IBM PC/AT Entry Model Package. **+$7,500**
Includes: GRASP, PC2A, GPIB cable, IBM PC/AT Entry Model, 1.2 Mb floppy, 360 Kb floppy, 256 Kb memory, enhanced color display, and serial/parallel interface.

NEW

GPIB

TekSPANS®

MEASUREMENTS
Harmonic Distortion
Amplitude Modulation
Signal-to-Noise
Frequency Response
Cursors

FILTER TESTS
Band-pass Filter
Low-pass Filter
High-pass Filter

SIGNAL SEARCH
Fast Search
Precise Search
Spur Search
Automatic Identify

WAVEFORM OPERATIONS
Acquire AVIEW from 49XP
Acquire BVIEW from 49XP
Send to 49XP
Store on Disk
Load from Disk
Graph Waveform
Overlay Waveform
Redraw Waveform
Normalize Waveform

UTILITIES
Talk/Listen (Command)
Sensitivity Test
Resolution Filter Test
Calibration Assistance
Select 49XP
Select Disk

The GRASP main menu lists all submenus and their routines.

General RF Applications Software Package (GRASP®)

Value Packed Software—Performs Automated Spectrum Analysis on Choice of Popular Controllers

Applications Routines Are Selected Through Easy, Menu-Driven Operation

Supports IBM PC XT/AT and Compatible Computers (Option 01/1A)

Supports HP Series 200 Controllers (Option 02/2A)

Supports Tek 4041 Controller and Multiple-Site/Remote-Site Monitoring of RF Equipment (Option 03)

Tek's GRASP (General RF Applications Software Package) is the first in a family of spectrum analyzer software packages called TekSPANS. GRASP is designed to capitalize on the power of Tektronix' programmable spectrum analyzers and a choice of controllers such as Tek's 4041, IBM PCs or compatibles, and HP Series 200.

This highly versatile software package offers many applications/utility routines that are selected through easy, menu-driven operation. Even a nontechnical operator has immediate access to operations such as swept-frequency measurements, waveform storage and recall, and performing signal analysis, including measurements of harmonic distortion and signal-to-noise ratio.

From GRASP's main menu, a user selects among any of the submenus for Measurements, Filter Tests, Signal Search routines, Waveform Operations, and Utilities. Selections are made by pressing the appropriate function key shown on screen. Prompts guide the user through each measurement task.

For example, users can utilize a Cursors routine which displays the instrument CRT on their terminal screen. It calculates and displays both the absolute amplitude and frequency of one or two marked signals, plus the relative (delta) amplitude and frequency difference between the two markers.

A powerful feature of GRASP is the ability to monitor one or more remote sites (option 03) via phone lines and modems. The user can exercise complete control over the spectrum analyzer at the remote site, and can graph the acquired waveform at the base-site terminal. The user can also specify a frequency and amplitude window, providing for an automatic telephone call back to the base site when the signal drops out of tolerance.

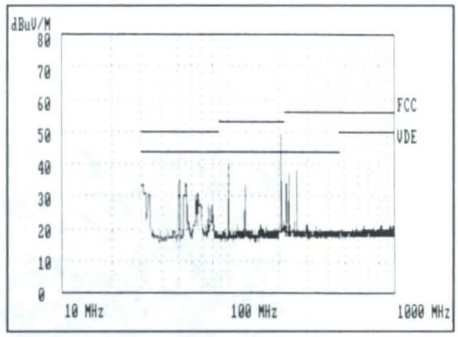
Complete source code is provided with GRASP, thereby simplifying the task of integrating user-written routines into GRASP.

ORDERING INFORMATION

S26RF00 General RF Applications Software Package (GRASP) **$875**
Includes: Software on appropriate media (see option details below), license agreement, and users manual.

OPTIONS

Option 01 — IBM PC AT high density disk. **NC**
Option 1A — IBM PC double density disk. **NC**
Option 02 — HP Series 200 5¼″ double density disk. **NC**
Option 2A — HP Series 200 3½″ micro disk. **NC**
Option 03 — Tek 4041 DC-100 Tape. **NC**



Sample graph from radiated emissions test.

NEW EMI Software

Provides Cost-Effective Approach to Automated EMI Testing

Software Runs on IBM PC XT/AT, and Compatible Computers

Provides Prequalification Testing for FCC/VDE and MIL-STD-461B/462 CE03 and RE02. Tests Are Accessed Through Easy, Menu-Driven Operation

Tek's EMI Prequalification Software provides a low-cost, time-saving approach to EMI conducted and radiated testing. It is particularly useful to design engineers who require a compact system for measuring and documenting EMI levels during the various design stages.

When used with a Tektronix programmable spectrum analyzer and an IBM PC (equipped with a National Instruments PC2A IEEE-488 interface card), this software enables a cost-effective approach for integrated EMI testing.

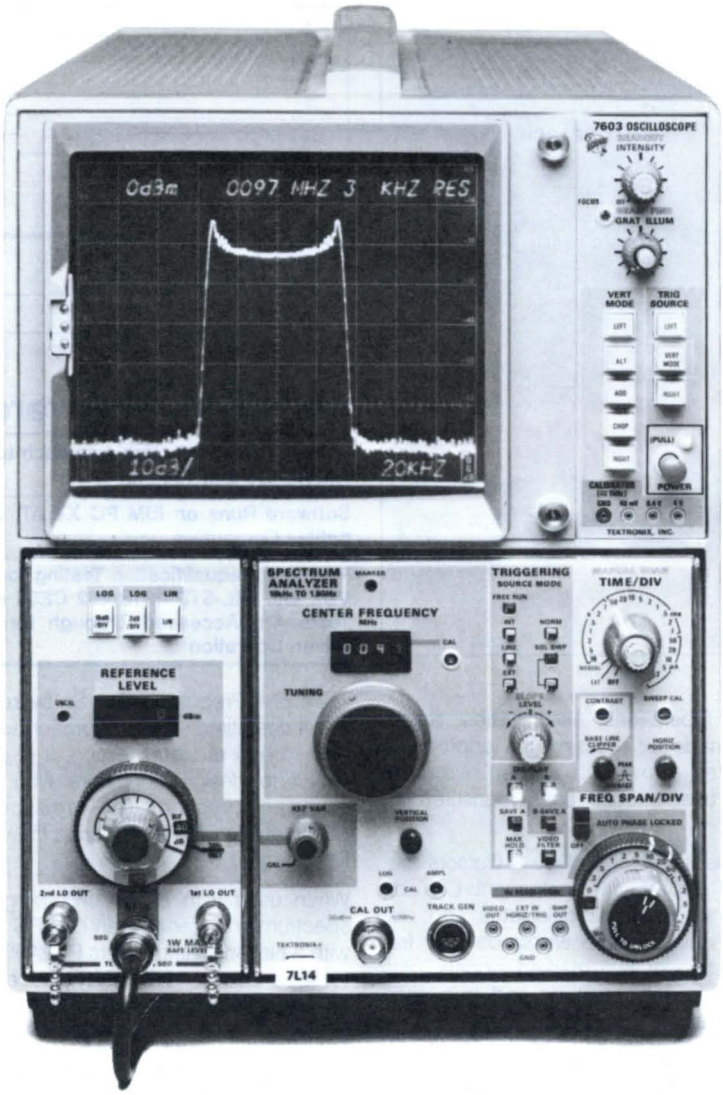
This highly versatile software package includes test routines for FCC Part 15J (A & B), VDE 0871 (A & B) and MIL-STD-461B/462 RE02 and CE03. Routines are accessed through easy, menu-driven operation. For each class of test, routines are provided for acquiring data, graphing the results (semilog plot with selected limits superimposed) and creating printouts of those frequencies which approach or exceed acceptable limits. Capability is also included for updating antenna factors.

The package provides a users manual, which includes a tutorial section on basic EMI measurements.

ORDERING INFORMATION

S26EM00 EMI Prequalification Software **$1,475**
Includes: Software on DS/DD diskettes, license agreement, and user's manual.

SPECTRUM ANALYZER SOFTWARE



7L14 in 7603 mainframe with internal spectrum analyzer graticule.

7L14

Resolution Bandwidth Range of 30 Hz to 3 MHz

−130 dBm Sensitivity

Swept Measurements With the Tek TR 502

1 kHz to 2.5 GHz Coverage With Option 39

Compatibility With 1405 TV Sideband Analyzer

Semiautomatic Measurements With the Tek 7854

The Tektronix 7L14 provides high performance spectrum analysis in the 10 kHz to 1.8 GHz range. Option 39 increases coverage to 1 kHz to 2.5 GHz. Option 23—deleting the built-in input limiter—results in 1 kHz to 1.8 GHz coverage.

7L14 capability translates to confidently making communications systems or EMC measurements. Narrow 4:1 or less resolution bandwidth filter shape factor (12:1 at 30 Hz) and 13 Hz p-p residual FM mean you can effectively examine close-in spurs or sidebands. Combined with the Tek TR 502 Tracking Generator, the 7L14 is the heart of a very stable scalar analysis system available at an affordable price. Check RF networks, filters, amplifiers, and more . . . see page 178 for details.

Digital storage helps you compare A and B displays; MAX HOLD captures maximum frequency excursions (as with a drifting oscillator) and max amplitudes, or short duration signals such as in spectrum occupancy monitoring. The 7L14 also features a built-in input limiter that protects the first mixer from overload—you can apply up to one watt to the 7L14.

Make semiautomatic measurements by using the Tek 7854 Digitizing Mainframe. This programmable unit's calculation and marker capabilities can greatly enhance your productivity using the 7L14 Spectrum Analyzer. The 7854 Mainframe can also be used with your choice of other Tek 7000 Series test and measurement plug-ins—versatility plus! Get full details from your Tek Sales Engineer or ask for Application Note 26-W-5653.

ORDERING INFORMATION

7L14 Spectrum Analyzer **$18,060**

Includes: Spectrum analyzer graticule, 6 ft 50 Ω coax cable with BNC connectors (012-0113-00); BNC male to female adaptor (103-0058-00); light filter (378-0625-07); amber light filter (378-0684-01); clear plastic implosion shield with Log, Lin, Ref, and F (frequency) direction markings (337-1439-01), for 7603 oscilloscope and (337-1159-02) for other 7000 Series oscilloscopes; instruction manual (070-3434-00).

OPTIONS

Option 23 — Deletes input limiter. **+$50**

Option 39 — 1 kHz to 2.5 GHz Extended Frequency Range. **+$500**

RECOMMENDED MAINFRAMES

7603 Oscilloscope, 100 MHz (see page 229) **$3,670**

R7603 Rackmount Oscilloscope, 100 MHz (see page 229) **$4,160**

OPTIONS (7603/R7603)

Option 06 — Internal Spectrum Analyzer Graticule. **+$50**

Option 08 — Protective Front Cover (cabinet only). **+$115**

Option 77 — GM (P7) Phosphor and Internal Spectrum Analyzer Graticule. **+$100**

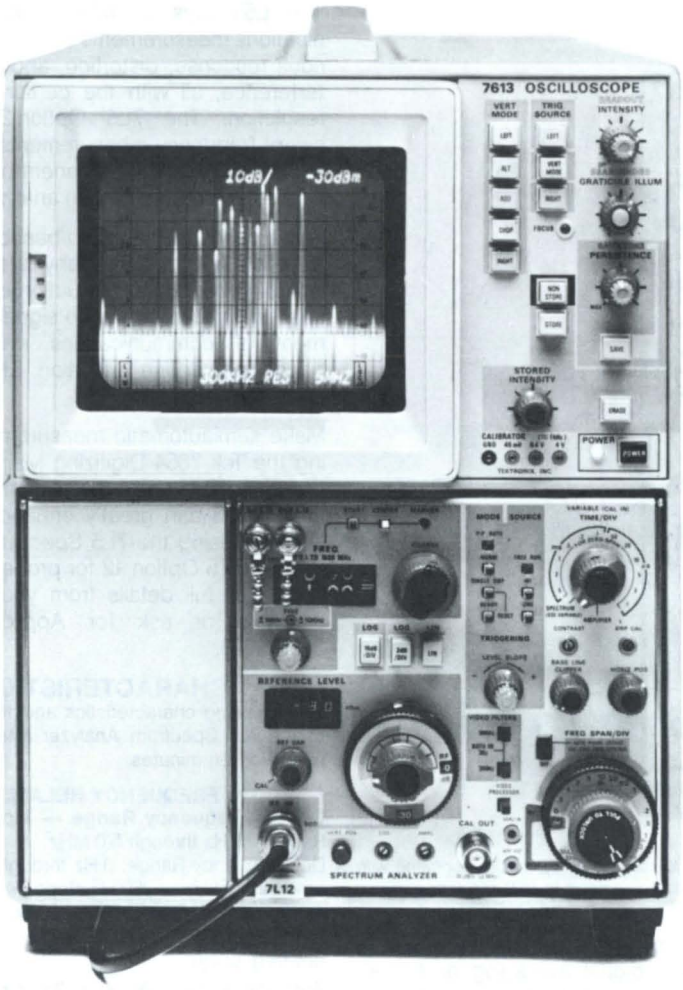
7854 Digitizing Oscilloscope, 400 MHz (see page 338) **$16,220**

TRAINING

Tektronix offers service training classes on the 7L14 Spectrum Analyzer. For further training information, contact your local Sales/Service Office or request a copy of the Tektronix Service Training Schedule on the return card in the center of this catalog.

ADDITIONAL INFORMATION

Request Tek Brochure 26-W-4787-1 for full specifications or call your local Sales Engineer for additional information.



7L12 with 016-0155-00 Blank Panel in 7613 Option 06 Variable Persistence mainframe with internal spectrum analyzer graticule.

ORDERING INFORMATION

7L12 Spectrum Analyzer **$10,960**

Includes: Spectrum analyzer graticule, clear plastic implosion shield with LOG, LIN, REF, and F (frequency) direction markings (337-1439-01) for 7603 Oscilloscopes, and (337-1159-02) for other 7000 Series oscilloscopes; light filter (378-0625-07); amber light filter (378-0684-01); 6 foot 50 Ω coax cable with BNC connectors (012-0113-00); BNC Male to N Female adaptor (103-0058-00); instruction manual (070-1298-02).

OPTION

Option 39 — 100 kHz to 2.5 GHz Extended Frequency Range. **+$500**

RECOMMENDED MAINFRAMES

7613 Storage Oscilloscope, 100 MHz (see page 236) **$6,145**

R7613 Rackmount Storage Oscilloscope, 100 MHz (see page 236) **$6,610**

7603 Oscilloscope, 100 MHz (see page 229) **$3,670**

R7603 Rackmount Oscilloscope, 100 MHz (see page 229) **$4,160**

7854 Digitizing Oscilloscope, 400 MHz (see page 338) **$16,220**

OPTIONS (7603/R7603, 7613/R7613)

Option 06 — Internal Spectrum Analyzer Graticule. **+$50**

Option 08 — Protective front cover (cabinet only). **+$115**

Option 77 — (7603/R7603 only) GM (P7) Phosphor and Internal Spectrum Analyzer Graticule. **+$100**

OPTIONAL ACCESSORY

Blank Plug-In Panel — Order 016-0155-00 **$60**

ADDITIONAL INFORMATION

Request Tek Brochure 26-W-4787-1 for full specifications or call your local Sales Engineer for additional information.

7L12

Proven, Economical VHF/UHF Coverage

Automatic Phase Lock 300 Hz to 3 MHz Resolution Bandwidth Range

Swept Measurements With the TR 502

Coverage to 2.5 GHz (Option 39)

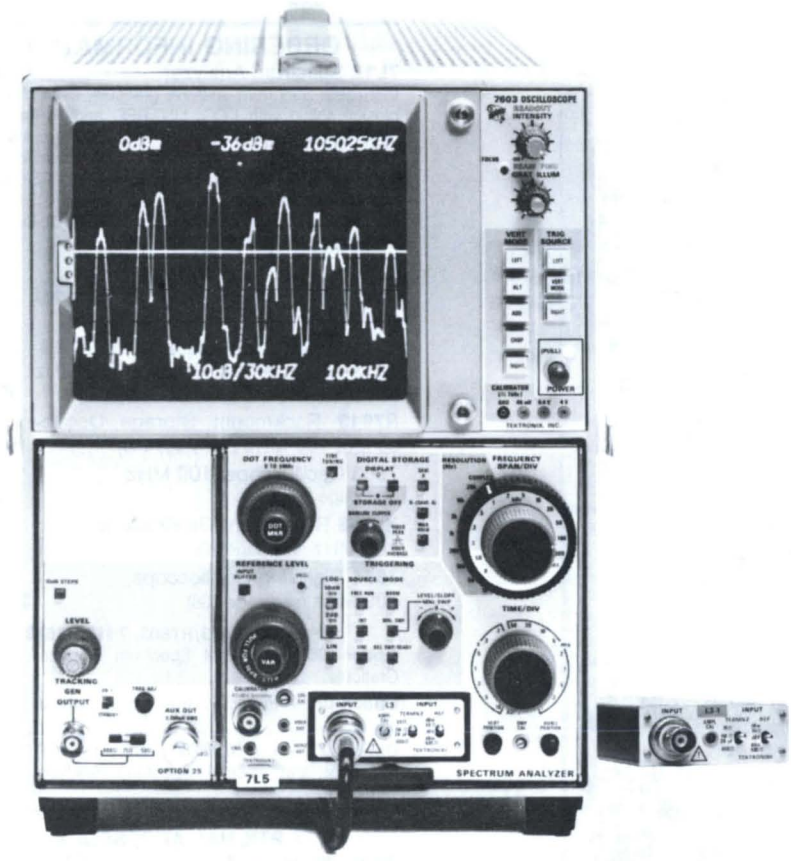
Semiautomatic Measurements With the Tek 7854

The Tek 7L12 Spectrum Analyzer is a proven, economical performer and very popular among users across a range of applications including AM, FM and TV Broadcasting, two-way radio, and other communications systems testing. The 7L12 is also very useful in EMC and other VHF/UHF applications. By ordering Option 39, the 7L12 may be used to 2.5 GHz.

Performance you can count on includes 300 Hz resolution bandwidth/automatic phase lock stabilization, 70 dB spurious-free dynamic range and a very stable swept measurement capability (100 kHz to 1.8 GHz) using the TR 502 (see page 178). Ease-of-use features include CRT readouts of key parameters, and fully calibrated displays.

The 7L12 is fully compatible with the Tek 1405 TV Sideband Analyzer (see page 179) permitting on-the-air transmitter evaluation.

Make semiautomatic measurements by using the Tek 7854 Digitizing Mainframe. This programmable unit's calculation and marker capabilities can greatly enhance your productivity using the 7L12 Spectrum Analyzer. The 7854 can also be put to work with your choice of other Tek 7000 Series test and measurement plug-ins—versatility plus! Get full details from your Tek Sales Engineer or ask for Application Note 26-W-5653.



7L5 Option 25 Spectrum Analyzer with L3 (50 Ω, 600 Ω, 1 MΩ) plug-in module in a 7603 Option 06 mainframe with internal spectrum analyzer graticule. The L3-1 module (shown at right) is switch selectable to 75 Ω, 600 Ω or 1 MΩ.

7L5

Synthesizer Tuning

Digital Storage and Averaging

Three-Knob Operation

Preset Reference Level and Dot Frequency for Extra Input Protection

Swept Measurements (Option 25 Tracking Generator)

Selectable Input Impedance; Calibration in dBm, dBV or Volts/Division

Semiautomatic Measurements With the Tek 7854

The Tektronix 7L5 is a high performance, high value spectrum analyzer providing easy-to-use low frequency measurement capability. The 7L5 can cover 20 Hz to 5 MHz in one display. Resolution bandwidth can be varied from 10 Hz to 30 kHz, with residual FM of no more than 1 Hz peak-to-peak.

Digital storage proves particularly useful in the 7L5. With digital averaging and peak detection, you can accurately measure low level signals, such as intermodulation distortion products, in the presence of noise. With Max Hold, you can capture short duration signals and random transient phenomena that would otherwise be lost.

The 7L5 combines high performance with easy-to-use three-knob operation—

1) Set frequency span
2) Set center frequency
3) Set reference level . . . and measure!

Sweep speed and resolution bandwidth are set automatically.

Digital tuning and synthesizer stability let you set center frequency with six-digit accuracy immediately upon turn-on. Reference level can be set in 1 dB and 10 dB steps, eliminating the need to interpolate amplitude levels. And for measuring wide relative amplitude differences, the 7L5 offers 80 dB spurious-free display dynamic range.

The 7L5 makes accurate baseband communications measurements such as noise, spurious response, distortion, and transient interference, all with the certainty of 10 Hz resolution. The 7L5 Option 25 provides swept frequency measurements from 20 Hz to 5 MHz. The tracking generator is built into a "three-wide" 7L5 plug-in analyzer.

This highly capable audio/baseband analyzer finds a place in many areas of use, including baseband evaluation of FM broadcast and television stereo signals, measurement of communications system basebands, power line distortion, EMC/RFI, and computer systems.

Make semiautomatic measurements by using the Tek 7854 Digitizing Mainframe. This programmable unit's calculation and marker capabilities can greatly enhance your productivity using the 7L5 Spectrum Analyzer. Specify 7L5 Option 12 for proper 7854 interface. Get full details from your Tek Sales Engineer or ask for Application Note 26-W-5653.

CHARACTERISTICS

The following characteristics and features apply to the 7L5 Spectrum Analyzer after a warm-up period of ten minutes.

FREQUENCY RELATED

Center Frequency Range — Input Frequency Range: 20 Hz through 5.0 MHz.
Dot Frequency Range: 0 Hz through 4999.75 kHz tuned in 10 kHz or 250 Hz steps.
Accuracy at 0°C to 50°C: ±(20 Hz + 10^{-5} of dot frequency). 20°C to 30°C: ±(5 Hz + 2 x 10^{-6} of dot frequency).

Frequency Span/Division Range — 50 Hz/div to 500 kHz/div (maximum) in a 1-2-5 sequence.
Accuracy: Within 5%.
Linearity: Within 5% over the center eight divisions.
Zero Span: Provides fixed frequency operation for time domain display.

Resolution Bandwidth (6 dB) — 10 Hz to 30 kHz in eight steps. Coupled position electronically couples resolution to span/division selection so that both are controlled by the same knob.
Accuracy: Within 20% of resolution selected (30 Hz to 30 kHz). 10 Hz is 100 Hz ±20 Hz 70 dB down.

Resolution Shape Factor (60/6 dB) — 10:1 or better for 10 Hz to 1 kHz and 5:1 or better for 3 kHz to 30 kHz.

Signal Level Change Between Any Two Bandwidths — 30 kHz to 100 Hz: ≤0.5 dB. 30 kHz to 10 Hz: ≤2.0 dB.

Residual FM — ≤1 Hz (p-p) for frequency span of 50 Hz/div to 2 kHz/div. ≤40 Hz (p-p) for frequency span of 5 kHz/div to 500 kHz/div.

Stability — ≤5 Hz/hour.

AMPLITUDE RELATED

Display Modes — Log 10 dB/Division: Provides 80 dB display dynamic range. Accuracy is within 0.08 dB/dB to 2 dB maximum over 80 dB display dynamic range.
Log 2 dB/Division: Provides 16 dB display dynamic range. Accuracy is within 0.15 dB/dB to 1 dB maximum over 16 dB display dynamic range.
LIN: 20 nV/div to 200 mV div in a 1-2-5 sequence. Accuracy is within 5%.

Reference Level — +21 dBm to −128 dBm (50 Ω or 75 Ω input impedance), +10 dBm to −139 dBm (600 Ω input impedance), +8 dBV to −141 dBV (1 MΩ input impedance). Calibrated in 1 dB and 10 dB steps.

Display Flatness — 0.7 dB maximum from 20 Hz to 5 MHz (add 0.5% quantization error in digital storage).

Sensitivity — Equivalent input noise for each resolution bandwidth setting is measured in video average mode with 10 s/div sweep rate and input buffer control off. Sensitivity is degraded an additional 8 dB when the input buffer is on.

Resolution Bandwidth	Averaged Noise Level	
	dBm 50 Ω	dBV 75 Ω
10 Hz	−135 dBm	−140.5 dBV
30 Hz	−133 dBm	−138.5 dBV
100 Hz	−130 dBm	−135.5 dBV
300 Hz	−125 dBm	−130.5 dBV
1 kHz	−120 dBm	−125.5 dBV
3 kHz	−115 dBm	−120.5 dBV
10 kHz	−110 dBm	−115.5 dBV
30 kHz	−105 dBm	−110.5 dBV

SPURIOUS RESPONSES

Residual — ≤ −143 dBV (noncalibrator related, referenced to the input).

Intermodulation Products — Within any frequency span for two on screen signals of any input level, third order down 75 dB or more and second order down 72 dB or more; of any input level up to −53 dBV or of any input level with input buffer on, second and third order down 80 dB or more.

GENERAL CHARACTERISTICS

Sweep — Triggered, manual, auto.

Sweep Time — 10 s/div to 0.1 ms/div in a 1-2-5 sequence.

Accuracy — Within 5% of selected time/division.

Triggering — Sources are free run, internal and line. Modes are normal, manual sweep and single sweep.

Sensitivity — ≥1.5 div of internal signal for both normal and single sweep modes over the approximate frequency range of 30 Hz to 500 kHz.

Shipping Weight — 7.6 kg (17 lb).

INPUT SIGNALS

Maximum Input Power Level —
1 MΩ/28 pF: 15 V (p-p) for ac or pulse signals with rise times of 2 V/μs or faster (pulses or ac beyond this specification may open an input fuse). 40 V (dc plus peak ac) for signals with rise times slower than 2 V/μs.
600 Ω (Internally Terminated): 12 V dc or RMS (+24 dBm).
50 Ω (Internally Terminated): 3.5 V dc or RMS (+24 dBm).

Input Impedance — Switch selectable 1 MΩ in parallel with 28 pF, 50 Ω (75 Ω for L3 Option 01) termination, or 600 Ω termination.

OUTPUT SIGNAL

Calibrator — (Cal Out) 500 kHz squarewave within ±0.15 dB of −40 dBV into the plug-in impedance.

Video Out — 50 mV/div ±5% (about the CRT center) with source impedance of 1 kΩ.

Horizontal Out — 0 V dc to about −6 V dc sawtooth with a source impedance of 5 kΩ.

Option 25 Tracking Generator

The 7L5 with Option 25 Tracking Generator, provides selectable 50 Ω, 75 Ω, or 600 Ω impedance source that has a calibrated output level for swept frequency tests from 20 Hz to 5.0 MHz. The output frequency can be adjusted so it tracks within 10 Hz of the spectrum analyzer frequency. The frequency span and rates are controlled with the spectrum analyzer. The output level is controlled from the tracking generator. Output level is calibrated and controlled in 10 dB and 1 dB steps over a 63 dB range. An Aux Output may be used to drive a frequency counter. The 7L5 with Option 25 is a three-wide unit for the 7000 Series mainframes.

CHARACTERISTICS

Frequency Range — 20 Hz to 5.0 MHz.

Output Impedance — 50 Ω, 75 Ω, or 600 Ω selected by a front panel switch.

Amplitude — The output level is calibrated in dBm or dBV and selectable in 10 dB or 1 dB steps. A vernier provides continuous variation between calibrated steps.

Range — 50 Ω: 0 dBm to −63 dBm. 75 Ω: −6 dBm to −69 dBm. 600 Ω: −17 dBm to −80 dBm.

Accuracy (Maximum Output Calibrated at 500 kHz) — 50 Ω: 0 dBm ±0.25 dB. 75 Ω: −6 dBm +0.4, −0.2 dB. 600 Ω: −17 dBm +0.5, −0.1 dB.

Attenuator — Range: 0 dB to 63 dB in 10 dB or 1 dB steps. Accuracy: Within 0.2 dB/dB to a maximum of 0.25 dB/10 dB absolute.

Flatness — 50 Ω and 75 Ω: Within 0.5 dB p-p. 600 Ω: Within 1.0 dB p-p. Total System Flatness (7L5 with L3 Plug-In Module and Option 25) 50 Ω and 75 Ω: Within 1.0 dB p-p. 600 Ω: Within 1.25 dB p-p.

Dynamic Range (7L5 With Option 25) — ≥110 dB.

Residual FM (p-p) — (7L5 with Option 25). Spans to 2 kHz/Div: 2 Hz. Spans 5 kHz/Div or Greater: 40 Hz.

Stability — 25 Hz/5 minutes after ten minute warm-up decreasing to 25 Hz/hour maximum after one hour.

Spurious Suppression, 20 Hz to 5.0 MHz (Harmonic and Nonharmonic) — 40 dB or more with respect to the carrier.

Auxiliary Output — ≥200 mV RMS into 50 Ω.

BALANCED INPUT TRANSFORMER

Frequency Range — 50 kHz to 3 MHz, usable from 10 kHz to 20 MHz.

Flatness — 0.25 dB p-p maximum (50 kHz to 3 MHz) including nominal 0.1 dB insertion loss.

Common-Mode Rejection — 25 dB minimum (50 kHz to 3 MHz).

Output Termination — Switchable between 124 Ω, 135 Ω, and none for bridging or external termination.

Connectors — WECO (0.37 in with 0.090 center) on 0.625 inch spacing for balanced input. BNC for single-ended output.

ORDERING INFORMATION

7L5 Spectrum Analyzer (Requires L3 Plug-In Module) **$11,070**
Includes: Spectrum analyzer graticule (337-1159-00); (7000 Series), and (337-1439-01); (7603), light blue filter (378-0684-00); operator manual (070-1734-01); service manual (070-2184-01).

OPTIONS

Option 11 — L3 Plug-In Module Option 01 shipped with 7L5. **+$1,580**

Option 12 — 7854 Waveform Oscilloscope compatibility. **+$150**

Option 20 — L3 Plug-In Module shipped with 7L5. **+$1,580**

Option 25 — Tracking Generator. **+$1,560**

L3 Plug-In Module, 1 MΩ, 50 Ω, 600 Ω **$1,580**
Includes: Instruction manual (070-2154-02).

Option 01 — (L3 only) 1 MΩ, 75 Ω, 600 Ω. **NC**

CONVERSION KIT

Tracking Generator — To add to existing 7L5. Order 040-0810-04 **$2,215**

RECOMMENDED MAINFRAMES

7603*1 Oscilloscope, 100 MHz (see page 229) **$3,670**

R7603*1 Rackmount Oscilloscope, 100 MHz (see page 229) **$4,160**

7854 Waveform Processing Oscilloscope, 400 MHz (see page 338) **$16,220**

1 Suggested oscilloscope.

OPTIONS (7603/R7603)

Option 06 — Internal Spectrum Analyzer Graticule. **+$50**

Option 08 — Protective Front Cover (cabinet only). **+$115**

Option 77 — GM (P7) Phosphor and Internal Spectrum Analyzer Graticule. **+$100**

OPTIONAL ACCESSORIES

75 Ω to 50 Ω Minimum Loss Attenuator — Ac coupled. Order 011-0112-00 **$70**

P6105A — 10X, 2 m Probe. **$93**

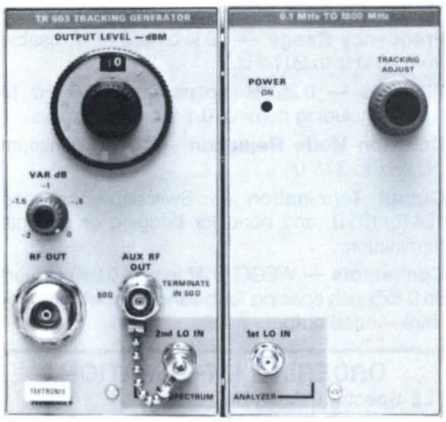
Balanced Input Transformer — Order 013-0182-00 **$310**

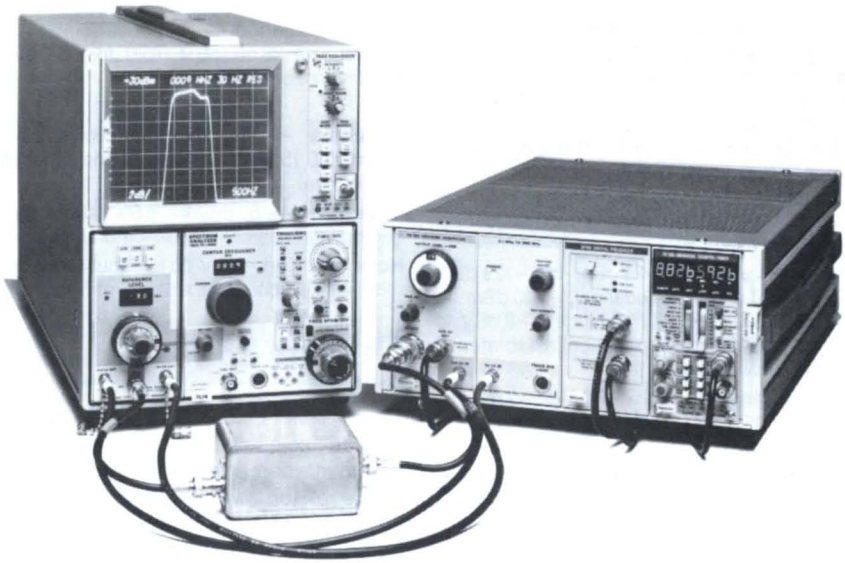
TRAINING

Tektronix offers service training classes on the 7L5 Spectrum Analyzer. For further training information, contact your local Sales/Service Office.

ADDITIONAL INFORMATION

Request Tek Brochure 26-W-4787-1 for full specifications or call your local Sales Engineer for additional information.





TR 502/TR 503

Tracking Generators

Swept Measurements to 1.8 GHz

Enhances Dynamic Range to Better Than 110 dB

Very Stable—Resolve Signals Using 30 Hz Resolution Bandwidth

Auxiliary, Constant-Level Output Provides for Frequency Counter Measurement—Even of Signals at the Noise Floor

For swept frequency tests and precise frequency measurements, the TR 502 Tracking Generator may be used with a DP 501 Digital Prescaler and DC 509 Option 01 Digital Counter, in a TM 504 Power Module. The TR 502 is linked to the 1st and 2nd LO of a 7L14 Spectrum Analyzer in a 7603 mainframe.

The TR 502 works with the 7L12 and 7L14 and the TR 503 works with all 490 Series spectrum analyzers to provide constant level, calibrated RF sources for swept frequency tests to 1.8 GHz.

The low residual FM of these systems enhances narrow bandwidth frequency response measurements. When used as a CW signal source with the analyzer in a manual mode, these systems have excellent frequency stability.

The tracking generators are two wide units compatible with the TM 500 and TM 5000 Modular Instrument Series.

The TR 502/TR 503 Aux RF Output may be used to drive a frequency counter package, such as the recommended DP 501, DC 509 Option 01. Frequencies up to 1.8 GHz may be measured accurately in the presence of high level adjacent signals to the sensitivity limits of the analyzer.

The tracking generator sweep rates are controlled with the spectrum analyzer, and the output level is controlled from the tracking generator. The output frequency of the tracking generator is the same as the frequency of the analyzer at any instant of the sweep.

Dot marker frequency measurement capability may be obtained with the TR 502/7L14 Spectrum Analyzer. For more information concerning the dot marker capability, contact your local Tektronix Sales Engineer.

OUTPUT CONNECTORS

RF Out — 0 dBm to −61 dBm signal source that tracks input frequency of spectrum analyzer. Output level is set by Output Level control and Var dB control.

Aux RF Out — For use with frequency counter.

CHARACTERISTICS

	TR 503/All 490 Series	TR 502/7L14	TR 502/7L12
Frequency Range	100 kHz −1.8 GHz	100 kHz −1.8 GHz	100 kHz −1.8 GHz
Output Level	(Maximum) 0 dBm ±0.5 dB	0 dBm ±0.5 dB	0 dBm ±0.5 dB
Range	0 to −59 dB in 10 dB and 1 dB steps	0 to −59 dB in 10 dB and 1 dB steps	0 to −59 dB in 10 dB and 1 dB steps
Flatness	Within ±2.25 dB Max from 100 kHz to 1.8 GHz (Typically ±1.5 dB)	Within ±2 dB maximum from 100 kHz to 1.8 GHz (Typically ±1.5 dB)	Within ±3.0 dB maximum from 100 kHz to 1.8 GHz (Typically ±2.0 dB)
Dynamic Range	⩾110 dB	⩾110 dB	⩾100 dB
Residual FM	50 Hz p-p	13 Hz p-p	200 Hz p-p
Output Impedance	50 Ω Nominal, VSWR 2:1 or less to 1.8 GHz	50 Ω nominal, VSWR 2:1 or less to 1.8 GHz	50 Ω nominal, VSWR 2:1 or less to 1.8 GHz
Auxiliary Output	0.1 V into 50 Ω load −7 dBm minimum	0.1 V RMS into 50 Ω Load	0.1 V RMS into 50 Ω Load
Spurious Signoff	Harmonic: −20 dBc Nonharmonic: −40 dBc	Harmonic: −20 dBc Nonharmonic: −40 dBc	Harmonic: −20 dBc Nonharmonic: −40 dBc

ORDERING INFORMATION

TR 502 Tracking Generator **$6,620**
Includes: Two 50 Ω coax cables (012-0649-00); logic interface cable (012-0648-00); N male to BNC female adaptor (103-0045-00); retainer plug-in (343-0604-00); 3 mm male to BNC female adaptor (015-1018-00); instruction manual (070-1735-00).

TR 503 Tracking Generator **$6,620**
Includes: Same as TR 502 except no logic interface cable and instruction manual (070-3526-00).

OPTIONAL ACCESSORIES

TM 503 — Power Module. **$390**

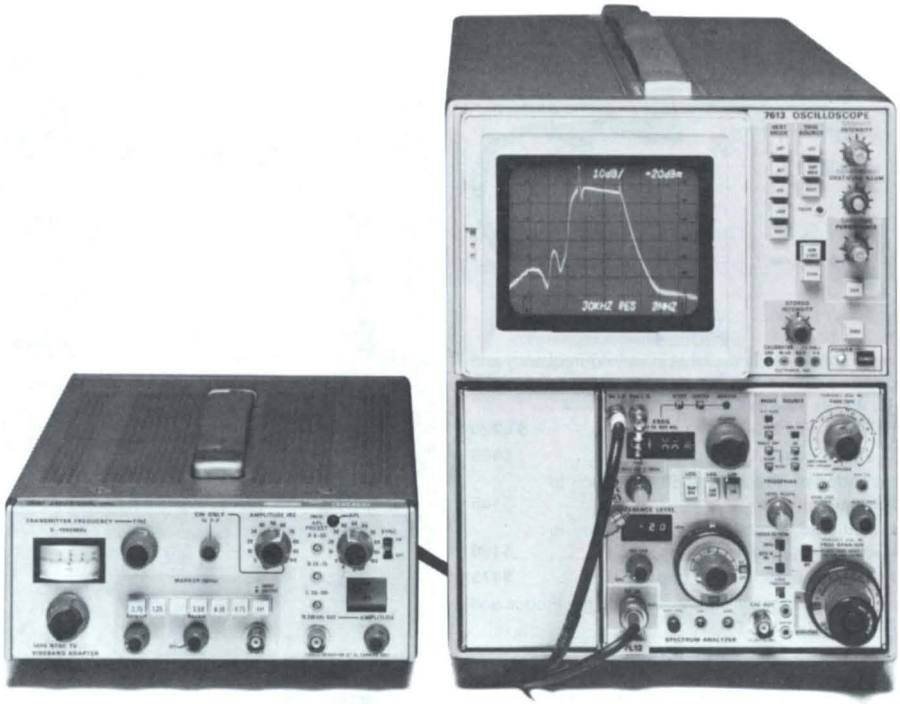
TM 504 — Power Module. For use with TR 50X, DC 509, and DP 501. **$580**

DC 509 Option 01 — Digital Counter with high stability time base. **$2,600**

DP 501 — Digital Prescaler. **$575**

Blank Panel — Order 016-0195-03 **$32**

10 dB, 3 mm Attenuator — Used in the 2nd LO input line to improve TR 502/7L12 Isolation. Order 307-0553-00 **$50**



1405/7L12 TV Sideband Adaptor Analyzer System.

1405 TV Sideband Adaptor

Facilitates In-Service Testing of Transmitter

Measure Transmitter Frequency Response to ±0.2 dB

Video Circuits Can be Swept

For In-Service Testing, Use of External Blanking Allows Either Full Field or Single Line Operation

Check Aural Fm Deviation With Built-In Bessel Null Technique

Flexible Marker System Will Accept Standard Crystals

To analyze the sideband response of a television transmitter, the 1405 Sideband Adaptor is recommended for use in tandem with the Tektronix 7L12, 7L14, and all 490 Series spectrum analyzers. It generates a composite video signal, which is applied as modulation to a television transmitter. The output is displayed on the spectrum analyzer and appears as a response curve, to within ±0.2 dB, of the transmitter being tested.

The 1405/Spectrum Analyzer combination will display frequency response characteristics of RF and IF circuits for transmitters with frequencies to 1 GHz. Video circuits can also be analyzed.

Option 02 provides the correct frequencies at the TV Channel marks on the dial readout so that it is ready for use with the 490 Series spectrum analyzers when shipped from the factory.

CHARACTERISTICS

The following characteristics apply to the 1405, 1405/7L12 or 7L14 combination and 1405/490 Series combination. They are applicable over the environmental specification limits for the 1405 and 7000 Series mainframes.

FREQUENCY (FREQUENCY OFFSET)

Range — Will tune and provide a swept video output for a center frequency range of 0 to 1 GHz.

Frequency Dial Accuracy — Dial reading is within 20 MHz of transmitter frequency when properly tuned.

Fine Tuning Range — From ±0.5 MHz to ±1.25 MHz, depending upon transmitter frequency setting.

Tuned Frequency Drift — <1 MHz/hour after a 30 minute warm-up.

OUTPUT SIGNAL LEVEL

Amplitude (Sync Off) — 100 IRE equals 0.714 V p-p when terminated in 75 Ω.

Output Impedance — 75 Ω ±1% at 100 IRE and ±2% from 0 IRE to 90 IRE.

Variable — 0 IRE to 100 IRE in 10 IRE steps.

Accuracy (at 200 kHz) — ±1 IRE at 100 IRE; ±2 IRE from 10 IRE to 90 IRE.

Output Level During Blanking — 0 V ±0.01 V at 0 IRE; 0 V ±0.04 V at 100 IRE from 0 MHz to 1 MHz; 0 V ±0.02 V at 100 IRE above 1 MHz.

CW Output Harmonics — Third harmonic content down 40 dB from 0.1 MHz to 5 MHz; down 35 dB from 5 MHz to 10 MHz.

FLATNESS

1405 — Within ±0.1 dB from 100 kHz to 10 MHz, within ±0.2 dB from 10 MHz to 15 MHz, within ±0.4 dB from 50 kHz to 20 MHz.

1405 Plus 7L12, 7L14, All 490 Series — For Transmitter Frequency >20 MHz: Within ±0.2 dB from 100 kHz to 10 MHz of picture carrier, increasing to ±0.3 dB at 15 MHz; within ±0.5 dB from 50 kHz to 20 MHz.

For Transmitter Frequency of 0 to 20 MHz: Within ±0.5 dB from 100 kHz to 15 MHz.

System Span — ⩾200 kHz/div.

Video Frequency Range — 15 MHz to 0 MHz to 15 MHz.

APL (AVERAGE PICTURE LEVEL)

Variable — 0 IRE to 100 IRE in 10 IRE steps.

Accuracy — ±2 IRE.

Three Preset Levels — Preset A: 0 IRE to 50 IRE. Preset B: 25 IRE to 75 IRE. Preset C: 50 IRE to 100 IRE.

Horizontal Sync, Blanking, and Pedestal Duration — Within NTSC (PAL — Option 01) limits (no vertical interval is provided). Transition time is 0.24 μs ±10%, from 10% to 90% points.

Composite Sync Source Blanking — 0 V turns CW on >−5 V turns CW off.

Line Strobe — TTL pulse from 0 V to 5 V turns CW on.

AURAL OUTPUT

Output Frequency — 10.396 kHz: ±0.01% (crystal controlled). Option 01: 9.058 kHz.

CW Output — Amplitude variable up to ⩾+12 dBm into 600 Ω. Harmonics down 45 dB or more.

Crystal Requirements — Series Resonant: R^2 <2000 Ω; Q >5000; Case, HC/6U or HC/25U.

MARKER CRYSTAL INSTALLATION

Because of the various international standards, the 1405 Option 01*[1] is shipped with the marker crystals installed. Frequencies installed are 0.75 MHz, 1.25 MHz, 2.25 MHz, 4.43 MHz, 5.00 MHz, and 5.75 MHz. Additional crystals are shipped with the unit.

*[1] *Option 01 instruments are connected for a nominal power line voltage of 240 V. They are furnished with the standard North American plug unless Options A1, A2, A3, A4, or A5 is specified.*

ORDERING INFORMATION

1405 TV Sideband Adaptor
525/60 Markers **$5,780**
Includes: Instruction manual (070-2078-00).

OPTIONS

Option 01 — TV Sideband Adaptor (625/50 Markers). **+$200**

Option 02 — Dial Readout for Use with 490 Series. **NC**

INTERNATIONAL POWER PLUG OPTIONS

Option A1 — Universal Euro 220 V, 50 Hz.
Option A2 — UK 240 V, 50 Hz.
Option A3 — Australian 240 V, 50 Hz.
Option A4 — North American 240 V, 60 Hz.
Option A5 — Switzerland 220 V, 50 Hz.

OPTIONAL ACCESSORY

Rackmount Conversion Kit — For Mounting 1405 or 1405 Option 01 in standard 19 inch rack. Order 016-0489-00 **$475**

POWER SPLITTER

75 Ω/50 Ω BNC Output, 50 Ω BNC Input — Order 067-1232-00 **$250**

CABLES, PADS AND ADAPTORS

Calibrator Jumper Cable — 50 Ω BNC to BNC 5.5 in. Order 012-0214-00 **$50**

Jumper Cable — BNC to BNC 50 Ω 42 in. Order 012-0057-01 **$18.50**

Jumper Cable — BNC to BNC 75 Ω, 42 in. Order 012-0074-00 **$19**

75 Ω to 50 Ω Minimum Loss Attenuator — With dc block, 5.7 dB loss. Order 011-0112-00 **$70**

75 Ω to 50 Ω Matching Attenuator — With 11.25 dB conversion factor from dBm to dBV with dc block. Order 011-0118-00 **$70**

Fixed 10 dB Attenuator — With 3 mm fittings for use with TR 502 with 7L12. Order 307-0553-00 **$50**

"F" Female to BNC Male Adaptor — Order 013-0126-00 **$18.75**

BNC Female to "F" Male Adaptor — Order 103-0158-00 **$10.50**

"N" Female to BNC Male Adaptor — Order 103-0058-00 **$8.50**

Pin to BNC Cable for 7000 Series Spectrum Analyzers — Order 175-1178-00 **$42**

DC BLOCKS

BNC to BNC — Maximum dc potential 50 V. Order 015-0221-00 **$100**

N(F) to N(M) — 10 kHz to 21 GHz 50 dc maximum. Order 015-0509-00 **$250**

PROTECTIVE VINYL COVERS

For extra protection in field environments, soft vinyl covers are available to fit over the entire cabinet model mainframe.

7000 Series 3 Hole Mainframe Cover — Order 016-0192-01 **$20**

7000 Series 4 Hole Mainframe Cover — Order 016-0531-00 **$15**

490 Series Rear Panel Connector Cover — Order 337-3274-00 **$5.00**

RIGID FRONT COVERS

Solid snap-on or friction fit covers are available to protect the instruments in transit or field use.

See appropriate spectrum analyzer and mainframe ordering information regarding the Option 08 Protective Front Cover for 7603 and 7613.

Protective Front Cover for existing 7603 or 7613 mainframes:

Blue — Order 040-0835-00 **$195**

Gray — Order 040-0628-00 **$185**

GRATICULES, FILTERS

Plastic Implosion Shield and Spectrum Analyzer Graticule — 7613 and 7623 Mainframes. Order 378-0625-07 **$14.50**

Plastic Implosion Shield and Spectrum Analyzer Graticule — 7403 and 7603 Mainframes. Order 337-1439-01 **$8.50**

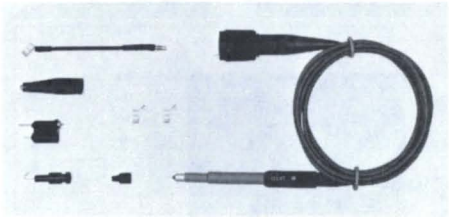
Plastic Implosion Shield and Spectrum Analyzer Graticule — For all other 7000 Series mainframes. Order 337-1159-02 **$8.50**

(Internal graticules are available with most 7000 Series mainframes.)

EMC Metal Screen Mesh Filter — For 7500, 7700, 7800, 7900 Series and 7613, 7623, 7633 instruments. Order 378-0603-00 **$65**

EMC Metal Screen Mesh Filter — For 7400 Series and 7603 instruments. Order 378-0696-00 **$65**

Complete selection of colored filters is available in the Accessories Section, page 492.



PROBES

A variety of probes is available in varying frequency and impedance ranges that can be used with the 7L5, 7L12, 7L14, and all 490 Series spectrum analyzers.

FET Probe P6201 — Dc to 900 MHz. **$1,220**

FET Probe P6202A — Dc to 500 MHz. **$680**

Conventional Probe P6056 — Dc to 3.5 GHz 6 ft. **$185**

Conventional Probe P6057 — Dc to 1.4 GHz with adaptor. **$190**

Current Probe P6022 — Dc to 150 MHz. **$475**

Complete specifications are available in the Probes and Accessories Section, page 439.

CAMERAS

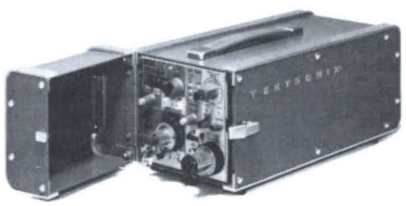
A camera can greatly enhance the versatility of a spectrum analyzer. Many different units are available. However, the most popular units for the 7000 and 490 Series spectrum analyzers are:

C-59AP — General Purpose Camera. **$1,335**

C-5C — Low Cost Camera. **$495**

C-4 Option 02 — Low Cost Camera. **$370**

Complete specifications on all cameras are available in the Camera Section, page 440.



CARRYING CASES AND MOUNTS

Specialized carrying cases are available in two forms to protect your spectrum analyzer.

Metal carrying cases are available for the 7L5, 7L12, or 7L14 plug-in units.

Military style fiberglass and foam type transit cases can be custom fitted to many of the instruments.

A special mounting bracket assembly can be fitted to bolt the analyzer securely into the mainframe if desired.

Securing Kit — Fits 7L12 or 7L14. Order 016-0637-00 **$65**

3-Wide Carrying Case — For 7L14, 7L5 Option 25. Order 016-0626-00 **$365**

2-Wide Carrying Case — For 7L12, 7L5. Order 016-0625-00 **$330**

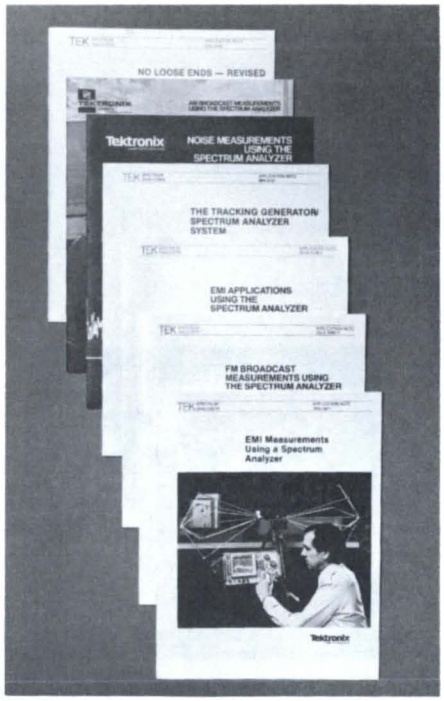
Luggage-Type Carrying Case — For 7603 Option 08, 7613 Option 08. Order 016-0628-00 **$575**

(Analyzer must have 016-0637-00 Securing Kit) **$65**

Hard Case — Transit for the 490 Series. Order 016-0658-00 **$750**

Soft Case — For the 490 Series. Order 016-0659-00 **$105**

Your local Sales Office or representative can quote prices and availability on any of these accessories.



Numerous Application Notes and magazine article reprints on spectrum analyzer measurements are available. Notes on baseband, EMC, AM, FM, two-way radio and television measurements, noise and pulse testing, and others have been written to help you with your measurements.

In addition, our staff of specialists stands ready to help you solve any special measurement problems. Contact your local Tektronix Sales Office or representative.

Option 08 protective front cover is shown with 7613 mainframe.

INSTRUMENTS/ SYSTEMS PRODUCTS

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Broadest Selection
We've added new capabilities to the world's broadest selection of portable and laboratory oscilloscopes, programmable and manual general purpose instruments, waveform digitizers, instruments and systems and accessories.

These additions illustrate our continuing commitment to make your time and resources more productive. Here are some examples:

A New Standard in Analog and Digitizing Oscilloscopes
The *NEW* programmable 11000 Series mainframes and plug-ins bring a new standard to the world of analog and digitizing oscilloscopes. The four new mainframes and five new vertical plug-ins provide unparalleled versatility and operator convenience. The 11402 digitizing oscilloscope provides 1 GHz bandwidth, long record lengths, and extensive on-board waveform processing. The 11302 analog mainframe, with its microchannel plate CRT, provides 500 MHz analog bandwidth and visual display of hard-to-see low repetition rate transients in the fastest signals. See page 197.

Software
GURU II supplies the important communication link between an IBM PC (or compatible) and GPIB instrumentation. See page 358.

The Signal Processing and Display (SPD) software product provides a useful library of over 190 complex functions callable from compiled test programs or from a menu-driven interface. SPD can be used in conjunction with an IBM PC or Tek digitizers to develop specialized measurement systems. See page 343.

ASYST Scientific Software turns your IBM PC, XT or AT into a complete scientific workstation. Integrated graphics, analysis and data acquisition provide a powerful tool to analyze measurements made with Tektronix GPIB programmable instrumentation. See page 342.

Optical-Electrical Converter 7000 Series Plug In
The 7F10 Optical-Electrical Converter provides a means of directly examining fiber-optic signals on single mode or multimode fibers. A built-in optical attenuator allows viewing a wide range of signal amplitudes and covers the 700 to 1550 nm spectrum. See page 240.

Portable Oscilloscopes
New capabilities and features add unmatched performance to our line of portable oscilloscopes.

The 350 MHz 2467 Oscilloscope features 4 div/ns visual writing rate, the fastest among portable scopes. Tek's exclusive microchannel plate CRT makes it possible to see single-shot, 1 ns pulse transitions in normal room light at 500 ps/div sweep speeds. See page 279.

The 2445A/2465A family has higher bandwidth (2465A only) and new auto set-up, instant recall, and set-up sequencing. Optional GPIB compatibility, digital timer/counter, digital multimeter, and video measurement capabilities enable this family of scopes to meet many service and bench test and measurement needs. See page 278.

The new General Purpose Scope (GPS) family includes the 2245 and 2246. These scopes feature four vertical channels, flexible triggering, extensive CRT readouts, and pushbutton ease of use. Channels 3 and 4 are optimized for logic signals. See page 300.

The 2430 brings the best features of the industry standard 2400 Series into the digital world. Tek's new patented feature, Save on Delta, provides unattended pass/fail testing. See page 326. The 2230 and 2220 each feature 4K record lengths, 100 ns peak detection and optional GPIB or RS-232C interfaces. See page 330.

Switching and Interfacing Solutions
For the first time, complete signal routing and DUT interfacing solutions can be configured from a single family of products, the *NEW* TSI 8150. This family of off-the-shelf components spans a broad range of voltage, current, and frequency capabilities, and provides unprecedented switching versatility and DUT interfacing capabilities. See page 360.

Curve Tracer
The *NEW* Sony®/Tektronix® 370 Programmable Curve Tracer will operate as a versatile, conventional semiconductor curve tracer, or it can digitize the characteristic curve and store it in nonvolatile bubble memory. Stored and nonstored curves can be displayed simultaneously for comparison. Bubble-memory cassettes will hold up to 16 families of curves and 6 front-panel setups. The 370 is completely programmable via the GPIB. See page 379.

Probes
NEW card-mountable probes are introduced by Tektronix this year. The active P6501 provides low loading with a 1 MΩ input impedance, and the P6507 offers a 50 Ω input/output path for test signals. Both probes offer replaceable tungsten or palladium tips and connectors for quick set-up and take-down of cabling.

Also new this year are the P6134, P6135, and P6231 probes for use with the 11000 Series Oscilloscope plug-ins. All feature the new TekProbe™ interface, which handles all signals, power and communication between the probe and mainframe.

Digitizing Camera System
The Digitizing Camera System, DCS01, will capture a waveform from the CRT of most oscilloscopes and digitize it for analysis on an IBM (or compatible) personal computer. Digitizes single-shot events up to 1 GHz when used with the 7104 or R7103.

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A BROAD PRODUCT LINE

Tektronix designs, manufactures, markets, supports, and services test and measurement products worldwide. Our test and measurement instruments and systems are used by scientists, engineers, and technicians in basic research, product design, manufacturing test, training, maintenance, and service applications in a broad range of industries and public institutions.

Products include:

- Fully automated desktop, controller and minicomputer-based acquisition/processing systems.
- The *NEW* easy-to-use programmable 11000 Series, equally at home on the engineer's bench and in the most complex automated test systems.
- The high performance laboratory 7000 Series plug-in instruments.
- The 5000 Series instruments, which continue the 7000 Series concept of flexibility and expandability with a line of plug-ins and mainframes for the cost-conscious user.
- A complete line of portable oscilloscopes that range from handheld, battery-operated miniscopes to full featured, high performance instruments that have become the standards against which all other portables are measured.
- Two modular and compact product lines of general purpose instrumentation, including the cost-effective TM 500s and the GPIB-compatible and programmable TM 5000s.
- Curve tracers that acquire complete information about a multitude of semiconductor devices and integrated circuits and present it in a quickly comprehensible display.
- A portable digital photometer/radiometer with eight interchangeable probes for measuring illuminance, irradiance, luminance, LED output, and relative intensity.
- Accessories, from cameras to isolation measurement devices, that support not only all Instruments products, but also many Tek Design Automation, Information Display, and Communication products.
- The *NEW* Digital Camera System allows waveform capture and analysis up to the writing speed of an analog oscilloscope.

MODULAR AND INTEGRATED INSTRUMENTS

There are two basic configurations for test and measurement instruments: modular and integrated. Modular instruments, also called "plug-in" or "laboratory" models, combine a mainframe and one or more interchangeable plug-in subassemblies. Integrated instruments (also called "monolithic") are one-piece units.

Although portable instruments are traditionally designed as integrated units, not all integrated instruments are portable, and some modular systems (such as scopes within the Tektronix TM 500 Instrument line) are designed for easy transport.

Modular Design Advantages

Examples of modular design in Tektronix Instrument products include the 11000 Series, 7000 Series, the 5000 Series, the TM 500 General Purpose Instruments and the TM 5000 Programmable General Purpose Instruments.

Versatility is the prime advantage of a modular instrument. Many more functions than could be economically or practically combined in a single unit are available by choosing the right plug-ins. Plug-ins can also extend the original instrument's range of functions. Digital multimeters, curve tracers, and spectrum analyzers are just a few examples of the many specialized plug-ins Tektronix offers for modular oscilloscope mainframes.

Performance is another advantage. In the case of the 11000 Series and 7000 Series instruments, modularity gives you the maximum performance available in an oscilloscope. And modularity also allows you to upgrade your instruments to take advantage of advances in technology.

Modular instruments can often be very cost effective too, because within a given product line, they can be shared. For example the TM 500 test and calibration plug-ins used in the lab for design work can be inserted in a portable mainframe and easily carried to the site of a service problem. Or as another example, a few high performance laboratory plug-ins from the 7000 Series can be shared among several 7000 Series mainframes.

Consider the versatility and performance advantages as you read about the wide range of Tektronix modular instruments: page 198 for the 11000 Series instruments, page 217 for the 7000 Series instruments, page 262 for 5000 Series instruments, page 377 for TM 5000 Programmable Instruments, and page 401 for TM 500 Test and Measurement Instruments.

Integrated Design Advantages

Integrated instruments are often optimized for a single range of functions. One-piece instrument design can provide reductions in weight, increased ease of use, smaller size, lower power requirements, and often, higher performance/price ratios for your key requirements.

Portability can be essential for some test and measurement applications, and in these cases, an integrated design is often the best choice. Because a wide variety of options and optional accessories extend their ranges of applications, versatility can also be a feature of Tektronix integrated instruments.

Tektronix integrated scopes, either portable or rackmounted, are instruments where the design emphasis is often on the factors of economy, ruggedness, environmental protection, and internal or external battery power. See page 276.

TM 500 MANUAL INSTRUMENTS

The Tektronix TM 500 line is a modular system. One-, three-, four-, five-, and six-compartment mainframes accept a broad selection of plug-in instruments. The mainframe provides a common primary power supply, keeping total instrument weight, size, and cost down. Just as important, TM 500 mainframes also provide a signal control and data interface between instrument modules. This allows TM 500 instruments to work either individually or together as integrated measuring systems. The Tektronix TM 500 Instrument line is extensive—more than 35 instruments, including digital multimeters, counter/timers, power supplies, signal sources, oscilloscopes, and more. Custom plug-in kits allow you to add your own unique circuits. With this feature, you can easily apply TM 500's capability to unusual applications.

The TM 500 instrument line has several configurations designed for portability. The TM 515 Traveler Mainframe, attractive and convenient enough to treat as carry-on luggage (it will even go beneath your seat on most airlines), is designed to take rugged travel. It carries up to five TM 500 plug-in instruments. The TM 503 three-compartment mainframe or the TM 504 four-compartment mainframe, with carrying case or protective cover, provide additional portability for the TM 500 instruments. Again, relatively lightweight, rugged construction and convenient size are the key to portability.

TM 5000 GPIB PROGRAMMABLE INSTRUMENTS

The Tektronix TM 5000 products extend the TM 500 concept of configurability to a line of IEEE Standard 488 compatible, fully programmable measurement, stimulus, and interfacing instruments. Tek's TM 5000 programmables are the easiest IEEE Standard 488 test and measurement instruments you can use. Because they are compatible with our TM 500 line of modular instruments, it is possible to configure literally hundreds of customized systems—systems that are programmable, manual, or hybrid—with plug-in, pull-out ease.

Tek's *Standard Codes and Formats* make communication between TM 5000 instruments easier than ever before. This same set of *Standard Codes and Formats* is used to communicate with other Tektronix IEEE Standard 488 instruments, such as the 2400 Family Oscilloscopes and 490P Series Spectrum Analyzers. TM 5000 commands are mnemonic. Each bus command is in "standard engineering English," matching the front panel nomenclature—ideal for the programmer who realizes the frustrations of working with many of today's instruments.

With the Learn Mode, one keystroke transfers a complete front panel setup to the controller for storage in memory. This greatly increases the productivity of the engineer by reducing setup time where test settings are constantly changing. You can change a routine without having to reprogram the whole system.

All TM 5000 programmables have diagnostics capability designed right in. They perform self-test on power-up, and indicate an error if a malfunction has occurred. Plus, they've all been designed for fast troubleshooting using signature analysis. All are UL listed.

As with TM 500, TM 5000 programmable systems take up less than half the space of standard rackmount equipment. This size advantage really pays off—on the bench, on the manufacturing floor, or in the field where portability is essential.

GPIB OSCILLOSCOPES

Tektronix has several oscilloscopes to choose from for GPIB capability. The *NEW* Tektronix 11000 Series—the 11301 and 11302 analog mainframes, the 11401 and 11402 digitizing mainframes, and their associated plug-in units—provide both GPIB and RS-232C interfaces as standard features. These instruments and the 7854, 2465A/2445A, 2220, 2230, 2430, 2467, 336, and 5223, with their respective GPIB features and options, give you an opportunity to improve the consistency of measurements and control costs. A GPIB system controller can consistently repeat a defined sequence of tests while the operator concentrates on the task instead of the tools. A system comprising a GPIB controller and programmable oscilloscope offers complete automation of many measurements.

The 7854's keystroke programming of local keyboard and remote Waveform Calculator allows user-designed waveform measurement routines—with all mainframe keystroke functions and operating modes remotely controlled via the GPIB.

The 2465A/2445A family offers a Counter/Timer/Trigger option for automatically measuring frequency, period, pulse width, and time between events. Also, by combining the GPIB and Digital Multimeter options, this system can efficiently perform both waveform and steady state measurements. For a truly comprehensive measurement system, combine GPIB, Counter/Timer/Trigger, and DMM options.

Software development won't overwhelm your program if you use the built-in "Learn mode" of the 2465A/2445A family GPIB option to generate detailed set-up instructions. With EZ-TEST software from Tektronix, your controller will do more for you while demanding less programming effort.

There are factory installed or retrofit options available for the 2230:

- GPIB (IEEE-488) Talker/Listener (instrument not fully programmable)
- RS-232 Talker/Listener (instrument not fully programmable)

Waveforms can be transferred each way on the bus. Only one of these options can be installed at the time of order. The scope is not programmable; however, single sweep reset and some limited storage functions are programmable to enable "babysitting" applications. The 2230 also includes 26K of battery-backed memory with either the RS-232 or GPIB option for additional waveform storage (up to 52 waveform sets).

The 2220 is available with GPIB or RS-232 options, but does not have battery backed reference memory.

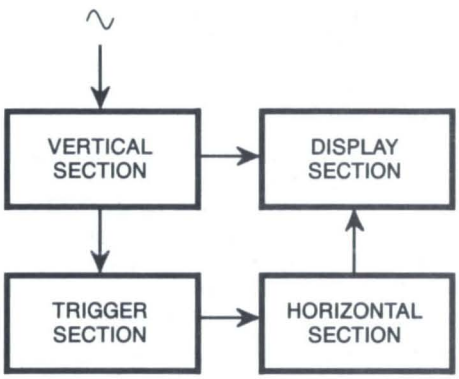
The compact 336 simultaneously displays real time and digitally stored waveforms. An Auto mode allows "hands-off" operation in many applications.

The 10 MHz 5223 has a roll mode to provide a strip-chart-like view of signals at slow speed, the GPIB interface for I/O of stored waveforms and control of several digital storage functions.

KEY OSCILLOSCOPE SPECIFICATIONS AND FEATURES

You should choose an oscilloscope by matching both performance and features to measurement applications. Don't choose by performance alone, because when features make measurements easier, the result is likely to be more accurate measurements. And if your applications involve repetitive measurements, features that make the measurement faster will be cost-effective.

The key oscilloscope specifications and features described below may help you make a decision.



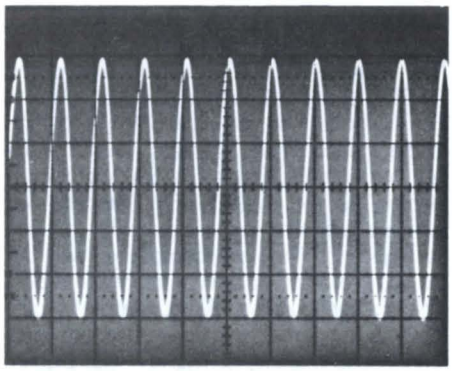
Vertical System Considerations

Because a faithful reproduction of the signal is necessary for measurement accuracy, and because very small signals must often be measured, the key specifications of the vertical system include bandwidth and sensitivity.

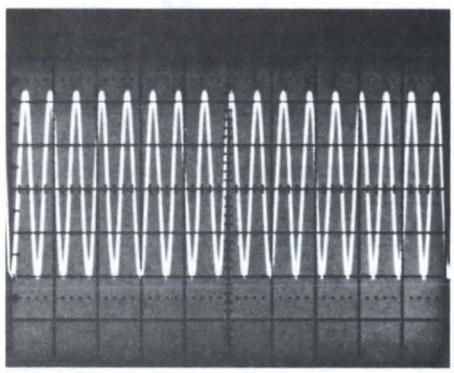
Depending on your applications, you might also want to consider oscilloscopes that display more than one signal at a time and those with differential or balanced inputs; these features are also described below.

Bandwidth and Rise Time

Bandwidth is the range of frequencies that a scope can handle with less than a 3 dB loss in amplitude compared to midband performance. Since modern oscilloscopes work well at low frequencies down to dc, the bandwidth specification is commonly the highest frequency that can be displayed; dc as the lowest, is implied. The following figures illustrate bandwidth specifications.



0 dB: 6 div at 50 kHz



−3 dB: 4.2 div at 100 MHz

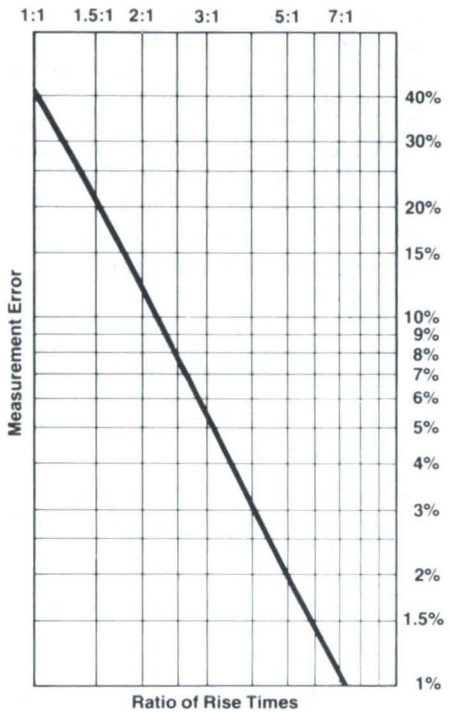
While a bandwidth specification is essential for the vertical system(s) of a scope, bandwidth is also sometimes specified for the horizontal system (which gives you a chance to evaluate performance in X-Y measurement applications) and for trigger systems (which permits you to determine the range of possible triggering signals).

Although bandwidth is the most important spec when making amplitude measurements, rise time is the specification to use if you are making timing measurements.

The frequency response of most scopes is designed so that there is a constant that allows you to relate the bandwidth and rise time of the instrument with this approximation:

$$T_r = \frac{0.35}{BW}$$

Given either specification (bandwidth or rise time), you can derive the other and determine if the instrument is suitable for your applications. The rule of thumb for timing measurements is to use an instrument with a rise time at least five times faster than the measurement you expect to make. A 5:1 ratio gives you a rise time measurement with ≤2% error. Other ratios and measurement errors are shown in the chart.



Note that very accurate absolute rise time measurements are not always a requirement. When you are comparing rise times, for instance, an instrument rise time equal to those being measured is often adequate.

Sensitivity

An oscilloscope sensitivity specification describes the input signal level needed to produce a stated deflection of the electron beam within the CRT. Specifications typically are given in mV/cm or mV/div; with this spec you can determine if small signals will be displayed with enough amplitude for you to make measurements quickly and accurately.

Note that at a given state-of-the-art, sensitivity and bandwidth are trade-offs. The small amount of noise in even the best input circuit will mask very small signals. Raising the bandwidth also increases the noise picked up by the amplifiers, requiring a larger signal to create a clear display. As a consequence of this relationship, many high sensitivity scopes provide bandwidth-limiting controls to allow you to make cleaner low level measurements at moderate frequencies.

Although sensitivity specifications are most often associated with oscilloscope vertical channels, this specification can also be provided for horizontal systems and for trigger circuits.

Multiple Inputs
It is often quite useful to be able to view more than one input signal without disturbing the connections to your scope. Common applications include: comparisons of a device's input and output signals; checking signals against standards; making timing and/or phase measurements between events. These measurement requirements are usually satisified by multitrace oscilloscopes that use electronic switching to alternately connect two or more input signals to a single deflection system. Multitrace scopes offer the lowest cost and the best comparison capabilities (because there is a single horizontal amplifier and one set of deflection plates). On the other hand, since a fast transient event might occur on one channel while the beam is tracing the other, dual beam scopes like the Tektronix 7844 (page 232) and 5113 (page 268) are recommended for viewing single shot phenomena. The 5113 has two independent vertical systems and a common horizontal system and can display up to eight waveforms in its Chop vertical operating mode. The dual-beam 7844 can be equipped with dual time base plug-ins and then used to see a single event at different locations in the signal path, at two sweep rates if necessary.

Vertical System Operating Modes
Multiple inputs, the Add vertical operating mode, and the ability to invert one channel lets you cancel or reject any signal components equal in amplitude and phase that appear at both inputs. This ability provides a simple and accurate way to measure the difference between two signals, and of rejecting most unwanted signal components common to both inputs (such as power supply hum).

Other vertical operating modes are Alternate (in which a complete waveform from one vertical channel is drawn before switching to draw the other), Chopped (in which the scope draws small parts of the waveforms while switching back and forth between the channels at a fixed rate), and Trigger View.

The Trigger View mode is useful any time you measure events dependent on an external triggering event.

Horizontal System Considerations
The horizontal system of a modern oscilloscope provides a built-in sawtooth sweep generator. With this constant-speed horizontal deflection, measurements calibrated directly in units of time are possible. (As a consequence, the horizontal system of a scope is often called the time base.) This permits direct measurement of time between events, accurate time measurements on small portions of pulse trains, and even time measurements on single, non-recurrent events.

Sweep Speeds
How fast a sweep speed do you need? One rule states that for frequency measurements at moderate frequencies, a sweep capable of displaying one cycle across the full horizontal scale is usually considered adequate. For example, one cycle of a 10 MHz signal can be displayed across 10 div with a 10 ns/div sweep. Don't apply this rule at ultra high frequencies, however, as scopes seldom have sweeps that fast.

Another approach emphasizes rise time measurements. For maximum accuracy here, the scope should show the step signal (squarewave, pulse, etc.) across most of the full vertical scale with the rising portion of the signal at nearly a 45° slope. For very fast rise times, this objective is rarely met because of compounding difficulties and the cost of providing extremely fast sweeps which are both linear and accurate.

Though neither rule can be applied at the very limits, fast sweep speeds are readily available: sweeps to 5 ns (500 ps/div magnified) in the 11000 Series and 2465A portables; to 200 ps/div with plug-in time bases for laboratory scopes; or to 10 ps/div with sampling plug-ins. (See Sampling Applications on page 194.)

Delayed Sweep Measurements
Delayed sweep scopes can offer you many measurement advantages. If the scope has two calibrated time bases and the Alternate horizontal operating mode (electronic switching of the trace between time bases), then convenient comparisons of the same signal at two different sweep speeds are possible.

If the second time base has an independent trigger, then jitter-free measurements on the delayed sweep are possible.

In every case, timing measurements with delayed sweep are easier to make, and in most cases, there is increased timing measurement accuracy. Many plug-in time bases for laboratory scopes and most portable scopes offer delayed sweep. The 2400 Series offers dual delayed sweeps for even greater flexibility.

Accuracy
Accuracy in a scope's horizontal system is as important to timing measurements as vertical accuracy is to vertical measurements. The built-in time bases of the *NEW* 11000 Series of oscilloscopes provide timing accuracies to parts per million. Several of the 7000 Series plug-in time bases provide timing accuracies to ±1.5%, and the 2465A/2445A portable oscilloscopes provide timing accuracies to ±1%.

Probe Considerations
An oscilloscope can only display a waveform as accurately as it receives it. Thus, a high accuracy Tektronix probe will complete a measurement system by establishing this critical link between the scope and circuit under test.

A wide range of Tek probes available to solve your specific measurement problems are shown beginning on page 463.

Trigger System Considerations
Besides sensitivity and bandwidth, the flexibility of a trigger system should be a consideration when choosing a scope. Some trigger system features you might need for your measurement applications include:

- High and low frequency reject coupling—for stable triggering with noisy signals.
- TV triggering—for automatic synchronization with video signals.
- Alternate triggering—for steady display of either signal with dual-channel scopes.
- Peak-to-peak autotriggering—for quick, convenient triggering with automatic level limits.
- Variable trigger holdoff—permits trigger holdoff period to be varied to trigger on repetitive complex waveforms.
- Single sweep operation—for special applications such as capturing a transient pulse and for CRT photography.
- Auto Level Trigger—for automatic setting of the trigger level.

By combining logic analyzer triggering capabilities with an oscilloscope, digital signals can be displayed in analog form for measurements of time and amplitude. The 7A42 Logic Triggered Vertical Amplifier extends the 7000 Series triggering into the arena of logic analysis. The 2400 Series offers options and accessories to provide delay-by-events triggering and Boolean logic triggering.

CRT System Considerations
CRT system specifications will tell you how well the scope can display waveforms for direct viewing and for photography. A full complement of CRT system controls contributes greatly to the instrument's ease of use.

CRT Controls
CRT system controls to consider include:

Beam Finder—A single pushbutton that allows you to quickly locate any off-screen trace.

Autofocus—Autofocusing on both laboratory and portable scopes reduces the need for manual readjustments with changes in trace intensity; very useful when traces are displayed at different sweep rates, as in the Alternate horizontal operating mode.

Auto Intensity—Maintains optimum trace intensity over a wide sweep-speed range.

External Z-Axis Input—Permits trace brightness modulation, makes some measurements easier by identifying events with an intensified zone on the trace.

PHOTOGRAPHIC WRITING RATE

Photographic writing rate is a measure of the scope/camera/film's capability to record high speed signals.

Recording high speed signals on film is dependent on at least three factors: the oscilloscope used, film characteristics, and the camera. For maximum writing rate capability, the objective is to get as much light energy to the film surface as possible. Since each component affects photographic writing rate, the selection for top performance is important.

A scope with a microchannel plate (MCP) CRT allows users to see clearly single shot events and infrequent noise or signal anomalies. The 7104/R7103, the 11302, and the 2467 all contain microchannel plate cathode ray tubes, which make them ideally suitable for research applications and digital design and troubleshooting. The microchannel plate, mounted just behind the front face of the CRT, multiplies the CRT beam current by a factor of 1000 to 10,000 to provide a trace many, many times brighter than is possible with a conventional cathode ray tube. In all of Tektronix' oscilloscopes with microchannel plate CRTs, the user can view a single shot transient at the maximum bandwidth and sweep rate of the oscilloscope in ambient light conditions, without the need of photographic aids. And when photographing of a single transient is desired for detailed study or documentation, the photography can be done simply, without the need for high speed lenses/film or film fogging techniques. (This is detailed in a footnote to the accompanying photographic writing rate graph.)

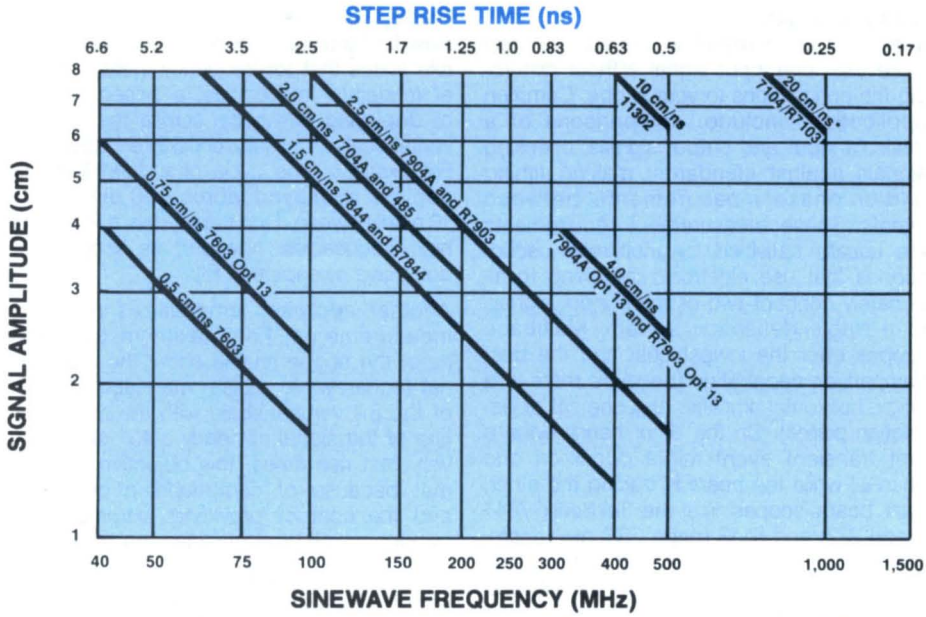
Writing Rate Comparison Graph

On the graph, vertical signal amplitude on the vertical scale is shown against maximum sinewave frequency (lower scale) and fastest rise time (upper scale). These speeds assume a small horizontal spot velocity compared to the maximum vertical velocity. The ramp is assumed to be a linear ramp measured between the 10% and 90% points.

There is an application note available from Tektronix which further describes photographic writing rate, including measurement procedures and applications. It is available on request by referencing 42-W-5335-1.

Selecting a Phosphor

The catalog description of each oscilloscope indicates the phosphors normally supplied or available as options. While a special phosphor may be desirable for a specific measurement application, remember that each phosphor has its own color, persistence, burn resistance, etc. Improvements in one characteristic are usually at the expense of others. The chart to the right provides comparisons.



Amplitude vs speed and photographic writing speed comparison of 7000 Series mainframes using BE (P11) phosphors (Option 78). 20,000 ASA film and the C-51 (f/1.2, 1:0.5) Camera.

BE (P11) phosphor has a different spectral output than GH (P31) phosphor and more closely matches the sensitivity spectrum of silver halide film types. While photographic writing speed is approximately two times the GH (P31) rate, the visual output luminance is approximately 15% of GH (P31) phosphor.

** The specified photographic writing speed indicated for the 7104/R7103, 11302, and 2467 are not directly comparable with that of the other mainframes shown. The microchannel plate CRT of the 7104/R7103, 11302, and 2467 allow for the following relaxed photographic requirements: P31 phosphor, C-53 camera with f/1.9, 1:0.85 lens, and Polaroid Type 107 3,000 ASA film without film fogging.*

NOTE: A writing speed enhancer used to fog the film may increase the photographic writing speed. *See page 441.*

COMPARATIVE CRT PHOSPHOR DATA

Phosphor*1		Fluorescence and Phosphorescence	Relative Luminance*2	Relative Photographic Writing Speed*3	Decay	Relative Burn Resistance	Comments	Ordering Information Option*6
WTDS	JEDEC							
GJ	P1	Yellowish-green	50%	20%	Medium	Medium	Replaced by GH (P31) in most applications	Special order
WW	P4	White	50%	40%	Med-Short	Med-High	Television displays	74
GM	P7	Blue*5	35%	75%	Long	Medium	Long decay, double-layer screen	76
BE	P11	Blue	15%	100%	Med-Short	Medium	For photographic applications	78
GH	P31	Green	100%	50%	Med-Short	High	General purposes, brightest available phosphor	80
GR	P39	Yellowish-green	27%	NA*4	Long	Medium	Low refresh rate displays	40
GY	P43	Yellowish-green	40%	NA*4	Medium	Very High	High current density phosphor	Special order
GX	P44	Yellowish-green	68%	NA*4	Medium	High	Bistable storage	
WB	P45	White	32%	NA*4	Medium	Very High	Monochrome TV displays	

**1 Tektronix is adopting the Worldwide Phosphor Type Designation System (WTDS) as a replacement for the older JEDEC "P" number system referenced in this catalog. The chart lists the comparable WTDS designations for the most common "P" numbers.*
**2 Measured with Tektronix J16 Photometer and J6523 Luminance Probe which incorporates a CIE standard eye filter. Representative of 10 kV aluminized screens. GH (P31) as reference.*
**3 BE (P11) as reference with Polaroid 612 or 106 film. Representative of 10 kV aluminized screens.*
**4 Not available.*
**5 Yellowish-green Phosphorescence.*
**6 Some phosphor options may not be available on some products.*

Camera Considerations

Tektronix manufactures a variety of cameras designed for use with oscilloscopes. Two key parameters are the f-number of the lens and the magnification. These parameters affect the light gathering capability of the camera. The chart utilizes a f/1.2 Tektronix C-51 Camera (f/1.9 Tektronix C-53 camera with the 7104 and 11302). More information on cameras is available on page 440.

Film characteristics are also an important parameter. Generally, the higher the ASA rating of the film used, the higher the film sensitivity and thus, photographic writing rate. It should be recognized that film speed can vary with storage conditions and environmental factors. More information is available from film vendors.

Writing Speed Enhancer

A writing speed enhancer provides controlled fogging of the film to increase its sensitivity. The degree of writing speed improvement is variable, and is dependent on the film, camera, and scope combination used. More information is available on page 441. A writing speed Application Note is also available by requesting 42-W-5335-1.

Digitizing Camera System

The DCS01 Digitizing Camera System easily and cost-effectively adds digitizing and signal processing capability to analog oscilloscopes. The DCS01 bridges the gap between acquisition tools such as 2467, 7104 and processing and analysis tools such as the PC. Now, digitize analog waveforms to 1 GHz and beyond, single shot, and analyze them immediately on an IBM PC/XT/AT or compatible.

DIGITAL FEATURES INCREASE OSCILLOSCOPE PERFORMANCE

The *NEW* Tektronix 11301 and 11302 programmable analog scopes provide many of the measurement capabilities normally associated only with digitizing oscilloscopes. Both scopes make up to eight selected pulse parameter measurements on the displayed signal automatically at a single request, without further operator intervention. The results of all eight measurements are displayed numerically on the screen, and are immediately available over the GPIB bus or RS-232C port.

The results of all measurements made with the instrument's built-in 500 MHz universal counter/timer—frequency, period, width, ratio, time A→B, and totalize—are also immediately available over the GPIB or RS-232C. Display of template waveforms allow immediate visual comparison of live signals with previously defined waveform limits. The touch-screen numeric keypad permits the immediate scaling of scale factors to match transfer characteristics of devices such as accelerometers, pressure transducers, etc.

The 2445A/2465A Family offers a Counter/Timer/Trigger (CTT) which is included on the Special Editions, 2465A CT, DM, and DV, and optional for the standard scopes. This CTT option provides crystal-controlled time base accuracy for several time-related measurements and is fully integrated with the operation of the scope and on-screen menus.

The DM 44 factory-installed option for 466 Storage Oscilloscopes allows you to read the delay time, time interval, or frequency right from a LED readout, with no calculation or interpolation required. The DM 44 also incorporates a digital volt/ohm meter and temperature measurement capabilities.

The 7B10, 7B15, 7B85 and 7B80 plug-ins for the 7000 Series oscilloscopes also provide Δtime measurements. With these plug-ins, the time interval measurement can be shown on the screen using the 7000 Series CRT readout capability.

For 7000 Series instruments, there are a variety of other digital plug-ins. These include a universal counter/timer, and a digital multimeter with a temperature mode.

Combining digital capabilities within the oscilloscope system offers many advantages over separate test units, such as: increased accuracy, scope-controlled digital measurements, measuring convenience and confidence, easier and faster solutions to complex problems, a lower dollar investment, more bench space, and signal conditioning.

MODULAR NONSTORAGE OSCILLOSCOPES

Product	Bandwidth*2	Minimum Deflection Factor	Number of Traces	Maximum Sweep Rate	Delayed Sweep	Page	Price*3
7104 R7103	1 GHz	10 mV/div at BW	Up to 4	200 ps/div	X	222	$24,590 $25,125
7904A R7903	500 MHz	10 mV/div at BW 10 μV/div 1 mA/div	Up to 4	500 ps/div	X	225	$10,115 $9,560
NEW 11302*1	500 MHz	10 mV/div at BW 1 mV/div at 250 MHz	Up to 8	500 ps/div	X	201	$12,950
NEW 11301*1	400 MHz	10 mV/div at BW 1 mV/div at 250 MHz	Up to 8	500 ps/div	X	201	$8,550
7844 R7844	400 MHz	20 mV/div at BW 10 μV/div 1 mA/div	Up to 4 Dual-Beam	1 ns/div	X	231	$15,365 $15,810
7704A Opt 09	250 MHz	20 mV/div at BW 10 μV/div 1 mA/div	Up to 4	2 ns/div	X	227	$6,160
7704A	200 MHz	10 mV/div at BW 10 μV/div 1 mA/div	Up to 4	2 ns/div	X	227	$5,635
7603 R7603	100 MHz	5 mV/div at BW 10 μV/div 1 mA/div	Up to 4	5 ns/div	X	229	$3,670 $4,160
5440 R5440	50 MHz	5 mV/div at BW 10 μV/div 0.5 mA/div	Up to 8	5 ns/div	X	264	$3,320 $3,385
5110 R5110 5116	2 MHz	1 mV/div at BW 10 μV/div 0.5 mA/div	Up to 8	100 ns/div	X	267	$1,815 $1,890 $2,585

**1 Programmable via GPIB or RS-232C; useful in Automated Test Applications.*
**2 Bandwidths are real time. Sampling plug-ins that extend bandwidths to 14 GHz are available for most mainframes.*
**3 Price does not include plug-ins.*

PORTABLE NONSTORAGE OSCILLOSCOPES

Product	Bandwidth	Minimum Deflection Factor	Dual Trace	Maximum Sweep Rate	Delayed Sweep	Page	Price
NEW 2467*1	350 MHz	2 mV/div at BW	4 Channels	500 ps/div	X	279	$11,900
NEW 2465A*1 2465A CT*1 2465A DM*1 2465A DV*1	350 MHz	2 mV/div at BW	4 Channels	500 ps/div	X	281	$5,350 $7,150 $8,400 $9,200
NEW 2455A*1	250 MHz	2 mV/div at BW	4 Channels	1 ns/div	X	281	$5,150
NEW 2445A*1	150 MHz	2 mV/div at BW	4 Channels	1 ns/div	X	281	$3,590
2337	100 MHz	5 mV/div at BW	X	5 ns/div	X	290	$4,275
2336	100 MHz	5 mV/div at BW	X	5 ns/div	X	290	$3,965
2336YA	100 MHz	5 mV/div at BW	X	5 ns/div	X	290	$4,175
2335	100 MHz	5 mV/div at BW	X	5 ns/div	X	290	$3,650
2235	100 MHz	5 mV/div at BW 2 mV/div	X	5 ns/div	X	296	$1,575
2235 Opt 01	100 MHz	5 mV/div at BW 2 mV/div	X	5 ns/div	X	296	$1,995
2236	100 MHz	5 mV/div at BW 2 mV/div	X	5 ns/div	X	294	$2,650
NEW 2225	50 MHz	500 μV/div at 5 MHz 5 mV/div at BW	X	5 ns/div	Alternate Magnification	303	$995
NEW 2245	100 MHz	2 mV/div	4 Channels	2 ns/div	X	300	$1,875
NEW 2246	100 MHz	2 mV/div	4 Channels	2 ns/div	X	300	$2,400
305	5 MHz	5 mV/div at BW	X	100 ns/div		311	$2,765
221	5 MHz	5 mV/div at BW	X	100 ns/div		312	$2,315
213	1 MHz	20 mV/div at BW 5 mV/div		400 ns/div		313	$2,900
212	500 kHz	10 mV/div at BW 1 mV/div	X	1 μs/div		315	$2,095
SC 504*2	80 MHz	5 mV/div at BW	X	5 ns/div		428	$3,895
SC 502*2	15 MHz	5 mV/div at BW 1 mV/div	X	20 ns/div		428	$2,795

**1 Programmable via included or optional GPIB; useful in Automated Test Applications.*
**2 The SC 502 and SC 504 are oscilloscopes that plug into a TM 500/TM 5000 mainframe for operation.*

STORAGE

When a conventional oscilloscope cannot capture an event and display it for your measurements because the signal is too slow, or too fast and infrequent, or when you need to compare events that happen at different times instead of simultaneously, consider a storage scope. These are obvious applications, but there are many other situations that also call for the unique advantages of storage. Storage can help you:

- Observe signal changes during circuit adjustments
- Compare new signals with a standard
- Increase the brightness of a dim, low repetition rate signal for normal viewing
- Reduce flicker or noise in a signal
- Babysit (unattended monitoring) for a transient event
- Capture fast signals that occur infrequently or only once
- Capture a complete display of a slowly occurring signal
- Enhance other recordkeeping techniques like photography

With the right Tektronix storage instrument, the capabilities you need are available, and the storage time can be anywhere from a few minutes to a practically unlimited length of time depending on your choice of instruments.

Only Tektronix Offers Four Distinct Storage Technologies

Two broad categories of storage instruments are named for the storage medium. CRT storage scopes store the captured waveform when the electron beam writes on a target within the cathode-ray tube. Digital storage scopes quantize the waveform and then store it in a digital memory. In addition, there are waveform digitizers, a very special class of storage instruments available in the Tektronix 7000 Series. Within each category there are different technologies and each has its own set of features and benefits.

Bistable CRT Storage

The phosphor in a bistable CRT storage scope has two stable states: written and unwritten. Once stored, this phosphor typically allows waveforms to be displayed for several hours, or until erased by the operator. Bistable storage is the easiest CRT storage type to use. It is also the least expensive CRT storage technology. It features bright, long lasting displays, but in comparison with other storage technologies, bistable storage displays have less contrast.

The advantages of bistable storage make it particularly useful for mechanical measurements, signal comparisons, and data recording.

Split-screen viewing is another advantage of most bistable storage scopes. This feature allows a reference waveform to be stored on one half of the screen while the other half can be used to store the effects of changes made on the circuit. You can also use the split screen to have the reference waveform in the stored mode and the other half of the display in the nonstored mode to monitor an external input.

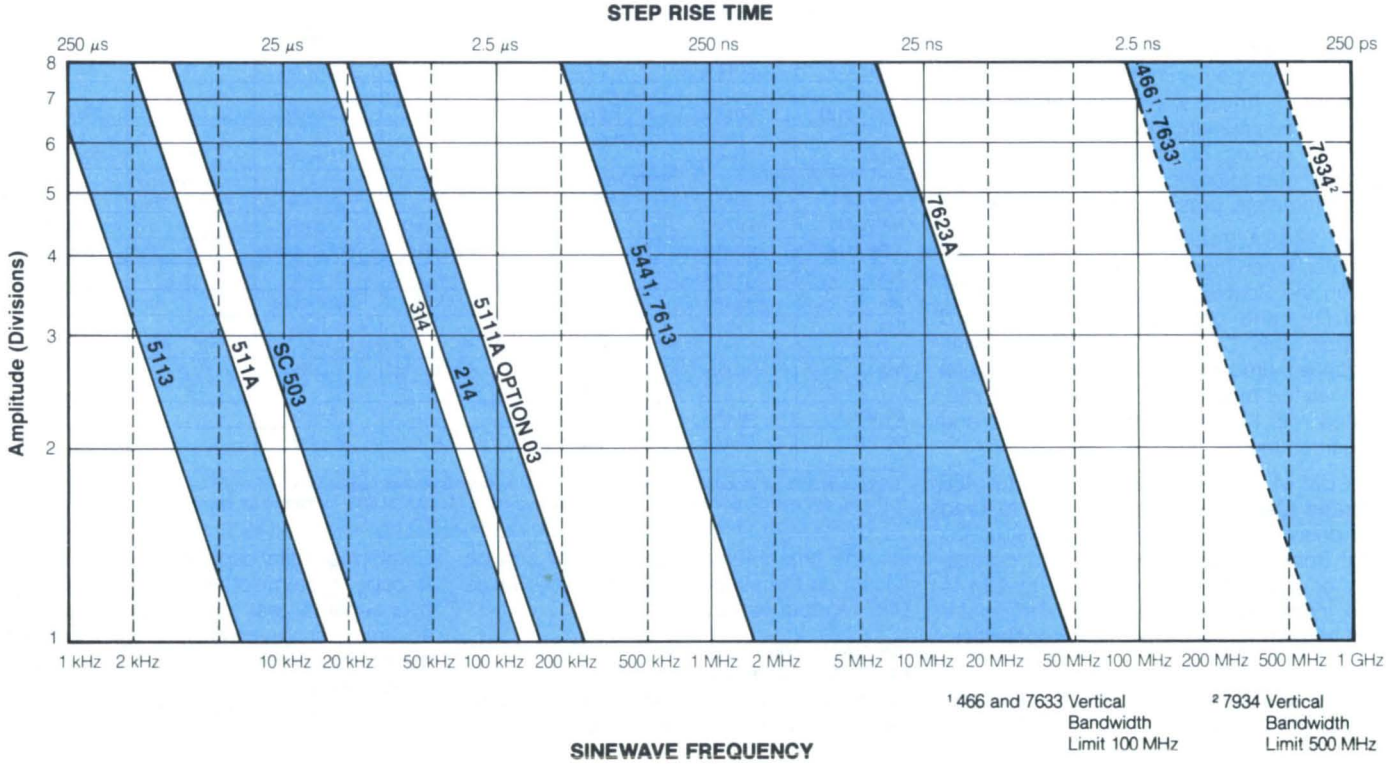
Variable Persistence CRT Storage

If you don't need to store waveforms for hours at a time, variable persistence CRT storage has advantages. The variable persistence storage CRT has a storage mesh where the electron beam writes the input signal; thereafter, flood guns in the CRT illuminate the phosphor where the storage mesh permits.

CRT storage controls vary the charge on the mesh, allowing you to control the contrast between the trace and the background and to fine tune how long the trace is stored.

The first capability provides easy viewing with high contrast between the dark background and bright waveforms. And this type of storage provides the best displays when viewing traces with varying intensities (such as delaying and delayed sweeps, or traces with external z-axis intensity modulation).

CRT STORAGE PERFORMANCE



[1] 466 and 7633 Vertical Bandwidth Limit 100 MHz

[2] 7934 Vertical Bandwidth Limit 500 MHz

Varying the persistence permits you to adjust the scope so that the entire waveform can be viewed, yet the stored trace will fade from view just as a new waveform is being stored. Or you can view several traces before the first one fades from view. Then you can see signal response variations as you make changes in a circuit.

Variable persistence can also be used to provide display integration so that only the coincident portions of a repetitive signal are displayed. Aberration or jitter not common to all traces will not be stored or displayed. Low repetition rate, fast rise time signals that are not discernible on conventional CRTs can be easily viewed with this storage technology by allowing each repetition to build up the trace brightness.

Applications for variable persistence storage include spectrum analysis, time domain reflectometry, sampling, and any other measurements that require displays of low repetition rate signals.

Fast Transfer CRT Storage

Fast transfer storage scopes use a CRT with a special intermediate mesh target optimized for speed. This target captures the waveform and then transfers it to another mesh, one optimized for longer term storage. As the name implies, the fast transfer storage mode provides increased writing speed (see the next heading) for the 466 Portable Oscilloscope and the 7623A, 7633, and 7934 lab scopes.

The second target can also be designed to offer bistable, variable persistence or both modes in combination with the transfer mesh or by itself. In the 7623A, 7633, and 7934, this combination of capabilities provides unique multimode storage instruments. Using front panel controls, you can select the operating mode suited to your specific measurement situation.

Stored Writing Speed

For CRT storage scopes, the storage capability specification is the stored writing speed. This figure of merit is expressed in distance per unit of time. Often div/μs is more meaningful in terms of your measurements. But because some scopes have nonstandard sized graticules (i.e., other than 1 cm square major divisions) cm/μs is useful for comparisons.

The specification is dependent on the speed and amplitude of the input signal. If you know the pulse rise time or sinewave frequency of the input signal and the amplitude of the waveform you want to display, you can use the table below to determine which storage scope is recommended.

CRT STORAGE OSCILLOSCOPES

In Order of Stored Writing Speed

Product	Stored Writing Speed	View Time	Type of Storage	Bandwidth*1	Minimum Deflection Factor	Number of Traces	Delayed Sweep	Plug-In	Page	Price
***NEW* 7934**	8900 div/μs 776 div/μs 12 div/μs 0.2 div/μs	30 s*3 30 min*4 minimum 30 s*3 30 min*4 minimum	Fast variable persistence Fast bistable Variable persistence Bistable	500 MHz	10 mV/div at BW	Up to 4	✓	✓	235	$13,365
466	3000 div/μs 3 div/μs	15 s*3 15 s*3	Fast variable persistence Variable persistence	100 MHz	5 mV/div at BW	Up to 2	✓		317	$7,940
7633	2200 div/μs 400 div/μs 3 div/μs 0.2 div/μs	30 s*3 30 min 30 s*3 30 min minimum	Fast variable persistence Fast bistable minimum Variable persistence Bistable	100 MHz	5 mV/div at BW; 10 μV/div; 1 mA/div	Up to 4	✓	✓	236	$9,215
7623A	150 div/μs 50 div/μs 0.5 div/μs 0.03 div/μs	30 s*3 30 min minimum 30 s*3 30 min minimum	Fast variable persistence Fast bistable Variable persistence Bistable	100 MHz	5 mV/div at BW; 10 μV/div; 1 mA/div	Up to 4	✓	✓	236	$7,135
7613	5 div/μs	1 hr	Variable persistence	100 MHz	5 mV/div at BW; 10 μV/div; 1 mA/div	Up to 4	✓	✓	236	$6,145
5441	5 div/μs	1 hr	Variable persistence	50 MHz	5 mV/div at BW; 10 μV/div; 0.5 mA/div	Up to 8	✓	✓	264	$332
5111A Opt 03 **5111A**	0.8 div/μs 0.05 div/μs	10 hr	Bistable split screen	2 MHz	1 mV/div at BW; 10 μV/div; 0.5 mA/div	Up to 8	✓	✓	267	$3,105 $2,900
214	0.5 div/μs	1 hr	Bistable	500 kHz	10 mV/div at BW; 1 mV/div	Up to 2			321	$2,865
314	0.4 div/μs	4 hr	Bistable	10 MHz	2 mV/div at BW	Up to 2			320	$4,550
SC 503*2	0.08 div/μs	4 hr	Bistable	10 MHz	1 mV/div at BW	Up to 2			428	$4,095
5113	0.02 div/μs	10 hr	Bistable split screen	2 MHz	1 mV/div at BW; 10 μV/div; 0.5 mA/div	Up to 8 dual-beam	✓	✓	267	$4,205

**1 Bandwidths are real time. Sampling plug-ins that extend bandwidths to 14 GHz are available for most mainframes.*
**2 The SC 503 is an oscilloscope that plugs into a TM 500/TM 5000 Mainframe for operation. Please turn to page 428 for more information.*
**3 View times are at full stored display intensity. They may be increased by using reduced intensity in the save display mode.*
**4 Save intensity at minimum.*

Digital Storage

The fundamental difference between digital storage scopes and CRT storage scopes is that digital scopes quantize the captured waveform and CRT storage scopes do not. Having quantized waveforms in a digital memory gives you measurement capabilities not possible with any other kind of oscilloscope.

With digital storage scopes, you have the advantage of pretrigger viewing. In other words, you can look at a waveform both before and after the trigger event. Another feature is "babysitting"; available because the digital storage scope's trigger can stop as well as start signal acquisition.

Other digital storage scope advantages include signal processing features such as averaging a number of samples of the input signal to reduce the effects of noise; performing calculations on the waveform parameters; or outputting the signal data over RS-232 or GPIB standard interfaces.

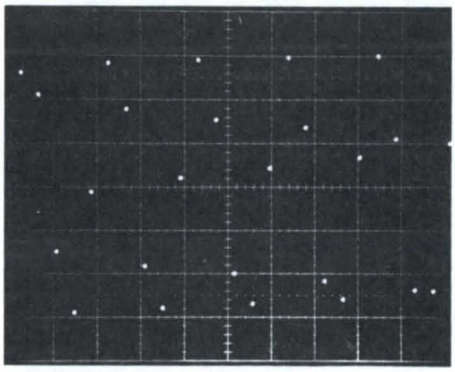
Digital storage scopes are typically easy to use and give you crisp, clear displays. Because the data is stored in a digital memory, no fading or blooming of the trace on the CRT phosphor will occur, and storage time is essentially unlimited. This type of storage is excellent for many applications involving single shot or low repetition signals, or where the unique advantages of a digitized waveform may be the answer to your measurement needs.

Quantization Techniques

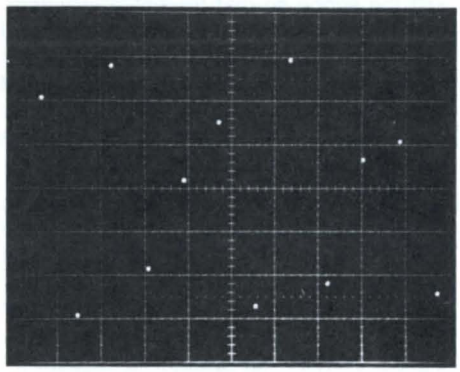
Within digital storage scopes there are two main techniques of quantizing signals—and the technique has a direct effect on the applications of the instruments in that only one kind of digital storage scope can capture single shot signals.

The digital scopes that can capture signals in a single sweep use what is called "real-time sampling." Other digital storage scopes use "equivalent time sampling." There are two equivalent time sampling methods and both require many repetitions of the input signal. In exchange for that requirement, you have the ability to measure signals more than ten times faster than can be captured with real time sampling.

With Dot Display

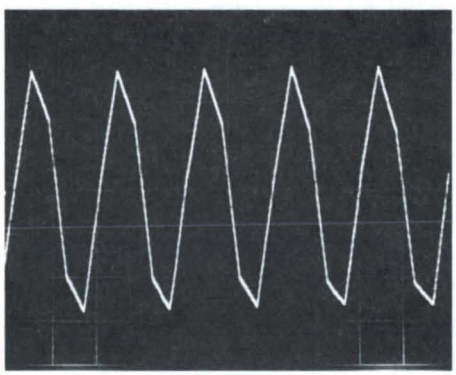


5 MHz Signal

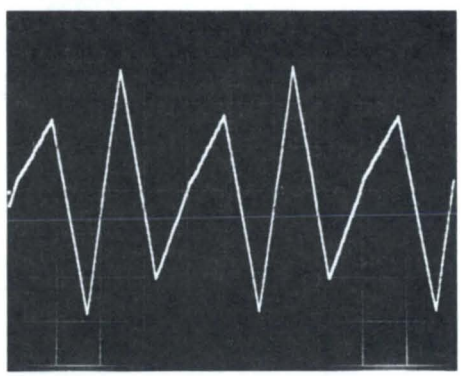


10 MHz Signal

With Pulse Interpolator

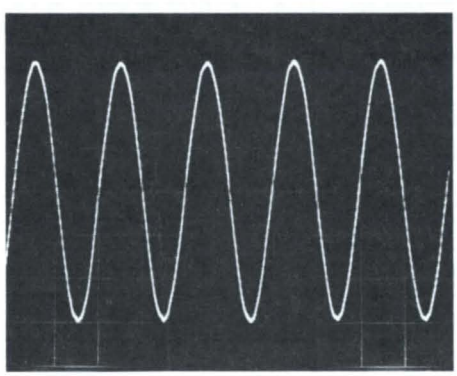


5 MHz Signal

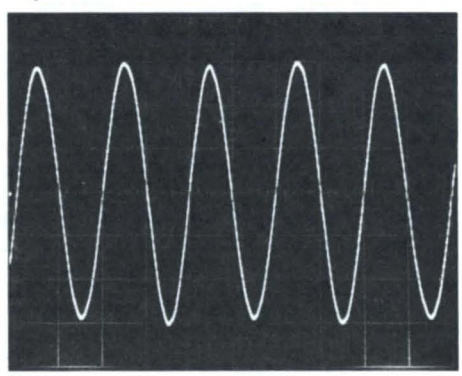


10 MHz Signal

With Sine Interpolator



5 MHz Signal



10 MHz Signal; Digitizing Rate—25 MHz

Digital Storage Scope Specifications

For digital storage oscilloscopes that use real time sampling, there is a useful storage bandwidth specification. It expresses the highest frequency sinewave that can be captured in a single sweep and displayed so that you can make measurements. Both the digitizing rate (how often the scope takes samples) and the display reconstruction technique (how the scope displays what's in its memory) must be taken into account in the useful storage bandwidth. See the examples below.

For digital scopes using equivalent time sampling, the specificaton is "equivalent-time bandwidth," the highest frequency signal that can be stored and displayed with less than 3 dB signal amplitude loss. Besides analog specifications (common to all oscilloscopes), other specifications of interest to digital scope users are:

Maximum Digitizing Rate—How often the instrument takes samples of the input signal.

Vertical Resolution (usually expressed in bits of resolution)—How finely the instrument can discriminate between signals very much alike in voltage; for example, 8-bits of resolution is 0.391% when expressed as a percentage, and 10-bits is 0.098%.

Record length or Horizontal Resolution—How many words of digital memory are used to store the captured waveform; if the signal is stored in 512 data words, the horizontal resolution is 1 in 512 or 0.195%.

Digital Storage Oscilloscope Summary

NEW 11401	Programmable Digitizing Oscilloscope. 500 MHz bandwidth. 512 to 10,240 point multiple record acquisition.
NEW 11402	Programmable Digitizing Oscilloscope. 1 GHz bandwidth. 512 to 10,240 point multiple record acquisition.
2220	Portable Storage Oscilloscope. 60 MHz bandwidth. 100 ns glitch capture (peak detect mode), 4K record length, and save reference memory.
2230	Portable Storage Oscilloscope. 100 MHz bandwidth. 100 ns glitch capture (selectable 1 K/4 K mode), record length, CRT readout, cursor measurements, and save reference memory.
2430	Portable Storage Oscilloscope. 150 MHz bandwidth. "Save on Delta" feature allows 2430 to make pass/fail decisions. 2 ns Transient capture at any sweep speed. Advanced cursors and readout.
336	Portable Digital Storage Oscilloscope. Useful storage bandwidth of 140 kHz, microprocessor controlled with features and modes chosen from menu on CRT.
5D10	Digital Storage Plug-In for the 5000 Series offering real time sampling to 100 kHz, CRT readout, 8-bit vertical resolution, and up to 1024 data words/waveform.
5223	Digitizing Oscilloscope with 10-bits of vertical resolution, roll mode, X-Y plotter output, and optional GPIB interface.
7D20	Full GPIB Programmable Waveform Digitizing Plug-In for the 7000 Series. Offers 70 MHz equivalent time bandwidth and capture of transients with frequency components up to 10 MHz.
7854	Waveform Processing Oscilloscope with 400 MHz equivalent time bandwidth, keystroke programming, and calibrated sweep speeds to 500 ps/div.

Color Digital Storage Oscilloscope

Tektronix' method of producing color oscilloscope displays, Liquid Crystal Display, is described in the technology section. This technology is combined with digital storage in our 5116 Oscilloscope. Full product specifications begin on page 269. Tek's C-59A, C-5C, C-7, or C-4 Cameras can save those color displays on color film. See pages 445-453 for a complete description. A color photography Application Note is available by requesting 52-W-5579.

Your local Tektronix Sales Engineer, representative, or distributor can help you determine the digital oscilloscope parameters necessary to meet your measurement applications needs.

SAMPLING OSCILLOSCOPES

Sampling is a powerful technique for examining very fast repetitive signals. In principle, sampling is similar to the use of stroboscopic light to study fast mechanical motion. Progressive samples of different portions of successive waveforms are taken; then they are "stretched" in time, amplified by relatively low bandwidth amplifiers, and finally shown (all seemingly at one time) on the screen of a CRT. The display produced is a replica of the sampled waveforms.

Sampling scopes are capable of resolving events that occur in less than 30 ps on an "equivalent" time base of less than 20 ps/div with less than 5 mV of peak amplitude.

If your measurement needs require equivalent bandwidths to 14 GHz or sweeps to 10 ps/div, consider the sampling plug-ins described on page 258.

To determine which instrument fits your requirements, refer to the sampling decision tree on page 253.

This sampling technique is limited to depicting repetitive signals, since no more than a portion of the signal is captured and displayed each time the signal occurs. The sampling method, however, provides a means of examining fast changing signals of low amplitude that cannot be examined in any other way.

TEKTRONIX DIGITIZER COMPARISON*1

Features	5223 Digital Scope	336 Digital Scope	2230/2220 Digital Scope	11401/11402 Digitizing Scope	7854 Waveform Processing Scope	7D20/7D20T Digitizer	2430 Digital Scope	390AD Digitizer	7612D Waveform Digitizer	7912AD Digitizer	DCS01 Digitizing Camera System
Digitizing Technique	Successive approx	Successive approx	Dual stage flash conversion	Dual stage flash conversion	Successive approx	CCD Successive approx	Successive approx	Dual stage flash conversion	EBS*2 flash conversion	Scan conversion	Scan conversion
Maximum Sample Rate	1 MS/s (1 μs/point)	1 MS/s (1 μs/point)	20 MS/s	20 MS/s	500 KS/s (2 μs/point)	40 MS/s (25 ns/point)	100 MS/s	60 MS/s (16.6 ns/point)	200 MS/s (5 ns/point)	100 GS/s (10 ps/point)	250 GS/s (4 ps/point)
Vertical Amplifier Analog Bandwidth	10 MHz	50 MHz	100 MHz (2230) 60 MHz (2220)	500 MHz (11401) 1 GHz (11402)	400 MHz/real (14 GHz/samp.)	70 MHz	150 MHz	15 MHz	80 MHz	500 MHz (7A29) 200 MHz (7A16P)	1 GHz (7A29)
Vertical Resolution	8-bits	8-bits	8-bits	10-bits; 14-bits with averaging	10-bits	8-bits	8-bits	10-bits	8-bits	9-bits	12-bits/rep 9-bits/single-shot
Record Length (Points)	254 to 1016	1024 per channel	2048 dual 4096 single	512 to 10,240	128 to 1024	820 or 1024 per channel	1024	2048 dual 4096 single	256 to 2048 per channel	512	512
Input Channels	Up to 4 chopped	2 chopped	2 chopped	Up to 12 (Up to 8 displayed)	Up to 4 chopped	2 acquisition	2 simultaneous	2	2	1	1
Independent Time Bases	1 plus	1 plus delaying	1 plus delaying (2230); 1 (2220)	1 main and 1 window	1 delaying	1 plus	1 plus delaying	1 plus delaying	1	2	1
Maximum Sweep Speed	200 ns/div (20 ns in X10)	100 ns/div (10 ns in X10)	50 ns/div (5 ns in X10)	500 ps/div	500 ps/div (20 ps/div) Sampling	50 ns/div	5 ns/div	N/A	N/A	500 ps/div	200 ps/div
Pretrigger	Yes, with 5B25N	pre, mid, post	Yes	Yes		Yes*3	Yes	Yes	Yes	Delay line only	No
Posttrigger	Yes, w/delaying	Yes	Yes	Yes	Yes, w/delaying	Yes	Yes	Yes	Yes	No	No
Waveform Storage Registers	2 to 4	2 plus 16 opt	3 plus 26 opt (2230); 1 (2220)	64K points 102K points (Opt)	2 to 16 (5 to 40 Opt)	6	6	2	2 to 16	1	26 (PC dependent)
Waveform Processing		averaging enveloping CH 1 ± CH 2 CH 1 x CH 2, RMS, mean, p-p	averaging smoothing enveloping	waveform functions pulse parameters	averaging parameters keystroke programming	averaging enveloping	averaging envelope save on delta multiply, add			averaging	waveform functions; pulse parameters; save on delta
Waveform Data Output Format	ASCII or binary	Binary	ASCII, binary, hex	ASCII or binary	ASCII	ASCII or binary	ASCII or binary	Binary	Binary	Binary	ASCII or binary
Other	Roll mode; XY recorder output cursors	XY output cursors; CRT readout	Roll mode; XY recorder output cursors; CRT readout cursors (2230)	Plug-in modularity; RS-232C, IEEE-488 Centronix interfaces; fully programmable; self-calibration; enhanced accuracy; differential amplifier	Measurement packages available; waveform parameter calculations cursors	Roll mode cursors; non-volatile settings	Analog plotter output cursors; Video Trigger; direct printout	Sample rate switching; digital plotter output; XY shift mode cursors	Sample rate switching; measurement packages	Measurement packages	IBM PC based; RS-170 video output; save on delta; auto logging; menu driven display
Format Optimization	Operator	Operator	Operator	Systems or operator	Operator	Systems or operator	Systems or operator	Systems	Systems	Systems	
Page	351	334	330	207	338	336	326	349	344	347	353
Prices begin at	$6,165	$5,060	$5,150/$4,150	$13,000/$15,500	$16,220	$7,445/$9,045	$8,900	$11,400	$28,075	$27,025	$5,300

*1 *For applications not requiring programmability, see the 5D10 Waveform Digitizer on page 270.*
*2 *Electron bombarded Silicon.*
*3 *The 7D20/7D20T has pretrigger capability in the equivalent time digitizing range for repetitive waveforms as well as for single shot.*

WAVEFORM DIGITIZERS

Along with conventional oscilloscopes, plug-in or integrated, and with storage oscilloscopes, both digital and analog, Tektronix leads the way in waveform acquisition instruments. This commitment to the future of test and measurement instrumentation can be seen today in three programmable waveform digitizers.

The 390AD Programmable Waveform Digitizer is a dual channel waveform acquisition digitizer with a maximum sampling rate of 30 MS/s (or 60 MS/s in single channel operations). Vertical resolution is 10 bits and the memory length is 2048 data words (4096, single channel) with one breakpoint provided to allow changing the digitizing rate during waveform digitizing. More information is available on page 349.

The 7612D Programmable Waveform Digitizer has full dual-channel operations, a maximum sampling rate of 200 MHz, selectable record lengths from 256 to 2048 data words, and the ability to change sampling rates several times during waveform digitizing. See page 344.

The 7912AD Programmable Transient Waveform Digitizer captures waveforms with a scan converter CRT capable of recording 500 MHz single shot signals. See page 347 for more information if your applications demand equivalent digitizing rates to 100 GHz and 9-bit resolution both vertically and horizontally.

In addition to individual instruments, Tek offers a line of acquisition/processing packages. These preconfigured packages utilize our existing programmable waveform digitzers. See pages 371-375.

Custom Systems

Complete Custom Systems
Customized Measurement Packages
Modified Products
Custom Support

When We Say We'll Custom Configure a System That Puts You in Charge of Your Automated Measurements, We Mean Just That

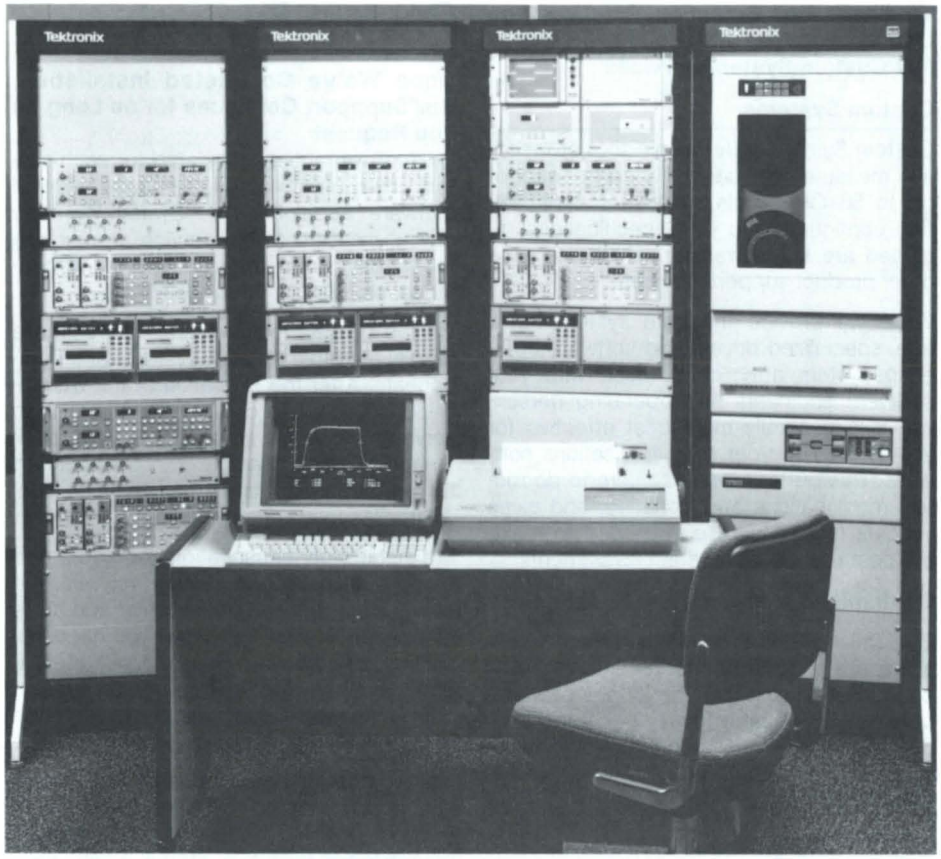
From one-of-a-kind complete systems to modifications of selected digitizing products, we can tailor a package based upon your present and future needs, your budget, and the desired degree of continuity with your current hardware and software components and requirements.

You Bring to the Table Your Unique Understanding of Your Requirements; We Bring Our Unique Expertise in Instrument Systems Integration

We're TEK's Custom Systems team—a small quasi-independent cadre of hardware, software and systems engineers. We work with entrepreneurial decisiveness and speed: your project gets the attention it deserves. At the same time we call on the vast resources of Tektronix—the world's leading manufacturer of test and measurement systems instrumentation.

Our Specialties

High speed acquisition and diagnostic test systems—multichannel or not—for research, design and engineering; time domain parametric measurement systems; and flexible, reconfigurable automated test systems for low run manufacturing environments.



Because It's Your System, the Choice of Logical Alternatives is Yours Whenever Possible

Together we evaluate hardware, custom software, including refined application and diagnostic programs and the drivers to run them, custom cabinetry and racks, and non-Tek components, if we agree they'll do a better job. Together, we'll define performance standards, and resolve other contract terms and conditions.

Then we'll design your system to meet your requirements. We'll assemble it and run a complete check-out *before* installing it on your site. We'll provide diagnostic programs, documentation, test procedures—all customized for your system.

By Blending the Best of Technologies, We Aim to Build Systems That Do in Minutes Tasks That May Now Take Days

Our systems combine Tek's leadership in waveform acquisition instruments with automated stimulus and acquisition measurement capability. All are computer-integrated and directed by powerful signal processing software.

As a result, your projects can get finished more quickly, improving the productivity of your engineering team and the cost effectiveness of your system investment, while lowering project costs.

To Ease Your Selection Process, You Can Contract for Any of Three Tiers of Tek Custom System Services

Custom Systems

Custom Systems offer single-shot or repetitive measurement capability and control of up to 56 GPIB instruments per controller, fully configurable to your specifications. Included are full warranties, installation, and other product support services.

While we provide the core system package, specialized drivers and software operating system after consultation with your software engineers and operating personnel, it is generally more cost effective for you to provide your own applications software. This better prepares users to do routine modifications and updating, and gives you the local expertise you need to make the best use of your system investments.

Customized Measurement Packages

Customized Tektronix Measurement Packages are modifications to existing preconfigured systems. Each offers powerful capability in a cost effective benchtop size. Signal acquisition units span bandwidths of up to 750 MHz real time and up to 14 GHz with sampling plug-ins.

Modified Products

Modified Products include the customization of selected digitizers, as well as the "system glue" (specialized internal interfaces, etc.) required to hold the system together.

These off-the-shelf custom items for your system needs include:

- Additional serial I/O drivers for your communications/printing needs. Up to 8 instrument channels and up to 4 peripheral ports may be supported.
- Special disk drivers for RL02 disk pack drives. For TEK SPS BASIC V02.
- GPIB program decoder plug-in that enhances the 7854 oscilloscope by interfacing to programmable vertical and time base settings with selected plug-ins.
- High speed data output modification for the 390AD digitizer.
- A high bandwidth modification (750 MHz) of the 7912AD digitizer.
- Auto-calibration MUX controller and stimulus generator.
- Others per your request.

Custom Support

Once We've Completed Installation, Our Suppport Continues for as Long as You Request

Product warranties, stipulated for each system instrument, cover all hardware and software. Additionally, our System Warranty covers installation and service at your site for 90 days from the date of your acceptance, or 120 days from the shipment.

On top of that, maintenance contracts are usually available for both systems and components. After the expiration of the warranty period, you can contract for Tektronix to serve as the single source for system maintenance. Such contracts can be arranged for any length of time through your local Tektronix service site.

Pre-installation consultation, operator and product maintenance training may also be arranged, at the Tek home office and sales offices, or on-site. And when you need additional support down the road, our applications engineering and product service staffs can help keep your systems tuned and your people informed.

Finally, documentation is thorough, clear and continuous, in the Tektronix tradition. Regular updates and a user's exchange program are only two of the many ways Tek stays in touch with its system owners.

When It Comes to Your Custom System Requirements, We Know the Right *Questions* to Ask as Well as the Right *Answers;* Let's Begin Discussing Your Special Needs Now

The Custom Systems Domain

The following list samples the breadth of activity typically performed by Tek's digitizer-based custom system services group.

Custom Systems
These include large, multichannel test and research systems incorporating a wide variety of Tek digitizers and acquisition instruments, both for major military installations and defense contractors, and for a variety of commercial test applications such as fiber optic research and disk testing.

Modified Standard Systems
Include laboratory and mobile systems for EMP susceptibility studies, plus several modified standard systems for energy research, for major governmental and private research labs.

Custom Instruments
Include plug-in interface for programmable plug-in control in the Tek 7854, plus custom drivers for large customer designed and assembled systems.

Modified Instruments
Include modified Tek 7912ADs for higher bandwidth; modified Tek 390ADs for higher data output rate; modified Tek digitizers and acquisition instruments for MIL-ATE applications.

Your local Tektronix representative can put you in touch with the right people . . . the people who help put you in charge of your automated measurements. Let's start working together today.

TRAINING GETS USERS UP TO SPEED, FAST

An Investment — Tektronix workshops develop your skills and are one of the best methods of deriving more effective utilization from your equipment.

New Perspective on Applications — Professional instructors are available to help you examine and evaluate your application problems during laboratory sessions.

New Methods of Making Measurements — Our workshops are designed to aid in developing new ideas through comprehensive discussion and laboratory exercises.

Tektronix offers formal classes and self-study aids. See the following pages for general information on our workshops, then ask your Sales Engineer for details about Customer Training.

Test and Measurement — Tektronix instruments and programmable instrument systems represent the upper limits of productivity potential. Tektronix has designed workshops to help enhance your understanding of the capabilities of your equipment.

Measurement workshops are a natural complement to the Tektronix commitment to help you achieve optimum utilization of your equipment. Our commitment begins with engineering excellence and continues through high quality training that will help you develop new and more productive applications.

These fast-paced workshops, conducted at key locations throughout the U.S., combine classroom lectures with supervised, hands-on laboratory sessions. You will spend at least 60% of your time in labs, so you can *learn by doing*. In all Tektronix workshops, you receive users manuals and workbooks containing detailed course notes and lab exercises.

For your convenience, Tektronix also offers private workshops conducted at your company.

The following workshops are currently offered by Tektronix:

XYZs OF USING A SCOPE Based on the 2200 Series

Length: 1 Day **Class Size:** 24 maximum **Tuition:** $250/person

Provides an introduction to the oscilloscope for the new user. Basic operation is explained, measurement techniques are described and performed in lab exercises.

Topics covered:

- Vertical Amplifier Concepts
  Dual trace measurements
  Differential applications
- Trigger Concepts and Operation
  Main and delayed trigger uses
  "Runs after" and "Trigger after" applications
- Horizontal Time Base Concepts
  Single time base measurements
  Delayed sweep applications

PARAMETRIC MEASUREMENTS Using the 2465A

Length: 1 Day **Class Size:** 24 maximum **Tuition:** $250/person

This fast-paced workshop covers parametric measurements typically made with an oscilloscope. This workshop gives the average oscilloscope user a high degree of expertise in making accurate parametric measurements to fully utilize the capabilities of their instrument.

ADVANCED PARAMETRIC MEASUREMENTS

Using the 2465A

Length: 1 Day **Class Size:** 24 maximum **Tuition:** $250/person

This fast-paced workshop teaches advanced applications using the enhanced measurement options available on the 2465A.

Advanced parametric measurements are made in "hands-on" labs utilizing the special features of the Digital Multimeter, TV/Video Trigger, Counter/Timer/Trigger, and Word Recognizer.

BASIC DIGITAL STORAGE MEASUREMENTS

Using the 2230

Length: 1 Day **Class Size:** 24 maximum **Tuition:** $250/person

Digital storage oscilloscopes present new and exciting measurement capabilities. Digital storage techniques save time, increase productivity, and signals can be acquired for direct viewing or stored for later viewing or analysis.

This workshop covers the operation of the 2230 and the basic concepts of digital acquisition and storage.

ADVANCED DIGITAL STORAGE MEASUREMENTS

Using the 2430

Length: 2 Days **Class Size:** 24 maximum **Tuition:** $500/person

This workshop covers the types of measurements that can be made with the 2430 Portable Digital Oscilloscope to be used in your individual measurement applications.

Many measurements which are too difficult or impossible with analog oscilloscopes are made faster, simpler, and more accurately with digital oscilloscopes. Waveform data can be transferred over a GPIB to computers for computation to allow analysis at the speeds required by today's measurements.

WAVEFORM PROCESSING Using the 7854

Length: 2 Days **Class Size:** 16 maximum **Tuition:** $500/person

This fast-paced, two day workshop is designed to increase your proficiency with the Tektronix 7854 Waveform Processing Oscilloscope to satisfy your application/measurement needs. The workshop is oriented toward technically competent oscilloscope users with wide variances in background and experience.

All 94 commands/operators, which are available on the front panel keyboard and the remote keyboard, are discussed. These commands are also available over the IEEE-488 GPIB.

ADVANCED WAVEFORM PROCESSING Using SPS BASIC

Length: 4 Days **Class Size:** 10 maximum **Tuition:** $1000/person

This comprehensive workshop teaches you how to effectively implement programming solutions to waveform digitizing and processing problems, using SPS BASIC. Also covered is controlling and transferring data with the 7912AD and 7612D Digitizers.

The workshop is oriented towards those with a fundamental knowledge of computers, computer programming and an understanding of oscilloscope operation/application.

USING A 4041 INSTRUMENT CONTROLLER

Length: 3 Days **Class Size:** 16 maximum **Tuition:** $750/person

Many measurements that were done manually in the past can now be made with automated systems. A very important element of the system is the controller. This workshop shows you how to quickly generate extensive 4041 Instrument Controller programs and gives you "hands-on" experience with an automated programmable instrument system.

USING THE IBM PC AS A CONTROLLER

Length: 1 Day **Class Size:** 16 maximum **Tuition:** $250/person

This workshop will take a new user of programmable instrumentation from the entry level (using menu-driven, general purpose interactive programs) through program development (using well-known Microsoft BASIC) and on to advanced uses with a test procedure generator tool.

You will learn to effectively use the IBM PC and the Tektronix **G**PIB **U**sers **R**esource **U**tility (**GURU**) to control GPIB (General Purpose Interface Bus) programmable instruments.

Software examples and application reference information are provided.

HIGH SPEED MEASUREMENTS USING SAMPLING TECHNIQUES

Sampling and Time Domain Reflectometry Measurements

Length: 1 Day **Class Size:** 16 maximum **Tuition:** $250/person

This workshop introduces the concepts of Analog Sampling and Time Domain Reflectometry. The workshop discusses measurement challenges and provides valuable hands-on experience.

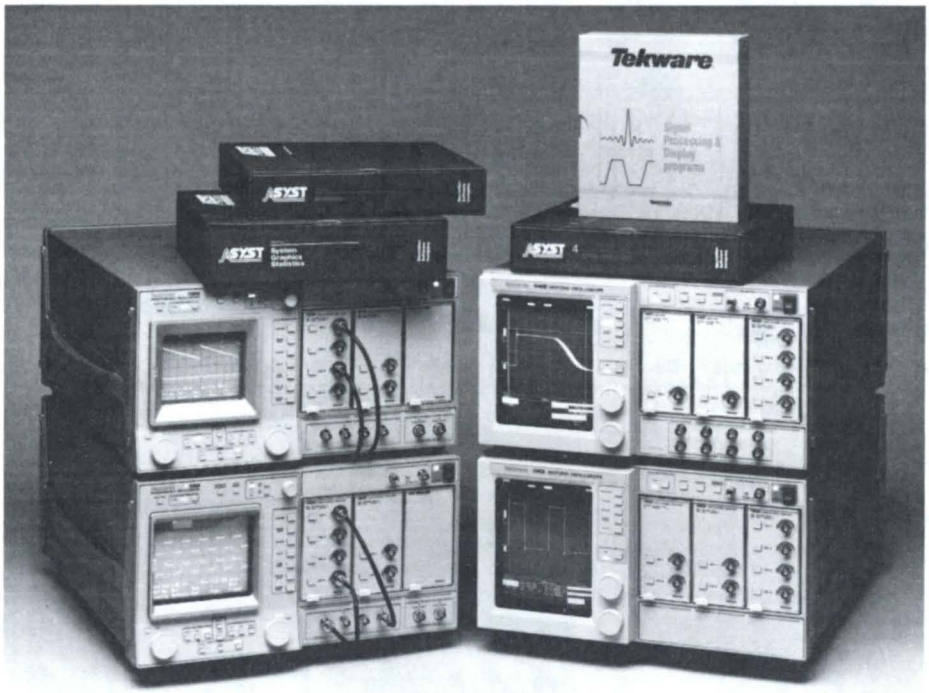
INFORMATION/REGISTRATION

If you are interested in registering for one of these workshops or would like more information, call Instrument Group Customer Training at 1-800-225-7802 or contact:

Tektronix, Inc.
Customer Training
P.O. Box 500, D.S. 54-074
Beaverton, Oregon 97077

For international orders, contact your local Sales Office.

11000 SERIES PROGRAMMABLE ANALOG AND DIGITIZING OSCILLOSCOPES



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THE NEW STANDARD IN DIGITIZING AND ANALOG OSCILLOSCOPES

We set out to create a new line of scopes that meet some very demanding requirements.

- The bandwidth must be high to meet present and future measurement needs.
- The architecture should be open and flexible and, thereby, avoid obsolescence. It should provide hardware and software modularity, be reliable, and easy to service.
- All functions must be programmable, both for systems applications and to help with front panel set-up.
- The user interface should be intuitive, giving easy access to a broad feature set.
- The scopes should offer more channels and more traces to stay relevant to the needs of today's design engineers.
- The instruments should be a good value, containing the best feature set possible in a moderately priced package.

We are proud to be able to offer this new line and confident that we accomplished what we set out to do. This new line of analog and digitizing oscilloscopes sets new standards in many key areas.

For characterization of waveforms, the 11000 Series offers:

- Higher levels of accuracy than any other oscilloscope system. This is accomplished through the use of the unique "Enhanced Accuracy" mode which provides an automatic self calibration of the oscilloscope's vertical and horizontal systems against a built-in stable dc source. Vertical measurement accuracies to ≤1% may be attained through the use of Enhanced Accuracy. The built-in counter/timer in the 11301 and 11302 and the precise digitizing clock in the 11401 and 11402 provide accuracies in parts per million for timing measurements.
- Longer record lengths and more waveform memory. Multiple 10,240 point records and up to 102,400 points of waveform memory let users digitize and store more data than ever before without tying up a computer.
- Unmatched waveform processing and automatic measurement features to quickly perform measurements that used to take hours.

For prototype troubleshooting and debugging, the 11000 Series offers:

- High resolution, exclusive high writing rate microchannel plate displays for viewing statistical fluctuations, fault conditions or catching glitches.
- A full line of probes and vertical amplifiers that can adapt the scope system to a broad range of digital and analog signals.

NEW

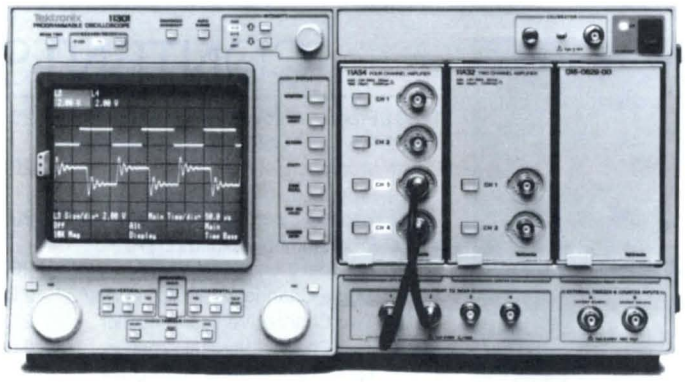
GPIB

For Measurement against a standard, the 11000 Series offers:

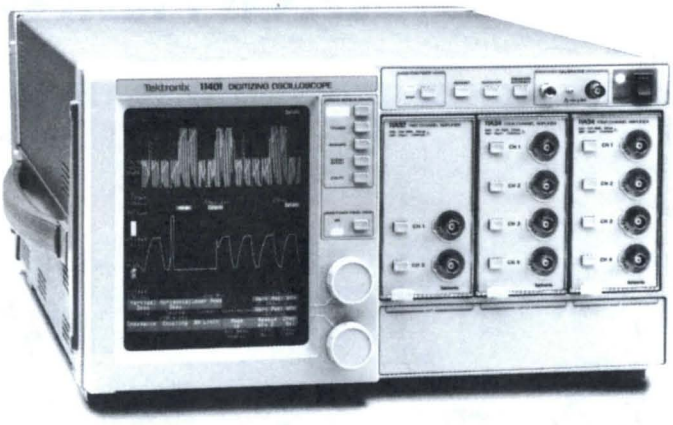
- Programmability through either GPIB or RS-232C.
- High measurement throughput to help meet tight production schedules.
- High reliability to make sure that your system stays up and running.
- On-site *Warranty-Plus* service options with fast response, and extensive diagnostics help get things back on-line quickly when you can't afford system down time.

Bandwidth

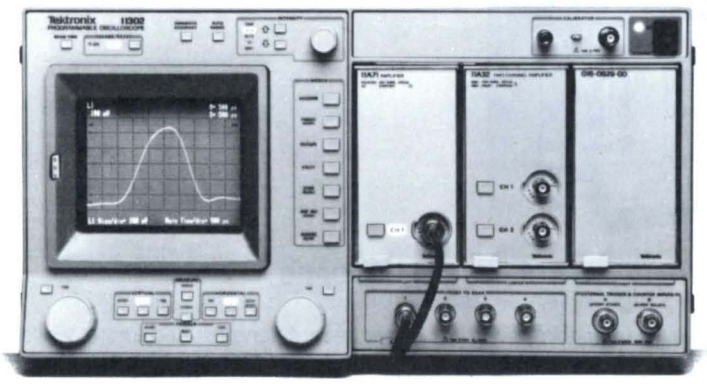
The 500 MHz microchannel plate 11302 and 400 MHz bandwidth 11301 Analog Oscilloscopes include a powerful 500 MHz counter/timer for making exacting timing measurements.



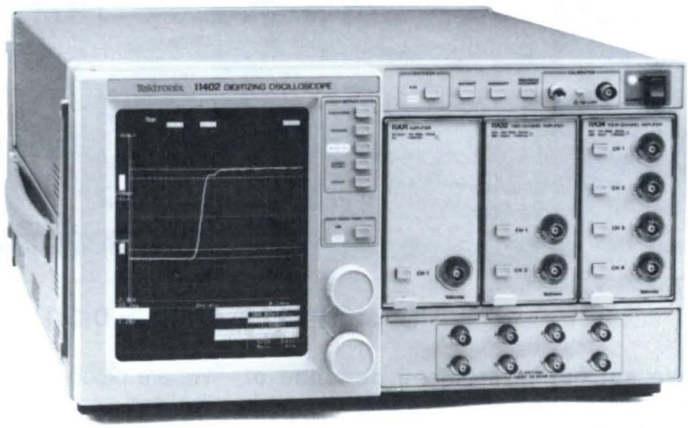
Large screen 11301 provides clear crisp display of multiple waveforms, menus and trace descriptions.



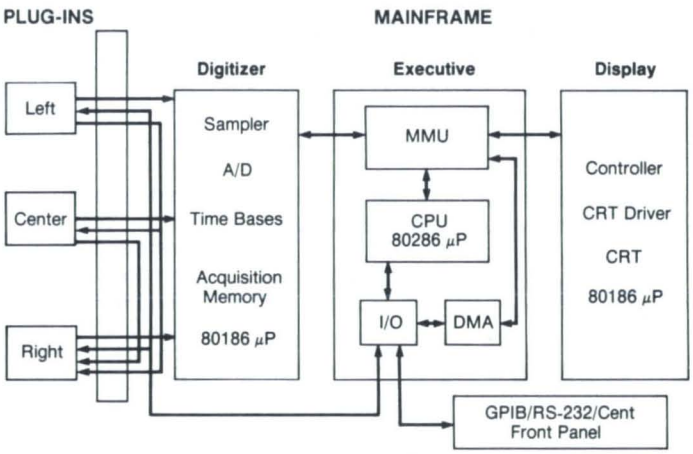
The 11401 Digitizing Oscilloscope is a complete waveform digitizing, measurement and storage instrument capable of capturing repetitive waveforms to 500 MHz.



View single shot transients at full 500 MHz bandwidth with the micro channel plate CRT of the 11302.



The 11402 Digitizing Oscilloscope has all of the features of the 11401 with 1 GHz maximum system bandwidth.



The 11400 Series digitizing scope architecture applies extensive processing power to waveform acquisition, measurement and display.

The 1 GHz bandwidth 11402 and 500 MHz bandwidth 11401 Digitizing Oscilloscopes are the most complete digitizing scopes available. They have a unique combination of high bandwidth, high vertical resolution, and high accuracy.

Architecture

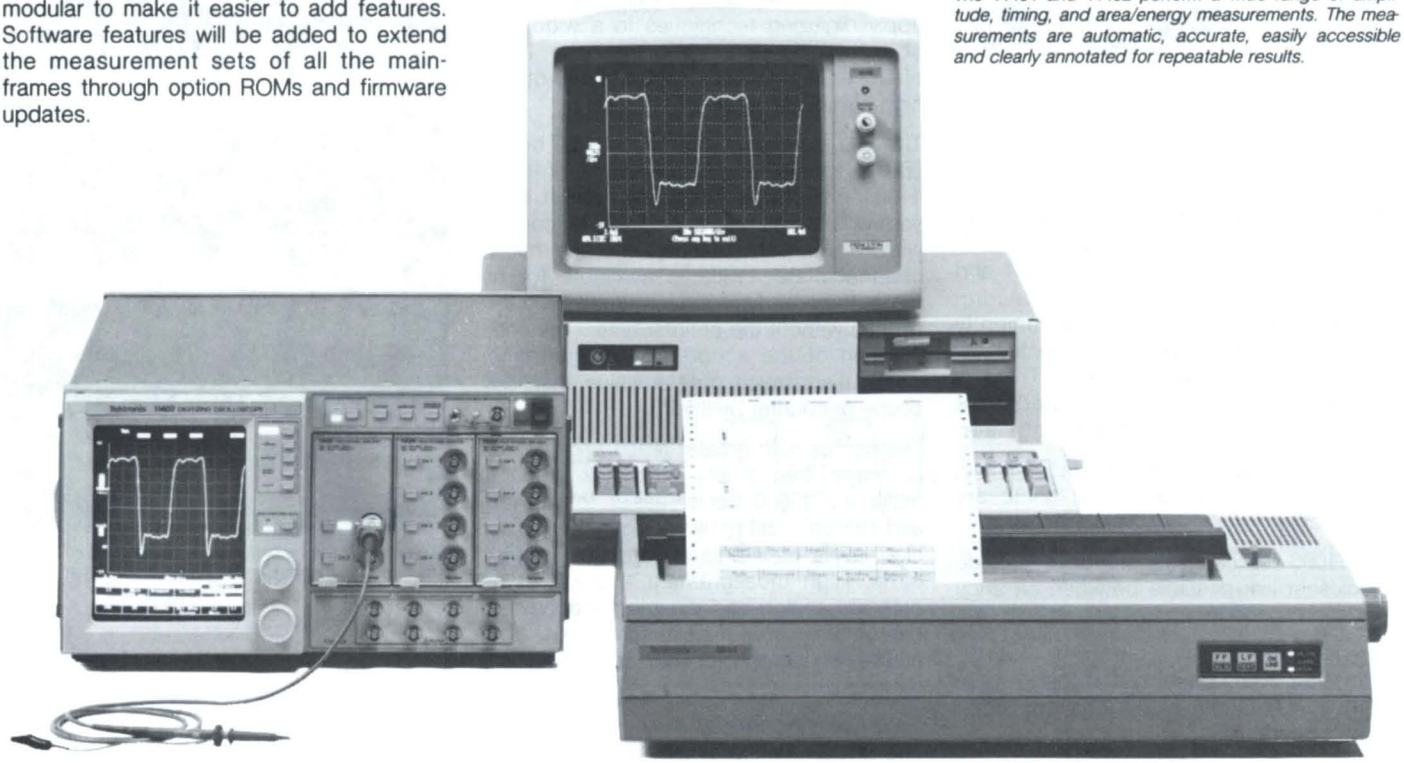
Hardware modularity is provided through three plug-in slots in each mainframe. The analog scopes support two vertical amplifiers and reserve the right compartment for triggering and other plug-ins. The digitizing scopes support up to three vertical amplifiers or combinations of verticals and a trigger plug-in. New plug-ins will be added to support stimulus, triggering, and signal conditioning needs.

The software architectures are general and modular to make it easier to add features. Software features will be added to extend the measurement sets of all the mainframes through option ROMs and firmware updates.

Programmability

All functions on all 11000 Series oscilloscopes are programmable. They can be controlled through either IEEE-488 (GPIB) or RS-232C interfaces, both of which are standard. The IEEE-488 interface is Tek *Standard Codes and Formats* compatible for ease and consistency of programming. RS-232C allows the instruments to be easily controlled by personal computers. Both can also be used to transfer waveform and measurement data between the instruments and a large mainframe or, via modem, transfer data and control instrument settings over a long distance link. A DMA option on the digitizing scopes speeds up waveform transfers, thereby improving throughput via the IEEE-488 port.

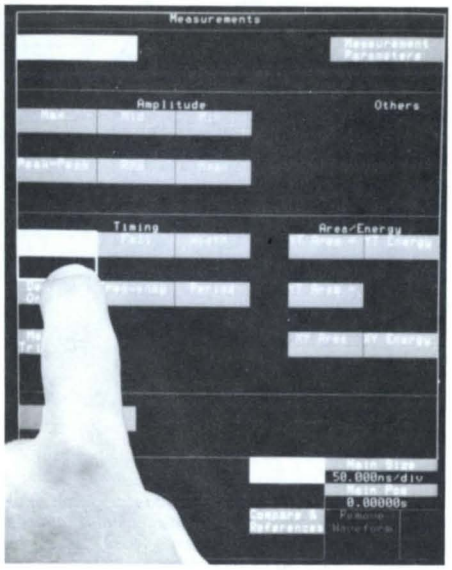
The 11401 and 11402 perform a wide range of amplitude, timing, and area/energy measurements. The measurements are automatic, accurate, easily accessible and clearly annotated for repeatable results.



All 11000 Series oscilloscope functions are programmable via either GPIB or RS-232C interfaces. Both are standard, allowing the scopes to easily interface with PCs, workstations, mainframe computers and instrument controllers.

11000 SERIES MAXIMUM BANDWIDTH MATRIX

Plug-In	11402	11401	11302	11301
11A71 Single Channel, 10 mV/div, 50 Ω	1 GHz	500 MHz	500 MHz	400 MHz
11A52 Dual Channel, 1 mV/div, 50 Ω	600 MHz	500 MHz	400 MHz	350 MHz
11A32 Dual Channel, 1 mV/div, 1 MΩ/50 Ω	350 MHz	350 MHz	350 MHz	300 MHz
11A34 Four Channel, 1 mV/div, 1 MΩ/50 Ω	300 MHz	300 MHz	250 MHz	250 MHz
11A33 Differential Comparator, 1 mV/div, 50 Ω/1 MΩ/1 GΩ	150 MHz	150 MHz	150 MHz	150 MHz



Simply touch up to six measurements and see the results quickly.

User Interface
Clean, consistent, tested and intuitive, the 11000 Series user interfaces make measurements easy. Parallel menus and touch screens keep the number of buttons and knobs down to a manageable few. All frequently used controls are conveniently grouped around the display where the users attention is already focused. There is no fumbling around a complicated front panel hunting for the right switch or button.

The touch screen is proven and reliable. Fingerprints, grease, dust and grime are not a problem.

The 11000 Series user interfaces provide the closest link possible between an engineer and his scope.

More Channels
All of the mainframes can display up to eight active traces, more than any other scope system.

The analog scopes can display traces from:

- Up to eight high bandwidth plug-in channels.
- Two triggerable delayed sweeps or window waveforms.
- A counter view trace.
- Template waveforms stored in memory.

The digitizing mainframes can display eight traces which may be any combination of:

- Live waveforms from up to 12 high bandwidth channels.
- Window waveforms (similar to delayed sweeps).
- Stored waveforms
- Mathematical combinations of live or live and stored waveforms.

These display features simplify measurements, make new measurements possible and make the 11000 Series ideal for prototype debugging and troubleshooting on printed circuit boards and custom ICs where multiple channels of data need to be viewed on the same screen.

A Good Value
These scopes deliver higher performance at a better price than any scopes now available.

High speed transient digitizers are still very costly and power hungry. The high resolution, high bandwidth A/D system in the 11401 and 11402 is a cost effective way to apply digitizing techniques to a wide variety of measurement problems. The 11402 offers the lowest cost per channel of any high bandwidth scope in its class.

The 11301 and 11302 both contain a built-in 500 MHz universal counter/timer. Yet the 11301 mainframe costs only about what you would pay for a standalone counter with similar performance. And the microchannel plate 11302 is available for no more than earlier conventional 500 MHz scopes without the counter/timer. The combination of the scope and counter/timer gives users much greater value than any scope or counter by itself.

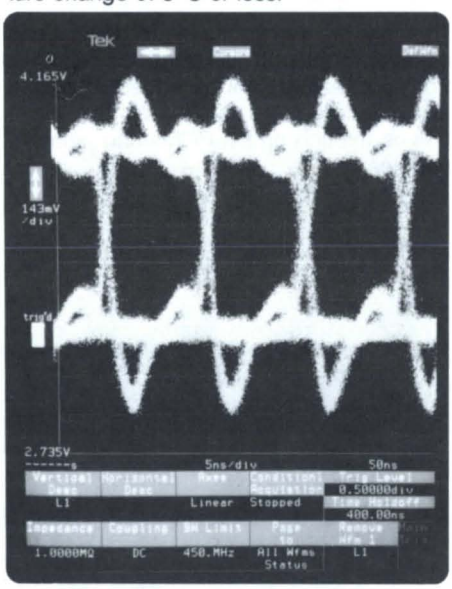
Diagnostics with greater reach and broader coverage than in any other Tek products make the 11000 Series easier to calibrate and service. Cost of ownership is low due to high levels of integration and few moving parts. High measurement throughput on both the analog and digitizing scopes help customers lower their testing costs and on-site service options keep down time to a minimum.

Enhanced Accuracy
The 11000 Series oscilloscopes provide measurement accuracies well beyond those available in any other current oscilloscope or oscilloscope system. This is accomplished through the unique "Enhanced Accuracy" mode, which may be invoked whenever measurement accuracy is a primary consideration.

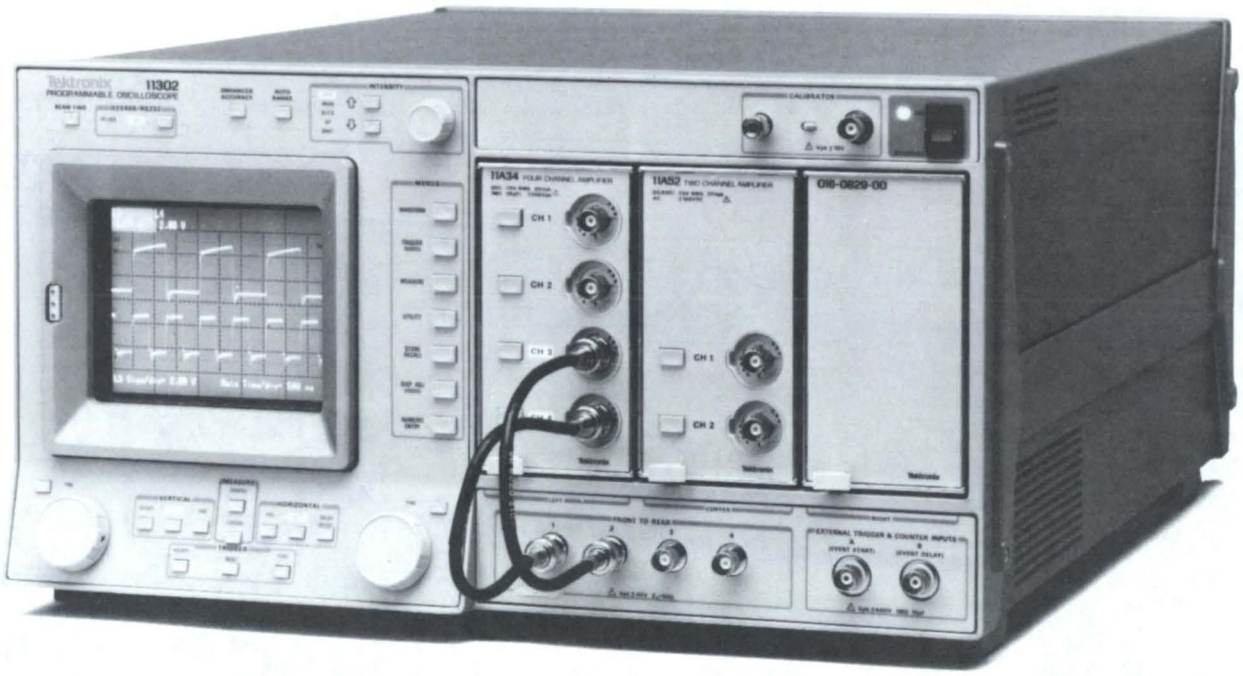
Each mainframe contains its own stable dc source. When Enhanced Accuracy is invoked, the instrument goes through a self-calibration routine which uses this reference to set the dc gain and offset of each channel of the vertical system (including the plug-ins), the gain and timing of the horizontal system, and the trigger path's gain and offset.

Enhanced Accuracy may be invoked in any of three ways: by pressing the front panel ENHANCED ACCURACY button, by instruction over the GPIB or RS-232, or automatically by the oscilloscope itself after a configuration or ambient temperature change since the last time Enhanced Accuracy was invoked.

Enhanced Accuracy permits the specification of much tighter tolerances on dc gain and timing of the 11000 Series oscilloscope systems than are feasible on conventional oscilloscopes. Once Enhanced Accuracy has been invoked, the instrument will remain within the Enhanced Accuracy tolerances through any ambient temperature change of 5°C or less.



Eye patterns can be created for checking bit error rates on communications systems.



11300 Series

GPIB IEEE-488 The 11300 Series complies with IEEE Standard 488-1978, RS-232C, and with Tektronix *Standard Codes and Formats.*

Up to 500 MHz Bandwidth at Probe Tip

Up to 8 Traces Displayed Simultaneously

Menu-Driven Touch-Screen Operation

Automatic Display of Selected Signals

Automatic Time and Amplitude Measurements

Built-In 500 MHz Universal Counter/Timer With Counter View

Dual Delayed Sweeps

10 cm/ns Visual Writing Rate (11302)

Large 6.5 Inch Display (11301)

Fully Programmable via IEEE-488 & RS-232C

TYPICAL APPLICATIONS
Timing Analysis of Complex Signals
Waveform Characterization
Component Evaluation

The 11301 and 11302 are easily the world's most versatile analog oscilloscopes. Fully programmable via either IEEE-488 or RS-232C, with any RS-232 equipped personal computer. They are equally at home in the most complex automated production test system or in smaller scale computer-assisted testing and data logging applications in the engineering environment.

For manual operation, the menu-driven touch screen operator interface places the 11301 and 11302 a step beyond anything presently available in convenience of use. Manual control of the instruments, including their plug-ins and probes, is accomplished by means of a few pushbuttons and two user-definable knobs located in the vicinity of the cathode ray tube, and the touch panel CRT screen itself. Operator menus on the screen guide the user through the selection of the functions to be performed; selection is made by touching the designated areas of the screen.

CRT readout gives displays of oscilloscope and plug-in settings, as well as numeric readout of desired measurements; no more need to count or interpolate betwen graticule divisions. Using IEEE-488 or RS-232C, up to eight lines of user-generated text (50 characters per line) can be displayed on the CRT for operator prompts, measurement annotation, and computer generated menus. The large CRT screen provides clear, crisp display of both text and traces.

Wide Choice of Plug-Ins

A choice of five amplifier plug-ins provides display of up to eight traces at 250 MHz bandwidth, four traces at 400 MHz, or two traces at 500 MHz bandwidth. The differential comparator amplifier unit provides exceptionally fast overdrive recovery from signals as high as 8 V at 1 mV/div sensitivity.

The 11301 and 11302 each accept up to three of the 11000 Series plug-in units. Signals from the amplifier plug-ins may be directed to either the vertical or horizontal system of the oscilloscope where they may be time shared with main or delayed sweeps. This allows an almost unlimited number of combinations of X-Y and Y-T traces to be displayed simultaneously to provide detailed views of signal relationships. Timed X-Y traces may be displayed through the application of delayed sweeps to X-Y displays.

Each of the inputs on each of the plug-ins is supported by the new TEKPROBE™ interface which, in addition to the high-quality signal path, also provides probe power for active probes and a communication link between the probe and the oscilloscope.

High Writing Rate CRT in 11302

The microchannel plate CRT of the 11302 provides 10 cm/ns visual writing rate, bright enough to view the fastest single shot transient in normal ambient room light. This allows viewing of intermittent glitches in the midst of bright repetitive signals at the full bandwidth of the scope.

Built-In 500 MHz Universal Counter/Timer

The built-in 500 MHz Universal Counter/Timer, with its 2 ns single-shot resolution, performs as an integral part of the 11301/11302. This combination of high performance counter and high performance oscilloscope greatly simplifies the most difficult counter/timer measurements and provides measurement capabilities not possible with conventional counter/timers. A counter-view trace indicates to the operator exactly what

portions of a signal are being measured by the counter/timer. This completely eliminates the concern that usually accompanies the measurement of complex signals with a conventional counter, whether what is being measured is really what the operator thinks is being measured.

The combination of integral oscilloscope and counter/timer allows you to make counter/timer measurements on any of 12 plug-in input channels or on the signals at the A and B External Trigger/Counter Inputs. Use of the A and B External Trigger/Counter Inputs allows the use of the counter/timer without tying up the oscilloscope functions of the instrument.

Automatic Display Setup
The Autoset feature provides scaled, triggered display of the selected signal immediately, automatically, with the simple press of a button on the front panel or at the probe tip where the user's attention is focused.

Automatic Measurements
The press of a front panel pushbutton and a touch of the touch screen provides automatic time and amplitude measurements, without further operator intervention. This automatic measurement sequence can also be invoked via the probe tip pushbutton, allowing the operator to display the results of up to eight measurements without removing his hands or attention from the circuit under test.

Cursors
Both vertical and horizontal cursors can be displayed to aid in making amplitude and timing measurements. Cursor scaling permits percentage, dB, and degree comparisons without the need for calculations. The results of the measurements are always displayed numerically on the screen, with appropriate units of measure.

Built-In Time Bases
Two built-in time bases provide sweep rates to 500 ps/div. The dual delayed sweeps provide magnification of any portion of the displayed waveforms and allow precise comparison of two signals occurring at different times in the same or different signal paths.

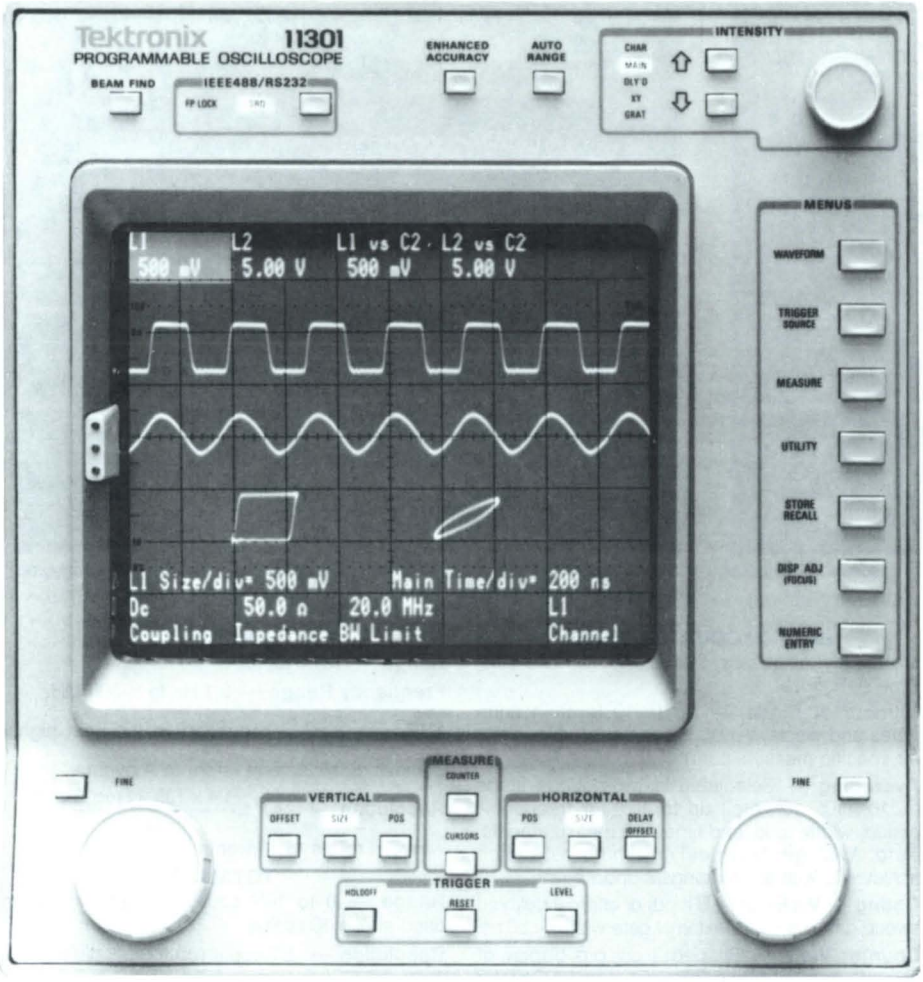
Display Versatility
The versatile and convenient trace definition capability of the 11301 and 11302 permits up to eight traces to be displayed simultaneously in a wide variety of signal combinations. Signals from separate plug-ins can be added or subtracted; YT and XY signals can be displayed simultaneously.

A nonvolatile time and date clock can be displayed for documentation of photographs. The clock setting is constantly available over the bus for time documentation of accumulated data in automated testing situations.

Holdoff
Holdoff provides the means of holding off the occurrence of the main sweep until a selected amount of time or number of events has occurred. This capability is essential in inspecting groups of pulses or events, particularly when they are not synchronized with any controllable framing pulse.

The 11301 and 11302 offer several modes of holdoff. Holdoff by time is settable either as a function of main sweep time/division or in 2 ns increments up to 5 x 10^8 seconds. Holdoff by events is settable up to 5 x 10^8 events.

The Countdown Holdoff function allows the sweep to be triggered on every Nth event within a pulse train. The companion Trigger-On-Next/Trigger-On-Previous function allows the user to move forward and backward through the pulse train in order to select the desired triggering point within the pulse train. Thus, any pulse within the pulse train can be inspected in detail and easily compared to other events occurring within a circuit at the same time.



11301 showing two Y-T traces and two X-Y traces, simultaneously displayed. Vertical control menu shown at the bottom of the screen.

The Holdoff By Events function permits the main sweep to run immediately, or be armed for triggering by another signal source, after N events following a selected start event. This function, in effect, permits four-deep "stacking" of delaying events: a start event, followed by a selected number of holdoff events, followed by a main sweep triggering event, followed by the running or triggering of one or both delayed sweeps.

Calibrated Fine Settings

A fine settings mode provides calibrated sweep timing and vertical sensitivity to 1% increments between the conventional 1-2-5 settings. This permits the operator to set the signal of interest to an integral number of divisions for simplified comparison of inputs and outputs of signal attenuators, multipliers, dividers, etc. It also permits convenient scaling of transducer outputs to oscilloscope graticule lines.

Stored Front Panel Setups

Up to 10 complete front panel setups can be stored and recalled for immediate setup of all instrument controls for repetitive testing. Manual sequencing of the stored setups can be accomplished by means of the pushbutton at the probe tip. This allows the operator to probe from point to point within a circuit to reset the entire oscilloscope for each test point without removing his attention from the device he is testing.

Reference Waveforms

On-board storage and display of two reference waveforms can provide templates for quick visual go/no go comparison of complex waveforms. These reference waveforms can be created by a computer or captured by a waveform digitizer and downloaded to the oscilloscope's internal memory.

Direct Numeric Entry, With Arithmetic Operators

A touch screen keypad permits immediate numeric entry of scale factors, holdoff events, offsets, counter/timer and cursor null references, etc.

CHARACTERISTICS

VERTICAL SYSTEM

System Bandwidth — Determined by mainframe and plug-in (see Bandwidth/Rise Time matrix on page 199).

Accuracy — Determined by mainframe and plug-in. See plug-in descriptions.

ΔDelay Between Channels — Adjustable ±500 ps.

Vertical System Delay — At least 20 ns of the sweep is displayed ahead of the triggering event.

HORIZONTAL SYSTEM

Main Sweep Timing Range — 5 ns/div to 0.5 s/div in 1-2-5 steps, plus 1% increments between steps and to 1.0 s/div. X10 Mag extends maximum sweep rate to 0.5 ns/div.

Delayed Sweep Timing Range — 5 ns/div to 0.5 s/div, plus 1% increments between steps and to 1.0 s/div. X10 Mag extends maximum sweep rate to 0.5 ns/div.

Main and Delayed Sweep Accuracy (Time/Div in 1-2-5 Steps) — ±(0.7% of time interval plus 0.06 div.)

ΔTime Accuracy Using Cursors — ±(0.5% of time interval plus 0.03 div.)

ΔTime Accuracy Using Delayed Sweep — ±(0.3% of time interval plus 0.01 div.)

X-Y Operation — From Center Plug-In: Bandwidth is dc to 3 MHz; Phase difference between X and Y with normal bandwidth is 1° or less from dc to 1 MHz, 3° or less from 1 MHz to 2 MHz.

TRIGGERING

Minimum p-p signal required for stable triggering.

Dc Coupled — 0.35 div from dc to 50 MHz; increasing to 1.0 div at system bandwidth.

Ac Coupled — 0.35 div from 50 Hz to 50 MHz, increasing to 1.0 div at system bandwidth.

HF Reject Coupled — 0.5 div from dc to 30 kHz.

LF Reject Coupled — 0.5 div from 80 kHz to 50 MHz, increasing to 1.0 div at system bandwidth.

Triggering sensitivity can be adjusted to reject unwanted noise components on noisy signals.

Minimum p-p signal required for stable triggering from A and B external inputs:

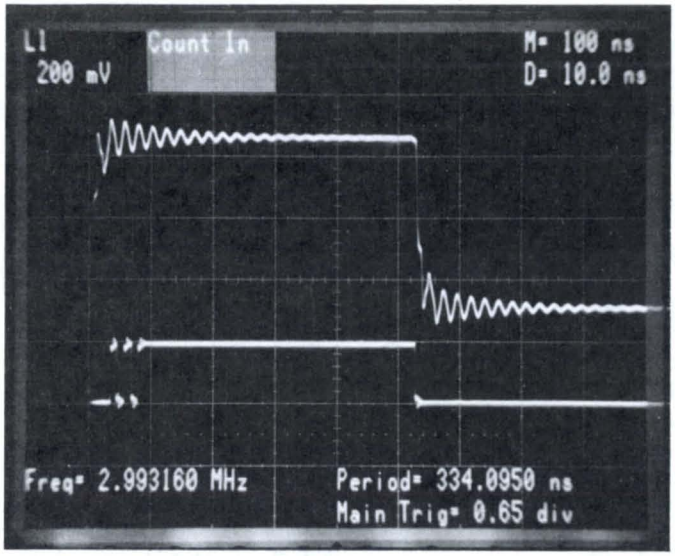
Dc Coupled — 20 mV from dc to 50 MHz, increasing to 90 mV at system bandwidth.

Ac Coupled — 20 mV from 50 Hz to 50 MHz, increasing to 90 mV at system bandwidth.

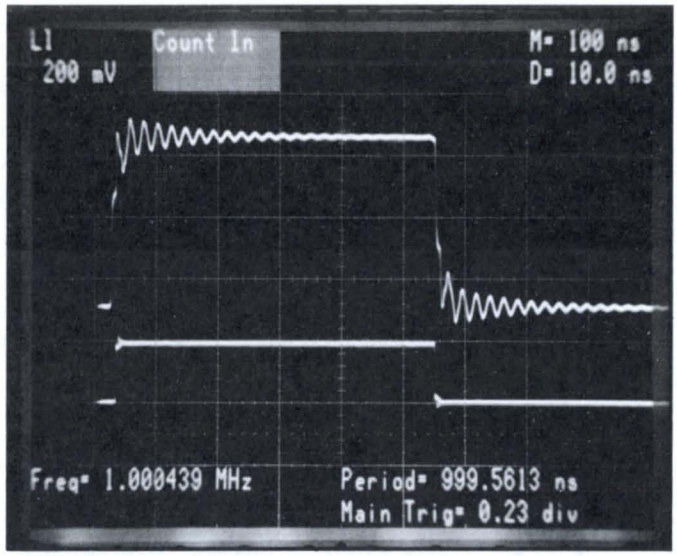
HF Reject Coupled — 28 mV from dc to 30 kHz.

LF Reject Coupled — 28 mV from 80 kHz to 50 MHz, increasing to 90 mV at system bandwidth.

Triggering sensitivity can be adjusted to reject unwanted noise components on noisy signals.



Count in signal (lower trace) shows clearly that counter/timer is miscounting because of ripple on the top of the signal (upper trace).



Count in signal (lower) gives confidence that counter/timer is being properly triggered for accurate measurements.

HOLDOFF

Holdoff By Time — Varies the minimum amount of time between the end of a main sweep and the start of the next; settable over at least a 20-to-1 range with a minimum of 2.5 μsec or two times the main sweep time/division.

Holdoff By 2-ns Step — Varies the minimum amount of time between the beginning of one main sweep and the beginning of the next main sweep; settable in 2 ns increments up to 5×10^8 seconds, or in increments of 1% of the main sweep time/div setting.

Countdown Holdoff — Selects number of main trigger events between occurrences of main sweep, settable from 2 to 5×10^8. Front panel Trigger-On-Next/Trigger-On Previous functions allows stepping through events in increments of one event (GPIB allows selectable increments). Maximum event frequency: 500 MHz or mainframe/plug-in bandwidth, whichever is less.

Holdoff By Events — Delays start of main sweep for N holdoff events following the occurrence of a start event. One-Start feature allows repetitive main sweep holdoff by events with only a single start event. Main or delayed trigger, B External Trigger/Counter Input, or 2 ns steps defines the holdoff events. Main trigger or A External Trigger/Counter Input defines start event, or holdoff operation can be self-starting.

Maximum holdoff event frequency when using internal triggers is determined by the bandwidth of the mainframe/plug-in combination used. Maximum holdoff event frequency through the B External Trigger/Counter Input is 300 MHz. One Start limits holdoff event frequency to 125 MHz.

BUILT-IN COUNTER/TIMER

Modes — Frequency, Period, Width, Ratio A/B, Time A→B, Totalize.

Number of Digits — Up to 10 (system computes and displays proper number of valid digits for specific measurement).

Averaging — Selectable in two-decade steps (1, 10^2, 10^4, 10^6, etc.) up to 10^{10} for frequency, period, width, ratio, and time A→B measurements. Auto Average provides maximum resolution achievable with a 3 readings/s update rate.

Gating — Via External B input or internal delayed sweep gate. Minimum external gate width: <50 ns.

Counter View — Shaped 1 div p-p display of any one or more of the following signals: Counter In, Gate, Sync Gate, A External Input, B External Input. Counter view traces are among the maximum eight displayed traces.

Sensitivity — Via External Counter Inputs: <100 mV p-p dc to 300 MHz, <500 mV p-p 300 MHz to 500 MHz. Via Internal Trigger Inputs: 2X sweep triggering sensitivities.

Counter Ref Clock In/Out — Connector on rear panel allows application of 0 dBm external clock, of 1 MHz or 10 MHz.

FREQUENCY

Range — <1 mHz to >500 MHz.

LSD — Greater of $\frac{\pm 2 \text{ ns} \times F^2}{N}$ rounded to the next higher decimal digit, or 1 count.

Resolution — Greater of LSD $\pm\frac{1.4 \times TJE \times F^2}{N}$ or 1 count.

Accuracy — Resolution ±(F x TBE).

PERIOD

Range — Without Averaging, 2 ns to >1000 s.

LSD — $\pm\frac{2 \text{ ns}}{N}$ rounded to next higher decimal digit.

Resolution — LSD $\pm\frac{1.4 \times TJE}{N \times \sqrt{G}}$.

Accuracy — Resolution Error ±TBE x P.

RATIO

Range — 10^{-11} to 10^{11}.

Frequency Range — 0.1 Hz to >500 MHz.

LSD — $\frac{\text{Freq A}}{\text{Freq B} \times N}$ rounded to the next higher decimal digit where N refers to A events.

Resolution — LSD $\pm\frac{1.4 \times TJE \times \text{Freq A}}{N}$ where N refers to A events.

TOTALIZE

Range — 0 to 10^{12} counts (scientific notation used above 10 digits).

Resolution — ±1 count (up to 10^{10} digits).

WIDTH

Range — Without Averaging, 2 ns to >1000 s.

Maximum Repetition Rate — >200 MHz.

LSD — $\frac{2 \text{ ns}}{\sqrt{N}}$

Resolution — ±LSD ±leading edge TJE ±trailing edge TJE.

Accuracy — Resolution ±[Width x TBE ±Hysteresis Error ±TLE x input slew rate at the start and end points ±2 ns systematic error].

TIME INTERVAL

Range — Without Averaging, 2 ns to 1000 s.

Maximum Repetition Rate — 100 MHz.

LSD — $\frac{2 \text{ ns}}{\sqrt{N}}$

Accuracy — ±1 (LSD + 100 ps + TBE + reading + 1.4 x $\frac{TJE}{\sqrt{N}}$ + (0.001% x main sweep time/div) x $\sqrt{N}$.

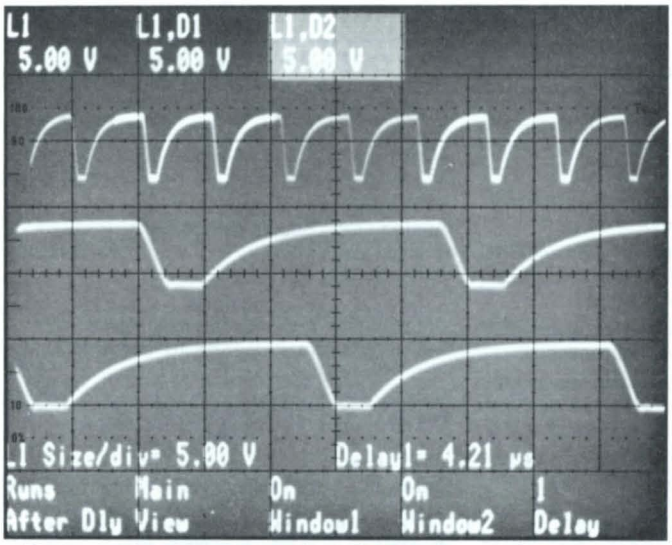
STANDARD TIME BASE

Frequency at Calibration — 10 MHz ±1 Hz.

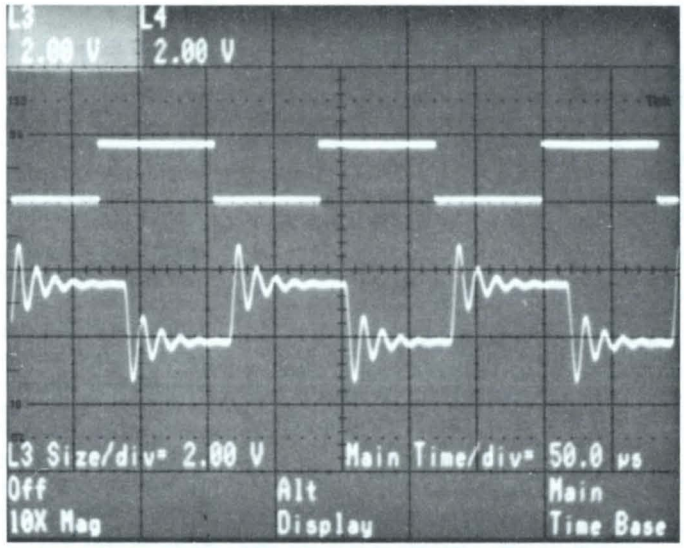
Temperature Stability — ±50 Hz, 0°C to 50°C (5 ppm).

Aging — <10 Hz/year (1 ppm).

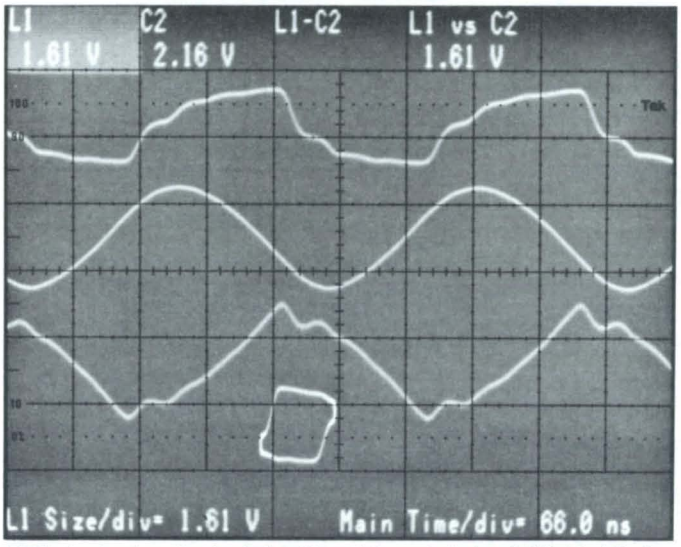
Adjustment Resolution — 0.5 Hz.



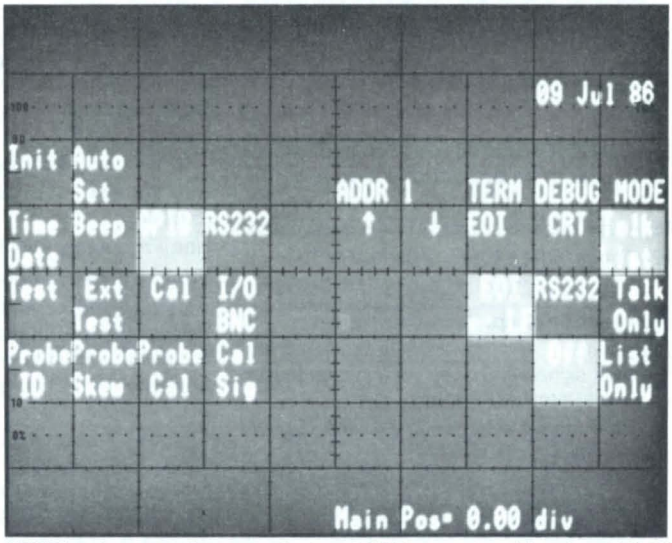
11301 showing dual delayed sweeps intensified on main sweep. Delay control menu shown at the bottom of the screen.



Dual-trace display on 11301. Horizontal control menu shown at the bottom of the screen.



11301 showing two signals singly, differentially, and displayed X-Y. L1 deflection factor and main time base/division set to calibrated FINE settings.



UTILITY major menu allows operator to set GPIB parameters (above) and RS-232 parameters (below) by means of the 11301/11302 touch screen.

HIGH STABILITY TIME BASE (OPTION 1T)

Frequency at Calibration — 10 MHz ±0.2 Hz.

Temperature Stability — ±2 Hz, 0°C to 50°C.

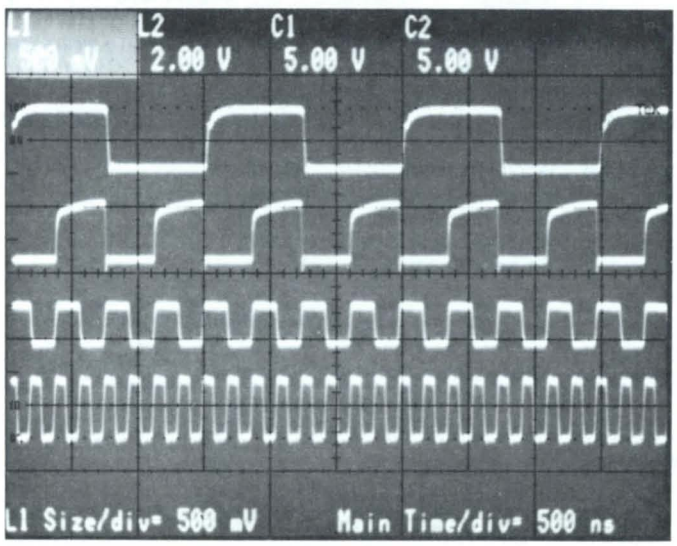
Warm-Up Time — 10 minutes at 25°C to within 0.2 ppm of final frequency.

Aging — $<1x10^{-8}$/day at time of shipping. $<4x10^{-8}$/week after 30 days continuous operation. $<1x10^{-6}$/year after 60 days continuous operation.

Short Term Stability — $<1x10^{-9}$ RMS based on 60 consecutive 1 s measurements.

Adjustment Resolution — 0.2 Hz.

Adjustment Range — Sufficient for 8 years of aging.



Four-trace display on 11301. Note deflection factor (V/div) of each of the four channels and the time/div of the main sweep.

DEFINITION OF TERMS

ATJE = CT external A input trigger jitter error.

BTJE = CT external B input trigger jitter error.

DTJ = Time base delay time jitter.

EALE = CT external A input level error.

EBLE = CT external B input level error.

F = Frequency of the signal being measured ($F=\frac{1}{P}$).

Hysteresis Error (in seconds) = $\frac{\text{sensitivity}}{\text{Input slew rate at the trigger in V/sec}}$

(For negative going transitions with + slope or positive going transitions with − slope selected.)

G = The number of gate intervals in one measurement.

LSD = The smallest amount that the display can change.

N = Number of events in a measurement interval; selectable in increments of ≈1, 10^2, 10^4, 10^6, 10^8, and 10^{10}. For Auto/Averaging, N is the greater of one or the number of events in a 200 ms interval. For gated measurements, N = number of events within the gate interval.

P = The period of the signal being measured ($P=\frac{1}{F}$).

RESOLUTION = The amount an input signal must change to be assured of a change on the display.

TBE = Time base error (see CT time base spec).

TJE = Trigger jitter error (in seconds RMS) = $\left[\frac{\sqrt{(en1^2+en2^2+en3^2)}}{\text{absolute value of input signal slew rate}}\right]$.

At trigger point,

en1 = Input signal RMS noise voltage (see trigger and external input specs).

en2 = RMS noise voltage contributed by the plug-in.

en3 = RMS noise voltage contributed by the mainframe trigger.

TLE = Trigger level error; error resulting from the actual trigger point being different from the set trigger point.

EXTERNAL CONNECTORS

Camera Power — 3-pin connector next to CRT is compatible with Tektronix C-50 Series cameras.

Calibrator Output — Front panel female BNC connector. Squarewave Mode: 5.0 V or 500 mV squarewave into open circuit; 10 Hz, 100 Hz, 1 kHz, 10 kHz, 100 kHz; 450 Ω output impedance. Fast Rise Mode: 0.5 V into open circuit, 2 ns transition time into 50 Ω; 50 Ω output impedance; same frequencies as Squarewave Mode plus 1 MHz.

A and B External Trigger and Counter Inputs — Front panel female BNC connectors. Input Impedance: 1 MΩ.

Trigger Ready Output — Rear panel female BNC connector. Low State: 0 V to 0.5 V. High State: +2.4 V to 5.0 V.

Trigger Reset Clock — Rear panel female BNC connector. Input TTL compatible.

Sweep Gate Output — Rear panel female BNC connector. Low State: 0 to 0.5 V. High State: 2.4 to 5.0 V.

Counter Ref Clock In/Out — Rear panel BNC connector. See Counter/Timer description.

Main Sweep Output — Rear panel female BNC connector. Positive going ramp, 0 V to 5 V, coincident with main sweep: Output Impedance: 950 Ω.

Z-Axis Input — Rear panel female BNC connector. Positive voltage decreases intensity; +2 V blanks a maximum intensity trace.

Left Vertical Out — Rear panel female BNC connector. Output signal amplitude: 100 mV/div of displayed trace. Bandwidth: Dc to 100 MHz.

CRT AND DISPLAY FEATURES

Standard CRT — 11301: 8 x 10 div (1.22 cm/div); P31 phosphor. 11302: 8 x 10 div (1.0 cm/div); P31 phosphor. 11302 Writing Speed: 10 div/ns single-shot visual writing speed in 20 footcandle ambient illumination.

POWER REQUIREMENTS

Line Voltage — 90 V to 132 V ac, and 180 V to 250 V ac.

Line Frequency — 48 Hz to 440 Hz.

Maximum Power Consumption — 240 W.

ENVIRONMENTAL AND SAFETY

Temperature — Operating: 0°C to +50°C. Nonoperating: −45°C to +75°C.

Humidity — Operating and Nonoperating: Up to 95% relative humidity, up to 50°C.

Altitude, Vibration, Shock, and Bench Handling — Meets MIL-T-28800C, Type III, Class 5.

Electromagnetic Compatibility — Meets MIL-T-28800C; MIL-STD-461B; FCC Part 15, Subpart J, Class B; VDE 0871/6.78 Class B; CE-01 Part 4, with exceptions; CE-03 Part 4, Curve 1; CE-03 Part 4, Curve 4, Navy, NB, BB (with exceptions); CS-01 Part 7; CS-02 Part 4 (with exceptions); CS-06 Part 5; RE-01 Part 4 (with exceptions); RE-02 Part 4; RS-01 Part 4; RS-03 Part 7 (limited to 1 GHz).

Safety — Listed UL 1244; CSA Bulletin 556B, September 1973; Tektronix self-certification to comply with IEC 348 recommendations.

ORDERING INFORMATION

11301 400 MHz Programmable Analog Oscilloscope **$8,550**

Includes: Operator manual (070-6104-00); user reference guide (070-6106-00); user pocket reference (070-6105-00).

11302 500 MHz Programmable Analog Oscilloscope With Microchannel Plate CRT **$12,950**

Includes: Same as 11301.

OPTIONS

Option 1C — Adds four additional rear-to-front feedthroughs to the existing standard four; total of eight. **+$150**

Option 1R — Rackmount **+$250**

Includes: Hardware, tooling, and instructions for converting bench model to rackmount configuration.

Option 1T — High stability Counter/Timer. **+$325**

INTERNATIONAL POWER PLUG OPTIONS

Option A1 — Universal Euro 220 V, 50 Hz.
Option A2 — UK 240 V, 50 Hz.
Option A3 — Australian 240 V, 50 Hz.
Option A4 — North American 240 V, 60 Hz.
Option A5 — Switzerland 220 V, 50 Hz.

WARRANTY-PLUS SERVICE PLANS

SEE PAGE 496

Contact your local Sales Engineer for prices.
S0 — On-Site Product Installation and Set-Up.
S1 — 1 Year On-Site Service.

OPTIONAL ACCESSORIES

SERVICE MANUALS

11301 —
(Volume I) Maintenance. Order 070-6107-00*1
(Volume II) Diagnostics. Order 070-6108-00*1
(Volume III) Diagrams and Parts Lists. Order 070-6109-00*1

11302 —
(Volume I) Maintenance. Order 070-6110-00*1
(Volume II) Diagnostics. Order 070-6111-00*1
(Volume III) Diagrams and Parts Lists. Order 070-6112-00*1

Cables —
(GPIB) 2 m. Order 012-0991-00 **$150**
(RS-232) 10 ft. Order 012-0911-00 **$100**

Blank Panel — For filling empty plug-in compartments. Order 016-0829-00 **$95**

DIGITIZING CAMERA SYSTEM

DCS01 — Digitizes waveforms or single-shot signals to the full bandwidth of the 11302 to allow analysis with a personal computer. **$5,300**

Recommended Cameras — See page 442.

Recommended Probes — See page 215.

Recommended Cart — K217. See page 462.

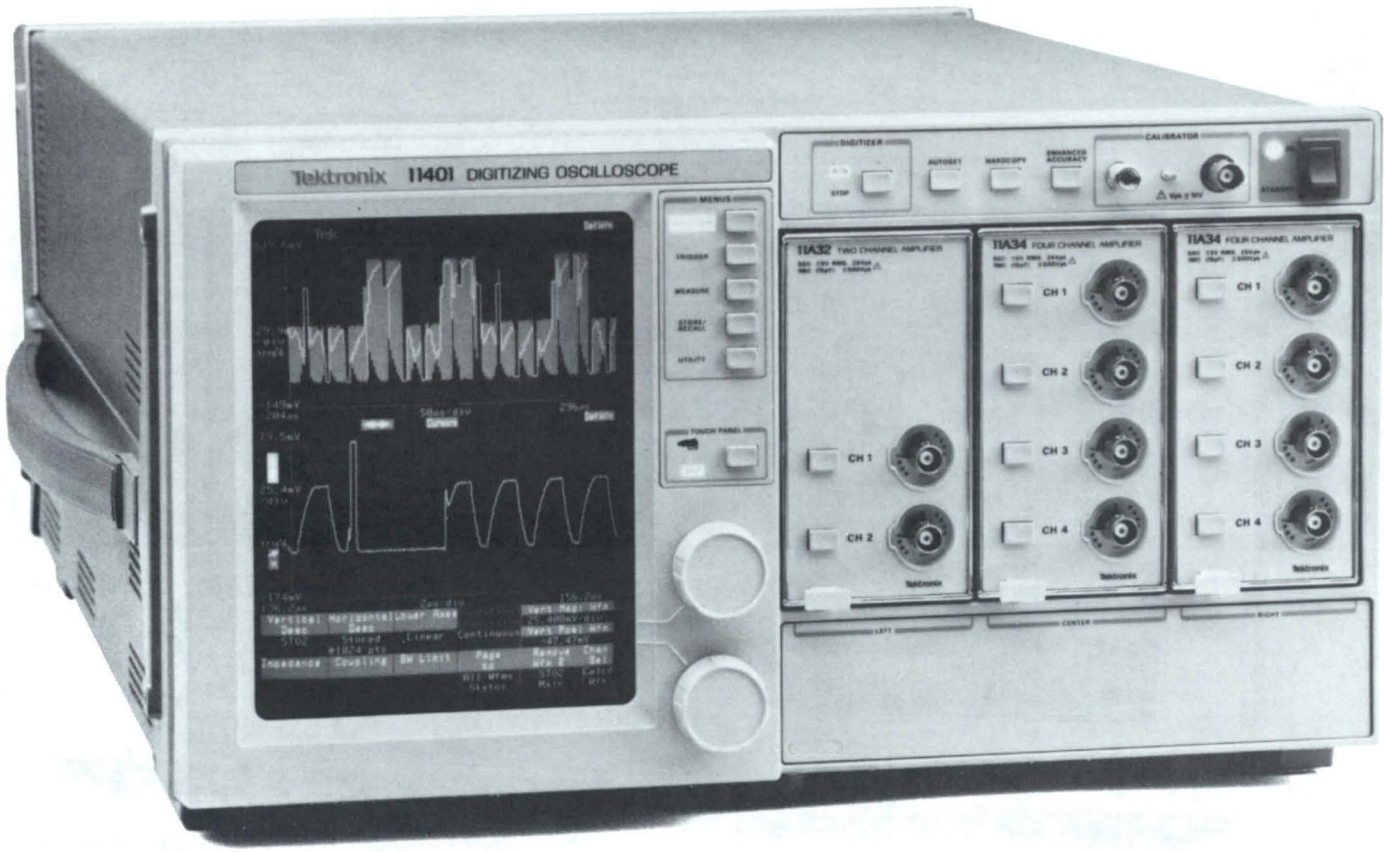
**1 To order, contact your local Tektronix Sales Office.*

TRAINING

Tektronix Instrument Group Customer Training offers operation and application training to help you get full value out of your instrumentation investment. Information is on pages 195-196. For further information, or to enroll, call us at 503-642-8013 (collect).

PHYSICAL CHARACTERISTICS

Instrument	11301		11302		Rackmount	
Dimensions	**mm**	**in**	**mm**	**in**	**mm**	**in**
Width, with handle	447	17.6	447	17.6	482	19.0
Height, with feet	239	9.4	239	9.4	222	8.8
Depth	581	22.9	581	22.9	548	21.6
Weights≈	**kg**	**lb**	**kg**	**lb**	**kg**	**lb**
Net	18.1	40.0	20.0	44.0		
Shipping	21.8	48.0	23.6	52.0		



The 11401 Digitizing Oscilloscope with 500 MHz System bandwidth.

11400 Series

Digitizing Oscilloscopes

GPIB IEEE-488

The 11400 Series complies with IEEE Standard 488-1978, RS-232C, and with Tektronix *Standard Codes and Formats.*

1 GHz and 500 MHz Bandwidth

Eight Channels of Display and Acquisition

Plug-In Modularity

Waveform Processing and Automatic Pulse Parameters

Multiple 10,240 Point Waveform Records

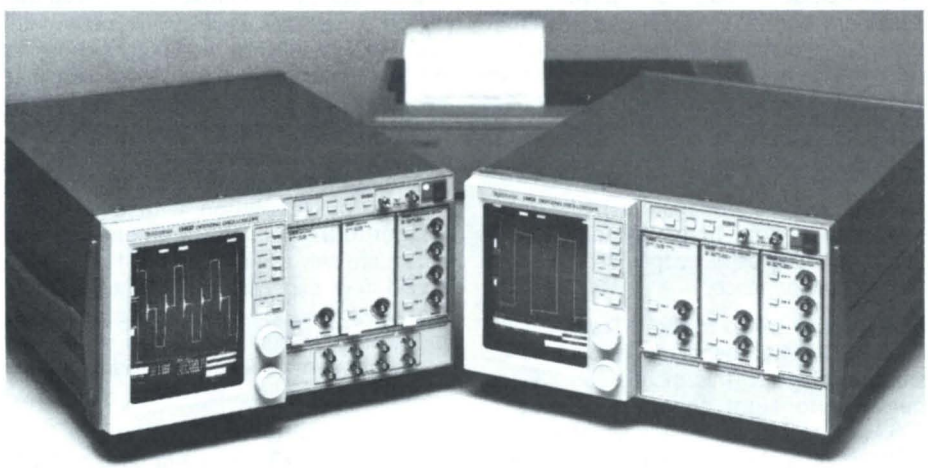
Accepts Differential, High Impedance and 50 Ω Input Amplifiers

Greatly Simplified Access to Features

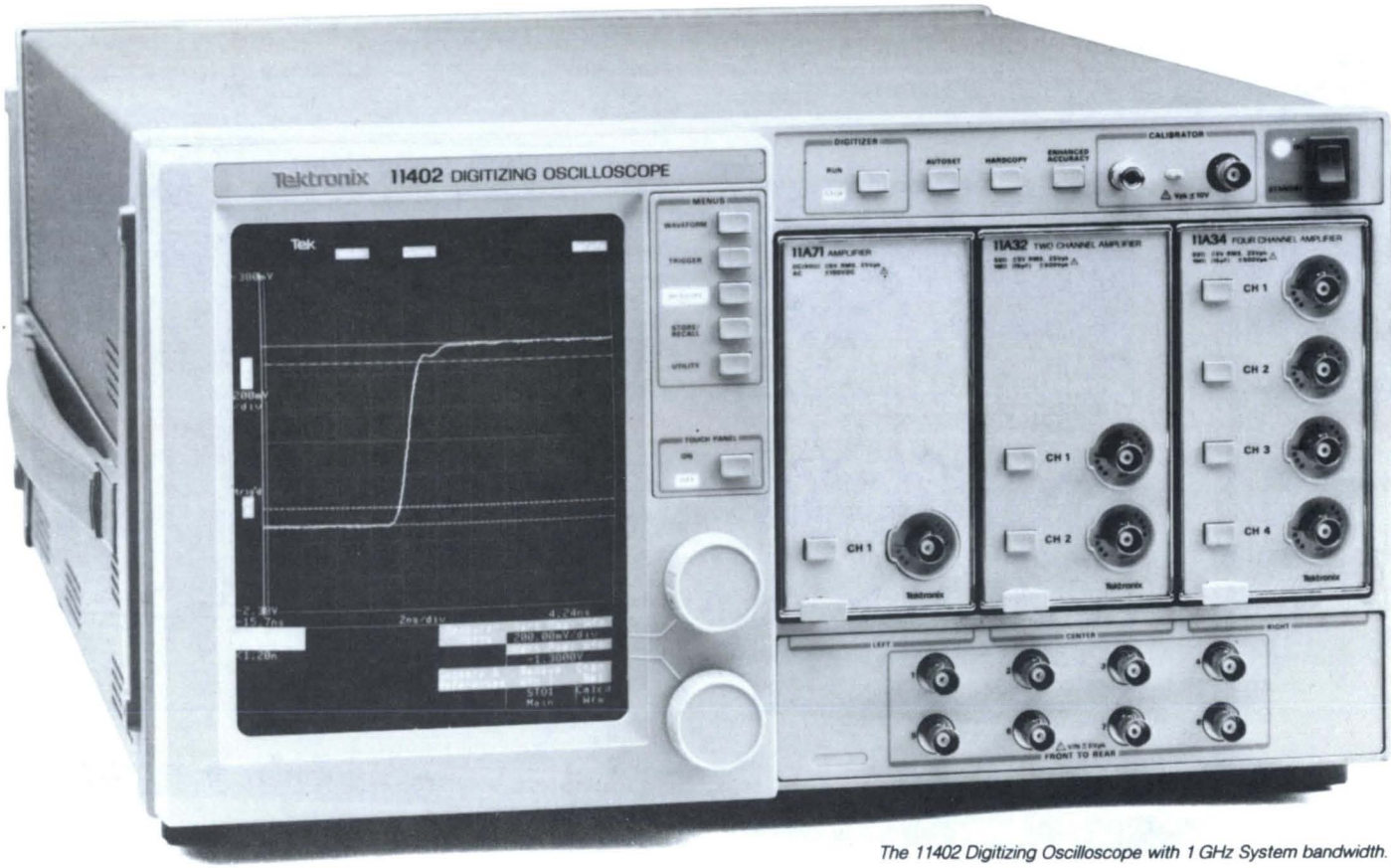
Fully Programmable via GPIB and RS-232C

TYPICAL APPLICATIONS
Waveform Characterization
Prototype Troubleshooting and Debugging
Measurement Against a Standard

The 11401 and 11402 are the first in a new line of digitizing oscilloscopes. These versatile scopes, with their array of new supporting plug-ins and probes, solve measurement problems equally well on a designer's bench or in a programmable



The 11401 and 11402 are the first in a new line of high bandwidth, programmable digitizing oscilloscopes. The 11401/11402 are ideal for digitizing and accurately measuring repetitive waveforms. 10–14 bit vertical resolution, 20 MS/s A/D conversion system provides a cost-effective solution to a wide range of measurement problems.



The 11402 Digitizing Oscilloscope with 1 GHz System bandwidth.

test system. Digital designers will benefit from flexible triggering features and an eight channel display. Analog and power supply designers can apply extensive waveform processing to signals acquired through high performance differential and single ended amplifiers. 11000 Series digitizing scopes can follow your designs into production. Full programmability via either IEEE-488 or RS-232C and features like a DMA controller for fast waveform transfers make these scopes a perfect fit for systems. 11000 Series digitizing oscilloscopes set new standards in performance.

Live Display of Up to Eight Traces

The 11401/11402 each support three vertical amplifier plug-ins. This means you can acquire up to eight channels of data at 300 MHz, up to six channels of data at 600 MHz or up to three channels of data at 1 GHz. You can, of course, mix and match the plug-ins to design the system that works best for you. Eight traces can be displayed at any one time so that you can get the whole picture on one screen. The update rate is so fast that the 11401 and 11402 have the look and feel of analog scopes.

High Vertical and Horizontal Resolution

The 11401 and 11402 uniquely combine wide bandwidth with 10 ps horizontal resolution and 10 bit vertical resolution (vertical resolution can be increased to 14 bits when signals are averaged). Other vendors have made a tradeoff; bandwidth for vertical resolution or vertical resolution for bandwidth. The 11401/11402 give you both for making demanding voltage and timing measurements in one box. In addition, the 11401/11402's trigger-to-trigger measurement feature delivers 200 ps resolution on single shot time A→B measurements and can even provide 10 ps resolution with averaging. Trigger-to-trigger measurements of this nature are only available on the 11401/11402 and a few expensive standalone counter timers. Also, window records can be used to increase horizontal resolution on specific segments of main records providing a clear picture of signal details.

Multiple Long Record Lengths

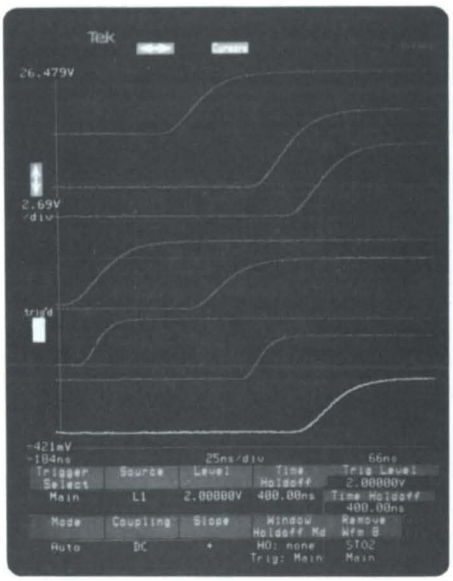
The 11401/11402 can acquire multiple records of up to 10,240 points each. No other scope can capture as much data at once on repetitive waveforms. The mainframes can contain up to 102,400 points of waveform memory with Option 2D. Long records and large storage capacity combine to let users gather data over relatively long periods of time with high resolution and improve measurement accuracy. One doesn't need a computer to log waveform data. Waveforms can be stored on-board the scope for later analysis.

Versatility for a Wide Range of Applications

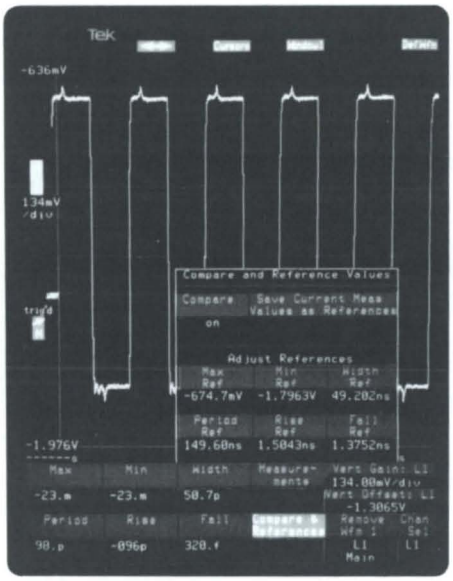
Five new plug-ins and three new probes bring outstanding versatility to the 11401/11402. The measurement system and waveform processing functions lead to quick solutions to a wide variety of voltage, time, area and energy problems. The 1 GHz 11402 can process and measure signals from high bandwidth 50 Ω amplifiers, high impedance amplifiers and differential amplifiers. 1 mV sensitivity and 500 V maximum input voltage let users capture small signals from transducers or monitor ac power lines. Fast overdrive recovery and up to 2000 divisions of dynamic range give these scopes the power to look at even the smallest detail on difficult to capture waveforms.

Unparalleled Ease of Use

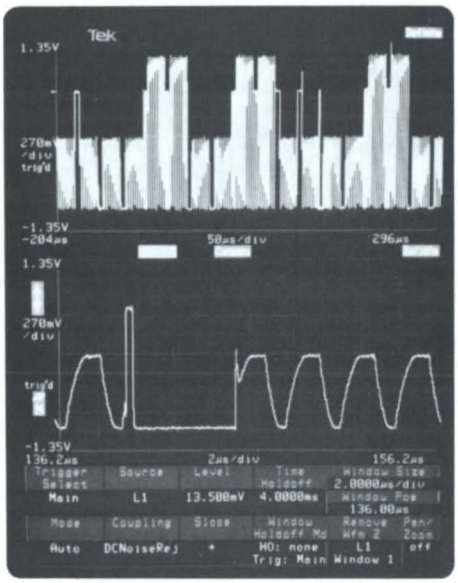
The 11401 and 11402 use simple parallel menus and touch screen to give easy access to their measurement and display features. All but a few of the buttons and knobs have been eliminated in favor of a system that only presents selections when they are valid and/or useful. An autoset function sets up the scope for you based upon the signal characteristics of the selected trace. This can be activated from



The 11401 and 11402 can display up to eight traces from a variety of sources. Display eight channels of live waveforms for timing analysis on digital systems. Or display combinations of live and stored waveforms.



Multiple waveform parameter measurements can be performed and are updated continuously. A compare and reference measurement mode allows measurement results to be compared to a standard, and the difference of two results to be displayed.



Two built-in time bases provide the functionality of delaying and delayed sweeps in analog scopes. The main time base defines the overall acquisition interval and the window time base allows high resolution acquisition of small portions of complex waveforms.

the probe tip, allowing for hands off operation of the scope. Autoset frees the operator to concentrate on the measurement problem and the probe connection. The most commonly used functions are no deeper than a second menu level. Icons let you assign the knobs to waveform size and position no matter what operating mode you are in. Pop-up menus present choices and fold down when those selections are made. One button hard copy generation is made possible by the use of a standard Centronix port and software drivers compatible with Tektronix 4644 and low cost Epson dot matrix printers. Overall, the operation of the 11401/11402 is intuitive. The instrument can be used easily even if it is not used every day. Acquisition, measurement and documentation is as simple as six touches: Autoset, measure, measurements, rise, exit, hardcopy. It doesn't get any simpler.

Plug-In Modularity

The 11401 and 11402 are compatible with five different vertical amplifiers. Each will accept three of these amplifiers in its plug-in compartments. You can configure a scope to meet your particular needs, for example:

- Timing Measurements on High Speed Logic
  Use three 11A71s in the 11402 for three 1 GHz bandwidth channels.
- Characterization of Waveforms in a Lab
  Select an 11A52 for two high bandwidth 50 Ω channels, an 11A33 for high bandwidth differential measurements, and an 11A34 for four high impedance channels.
- Prototype Troubleshooting and Debugging
  Use two each, four channel amplifiers and a two channel high bandwidth amplifier. This configuration gives you eight channels of acquisition for timing analysis and two high bandwidth channels for exacting pulse response measurements.
- Power Supply Evaluation
  Use three differential amplifiers to determine efficiency and stability and to measure noise and ripple.
- Medical or Mechanical Measurements
  Use two each, four channel plug-ins for eight channels of data acquisition and a differential amplifier for digitizing small signals from transducers.

The Most Accurate Instruments of Their Kind

The 11401 and 11402 are the most accurate high bandwidth scopes on the market. They combine the timing accuracy inherent in digital time bases with 1% vertical accuracy. The Enhanced Accuracy feature prompts the user to start self-calibration routines whenever temperature or configuration changes warrant it. You can even assign the 11401/11402 to start a self-calibration automatically. Time base accuracy is 100 ps +.002% of the time interval. The 11401 and 11402's accurate, automatic measurements can replace dedicated counter/timers and ac voltmeters. Devices and subassemblies can be tested to tighter tolerances, improving end product performance and quality.

On-Site Serviceability

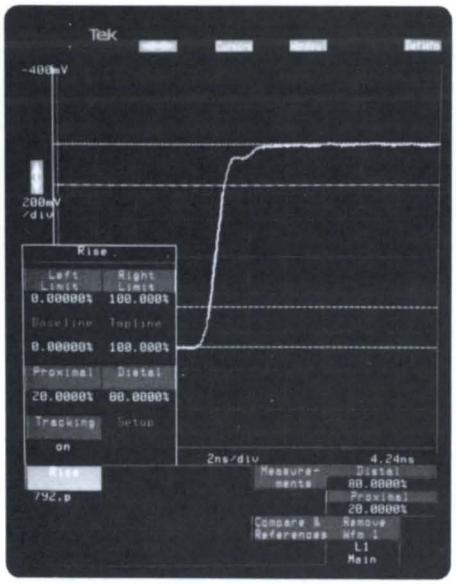
These scopes are card modular, they have extensive self-test and diagnostic routines and they have reliability built-in. On-site *Warranty-Plus* service options help you keep the instruments up and running when down time might otherwise halt your production line. Tektronix service technicians can be at your facility repairing these products within eight working hours if you are within 75 miles of designated U.S. service centers.

All New Probe Interface

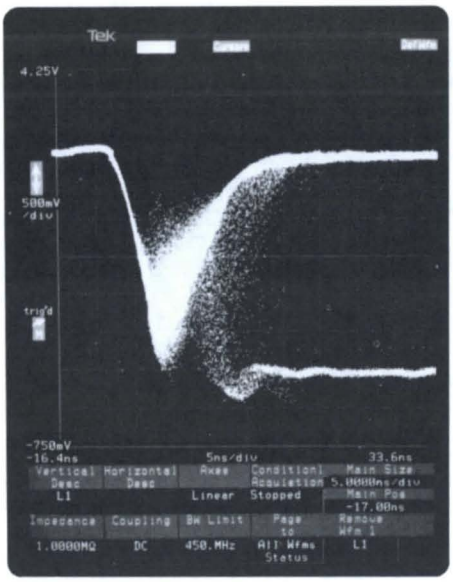
We've set a new standard for probe interfacing. Signal and probe power connections are all made at the amplifier input eliminating extra probe power lines. We can support as many active probes as you have channels. A smart serial interface between the probe and the scope lets you stop worrying about the proper termination impedance; it is set automatically. You can autoset the scope or sequence through a series of front panel set-ups all from the probe ID button. This leaves your hands free to probe your circuit. A full complement of active and passive probes with this new interface is ready to assist in the solution to your measurement problems.

Choose Your Computer Interface

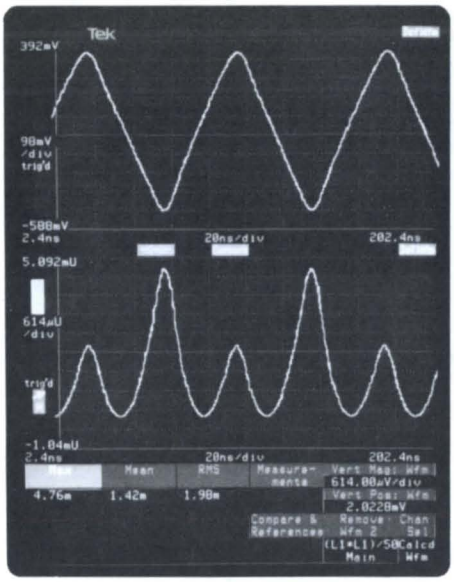
The 11401 and 11402 have both IEEE-488 and RS-232C interfaces as standard features for data transfer and instrument control. The RS-232C port lets you control the instrument with a PC, upload or download waveforms from a workstation or main



High bandwidth allows capture and measurement of fast rise times. Measurements can be customized and annotated to clearly show where and how the measurement is being made.



A high resolution display with Point Accumulate Mode along with powerful triggering makes it much easier to capture and display common digital fault conditions like metastable states, glitches and race conditions.



Powerful waveform processing functions let users define traces such as the power waveform shown above. The top waveform is a voltage waveform and the bottom waveform is a power waveform created by squaring the voltage waveform and dividing it by a load resistance.

frame, or run diagnostics over a modem. GPIB and RS-232C menus let you match interface parameters with a controller, modem or host. If speed is a consideration the parallel interface provided by the IEEE-488 port should be used. A DMA option can be added to speed up GPIB data transfers even further. Whichever bus is chosen, the instruments respond to a logical set of Tektronix *Standard Codes and Formats* commands that make it easy to write your test procedures.

Accurate, Automatic Measurements

The only reason oscilloscopes exist is for making measurements. The 11401 and 11402 perform waveform processing functions, pulse parameter analysis, cursor functions and trigger-to-trigger measurements that combine to cover a full range of measurement needs. A special annotation mode shows where measurements are being made on the trace so users can feel confident that they are on target. Dot cursors can be split between two waveforms to make propagation delay measurements or compare voltages. Measurement zones can be set to limit the automatic measurement to a portion of a displayed trace. Users can set proximal, distal and mesial levels to customize timing measurements. Up to six measurement results can be displayed and continuously updated as the data changes. This lets users make adjustments and see the results quicker than ever before. A direct hard copy output is provided that includes time and date of the measurement for archiving.

A Measureable Advance in Oscilloscope Technology

Higher bandwidths, better resolution, more accuracy, more versatility, hardware and software modular, easier to use and service, the 11000 Series sets new standards in digitizing oscilloscopes.

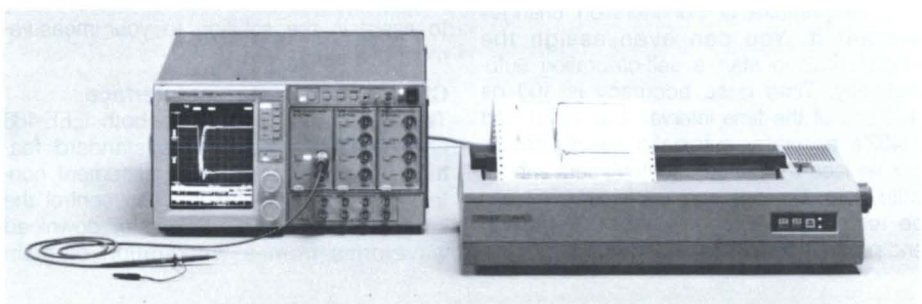
CHARACTERISTICS

VERTICAL SYSTEM

Accuracy With Enhanced Accuracy — Depends on plug-in unit.

Equivalent Time Bandwidth — Depends on plug-in used. See matrix on page 199.

Vertical Resolution — 10 bits (1024 levels.) Resolution can be increased to 14 bits (16384 levels) using signal averaging.



Direct hard copy output to dot matrix printers is provided through a standard Centronics port. Hard copies are time and date stamped for archiving.

HORIZONTAL SYSTEM

Time Bases — Two identical built-in time bases.

Record Duration — 5.12 ns to 1024 s in 1-2-5 sequence.

Time Base Accuracy — 100 ps +0.002% of measurement interval.

Record Length — 512 points to 10,240 points.

Sampling Rate — 20 MS/s maximum.

Main Record Positioning — Position of the main record with respect to the trigger point of the main record. Pretrigger: 1 record duration. Posttrigger: 1 record duration. Resolution: 1 main record point.

Windows — In addition to the main record, either one or two window records may be acquired and displayed. The window records may be of a different length (duration) and may have a smaller time/div than the main record. If two window records are used, they have the same duration and time/div settings and can be positioned independently.

Window Record Positioning — The window records are positioned relative to a window trigger point which may be positioned relative to the main record's trigger point delayed by either time or events.

Precision Time Measurement — The time between the beginning of the MAIN record trigger and the WINDOW trigger can be measured precisely, even if each trigger only occurs once. Repetitive events allow this measurement to be averaged for better resolution and accuracy. Single Trigger Resolution: 200 ps. Repetitive Resolution: 10 ps, after 100 averages. Accuracy: 100 ps +0.002% of record duration.

TRIGGERING SYSTEM

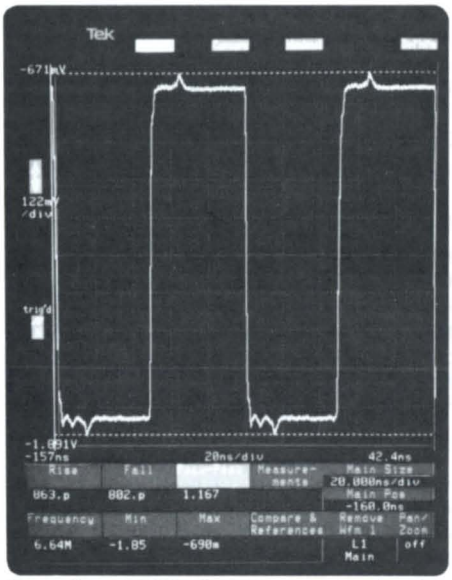
Range — ±Full screen.

Level Accuracy — Within 1% of full screen (10 LSBs).

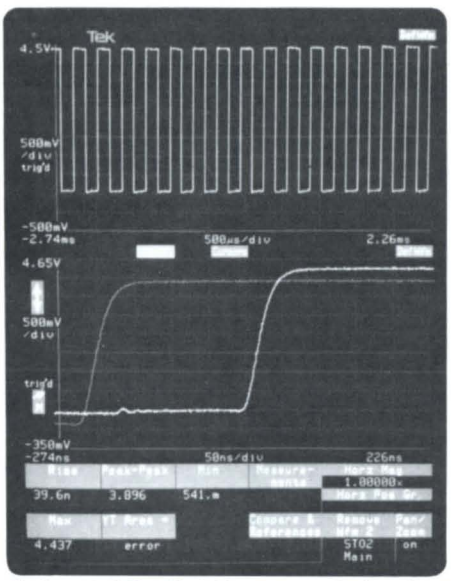
Coupling and Sensitivity —

Dc Coupled: 0.35 div from dc to 50 MHz, increasing to 1 div at 500 MHz.

Noise Reject Coupled: 1.2 div or less from dc to 50 MHz, increasing to 3 div at 500 MHz.



The 11401 and 11402 offer a unique combination of accurate timing and accurate amplitude measurements in one instrument.



Single or dual 10 x 10 division axes may be brought up for waveform display. Each axis represents a full 10 bit digitizing window.

The 11401 and 11402 are easily integrated into automated test systems. Options for rack conversion, rear to front signal routing and DMA transfer of waveform data and measurement results makes the 11401/11402 ideal for systems applications.

Ac Coupled: 0.35 div from 60 Hz to 50 MHz increasing to 1 div at 500 MHz. Attenuates signals below 50 Hz.

HF Reject Coupled: 0.5 div from dc to 30 kHz.

LF Reject Coupled: 0.5 div from 80 kHz to 50 MHz, increasing to 1 div at 500 MHz.

Holdoff Range — 500 ns to 10 s.

MEASUREMENT SYSTEM

Waveform Processing Functions — Waveform Functions: Differentiate, integrate, interpolate, smooth, average, and envelope. Arithmetic Operators: Plus, minus, multiply, divide, square root, logn, absolute value, signum, exp.

Measurement Set — Amplitude Measurements: Min, max, mid mean, peak-peak, RMS. Timing Measurements: Rise, fall, width, delay1, main→window, period, frequency. Area and Energy: Area +, Area −, energy. Cursors: Single or dual dots, split or paired mode, horizontal and vertical bars, measurement zone delimiters.

CRT AND DISPLAY FEATURES

Standard CRT — 9 inch diagonal, monochrome, magnetic deflection. Vertical raster scan orientation.

Standard Phosphor — GH (P31).

Video Resolution — 552 horizontal by 704 vertical displayed pixels.

POWER REQUIREMENTS

Line Voltage Ranges — 90 V RMS to 132 V RMS. 180 V RMS to 250 V RMS.

Line Frequency — 48 Hz to 440 Hz.

Maximum Power Consumption — 320 W.

ENVIRONMENTAL AND SAFETY

Temperature — Operating: 0°C to +50°C. Nonoperating: −40°C to +75°C.

Humidity — Operating and Nonoperating: Up to 95% relative humidity, up to +50°C.

Altitude, Vibration, Shock, Bench Handling — Meets MIL-T-28800C, Type III, Class 5.

Electromagnetic Compatibility — Meets MIL-T-28800C; MIL-STD-461B; FCC Part 15, Subpart J, Class B; VDE 0871/6.78 Class B; CE-01 Part 4, with exceptions; CE-03 Part 4, Curve 1; CE-03 Part 4, Curve 4, Navy, NB, BB (with exceptions); CS-01 Part 7; CS-02 Part 4 (with exceptions); CS-06 Part 5; RE-01 Part 4 (with exceptions); RE-02 Part 4; RS-01 Part 4; RS-03 Part 7 (limited to 1 GHz).

Safety — Listed UL 1244; CSA Bulletin 556B, September 1973; Tektronix self-certification to comply with IEC 348 recommendations.

PHYSICAL CHARACTERISTICS

Standard Instrument	Benchtop		Rackmount	
Dimensions	**mm**	**in**	**mm**	**in**
Width	448	17.6	483	19.0
Height	238	9.4	222	8.8
Depth	599	23.6	550	21.6
Weights≈	**kg**	**lb**	**kg**	**lb**
Net	20	41.6	27.8	—
Shipping	23.6	58.4	31.4	64.8

ORDERING INFORMATION

11401 500 MHz Programmable Digitizing Oscilloscope **$13,000**
Includes: Operator guide (070-6103-00); operator reference (070-5791-00); operator pocket reference (070-6255-00); power cord (161-0066-00).

11402 1 GHz Programmable Digitizing Oscilloscope **$15,500**
Includes: Same as 11401.

OPTIONS

Option 1C — Cable Feedthroughs. Adds eight rear-to-front feedthroughs. **+$200**

Option 1R — Rackmount. **+$250**
Includes: Hardware, tooling, and instructions for converting bench model to rackmount configuration.

Option 2D — Memory Expansion. Expands total waveform memory to 102,400 points for storage of waveform records. **+$600**

Option 4D — DMA Controller. Increases transfer speed over GPIB. Improves the overall throughput of the scope system. **+$300**

INTERNATIONAL POWER PLUG OPTIONS

Option A1 — Universal Euro 220 V, 50 Hz.
Option A2 — UK 240 V, 50 Hz.
Option A3 — Australian 240 V, 50 Hz.
Option A4 — North American 240 V, 60 Hz.
Option A5 — Switzerland 220 V, 50 Hz.

WARRANTY-PLUS SERVICE PLANS

SEE PAGE 496

Contact your local Sales Engineer for prices.
S0 — On-Site Product Installation and Set-Up.
S1 — 1 Year On-Site Service.

OPTIONAL ACCESSORIES

SERVICE MANUALS

11401/11402 —
(Volume I) Maintenance. Order 070-6100-00*1
(Volume II) Diagnostics and Troubleshooting. Order 070-6101-00*1
(Volume III) Diagrams and Parts List. Order 070-6102-00*1

Cables —
(GPIB) 2 m. Order 012-0991-00 **$150**
(RS-232C) 10 ft. Order 012-0911-00 **$100**
(Centronics) 10 ft for hard copy output. Order 012-0555-00 **$70**

Blank Panel — For filling empty plug-in compartments. Order 016-0829-00 **$95**

Extender Board — Order 067-1297-00.*1

Hard Copy Unit — Tektronix 4644 Dot Matrix Printer **$1,350**

Recommended Cameras — See page 442.
Recommended Probes — See page 215.
Recommended Cart — K217. See page 462. **$495**

**1 To order, contact your local Tektronix Sales Office.*

SOFTWARE SUPPORT

For information on utility and application software, see page 359 or consult your local sales or applications engineer.

TRAINING

Tektronix Instrument Group Customer Training offers operation and application training to help you get full value out of your instrumentation investment. See page 195-196 for information or call (503) 642-8013 (collect).

NEW

GPIB

11000 Series Plug-Ins

Single Trace (11A71)

Dual Trace (11A32, 11A52)

Differential (11A33)

Four Channel (11A34)

Up to 500 MHz Bandwidth (With 11302)

Up to 1 GHz Bandwidth (With 11402)

1 mV/Div Deflection Factor

Calibrated Offset With Fast Overdrive Recovery

Switchable Input Impedances

Wide bandwidth, unsurpassed accuracy, clean response, low noise, and calibrated dc offset with fast overdrive recovery characterize the amplifier plug-in units available for use with the Tektronix 11000 Series oscilloscopes. The 11A71 provides 1 GHz bandwidth in the 11402 digitizing mainframe and up to 500 MHz bandwidth in the 11302 analog mainframe. The matrix on page 199 shows the bandwidth and rise time of each of the amplifier plug-in units in each of the four 11000 Series mainframes.

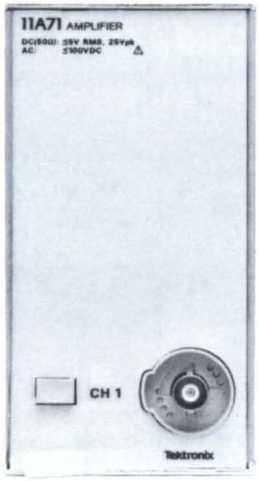
Control of the 11000 Series plug-ins is accomplished through the mainframe controls, either manually or over the IEEE-488 or RS-232C bus. The only control on the amplifier plug-ins is a single pushbutton for each channel. This button is used only to turn the display of the associated channel on and off; it has no effect on the availability of the input signal to the triggering system.

Each of the input channels on all amplifier plug-ins uses the new TEKPROBE™ interface. This interface allows the mainframe to supply power to active probes, to sense the type (and, with some probes, the serial number) of the probe, to supply offset voltage to probes so equipped, to detect activation of the probe's ID pushbutton, and to provide other communication between probe and oscilloscope as appropriate to the type of probe. A serial data line in the TEKPROBE™ interface provides the means for a high level of communication with current and future special purpose probes.

A sixth plug-in under development will expand the triggering capability of 11000 Series scopes far beyond that available in any current oscilloscope. This unit provides the means of triggering on a wide range of intermittent signal anomalies present in any of up to eight signals. This will permit the user to examine circuit conditions which exist only during aberrant circuit behavior unobscured by "normal" signals. This specialized triggering plug-in will also permit timed combinational triggering on up to eight applied signals, preconditioned by plug-in amplifiers within the same mainframe.

11000 SERIES AMPLIFIERS

11A71



11A71

Dc to 1 GHz Bandwidth (in 11402)

Single-Trace

10 mV/Div to 1 V/Div Calibrated Deflection Factor

±10 Div Offset

50 Ω Input Impedance

The single channel 11A71 is the highest bandwidth amplifier currently available for the Tektronix 11000 Series mainframes. It provides 1 GHz bandwidth in the 11402 digitizing mainframe and 500 MHz bandwidth in the 11302 analog mainframe.

Dc offset can be set to 40 steps per division over a range of ±10 div at all sensitivities.

CHARACTERISTICS

Number of Channels — One.

Bandwidth — All Deflection Factors

11301	11302	11401	11402
400 MHz	500 MHz	500 MHz	600 MHz

Deflection Factor — 10 mV/div to 1 V/div in 1-2-5 sequence.

Accuracy —
ΔVolts dc accuracy:
With 11301/11302: ±(0.9% + 0.05 div).
With 11401/11402: ±(0.7% + 0.03 div).

Dc Balance: ±0.2 div.

Input Impedance — 50 Ω ±2%; VSWR <1.45:1, dc to 1 GHz.

Input Coupling Modes — Ac, dc, off.

Ac Low Frequency −3dB Point — 1 kHz.

Offset Range — ±10 divisions, 0.025 division resolution, all deflection factors.

Max Input Voltage — 50 Ω input automatically disconnects when the signal exceeds safe limits. Manual reset.

Typical Noise (RMS) — 0.01 div.

ORDERING INFORMATION

11A71 Single Channel Vertical Amplifier **$2,700**

Includes: Operator manual supplement.

Option 26 — Includes one P6231 probe.*1

***WARRANTY-PLUS* SERVICE PLANS**
SEE PAGE 496

Contact your local Sales Engineer for prices.
S0 — On-Site Product Installation and Set-Up.
S1 — 1 Year On-Site Service.
S2 — 2 Years On-Site Service.
S3 — 3 Years On-Site Service.

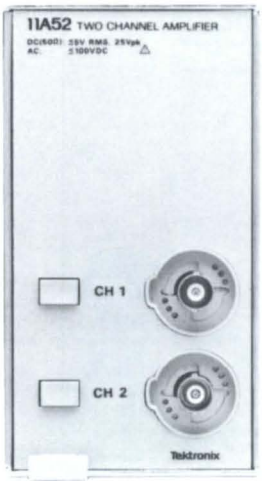
OPTIONAL ACCESSORIES

Service Manual — Order 070-6289-00*1

Recommended Probe — P6231 10X 1.5 GHz active probe. See page 215. **$410**

*1 *To order, contact your local Tektronix Sales Office.*

11A52



11A52

Dc to 600 MHz Bandwidth (in 11402)

Dual Trace

1 mV/Div to 10 V/Div Calibrated Deflection Factors in 1% Increments

50 Ω Input Impedance

High Resolution Calibrated Dc Offset

Fast Overdrive Recovery

The 11A52 is the highest bandwidth dual trace amplifier plug-in currently available for the 11000 Series mainframes. The bandwidth, noise and overdrive recovery are superior to that of the 11A32 and 11A34, but no 1 MΩ input impedance is available as in the 11A32 and 11A34.

The 11A52 provides 600 MHz bandwidth in the 11402 digitizing mainframe and 400 MHz bandwidth in the 11302 analog mainframe. Two built-in four-pole bandwidth limiting filters (100 MHz and 20 MHz) may be activated to reduce unwanted high frequency noise at 24 dB/octave.

Both coarse and fine deflection factor steps are fully calibrated. At 1 mV/div, the high resolution calibrated dc offset has a setability of 25 μV and a range of ±1 V (equivalent to 16 bits), giving an effective screen height of 2000 divisions and permitting absolute dc measurement accuracies to ±0.3%.

CHARACTERISTICS

Number of Channels — Two.

Bandwidth

Volts/div	11301	11302	11401	11402
>10 mV	350 MHz	400 MHz	500 MHz	600 MHz
5 mV to 9.95 mV	350 MHz	400 MHz	450 MHz	500 MHz
2 mV to 4.98 mV	300 MHz	300 MHz	350 MHz	400 MHz
1 mV to 1.99 mV	200 MHz	250 MHz	250 MHz	250 MHz

Calibrated Deflection Factors — Coarse: 1 mV/div to 10 V/div in 1-2-5 steps. Fine: between coarse steps in 1% increments of next more-sensitive coarse step.

Accuracy —
ΔVolts dc accuracy:
With 11301/11302: ±(1.0% + 0.04 div).
With 11401/11402: ±(0.8% + 0.01 div).

Dc Balance, 1 mV/div to 99.5 mV/div: With 11301 and 11302: ±(0.2 mV + 0.13 div). With 11401 and 11402: ±(0.2 mV + 0.10 div).

Offset Accuracy, 1 mV/div to 99.5 mV/div (±1 V range): ±(0.15% + 0.4 mV).

For absolute dc accuracy of single-point measurements using offset, add the Offset Accuracy and Dc Balance terms.

Offset Range —
1 mV/div to 99.5 mV/div: ±1 V; Resolution: 25 μV.
100 mV/div to 0.995 V/div: ±10 V; Resolution: 250 μV.
1 V/div to 10 V/div: ±100 V; Resolution: 2.5 mV.

Overdrive Recovery —
1 mV/div to 99.5 mV/div: To within ±(0.2% + 0.1 div) within 20 ns from ±2 V step.

100 mV/div to 995 mV/div: To within ±(0.2% + 0.1 div) within 20 ns from ±20 V step.

Typical Noise (RMS) —
1 mV/div to 1.99 mV/div: 0.087 div.
2 mV/div to 4.98 mV/div: 0.04 div.
5 mV/div to 9.95 mV/div: 0.02 div. 10 mV/div to 10 V/div: 0.012 div.

Input Impedance — 50 Ω ±0.5%; VSWR: <1.25:1 dc to 500 MHz.

Input Coupling Modes — Ac, dc and off.

Ac Low-Frequency −3 dB point — 1 kHz or less when driven from 50 Ω.

Maximum Input Voltage — Input automatically disconnects when the input signal exceeds safe limits. Manual reset.

ORDERING INFORMATION

11A52 Two Channel Vertical Amplifier **$2,405**
Includes: Operator manual supplement.

OPTION

Option 25 — Includes two P6231 probes.*1
Includes: User manual 070-6114-00.

***WARRANTY-PLUS* SERVICE PLANS**
SEE PAGE 496

Contact your local Sales Engineer for prices.
S0 — On-Site Product Installation and Set-Up.
S1 — 1 Year On-Site Service.
S2 — 2 Years On-Site Service.
S3 — 3 Years On-Site Service.

OPTIONAL ACCESSORY

Service Manual — Order 070-6117-00*1

*1 *To order, contact your local Tektronix Sales Office.*

NEW

GPIB

11A32/11A34

Dc to 350 MHz Bandwidth (11A32 in 11402 Mainframe)

Dual Trace (11A32) or Four Trace (11A34)

1 mV/Div to 10 V/Div Calibrated Deflection Factors in 1% Increments

Switchable 50 Ω or 1 MΩ Input Impedance

High Resolution Calibrated Dc Offset

Fast Overdrive Recovery

The 11A32 and 11A34 amplifier plug-in units are virtually identical to one another except for the number of channels. The 11A32 is a dual-trace unit, and the 11A34 is a four-trace unit. The bandwidth of the 11A32 is slightly higher than that of the 11A34 in each of the four 11000 Series mainframes.

Two built-in four-pole bandwidth limit filters (100 MHz and 20 MHz) may be activated to reduce unwanted high frequency noise at 24 dB/octave for each channel.

Both coarse and fine deflection factors steps are fully calibrated. At 1 mV/div, the high resolution calibrated dc offset has a setability of 25 μV and a range of ±1 V (equivalent to 16 bits), giving an effective screen height of 2000 div and permitting absolute dc measurement accuracies to ±0.4%.

CHARACTERISTICS

Number of Channels — 11A32: Two; 11A34: Four.

Bandwidth — 11A32

Volts/div	11301	11302	11401	11402
>10 mV	300 MHz	350 MHz	350 MHz	400 MHz
5 mV to 9.95 mV	300 MHz	300 MHz	350 MHz	400 MHz
2 mV to 4.98 mV	250 MHz	250 MHz	300 MHz	300 MHz
1 mV to 1.99 mV	200 MHz	200 MHz	200 MHz	250 MHz

Bandwidth — 11A34

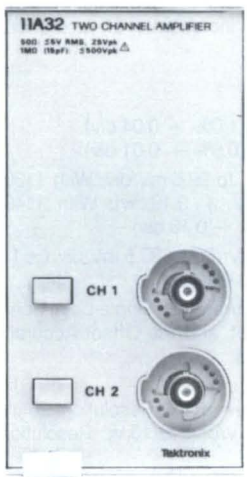
Volts/div	11301	11302	11401	11402
>10 mV	250 MHz	250 MHz	300 MHz	300 MHz
5 mV to 9.95 mV	250 MHz	250 MHz	250 MHz	300 MHz
2 mV to 4.98 mV	200 MHz	250 MHz	250 MHz	250 MHz
1 mV to 1.99 mV	200 MHz	200 MHz	200 MHz	200 MHz

Calibrated Deflection Factors — Coarse steps: 1 mV/div to 10 V/div in 1-2-5 sequence. Fine steps: Between coarse steps in 1% increments of next more-sensitive coarse step.

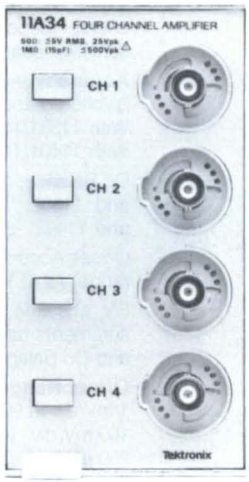
Accuracy —
ΔVolts dc accuracy: With 11301/11302: ±(1.0% + 0.04 div). With 11401/11402: ±(0.9% + 0.012 div).

Dc Balance, 1 mV/div to 99.5 mV/div: With 11301 and 11302: ±(1.0 mV + 0.13 div). With 11401 and 11402: ±(1.0 mV + 0.10 div).

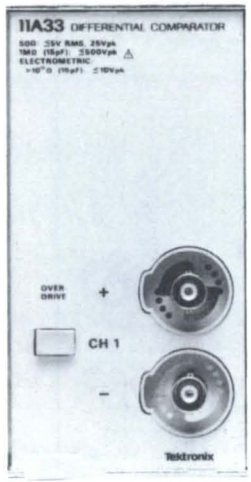
11A32



11A34



11A33



Offset Accuracy, 1 mV/div to 99.5 mV/div (±1 V range): ±(0.2% + 0.5 mV).

For absolute dc accuracy of single point measurements using offset, add the Offset Accuracy and Dc Balance terms.

Offset Range —
1 mV/div to 99.5 mV/div: ±1 V; Resolution: 25 μV.
100 mV/div to 0.995 V/div: ±10 V; Resolution: 250 μV.
1 V/div to 10 V/div: ±100 V; Resolution: 2.5 mV.

Overdrive Recovery —
1 mV/div to 99.5 mV/div: To within ±(0.3% + 0.1 div) within 50 ns from ±2 V step.
100 mV/div to 995 mV/div: To within ±1% within 50 ns from ±20 V step.
1 V/div to 10 V/div: To within ±1% within 50 ns from ±200 V step.

Typical Noise (RMS) —
1 mV/div to 1.99 mV/div: 0.12 div.
2 mV/div to 4.98 mV/div: 0.06 div.
4 mV/div to 9.95 mV/div: 0.025 div.
10 mV/div to 10 V/div: 0.014 div.

Input Impedance — Switchable 1 MΩ in parallel with 15 pF or 50 Ω ±0.5%.

Input Coupling Modes — Ac, dc and off.

Ac Coupling Low Frequency −3 dB Point — 10 Hz or less (1 MΩ input impedance).

Maximum Input Voltage — 1 MΩ: 500 V (dc + peak ac). 50 Ω: Input automatically disconnects when the input signal exceeds safe limits. Manual reset.

ORDERING INFORMATION

11A32 Two Channel Vertical Amplifier **$2,025**
Includes: Operator manual supplement.

11A34 Four Channel Vertical Amplifier **$3,525**
Includes: Operator manual supplement.

OPTIONS

Option 22 — Includes two P6134 probes.*1

Option 23 — Includes four P6134 probes.*1

OPTIONAL ACCESSORY

Service Manual —
(11A32) Order 070-6115-00*1
(11A34) Order 070-6116-00*1

*1 *To order, contact your local Tektronix Sales Office.*

11A33

Differential Comparator

Dc to 150 MHz Bandwidth

1 mV/Div to 10 V/Div Calibrated Deflection Factors in 1% Increments

Very High Resolution Calibrated Dc Offset

16000 Division Effective Screen Height

High Common Mode Rejection

Fast Overdrive Recovery From Large Input Signals

Selectable 50 Ω, 1 MΩ, or 1 GΩ Input Impedance

The 11A33 Differential Comparator plug-in is a single channel differential amplifier with high common-mode rejection ratio and fast overdrive recovery from very large signals. As a differential amplifier, common mode input voltage range is ±8 V at 1 mV/div. As a comparator, the built-in comparison voltage (Vc) is used to measure the fine structure of very large signals, such as the settling time of a digital-to-analog converter, with unprecedented accuracy and resolution.

Maximum bandwidth in the 11301, 11302, 11401, and 11402 mainframes is 150 MHz. Two built-in four-pole bandwidth limit filters (100 MHz and 20 MHz) may be activated to reduce unwanted high frequency noise at 24 dB/octave for each channel.

Both coarse and fine deflection factors are fully calibrated. At 1 mV/div, the high resolution comparison voltage has a setability of 25 μV throughout its ±8 V range (equivalent to 19 bits), giving an effective screen height of 16,000 div and permitting absolute dc measurement accuracies of ±0.2%.

CHARACTERISTICS

Number of Channels — One.

Bandwidth — Dc to 150 MHz in 11301, 11302, 11401, and 11402 mainframes.

Calibrated Deflection Factors — Coarse steps: 1 mV/div to 5 V/div in 1-2-5 sequence. Fine steps: Between coarse steps in 1% increments of next more-sensitive coarse step.

Accuracy — ΔVolts dc accuracy: With 11301/11302: ±(1.4% + 0.04 div). With 11401/11402: ±(1.2% + 0.01 div).

Dc Balance, 1 mV/div to 99.5 mV/div: With 11301 and 11302: ±(0.5 mV + 0.13 div). With 11401 and 11402: ±(0.5 mV + 0.10 div).

Vc Accuracy, 1 mV/div to 99.5 mV/div (8 V range): ±0.15% + 0.6 mV).

Vc Range —
1 mV/div to 99.5 mV/div: ±8 V; Resolution: 25 μV. 100 mV/div to 0.995 V/div: ±80 V; Resolution: 250 μV. 1 V/div to 10 V/div: ±500 V; Resolution: 2.5 mV.

Overdrive Recovery —
1 mV/div to 99.5 mV/div: To within ±0.2% within 30 ns from ±8 V step.

Typical Noise (RMS) —
1 mV/div to 1.99 mV/div: 0.24 div.
2 mV/div to 4.98 mV/div: 0.12 div.
5 mV/div to 9.95 mV/div: 0.05 div.
10 mV/div to 19.9 V/div: 0.025 div.
20 mVdiv to 10 V/div: 0.015 div.

Common Mode Rejection Ratio —
1 mV/div to 99.5 mV/div: 10,000:1 dc to 1 MHz; 1000:1 at 40 MHz.
100 mV/div to 0.995 V/div: 1000:1 dc to 1 MHz; 100:1 at 40 MHz.
1 V/div to 10 V/div: 500:1 dc to 1 MHz; 100:1 at 40 MHz.

Input Impedance — 50 Ω, 1 MΩ in parallel with 15 pF, or 1 G Ω in parallel with 15 pF from 1 mV/div to 99.5 mV/div.

Input Coupling Modes — Ac, dc, and off (each input).

Ac Coupling Low Frequency −3 dB Point — 10 Hz or less (1 MΩ input impedance).

Max Input Voltage — 1 MΩ mode: 1 mV/div to 99.5 mV/div: 40 V (dc + peak ac); 100 mV/div to 0.995 V/div: 400 V (dc + peak ac); 1 V/div to 10 V/div: 500 V (dc + peak ac). (At 1 mV/div to 99.5 mV/div, derate max input voltage at 20 dB/decade above 10 MHz; at 100 mV/div to 10 V/div, derate max input voltage at 20 dB/decade above 1 MHz.) 50 Ω: Input automatically disconnects when the input signal exceeds safe limits. Manual reset.

ORDERING INFORMATION

11A33 Differential Comparator **$3,000**
Includes: Operator manual supplement.

OPTION

Option 24 — Includes a P6135 probe pair.*1

***WARRANTY-PLUS* SERVICE PLANS**
SEE PAGE 496

Contact your local Sales Engineer for prices.
S0 — On-Site Product Installation and Set-Up.
S1 — 1 Year On-Site Service.
S2 — 2 Years On-Site Service.
S3 — 3 Years On-Site Service.

OPTIONAL ACCESSORY

Service Manual — Order 070-6118-00*1

*1 *To order, contact your local Tektronix Sales Office.*

P6134 10X, 10 MΩ Passive Probe

P6135 10X, Matched Pair of 1 MΩ Differential Passive Probes

P6231 10X, 450 Ω Active Probe

Three *NEW* high performance probes round out the capabilities of the 11000 Series oscilloscopes and plug-ins.

The P6134 is a 10X passive probe which is intended primarily for use with the 11A32 and 11A34, with their 1 MΩ input impedances. The P6135 is actually a matched pair of probes clipped together at the scope input end. The P6135 has attenuation adjustments to match the attenuation of the two halves to provide high common mode rejection compatible with the 11A33 Differential Comparator plug-in.

The P6231 is a 1.5 GHz, low-impedance, subminiature, 10X active probe intended primarily for use with high-speed logic circuits. The P6231 provides a "nulling voltage," adjustable via the mainframe controls over a ±5 volt range. This nulling voltage reduces the dc-loading effects of the probe when it is used to measure signals whose mid-voltage is other than zero volts, or in circuits where the termination resistance is returned to other than ground level.

The 50 Ω termination required by the P6231 at the plug-in input is automatically accommodated by the 11000 Series mainframe. When the mainframe senses that a P6231 has been connected to an input connector of an 11A32, 11A33, or 11A34 Amplifier plug-in unit, it automatically switches the plug-in input impedance to 50 Ω. The 11A52 and 11A71 Amplifier plug-ins have fixed 50 Ω input impedances.

Each of the four probes has an "ID" button which, when pressed, will cause any one or more of several actions to be taken by the mainframe—autoset, recall the next in a series of stored setups, invoke the automatic measurement function, or issue an SRQ. These actions are selectable via the mainframe UTILITY major menu.

All of the new 11000 Series probes make use of the new probe interface of the 11000 Series plug-ins. Each of the probes communicates its attenuation ratio to the mainframe. Power for the P6231 active probe comes through that interface, eliminating the need for a special power cable or power source. The bias voltage for the P6231 is applied through that interface. The P6231 also communicates its type and serial number through the serial data communication lines in the interface connector. Sensing of the pressing of the ID buttons on the probes is done through the interface.

All of the probes are compatible with the subminiature accessories shown on page 487, including the KLIPKIT.

All of the other voltage probes described in this catalog which can be compensated to 1 MΩ and 15 pF or to 50 Ω are also compatible with the 11000 Series plug-in units, including the operation of the ID button on probes so equipped. See pages 463–490 for full descriptions of all available Tektronix signal probes and other accessories.

7000 SERIES INSTRUMENTS

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The 7000 Series . . .

Superior Performance

The 7000 Series plug-in laboratory instruments embody more state-of-the-art performance features than any other oscilloscope-based measurement system. The 7104 and the R7103 Oscilloscopes feature a 1 GHz bandwidth combined with the fastest rise time and highest photographic writing speed available today.

Maximum Flexibility

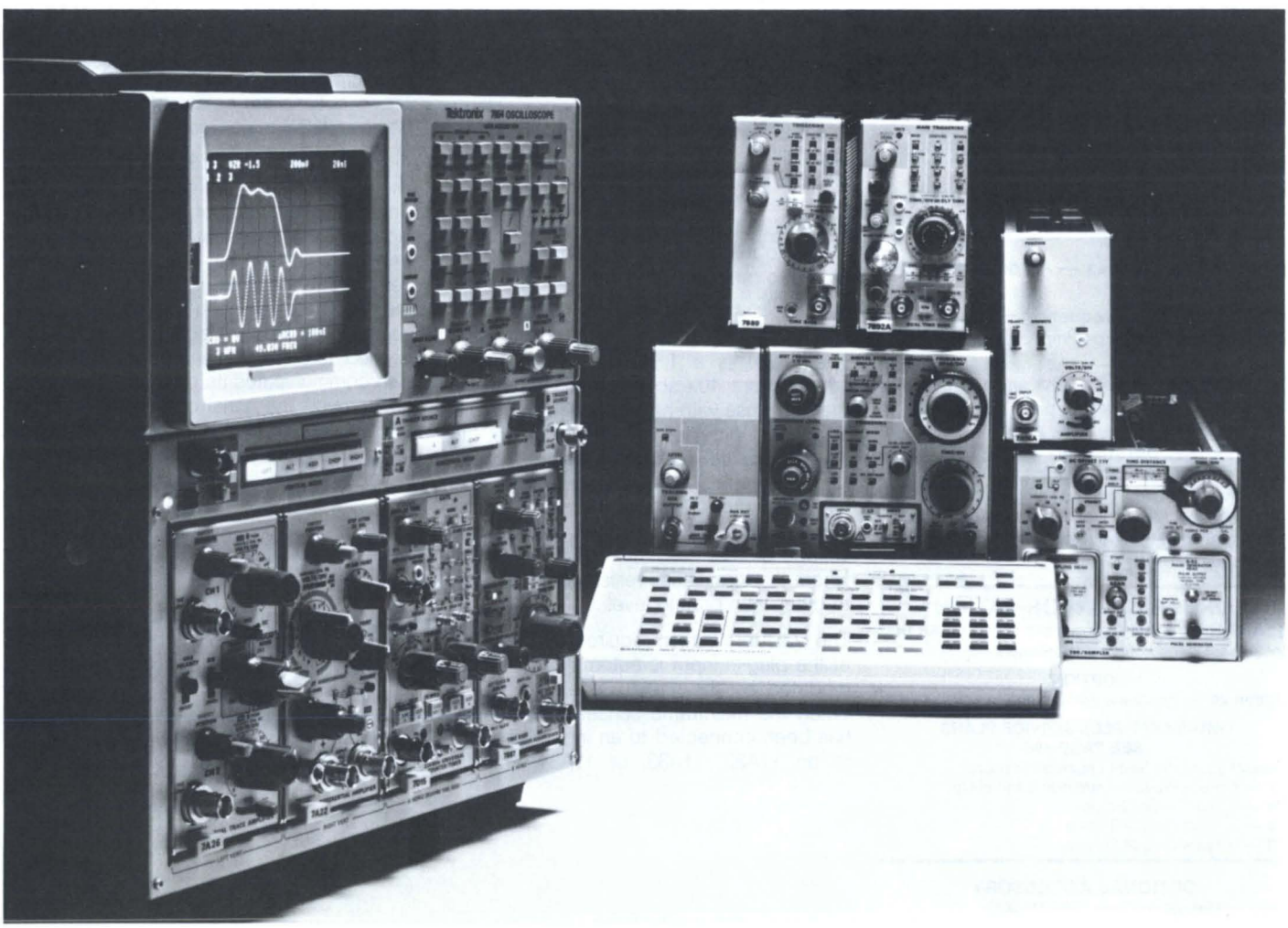
A choice of over 40 plug-ins and 19 mainframes gives you the flexibility to configure the scope package to meet your individual needs. When your needs change, your present package can be reconfigured with a minimum of additional equipment and effort.

Expandability

This assures you that the instrument you buy today will adapt to changing measurement needs, and that it won't become obsolete soon after you buy it. Tektronix' most recent developments in plug-in scope capability are: the Waveform Processing Oscilloscope, the 1 GHz High Writing Rate Oscilloscope, the Programmable Digitizer Plug-In Unit, and the four channel Logic Triggered Vertical Amplifier.

Digital Storage Capability

The 7854 provides digital storage, pre- and post-trigger viewing, equivalent time sampling, and waveform processing. The IEEE Standard 488 interface is standard.



The 7000 Series is a unique family of instrumentation components, a continuation of the Tektronix commitment to bringing the ultimate in measurement technology to the laboratory.

400 MHz Dual Beam

A dual-beam oscilloscope is essentially two oscilloscopes in one. A dual-beam oscilloscope is required in applications where two transient events must be compared simultaneously. These application areas commonly include the observation of simultaneous stimulation and reaction in such fields as medicine, biology, chemistry, and mechanical engineering.

Digital Measurement Plug-Ins

The 7000 Series digital plug-ins include: A universal counter/timer and digital multimeter with temperature measurement capability. Together with a 7000 Series mainframe, these give you the advantage of seeing what you're measuring, plus accuracy of digital measurements.

Sampling

The 7000 Series sampling plug-ins provide some unique measurement capabilities not available in other sampling oscilloscopes. You get: a low-cost storage CRT for slow scans, a random mode that lets you see leading edges without pretrigger or bandwidth-limiting delay line, a wide choice of sampling heads at minimal cost, and the convenience of sampling and conventional display at the same time on the CRT.

CRT Storage

Seven 7000 Series mainframes provide some combination of bistable and/or variable persistence storage. The 7934 Storage Oscilloscope can capture single-shot transient events of <700 ps rise time. Variable persistence is valuable for effective viewing of slowly changing events or signals.

Digital Storage

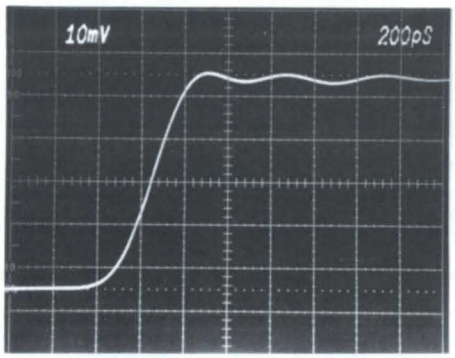
The 7854 Waveform Processing Oscilloscope stores repetitive signals up to 400 MHz with conventional plug-ins, up to 14 GHz with the 7S12 TDR/Sampling plug-in. The 7854 provides digital storage with waveform processing, waveform measurements at the touch of a button, keystroke programming, and a GPIB interface. The 7D20 Programmable Digitizer plug-in provides dual-trace digital storage of signals up to 70 MHz in any 7000 Series mainframe, except the 7104 and R7103.

Spectrum Analysis

Unexcelled plug-in performance from 20 Hz to 2.5 GHz is provided by the 7L5, 7L12 and 7L14 Spectrum Analyzer plug-ins. Stable, sensitive and spurious-free, these analyzers work in any 7000 Series mainframe.

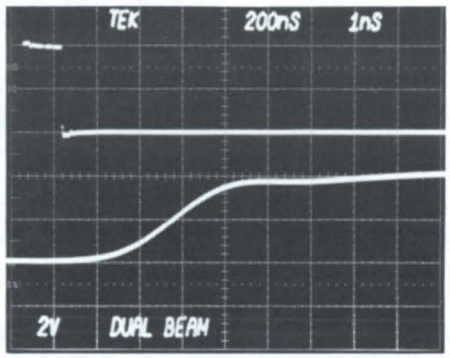
Refer to the Spectrum Analyzer section beginning on page 155 for more information.

Nonstorage 1 GHz 7104/R7103



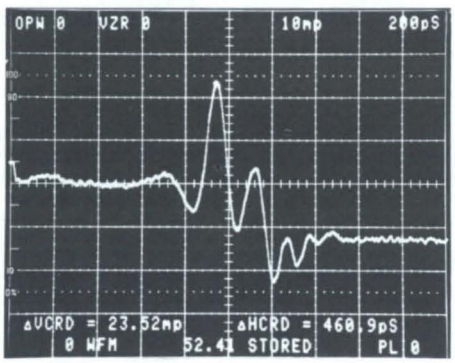
This 300 ps rise time is displayed on a 7104 Oscilloscope. Readout indicates 10 mV/div vertical sensitivity and 200 ps/div sweep speed. The 7104 and R7103 provide ultra bright displays which permit the viewing of a single-shot transient event up to the maximum bandwidth of the oscilloscope (1 GHz) in ambient light.

Dual Beam 7844/R7844



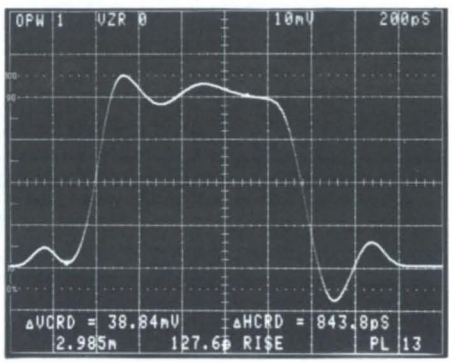
The 400 MHz 7844 Dual-Beam Oscilloscope displays one input signal at two sweep speeds. The 7844 provides full vertical and horizontal crossover switching and full overlap of both vertical amplifiers on its 8 x 10 cm display.

Sampling/Time Domain Reflectometry



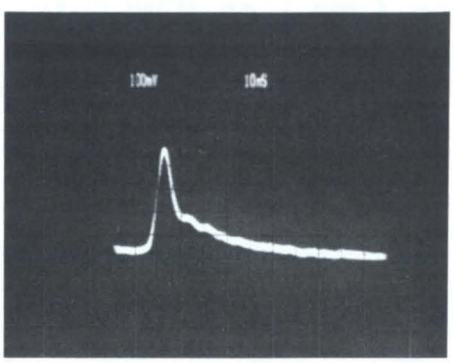
7854 Waveform Processing Oscilloscope with 7S12 TDR/Sampling plug-in provides time domain reflectometry and digital processing of sampling. In this photo, the 7854/7S12 measures a discontinuity in millirho/division and calculates an impedance of 52.41 Ω at the discontinuity.

Digital Storage 7854



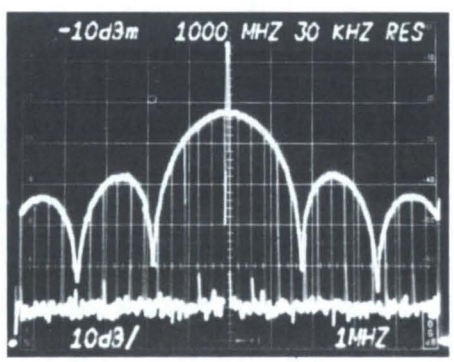
Here, the 7854 measures the 127.6 ps rise time of a 38.83 mV pulse displayed at a sweep speed of 200 ps/div.

Analog Storage 500 MHz 7934



Transient Capture—A 7A29 plug-in and the 7934's Fast Variable Persistence storage mode in reduced scan capture a single-shot electrostatic discharge.

Spectrum Analysis



Max Hold feature of the 7L14 Spectrum Analyzer plug-in in a 7000 Series mainframe produces perfectly proportioned Sin x/x spectrum of low rep rate burst of 2.66 MHz, 6.67 μs in width.

CRT Storage, see page 233.
Digitizers, see page 324.

7000 SERIES VERTICAL SYSTEM SPECIFICATIONS

Plug-In		7A13	7A15A	7A16A	7A18A	7A19	7A22	7A24	7A26	7A29	7A42	7F10
Features		Differential dc offset, high-freq CMRR amplifier	Low cost conventional input amplifier	Wide bandwith conventional input amplifier	Dual-channel amplifier	Wide band-width 50Ω input amplifier	Dc-coupled high-gain differential amplifier	Dual-channel 50 Ω amplifier	Dual-channel amplifier	Widest band-width single channel	Four-channel logic triggered	Optical/Electrical converter with built-in amplifier
Minimum Deflection Factor		1 mV/div	5 mV/div (0.5 mV/div)*2	5 mV/div	5 mV/div	10 mV/div	10 μV/div	5 mV/div	5 mV/div	10 mV/div	20 mV/div	2 μW/div
Accuracy*1 Without Probe		1.5%	2%	2%	2%	3%	2%	2%	2%	2%	3%	—
7104 **R7103** 0 to 35°C	BW T_r	105 MHz 3.4 ns	80 MHz 4.4 ns	225 MHz 1.6 ns	100 MHz 4.7 ns	600 MHz 0.6 ns	1 MHz ±10% 350 ns ±9%	400 MHz 0.9 ns	200 MHz 1.8 ns	1000 MHz 0.35 ns	350 MHz 1.0 ns	750 MHz
7904A **R7903** **7934** 0 to 30°C	BW T_r SIG OUT	105 MHz 3.4 ns 100 MHz	80 MHz 4.4 ns 70 MHz	225 MHz 1.6 ns 140 MHz	100 MHz 4.7 ns 90 MHz	500 MHz 0.8 ns 300 MHz	1 MHz ±10% 350 ns ±9% 1 MHz ±9%	350 MHz 1.0 ns 140 MHz	200 MHz 1.8 ns 140 MHz	500 MHz 0.7 ns*7 300 MHz	300 MHz 1.2 ns NA	400 MHz 300 MHz
7912AD*6 0 to 30°C	BW T_r	105 MHz 3.4 ns	80 MHz 4.4 ns	225 MHz 1.6 ns	100 MHz 4.7 ns	500 MHz 0.8 ns	1 MHz ±10% 350 ns ±9%	350 MHz 1.0 ns	200 MHz 1.8 ns	500 MHz 0.7 ns*7	300 MHz 1.2 ns	400 MHz
7844/R 0 to 35°C	BW T_r	100 MHz 3.5 ns	80 MHz 4.4 ns	200 MHz 1.8 ns	100 MHz 4.7 ns	400 MHz*3 0.9 ns	1 MHz ±10% 350 ns ±9%	300 MHz 1.2 ns	180 MHz 1.9 ns	400 MHz 0.9 ns	275 MHz 1.3 ns	300 MHz
7854*5 0 to 35°C	BW T_r	100 MHz 3.5 ns	80 MHz 4.4 ns	200 MHz 1.8 ns	100 MHz 4.7 ns	400 MHz*3 0.9 ns	1 MHz ±10% 350 ns ±9%	300 MHz 1.2 ns	180 MHz 1.9 ns	400 MHz 0.9 ns	275 MHz 1.3 ns	300 MHz
7704A 0 to 30°C (Opt 09)	BW T_r SIG OUT	100 MHz 3.6 ns 60 MHz	75 MHz 4.7 ns 55 MHz	170 MHz 2.1 ns 70 MHz	90 MHz 4.7 ns 55 MHz	250 MHz*4 1.5 ns 80 MHz	1 MHz ±10% 350 ns ±9% 1 MHz ±10%	200 MHz 1.8 ns 70 MHz	170 MHz 2.1 ns 70 MHz	250 MHz 1.5 ns*7 80 MHz	180 MHz 1.9 ns NA	250 MHz 80 MHz
7704A 0 to 50°C	BW T_r SIG OUT	95 MHz 3.8 ns 60 MHz	75 MHz 4.7 ns 55 MHz	160 MHz 2.2 ns 70 MHz	75 MHz 4.7 ns 55 MHz	200 MHz 1.8 ns 80 MHz	1 MHz ±10% 350 ns ±9% 1 MHz ±10%	200 MHz 1.8 ns 70 MHz	150 MHz 2.4 ns 70 MHz	200 MHz 1.8 ns*7 80 MHz	175 MHz 2.0 ns NA	200 MHz 80 MHz
7603/R 0 to 50°C	BW T_r SIG OUT	75 MHz 4.8 ns 55 MHz	65 MHz 5.4 ns 50 MHz	100 MHz 3.5 ns 60 MHz	75 MHz 4.7 ns 50 MHz	100 MHz 3.5 ns 65 MHz	1 MHz ±10% 350 ns ±9% 1 MHz ±10%	100 MHz 3.5 ns 60 MHz	100 MHz 3.5 ns 60 MHz	100 MHz 3.5 ns 65 MHz	100 MHz 3.5 ns NA	100 MHz 65 MHz
7633/R **7623A/R** **7613/R** 0 to 50°C	BW T_r SIG OUT	75 MHz 4.8 ns 55 MHz	50 MHz 5.4 ns 50 MHz	100 MHz 3.5 ns 60 MHz	70 MHz 4.7 ns 50 MHz	100 MHz 3.5 ns 65 MHz	1 MHz ±10% 350 ns ±9% 1 MHz ±10%	100 MHz 3.5 ns 60 MHz	100 MHz 3.5 ns 60 MHz	100 MHz 3.5 ns 65 MHz	100 MHz 3.5 ns NA	100 MHz 65 MHz
7612D*6 0 to 40°C	BW T_r (calculated)	65 MHz 6.0 ns	60 MHz 6.7 ns	80 MHz 5.0 ns	65 MHz 6.0 ns	80 MHz 5.0 ns	1 MHz ±10% 350 ns ±9%	80 MHz 5.0 ns	80 MHz 5.0 ns	80 MHz 5.0 ns	80 MHz 5.0 ns	80 MHz
Page		244	241	241	242	240	245	242	242	240	243	240
Price		$3,400	$730	$1,305	$1,465	$2,895	$1,790	$2,655	$2,350	$3,325	$6,200	$6,495

*1 *Accuracy percentages apply to all deflection factors. Plug-in gain must be set at the deflection factor designated on each plug-in. When a probe is used, the gain must be set with the calibration signal applied to the probe tip. The calibration signal is supplied by an external calibrator whose accuracy is within 0.25%.*

*2 *Obtained with 10X gain at reduced bandwidth of 10 MHz.*

*3 *Bandwidth is 325 MHz at 10 mV/div.*

*4 *Bandwidth is 200 MHz at 10 mV/div.*

*5 *Bandwidth with equivalent time sampling and time display only.*

*6 *Fully programmable mainframe. 7A16P Programmable Amplifier recommended. See pages 346.*

*7 *R7903 with 7A29 T_r is 0.8 ns.*

7000 SERIES MAINFRAME/TIME BASE/CAMERA SELECTION GUIDE

	Time Bases								Cameras				
Plug-In	**7B50A**	**7B53A**	**7B80**	**7B85**	**7B92A**	**7B10**	**7B15**	**C-51**	**C-53**	**C-59**	**C-5C**	**C-7**	**C-4 Opt 02**
Features	Single Time Base	Dual Time Base with Mixed Sweep	Single Time Base	Single Time Base with Delaying Δ Delay	Dual Time Base with Display Switching	Single Time Base	Single Time Base with Delaying Δ Delay	High Writing Rate	General Purpose	General Purpose	Low Cost	Low Cost	Low Cost
7104/R7103					✓	✓	✓		✓		✓	✓	✓
7904A/R7903			✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
7934			✓	✓	✓	✓	✓		✓		✓	✓	✓
7844/R7844			✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
7854		Opt 05*1	✓	✓*1	✓*1	✓	✓*1	✓	✓		✓	✓	✓
7704A			✓	✓	✓	✓	✓	✓	✓				✓
7603/R7603	✓	✓								✓	✓	✓ Opt 01	✓ Opt 01
7633/R7633 **7623A/R7623A**	✓	✓							✓		✓	✓	✓
7613/R7613	✓	✓							✓		✓	✓	✓
Page	251	251	246	246	248	249	249	451	451	453	449	447	445
Prices begin at	$1,130	$1,860	$1,660	$1,940	$3,745	$2,555	$2,900	$2,360	$1,940	$1,335	$495	$595	$370

*1 *Single sweep mode operable for real time only.*

7000 SERIES OSCILLOSCOPE SYSTEMS/PROBE SELECTION GUIDE*1

This selection guide lists the most popular combinations for optimum performance, but is not all inclusive. Current probes and other compatible probes are listed in the Probes Section on page 464.

		Passive Voltage 1 MΩ Input Compatible								Passive Voltage 50 Ω Input Compatible		Active Probes 50 Ω/1 MΩ Input Compatible			
Probe		P6101A 1 m	P6105A 2 m	P6130 1.5 m P6106A 1 m	P6131 1.3 m	P6055*2 3.5 ft	P6062B*5 6 ft	P6009 9 ft	P6015 10 ft	P6056 1.5 m	P6057 6 ft	P6201*4 6 ft	P6202A*4 2 m	P6230*4 1.5 m	P6046 6 ft
Features		Miniature	Miniature	Miniature Fast Rise Time	Sub-miniature Fast Rise Time	Adj Attenuation Differential	Selectable Attenuation 1X:10X	1.5 kV Rise Time	40 kV Peak	Fastest 10X Passive Probe Low C	Fastest 100X Passive Probe Low C	Low Capactive Loading Ac Coupling Dc Offset	10 MΩ Input Impedance Dc Offset	ECL Bias/ Offset	Differential High CMRR
Attenuation		1X	10X	10X	10X	10X	Selectable	100X	1000X	10X	100X	Selectable	Selectable	10X	Selectable
7100 Family	7A19	NC	NC	NC	NC	NC	NC	NC	NC	500 MHz	480 MHz	430 MHz	300 MHz	480 MHz	100 MHz
	7A24	NC	NC	NC	NC	NC	NC	NC	NC	350 MHz	350 MHz	310 MHz	300 MHz	350 MHz	100 MHz
	7A26	34 MHz	100 MHz	175 MHz	NC			125 MHz	75 MHz			195 MHz	185 MHz	200 MHz	90 MHz
	7A29	NC	NC	NC	NC	NC	NC	NC	NC	950 MHz	800 MHz	660 MHz	450 MHz	800 MHz	100 MHz
	7A42	34 MHz	100 MHz	250 MHz	300 MHz			130 MHz	80 MHz	350 MHz	350 MHz	300 MHz	280 MHz	350 MHz	100 MHz
7900 Family	7A13	34 MHz	75 MHz	105 MHz	NC	65 MHz		85 MHz	65 MHz		105 MHz	105 MHz	105 MHz	105 MHz	70 MHz
	7A15A	34 MHz	75 MHz	75 MHz	NC		75 MHz	70 MHz	60 MHz		80 MHz	80 MHz	75 MHz	80 MHz	60 MHz
	7A16A	34 MHz		200 MHz	NC			130 MHz	80 MHz		205 MHz	215 MHz	205 MHz	205 MHz	90 MHz
	7A18A	34 MHz	75 MHz	75 MHz	NC		75 MHz	70 MHz	60 MHz		75 MHz	75 MHz	75 MHz	75 MHz	60 MHz
	7A19	NC	NC	NC	NC	NC	NC	NC	NC	500 MHz	480 MHz	430 MHz	300 MHz	480 MHz	95 MHz
	7A22	1 MHz	NC	NC	NC	1 MHz	1 MHz								
	7A24	NC	NC	NC	NC	NC	NC	NC	NC	350 MHz	350 MHz	310 MHz	290 MHz	350 MHz	90 MHz
	7A26	34 MHz	100 MHz	175 MHz	NC			125 MHz	75 MHz			185 MHz	185 MHz	290 MHz	85 MHz
	7A42	34 MHz	100 MHz	250 MHz	300 MHz			130 MHz	80 MHz	300 MHz	300 MHz	300 MHz	300 MHz	300 MHz	90 MHz
7800 Family	7A13	34 MHz	100 MHz	100 MHz	NC	65 MHz		85 MHz	60 MHz			100 MHz	100 MHz	100 MHz	70 MHz
	7A15A	34 MHz	75 MHz	75 MHz	NC		75 MHz	70 MHz	55 MHz			80 MHz	80 MHz	80 MHz	60 MHz
	7A16A	34 MHz	100 MHz	160 MHz	NC			110 MHz	75 MHz			165 MHz	170 MHz	190 MHz	85 MHz
	7A18A	34 MHz	85 MHz	85 MHz	NC		85 MHz	80 MHz	60 MHz			90 MHz	75 MHz	90 MHz	65 MHz
	7A19	NC	NC	NC	NC	NC	NC	NC	NC	400 MHz	400 MHz	360 MHz	320 MHz	400 MHz	95 MHz
	7A22	1 MHz	1 MHz	NC	NC	1 MHz	1 MHz	1 MHz	1 MHz						
	7A24	NC	NC	NC	NC	NC	NC	NC	NC	300 MHz	300 MHz	280 MHz	270 MHz	300 MHz	90 MHz
	7A26	34 MHz	100 MHz	145 MHz	NC			105 MHz	75 MHz			155 MHz	150 MHz	180 MHz	85 MHz
	7A42	34 MHz	100 MHz	200 MHz	275 MHz			110 MHz	75 MHz	275 MHz	275 MHz	260 MHz	260 MHz	275 MHz	90 MHz
7704A Family	7A13	34 MHz	70 MHz	95 MHz	NC	65 MHz		85 MHz	65 MHz			100 MHz	100 MHz	100 MHz	70 MHz
	7A15A	34 MHz	70 MHz	70 MHz	NC		70 MHz	65 MHz	55 MHz			75 MHz	70 MHz	75 MHz	55 MHz
	7A16A	34 MHz	100 MHz	145 MHz	NC			115 MHz	75 MHz			160 MHz	150 MHz	160 MHz	80 MHz
	7A18A	34 MHz	75 MHz	75 MHz	NC		75 MHz	70 MHz	60 MHz			75 MHz	75 MHz	75 MHz	60 MHz
	7A19*3	NC	NC	NC	NC	NC	NC	NC	NC	250 MHz	250 MHz	220 MHz	215 MHz	250 MHz	85 MHz
	7A22	1 MHz	1 MHz	NC	NC	1 MHz	1 MHz								
	7A24	NC	NC	NC	NC		NC	NC	NC	200 MHz	200 MHz	185 MHz	180 MHz	200 MHz	80 MHz
	7A26	34 MHz	100 MHz	140 MHz	NC			105 MHz	75 MHz			160 MHz	140 MHz	165 MHz	80 MHz
	7A42	34 MHz	100 MHz	150 MHz	180 MHz			115 MHz	75 MHz	180 MHz	180 MHz	170 MHz	160 MHz	180 MHz	80 MHz
7600 Family	7A13	34 MHz	70 MHz	75 MHz	NC	55 MHz	70 MHz	60 MHz	55 MHz			75 MHz	75 MHz	75 MHz	55 MHz
	7A15A	34 MHz	60 MHz	60 MHz	NC		60 MHz	55 MHz	50 MHz			65 MHz	65 MHz	65 MHz	50 MHz
	7A16A	34 MHz	95 MHz	95 MHz	NC		95 MHz	85 MHz	65 MHz			100 MHz	100 MHz	100 MHz	70 MHz
	7A18A	34 MHz	70 MHz	70 MHz	NC		70 MHz	65 MHz	55 MHz			75 MHz	75 MHz	75 MHz	55 MHz
	7A22	1 MHz	1 MHz	NC	NC	1 MHz	1 MHz								
	7A26	34 MHz	95 MHz	95 MHz	NC		95 MHz	85 MHz	65 MHz			100 MHz	100 MHz	100 MHz	70 MHz
	7A42	34 MHz	95 MHz	95 MHz	100 MHz		95 MHz	85 MHz	65 MHz			100 MHz	100 MHz	100 MHz	70 MHz

*1 *The values in the above table represent the approximate useful frequency response for the measurement systems at the probe tip.*

*2 *Matched pair recommended.*

*3 *Option 09 Mainframe.*

*4 *Requires 1101/1101A Power Supply or other external source of power when used with 7854, 7603, 7633, 7623, or 7613.*

*5 *Bandwidths given for 10X switch position.*

NC = Not compatible

If there is no bandwidth specified, the probe/plug-in combination is compatible but not recommended.

7000 SERIES MAINFRAMES AND PLUG-INS DIMENSIONS AND WEIGHTS

Dimensions		7612D	7912AD	7854*1	7104	R7103	7904A	R7903	7934	7844	R7844	7704A	7603	R7603	7633, 7623A, 7613	R7633, R7623A, R7613	Plug-Ins Single	Plug-Ins Double
Width	mm	483	483	305	305	483	305	483	305	305	483	483	221	305	221	483	7.1	140
	in	19.0	19.0	12.0	12.0	19.0	12.0	19.0	12.0	12.0	19.0	19.0	8.7	12.0	8.7	19.0	2.8	5.5
Height	mm	178	178	348	345	178	345	135	345	328	178	345	290	133	305	133	127	127
	in	7.0	7.0	13.7	13.6	7.0	13.6	5.3	13.6	12.9	7.0	13.6	11.4	5.3	12.0	5.3	5.0	5.0
Depth	mm	679	679	627	592	704	577	579	622	605	630	577	610	627	597	566	368	368
	in	26.8	26.8	24.7	23.3	27.7	22.7	22.8	24.5	23.8	24.8	22.7	24.0	24.7	23.5	22.3	14.5	14.5
Weights ≈																		
Net	kg	25.0	22.7	20.4	19.8	20.0	16.9	12.3	17.2	16.3	15.0	13.6	13.6	13.6	13.6	14.5	0.9	4.1
	lb	55.0	50.0	45.0	43.6	44.0	37.2	27.0	37.8	36.0	33.0	30.0	30.0	30.0	30.0	32.0	2.0	9.0
Shipping	kg	42.1	32.6	28.1	25.4	30.9	21.4	23.6	21.6	21.6	28.5	19.5	20.8	28.2	19.0	28.2	2.3	5.4
	lb	93.0	72.0	62.0	56.0	68.0	47.0	52.0	47.6	47.0	63.0	43.0	46.0	62.0	42.0	62.0	5.0	12.0

*1 *Calculator dimensions and weights, width 277 mm (10.9 in), height 69 mm (2.7 in), depth 165 mm (6.5 in).*

K213 Lab Instrument Cart
The K213 Lab Instrument Cart accepts all 7000 Series oscilloscopes. A lockable drawer for storage and a movable shelf for additional instrumentation are included. The shelf accepts TM 500 Test and Measurement instruments, 5000 Series oscilloscopes, or 400 Series oscilloscopes. A drawer for the 7854 keyboard and a plug-in storage cabinet are available as Options 10 and 12 respectively, or Option 22 for both. For full details, see Cart Section, page 462.

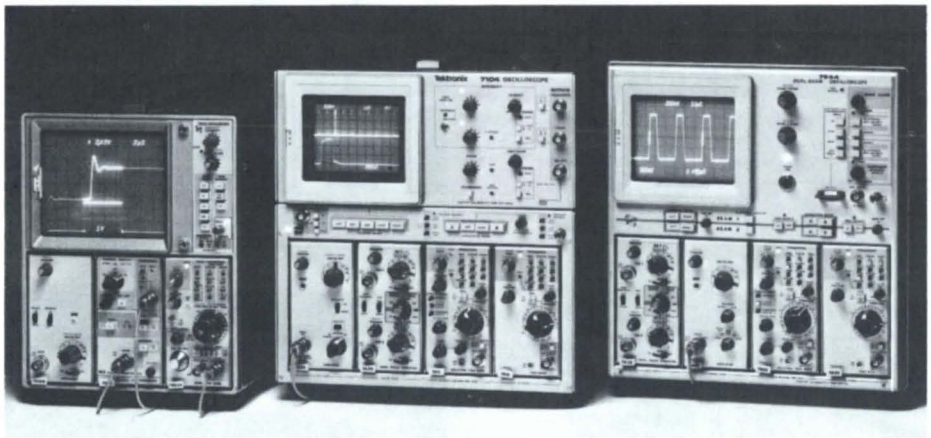
TEK C-53 Camera
The full line of cameras designed for 7000 Series oscilloscopes is summarized on the preceding page. For full details, see Camera Section, page 451.

APPLICATION NOTES FOR 7000 SERIES

Title	Description	Order
Pulse Echo Measurements with digital accuracy	7603/7A22/7D15/7B53A timing measurements between nonadjacent pulses Ultrasonic transducers	42-W-3681-1
7A42	7A42 Logic triggered amplifier, checking logic levels	42-W-5629
7A42 Bus Contention	7A42 Microprocessor Bus Contention measurements	42-W-5630
7A42 Advanced Trigger Application	7A42 measures complex signals easily	42-W-5588
X-Y Displays with Interval Timing for Measuring SOA	7D15/7A18/7A22 X-Y power dissipation measurements	42-AX-3957
DAC Measurements: The sampling oscilloscope approach	7S14/7D12/M2/7B92A/7904 measuring DAC (digital analog converter) settling time	42-W-3632-1
Accurate Radar Pulse Measurements	7D11 example of radar pulse delay time measurement	42-W-2659-3
Measuring time interval between nonadjacent digital word train pulses or multiecho radar pulses	7D15 demonstrates ability to measure the time between adjacent pulses with digital counter accuracy	42-W-2680-3
The 7D20 Programmable Digitizer: Performing a Wide Range of Measurement Tasks Easier, Faster, and more Accurately	7D20 application examples including ultrasonic testing, monitoring nerve activity, measuring pulse jitter, and SOA analysis of power devices	42-W-5085
Measuring memory core I/O signals with digital accuracy	7000 Series digital plug-ins demonstrate how to make accurate pulse parameter measurements both of amplitude and pulse timing	42-AX-2686-1
Measuring disc drive time and access voltages with Tektronix 7000 Series Digital Plug-ins	7000 Series digital plug-ins use a single CRT display to perform both digital and analog analysis of complex waveforms	42-W-2687-2
Measurement Variety: An Engineering challenge featuring the 7854	7854/Waveform Calculator basic operation, application software for percent overshoot, data monitoring and histogram	42-W-4281-1
GPIB communication with the 7854	7854/4052 and 7854/4924 types of I/O transfers transmissions formats, and operational software in TEK BASIC compatible with any 4050 Series computer	42-W-4416-1

Title	Description	Order
Pulse and digital timing measurements—a better technique	7B80/7B85 general operation overview	42-AX-3379-1
Using storage to find troublesome logic glitches	7633 shows how to capture and evaluate glitches	42-AX-3085
Variable persistence storage applications	7613/5441 various applications for variable persistence storage oscilloscopes	42-AX-3198
Automated TDR Testing	Made easy with the 7854 oscilloscope/ 7S12 sampler plug-in	42-W-5334-1
Bistable storage applications	Tektronix Storage Oscilloscopes Describes various applications	42-AX-3199
Increased measurement accuracy using a 7D15 in any 7000 Series scope	Introduction demonstrating variety of counting and timing measurements	42-W-5017-1
7D20 Programmable Digitizer: Digitizing Performance and versatility in a power plug-in	In-depth discussion of the features, functions and capabilities	42-W-5079-1
Sampling for High Speed Measurements	Describes how sampling works, TDR measurements, probes and sampling systems	42-W-5195
Measurement Techniques with Differential Amplifiers	Outlines what they are, functions and benefits	42-W-5325
Applying Photographic Writing Rate to High Speed Signal Measurements	Describes how scope/camera systems photograph fast moving traces	42-W-5335-1
Power Supply/Device Testing	Describes advanced 7854 waveform processing functions of typical series of five power supply and device test operations	42-W-5700
Basic SW Programs for Communicating Between 7854 and IBM PC	Describes installation and configuration of National Instrument's IEEE-488 card, and programs to make transfers and specific programs in IBM BASIC	42-W-5802-1
7854 Measurement Primer	Teaches most basic functions, including acquiring waveform, stored waveform measurements, storing/displaying multiple waveforms	42-W-5968
Sampling Primer	Basic sampling principles in signal acquisition for scope measurements	42-W-5969

7000 SERIES NONSTORAGE MAINFRAMES



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7000 SERIES NONSTORAGE SELECTION GUIDE

Features	7104/R7103	7904A/R7903	7844/R7844	7704A Opt 09	7704A	7603/R7603
Bandwidth*1	1 GHz	500 MHz	400 MHz	250 MHz	200 MHz	100 MHz
Minimum Deflection Factor	10 mV/div at BW	10 mV/div at BW 10 μV/div 1 mA/div	20 mV/div at BW 10 μV/div 1 mA/div	20 mV/div at BW 10 μV/div 1 mA/div	10 mV/div at BW 10μV/div 1 mA/div	5 mV/div at BW 10μV/div 1 mA/div
Maximum Sweep Rate	200 ps/div	500 ps/div	1 ns/div	2 ns/div	2 ns/div	5 ns/div
Four Traces	✓	✓	✓ Dual Beam	✓	✓	✓
Delayed Sweep	✓	✓	✓	✓	✓	✓
Page	222	225	231	227	227	229
Prices*2 begin at	$24,590/$25,125	$10,115/$9,560	$15,365/$15,810	$6,160	$5,635	$3,670/$4,160

1 Bandwidths are real time. Sampling plug-ins that extend bandwidths to 14 GHz are available for most mainframes.
2 Price does not include plug-ins.

A high performance instrument system begins with the basic oscilloscope building block—the 7000 Series mainframe. Each mainframe consists of a cathode-ray tube, a power supply, electron beam deflection systems, and the switching circuitry necessary to integrate a versatile and complete measurement system.

The Tektronix 7104 and the R7103 are 1 GHz oscilloscopes featuring the fastest rise time (350 ps) and highest photographic writing speed (20 cm/ns) available today.

Choose from a variety of features, including bandwidth, photographic writing speed, dual beam, alphanumeric displays, rack-mounting, and three or four plug-in flexibility.

7104/R7103

1 GHz at 10 mV/Div

350 ps Rise Time

200 ps/Div Fastest Calibrated Sweep Rate

Horizontal Bandwidth 350 MHz

Ultra High Photographic Writing Speed—at Least 20 cm/ns

CRT Readout

7 Inch Rackmount (R7103 Only)

Phase Compensation Option—Phase Matching to 250 MHz (7104 Only)

TYPICAL APPLICATIONS

High Speed Semiconductor Design
Laser and High Energy Research
Digital Communications

See page 220 for available Application Notes.

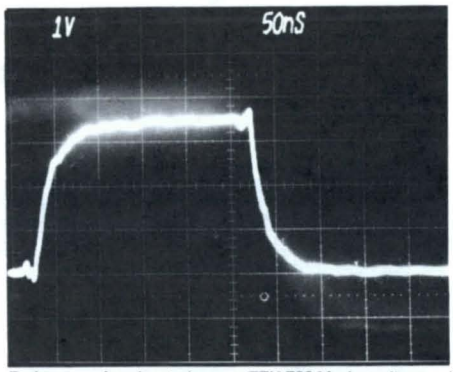
The capabilities of the 7104 and the seven inch rackmount R7103 are of substantial value in numerous high technology environments. The 7104/R7103 have both the highest writing speed and highest bandwidth available in a general purpose oscilloscope today.

The 7104/R7103's outstanding writing speed means unsurpassed single shot capability, with trace brightness about **one-thousand** times that of conventional oscilloscopes. Any single shot signal within the 1 GHz bandwidth can be seen directly on the CRT in average room light. Also, singleshot photography is now simple and straightforward, using standard oscillographic cameras and film without high speed enhancement techniques.

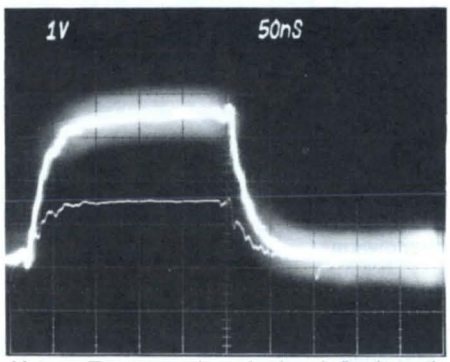
It is by no means unusual to see 250 MHz data rates and 900 MHz analog frequencies outside the lab and on the production line. In digital design, too, anomalies such as ringing and overshoot can only be dealt with by evaluating the signal's analog characteristics.

You can capture the fastest transients without expensive high speed film or other time consuming and complex techniques like fogging or reducing the scan. In fact, you can see those signals on the CRT, and eliminate costly time consuming photographs.

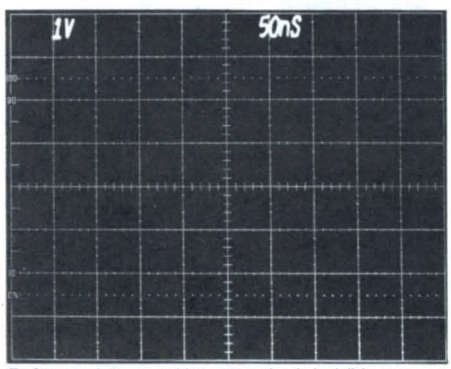
See What You Could Never See Before.



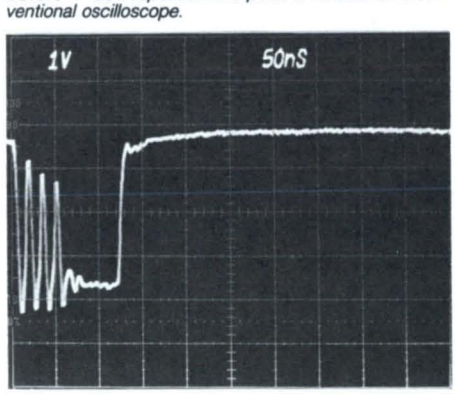
Before *— A pulse train on a TEK 7904A doesn't reveal the low level glitch occurring every ten-thousandth pulse. (The TEK 7904A was previously the world's fastest-writing-rate scope.)*



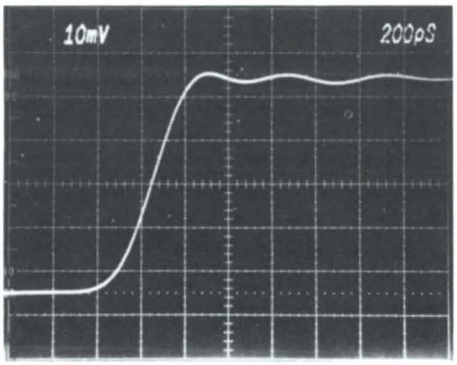
After *— The same pulse train viewed directly on the 7104/R7103, with one-thousand times the brightness of conventional scopes. The researcher can now analyze the pulse with the naked eye and take pictures with ease.*



Before *— Low repetition rate pulse is invisible on a conventional oscilloscope.*



After *— The same pulse as seen on the 7104/R7103 readily indicates that the problem is input signal bounce.*



With its sweep speed of 200 ps/div, the 7104/R7103 clearly shows a single-shot, 350-ps step, five divisions in amplitude.

Horizontal bandwidth of 350 MHz, with the X-Y phase compensation Option 02 (7104), gives accurate X-Y displays to 250 MHz. Designers can now directly obtain V-I curves for high speed switching power supply evaluation or monitor performance of digital communication systems using phase constellation displays.

CHARACTERISTICS

The following characteristics are common to the 7104 and the R7103, except those noted under the R7103.

VERTICAL SYSTEM

Channels — Two left-hand plug-in compartments. Compatible with all 7000 Series plug-ins (except 7D01, 7D02, and 7D20).

Bandwidth — Determined by mainframe and plug-in unit. See page 218.

Rise Time — Determined by mainframe and plug-in unit. See page 218.

Deflection Factor — Determined by plug-in unit. See page 218.

Display Modes — Left, Alt, Add, Chop, Right. Chopped mode repetition rate is ≈1 MHz.

Trace Separation — (7104 only) In dual sweep modes positions B trace at least four divisions above and below A trace.

Delay Line — Permits viewing leading edge of displayed waveform.

HORIZONTAL SYSTEM

Channels — Two right-hand plug-in compartments. Compatible with the 7B10 Series, 7B80 Series, 7B50A, 7B92A, 7000 Series vertical amplifiers and specialized plug-ins (7B92, 7D01, 7D02, and 7D20 not recommended).

Bandwidth — Dc to 350 MHz.

Display Modes — (7104 only) A, Alt, Chop, B. Chopped mode repetition rate is ≈200 kHz.

Fastest Calibrated Sweep Rate — 200 ps/div with the 7B10 or 7B15.

X-Y Mode — With Option 02, X-Y Phase Compensation (7104 only, using 7A19s or 7A29s at least one having Variable Delay Option, B horizontal compartment only): Phase shift is 2° from dc to 50 MHz (after adjusting variable delay for balance at 35 MHz). Phase balance can be obtained at any frequency up to 250 MHz. Without Option 02, X-Y Phase Compensation: Phase shift is 2° from dc to 50 kHz.

CRT AND DISPLAY FEATURES

For CRT phosphor data see page 186.

CRT — Internal 8 x 10 division (0.85 cm/div) graticule with variable illumination. Accelerating potential is 12.5 kV. GH (P31) phosphor standard.

Readout and Graticule Modes — Each continuous or pulsed. Pulse Source Front Panel Selectable: +Gate, External, Manual. Pulsed graticule is on for ≈0.5 s.

Typical Photographic Writing Speed*1

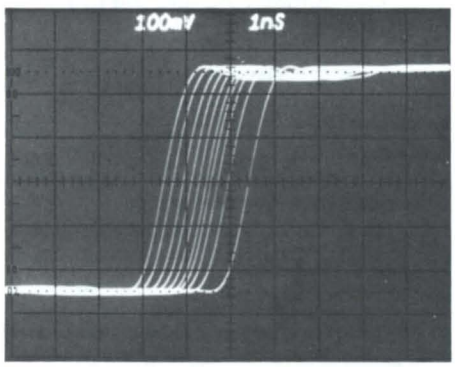
CRT	Camera	Lens	Writing Speed cm/ns
Standard 8 cm x 10 cm	C-53	f/1.9 1:0.85	20

**1 Using the standard GH (P31) phosphor and Polaroid Type 107, 3,000 ASA film without film fogging.*

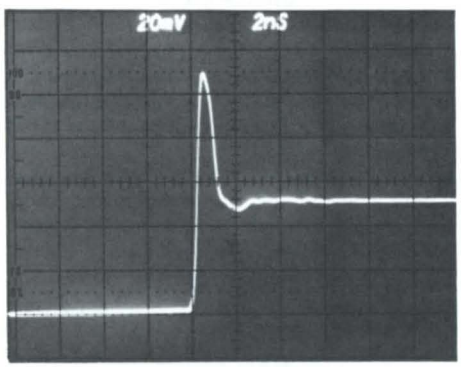
Autofocus — Reduces the need for additional manual focusing with changes in intensity after focus control has been set.

Beam Finder — Aids in locating offscreen signal.

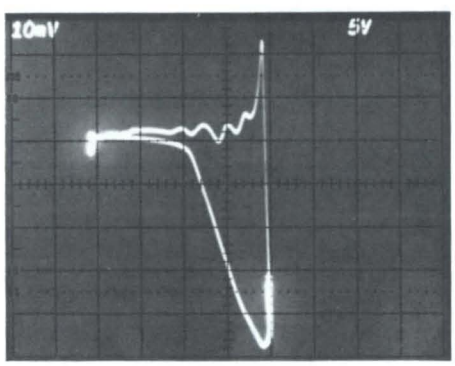
External Z-Axis Input — 2 V p-p for full intensity range. A positive signal blanks the trace. Maximum input voltage is 15 V (dc + peak ac) and p-p ac. Input is dc coupled.



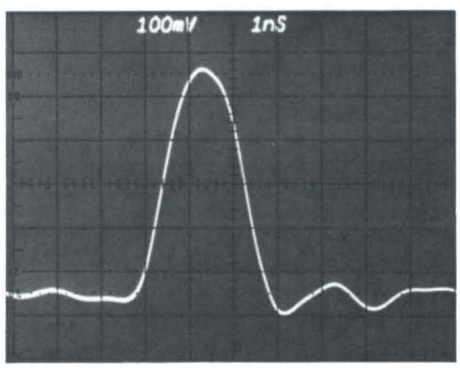
A digital circuit that shows no jitter on a conventional oscilloscope is found to have a 2.0 ns jitter when viewed with the distinct image viewing capability of the 7104/R7103.



Circuit faults such as high frequency pulse overshoot and ringing can easily be observed with the 7104/R7103's 1 GHz bandwidth.



The transient load line of a fast switching transistor in a power supply prototype (switching time = 10 ns) is easily measured for compliance with safe operating area (Horizontal = Voltage; Vertical = Current).



View of a single clocking pulse 0.8 ns rise and 2 ns pulse width.

The R7103 requires only seven inches of rack height in a standard 19 inch rack. It is fan-cooled and comes complete with slideout chassis tracks.

CALIBRATOR

Voltage Output — Squarewave positive-going from ground.

Voltage Ranges — 40 mV, 0.4 V, and 4 V into 100 kΩ; 4 mV, 40 mV, and 0.4 V into 50 Ω. Amplitude accuracy is within 1%. Repetition rate is 1 kHz within 0.25%.

Current Output — 40 mA rectangular waveshape with optional current-loop accessory (012-0341-00) connected to calibrator output. Output R is 450 Ω.

OUTPUTS/INPUTS

+Sawtooth — Starts 1 V or less from ground into 1 MΩ. Output voltage is 50 mV/div (±15%) into 50 Ω, 1 V/div (±10%) into 1 MΩ. Output R is ≈950 Ω.

+Gate — Positive-going rectangular waveform. Output voltage is 0.5 V (±10%) into 50 Ω, 10 V (±10%) into 1 MΩ. Rise time is 5 ns or less into 50 Ω. Output R is ≈950 Ω.

Vertical Signal Out — Output voltage is 25 mV/div into 50 Ω, 0.5 V into 1 MΩ. Output R is ≈950 Ω. Bandwidth depends upon vertical plug-in. See page 219.

Camera Power — Three-prong connector to the left of the CRT provides power, ground, and remote single-sweep reset access for C-50 Series camera.

Probe Power — Two rear-panel connectors for active probes (i.e., P6201, P6202A, P6230).

External Single-Sweep Reset — Ground closure, rear panel BNC, input to reset sweep.

Single-Sweep Ready Indicator — Rear panel BNC provides 5 V out to indicate single-sweep ready condition.

Graticule/Readout, Single Shot — Ground closure, rear panel BNC input initiates one frame of CRT read-out. Graticule Illumination is illuminated for ≈0.5 s.

POWER REQUIREMENTS

Line Voltage Ranges — 90 V to 132 V ac and 180 V to 250 V ac.

Line Frequency — 48 Hz to 440 Hz.

Maximum Power Consumption — 215 W, 3.3 A at 90 V line, 60 Hz.

The 7D01, 7D02 Logic Analyzers and 7D20 Digitizer are not recommended for use in the 7104/R7103 mainframe. Such use will void the 7104/R7103 warranty.

ENVIRONMENTAL AND SAFETY

Ambient Temperature — Operating: 0°C to +50°C. Nonoperating: −55°C to +75°C.

Altitude — Operating: 5000 m (15,000 ft). Nonoperating: 15 000 m (50,000 ft).

Vibration — Operating: 15 minutes along each of the three major axes. 0.04 cm (0.015 in) p-p displacement 10 Hz to 50 Hz to 10 Hz in one minute cycles. Held for three minutes at 50 Hz.

Humidity — Operating and Nonoperating: 95%, five cycles (120 hours), referenced to MIL-E-16400F.

Shock — Nonoperating: 30 g's, ½ sine, 11 ms duration in each direction along each major axis. Total of six shocks.

EMC Capability — (R7103, 7104 Option 03) Meets MIL-STD-461B requirements when tested in accordance with certain test methods of MIL-STD-462. Contact your Tektronix representative for more information.

Safety — UL listed (UL 1244) and CSA certified (CSA 556B).

PHYSICAL CHARACTERISTICS

	Cabinet		Rackmount	
Dimensions	**mm**	**in**	**mm**	**in**
Width	305	12.0	483	19.0
Height	345	13.6	178	7.0
Depth	592	23.3	704	27.7
Weights≈	**kg**	**lb**	**kg**	**lb**
Net	19.8	45.0	20.0	44.0
Shipping	25.4	56.0	30.9	68.0

CHARACTERISTICS (R7103)

The following characteristics for the R7103 are in addition to or in lieu of those listed previously.

HORIZONTAL SYSTEM

Single Channel — Right-hand plug-in compartment compatible with time bases of the 7B10 and 7B80 Series and the 7B50A and 7B92A. The 7B50 Series (except 7B50A), the 7B70 Series and the 7B92 (non-A) are not recommended. 7000 Series vertical amplifiers and specialized plug-ins (except 7D01, 7D02, and 7D20) may also be used.

Bandwidth — Dc to 350 MHz.

X-Y Mode — Phase shift is 2° from dc to 50 kHz.

OUTPUTS/INPUTS

Vertical Signal Out — Output voltage is 25 mV/div within 25% into 50 Ω, 0.5 V into 1 MΩ. Output R is ≈950 Ω.

ORDERING INFORMATION

(PLUG-INS NOT INCLUDED)

7104 Oscilloscope **$24,590**
Includes: Power cord (161-0066-00); instruction manual (070-2314-00).

R7103 Rackmount Oscilloscope **$25,125**
Includes: Power cord (161-0066-00); mask frame (426-0514-00); CRT filter (378-0625-00); drawer slide (351-0375-01); right spacer (361-0806-00); left spacer (361-0807-00); hardware kit (016-0099-00); instruction manual (070-0539-00).

OPTIONS (7104)

Option 02 — X-Y Horizontal Compensation. **+$315**
Option 03 — EMC Capability. **+$395**

CONVERSION KIT (7104)

EMC Modification — Order 040-0965-00 **$565**

INTERNATIONAL POWER PLUG OPTIONS

Option A1 — Universal Euro 220 V, 50 Hz.
Option A2 — UK 240 V, 50 Hz.
Option A3 — Australian 240 V, 50 Hz.
Option A4 — North American 240 V, 60 Hz.
Option A5 — Switzerland 220 V, 50 Hz.

RECOMMENDED PLUG-INS

7A29 — Vertical amplifier, 50 Ω input, dc to 1 GHz; 10 mV/div to 1 V/div vertical sensitivity. **$3,325**

7A42 — Four channel, 350 MHz bandwidth vertical amplifier with Boolean logic triggering capabilities. **$6,200**

7B10 — Delayed time base with 200 ps/div to 0.2 s/div calibrated sweep speed; triggering up to 1 GHz. **$2,555**

7B15 — Delaying time base with 200 ps/div to 0.2 s/div calibrated sweep speed; triggering up to 1 GHz; capable of Δtime measurements in conjunction with 7B10. **$2,900**

7B92A — Dual time base with 500 ps/div to 0.2 s/div calibrated sweep speed; triggering up to 500 MHz; capable of delay time measurements. **$3,745**

OPTIONAL ACCESSORIES

Recommended Cameras — See page 218 and 442.

NEW **DCS01**

The *NEW* DCS01 Digitizing Camera System combines CCD technology with an IBM PC, XT, AT, or compatible to acquire and digitize repetitive and transient waveforms displayed on oscilloscopes, spectrum analyzers, and other displays. Used with scopes having the microchannel plate CRT, such as the 7104 and 2467, the DCS01 can acquire repetitive and transient signals at the full bandwidth of the scope. With other scopes, the DCS01 will acquire repetitive events at the full scope bandwidth and transient events according to the photographic writing rate of the oscilloscope. See page 353.

Recommended Probes — See page 219 and 464.
Recommended Carts —
K213 Option 12 (7104), see page 462.
K217 (R7103), see page 462.

7904A/R7903

500 MHz at 10 mV/Div

700 ps Rise Time (7904A)

500 ps/Div Fastest Calibrated Sweep Rate

Greater Than 7 cm/ns Writing Speed With Optional CRT (Option 13) and WSEN

CRT Readout

Over 30 Compatible Plug-Ins

900 MHz FET Probe Available

TYPICAL APPLICATIONS
Digital Design
Radar
Laser Research

See page 220 for available Application Notes.

The 7904A and 5.25 inch rackmount R7903 are high bandwidth, general purpose oscilloscopes. The 7A29 Amplifier/7904A mainframe attains 500 MHz at 10 mV/div. A 7A29 variable delay option allows for the matching of signal transit times of two plug-ins and their probes to better than 50 ps.

The P6201 1X FET probe gives you high impedance and wide bandwidth. It has a 900 MHz bandwidth by itself, and in combination with the 7A29/7904A, it provides a system bandwidth of 450 MHz at 10 mV.

The CRT, the major contributor to the performance of the 7904A and R7903, has good visual brightness and an 8 cm x 10 cm display area.

For high photographic writing speed applications, Option 13 provides BE (P11) phosphor and a reduced scan CRT yielding greater than 7 cm/ns photographic writing rate. Addition of WSEN (writing speed enhancer described on page 441) increases writing speed to >7 cm/ns. For comparison of 7000 Series photographic writing speeds, see page 186.

CHARACTERISTICS

The following characteristics are common to the 7904A and R7903, except those noted under the R7903.

VERTICAL SYSTEM

Channels — Two left-hand plug-in compartments. Compatible with all 7000 Series plug-ins.

Bandwidth — Determined by mainframe and plug-in unit. See page 218.

Rise Time — Determined by mainframe and plug-in unit. See page 218.

Deflection Factor — Determined by plug-in unit. See page 218.

Display Mode — Left, Alt, Add, Chop, Right. Chopped mode repetition rate is ≈1 MHz.

Trace Separation Range — (7904A only) In dual sweep modes, positions B trace at least four divisions above and below A trace.

Delay Line — Permits viewing leading edge of displayed waveform when using 7B80 and 7B90 Series time bases. 7B50 Series not recommended.

HORIZONTAL SYSTEM

Channels — 7904A: Two right-hand plug-in compartments. R7903: One right-hand plug-in compartment. 7904A and R7903: Compatible with 7B80 and 7B90 Series time bases, 7000 Series vertical amplifiers and specialized plug-ins.

Bandwidth — Dc to at least 1 MHz.

Display Modes — A, Alt, Chop, B. Chopped mode repetition rate is ≈200 kHz.

Fastest Calibrated Sweep Rate — 500 ps/div with the 7B92A.

X-Y Mode — With Delay Compensation: Phase shift is within 2° from dc to 1 MHz. Without Delay Compensation: Phase shift is within 2° from dc to 35 kHz.

CRT AND DISPLAY FEATURES

For CRT phosphor data see page 186.

CRT — Internal 8 x 10 division (0.85 cm/div) graticule with variable illumination. Accelerating potential is 24 kV. GH (P31) phosphor is standard.

Option 04, CRT With Reduced Area — Internal 4 cm x 5 cm graticule with variable illumination. Accelerating potential is 24 kV. GH (P31) phosphor is standard.

Option 13, Maximum Brightness CRT With Reduced Area — Internal 4 cm x 5 cm graticule with variable illumination. Accelerating potential is 24 kV with BE (P11) phosphor.

Option 78, BE (P11) Phosphor — Replaces standard GH (P31) phosphor.

Typical Photographic Writing Speed*[1]

CRT	Camera	Lens	Writing Speed cm/ns
Opt 04 4 cm x 5 cm	C-51P	f/1.2 1:0.5	2
Opt 13 4 cm x 5 cm			7
Opt 78 8 cm x 10 cm			2.5

*[1] *Using Polaroid Type 612 20,000 ASA Film without film fogging.*

In typical applications, GH (P31) phosphor has approximately one-half the writing speed of BE (P11) phosphor. The writing speed can be increased by using controlled film fogging with a writing speed enhancer (camera accessory). See page 441.

Autofocus — Reduces the need for additional manual focusing with changes in intensity after focus control has been set.

Beam Finder — Aids in locating offscreen signal.

External Z-Axis Input — 2 V p-p for full intensity range. A positive signal blanks the trace. Maximum input voltage is 15 V (dc + peak ac) and p-p ac. Input is dc coupled.

CALIBRATOR

Output Waveshape — Rectangular positive-going from ground.

Voltage Ranges — 40 mV, 0.4 V, 4 V into an open circuit. 4 mV, 40 mV, 0.4 V into 50 Ω. Amplitude accuracy is within 1%. Repetition rate is 1 kHz within 0.25%.

Current Output — 40 mA with optional current loop accessory (012-0341-00) connected to calibrator output. Output R is 450 Ω.

The R7903 requires only 5.25 inches of rack height in a standard 19-inch rack. It is fan-cooled and comes complete with slideout chassis tracks.

OUTPUTS/INPUTS

+Sawtooth — Sawtooth starts 1 V or less from ground into 1 MΩ. Front panel selectable from A or B horizontal. Output voltage is 50 mV/div (±15%) into 50 Ω, 1 V/div (±10%) into 1 MΩ. Output R is ≈950 Ω.

+GATE — Positive-going rectangular waveform derived from A, B, or Delayed Gate, front panel selectable. Output voltage is 0.5 V (±10%) into 50 Ω, 10 V (±10%) into 1 MΩ. Rise time is 5 ns or less into 50 Ω.

Vertical Signal Out — Selected by B Trigger Source switch. Output voltage is 25 mV/div into 50 Ω, 0.5 V/div into 1 MΩ. Output R is ≈950 Ω. Bandwidth depends upon vertical plug-in. See page 218.

Camera Power — Three-prong connector to the left of the CRT provides power, ground, and remote single-sweep reset access for C-50 Series cameras.

Probe Power — Two rear panel connectors for two active probes.

POWER REQUIREMENTS

Line Voltage Ranges — 90 V to 132 V ac and 180 V to 250 V ac.

Line Frequency — 48 Hz to 440 Hz.

Maximum Power Consumption — 210 W, 3.5 A at 90 V line, 60 Hz.

ENVIRONMENTAL AND SAFETY

Ambient Temperature — Operating: 0°C to +50°C. Nonoperating: −55°C to +75°C.

Altitude — Operating: 5000 m (15,000 ft). Nonoperating: 15 000 m (50,000 ft).

Vibration — Operating: 15 minutes along each of the three major axes. 0.04 cm (0.015 in) p-p displacement 10 Hz to 55 Hz to 10 Hz in one minute cycles. Held for three minutes at 50 Hz.

Humidity — Operating and Nonoperating: 95%, five cycles (120 hours), referenced to MIL-E-16400F.

Shock — Nonoperating: 30 g's, ½ sine, 11 ms duration in each direction along each major axis. Total of six shocks.

EMC Capability — (Option 03) Meets MIL-STD-461B requirements when tested in accordance with certain test methods of MIL-STD-462. Contact your Tektronix representative for more information.

Safety — UL listed (UL 1244) and CSA certified (CSA 556B).

PHYSICAL CHARACTERISTICS

	Cabinet		Rackmount	
Dimensions	**mm**	**in**	**mm**	**in**
Width	305	12.0	483	19.0
Height	345	13.6	135	5.3
Depth	577	22.7	579	22.8
Weights≈	**kg**	**lb**	**kg**	**lb**
Net	16.9	37.2	12.3	27.0
Shipping	21.4	47.0	23.6	52.0

CHARACTERISTICS (R7903)

The following characteristics for the R7903 are in addition to or in lieu of those listed previously.

HORIZONTAL SYSTEM

Channel — Single right-hand plug-in compartment. Compatible with 7B80 Series, 7B90 Series, 7000 Series vertical amplifiers and specialized plug-ins.

Fastest Calibrated Sweep Rate — 500 ps/div with the 7B92A.

CRT AND DISPLAY FEATURES

Option 10, Pulsed Graticule — Provides a means of pulsing the graticule lights at a preset level coincident with a single-shot event in one exposure. The graticule lights may be pulsed by the event, an external ground closure, or a front panel pushbutton. If the mainframe is equipped with CRT readout, Option 10 provides additional controls and inputs for CRT readout pulsed operation.

CALIBRATOR (NOT AVAILABLE WITH OPTION 10)

Voltage Ranges — 4 mV, 40 mV, 0.4 V, 4 V into an open circuit; 4 mV, 40 mV, 0.4 V into 50 Ω.

Current Output — 40 mA rectangular waveshape with optional current-loop accessory (012-0341-00) connected to calibrator output. Output R is 450 Ω.

OUTPUTS/INPUTS (STANDARD)

+Sawtooth — Sawtooth starts 1 V or less from ground (into 1 MΩ). Output voltage is 50 mV/div (±15%) into 50 Ω, 1 V/div (±10%) into 1 MΩ. Output R is ≈950 Ω.

+Gate — Positive-going rectangular waveform derived from Main or Auxiliary Gate. Output voltage 0.5 V (±10%) into 50 Ω. 10 V (±10%) into 1 MΩ. Rise time is 7 ns or less into 50 Ω. Output R is ≈950 Ω.

Vertical Signal Out — Selected by Trigger Source switches. Output voltage is 25 mV/div into 50 Ω, 0.5 V/div into 1 MΩ. Output R is ≈950 Ω. Bandwidth depends upon vertical plug-in. See page 219.

External Single Sweep Reset — Ground closure, rear panel input to reset sweep.

Single Sweep Ready Output — Rear panel BNC provides 5 V out to indicate single sweep ready condition.

Probe Power — Two front panel connectors for two active probes. Not available for Option 10.

CRT Readout — Inhibit: Ground closure, rear panel BNC input locks out CRT readout. Not available with Option 10. Single Shot: Ground closure, rear panel BNC input initiates one frame of CRT readout. Not available with Option 10 separately, but in combination with the pulsed graticule input.

OUTPUTS/INPUTS (OPTIONS)

Option 10, Pulsed Graticule — No CRT readout single-shot input, CRT readout inhibit input, calibrator, and probe power. Single-shot graticule and CRT readout (ground closure) rear panel BNC input is added. Initiates one frame of CRT readout and pulsed graticule.

POWER REQUIREMENTS

Line Voltage Ranges — 90 V to 132 V ac and 180 V to 264 V ac.

Maximum Power Consumption — 160 W, 2 A at 115 V line, 60 Hz.

ORDERING INFORMATION

(PLUG-INS NOT INCLUDED)

Ordering information is common to the 7904A and R7903 unless otherwise noted.

7904A Oscilloscope **$10,115**
Includes: Power cord (161-0066-00); instruction manual (070-4593-00).

R7903 Oscilloscope **$9,560**
Includes: Power cord (161-0066-00); test adaptor (012-0092-00); two 18 in test leads (012-0087-00); slide guide (351-0314-01); hardware kit (016-0099-00); instruction manual (070-1464-00).

OPTIONS

Option 02 — (7904A only) X-Y Horizontal Compensation. Adds X-Y delay compensation network to equalize the signal delay between the vertical and the B horizontal compartments. **+$260**

Option 03 — EMC Capability. Adds special shielding for protection to the instrument when operated in severe EMC environments. **+$395**

Option 04 — (R7903 only) Reduced Scan 4 cm x 5 cm CRT Display. GH (P31) Phosphor is standard. **+$500**

Option 10 — (R7903 only) Pulsed Graticule. **+$260**

Option 13 — Maximum Brightness 4 cm x 5 cm CRT Display with BE (P11) Phosphor. **+$600**

Option 78 — BE (P11) Phosphor. **+$100**

CONVERSION KITS

X-Y Horizontal Compensation —
(7904A only) Order 040-0606-00 **$440**

EMC Capability —
(7904A) Order 040-0570-00 **$450**
(R7903) Order 040-0647-00 **$375**

CRT Readout —
(R7903 only) Order 040-0605-05 **$520**

INTERNATIONAL POWER PLUG OPTIONS

Option A1 — Universal Euro 220 V, 50 Hz.
Option A2 — UK 240 V, 50 Hz.
Option A3 — Australian 240 V, 50 Hz.
Option A4 — North American 240 V, 60 Hz.
Option A5 — Switzerland 220 V, 50 Hz.

OPTIONAL ACCESSORIES

Recommended Plug-Ins — See page 218.
Recommended Probes — See pages 219 and 464.
Recommended Cameras — See pages 218 and 442.
Recommended Carts —
K213 Option 12 (7904A), see page 462.
K217 (R7903), see page 462.

TRAINING

Tektronix offers service training classes on the 7904A General Purpose Oscilloscope. For further training information, contact your local Sales/Service Office or request a copy of the Customer Service Training Catalog on the return card in the back of this catalog.

7704A

Dc to 250 MHz Bandwidth (Option 09)

Dc to 200 MHz With Optimum Pulse Response

1.8 ns Rise Time

2 ns/Div Fastest Calibrated Sweep Rate

Greater Than 7 cm/ns Enhanced Writing Speed With Optional CRT (Option 13) and WSEN

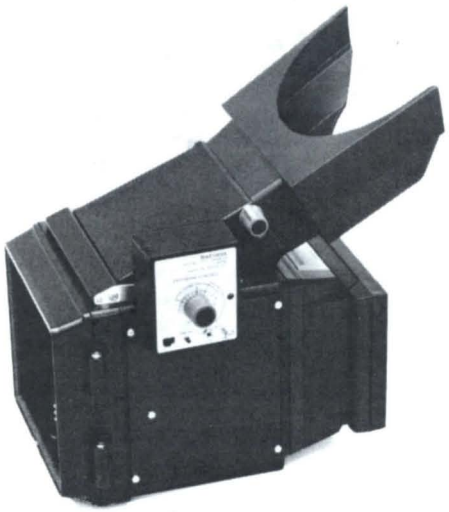
CRT Readout

TYPICAL APPLICATIONS
Communications
Digital Design
Component Testing

See page 220 for available Application Notes.

The 7704A offers you a choice of bandwidth performances to optimize the oscilloscope for your type of application. In the standard model, pulse aberrations are minimized while giving you a bandwidth of 200 MHz. For higher frequency applications, Option 09 provides a bandwidth of 250 MHz.

For high writing speed applications, Option 13 provides BE (P11) phosphor and a reduced scan CRT yielding >7 cm/ns photographic writing rate with the Tektronix C-51 Camera and WSEN (writing speed enhancer described on page 441). For a comparison of 7000 Series photographic writing speeds, see page 186.



C-51P Camera shown with WSEN.

CHARACTERISTICS

VERTICAL SYSTEM

Channels — Two left-hand plug-in compartments. Compatible with all 7000 Series plug-ins.

Bandwidth — Determined by mainframe and plug-in unit. See page 218.

Option 09, Bandwidth Change (250 MHz) — 7704A vertical circuit performance is adjusted to extend frequency response to 250 MHz at 20 mV/div (upper −3 dB) when 7A29 is used. Provides additional performance for those working in this frequency domain.

Rise Time — Determined by mainframe and plug-in unit. See page 218.

Deflection Factor — Determined by plug-in unit. See page 218.

Display Modes — Left, Alt, Add, Chop, Right. Chopped mode repetition rate is internally selectable ≈100 kHz or 1 MHz.

Trace Separation — In dual sweep modes, positions B trace above and below A trace.

Delay Line — Permits viewing leading edge of waveform.

HORIZONTAL SYSTEM

Channels — Two right-hand plug-in compartments. Compatible with all 7000 Series plug-ins.

Fastest Calibrated Sweep Rate — 2 ns/div.

Chopped Mode (between horizontal plug-ins) — Repetition rate is internally selectable, ≈20 kHz or 200 kHz.

X-Y Mode — Phase shift is within 2° from dc to 50 kHz between vertical and horizontal channels. Frequency response: <10% down at 3 MHz.

CRT AND DISPLAY FEATURES

CRT — Internal 8 cm x 10 cm graticule with variable illumination. Accelerating potential is 24 kV. GH (P31) phosphor is standard.

Option 04, CRT With Reduced Area — Internal 4 cm x 5 cm graticule with variable illumination. Accelerating potential is 24 kV. GH (P31) phosphor is standard.

Option 13, Maximum Brightness CRT With Reduced Area — Internal 4 cm x 5 cm graticule with BE (P11) phosphor. Accelerating potential is 24 kV.

Option 78, BE (P11) Phosphor — Replaces standard GH (P31) phosphor.

Typical Photographic Writing Speed*[1]

CRT	Camera	Lens	Writing Speed cm/ns
Opt 04 4 cm x 5 cm	C-51P	f/1.2 1:0.5	2
Opt 13 4 cm x 5 cm			4
Opt 78 8 cm x 10 cm			2

[1] Using Polaroid Type 612 20,000 ASA Film without film fogging.

Autofocus — Reduces the need for additional manual focusing with changes in intensity after focus control has been set.

Beam Finder — Aids in locating offscreen signal.

External Z-Axis Input — 2 V p-p for full intensity range. A positive signal blanks the trace. Minimum pulse width to blank trace is 30 ns at 2 V. Maximum input voltage is 15 V (dc + peak ac) and p-p ac. Input is dc-coupled.

OUTPUTS/INPUTS

+Sawtooth — Sawtooth starts 1 V or less from ground (into 1 MΩ). Internally selectable from A or B horizontal. Output voltage is 50 mV/div (±15%) into 50 Ω, 1 V/div (±10%) into 1 MΩ. Output R is 950 Ω nominal.

+Gate — Positive-going rectangular waveform derived from A, B, or Delayed Gate, internally selectable. Output voltage is 0.5 V (±10%) into 50 Ω, 10 V (±10%) into 1 MΩ. Rise time is 20 ns or less into 50 Ω. Output R is 950 Ω nominal.

Vertical Signal Out — Selected by B Trigger Source switch. Output voltage is 25 mV/div into 50 Ω, 0.5 V/div into 1 MΩ. The bandwidth depends upon vertical plug-in. Output R is 950 Ω nominal.

External Single-Sweep Reset — Ground closure, rear panel input to reset sweep.

Camera Power — Three-prong connector to the left of the CRT provides power, ground, and remote single-sweep reset access for the C-50 Series cameras.

Probe Power — Two rear panel connectors provide correct operating voltages for two active probes.

CALIBRATOR

Voltage Output — Rectangular waveshape, positive-going from ground (40 V and 4 mV available when selected by internal jumper). Ranges are 40 mV, 0.4 V, 4 V into 1 MΩ; 20 mV, 0.2 V, 0.4 V into 50 Ω. Amplitude accuracy is within 1% (+15°C to +35°C); within 2% (0°C to +50°C). Repetition rate is 1 kHz within 0.25% (+15°C to +35°C); within 0.5% (0°C to +50°C).

Current Output — 40 mA rectangular waveshape with optional current-loop accessory (012-0259-00) connected between 4 V and ground pin jacks.

POWER REQUIREMENTS

Line Voltage Ranges — 90 V to 132 V ac and 180 V to 264 V ac.

Line Frequency — 48 Hz to 440 Hz.

Maximum Power Consumption — 180 W, 2.5 A at 115 V line, 60 Hz.

ENVIRONMENTAL AND SAFETY

Ambient Temperature — Operating: 0°C to +50°C. Nonoperating: −55°C to +75°C.

Altitude — Operating: 5000 m (15,000 ft). Nonoperating: 15 000 m (50,000 ft).

Vibration — Operating: 15 minutes along each of the three major axes. 0.04 cm (0.015 in) p-p displacement 10 Hz to 50 Hz to 10 Hz in one minute cycles. Held for three minutes at 50 Hz.

Humidity — Operating and Nonoperating: 95%, five cycles (120 hours), referenced to MIL-E-16400F.

Shock — Nonoperating: 30 g's, ½ sine, 11 ms duration in each direction along each major axis. Total of six shocks.

EMC Capability — (Option 03) Meets MIL-STD-461B requirements when tested in accordance with certain test methods of MIL-STD-462. Contact your Tektronix representative for more information.

Safety — UL listed (UL 1244) and CSA certified (CSA 556B).

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	305	12.0
Height	345	13.6
Depth	577	22.7
Weight≈	**kg**	**lb**
Net	13.6	30.0
Shipping	19.5	43.0

ORDERING INFORMATION
(PLUG-INS NOT INCLUDED)

7704A Oscilloscope **$5,635**

Includes: 20 in two-pin-to-BNC cable (175-1178-00); instruction manual (070-0981-02).

OPTIONS

Option 03 — EMC Capability. **+$395**

Option 04 — Maximum Brightness 4 cm x 5 cm CRT Display. GH (P31) Phosphor is Standard. **+$500**

Option 09 — Bandwidth Change to 250 MHz. **+$525**

Option 13 — Maximum Brightness 4 cm x 5 cm CRT Display with BE (P11) Phosphor. **+$600**

Option 78 — BE (P11) Phosphor. **+$100**

CONVERSION KITS

CRT Readout — With Probe Power. Order 040-0613-06 **$760**

EMC Capability — Order 040-0612-00 **$465**

Signal Out/In — Order 040-0619-03 **$200**

INTERNATIONAL POWER PLUG OPTIONS

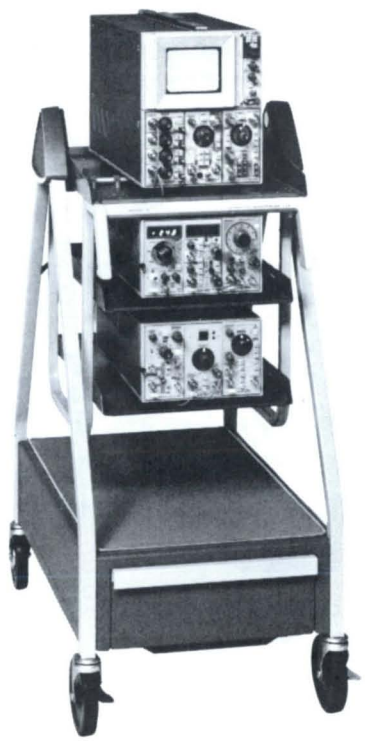
Option A1 — Universal Euro 220 V, 50 Hz.
Option A2 — UK 240 V, 50 Hz.
Option A3 — Australian 240 V, 50 Hz.
Option A4 — North American 240 V, 60 Hz.
Option A5 — Switzerland 220 V, 50 Hz.

OPTIONAL ACCESSORIES

Recommended Plug-Ins — See page 218.
Recommended Probes — See pages 219 and 464.
Recommended Cameras — See pages 218 and 442.
Recommended Cart — K213 Option 12, see page 462.

TRAINING

Tektronix offers service training classes on the 7704A General Purpose Oscilloscope. For further training information, contact your local Sales/Service Office or request a copy of the Customer Service Training Catalog on the return card in the back of this catalog.



The K213 cart shown with optional plug-in storage.

7603/R7603

Dc to 100 MHz Bandwidth

3.5 ns Rise Time

5 ns/Div Fastest Calibrated Sweep Rate

Greater Than 260 cm/μs Writing Speed With Optional CRT (Option 13)

6.5 Inch CRT

CRT Readout

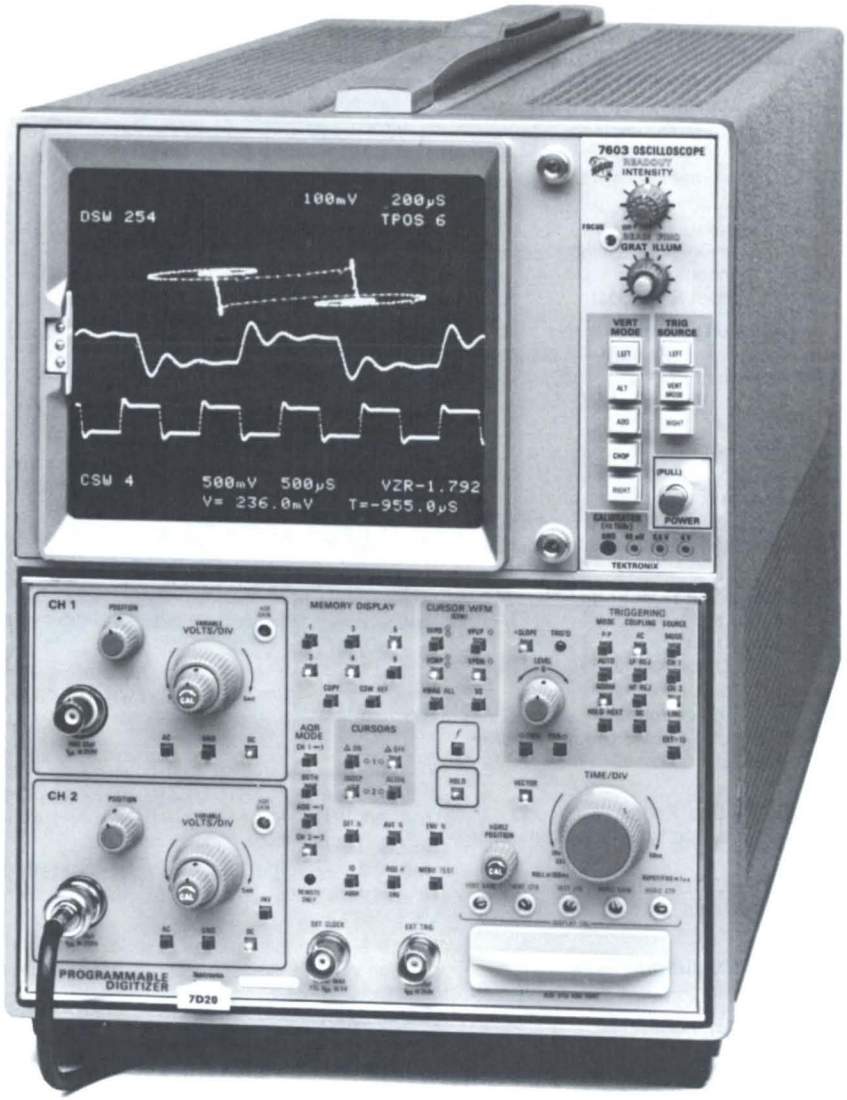
5.25 Inch Rackmount

TYPICAL APPLICATIONS
Digital Design and Testing **Communications** **Spectrum Analysis**

See page 220 for available Application Notes.

The Tektronix 7603 and R7603 Oscilloscopes represent the best price/performance ratio available in the 100 MHz plug-in oscilloscope market today.

The CRT is large—8 x 10 division (1.22 cm/div)—and features an internal graticule with variable illumination and 15 kV accelerating potential. An optional maximum brightness CRT with a smaller 8 cm x 10 cm display and 18 kV potential gives you greater visual brightness and higher photographic writing speed. See page 186 for writing speed specifications.



CHARACTERISTICS

VERTICAL SYSTEM

Channels — Two left-hand plug-in compartments. Compatible with all 7000 Series plug-ins.

Bandwidth — Determined by mainframe and plug-in unit. See page 218.

Rise Time — Determined by mainframe and plug-in unit. See page 218.

Deflection Factor — Determined by plug-in unit. See page 218.

Display Modes — Left, Alt, Add, Chop, Right. Chopped mode repetition rate is ≈1 MHz.

Delay Line — Permits viewing leading edge of displayed waveform.

HORIZONTAL SYSTEM

Channels — One right-hand plug-in compartment. Compatible with all 7000 Series plug-ins.

Bandwidth — Dc to 2 MHz.

Fastest Calibrated Sweep Rate — 5 ns/div.

X-Y Mode — The phase shift is within 2° from dc to 35 kHz.

CRT AND DISPLAY FEATURES

CRT — Internal 8 x 10 division (1.22 cm/div) graticule with variable illumination. Accelerating potential is 15 kV. GH (P31) phosphor is standard.

Option 01, Without CRT Readout — (CRT readout may be added later with conversion kit 040-0654-04).

Option 04, Maximum Brightness CRT With Reduced Area — Internal 8 cm x 10 cm graticule with variable illumination. Accelerating potential is 18 kV. GH (P31) phosphor is standard.

Option 06, Spectrum Analyzer Graticule — Provides internal spectrum analyzer graticule.

Option 13, Maximum Brightness CRT With Reduced Area — Internal 8 cm x 10 cm graticule with BE (P11) phosphor. Accelerating potential 18 kV.

Optional Phosphors (Specify) — GM (P7), BE (P11), or GM (P7)/SA (phosphor/spectrum analyzer graticule combination).

Typical Photographic Writing Speed*1

CRT	Camera	Lens	Writing Speed cm/μs
Standard 8 div x 10 div	C-53	f/1.9 1:0.85	122
Opt 13 8 cm x 10 cm			260
Opt 78 8 cm x 10 cm			180

*1 *Using Polaroid Type 107 3,000 ASA film without film fogging.*

Autofocus — Reduces the need for additional manual focusing with changes in intensity after focus control has been set.

Beam Finder — Aids in locating an offscreen signal.

External Z-Axis Input — 2 V p-p for full intensity range from dc to 2 MHz; intensity range diminishes to 20% of full range at 10 MHz. A positive signal blanks the trace. Maximum input voltage is 10 V (dc + peak ac) and p-p ac.

CALIBRATOR

Voltage Output — Rectangular waveshape, positive-going from ground (dc voltage available when selected by internal jumper).

Voltage Ranges — 40 mV, 0.4 V, 4 V into 1 MΩ; 20 mV, 0.2 V, 0.4 V into 50 Ω. Amplitude accuracy is within 1% (+15°C to +35°C); within 2% (0°C to +50°C). Repetition rate is ≈1 kHz.

Current Output — 40 mA rectangular waveshape (dc current available when selected by internal jumper) with optional current-loop accessory (012-0259-00) connected between 4 V and ground pin jacks. Output R is 950 Ω.

OUTPUTS/INPUTS

+Sawtooth Out (Rear Panel) — Sawtooth starts 1 V or less from ground (into 1 MΩ). Output voltage is 1 V/div (±10%) into 1 MΩ, 50 mV/div (±15%) into 50 Ω. Output R is 950 Ω.

+Gate Out (Rear Panel) — Positive gate of the same duration and coincident with sweep. Selectable from Main, Delay, or Auxiliary Gate. Output voltage is 10 V (±10%) into 1 MΩ, 0.5 V (±10%) into 50 Ω. Rise time is 20 ns or less into 50 Ω. Output R is 950 Ω.

Vertical Signal Out (Rear Panel) — Selected by Trigger Source switch. Output voltage is 0.5 V/div into 1 MΩ, 25 mV/div into 50 Ω. Output R is 950 Ω. Bandwidth determined by vertical plug-in. See page 219.

Camera Power — Three-prong connector to the left of the CRT provides power, ground, and remote single-sweep reset access for the C-50 Series cameras.

External Single-Sweep Reset — Ground closure, rear panel BNC provides input to reset sweep.

Single-Sweep Ready Output — Rear panel BNC provides 5 V out to indicate single-sweep ready condition.

POWER REQUIREMENTS

Line Voltage Ranges — 100, 110, 120, 200, 220, and 240 V ac ±10%; internally selectable with quick-change jumpers.

Line Frequency — 50 Hz to 60 Hz.

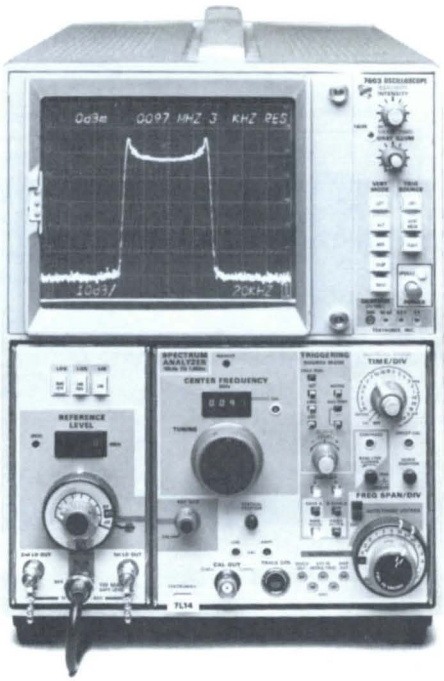
Option 05, Line Frequency Change (50 Hz to 400 Hz) — Converts the R7603 and 7603 from 50 Hz to 400 Hz operation.

Maximum Power Consumption — 180 W, 2.0 A at 115 V line, 60 Hz. Cooling is provided by a fan.

ENVIRONMENTAL AND SAFETY

Ambient Temperature — Operating: 0°C to +50°C. Nonoperating: −55°C to +75°C.

Altitude — Operating: 5000 m (15,000 ft). Nonoperating: 15 000 m (50,000 ft).



The 7L14 converts the 7603 Oscilloscope to a 1.8 GHz Spectrum Analyzer.

Vibration — Operating: 15 minutes along each of the three major axes. 0.04 cm (0.015 in) p-p displacement 0 Hz to 55 Hz to 9 Hz in one minute cycles. Held for three minutes at 55 Hz.

Humidity — Operating and Nonoperating: 95%, five cycles (120 hours), referenced to MIL-E-16400F.

Shock — Nonoperating: 30 g's, ½ sine, 11 ms duration in each direction along each major axis. Total of six shocks.

EMC Capability — (Option 03) Meets MIL-STD-1-A-6181B. Contact your Tektronix representative for more information.

Safety — CSA certified (CSA 556B).

PHYSICAL CHARACTERISTICS

	Cabinet		Rackmount	
Dimensions	**mm**	**in**	**mm**	**in**
Width	221	8.7	483	19.0
Height	290	11.4	133	5.0
Depth	610	24.0	627	24.7
Weights≈	**kg**	**lb**	**kg**	**lb**
Net	13.6	30.0	13.6	30.0
Shipping	20.8	46.0	19.0	42.0

ORDERING INFORMATION
(PLUG-INS NOT INCLUDED)

Ordering information is common to the 7603 and R7603 unless otherwise noted.

7603 Oscilloscope **$3,670**
Includes: Clear CRT filter (337-1700-04); blue CRT filter (337-1700-01); 20 in two-pin-to-BNC cable (175-1178-00); instruction manual (070-1310-00).

R7603 Rackmount Oscilloscope **$4,160**
Includes: In addition to the above, a rackmounting hardware kit (016-0099-00).

OPTIONS

Option 01 — Without CRT Readout. **−$280**
Option 03 — EMC Capability. Adds special shielding for protection to the instrument when operated in severe EMC environments. **+$395**
Option 04 — Maximum Brightness 8 cm x 10 cm CRT Display. GH (P31) Phosphor is Standard. **+$500**
Option 05 — Line Frequency Change (50 Hz to 400 Hz). **+$315**
Option 06 — With Internal Spectrum Analyzer Graticule. **+$50**
Option 08 — (7603) Protective Panel Cover. **+$115**
Option 13 — Maximum Brightness 8 cm x 10 cm CRT Display with BE (P11) Phosphor. **+$600**
Option 20 — (R7603) IEEE Standard 488 Interface for the 7D20 only. (Deletes rear panel + sawtooth out, + gate out, and vert sig out.) **+$105**
Option 76 — GM (P7) Phosphor. **+$100**
Option 77 — GM (P7) Phosphor with Internal Spectrum Analyzer Graticule. **+$100**
Option 78 — BE (P11) Phosphor. **+$100**

CONVERSION KITS

CRT Readout — (7603) Order 040-0654-04 **$775**
(R7603) Order 040-0674-04 **$650**
EMC Capability — (7603) Order 040-1000-00 **$395**
(R7603) Order 040-0955-00 **$300**
Power Supply — To Light Plug-in Pushbuttons. Order 040-0686-01 **$85**
X-Y Horizontal Comp — Order 040-0718-00 **$390**

INTERNATIONAL POWER PLUG OPTIONS

Option A1 — Universal Euro 220 V, 50 Hz.
Option A2 — UK 240 V, 50 Hz.
Option A3 — Australian 240 V, 50 Hz.
Option A4 — North American 240 V, 60 Hz.
Option A5 — Switzerland 220 V, 50 Hz.

FIELD INSTALLED KITS

Field Installable Option 20 — (R7603 only) Intended for use with a previously purchased R7603. This kit provides parts to connect the 7D20's IEEE Standard 488 Interface to the R7603 mainframe. Order 040-1093-00 **$470**

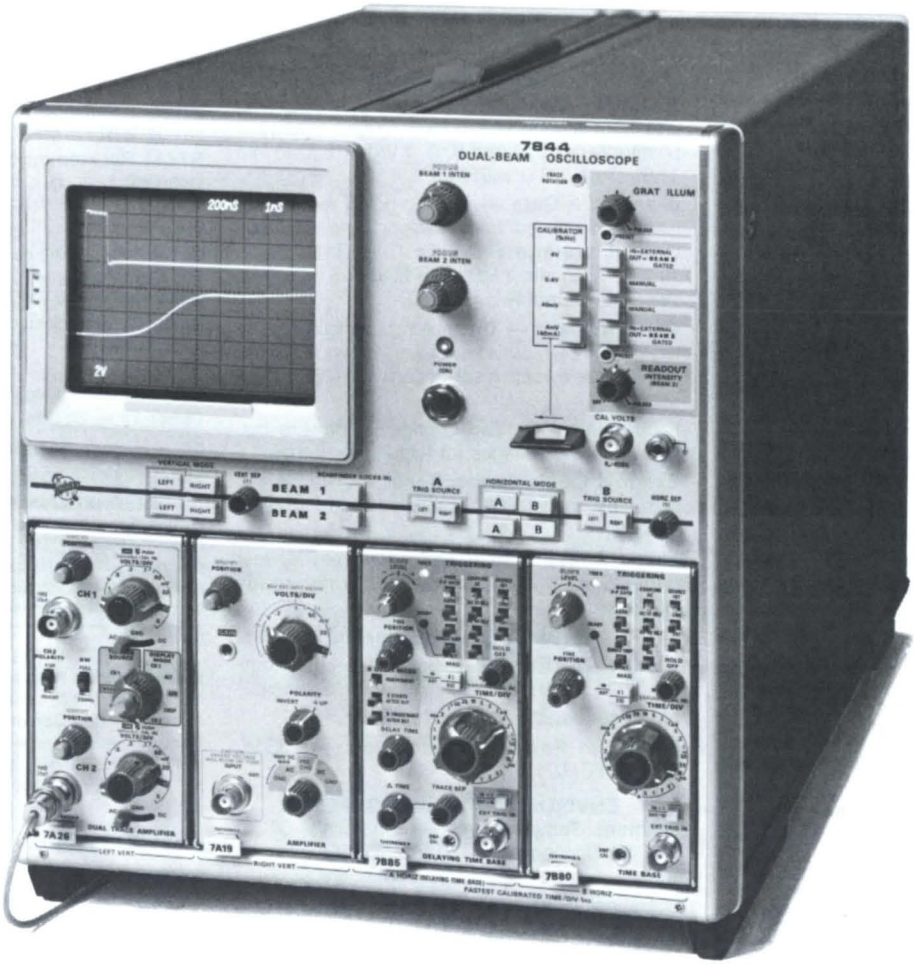
Five field installed kits are available for the international power plug options, A1–A5. Contact your local Tektronix Sales Office for information.

A1 — Universal Euro. Order 040-1094-00 **$415**
A2 — UK. Order 040-1095-00 **$300**
A3 — Australian. Order 040-1096-00 **$300**
A4 — North American. Order 040-1097-00 **$300**
A5 — Switzerland. Order 040-1098-00 **$300**

OPTIONAL ACCESSORIES

Recommended Plug-Ins — See page 218.
Recommended Probes — See pages 219 and 464.
Recommended Cameras — See pages 218 and 442.
Recommended Carts —
K213 Option 12 (7603), see page 462.
K217 (R7603), see page 462.

The R7603 requires only 5.25 inches of rack height in a standard 19-inch rack. It is fan-cooled and comes complete with slideout chassis tracks.



7844/R7844

- 400 MHz Bandwidth
- 900 ps Rise Time
- 1 ns/Div Fastest Calibrated Sweep Rate
- Greater Than 1.5 cm/ns Writing Speed
- 8 cm x 10 cm Display
- CRT Readout
- True Dual Beam (Dual-Gun)
- Full Vertical Crossover Switching

TYPICAL APPLICATIONS

Radar/Lidar
Destructive Testing
SCR Switching

See page 220 for available Application Notes.

The 7844 and seven inch rackmount R7844 are wide bandwidth, dual-beam oscilloscopes designed primarily for fast, single-shot events. Unique features such as pulsed graticule and pulsed CRT readout allow you to photograph vertical and horizontal scale factors, test date, test number, and other pertinent data before or after an event. Vertical signal crossover switching permits you to view a single event from a single probe at two sweep speeds. See page 186 for photographic writing speed specifications.

CHARACTERISTICS

VERTICAL SYSTEM

Channels — Two left-hand plug-in compartments. Compatible with all 7000 Series plug-ins.

Bandwidth — Determined by mainframe and plug-in unit. See page 218.

Rise Time — Determined by mainframe and plug-in unit. See page 218.

Deflection Factor — Determined by plug-in unit. See page 218.

Display Logic

	Beam 1	Beam 2
Vertical Compartment Controlling Beam	Left Left Right Right	Left Right Left Right

Crossover — Permits viewing the same signal on two time bases.

Trace Separation — Beam 1 can be positioned ±4 cm with respect to Beam 2.

Delay Line — Permits viewing leading edge of displayed waveform when using 7B80 and 7B90 Series time bases. Not compatible with 7B50 Series.

HORIZONTAL SYSTEM

Channels — Two right-hand plug-in compartments. Compatible with 7B80 Series, 7B90 Series, 7000 Series vertical amplifiers, and specialized plug-ins.

Bandwidth — Dc to at least 1 MHz.

Fastest Calibrated Sweep Rate — 1 ns/div.

X-Y Mode — Phase shift is within 2° from dc to 50 kHz.

Horizontal Separation — Beam 1 can be positioned at least 0.25 cm to the right and at least 0.25 cm to the left of Beam 2 with a total 2 cm range.

Display Logic

Beam 1	Beam 2
A Horizontal	A Horizontal
A Horizontal	B Horizontal
B Horizontal	A Horizontal
B Horizontal	B Horizontal

CRT AND DISPLAY FEATURES

CRT — Dual beam, full overlap. 8 x 10 cm graticule with variable illumination. CRT readout intensity is adjustable with front panel control. Accelerating potential is 24 kV. GH (P31) phosphor.

Option 78, BE (P11) Phosphor — Replaces standard GH (P31) phosphor.

Pulsed Readout and Graticule Illumination — Provides a means of pulsing the graticule lights and CRT readout at a preset level, coincident with a single-shot event in one exposure. The graticule lights and CRT readout can be pulsed by the event, an external ground closure, or front panel pushbutton.

Typical Photographic Writing Speed*[1]

CRT	Camera	Lens	Writing Speed cm/ns
Standard 8 cm x 10 cm	C-51	f/1.2	0.75
Opt 78 8 cm x 10 cm		1:0.5	1.5

*[1] *Using Polaroid Type 107 3,000 ASA film without film fogging.*

The photographic writing speed enhancer, Option 22, provides a preset automatic method of film fogging for the 7844. Option 22 is recommended for writing speed enhancement when a camera with a writing speed enhancer is not available.

Autofocus — Reduces the need for additional manual focusing with changes in intensity after focus control has been set.

Beam Finder (Beam 1 and Beam 2, Independent Controls) — Aids in locating off screen signal.

External Z-Axis Input (Beam 1 and Beam 2) — 2 V p-p for full intensity range. A positive signal blanks the trace. Maximum input voltage is 15 V (dc + peak ac), p-p ac and dc coupled.

CALIBRATOR

Voltage Output — Rectangular waveform positive-going from ground, 1 kHz (±0.25%).

Voltage Ranges — 4 mV, 40 mV, 0.4 V, 4 V (±1%) into an open circuit; 0.4 mV, 4 mV, 40 mV, 0.4 V (±1%) into 50 Ω.

Current Output — 40 mA (±1%) rectangular waveshape. Front panel current loop on 7844; optional current loop adaptor (012-0341-00) required for R7844. Output R is 450 Ω.

OUTPUTS/INPUTS

A and B + Sawtooth — Sawtooth starts 1 V or less from ground (into 1 MΩ). Output voltage is 50 mV/div (±15%) into 50 Ω, 1 V/div (±10%) into 1 MΩ. Output R is ≈950 Ω.

A and B + Gate — Positive-going rectangular waveform derived from Main or Delayed Gate. Output voltage 0.5 V (±10%) into 50 Ω. 10 V (±10%) into 1 MΩ. Rise time is 5 ns or less into 50 Ω. Output R is ≈950 Ω.

Camera Power — Three-prong connector to the left of the CRT provides power, ground, and remote single-sweep reset access for C-50 Series cameras.

Probe Power — Two connectors provide correct operating voltages for two active probes.

External Single-Sweep Reset — Ground closure, rear panel BNC, provides input to reset sweeps.

Single-Sweep Ready Output — +5 V, rear panel BNC output, for single-sweep ready indication.

POWER REQUIREMENTS

Line Voltage Ranges — Selectable 115 V nominal (90 to 132 V), 230 V nominal (180 to 264 V).

Line Frequency — 48 Hz to 440 Hz.

Maximum Power Consumption — 235 W, 2.9 A at 60 Hz 115 V line.

ENVIRONMENTAL AND SAFETY

Ambient Temperature — Operating: 0° to +50°C. Nonoperating: −55° to +75°C.

Altitude — Operating: 5000 m (15,000 ft). Nonoperating: 15 000 m (50,000 ft).

Vibration — Operating: 15 minutes along each of the three major axes. 0.04 cm (0.015 in) p-p displacement 10 Hz to 50 Hz to 10 Hz in one minute cycles. Held for three minutes at 50 Hz.

Humidity — Operating and Nonoperating: 95%, five cycles (120 hours), referenced to MIL-E-16400F.

Shock — Nonoperating: 30 g's, ½ sine, 11 ms duration in each direction along each major axis. Total of six shocks.

EMC Capability — (Option 03) Meets MIL-STD-461B requirements when tested in accordance with certain test methods of MIL-STD-462. Contact your Tektronix representative for more information.

Safety — UL listed (UL 1244) and CSA certified (CSA 556B).

PHYSICAL CHARACTERISTICS

	Cabinet		Rackmount	
Dimensions	**mm**	**in**	**mm**	**in**
Width	305	12.0	483	19.0
Height	328	12.9	178	7.0
Depth	605	23.8	630	24.8
Weights≈	**kg**	**lb**	**kg**	**lb**
Net	16.3	36.0	15.0	33.0
Shipping	21.3	47.0	28.5	63.0

ORDERING INFORMATION
(PLUG-INS NOT INCLUDED)

Ordering information is common to the 7844 and R7844 unless otherwise noted.

7844 Oscilloscope **$15,365**
Includes: Power cord (161-0066-00); instruction manual (070-1676-02).

R7844 Rackmount Oscilloscope **$15,810**
Includes: In addition to the above a hardware rackmount kit (016-0099-00); slide guide (351-0314-01).

OPTIONS

Option 03 — EMC capability. Adds special shielding for protection to the instrument when operated in severe EMC environments. **+$395**

Option 21 — Dedicated Mode. Left vertical is dedicated to Beam 1; right vertical is dedicated to Beam 2. **NC**

Option 22 — Writing Speed Enhancer. **+$400**

Option 78 — BE (P11) Phosphor. **+$100**

CONVERSION KIT

EMC Capability — (7844) Order 040-0834-01 **$535**

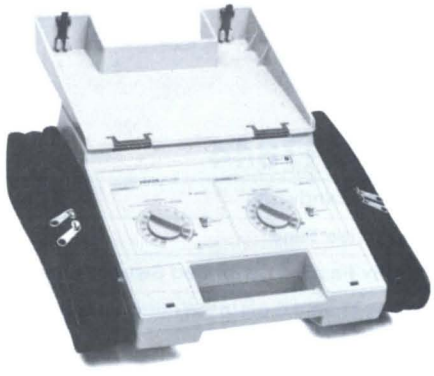
INTERNATIONAL POWER PLUG OPTIONS

Option A1 — Universal Euro 220 V, 50 Hz.
Option A2 — UK 240 V, 50 Hz.
Option A3 — Australian 240 V, 50 Hz.
Option A4 — North American 240 V, 60 Hz.
Option A5 — Switzerland 220 V, 50 Hz.

OPTIONAL ACCESSORIES

Recommended Plug-Ins — See page 218.
Recommended Probes — See pages 219 and 464.
Recommended Cameras — See pages 218 and 442.
Recommended Carts —
K213 Option 12 (7844), see page 462.
K217 (R7844), see page 462.

A6902B Isolator



A dual-channel, optical and transformer-coupled voltage isolator, the A6902B allows safely grounded test instruments to make floating measurements at high sensitivity levels in the presence of large common-mode signals.

Designed for use with any dual-channel oscilloscope, the A6902B permits simultaneous observation of two signals at two different points in the same circuit; or signals in two different circuits without respect to common lead voltages. See page 479.

A6902B Isolator **$1,795**

7000 SERIES CRT STORAGE MAINFRAMES

7613

7623A

7633

NEW 7934

7854 Digital Storage (400 MHz Waveform Processing).
See page 338.

A Selection of Storage Modes
7000 Series storage mainframes offer a selection of storage modes and features:

- Bistable—For long view time
- Fast Bistable—Captures fast single or multiple events
- Variable Persistence—High contrast displays
- Fast Variable Persistence—Provides maximum stored writing rate

Selection of Writing Speeds
Storage mainframes in the 7000 Series offer a full selection of stored writing speeds: from ≈0.03 cm/μs for mechanical, spectrum analysis, or TDR applications, to 4 cm/ns for capturing fast single events such as high speed digital logic.

CONTENTS

7934 Fast Storage 234
7633/R7633 Multimode Storage 236
7623A/R7623A Multimode Storage 236
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Nonstorage Mainframes 221
Plug-Ins 239
High Performance Digitizing Mainframes . 324

7000 SERIES STORAGE SELECTION GUIDE

Features	*NEW* 7934	7633/R7633	7623A/R7623A	7613/R7613
Bandwidth	500 MHz	100 MHz	100 MHz	100 MHz
Maximum Sweep Rate	500 ps/div	5 ns/dv	5 ns/div	5 ns/div
Rise Time	700 ps	3.5 ns	3.5 ns	3.5 ns
Stored Writing Speed	4 cm/ns	1000 cm/μs	135 cm/μs	4.5 cm/μs
Storage Mode				
Bistable	✓	✓	✓	
Fast Bistable	✓	✓	✓	
Variable Persistence	✓	✓	✓	✓
Fast Variable Persistence	✓	✓	✓	
Page	234	236	236	236
Prices Begin At*[1]	$13,365	$9,215/9,725	$7,135/7,580	$6,145/6,610

[1] Price does not include plug-in.

NEW 7934

Dc to 500 MHz Bandwidth

700 ps Single-Shot Rise Time Storage Capability

4 cm/ns Stored Writing Speed

500 ps/Div Fastest Calibrated Sweep Rate

Multimode Storage Flexibility

Wide Selection of Plug-In Amplifiers and Time Bases

TYPICAL APPLICATIONS
Laser Research
High Speed Logic
ESD Testing
Data Base Analysis

See page 220 for available Application Notes.

The 7934 Storage Oscilloscope is designed for fast single-shot, low repetition rate, and high speed pulse analysis. The 7934 captures the most difficult types of signals for stored viewing and analysis. This includes storing unexpected transient pulses common in power generation and nuclear test studies, high frequency bursts occurring at low repetition rates, and fast pulses in applications ranging from lasers to high speed ECL design.

A 4 cm/ns storage writing rate, 700 ps rise time, and 500 MHz bandwidth ensure undistorted capture and clear display of the fastest waveform details.

The 7934 stores single-shot rise times to 700 ps, 3.6 cm high, at eight divisions amplitude, in the reduced scan mode. The 7934's mainframe bandwidth is 500 MHz. The system bandwidth may vary from 80 MHz to 500 MHz, depending on the plug-in selected.*[1]

The instrument has four storage modes: Bistable, Variable Persistence, Fast Bistable and Fast Variable Persistence.

Bistable provides stored displays with long (30 minute) view time.

Variable Persistence gives high contrast displays of both single-shot and repetitive phenomena. When viewing changing waveshapes, variable persistence provides continuous bright displays of new information as old information fades from the CRT.

Fast Bistable increases bistable writing speed to 350 cm/μs (reduced scan).

Fast Variable Persistence provides the maximum stored writing speed of 4 cm/ns (reduced scan). View time is at least 30 seconds.

The 7934 also offers Store Off for conventional oscilloscope use . . . Multitrace Delay to adjust view time before the next stored trace in Fast transfer . . . Storage Level for adjustable writing speed . . . Save to prevent display erasure and provide up to 30-times extension of viewing time in the variable persistence modes . . . Auto Erase with time interval selection to more than 10 seconds between erasures.

The 7934 has four plug-in compartments with pushbutton selection of active compartments and trigger sources. There is also a choice of over 30 Tektronix 7000 Series plug-in amplifiers, time bases, and special purpose plug-ins. This provides the flexibility to design a complete measurement system to fit a specific need, and quickly change it when measurement needs change.

*[1] *High gain differential amplifiers offer very high gain at lower bandwidths.*

CHARACTERISTICS

VERTICAL SYSTEM

Channels — Two left-hand plug-in compartments. Compatible with all 7000 Series plug-ins.

Bandwidth — 500 MHz with 7A29 Amplifier plug-in. See page 218.

Rise Time — 700 ps or less with 7A29 Amplifier plug-in (1.1 ns at 10 mV). See page 218.

Deflection Factor — Determined by plug-in unit. See page 218.

Display Modes — Left, Alt, Add, Chop, Right. Chopped mode repetition rate is ≈1 MHz.

Trace Separation — In dual-sweep modes, positions B trace at least four divisions above or below the A trace.

Delay Line — Permits viewing leading edge of displayed waveform (not recommended for use with 7B50 Series time bases).

HORIZONTAL SYSTEM

Channels — Two right-hand plug-in compartments. Compatible with most 7000 Series plug-ins. 7000 Series vertical amplifiers and special plug-ins may also be used.

Bandwidth — Dc to at least 1 MHz.

Display Modes — A, Alt, Chop, B. Chopped mode repetition rate is ≈200 kHz.

Fastest Calibrated Sweep Rate — 500 ps/div.

X-Y Mode — Phase shift between vertical and horizontal channels is within 2° from dc to 35 kHz without phase correction (dc to 1 MHz with phase correction, B horizontal only, Option 02). Bandwidth is dc to at least 1 MHz.

CRT AND DISPLAY FEATURES

CRT — Internal variable illuminated graticule. 8 x 10 division (0.9 cm/div) graticule in full scan and 8 x 10 division (0.45 cm/div) in reduced scan. Accelerating potential is ≈10 kV full scan mode, and 12 kV in reduced scan mode. GH (P31) phosphor standard.

Auto Focus — Maintains CRT focus following changes in display intensity after focus control has been set.

Beam Finder — Aids in locating an off-screen signal.

CRT Display Modes — Store Off, Bistable, Variable Persistence, Fast Bistable and Fast Variable Persistence (full and reduced scan).

NEW

Auto Erase — Continuously variable from <1 s to >10 s.

Multitrace Delay — Adjusts the transfer cycle time in the fast transfer modes. Continuously variable from <1 s to >4 s.

Persistence — (Variable Persistence Mode only) Controls rate of continuous erasure of the variable persistence and fast variable persistence stored displays.

Save — Prevents display from being accidentally erased, and provides up to 30 times longer viewing times in variable persistence modes.

External Z-Axis Input — 2 V p-p for full intensity range from dc to 1 MHz. Positive signal blanks the trace. Maximum input voltage is 15 V (dc plus peak ac).

Storage Writing Speed

Full Scan (Center 6 div x 8 div at 0.9 cm/div)

Display Mode	Fast Variable Persistence	Fast Bistable	Variable Persistence	Bistable
Stored Writing Speed	270 cm/μs (300 div/μs)	45 cm/μs (50 div/μs)	1.8 cm/μs (2 div/μs)	0.027 cm/μs (.03 div/μs)
View Time	30 s*1	30 min	30 s*1	30 min
≈Erase Time	1.4 s	1.4 s	0.9 s	0.9 s

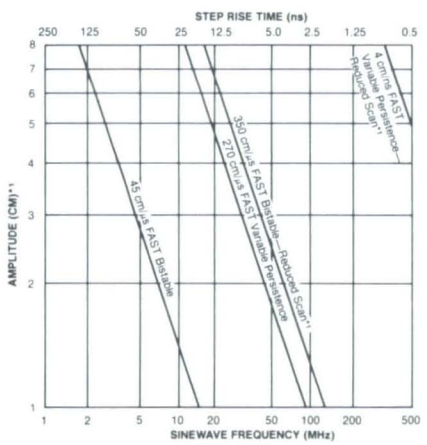
Reduced Scan (Center 8 div x 10 div at 0.45 cm/div)

Display Mode	Fast Variable Persistence	Fast Bistable	Variable Persistence	Bistable
Stored Writing Speed	4 cm/ns (8.9 div/ns)	350 cm/μs (776 div/μs)	5.4 cm/μs (12 div/μs)	0.09 cm/μs (0.2 div/μs)
View Time*1	30 s*1	30 min	30 s*1	30 min
≈Erase Time	1.4 s	1.4 s	0.9 s	0.9 s

*1 *View times are at full stored display intensity. They may be increased more than 30 times by using reduced intensity in the Save display mode.*

Fast Variable Persistence Writing Speed

Scan Mode	Sweep Speed	Peak-to-Peak Sinewave	Step Response
Reduced Scan 8,900 div/μs (0.45 cm/div)	≥1 ns/div	7.1 div 325 MHz	7.7 div 1.07 ns
		8 div 290 MHz	8 div 1.2 ns
Full Scan 300 div/μs (0.9 cm/div)	≥10 ns/div	3.2 div 30 MHz	3 div 10 ns
		6.4 div 15 MHz	5 div 16.6 ns



Graph showing the stored writing speed needed to display a given sinewave or step rise time at a given amplitude.

*1 *Reduced Scan divisions are 0.45 cm.*

CALIBRATOR

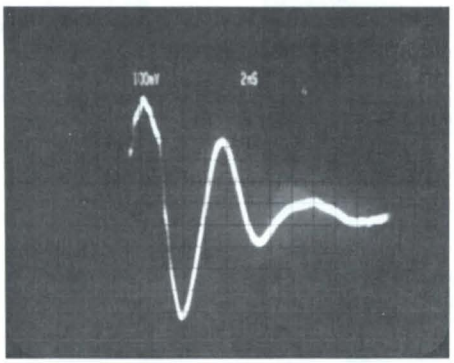
Voltage Output — Squarewave, positive-going from ground.

Voltage Range — 40 mV, 0.4 V, and 4 V into 100 kΩ; 4 mV, 40 mV, and 0.4 V into 50 Ω. Amplitude accuracy is within 1%; repetition rate is 1 kHz within 0.25%.

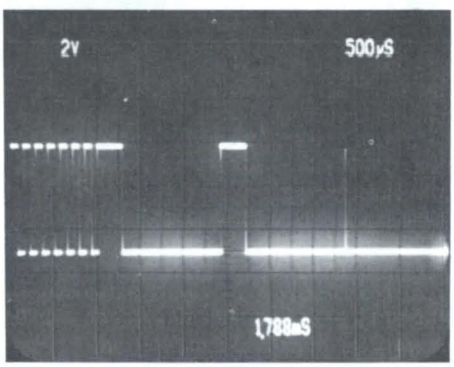
Current Output — 40 mA squarewave with optional current-loop accessory (012-0341-00) connected to calibrator output. Output R is 450 Ω.

OUTPUTS/INPUTS

+Sawtooth — Starts 1 V or less from ground into 1 MΩ. Output voltage is 1 V/div (±10%) into 1 MΩ, 50 mV/div (±15%) into 50 Ω. Output R is ≈950 Ω.



In laser research—The 7934 captures a laser primary and reflected pulse using Fast Variable Persistence storage (reduced scan) and two 7A29 plug-ins in ADD mode.



Glitch Capture—The 7934 captures a glitch (near the 8th) using a 7A29 plug-in and variable persistence storage.

+Gate — Positive pulse of the same duration and coincident with sweep selectable from A Gate, B Gate or A Delayed Gate. Output voltage is 10 V (±10%) into 1 MΩ, 0.5 V (±10%) into 50 Ω. Output R is ≈950 Ω.

Vertical Signal Out — Selected by B Trigger Source switch. Output voltage is 0.5 V (±10%) into 1 MΩ, 25 mV (±10%) into 50 Ω. Output R is ≈950 Ω.

Bandwidth — Determined by vertical plug-in. See page 218.

Remote Single Sweep Reset, Remote Save and Remote Erase — Rear panel BNC connector inputs, ground closure activated.

Remote Fast Transfer Gate — TTL compatible. Low to high transition enables high speed target to receive information to be stored; high to low transition initiates transfer from high speed target to storage target.

Camera Power — Three-prong connector to the left of the CRT provides power, ground, and remote single-sweep reset access for the C-50 Series cameras.

Probe Power — Two rear panel connectors for two active probes.

POWER REQUIREMENTS

Line Voltage Ranges — 90 V to 132 V ac and 180 V to 250 V ac.

Line Frequency — 48 Hz to 440 Hz.

Maximum Power Consumption — 230 W.

ENVIRONMENTAL AND SAFETY

Ambient Temperature — Operating: 0°C to +50°C. Nonoperating: −55°C to +75°C.

Altitude — Operating: 5000 m (15,000 ft). Nonoperating: 15 000 m (50,000 ft).

Vibration — Operating: 15 minutes along each of the three major axes. 0.04 cm (0.015 in) p-p displacement 10 Hz to 55 Hz to 10 Hz in one minute cycles. Held for three minutes at 55 Hz, referenced to MIL-T-28800C.

Humidity — Operating/Nonoperating: 95%, 5 cycles (120 hours), referenced to MIL-E-16400F.

Shock — Nonoperating: 30 g's, ½ sine, 11 ms duration in each direction along each major axis. Total of six shocks, referenced to MIL-T-28800C.

EMC Capabilty — Meets MIL-STD-461B requirements when tested in accordance with certain test methods of MIL-STD-462. Contact your Tektronix representative for more information.

Safety — UL listed (UL 1244) and CSA certified (CSA 556B); meets VDE 0871 Class B.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	305	12.0
Height	345	13.6
Depth	622.5	24.5
Weight≈	**kg**	**lb**
Net, without plug-ins	17.2	37.8
Shipping, without plug-ins	21.6	47.6

ORDERING INFORMATION

(PLUG-INS NOT INCLUDED)

7934 Storage Oscilloscope **$13,365**

Includes: Installed gray CRT filter (378-0625-02); green CRT filter (378-0625-08); power cord (161-0066-00); operator's manual (070-5879-00).

OPTIONS

Option 02 — X-Y Mode Phase Correction. Adds X-Y delay compensation network to equalize the signal delay between either vertical compartment and the B horizontal compartment. **+$260**

Option 03 — EMC capability. Adds special shielding for protection to the instrument when operated in severe EMC environments. **+$395**

CONVERSION KITS

X-Y Mode Phase Correction — Order 040-0942-01 **$195**

EMC Capability — Order 040-1195-00 **$375**

INTERNATIONAL POWER PLUG OPTIONS

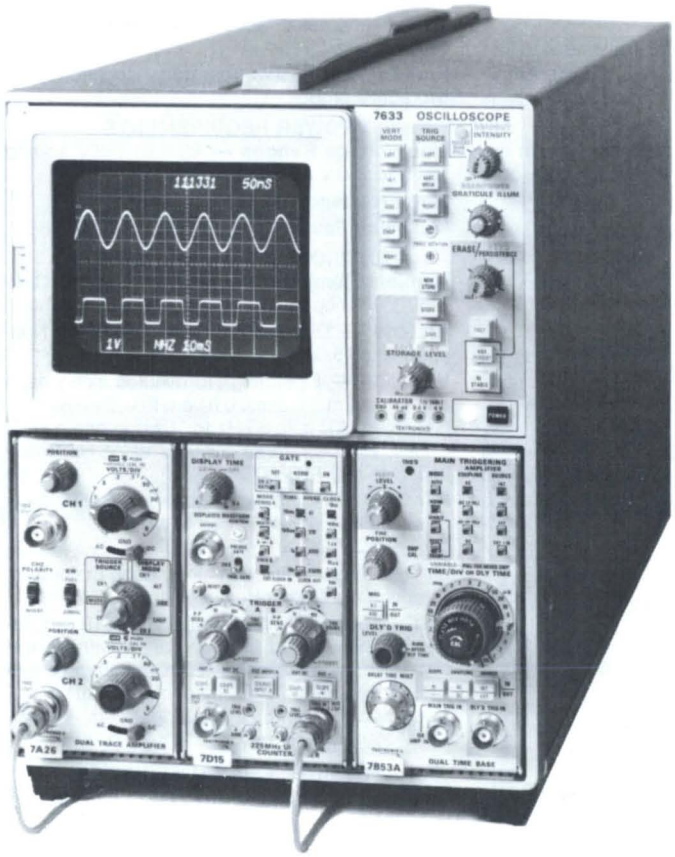
Option A1 — Universal Euro 220 V, 50 Hz.
Option A2 — UK 240 V, 50 Hz.
Option A3 — Australian 240 V, 50 Hz.
Option A4 — North American 240 V, 60 Hz.
Option A5 — Switzerland 220 V, 50 Hz.

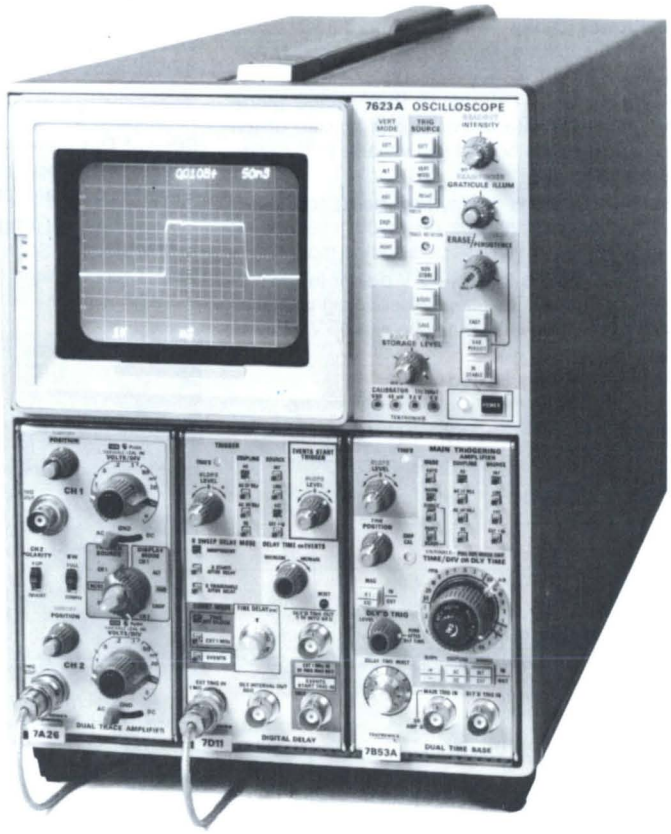
OPTIONAL ACCESSORIES

Service Manual — Order 070-5880-00 **NC**

Cradle Mount Adaptor — For rackmounting. Order 040-0560-00 **$490**

Recommended Plug-Ins — See page 218.
Recommended Probes — See pages 219 and 464.
Recommended Cameras — See pages 218 and 442.
Recommended Cart — K213 Option 12, see page 462.





7600 Series

- Dc to 100 MHz Bandwidth
- 3.5 ns Rise Time
- 5 ns/Div Fastest Calibrated Sweep Rate
- 5.25 Inch Rackmount Height
- Long View Time

7633/R7633 Features:

- 1000 cm/μs Stored Writing Speed
- Multimode Storage

TYPICAL APPLICATIONS
Digital Design
Destructive Testing
Communications

7623A/R7623A Features:

- 135 cm/μs Stored Writing Speed
- Multimode Storage

TYPICAL APPLICATIONS
Ultrasonics
Power Supply Design
Component Testing

7613/R7613 Features:

- 4.5 cm/μs Stored Writing Speed
- Variable Persistence Storage

TYPICAL APPLICATIONS
Audio
Mechanical Transducers
Spectrum Analysis

See page 220 for available Application Notes.

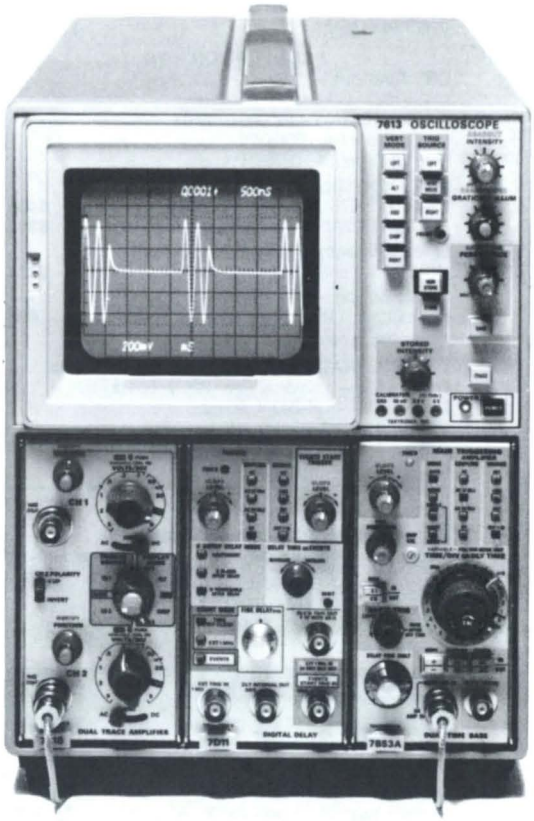
The Tektronix 7633 Storage Oscilloscope provides 2200 div/μs (1000 cm/μs) stored writing speed and 100 MHz bandwidth. The instrument has three display modes—store, nonstore, and save—and four storage modes—bistable, variable persistence, fast bistable, and fast variable persistence. The maximum writing speed of 1000 cm/μs (using the center 8 x 10 reduced scan divisions, 0.45 cm/div) is achieved in reduced scan mode.

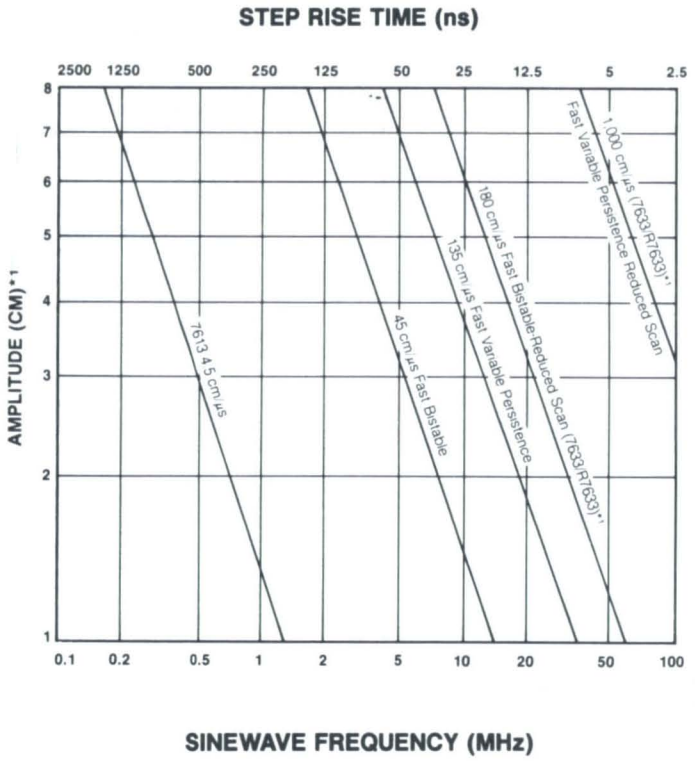
This multimode storage instrument allows for retention and viewing for fast-rise, low-repetition-rate, single-shot, or slow-moving waveforms.

The Tektronix 7623A and R7623A Storage Oscilloscope have all the features and performance of the 7633/R7633 except the reduced scan mode.

The Tektronix 7613 Storage Oscilloscope offers variable persistence operation with a stored writing speed of 5 div/μs or non-storage operation. Stored traces may be viewed up to 60 minutes on a display area of 8 x 10 division (0.9 cm/div).

The R7633, R7623A, and R7613 require only 5.25 inches of rack height in a standard 19-inch rack. They are fan cooled and come complete with slide-out chassis tracks.





Graph showing the stored writing speed needed to display a given sinewave or step rise time at a given amplitude.

**1 Reduced Scan divisions are 0.45 cm.*

CHARACTERISTICS

Characteristics are common to the 7633/R7633, 7623A/R7623A, and the 7613/R7613 unless otherwise noted.

VERTICAL SYSTEM

Channels — Two left-hand plug-in compartments. Compatible with all 7000 Series plug-ins. See page 218.

Bandwidth — Determined by mainframe and plug-in unit. See page 218.

Rise Time — Determined by mainframe and plug-in unit. See page 218.

Deflection Factor — Determined by plug-in unit. See page 218.

Display Modes — Left, Alt, Add, Chop, Right. Chopped mode repetition rate is ≈1 MHz.

Delay Line — Permits viewing leading edge of displayed waveform.

HORIZONTAL SYSTEM

Channel — One right-hand plug-in compartment. Compatible with all 7000 Series plug-ins. See page 218.

Bandwidth — Dc to at least 2 MHz.

Fastest Calibrated Sweep Rate — 5 ns/div.

X-Y Mode — Phase shift <2° from dc to 35 kHz.

CRT AND DISPLAY FEATURES

CRT — Internal 8 x 10 division (0.9 cm/div) graticule with variable illumination. 7633/R7633 have additional (0.45 cm/div) graticule used in the reduced scan mode. Accelerating potential is 8.5 kV (10 kV for 7633/R7633 in reduced scan mode). GH (P31) phosphor is standard.

Option 01, Without CRT Readout — CRT readout can be added later with a conversion kit (040-0748-01 for 7633/7623A, 040-0759-03 for R7633/R7623A, 040-1656-02 for 7613, or 040-0676-04 for R7613).

Autofocus — Reduces the need for additional manual focusing with changes in intensity after focus control has been set.

Beam Finder — Aids in locating an offscreen signal.

CRT Display Modes — Nonstore, Bistable, Variable Persistence, Fast Bistable, Fast Variable Persistence (7633/R7633 and 7623A/R7623A only); Nonstore and Variable Persistence (7613/R7613). Full or reduced scan may be selected on the 7633/R7633 in all display modes. Select normal scan to view the entire CRT; select reduced scan for the fastest writing rate.

Auto Erase — 7633/R7633 and 7623A/R7623A: Continuously variable to >10 s. 7613/R7613: Erase time is 0.5 s or less.

Save — Prevents accidental erasure of display and extends view time up to 30 times longer in all modes.

Persistence — (Variable) Controls rate of continuous erasure of stored displays.

External Z-Axis Input — 2 V p-p for useful intensity range from dc to 2 MHz. Intensity range diminishes to 20% of full range at 10 MHz. Positive signal blanks the trace. Maximum input voltage is 10 V (dc + peak ac) and p-p ac.

Storage Writing Speed

Full Scan (7633/R7633 and 7623A/R7623A)

Display Mode	Fast Variable Persistence	Fast Bistable	Variable Persistence	Bistable
Stored Writing Speed	135 cm/µs	45 cm/µs	0.45 cm/µs	0.03 cm/µs
View Time	30 s*1	30 min minimum	30 s*1	30 min minimum
≈Erase Time	1.4 s	1.4 s	0.9 s	0.9 s

Reduced Scan (7633/R7633 only)

Display Mode	Fast Variable Persistence	Fast Bistable	Variable Persistence	Bistable
Store Writing Speed	1000 cm/µs	180 cm/µs	1.35 cm/µs	0.09 cm/µs
View Time	30 s*1	30 min minimum	30 s*1	30 min minimum
≈Erase Time	1.4 s	1.4 s	0.9 s	0.9 s

**1 These times are at full stored display intensity. They may be increased more than 30 times by using reduced intensity in the Save display mode.*

Fast Variable Persistence Writing Speed

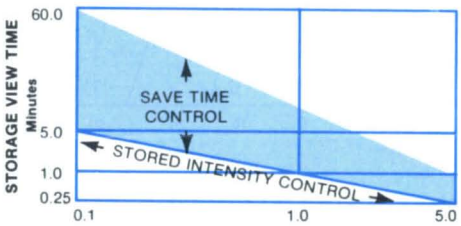
Scan Mode	Sweep Speed	Peak-to-Peak Sinewave	Step Response
Reduced Scan*1 2200 div/μs (0.45 cm/div)	≥5 ns/div	7.1 div 100 MHz 8 div 89 MHz	7.7 div 3.5 ns 8 div 3.7 ns
Full Scan*2 150 div/μs (0.9 cm/div)	≥50 ns/div	3.2 div 15 MHz 6.4 div 7.5 MHz	3 div 20 ns 5 div 33 ns

*1 Applies to 7633/R7633 only.
*2 Applies to 7633/R7633 and 7623A/R7623A.

Save Time Control — (7613/R7613 only) Allows an extension of the view time (see Storage View Time Chart on page 237).

Storage Viewing Time — (7613/R7613 only) Amount of time the stored signal can be viewed before it fades away.

At the maximum writing speed the view time is 15 s or 0.25 minutes with the stored intensity control fully cw. Adjusting the stored intensity ccw will reduce the stored writing speed, but view time can be increased up to five minutes (see the chart below).



STORED WRITING SPEED (div/μs at MAXIMUM PERSISTENCE)

CALIBRATOR

Voltage Output — Rectangular waveshape, positive-going from ground (dc voltage available when selected by internal jumper).

Voltage Ranges — 40 mV, 0.4 V, 4 V into 1 MΩ; 20 mV, 0.2 V, 0.4 V into 50 Ω. Amplitude accuracy is within 1% (15°C to 35°C); within 2% (0°C to 50°C). Repetition rate is ≈1 kHz.

Current Output — 40 mA rectangular waveshape with optional current-loop accessory (012-0259-00) connected between 4 V and ground pin jacks. Output R is ≈450 Ω.

OUTPUTS/INPUTS

+Sawtooth — Sawtooth starts 1 V or less from ground into 1 MΩ. Output voltage is 50 mV/div (±15%) into 50 Ω, 1 V/div (±10%) into 1 MΩ. Output R is 950 Ω within 2%.

+Gate — Positive going waveform of the same duration and coincident with sweep selectable from main, delay, or auxiliary gate. Output voltage is 0.5 V (±10%) into 50 Ω, 10 V (±10%,) into 1 MΩ. Rise time is 20 ns or less into 50 Ω. Output R is 950 Ω within 2%.

Vertical Signal Out — Selected by Trigger Source switch. Output voltage is 25 mV/div into 50 Ω, 0.5 V/div into 1 MΩ. Output R is 950 Ω within 2%. Bandwidth is determined by vertical plug-in. See page 218.

Camera Power Output — Three-prong connector to the left of the CRT provides power, ground and remote single-sweep reset access for the C-50 Series cameras.

External Single-Sweep Reset — Ground closure; rear panel BNC input to reset sweep.

Remote Erase — Rear panel BNC connector inputs, ground closure activated.

POWER REQUIREMENTS

Line Voltage Ranges — 100 V, 110 V, 120 V, 200 V, 220 V, and 240 V ac ±10%; internally selectable with quick change jumpers.

Line Frequency — 50 Hz to 60 Hz.

Option 05, Line Frequency Change (50 Hz to 400 Hz) — Converts 50 Hz to 400 Hz operation.

Maximum Power Consumption — 180 W, 2.0 A at 115 V line, 60 Hz. Fan cooling is provided for all models.

ENVIRONMENTAL AND SAFETY

Ambient Temperature — Operating: 0°C to +50°C. Nonoperating: −55°C to +75°C.

Altitude — Operating: 5000 m (15,000 ft). Nonoperating: 15 000 m (50,000 ft).

Vibration — Operating: 15 minutes along each of the three major axes. 0.04 cm (0.015 in) p-p displacement 10 Hz to 55 Hz to 10 Hz in one minute cycles. Held for three minutes at 55 Hz (MIL-T-28800B).

Humidity — Operating and Nonoperating: 95%, five cycles (120 hours), referenced to MIL-E-16400F.

Shock — Nonoperating: 30 g's, ½ sine, 11 ms duration in each direction along each major axis. Total of six shocks (MIL-T-28800C).

EMC Capability — Meets MIL-STD-461B requirements when tested in accordance with certain test methods of MIL-STD-462. Contact your Tektronix representative for more information.

Safety — UL listed (UL 1244) and CSA certified (CSA 556B).

PHYSICAL CHARACTERISTICS

	Cabinet		Rackmount	
Dimensions	**mm**	**in**	**mm**	**in**
Width	221	8.7	483	19.0
Height	305	12.0	133	5.3
Depth	597	23.5	566	22.3
Weights≈	**kg**	**lb**	**kg**	**lb**
Net	13.6	30.0	14.5	32.0
Shipping	19.0	42.0	28.2	62.0

ORDERING INFORMATION
(PLUG-INS NOT INCLUDED)

7633 Storage Oscilloscope **$9,215**
Includes: 20 in two-pin-to-BNC cable (175-1178-00); green CRT filter (378-0625-08); power cord (161-0066-00); instruction manual (070-1767-00).

R7633 Storage Oscilloscope **$9,725**
Includes: Same as 7633 plus rackmounting hardware.

7623A Storage Oscilloscope **$7,135**
Includes: Same as 7633, instruction manual replaced with 070-1685-00.

R7623A Storage Oscilloscope **$7,580**
Includes: Same as 7633 plus rackmounting hardware, instruction manual replaced with 070-1685-00.

7613 Storage Oscilloscope **$6,145**
Includes: 20 in two-pin-to-BNC cable (175-1178-00); gray CRT filter (378-0625-02); power cord (161-0066-00); instruction manual (070-1463-01).

R7613 Storage Oscilloscope **$6,610**
Includes: Same as 7613 plus rackmounting hardware.

OPTIONS

Option 01 — Without CRT Readout. **−$280**

Option 03 — EMC capability. Adds special shielding for protection to the instrument when operated in severe EMI environments.
(7633/7623A/7613) **+$395**
(R7633/R7623A/R7613) **+$375**

Option 05 — Line Frequency Change (50 Hz to 400 Hz). **+$315**

Option 06 — (7613/R7613 only) Special Internal Graticule (Spectrum Analyzer). **+$50**

Option 08 — (7633/7623A/7613 only) Protective Panel Cover. **+$15**

Option 23 — (7633/7623A/7613 only) VDE RPM Mark. **+$50**

CONVERSION KITS

CRT Readout —
(7633/7623A) Order 040-0748-01
(R7633/R7623A) Order 040-0759-03
(7613) Order 040-0656-04*1
(R7613) Order 040-0676-04*1

EMC Capability —
(7633/7623A/7613) Order 040-0663-01 **$465**
(R7633/R7623A/R7613) Order 040-0678-01 **$395**

Line Frequency Change —
(7613/R7613 only) Order 040-0687-02 **$230**

Power Supply — To light plug-in pushbuttons. Order 040-0686-01 **$85**

1 To order, contact your local Tektronix Sales Office.

INTERNATIONAL POWER PLUG OPTIONS

Option A1 — Universal Euro 220 V, 50 Hz.
Option A2 — UK 240 V, 50 Hz.
Option A3 — Australian 240 V, 50 Hz.
Option A4 — North American 240 V, 60 Hz.
Option A5 — Switzerland 220 V, 50 Hz.

OPTIONAL ACCESSORIES

Recommended Plug-Ins — See page 218.
Recommended Probes — See pages 219 and 464.

RECOMMENDED CARTS

K213 Opt 12 — (7633/7623A/7613) See page 462.
K217 — (R7633/R7623A/R7613) See page 462.

K213 cart shown with optional plug-in storage and keyboard drawer (Option 22).

RECOMMENDED CAMERAS

See pages 219 and 442.

C-53P — General purpose. See page 451. **$1,940**
C-5C Option 01 — Low cost. See page 445. **$465**

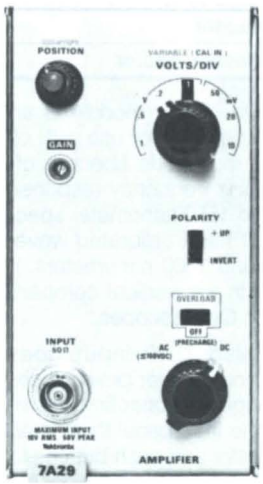
A6902B

Allows high CMRR differential, floating and high voltage measurements safely. See page 479.

A6902B Isolator **$1,795**

7000 SERIES PLUG-INS

7A29



Dc to 1 GHz Amplifier

7A29

Dc to 1 GHz Bandwidth

10 mV/Div to 1 V/Div Calibrated Deflection Factors

50 Ω Input

±500 ps Variable Delay Line (Option 04)

The 7A29 is a high performance, wide band, single trace amplifier which provides a bandwidth of 1 GHz in the 7100 Series mainframes. Bandwidth is constant over the entire range of calibrated deflection sensitivities of 10 mV/div to 1 V/div. Input impedance is 50 Ω. Manually resettable input protection circuitry protects the input against most common overloads. Polarity of the display is selectable by a front panel switch. An optional variable delay line (front panel adjustable) permits matching the transit time of two 7A29s and/or probes to better than 10 ps.

CHARACTERISTICS

Bandwidth — Dc Coupled: 1 GHz (10 mV/div to 1V/div).

Deflection Factor — Calibrated: 10 mV/div to 1 V/div in seven steps (1-2-5 sequence). Accuracy is within 2% with gain adjusted at 0.1 V/div. Uncalibrated: Variable continuously between steps and a maximum of at least 2.5 V/div (with some bandwidth reduction).

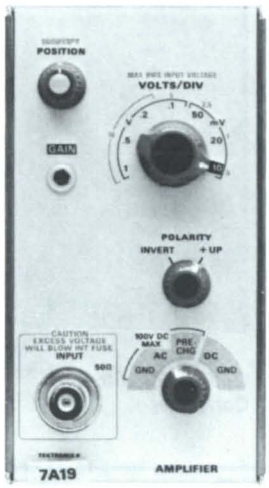
Input Z — 50 Ω.

Ac Coupling — −3 dB at 1 kHz or less from a 50 Ω source.

Option 04, Variable Signal Delay — Permits matching the transit time of two preamps and probes to better than 10 ps. Range is ±500 ps.

Maximum Input Voltage — Dc Coupled: 50 V or 10 V RMS (whichever is less). Ac Coupled: 100 V additional.

7A19



Dc to 600 MHz Amplifier

Dc Stability — Drift with Ambient Temperature (Line Voltage Constant): 0.04 div/°C or less.

Input Protection — Internal detection circuitry provides protection by automatically disconnecting excessive signals of up to 50 V. The "disconnected" condition is indicated and has manual reset.

ORDERING INFORMATION

7A29 Amplifier **$3,325**
Includes: Instruction manual (070-2320-00).
Option 04 — Variable Signal Delay. **+$435**

7A19

Dc to 600 MHz Bandwidth

10 mV/Div to 1 V/Div Calibrated Deflection Factors

50 Ω Input

±500 ps Variable Delay Line (Option 04)

The 7A19 is a high performance, wide band, single trace amplifier which provides a bandwidth of 600 MHz in the 7100 Series mainframes. Bandwidth is constant over the entire range of calibrated deflection sensitivities of 10 mV/div to 1 V/div. Input impedance is 50 Ω. An optional variable delay line (front panel adjustable) permits matching the transit time of two 7A19s and/or probes to better than 50 ps.

CHARACTERISTICS

Bandwidth — Dc Coupled: 600 MHz (10 mV/div to 1 V/div).

Deflection Factor — Calibrated: 10 mV/div to 1 V/div in seven steps (1-2-5 sequence). Accuracy is within 3%.

Input Z — 50 Ω.

For recommended probes, see pages 219 and 464.
For 7000 Series vertical system specifications, see page 218.

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Option 04, Variable Signal Delay — Permits matching the transit time of two preamps and probes to better than 50 ps. Range is ±500 ps.

Maximum Input Voltage — Dc Coupled: 50 V or 10 V RMS (whichever is less). Ac Coupled: 100 V additional.

Dc Stability — Drift with Ambient Temperature (Line Voltage Constant): 100 μV/°C or less.

ORDERING INFORMATION

7A19 Amplifier **$2,895**
Includes: Instruction manual (070-2129-00).
Option 04 — Variable Signal Delay. **+$435**

P6201 FET Probe

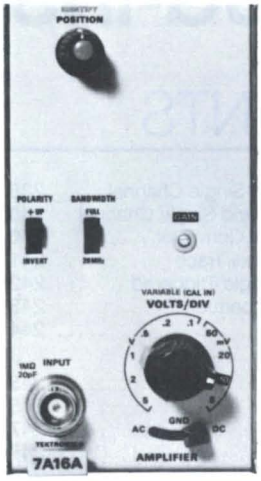
Dc to 900 MHz Bandwidth

50 Ω or 1 MΩ Inputs

ORDERING INFORMATION

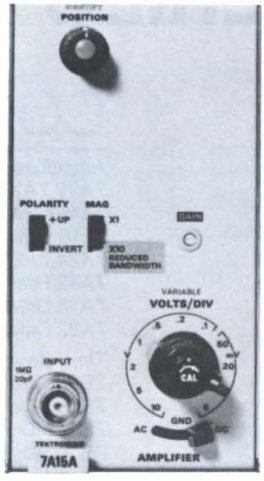
P6201 1X, FET Probe **$1,220**

7A16A



Dc to 225 MHz Amplifier

7A15A



Dc to 80 MHz Amplifier

7F10

Optical-Electrical Converter

7A16A

Dc to 225 MHz Bandwidth

5 mV/Div to 5 V/Div Calibrated Deflection Factors

1 MΩ Input

The 7A16A is a single-trace amplifier which provides a bandwidth of 225 MHz in the 7900 and 7100 Series mainframes. Bandwidth is constant over the entire range of deflection sensitivities of 5 mV/div to 5 V/div. Bandwidth may be limited to 20 MHz to reduce displayed noise in lower-frequency applications.

CHARACTERISTICS

Bandwidth — Dc Coupled: 5 mV/div to 5 V/div; 225 MHz. Ac Coupled: 10 Hz or less to 225 MHz.

Deflection Factor — Calibrated: 5 mV/div to 5 V/div in 10 steps (1-2-5 sequence). Accuracy is within 2% with gain adjusted at 10 mV/div. Uncalibrated: Variable continuously between steps to at least 12.5 V/div.

Input R and C — 1 MΩ within 2%; ≈20 pF.

Maximum Input Voltage — Dc Coupled: 250 V (dc + peak ac), ac component 500 V p-p maximum, 1 kHz or less. Ac Coupled: 500 V (dc + peak ac), ac component 500 V p-p maximum, 1 kHz or less.

Dc Stability — Drift with Ambient Temperature (Line Voltage Constant): 0.02 div/°C. Drift with Time (Ambient Temperature and Line Voltage Constant): 0.02 div in any one minute after one hour warm-up.

Displayed Noise — ⩽0.1 div at 5 mV/div (with a 7900 Series mainframe).

ORDERING INFORMATION

7A16A Amplifier **$1,305**

Includes: Instruction manual (070-1378-01).

For recommended probes, see pages 219 and 464.

For 7000 Series vertical system specifications, see page 218.

7A15A

Dc to 80 MHz Bandwidth

5 mV/Div to 10 V/Div Calibrated Deflection Factors

1 MΩ Input

500 μV/Div at 10 MHz (10X Gain)

The 7A15A is a single-trace amplifier which provides a bandwidth of 80 MHz in the 7800, 7900, and 7100 Series mainframes. Bandwidth is constant over the entire range of deflection sensitivities of 5 mV/div to 10 V/div. A 10X gain amplifier provides 500 μV sensitivity with a bandwidth of 10 MHz. Polarity of the display is selectable by a front-panel switch.

CHARACTERISTICS

Bandwidth — Dc Coupled: 80 MHz (5 mV/div to 10 V/div). Ac coupled: 10 Hz or less to 80 MHz.

Deflection Factor — Calibrated: 5 mV/div to 10 V/div in 11 steps (1-2-5 sequence). Accuracy is within 2% with gain adjusted at 10 mV/div. X10 mag (increases sensitivity to 500 μV) accuracy is within 10% at 10 MHz bandwidth throughout deflection factor settings. Uncalibrated: Variable continuously between steps to a maximum of at least 25 V/div.

Input R and C — 1 MΩ within 2%; ≈20 pF.

Maximum Input Voltage — Dc Coupled: 250 V (dc + peak ac), ac component 500 V p-p maximum, 1 kHz or less. Ac Coupled: 500 V (dc + peak ac), ac component 500 V p-p maximum, 1 kHz or less.

Dc Stability — Drift with Ambient Temperature (Line Voltage Constant): 0.01 div/C°. Drift with Time (Ambient Temperature and Line Voltage Constant): 0.02 div in any one minute after one hour warm-up.

ORDERING INFORMATION

7A15A Amplifier **$730**

Includes: Instruction manual (070-1210-00).

For floating measurements, order A6902B Isolator. See page 479 for complete description.

NEW 7F10

Optical-Electrical Converter

Single Mode/Multimode Fiber Optical Input

700 to 1550 Nanometer Wavelength

10 kHz to 750 MHz Frequency Response

Built-In Optical Attenuator

CRT Readout of Deflection Factor

The 7F10 single wide plug-in module is an optical to electrical converter for use with either single mode or multimode fibers. It offers 10 kHz to 750 MHz frequency response and covers the 700 to 1550 nanometer spectrum with a choice of three calibrated wavelengths: 825, 1300, and 1500 nanometers. It is designed for use in the vertical compartments of 7000 Series Oscilloscopes.

The optically coupled 7F10 input goes through a built-in attenuator that provides sixteen calibrated settings for controlling the input signal level. On the front panel there is an optical overload indicator and push buttons to vary the attenuation level. Readout for deflection factor, uncalibrated indication, and polarity invert appears on the CRT.

CHARACTERISTICS

Converter-Amplifier

Optical Input — Diamond 3.5 mm connector, 50/125 μm multimode fiber.

Wavelength — Operates from 700 to 1550 nm continuously with selectable calibrated settings at 825, 1300, and 1500 nm.

Photo Element — Ge-APD.

Maximum Linear Input — +10 mW optical carrier, 70% modulation.

Deflection Factor — 16 selectable 2.5 dB steps. Calibrated 1500 nm Wavelength: 2.5 μW/div ± 30% at 0 dB attenuation setting. Calibrated 1300 nm Wavelength: 2 μW/div ±30% at 0 dB attenuation setting. Calibrated 850 nm Wavelength: 4 μW/div ±30% at 0 dB attenuation setting.

Variable Range — At least 4 dB.

Frequency Response

7104/R7103	10 kHz to 750 MHz, ±3 dB
7900 Series	10 kHz to 400 MHz, ±3 dB
7800 Series	10 kHz to 300 MHz, ±3 dB

Position Range — 9 divisions each direction from graticule center, within 1 division.

ENVIRONMENTAL

Temperature — Calibration: 20°C to 30°C. Operating: 0°C to 50°C, to 95%. Nonoperating: −55°C to +75°C to 95% humidity.

Altitude — Operating: To 4500 m (15,000 ft). Nonoperating: To 15 000 m (50,000 ft).

ORDERING INFORMATION

7F10 Optical-Electrical Converter **$6,495**

Includes: Instruction manual (070-6277-00).

OPTIONAL ACCESSORIES

1 m Optical Fiber Interface Cables*1 —

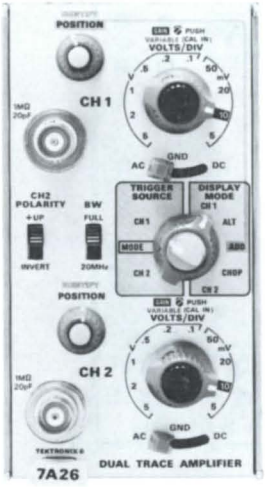
(Diamond 3.5 to Diamond 3.5) Order 174-0045-01	**$235**
(Diamond 3.5 to SMA) Order 174-0524-01	**$150**
(Diamond 3.5 to FC) Order 174-0527-01	**$200**
(Diamond 3.5 to D4) Order 174-0528-01	**$235**
(Diamond 3.5 to AT&T Biconic) Order 174-0530-01	**$180**

**1 3 m cables are also available. To order, contact your local Tektronix Sales Office.*

7A24

Dc to 400 MHz Amplifier

7A26



Dc to 200 MHz Amplifier

7A18A

Dc to 75 MHz Amplifier

7A24

Dc to 400 MHz Bandwidth

5 mV/Div to 1 V/Div Calibrated Deflection Factors

50 Ω Input

The 7A24 is a high-performance, wide-band, dual-trace amplifier which provides 400 MHz bandwidth in the 7100 Series mainframes. Bandwidth is constant over the entire range of deflection sensitivities from 5 mV/div to 1 V/div. Input impedance is 50 Ω. The 7A24 features five operating modes, trigger source selectability and trace identify.

CHARACTERISTICS

Bandwidth — Dc Coupled: 400 MHz (5 mV/div to 1 V/div).

Deflection Factor — Calibrated: 5 mV/div to 1 V/div in eight steps (1-2-5 sequence). Accuracy is within 2% with gain adjusted to 5 mV/div. Uncalibrated: Variable continuously between steps to a maximum of at least 2.5 V/div.

Input Z — 50 Ω within 0.5%;

VSWR

5mV–20mV	≤1.25 ≤1.40	Dc to 350 MHz 350 MHz to 400 MHz
50mV–1V	≤1.20	Dc to 400 MHz

Maximum Input Voltage — Dc Coupled: 5 V RMS.

Dc Stability — Drift with Ambient Temperature (Line Voltage Constant): 0.02 div/°C. Drift with Time (Ambient Temperature and Line Voltage Constant): 0.02 div in any one minute after one hour warm-up.

Displayed Noise — 0.7 div or less at 5 mV/div (with a 7900 Series mainframe).

Common-Mode Rejection Ratio — At least 10:1, dc to 50 MHz.

ORDERING INFORMATION

7A24 Amplifier **$2,655**
Includes: Instruction manual (070-1485-00).

7A26

Dc to 200 MHz Bandwidth

5 mV/Div to 5 V/Div Calibrated Deflection Factors

1 MΩ Input

The 7A26 is a dual-trace amplifier which provides a bandwidth of 200 MHz in the 7900 and 7100 Series mainframes. Bandwidth is constant over the entire range of deflection sensitivities of 5 mV/div to 5 V/div. Bandwidth may be limited to 20 MHz to reduce displayed noise in lower-frequency applications. The 7A26 features five operating modes, trigger source selectability and trace-identify.

CHARACTERISTICS

Bandwidth — Dc Coupled: 200 MHz (5 mV/div to 5 V/div). Ac Coupled: 10 Hz or less to 200 MHz (5 mV/div to 5 V/div).

Deflection Factor — Calibrated: 5 mV/div to 5 V/div in ten steps (1-2-5 sequence). Accuracy is within 2% with gain adjusted at 10 mV/div. Uncalibrated: Variable continuously between steps to a maximum of at least 12.5 V/div.

Input R and C — 1 MΩ within 2%; ≈20 pF.

Maximum Input Voltage — Dc Coupled: 250 V (dc + peak ac), ac component 500 V p-p maximum, 1 kHz or less. Ac Coupled: 500 V (dc + peak ac), ac component 500 V p-p maximum, 1 kHz or less.

Dc Stability — Drift with Ambient Temperature (Line Voltage Constant): 0.02 div/°C. Drift with Time (Ambient Temperature and Line Voltage Constant): 0.02 division in any one minute after one hour warm-up.

Displayed Noise — 0.1 div or less at 5 mV/div (with a 7900 Series mainframe).

Common-Mode Rejection Ratio (Add, CH 2 Invert) — At least 10:1, dc to 50 MHz.

ORDERING INFORMATION

7A26 Amplifier **$2,350**
Includes: Instruction manual (070-1484-01).

7A18A

Dc to 75 MHz Bandwidth

5 mV/Div to 5 V/Div Calibrated Deflection Factors

1 MΩ Input

Dc Offset (Option 06)

The 7A18A is a dual-trace amplifier which provides a bandwidth of 75 MHz in the 7800, 7900 and 7100 Series mainframes. Bandwidth is constant over the entire range of deflection sensitivities of 5 mV/div to 5 V/div. The 7A18A features five operating modes, trigger source selectability, and a trace-identify function.

CHARACTERISTICS

Bandwidth — Dc Coupled: 75 MHz (5 mV/div to 5 V/div). Ac Coupled: 10 Hz or less to 75 MHz (5 mV/div to 5 V/div).

Deflection Factor — Calibrated: 5 mV/div to 5 V/div in ten steps (1-2-5 sequence). Accuracy is within 2% with gain adjusted to 10 mV/div. Uncalibrated: Variable continuously between steps to a maximum of at least 12.5 V/div.

Input R and C — 1 MΩ within 2%; ≈20 pF.

Maximum Input Voltage — Dc Coupled: 250 V (dc + peak ac), ac component 500 V p-p maximum, 1 kHz or less. Ac Coupled: 500 V (dc + peak ac), ac component 500 V p-p maximum, 1 kHz or less.

Dc Stability — Drift with Ambient Temperature (Line Voltage Constant): 0.01 div/°C. Drift with Time (Ambient Temperature and Line Voltage Constant): 0.02 div in any one minute after one hour warm-up.

Displayed Noise — 0.06 div or less.

Common-Mode Rejection Ratio (Add, CH 2 Invert) — At least 10:1, dc to 50 MHz.

DC OFFSET OPTION

Option 06, Dc Offset — Allows small signals riding on larger signals, such as power supply ripple, to be analyzed. Separate Channel 1 and Channel 2 variable offset controls are concentric with the position controls replacing the identify push-buttons of the standard 7A18A. The ac-dc-ground switch of each channel is expanded to accommodate a fourth position for dc offset.

Offset Range Display — ±200 division maximum, equivalent to ±1 V at 5 mV/div.

Accuracy — When in dc Offset the deflection accuracy is derated by 1%.

ORDERING INFORMATION

7A18A Amplifier **$1,465**
Includes: Instruction manual (070-4329-00).
Option 06 — Dc Offset. **+$210**

ISOLATOR

A6902B — For floating and differential measurements. See page 479. **$1,795**

For recommended probes, see pages 219 and 464.
For 7000 Series vertical system specifications, see page 218.

7A42

Up to 350 MHz Bandwidth (7100 Family)

Four Input Channels

Boolean Logic Triggering

Nested Trigger Functions

Variable Switching Thresholds

Precise Amplitude and Timing Measurement

External Clock Synchronization

1 MΩ/50 Ω Switchable Inputs

Variable/Bias Offset Probe Compatibility

7000 Series Mainframe Compatible

The 7A42 Four Channel Logic Triggered Vertical Amplifier is a combination of amplifier and triggering technologies.

High Resolution Analog Display of Digital Signals

Accurate analog representations of digital signals are displayed. A 1 ns rise time with 200 ps or less delay difference between the four input channels provides precise, high resolution timing measurements.

Advanced Triggering

Triggers are generated by the 7A42 upon recognition of user-programmed Boolean combinations of logic levels and transitions at any or all of its input channels. Triggers may be generated on event "A," event "B," or on "A then B."

Trigger View trace shows where the trigger event occurred and how long it lasted. A trigger filter eliminates requirements that a trigger function remain true longer than the Trigger Filter setting.

External Clock Synchronization

A triggering event can coincide with either a positive or negative transition of an external clock signal.

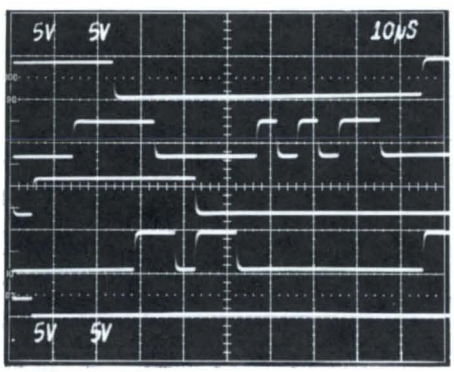
Special Probe Features

The P6230 is a 1.5 GHz, 450 Ω probe with the ability to place bias voltage at its tip. The P6131 10X high impedance probe is the recommended probe for TTL, high speed TTL, and CMOS logic families.

Easy Set-Up

CRT readout of attenuator settings, the display of error messages and use of multi-colored LEDs communicate the status of other 7A42 functions at a glance. A battery backup system preserves the current settings when power is removed.

Four Channel Analog Display With Trigger View



Up to four logic signals can be displayed by the 7A42 in true analog form. Additionally, the Trigger View trace provides the ability to view exactly when the programmed Trigger Function is satisfied.

CHARACTERISTICS

VERTICAL SYSTEM

Input — Four channels, BNC connectors.

Bandwidth — To 350 MHz maximum. See page 219.

Input Impedance — Selectable between 1 MΩ and 50 Ω.

Maximum Input Voltage — 1 MΩ: 25 V (dc + peak ac). 50 Ω: 5 V RMS during any 1 ms time interval. Active internal protection opens all inputs if overvoltage is applied to any channel.

Differential Delay — 200 ps maximum between the four input channels.

Trigger View or External Clock View — Time Coincidence with Channel Display: Trigger View is within 3 ns. External Clock View is within 5 ns.

TRIGGER SYSTEM

External Clock Input — Maximum Voltage Range: +5 V to −5 V (dc + peak ac). Pulse Width: TTL level is 20 ns minimum, either pulse transition selected. ECL level is 5 ns minimum, leading edge or 10 ns minimum, trailing edge.

Channel Edge Sensitivity — Set-Up Time, Channel to Channel: 5 ns minimum (time that level sensitive portion of trigger function must be true before Edge Sensitive Channel transition). Hold Time, Channel to Channel: 5 ns minimum (time that level sensitive portion of trigger function must remain true after Edge Sensitive Channel transition). Set-Up Time, Edge Sensitive Channel: 10 ns minimum (time that level of Edge sensitive channel must be stable before transition). Hold Time, Edge Sensitive Channel: 5 ns minimum (time that level of Edge Sensitive Channel must remain stable after transition).

Trigger Out Connector — Output Voltage: 1 V into 50 Ω. Output Impedance: ≈50 Ω. Toggle Frequency: 125 MHz maximum.

Reset Input — Maximum Input Voltage: +5 V to −5 V (dc + peak ac). Input Impedance: ≈50 Ω. Logic Zero Level: ≤0.2 V. Logic One Level: ≥0.8 V. Pulse Width: 100 ns minimum. Timing (Post-Reset Inhibit Time to Next Trigger): 10 ns minimum (time from falling edge of Reset to next recognizable event).

Response Time: Reset pulse must lead or be coincident with event recognition to inhibit trigger output. Event recognition must lead the Reset pulse by 10 ns to guarantee trigger output.

BATTERY BACK-UP

Ni-Cad Battery (3.75 V) — Provides power to preserve front panel control status a minimum of 200 hours while main power is off. Battery requires about 24 hours to fully charge from discharged condition.

ORDERING INFORMATION

7A42 Logic Triggered Vertical Amplifier **$6,200**
Includes: Instruction manual (070-4285-00).

OPTIONAL ACCESSORIES

P6230 — 10X Variable Bias/Offset **$395**

P6131 — 10X Passive **$140**

KLIPKIT — Provides hands-free connection to integrated circuits. See page 489 for complete description. Order 013-0197-00 **$40**

For recommended probes, see pages 219 and 464.
For 7000 Series vertical system specifications, see page 218.

7A13

Differential Comparator Amplifier

7A13

Dc to 105 MHz Bandwidth

1 mV/Div to 5 V/Div Calibrated Deflection Factors

1 MΩ Input Switchable to ∞

20,000:1 CMRR

10,000 cm Effective Screen Height

The 7A13 is a differential comparator amplifier which provides dc to 105 MHz bandwidth in all the 7100 and 7900 Family instruments. It incorporates a number of features which make it particularly versatile, especially in multitrace combination with other 7000 Series vertical plug-ins.

The 7A13 has constant bandwidth over the 1 mV/div to 5 V/div deflection factor range. The bandwidth is selectable to Full or 5 MHz for best displayed noise conditions for low-frequency applications.

As a differential amplifier the 7A13 provides a balanced (+ and −) input for applications requiring rejection of a common-mode signal. The CMRR is 20,000:1 from dc to 100 kHz, derating to 200:1 at 20 MHz. The unit can reject up to 10 V of common-mode signal at a deflection factor setting of 1 mV/div, increasing to 100 V at 10 mV/div (X10 Vc pulled) and 500 V at 0.1 V/div.

As a comparator amplifier the 7A13 provides an accurate (0.1%) positive or negative internal offsetting voltage of up to ±10 V. This precision offset voltage effectively provides a screen height of 10,000 div at 1 mV/div. The offset voltage is also available as an output for external monitoring.

CHARACTERISTICS

Bandwidth — Dc Coupled: 105 MHz (1 mV/div to 5 V/div).

Input R and C — 1 MΩ within 0.15%; ≈20 pF. R_{in} ≈∞ is available in the 1 mV to 50 mV/div range, selectable by an internal switch.

Deflection Factor — Calibrated: 1 mV/div to 5 V/div in 12 steps (1-2-5 sequence). Accuracy is within 1.5% with gain adjusted at 1 mV/div. Uncalibrated: Variable continuously between steps to a maximum of at least 12.5 V/div.

Maximum Input Gate Current — 0°C to +35°C: 0.2 nA or less. +35°C to +50°C: 2 nA or less.

Dc Stability — Drift with Ambient Temperature (Line Voltage Constant): 2 mV/10°C to 0.2 div/10°C or less (whichever is greater). Drift with Time (Ambient Temperature and Line Voltage Constant): Short term is 1 mV p-p or 0.1 div or less (whichever is greater) over any one minute interval after 20 minute warm-up. Long term is 1 mV p-p or 0.1 division or less (whichever is greater) during any one hour interval after 20 minute warm-up.

Signal Range

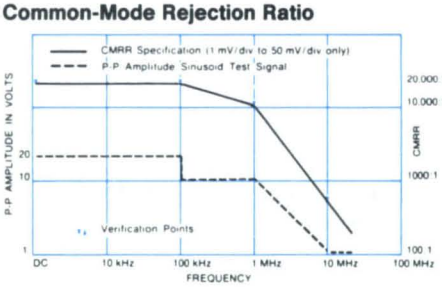
Deflection Factor Settings	1 mV to 50 mV/div	10 mV to 50 mV/div (X10 Vc out) and 0.1 V to 0.5 V/div	0.1 V to 0.5 V/div (X10 Vc out) and 1 V to 5 V/div
Common-Mode Signal	±10 V	±100 V	±500 V
Maximum Dc Coupled Input (dc + peak ac at 1 kHz or less)	±40 V	±400 V	±500 V
Maximum Ac Coupled Input (dc voltage)		±500 V	

Displayed Noise (Tangentially Measured) — With X10 Vc In: 400 μV (200 μV RMS) or less at 1 mV/div; 0.2 div or less at 2 mV/div to 5 mV/div; 0.05 div or less at 10 mV/div to 5 V/div. With X10 Vc Out: 0.4 div or less at 10 mV/div to 0.5 V/div.

Overdrive Recovery — 1 μs to recover to within 2 mV and 0.1 ms to recover to within 1 mV after a pulse of ±10 V or less at 1 mV/div only, regardless of pulse duration.

Internal Comparison Voltage — Range: 0 V to ±10 V. Accuracy: ±(0.1% of setting +3 mV). Vc Output R: ≈15 kΩ.

Common-Mode Rejection Ratio



At least 2000:1, 10 mV/div to 50 mV (X10 Vc out) and 0.1 V/div to 5 V/div. Ac coupled input at least 500:1 at 60 Hz.

ORDERING INFORMATION

7A13 Amplifier **$3,400**

Includes: Instruction manual (070-1948-00).

For floating measurements, order A6902B Isolator. See page 479 for complete description.

For recommended probes, see pages 219 and 464.
For 7000 Series vertical system specifications, see page 218.

P6055

20,000:1 CMRR, 10X With Readout

Dc to 60 MHz

Low Capacitance

High CMRR

Compact Size

The P6055 is a miniature, low-capacitance, 10X probe designed for use with Tektronix differential amplifiers with nominal input capacitances from 20 pF to 47 pF. The attenuation ratio is adjustable to compensate for differences in input resistance of the amplifier (the amplifier input resistance must be 1 MΩ ±2%). A special locking type readout connector allows the probe to be used with instruments with or without readout capability.

When two P6055 probes are used to drive the two inputs of a differential amplifier, the ability to change the attenuation ratio of one probe versus the other is helpful in maintaining the CMRR of the system. The use of a matched pair of P6055 differential probes provides the best possible system CMRR.

CHARACTERISTICS

Maximum Useful Bandwidth — 60 MHz.

Rise Time — 5.8 ns.

Input Capacitance — ≈10 pF when used with instrument that has 20 pF input capacitance; 12.5 pF when used with instrument that has 47 pF input capacitance.

Attenuation — Adjustable to 10X.

Input Resistance — 1 MΩ ±0.5%.

CMRR — 20,000:1 from dc to 1 kHz derating to 100:1 at 20 MHz.

Maximum Voltage — 500 V (dc + peak ac) from dc to 12 MHz. P-p voltage derates to 100 V at 70 MHz.

ORDERING INFORMATION

P6055 Matched pair of 10X, 3.5 ft Differential Probes **$535**

Includes: Retractable hook tip (BB, 013-0107-05); 13 cm (5 inch) ground lead (175-0124-01); two electrical insulating sleeves (BP, 166-0404-01); two alligator clips (AS, 344-0046-00); probe holder (352-0090-00); adjustable tool (CP, 003-0675-01); hook tip (BU, 206-0114-00); 13 cm (6 inch) electrical ground lead (DF, 175-1256-00); 30 cm (12 inch) ground lead (175-0125-01); instruction manual (070-1115-00).

Option 01 — Single probe with accessories **−$260**

To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext 99.

7A22

Dc to 1 MHz Bandwidth

10 μV/Div to 10 V/Div Calibrated Deflection Factors

1 MΩ Input

100,000:1 CMRR

Selectable Upper and Lower −3 dB Points

Dc Offset

10 μV/Hour Dc Drift*[1]

[1] With constant temperature. See dc stability specifications.

The 7A22 is a high gain differential amplifier well suited for difficult low-amplitude, low-frequency measurements. Selectable high and low pass filters help eliminate unwanted noise and drift from the display and from the triggering signal.

CHARACTERISTICS

Bandwidth — HF: −3 dB point. Selectable in nine steps (1-3 sequence) from 100 Hz to 1 MHz. Accuracy is within 10% of selected frequency. Rise time is 350 ns ±9% in 1 MHz position. LF: −3 dB point. Selectable in six steps (1-10 sequence) from 0.1 Hz to 10 kHz. Accuracy is within 12% of selected frequency. The switch also contains dc and dc with Offset positions. Ac coupled at input, 2 Hz or less.

Deflection Factor — Calibrated: 10 μV/div to 10 V/div in 19 steps (1-2-5 sequence). Accuracy is within 2% with gain adjusted to 1 mV/div. Uncalibrated: Variable continuously between steps to a maximum of at least 25 V/div.

Signal and Offset Range

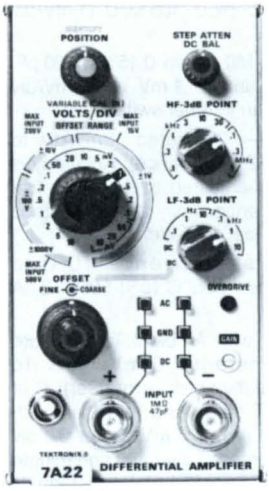
Deflection Factor Settings	10 μV to 10 mV/div	20 mV to 0.1 V/div	0.2 V to 1 V/div	2 V to 10 V/div
Common-Mode Signal	±10 V	±100 V	±500 V	
Maximum Dc Coupled Input (dc + peak ac at 1 kHz or less)	±15 V	±200 V	±500 V	
Maximum Ac Coupled Input (dc voltage)	±500 V dc rejection, at least 4 x 10^5:1			
Dc Offset	+1 V to −1 V	+10 V to −10 V	+100 V to −100 V	+100 V to −100 V

Input R and C — 1 MΩ within 1%; ≈47 pF.

Maximum Input Gate Current (Differentially Measured) — 10 μV/div to 10 mV/div: 40 pA at +25°C; 200 pA at +50°C. 20 mV/div to 10 V/div: 10 pA at +25°C; 20 pA at +50°C.

Single ended, one-half the differential measurement. Display shift (10 μV/div, ac coupled) is ±4 division at +25°C; ±20 division at +50°C.

7A22



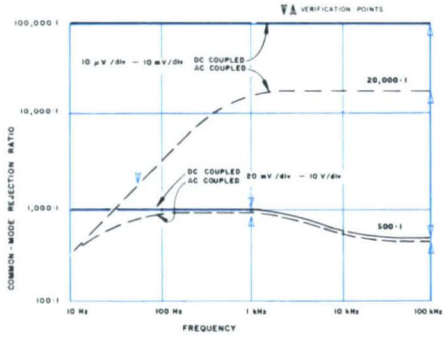
Differential Amplifier

Dc Stability — (Line Voltage Constant): 50 μV/°C or less. Drift with Time (Ambient Temperature and Line Voltage Constant): Short term is 5 μV p-p or 0.1 div (whichever is greater) over any one minute interval after one hour warm-up. Long term is 10 μV p-p or 0.1 div (whichever is greater) in any one hour interval after one hour warm-up.

Displayed Noise — 16 μV or 0.1 div (whichever is greater) at maximum bandwidth. Source resistance 25 Ω or less measured tangentially.

Overdrive Recovery — 10 μs or less to recover within 0.5% of zero level after removal of a test signal applied for 1 s (signal amplitude not to exceed differential dynamic range). Front panel Overdrive light indicates that an overdrive condition is being approached.

Common-Mode Rejection Ratio (for signals not exceeding common-mode signal range)



ORDERING INFORMATION

7A22 Amplifier **$1,790**
Includes: Instruction manual (070-0931-00).

High CMRR Differential Probes
P6055 — Matched pair of probes for maximum CMRR. (See page 480 for complete P6055 description.) **$535**

7CT1N

Curve Tracer

7CT1N

10 nA/Div to 20 mA/Div Vertical Deflection Factors

0.5 V/Div to 20 V/Div Horizontal Deflection Factors

The 7CT1N converts your 7000 Series oscilloscope into a semiconductor curve tracer capable of displaying characteristics of small signal devices to power levels up to 0.5 W. The 7CT1N operates in either the horizontal or vertical compartments of any 7000 Series mainframe. It may be used in conjunction with standard amplifier and time base plug-in units to display signal waveforms along with characteristic curve families.

For more information on the 7CT1N, see page 389 in Curve Tracer section.

ORDERING INFORMATION

7CT1N Curve Tracer **$1,785**
Includes: Instruction Manual (070-1247-00).

For recommended probes, see pages 219 and 464.
For 7000 Series vertical system specifications, see page 218.

7B80/7B85

1 ns/Div to 5 s/Div Calibrated Time Bases

Triggering to 400 MHz

Variable Trigger Holdoff

Peak-to-Peak Auto Triggering

7B85 Features:

ΔTime Measurements With CRT Readout

Delayed Time Measurements With CRT Readout

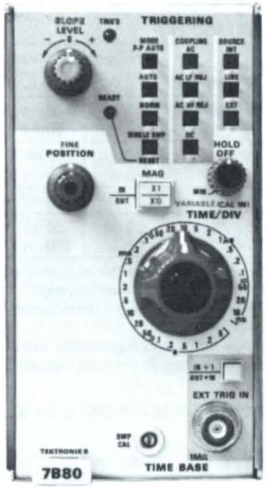
Vertical Trace Separation Between Two Delayed Sweeps

The 7B80 and 7B85 are horizontal time bases recommended for use with the 7700, 7800 or 7900 Series mainframes to provide optimum bandwidth/sweep-speed compatibility. (Each may be used in any slower 7000 Series mainframe with some reduction in sweep accuracy at the fastest sweep speed.)

Each plug-in can be used separately as an independent single time base, or combined in any mainframe with two horizontal compartments for delaying and delayed operation.

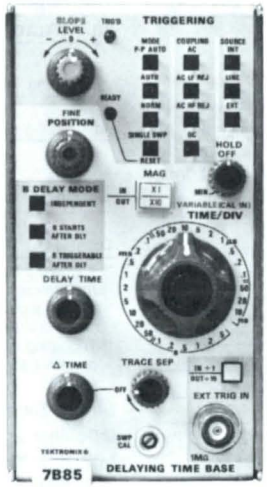
X-Y displays are available using a 7B80 with Option 02. A front panel button (Display Mode) selects normal sweep or X-Y display. Both signals are applied to vertical (Y) amplifiers, and the desired horizontal (X) signal is then routed through plug-in and mainframe trigger paths to the 7B80. An X-Y mode selection then applies the signal to the horizontal deflection system. This option is appropriate where the user is making Y-T and X-Y measurements, and changing the amplifier frequently from the vertical to the horizontal compartment is not acceptable.

7B80



Delayed Time Base

7B85



ΔDelaying Time Base

7000 SERIES TIME BASE SELECTION GUIDE

Performance Feature	7B50A	7B53A	7B80	7B85	7B92A	7B10	7B15
Single time base	✓		✓	✓		✓	✓
Dual time base		✓			✓		
With mixed sweep		✓					
TV Sync Triggering		Opt 05					
Used also as delayed time base			✓			✓	
Delaying sweep				✓			✓
ΔDelay Sweep				✓			✓
Display switching					✓		
Page	249	250	245	245	247	248	248
Prices begin at	$1,130	$1,860	$1,660	$1,940	$3,745	$2,555	$2,900

7000 SERIES TIME BASE/MAINFRAME RECOMMENDATION

Mainframe	7B50A	7B53A	7B80	7B85	7B92A	7B10	7B15
7104/R7103					✓	✓	✓
7904A/R7903			✓	✓	✓	✓	✓
7844/R7844			✓	✓	✓	✓	✓
7934			✓	✓	✓	✓	✓
7854			✓	✓*1	✓*1	✓	✓*1
7704A/R7704			✓	✓	✓	✓	✓
7603/R7603	✓	✓					
7633/R7633 7623A/R7623A	✓	✓					
7613/R7613	✓	✓					

*1 *Single sweep mode operable for real time only.*

CHARACTERISTICS

Characteristics are common to both units unless otherwise noted.

MAIN SWEEP

Sweep Rates — Calibrated: 5 s/div to 10 ns/div in 27 steps (1-2-5 sequence). X10 Magnifier extends fastest calibrated sweep rate to 1 ns div. Uncalibrated: Variable is continuous to at least 2.5 times the calibrated sweep rate.

Sweep Accuracy — Measured over the center eight divisions, +15°C to +35°C, in the 7700, 7800, or 7900 Series mainframe. Derate accuracies by an additional 1% for 0°C to +50°C.

Time/Div*1	Unmagnified	Magnified
5 s/div to 1 s/div	4.0%	Unspecified
0.5 s/div to 50 ns/div	1.5%	2.5%
20 ns/div to 10 ns/div	2.5%	4.0%

*1 *Fastest calibrated sweep rate is limited by 7700 and 7600 Series Mainframes.*

Trigger Holdoff Time

	Minimum	Maximum With Variable
5s/div to 1 μs/div	2 times Time/Div setting or less	2 times Time/Div setting
0.5 μs/div to 10 ns/div	2.0 μs or less	2 times Time/Div setting
20 ms/div or faster	2 times Time/Div setting	20 times Time/Div setting

ΔTime Range — (7B85 only) 0 to at least 9.0 times Time/Div setting.

ΔTime Accuracy (+15°C to +35°C) — (7B85 only) 0.5 s/div to 50 ms/div: Within (0.5% of reading +0.1% full scale +1 count)*1. 20 ms/div to 100 ns/div: Within (0.5% of reading +0.03% full scale +1 count)*1.

*1 *Full scale equals ten times the Time/Div switch setting.*

Trace Separation Range — Functional only in ΔDelay Time mode when alternating or chopping between time base units. The second delayed sweep display can be vertically positioned at least three division below the first delayed sweep display.

Delay Time Range — 0.2 or less to at least 9.0 times Time/Div setting.

Delay Time Jitter — 0.02% or less of Time/Div setting plus 0.1 ns.

TRIGGERING

Triggering Sensitivity From Repetitive Signals (Auto and Norm Modes)

Coupling	Triggering Frequency Range*1	Min Signal Required Int	Min Signal Required Ext
Ac	30 Hz to 50 MHz 50 MHz to 400MHz	0.3 div 1.5 div	50 mV 250 mV
Ac LF Rej*2	30 kHz to 50 MHz 50 MHz to 400 MHz	0.3 div 1.5 div	50 mV 250 mV
Ac HF Rej	30 Hz to 50 kHz	0.3 div	50 mV
Dc*3	Dc to 50 MHz 50 MHz to 400 MHz	0.3 div 1.5 div	50 mV 250 mV

*1 *Triggering frequency ranges are limited to the frequency of the vertical system when operating in the Internal mode.*
*2 *Will not trigger on sinewaves of less than eight division Internal, or 3 V External, at or below 60 Hz.*
*3 *Triggering Frequency Range for dc coupling applies to frequencies above 30 Hz when operating in the Auto Triggering mode.*

Single Sweep — Requirements are same as for repetitive signals.

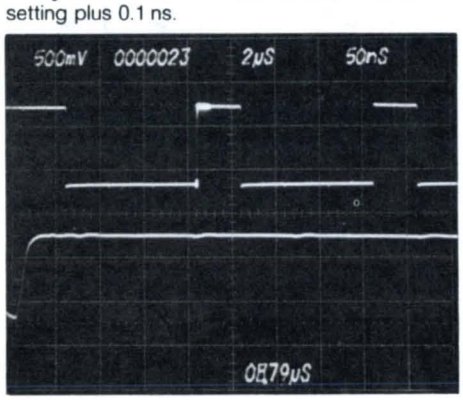
Internal Trigger Jitter — 0.1 ns or less at 400 MHz.

Triggering Sensitivity in P-P Auto Mode

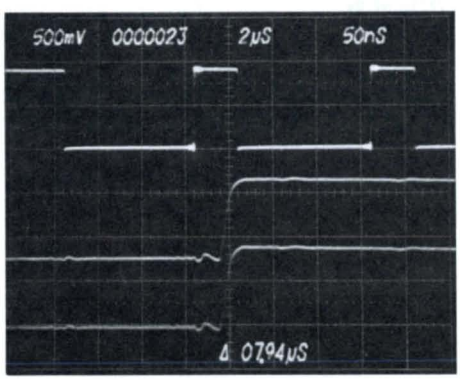
Coupling	Triggering Frequency Range	Min Signal Required Int	Min Signal Required Ext
Ac or dc	Low Frequency Response: At least 50 Hz	2.0 div	500 mV
Ac or dc	200 Hz to 50 MHz	0.5 div	125 mV
Ac or dc	50 MHz to 400 MHz	1.5 div	375 mV

External Trigger Input — Maximum Input Voltage: 250 V (dc + peak ac). Input R and C: 1 MΩ within 5% and 20 pF within 10%. Level Range (Excluding P-P Auto): At least ±1.5 V in Ext÷1, at least ±15 V in Ext÷10.

7B80 Option 02, X-Y Display Capability — A front panel switch selects either normal sweep displays or X-Y displays. In the X-Y mode, the X and Y signals are applied to the inputs of a dual trace vertical amplifier or two single trace vertical amplifiers. The X signal is routed via the amplifier/mainframe trigger path to the 7B80 Option 02, and then to the mainframe horizontal amplifier for display.



Delaying and delayed sweeps are shown with the mainframe selecting Alt sweep modes. The delay time to the start of the delayed sweep is digitally presented on the lower edge of the CRT.



With the mainframe still selecting Alt sweeps, delaying and both delayed sweeps are shown. The digital readout on the lower CRT edge shows the time between the two sweep delays. The Trace Separation knob is used to position the second delayed sweep below the first delayed sweep with up to three division of separation.

ORDERING INFORMATION

7B80 Time Base **$1,660**
Includes: Instruction manual (070-1959-00).
Option 02 — X-Y Display Capability. **+$105**

7B85 Delaying Time Base **$1,940**
Includes: Instruction manual (070-1961-01).

7B92A

Dual Time Base

7B92A

0.5 ns/Div to 0.2 s/Div Calibrated Time Base

Triggering to 500 MHz

Alternate Display of Intensified Delaying and Delayed Sweeps

Contrast Regulation Between Delaying and Delayed Sweeps

The 7B92A Dual Time Base is recommended for use in the 7100, 7800 and 7900 Series mainframes. (The 7B92A may be used in all other mainframes at slower sweep speeds.)

There are four display modes: normal sweep, intensified delaying sweep, delayed sweep, and alternate sweep. When operating in the Auto mode of main triggering, a bright base line is displayed in the absence of a trigger signal.

CHARACTERISTICS

DELAYING SWEEP (MAIN SWEEP)

Sweep Rate — Calibrated: 0.2 s/div to 0.5 ns/div in 27 steps (1-2-5 sequence). Uncalibrated: Variable continuously between steps to at least 2.5 times the calibrated sweep rate. The variable control is internally switchable between delaying and delayed sweeps.

Sweep Accuracy — Measured over the center eight divisions in a 7900 Series mainframe:

Time/Div	+15°C to +35°C	0°C to +50°C
0.2 s/div to 20 ns/div	Within 2%	Within 3%
10 ns/div	Within 3%	Within 4%
2 ns/div to 1 ns/div	Within 4%	Within 5%
0.5 ns/div	Within 5%	Within 6%

Delay Time Multiplier Range — 0 to 9.8 times the Delay Time/Div setting from 0.2 s/div to 10 ns/div (0 s to 1.96 s).

Delay Time Jitter*1

0.2 s/div to 50 μs/div	0.2% of main sweep time/div switch setting or less
20 μs/div to 10 ns/div	0.3% of the main sweep time/div switch setting or less

**1 Not applicable for the first 2% of maximum available delay time (Delay Time Mult dial setting >0.2). Maximum available delay time is ten times the Time/Div or Delay Time switch setting.*

Differential Delay Time Measurement Accuracy*1

	Sweep Speed	
0.2 s/div to 0.1 μs/div	Both Delay Time Mult dial settings at 0.5 or greater	±(0.75% of reading +0.25% of full scale*2)
	One or both Delay Time Mult dial settings at less than 0.5	±(0.75% of reading +0.5% of full scale*2 +5 ns)
50 ns/div to 10 ns/div	Both Delay Times equal to or greater than 25 ns	±(1% of reading +0.5% of full scale*2)
	One or both Delay Times less than 25 ns	±(1% of reading +1% of full scale*2 +5 ns)

**1 +15°C to +35°C.*

**2 Full scale is ten times the Time/Div or Delay Time setting. Accuracy applies over the center eight divisions from +15°C to +35°C.*

TRIGGERING

Triggering Sensitivity

Auto and Norm Modes

Coupling	Triggering Frequency Range	Min Signal Required Int	Min Signal Required Ext
Ac	30 Hz to 20 MHz 20 MHz to 500 MHz	0.5 div 1.0 div	100 mV 500 mV
Ac LF Rej	30 kHz to 20 MHz 20 MHz to 500 MHz	0.5 div 1.0 div	100 mV 500 mV
Ac HF Rej	30 Hz to 50 kHz	0.5 div	100 mV
Dc to 20 MHz Dc	0.5 div 20 MHz to 500 MHz	100 mV 1.0 div	 500 mV

HF Sync — Triggering sensitivity is 0.5 div Int or 100 mV Ext, from 100 MHz to 500 MHz for any coupling except Ac HF Rej.

Single Sweep — Triggering requirements are the same as normal sweep. When triggered, time base produces one sweep only until reset.

Internal Trigger Jitter — 50 ps or less at 500 MHz.

External Trigger Input — Selectable 50 Ω or 1 MΩ inputs (1 MΩ is paralleled by ≈20 pF). Maximum Input Voltage: 250 V (dc + peak ac) for 1 MΩ input and 1 W average for 50 Ω input. Level Range: At least ±3.5 V in Ext, at least ±35 V in Ext÷10.

DELAYED SWEEP

Sweep Rate — Calibrated: 0.2 s/div to 0.5 ns/div in 27 steps (1-2-5 sequence). Uncalibrated: Variable continuously between steps to at least 2.5 times the calibrated sweep rate. The variable control is internally switchable between delaying and delayed sweeps.

Sweep Accuracy — Measured over the center eight divisions in a 7900 Series mainframe:

Time/Div	+15°C to +35°C	0°C to +50°C
0.2 s/div to 20 ns/div	Within 2%	Within 3%
10 ns/div to 5 ns/div	Within 3%	Within 4%
2 ns/div to 1 ns/div	Within 4%	Within 5%
0.5 ns/div	Within 5%	Within 6%

Delayed Triggering Sensitivity

Coupling	Triggering Frequency Range	Min Signal Required Int	Min Signal Required Ext
Ac	30 Hz to 20 MHz 20 MHz to 500 MHz	0.5 div 1.0 div	100 mV 500 mV
Dc	Dc to 20 MHz 20 MHz to 500 MHz	0.5 div 1.0 div	100 mV 500 mV

Internal Trigger Jitter — 50 ps or less at 500 MHz.

External Trigger Input — Selectable 50 Ω or 1 MΩ inputs (1 MΩ is paralleled by ≈20 pF). Maximum Voltage Input: 250 V (dc + peak ac) for 1 MΩ input, and 1 W average for 50 Ω input. Level Range: At least ±3.5 V in Ext.

ORDERING INFORMATION

7B92A Dual Time Base **$3,745**

Includes: Instruction manual (070-1751-02).

7B10/7B15

0.2 ns/Div to 0.2 s/Div Calibrated Time Bases

Triggering to 1 GHz

Variable Trigger Holdoff

Peak-to-Peak Auto Triggering

7B15 Features:

ΔTime Measurements With CRT Readout

Delayed Time Measurements With CRT Readout

Vertical Trace Separation Between Two Delayed Sweeps

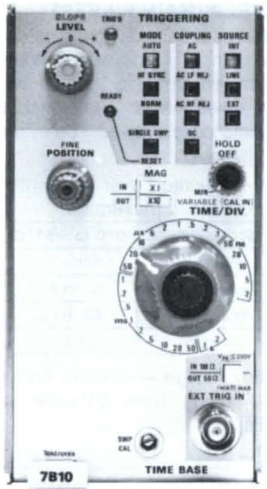
The 7B10 and 7B15 are horizontal time bases designed for use with the 7100 Series mainframes to provide optimum bandwidth/sweep-speed compatibility, but may also be used with the 7700, 7800, and 7900 Series mainframes. (Each may be used in any slower 7000 Series mainframe with some reduction in sweep accuracy at the fastest sweep speed.)

Either plug-in can be used separately as an independent single time base, or they can be combined in any mainframe with two horizontal compartments for delaying and delayed operation.

The 7B10 and 7B15 provide Δtime measurement in addition to the standard delay time display.

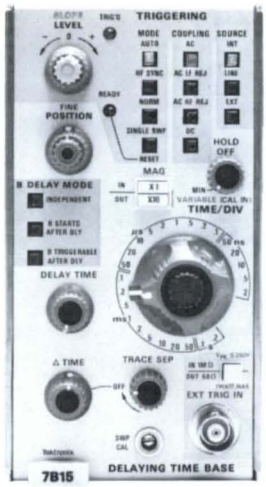
Delta time measurement is accomplished simply by manually positioning two intensified zones on the waveform. The time difference between the two zones is displayed in the CRT readout. (See waveform photos on page 246.) Expansion and overlapping of the two intensified zones is possible to allow very precise setting of the zones to the desired points on the displayed waveform.

7B10



Delayed Time Base

7B15



ΔDelaying Time Base

CHARACTERISTICS

MAIN SWEEP

Sweep Rates — Calibrated: 2 ns/div to 0.2 s/div in 25 steps (1-2-5 sequence). X10 Magnifier extends fastest calibrated sweep rate to 0.2 ns/div. Uncalibrated: Variable is continuous to at least 2.5 times the calibrated sweep.

Sweep Accuracy — Measured over the center eight divisions, +15°C to +35°C, in a 7100, 7800 or 7900 Series mainframe. Derate accuracies by an additional 1% for 0°C to +50°C.

Time/Div*1	Unmagnified	Magnified
0.2 s/div to 10 ns/div	2%	3%
5 ns/div and 2 ns/div	3%	4%

**1 Fastest calibrated sweep rate is limited by 7900, 7800, 7700, and 7600 Series mainframes.*

Trigger Holdoff Time

	Minimum	Maximum With Variable
0.2 s/div to 50 ms/div	40 ms or less	400 ms or greater
20 ms/div to 2 μs/div	2 times the Time/Div Setting	20 times the Time/Div Setting
1 μs/div to 0.5 μs/div	2 μs or less	20 μs or greater
0.2 μs/div to 2 ns/div	2 μs	6 μs or greater

ΔTime Range — (7B15 only) 0 to at least 9.0 times Time/Div setting.

ΔTime Accuracy — 20 ms/div to 100 ns/div. Within 0.5% of reading +3 counts.

Trace Separation Range — (7B15 only) Functional only in ΔDelay Time mode when alternating or chopping between time base units. The second delayed sweep display can be vertically positioned at least three divisions below the first delayed sweep display.

Delay Time Range — (7B15 only) 0.2 or less to at least 9.0 times Time/Div setting.

Delay Time Jitter — (7B15 only) 0.02% of Time/Div setting up through 50 μs/div. 0.03% of Time/Div setting plus 0.1 ns for sweep speeds of 20 μs/div through 100 ns/div.

TRIGGERING

Triggering Sensitivity for Repetitive Signals

Coupling	Triggering Frequency Range*1	Min Signal Required Int	Min Signal Required Ext
Ac	30 Hz to 250 MHz 250 MHz to 1 GHz	0.5 div 1.5 div	50 mV 150 mV
Ac LF Rej*2	50 kHz to 250 MHz 250 MHz to 1 GHz	0.5 div 1.5 div	50 mV 150 mV
Ac HF Rej	30 Hz to 40 kHz	0.5 div	50 mV
Dc*3	Dc to 250 MHz 250 MHz to 1 GHz	0.5 div 1.5 div	50 mV 150 mV

**1 The triggering frequency ranges given here are limited to the −3 dB frequency of the oscilloscope vertical system when operating in the Internal mode.*

**2 Will not trigger on sinewaves at or below 60 Hz when amplitudes are less than eight division Internal or 3 V External.*

**3 The Triggering Frequency Range for Dc Coupling applies to frequencies above 30 Hz when operating in the Auto Triggering Mode.*

Single Sweep — Requirements are the same as for repetitive signals.

Internal Trigger Jitter — 30 ps or less at 1 GHz.

HF Sync Mode — 250 MHz to 1 GHz 0.3 div Internal and 0.75 mV External.

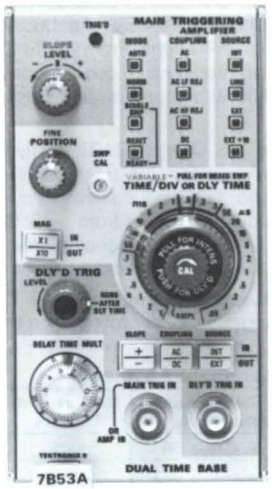
External Trigger Input — Maximum Input Voltage: 250 V (dc + peak ac) for 1 MΩ input, 1 W average for 50 Ω input. Input R and C: 1 MΩ within 5% and 20 pF within 10%; for 50 Ω input, 50 Ω within 2%. Level Range: At least ±3.5 V in Ext÷1.

ORDERING INFORMATION

7B10 Time Base **$2,555**
Includes: Instruction manual (070-2316-00).

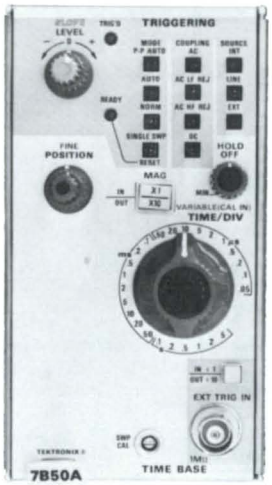
7B15 Delaying Time Base **$2,900**
Includes: Instruction manual (070-2318-00).

7B53A



Dual Time Base

7B50A



Time Base

7B53A/7B50A

5 ns/Div to 5 s/Div Calibrated Time Base

Triggering to 100 MHz (7B53A) and 150 MHz (7B50A)

Variable Trigger Holdoff (7B50A)

P-P Auto Triggering (7B50A)

Single Sweep Operation

Calibrated Mixed Sweep (7B53A)

TV Sync Separator Triggering (7B53A Option 05)

The easy-to-use 7B53A and 7B50A Time Bases are recommended for use with 7600 Series mainframes to provide optimum bandwidth/sweep speed compatibility. They may, however, be used in any 7000 Series mainframe to provide sweep rates of 5 ns/div.

The 7B53A provides normal, intensified delaying, delayed, and mixed sweep.

CHARACTERISTICS (7B53A)

DELAYING SWEEP

Sweep Rate — Calibrated: 50 ns/div to 5 s/div in 25 steps (1-2-5 sequence). 5 ns/div, the fastest calibrated sweep rate, is obtained with the X10 Magnifier. Uncalibrated: Variable continuously between steps to at least 2.5 times the calibrated sweep rate. The variable control is internally switchable between main, delayed-sweep, and variable main-sweep holdoff.

Sweep Accuracy — Measured over the center eight divisions.

Time/Div	Unmagnified		Magnified	
	+15°C to +35°C	0°C to +50°C	+15°C to +35°C	0°C to +50°C
5 s/div to 1 s/div	3%	4%	Unspecified	Unspecified
50 ms/div to 0.5 μs/div	2%	3%	2.5%	4%
0.2 μs/div to 0.05 μs/div	3%	4%	3.5%	5%

Delay Time Multiplier Range — 0 to 10 times the Delay Time/Div setting from 5 s/div to 1 μs/div.

Differential Delay Time Measurement Accuracy — 5 s/div to 1 s/div: ±1.4% of measurement +0.3% of full scale. 0.5 s/div to 1 μs/div: ±0.7% of measurement +0.3% of full scale. Full scale is ten times the Delay Time/Div setting. Accuracy applies over the center 8 DTM div from +15°C to +35°C.

Delay Time Jitter — 0.05% or less of Time/Div setting.

TRIGGERING

Triggering Sensitivity

Coupling	Triggering Frequency Range	Min Signal Required Int	Min Signal Required Ext
Ac	30 Hz to 10 MHz 10 MHz to 100 MHz	0.3 div 1.5 div	100 mV 500 mV
Ac LF Rej*[1]	30 kHz to 10 MHz 150 kHz to 10 MHz 10 MHz to 100 MHz	0.3 div — 1.5 div	— 100 mV 500 mV
Ac HF Rej	30 Hz to 50 kHz	0.3 div	100 mV
Dc	Dc to 10 MHz 10 MHz to 100 MHz	0.3 div 1.5 div	100 mV 500 mV

[1] Will not trigger on sinewaves of three divisions or less Int or 1.5 V Ext below 120 Hz.

Single Sweep — Triggering requirements are the same as normal sweep. When triggered, sweep generator produces one sweep only until reset.

Internal Trigger Jitter — 1 ns or less at 75 MHz.

External Trigger Input — Maximum Input Voltage: 500 V (dc + peak ac), 500 V p-p ac at 1 kHz or less. Input R and C: 1 MΩ within 2% and 20 pF within 2 pF. Level Range: At least +1.5 V to −1.5 V in Ext, at least +15 V to −15 V in Ext÷10.

DELAYED SWEEP

Sweep Rate — Calibrated: 0.05 μs/div to 0.5 s/div in 22 steps (1-2-5 sequence). 5 ns/div, the fastest calibrated sweep rate, is obtained with the X10 Magnifier. Uncalibrated: Variable continuously between steps to at least 2.5 times the calibrated sweep rate. The variable control is internally switchable between main, delayed sweep, and variable main sweep holdoff.

Sweep Accuracy — Measured over the center eight divisions.

Time/Div	Unmagnified		Magnified	
	+15°C to +35°C	0°C to +50°C	+15°C to +35°C	0°C to +50°C
0.5 s/div to 0.1 s/div and 0.2 μs/div to 0.05 μs/div	4%	5%	4.5%	6%
50 ms/div to 0.5 μs/div	3%	4%	3.5%	5%

Delayed Sweep Gate — Output Voltage: ≈ +3.5 V into at least 10 kΩ shunted by 100 pF or less, or 0.5 V into 50 Ω. Rise time: 50 ns or less. Output R is 350 Ω within 10%. Gate is available at the Dly'd Trig In connector when the delayed sweep source switch is set to Int.

Triggering Sensitivity

Coupling	Triggering Frequency Range	Min Signal Required Int	Min Signal Required Ext
Ac	30 Hz to 10 MHz 10 MHz to 100 MHz	0.3 div 1.5 div	100 mV 500 mV
Dc	Dc to 10 MHz 10 MHz to 100 MHz	0.3 div 1.5 div	100 mV 500 mV

Internal Trigger Jitter — 1 ns or less at 75 MHz.

External Trigger Input — Maximum Input Voltage: 500 V (dc + peak ac), 500 V p-p ac at 1 kHz or less. Input R and C: 1 MΩ within 2% and 20 pF within 2 pF. Level Range: At least +1.5 V to −1.5 V in Ext.

MIXED SWEEP

Sweep Accuracy — Within 2% plus measured main sweep error. Exclude the following portions of mixed sweep: First 0.5 div after start of main sweep display and 0.2 div or 0.1 μs (whichever is greater) after transition of main to delayed sweep.

EXT HORIZONTAL INPUT

Deflection Factor — 10 mV/div within 10% when in Ext, Mag X10; 100 mV/div within 10% when in Ext; 1 V/div within 10% when in Ext÷10.

Bandwidth

Coupling	Lower −3 dB	Upper −3 dB
Ac	40 Hz	2 MHz
Ac LF Rej	16 kHz	2 MHz
Ac HF Rej	40 Hz	100 kHz
Dc	Dc	2 MHz

TV SYNC

Option 05, TV Sync Separator Triggering — Permits stable internal line or field rate triggering from displayed composite video or composite sync waveforms. Conventional waveform displays and measurements can be made from standard broadcast or closed circuit TV systems, domestic or international, with up to 1201-line, 60 Hz field rates. Individual lines may be displayed with delayed sweep features. The wide range of delayed sweeps permits accurate alternate-frame, color-burst observations in the PAL color system. Option 05 deletes ac line trigger and Ext÷10 from trigger source.

CHARACTERISTICS (7B50A)

Sweep Rates — 0.05 μs/div to 5 s/div in 25 steps (1-2-5 sequence). 5 ns/div, the fastest calibrated sweep rate, is obtained with the X10 Magnifier. Uncalibrated: Variable continuously between steps to at least 2.5 times the calibrated sweep rate.

Sweep Accuracy — Measured over center eight division, +15°C to +35°C, with any 7000 Series mainframe. Derate accuracies by an additional 1% each for 0°C to +50°C.

Time/Div	Unmagnified	Magnified
5 s/div to 1 s/div	4%	Unspecified
0.5 s/div to 0.5 μs/div	2%	3%
0.2 μs/div to 0.05 μs/div	3%	4%

TRIGGERING

Trigger Holdoff Time

Minimum 5 s/div to 1 μs/div	2 times Time/Div setting or less
0.5 μs/div to 50 ns/div	2.0 μs or less
Variable	Extends holdoff time through at least 2 sweep lengths for sweep rates of 20 ms/div or faster

Triggering Sensitivity*1

Coupling	Triggering Frequency Range*2	Min Signal Required Int	Min Signal Required Ext
Ac	30 Hz to 50 MHz 50 MHz to 150 MHz	0.3 div 1.5 div	50 mV 250 mV
Ac LF Rej*3	30 kHz to 50 MHz 50 MHz to 150 MHz	0.3 div 1.5 div	50 mV 250 mV
Ac HF Rej	30 Hz to 50 kHz	0.3 div	50 mV
Dc*4	Dc to 50 MHz 50 MHz to 150 MHz	0.3 div 1.5 div	50 mV 250 mV

*1 *Auto and Norm modes.*
*2 *Triggering frequency ranges are limited to the frequency of the vertical system when operating in the Int mode.*
*3 *Will not trigger on sinewaves of less than eight division Internal, or 3 V External, at or below 60 Hz.*
*4 *Triggering Frequency Range for dc coupling applies to frequencies above 30 Hz when operating in the Auto Triggering mode.*

Triggering Sensitivity (P-P Auto Mode)

Coupling	Triggering Frequency Range	Min Signal Required Int	Min Signal Required Ext
Ac or dc	200 Hz to 50 MHz	0.5 div	125 mV
Ac or dc	50 MHz to 150 MHz	1.5 div	375 mV

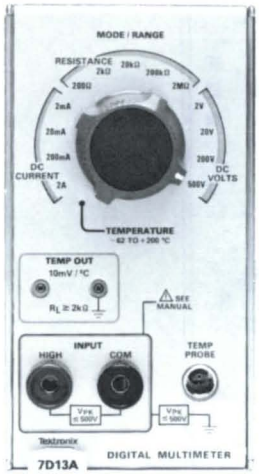
Single Sweep — Triggering requirements are the same as normal sweep. When triggered, sweep generator produces only one sweep until reset.

Option 02, X-Y Display Capability — A front panel switch selects either normal sweep displays or X-Y displays. In the X-Y mode, the X and Y signals are applied to the inputs of a dual-trace vertical amplifier or two single-trace vertical amplifiers. The X signal is routed via the amplifier/mainframe trigger path to the 7B50A Option 02, and then to the mainframe horizontal amplifier for display.

ORDERING INFORMATION

7B53A Dual Time Base **$1,860**
Includes: Instruction manual (070-1342-01).
Option 05 — TV Triggering. **+$170**
Includes: Instruction manual (070-1471-00).
7B50A Time Base **$1,130**
Includes: Instruction manual (070-1986-00).
Option 02 — X-Y Display Capability. **+$105**

7D13A



Digital Multimeter

7D13A

3½ Digit CRT Readout

500 V Maximum Common-Mode Voltage

Temperature Mode

The 7D13A Digital Multimeter is designed for use in all 7000 Series oscilloscope mainframes with CRT readout. The 7D13A functions in any compartment.

The 7D13A measures dc volts, dc current, and resistance. It also measures temperature from a temperature sensor on the tip of the P6601 temperature probe. The temperature probe functions regardless of 7D13A mode or range setting and provides a front-panel analog signal output of 10 mV/°C (0°C=0 V). Temperature may be measured simultaneously along with any other function.

When the 7D13A is used, the character generator traces out a 3½-digit display on the CRT and a legend for units such as kΩ, mA, °C.

CHARACTERISTICS

Dc Voltage Range — 0 V to 500 V in four ranges. 3½-digit presentation of 1.999 V, 19.99 V, 199.9 V, and 500 V full scale. Accuracy is ±0.1% of reading ±1 count from +15°C to +35°C, ±0.2% of reading ±2 counts from 0°C to +50°C. Input impedance is 10 MΩ on all ranges. Maximum safe input is 500 V peak between either contact and ground, 500 V peak between voltage contacts.

Dc Current Range — 0 A to 2 A in four ranges. 3½-digit presentation of 1.999 mA, 19.99 mA, 199.9 mA, and 1999 mA full scale. Accuracy is ±0.5% of reading ±2 counts from +15°C to +35°C, ±0.7% of reading ±4 counts from 0°C to +50°C. Maximum input is 3 A (fuse protected).

Resistance Range — 0 Ω to 2 MΩ in five ranges. 3½-digit presentation 199.9 Ω, 1999 Ω, 19.99 kΩ, 199.9 kΩ, and 1999 kΩ full scale. Accuracy is ±0.5% of reading ±1 count from +15°C to +35°C, ±0.8% of reading ±2 counts from 0°C to +50°C. Input is fuse protected.

Temperature Measurement Range — −62°C to +200°C in one range. 3½-digit presentation to +200°C.

Temperature Measurement Accuracy*1

7D13A Operating Conditions	Temperature Value Measured	Measurement Accuracy
+18°C to +28°C (room temperature)	−62°C to +150°C	±2°C
	+150°C to +200°C	0°C, −6°C
0°C to +18°C +28°C to +50°C	−62°C to +200°C	Add 1.5°C to above tolerance in each direction

*1 *Probe calibrated to the instrument.*

Settling Time — 1 s or less (voltage, current, and resistance modes).

Polarity — Automatic indication.

Maximum Common-Mode Voltage — 500 V peak between two terminals and ground.

Normal-Mode Rejection Ratio — At least 30 dB at 60 Hz.

Common-Mode Rejection Ratio — With a 1 kΩ imbalance, at least 100 dB at dc; 80 dB at 60 Hz.

Over Range Indication — When over range occurs, the readout blinks and the most significant digit displays a three.

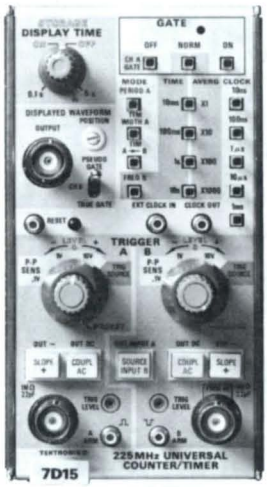
Temperature Out — 10 mV/°C into a load of at least 2 kΩ.

ORDERING INFORMATION

7D13A Digital Multimeter **$1,380**
Includes: Pair of test leads (003-0120-00); P6601 Temperature Probe package (010-6601-01); instruction manual (070-3972-00).

For recommended probes, see pages 219 and 464.

7D15



Modes	Range	Accuracy
Frequency Mode	Dc to 225 MHz Resolution 0.1 Hz max	$\epsilon_{Freq(Hz)} = \pm TB \cdot f_{in} \pm \frac{1}{T}$
Period and Multi-Period Mode	10 ns to 10^5 seconds with selected averaging of 1 to 1000 events in decade steps. Resolution to 10 ps.	$\epsilon_{Period(s)} = \pm TB \cdot P_{in} \pm \frac{10^{-9}}{N} \pm \frac{2E_{npk}}{\frac{dv}{dt}} \cdot N \pm \frac{P_{ck}}{N}$
Time Interval (TI) and TI Average Mode	6 ns to 10 seconds with selected averaging of 1 to 1000 in decade steps. Resolution is 0.1 ns.	$\epsilon_{TI(s)} = \pm TB \cdot P_{in} \pm \frac{P_{ck}}{\sqrt{N}} \pm 10^{-9} \pm \frac{2E_{npk}}{\frac{dv}{dt}}$
Frequency Ratio, CH B/Ext Clock	10^{-7} to 10^4	
Manual Stop Watch	0 to 10^5 seconds	
Totalize, CH B	0 to 10^8 counts	

Note: Formulas given where ϵ is the error; TB (expressed as a decimal) is the time base accuracy; P_{in} is the period of time interval of unknown signal; N is the number of events averaged; P_{ck} is the measurement clock period; T is the gate time; f_{in} is the frequency of the unknown signal; E_{npk} equals peak noise pulse amplitude as presented to Schmitt trigger circuit; dv/dt equals signal slope at input to Schmitt trigger (volts per second).

225 MHz Counter/Timer

7D15

Oscilloscope-Controlled Time and Frequency Measurements

10 ns Single-Shot Time Interval Measurement Resolution

Time Interval Averaging

CRT Display of Counting Interval

10 ps Period-Averaging Resolution

Frequency Measurements Directly to 225 MHz

Signal Conditioning via Mainframe Trigger Source

For Measurement Applications Guide order 42-W-5017-1.

The 7D15 Universal Counter/Timer is designed for use in all 7000 Series oscilloscope mainframes with CRT readout.

The 7D15 can be completely controlled by the oscilloscope's delayed gate. Arming inputs are provided for each channel. By using the delayed B gate to control the start and stop count points, measurements can be made between any two points on the CRT display (see Figure 1).

The 7D15 offers all the measurement capabilities of a Universal Counter/Timer, such as time interval, period, period and time interval averaging, frequency, frequency ratio, totalize, and manual stop watch.

The 7D15 may be used in vertical or horizontal compartments of 7000 Series mainframes. It provides a full eight-digit CRT display with leading zero suppression and positioned decimal. Legend and averaging information appear at the bottom of the CRT display.

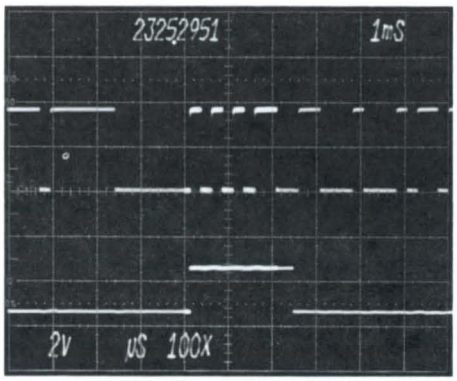


Figure 1. Oscilloscope-controlled digital measurements using the delayed B gate as the arming input logic allow user to make precise time interval measurement from third to seventh pulse on CRT display. Counter CH A is "armed" with leading edge of B gate while CH B Counter is "armed" with falling edge of B gate. Lower trace is pseudo gate of 7D15. CRT readout displays the result of 2325.295 µs.

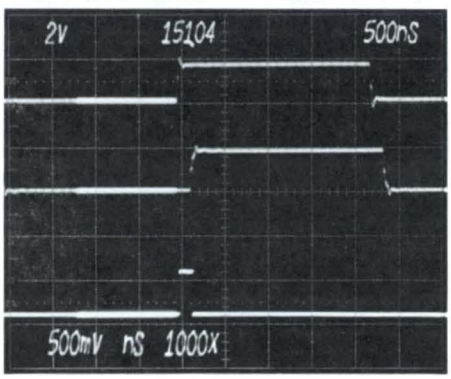


Figure 2. The propagation delay time between the input of a delay line (upper trace) and the output of the delay line (middle trace) is measured digitally. Lower trace is 7D15 pseudo gate display. CRT readout displays the result of 151.0 ns.

CHARACTERISTICS

INPUT SIGNAL CH A & B

Frequency Range (CH B Only) — Dc Coupled: Dc to 225 MHz. Ac Coupled: 5 Hz to 225 MHz.

Sensitivity (CH A and B Inputs) — 100 mV p-p. Trigger Source: 0.5 division to 100 MHz, 1.0 division to 225 MHz, or to the vertical system bandwidth, whichever is less.

Input R and C — 1 MΩ and 22 pF.

Triggering (Preset Position) — Automatically triggers at 0 V.

Level Control Range (CH A and B Inputs) — 100 mV Range: ±500 mV. 1 V Range: ±5 V. 10 V Range: ±50 V.

Arming Inputs — Input R and C: 10 kΩ and 20 pF. Sensitivity Arm A: Logical 1 ≥ +0.5 V, logical 0 ≤ +0.2 V. Sensitivity Arm B: Logical 1 ≤ +0.2 V, logical 0 ≥ +0.5 V.

External Clock-In — 20 Hz to 5 MHz.

Reset Front Panel — Readies the instrument. All counters are affected, including averaging circuits.

INTERNAL TIME BASE

Crystal Oscillator — Accuracy: Within 0.5 ppm (0°C to +50°C ambient). Long-Term Drift: 1 part or less in 10^7 per month. Oscillator: Temperature compensated; no warm up is required.

OUTPUT SIGNALS

Clock Out — Logical 1 ≥ +0.5 V into 50 Ω. Logical 0 ≤ 0 V into 50 Ω. TTL compatible without 50 Ω load (1.6 mA current capacity).

A and B Trigger Level — $Z_{out} \approx 1$ kΩ, $V_{out} = \pm 0.5$ V into 1 MΩ.

Displayed Waveform (Internally Connected) — Front-panel switch screwdriver controlled selects true gate, pseudo gate, or CH B signal out.

External Display — Same as internal except position control has no effect.

Display Mode Switch — 0.1 s to 5 s; also a preset position for infinite display time. Allows selection of readout "follow or store."

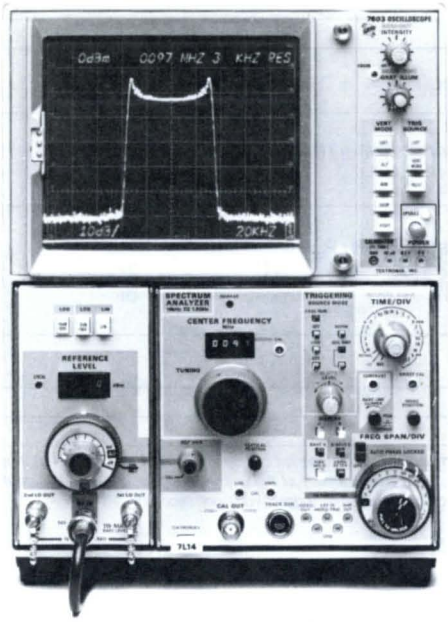
Readout — Eight-digit display; the four most significant have zero suppression. Overflow indicated by a greater than symbol.

ORDERING INFORMATION

7D15 Universal Counter/Timer **$3,580**

Includes: Two 44 inch Sealectro to BNC connector cables (012-0403-00); instruction manual (070-1433-00).

For recommended probes, see pages 219 and 464.



7L14

Excellent Stability, Resolution Bandwidth Range

Digital Storage and Averaging

Swept Measurements With the Tek TR 502

1 kHz to 2.5 GHz Coverage (Option 39)

Input Limiter for Extra Input Protection

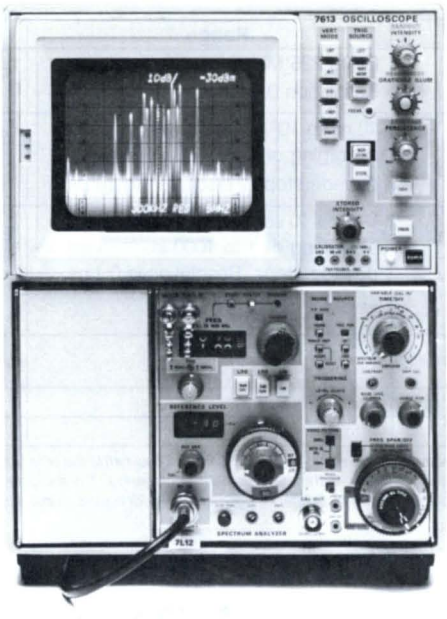
Semiautomatic Measurements With the Tek 7854

The Tektronix 7L14 is a VHF/UHF analyzer with digital storage. It provides high performance in the 10 kHz to 1.8 GHz range. Measurements for RFI/EMC, FM, TV, avionics, navigation, two-way and other communications sytems are made with accuracy and convenience.

Resolution bandwidth can be varied from 30 Hz to 3 MHz over the entire frequency range. Automatic phase lock ensures excellent stability—incidental FM is ≤13 Hz peak-to-peak. Phase noise sidebands are no greater than −70 dBc at 25 resolution bandwidths away.

All this gives you the critical accuracy necessary for design and proof-of-performance measurements. Check broadband RF networks, filter networks, amplifiers, and more . . . easily and economically.

For a complete description of the 7L14, see page 174.



7L12

Proven, Economical VHF/UHF Coverage

Automatic Phaselock, 300 Hz Resolution Bandwidth

Swept Measurements With the TR 502

1 kHz to 2.5 GHz Coverage (Option 39)

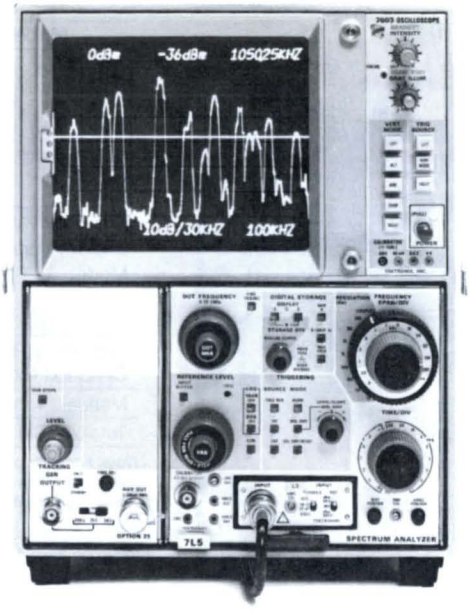
Semiautomatic Measurements With the Tek 7854

The 7L12 is a popular instrument in applications not requiring the resolution, low-end coverage, and digital storage of the 7L14. Resolution bandwidth can be varied from 300 Hz to 3 MHz, with −115 dBm sensitivity at 300 Hz. Automatic phase lock results in good stability; residual FM is ≤200 Hz peak-to-peak.

The 7L12 meets the measurement requirements of many AM, FM, two-way radio and other communications systems.

The 7L12 has a 70 dB spurious-free display dynamic range; low level noise measurements are made accurately, easily.

For a complete description of the 7L12, see page 175.



7L5

Synthesizer Tuning

Digital Storage and Averaging

Three-Knob Operation

Preset Reference Level and Dot Frequency for Extra Input Protection

Swept Measurements (Option 25)

Selectable Input Impedance; Calibration in dBm, dBV or Volts per Division

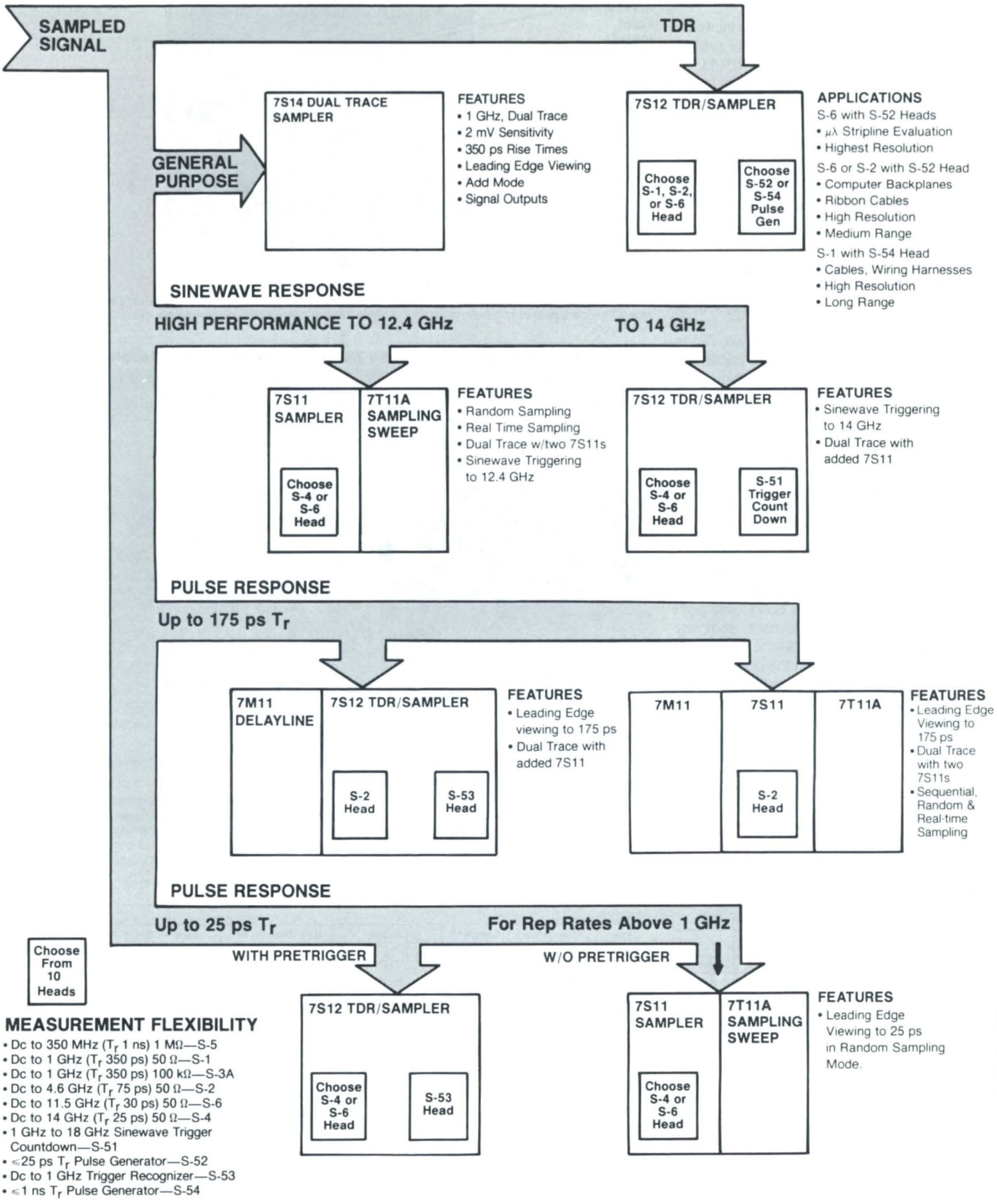
Semiautomatic Measurements With the Tek 7854

The Tektronix 7L5 provides easy-to-use low-frequency measurement capability. The 7L5 can cover 20 Hz to 5 MHz in one display. Resolution bandwidth can be varied from 10 Hz to 30 kHz, with residual FM of no more than 1 Hz peak-to-peak. Comparing baseband channel performance is easy because the 7L5 switches from a single channel to a 60-channel supergroup without retuning. You see all channel amplitudes at a glance, side-by-side.

Probe-compatible plug-in input modules provide a variety of impedances for the 7L5. The L3 may be switch-selected to 50 Ω, 600 Ω or 1 MΩ. The L3 Option 01 is switch-selectable to 75 Ω, 600 Ω or 1 MΩ.

For a complete description of the 7L5, see page 176.

SAMPLING DECISION TREE FOR REPETITIVE SIGNALS



MEASUREMENT FLEXIBILITY

- Dc to 350 MHz (T_r 1 ns) 1 MΩ—S-5
- Dc to 1 GHz (T_r 350 ps) 50 Ω—S-1
- Dc to 1 GHz (T_r 350 ps) 100 kΩ—S-3A
- Dc to 4.6 GHz (T_r 75 ps) 50 Ω—S-2
- Dc to 11.5 GHz (T_r 30 ps) 50 Ω—S-6
- Dc to 14 GHz (T_r 25 ps) 50 Ω—S-4
- 1 GHz to 18 GHz Sinewave Trigger Countdown—S-51
- ≤25 ps T_r Pulse Generator—S-52
- Dc to 1 GHz Trigger Recognizer—S-53
- ≤1 ns T_r Pulse Generator—S-54

Sampling Plug-Ins

7000 Series sampling plug-ins can increase the versatility of your mainframe by providing measurement capabilities up to 14 GHz on repetitive signals. The Sampling family consists of five plug-ins, ten specially-designed sampling heads, and various supporting accessories that provide maximum configurability for numerous applications.

Specific uses for samplers include general UHF measurement and TDR (Time Domain Reflectometry).

UHF Measurements

For flexibility in time domain measurement, the 7S11 Sampling Unit/7T11A Sampling Sweep combination provides triggering to 12.4 GHz, and the choice of modular heads for optimum signal acquisition. Two 7S11s and one 7T11A provide dual-trace capability. For plug-in sampler operationally similar to conventional vertical/time base plug-ins, the 1 GHz 7S14 is available. Two identical channels provide 2 mV/div sensitivity, dual trace display, built-in time base, and calibrated delayed sweep. All of these plug-ins provide a cost-effective way to obtain Gigahertz measurement capability for repetitive signals.

TDR

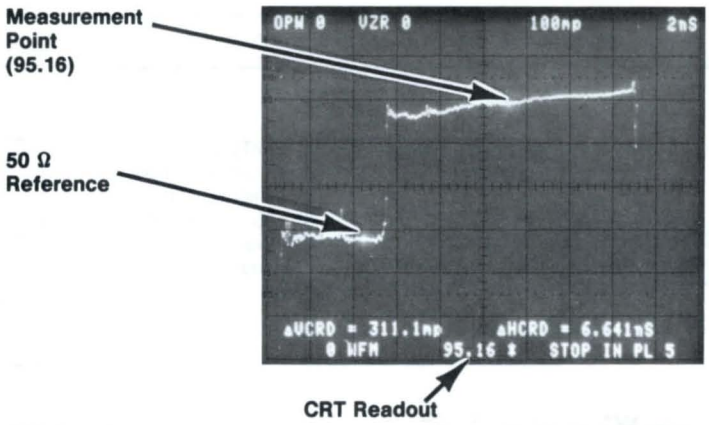
TDR is widely used in microwave stripline evaluation, computer backplane measurements, and printed circuit board testing. With TDR, a pulse is sent down a conductive path and measured as it reflects back from any impedance changes in the device under test. Any impedance variations in the path cause a corresponding signal to be displayed on the scope. The precise location and type of impedance anomaly (open, short, step change) in the conductive path is directly readable on the display. The fast rise times of samplers make them well suited for these measurements. The high resolution 7S12 TDR Sampler provides maximum versatility in addition to general purpose applications.

Use the Sampling Decision Tree diagram on the preceding page to select the configuration for your measurement requirement.

SAMPLING HEAD CHARACTERISTICS

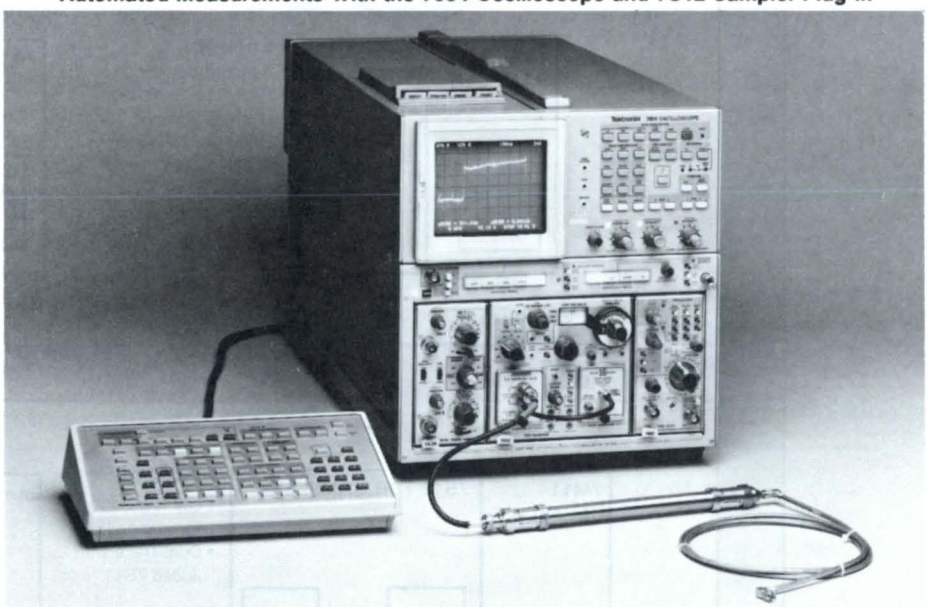
	Bandwidth	Rise Time	Input Impedance	Noise	Connector
S-1	Dc to 1 GHz	≤350 ps	50 Ω	≤1 mV*1 ≤2 mV*2	GR
S-2	Dc to 4.6 GHz	≤75 ps	50 Ω	≤3 mV*1 ≤6 mV*2	GR
S-3A	Dc to 1 GHz	≤350 ps	— 100 kΩ	≤3 mV at probe tip*2	Probe
S-4	Dc to 14 GHz	≤25 ps	50 Ω	≤2.5mV*1 ≤5 mV*2	SMA (3 mm)
S-5	Dc to 350 MHz	≤1 ns	1 MΩ	≤500 μV*1 ≤5 mV*2	BNC
S-6	Dc to 11.5 GHz	≤30 ps	50 Ω feed thru	— ≤5 mV*2 ≤5 mV*2	SMA (3 mm) (3 mm)

*1 Smoothed
*2 Unsmoothed



CRT photo shows an automated impedance measurement on a four foot length of 93 Ω coax. An easy-to-use program allows the operator to obtain a direct readout in ohms (bottom center) after positioning cursors on selected points on the display.

Automated Measurements With the 7854 Oscilloscope and 7S12 Sampler Plug-In



The 7854/7S12 combination is ideally suited for making a wide variety of automated sampling measurements. Examples of easy-to-program measurements are: measuring propagation delay through active or passive devices; measuring distance to faults in coax cables; and measuring impedance in EC boards and other controlled-impedance devices. Programs can be entered into the 7854 via the calculator keyboard for simple operator-controlled measurements, or tests can be computer-controlled via a remote terminal on the GPIB for production applications.

ACCESSORY PROBES FOR 50 Ω SAMPLERS

Passive

Type	Attenuation	Length*1	Loading		Rise Time (in ns)	Bandwidth	Package Number*2
P6056	10X	6.0	500 Ω	1 pF	<0.1	Dc to 3.5 GHz	010-6056-03
P6057	100X	6.0	5 kΩ	1 pF	<0.25	Dc to 1.4 GHz	010-6057-03

Active — FET*3

P6201	1X 10X 100X	6.0 6.0 6.0	100 kΩ 1 MΩ 1 MΩ	3 pF 1.5 pF 1.5 pF	<0.4 <0.4 <0.4	Dc to 900 MHz Dc to 900 MHz Dc to 900 MHz	010-6201-01 (includes attenuators)
P6202A	10X 100X	2 m 2 m	10 MΩ 10 MΩ	2 pF 2 pF	<0.7 <0.7	Dc to 500 MHz Dc to 500 MHz	010-6202-03 plus 010-0384-00 to provide 100X

Active — Variable Bias/Offset*3

P6230	10X	1.6	450 Ω	1.6 pF	≤0.23 ps	Dc to 1.5 GHz	010-6230-01

*1 Length in feet except where specified.
*2 Refer to probe section for additional information.
*3 Requires power source: Most four compartment mainframes provide probe power. See page 463 for Probe Power Supplies.

7S14

Calibrated Delayed Sweep

Two-Dot Time Measurement

Dc to 1 GHz Bandwidth

Dual Trace, 2 mV Sensitivity

CRT Readout

Simplified Triggering

Operational Ease of a Conventional Oscilloscope

The 7S14 Sampling Unit provides dual-trace 1 GHz bandwidth in the 7000 Series oscilloscope mainframes. The 7S14 occupies two plug-in compartments of a mainframe.

The two identical vertical channels of the 7S14 provide two millivolts per division sensitivity at the full 1 GHz bandwidth of the instrument. The 7S14 also uses a two-ramp time base which provides calibrated delayed sweep to 100 picoseconds per division.

Learning to operate the 7S14 requires a minimum of effort for those familiar with conventional oscilloscope operation for 7000 Series oscilloscopes. Front-panel controls are grouped and color coded by function, and control nomenclature is similar to that of conventional oscilloscopes.

The two-dot measurement capability of the 7S14 provides an easy and accurate means of measuring time intervals on the displayed waveform. The two dots are positioned by the Delay controls; the time interval between them is determined by multiplying the Delay Time Multiplier setting by the selected time per division. This eliminates the need to interpolate between graticule markings on the CRT.

CHARACTERISTICS

VERTICAL CHANNEL

Modes — CH 1 only; CH 2 only; Dual Trace; CH 1 added to CH 2; CH 2 subtracted from CH 1 (CH 2 Invert); CH 1 Vertical (Y), CH 2 Horizontal (X).

Input Impedance — Nominally 50 Ω.

Bandwidth — Equivalent to dc to 1 GHz.

Rise Time — 350 ps or less.

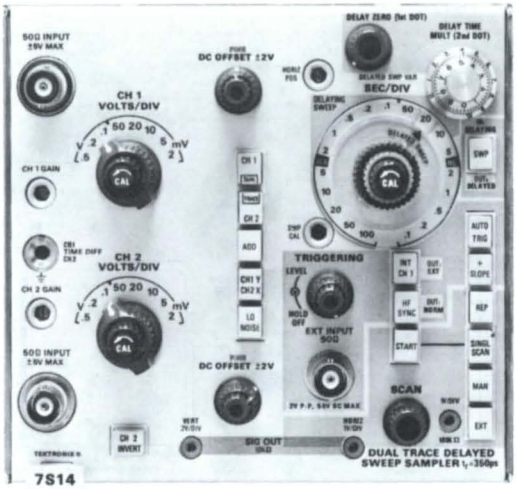
Step Aberrations — +2%, −3%, total of 5% p-p within first 5 ns, ±1% thereafter, both tested with a 284 Pulse Generator.

Deflection Factor — 2 mV/div to 0.5 V/div in eight steps (1-2-5 sequence). Continuously variable between steps by at least 2.5 to 1.

Accuracy — Within ±3%.

Maximum Input Voltage — ±5 V.

Input Signal Range — 2 V p-p maximum within a +2 V to −2 V window at any sensitivity.



Dual Trace Delayed Sweep Sampler

Dc Offset Range — At least +2 V to −2 V.

Displayed Noise — 2 mV or less unsmoothed (measured tangentially). Low noise pushbutton reduces random noise by a factor of 4 to 1 or more.

Vertical Signal Output — 0.2 V/div of vertical deflection; 10 kΩ source resistance.

Channel Delay Difference — Adjustable to zero, or for any time difference up to at least 1 ns.

TIME BASE

Scan Modes — Repetitive, single, manual, or external.

Delaying Sweep — May be used as the CRT time base or as a delay generator for the delayed sweep. The sweep starts with minimum delay from the instant of trigger recognition. When the delaying sweep mode is selected for the time base, two bright dots in the trace, which may be positioned anywhere on the displayed waveform, are generated. The time between dots is equal to the reading on the Delay Time Multiplier dial multiplied by the Time/div.

Delayed Sweep — This mode is used when the signal to be displayed occurs considerably later than the instant of trigger recognition or when the time must be 5 ns or less per division. The delayed sweep may be started with zero delay time with respect to the start of the delaying sweep. Or the start may be delayed by any time interval up to that represented by ten divisions of the delaying sweep selected.

Horizontal Signal Output — 1.0 V/div of horizontal deflection; 10 kΩ source resistance.

DELAYING SWEEP

Range — 10 ns/div to 100 μs/div in 13 steps (1-2-5 sequence).

Accuracy — Within ±3%, excluding first 0.5 division of displayed sweep.

Delayed Zero (1st Dot) — Adjustable to correspond to any instant within the time interval represented by the first nine divisions of the delaying sweep selected.

Delay Time (2nd Dot) — Adjustable to any position of the time interval represented by ten divisions of the delaying sweep selected.

Delay Accuracy — Within ±1% of ten divisions when measurement is made within the last 9.5 division.

DELAYED SWEEP

Range — 100 ps/div to 100 μs/div in 19 steps (1-2-5 sequence). Variable between steps by at least 2.5 to 1.

Accuracy — Within ±3% excluding first 0.5 divisions of displayed sweep.

Start Delay —Depends on the delaying sweep time selected and the setting of the Delay Time Multiplier dial. Adjustable from zero to any time interval up to that represented by ten divisions of the delaying sweep selected. The delaying sweep start point corresponds to the position of the second bright dot.

Delay Jitter — <0.05% of the time represented by one division of the delaying sweep selected.

TRIGGERING AND SYNC

Signal Sources — Internal from CH 1 vertical input or external through front-panel connector.

External Triggering — Nominal 50 Ω input, ac coupled, 2 V p-p 50 V dc maximum. Trigger pulse amplitude 10 mV p-p or more with rise time of 1 μs or less. 10 Hz to 100 MHz. Sinewave amplitude 10 mV p-p or more from 150 kHz to 100 MHz.

Internal Triggering — Pulse amplitude 50 mV p-p or more with rise time of 1 μs or less. Sinewave amplitude 50 mV p-p or more from 150 kHz to 100 MHz.

Triggered Mode — Trigger recognition may be made to occur at any selected voltage level between +0.5 V and −0.5 V on either a + slope or a − slope of the triggering signal.

Autotrigger Mode — For small signals or when there may be no triggering signal. Sampling pulses are automatically generated at a low rate in the absence of a triggering signal so that a trace may always be generated and displayed. The trigger level range automatically adjusts to approximately the p-p voltage of the signal.

Holdoff — Varies the length of the interval during which recognition is inhibited. Variation is at least 5 to 1. The control is particularly useful for displaying digital words when triggering on binary pulses.

HF Sync Mode — For sinewaves from 100 MHz to 1 GHz, 10 mV p-p or more from external source, 50 mV p-p or more from internal pickoff.

ORDERING INFORMATION

7S14 Dual Trace Delayed Sweep Sampler for 7000 Series Oscilloscopes **$6,245**

Includes: Two X10 attenuators (011-0059-02); two 42 in 50 Ω coaxial cables (012-0057-01); instruction manual (070-1410-00).

TRAINING

Tektronix Instrument Group Customer Training offers operation and application training to help you get full value out of your instrumentation investment. Information is on pages 195, 493. For further information, or to enroll, call us at 1-800-225-7802. For international orders contact your local Sales Office.

7S12

45 ps TDR or a General Purpose Sampler

6 Plug-In Sampling Heads Available

2 Plug-In Pulse Sources Available

1 Trigger Recognizer Head Available

1 Trigger Countdown Head Available

The 7S12 is a combined vertical-horizontal, double-width plug-in for high resolution TDR or general purpose sampling measurements. As a TDR using the S-6 Sampling Head and S-52 Pulse Generator Head, the 7S12 has a system rise time of 45 ps (return from short-circuit termination) and distance range to 250 feet in any cable. Its vertical scale is calibrated in reflection coefficient (ρ) from 2 mρ/div to 500 mρ/div and in voltage from 2 mV/div to 500 mV/div. Two-way time or one-way distance to a discontinuity of interest is read directly from tape dial calibrated for time, air, polyethylene, or your choice of dielectrics. As a long line TDR using the S-5 Sampling Head and S-54 Pulse Generator Head, distance calibration extends to 4900 feet (air line) and discontinuities to twice this distance may be viewed. System rise time with this combination is 1.5 ns.

General-purpose measurements may be made by using an S-1, S-2, S-3A, S-4, S-5, or S-6 Sampling Head with an S-53 Trigger Recognizer Head or S-51 Trigger Countdown Head. For dual-trace sampling displays, use a 7S11 Sampling Unit with a 7S12. The addition of a 7M11 Dual Delay Line provides the signal delay necessary to view the triggering event when a pretrigger signal is not available.

CHARACTERISTICS

SYSTEM PERFORMANCE WITH S-6 AND S-52

System Rise Time — 35 ps or less for the incident step. 45 ps or less for the displayed reflection from a short-circuited, 1 ns test line.

Time and Distance Ranges — Direct-reading tape dial gives calibrated one-way distance to at least 375 ft (air line). Time range is at least 0.75 μs round trip. Both ranges are limited by the duration of the pulse from the S-52.

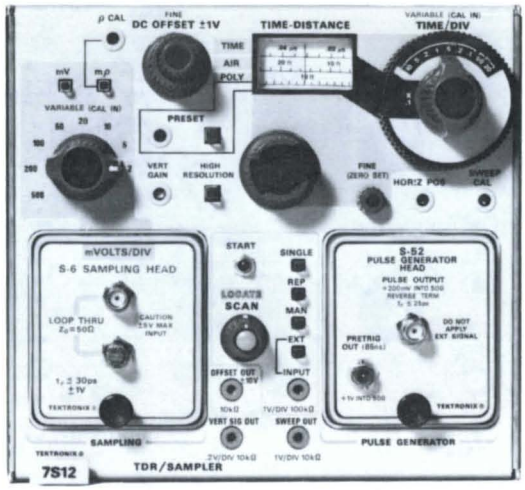
Pulse Amplitude — At least +200 mV into 50 Ω.

Input Characteristics — Nominal 50 Ω, feed-through signal channel (termination supplied). SMA (3 mm) connectors.

Jitter — <10 ps (without signal averaging).

Aberrations — +7%, −7%, total of 10% p-p within 1.8 ns of step with reference point at 1.8 ns from step; +2%, −2%, total of 4% p-p after first 2.5 ns with reference point at 300 ns from step.

7S12



TDR/Sampler

TDR SYSTEM PERFORMANCE WITH S-5 AND S-54

System Rise Time — 1.5 ns or less for the displayed reflection from a short-circuited test line.

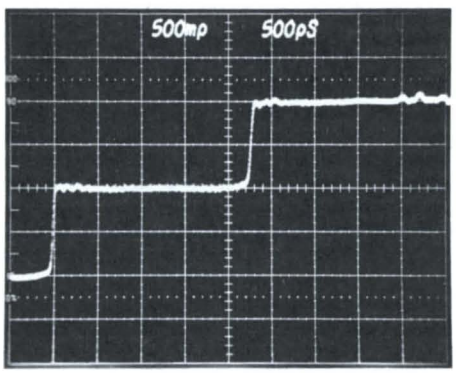
Time and Distance Ranges — Direct-reading tape dial gives calibrated one-way distances to 4900 ft (air line), 3240 ft solid polyethylene. Time range is 20 μs round trip.

Pulse Amplitude — At least +400 mV into 50 Ω.

Input Characteristics — Nominal 50 Ω test line connection (cable and T supplied). BNC connectors.

Jitter — <20 ps (without signal averaging).

Aberrations — +4%, −6%, total of 10% p-p within first 17 ns of step; +1.5%, −1.5%, total of 3% thereafter.



The 7S12 displays reflection coefficient (ρ) versus distance on a device-under-test. Here the 7S12 measures a reflection caused by a crack (open) in a PCB under test. Distance can be read directly from the 7S12 front panel, or calculated from the time base settings.

OTHER 7S12 CHARACTERISTICS

Vertical Scale — Calibrated in mρ (reflection coefficient 10^{-3}) and mV from 2 to 500 units/division in eight steps (1-2-5 sequence), accurate within 3%. Uncalibrated variable is continuous between steps.

Resolution — Reflection coefficients as low as 0.001 may be observed. Signal averaging reduces test-line noise in display.

Dc Offset Range — +1 V to −1 V. Allows open-circuit reflections to be displayed at full sensitivity. Monitor jack provides X10 dc offset through 10 kΩ.

Time/Distance — Tape Dial is Calibrated in Time and Distance: Full-scale ranges of 4900 ft, 490 ft, 49 ft (air dielectric); 3200 ft, 320 ft, 32 ft (polyethylene dielectric); and 10 μs, 1 μs, 0.1 μs (time). Accurate within 1%. Distance calibration may be preset for dielectric having propagation factors from 0.6 to 1.

Time/Div — 20 ps/div to 1 μs/div (1-2-5 sequence) in three ranges with direct-reading magnifier. Accurate within 3%. Uncalibrated variable is continuous between steps.

Locate Button — Provides instant return to unmagnified display showing entire full-scale range. Brightened portion of trace indicates time position and duration of magnified display.

Display Modes — Repetitive or single sweep, manual or external scan.

Signal Outputs — Pin jacks provide both vertical signal and sweep outputs.

ORDERING INFORMATION

7S12 TDR/Sampler Without Sampling Heads (Tape Dial in Feet) **$4,085**

Includes: 750 ps rigid "U" delay line (015-1017-01); short-circuit termination (015-1021-00); TDR graticule overlay (331-0296-00); TDR slide rule (003-0700-00); TDR graticule overlay (331-0297-00); instruction manual (070-1244-00).

Option 03 — Tape Dial Change (Meters). **+$25**

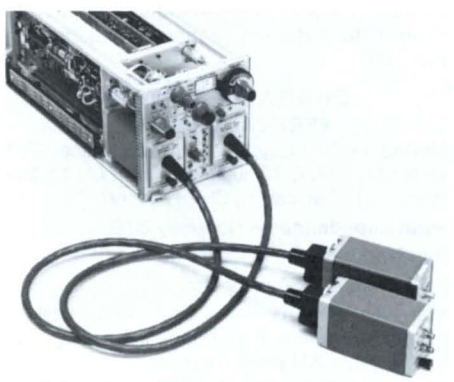
RECOMMENDED MAINFRAME

See page 229

7603 Oscilloscope Mainframe **$3,670**

OPTIONAL ACCESSORIES

Sampling-Head Extender —
(3 ft) Order 012-0124-00 **$470**
(6 ft) Order 012-0125-00 **$535**



Extenders allow the user to locate the sampling head directly in a test fixture, avoiding potential signal degradation by cables.

TRAINING

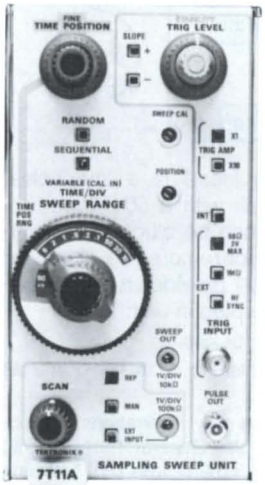
Tektronix Instrument Group Customer Training offers operation and application training to help you get full value out of your instrumentation investment. Information is on pages 195, 493. For further information, or to enroll, call us at 1-800-225-7802. For international orders, contact your local Sales Office.

For sampling heads, see pages 259 and 260.
See 1502 and 1503 Portable TDR Cable Testers on page 154.

7S11

Sampling Unit

7T11A



Sampling Sweep Unit

7S11

2 mV/Div to 200 mV/Div Calibrated Deflection Factors

Plug-In Sampling Heads

The 7S11 single-channel sampling unit employs the sampling plug-in head concept. The heads, which mount in the 7S11, range in bandwidth from 350 MHz to 14 GHz.

The 7S11 can be used for a variety of applications. Single-channel sampling uses one 7S11 with a 7T11A Time Base. Two 7S11s and one 7T11A provide dual-trace sampling. One 7S11 and one 7S12 provide dual-trace sampling. Two 7S11s can be used for X-Y operations.

CHARACTERISTICS

Deflection Factor — 2 mV/div to 200 mV/div in seven steps (1-2-5 sequence), accurate within 3%. Uncalibrated variable is continuous (extends deflection factor from 1 mV/div or less to at least 400 mV/div). Deflection factor is determined by the plug-in sampling head.

Bandwidth — Determined by the sampling head.

Input Impedance — Determined by the sampling head.

Dc Offset — Range, +1 V to −1 V or more. Offset out is 10X the offset voltage within 2%. Source R is 10 kΩ within 1%.

Delay Range — At least 10 ns for comparing two signals in a dual-trace application.

Memory Slash — 0.1 div or less at 20 Hz.

Vertical Signal Out — 200 mV per displayed div within 3%.

Ambient Temperature — Performance characteristics are valid over an ambient temperature range of 0°C to +50°C.

ORDERING INFORMATION

7S11 Sampling Unit Without Sampling Head **$2,140**

Includes: Instruction manual (070-0985-00).

7T11A

10 ps/Div to 5 ms/Div Calibrated Time Base

Random or Sequential Sampling

Equivalent or Real Time Sampling

No Pretrigger Required

The 7T11A Sampling Time Base provides equivalent-time and real time horizontal deflection for single-trace or dual-trace sampling. Timing accuracy is within 3% and nonlinearity is well below 1%. Triggering range is from approximately 10 Hz (sequential mode) to above 12.4 GHz. The 7T11A works with all 7000 Series instruments and is a companion unit to the 7S11.

CHARACTERISTICS

Time/Division Range — 10 ps/div to 5 ms/div (1-2-5 sequence) directly related to time position ranges. Uncalibrated variable is continuous between steps to at least 4 ps/div.

Time Position Range — Equivalent time is 50 ns to 50 μs in four steps; real time is 0.05 ms to 50 ms in three steps.

Time/Division Accuracy — Within 3% for all time/division settings over center 8 cm.

TRIGGERING

External 50 Ω Input — Frequency range is dc to 1 GHz in 1X Trig Amp mode. Sensitivity range is 12.5 mV to 2 V p-p (dc to 1 GHz) in X1 Trig Amp, 1.25 mV to 2 V p-p (1 kHz to 50 MHz) in X10 Trig Amp. Input R is 50 Ω within 10%. Maximum input voltage is 2 V (dc + peak ac).

External 1 MΩ Input — Frequency range is dc to 100 MHz in X1 Trig Amp mode. Sensitivity range is 12.5 mV to 2 V p-p (dc to 100 MHz) in X1 Trig Amp, 1.25 mV to 2 V p-p (1 kHz to 50 MHz) in X10 Trig Amp. Input R is 1 MΩ within 5%. Maximum input voltage is 100 V p-p to 1 kHz (derating 6 dB per octave to a minimum 5 V p-p).

External HF Sync — Frequency range is 1 GHz to 12.4 GHz. Sensitivity range is 10 mV to 500 mV p-p. Input R is 1 MΩ. Maximum input voltage is 2 V p-p.

Internal Trigger Source (Sinewave Triggering)*1 — Frequency range is 5 kHz to 500 MHz in X1 Trig Amp: 5 kHz to 50 MHz in X10 Trig Amp. Sensitivity range is 125 mV to 1 V p-p (referred to the vertical input) in X1 Trig Amp; 12.5 mV to 1 V p-p (referred to the vertical input) in the X10 Trig Amp.

**1 Trigger circuits will operate to dc with pulse triggering, except for HF Sync.*

Random Mode Trigger Rate — 100 Hz minimum.

Display Jitter*1

Time Pos Range	Sequential Mode	Random Mode
50 μs to 500 ns	0.4 div or less	1 div or less
50 ns	10 ps	30 ps

**1 Measured under optimum trigger conditions with Time/Division switch clockwise.*

Pulse Out — Positive pulse amplitude at least 400 mV (into 50 Ω) with 2.5 ns rise time or less.

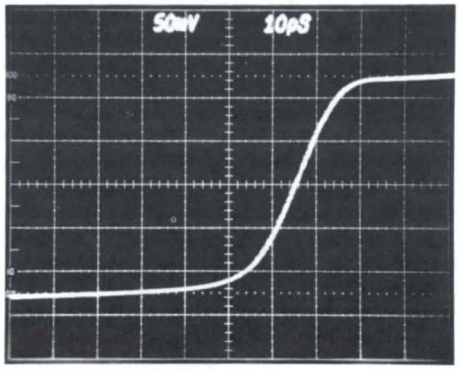
Trigger Kickout — 2 mV or less into 50 Ω (except HF Sync).

Display Scan Rate — Continuously selectable from at least 40 sweeps/s to <2 sweeps/s.

External Scan — Deflection factor is continuously variable from 1 V/div to 10 V/div. Input R is 100 kΩ with 10%. Maximum input voltage is 100 V (dc + peak ac).

Sweep Out — 1 V/div within 2%. Source R is 10 kΩ within 1%.

Ambient Temperature — Performance characteristics are valid over an ambient temperature range of 0°C to +50°C.



7S11 and 7T11A Plug-ins together provide accurate measurements on repetitive signals. Pulse rise time of 21 ps shown.

ORDERING INFORMATION

7T11A Sampling Sweep Unit **$5,370**

Includes: 42 inch BNC 50 Ω cable (012-0057-01); 3 mm SMA male to BNC adaptor (015-1018-00); 3 mm SMA male to GR874 adaptor (015-1007-00); 10X 50 Ω attenuator (011-0059-02); instruction manual (070-0986-00).

TRAINING

Tektronix Instrument Group Customer Training offers operation and application training to help you get full value out of your instrumentation investment. Information is on pages 195, 493. For further information, or to enroll, call us at 1-800-225-7802. For international orders, contact your local Sales Office.

7M11

Delay Line

7M11

75 ns Time Delay

Selectable Trigger out

175 ps Rise Time

The 7M11 is a passive dual delay line for use with the 7000 Series sampling system. In low-repetition-rate applications requiring the sequential mode of operation, the 7M11 provides the trigger source and signal delay necessary to view the triggering event at fast time-per-division settings.

Vertical delay for two 7S11 vertical sampling units is available with the dual 50 Ω, 75 ns delay lines. The closely matched (30 ps) lines have GR874 input-output connectors, 175 ps rise time, and 2X signal attenuation. Trigger selection is from either input, 5X attenuated, with a rise time of 600 ps or less.

CHARACTERISTICS

DELAY LINE

Time Delay — 75 ns within 1 ns.

Delay Difference — 30 ps or less between channels.

Rise time — 175 ps or less.

Attenuation — 2X within 2% into 50 Ω.

Input Impedance — 50 Ω within 2%.

Maximum Input — ±5 V (dc + peak ac).

TRIGGER OUTPUT

Rise Time — 600 ps or less.

Attenuation — 5X within 10% into 50 Ω (referred to input).

Output Impedance — 50 Ω within 10%.

Ambient Temperature — Performance characteristics are valid over an ambient temperature range of 0°C to +50°C.

ORDERING INFORMATION

7M11 Delay Line **$1,625**

Includes: Two 2 ns GR cables (017-0505-00); ten inch BNC cables (012-0208-00); instruction manual (070-0987-00).

S-1

Dc to 1 GHz Bandwidth

Clean Transient Response

Internal Trigger Pickoff

The S-1 Sampling Head is a low noise, 350 ps rise time unit with a 50 Ω input impedance. The S-1 can be plugged in or attached by a cable for remote use. A trigger pickoff within the S-1 provides a trigger signal output from the plug-in unit.

Rise Time — 350 ps or less.

Bandwidth — Equivalent to dc to 1 GHz at 3 dB down.

Transient Response — Aberrations as observed with the 284 Pulse Generator are +0.5%, −3% or less, total of 3.5% or less p-p, first 5 ns following the step transition; −0.5% or less, total of 1% or less p-p after 5 ns.

Displayed Noise — Smoothed: 1 mV. Unsmoothed: 2 mV or less.

Signal Range — Variable dc offset allows signals between +1 V and −1 V limits to be displayed at 2 mV/div. Signals between +2 V and −2 V limits may be displayed at 200 mV/div. For best dot response with random-sampling sweep unit, signal amplitude should be <500 mV p-p.

Input Characteristics — Norminally 50 Ω. Safe overload is ±5 V. GR874 input connectors.

Weights — Net: 0.5 kg (1.0 lb). Shipping: 1.4 kg (3.0 lb).

ORDERING INFORMATION

S-1 Sampling Head **$1,395**

Includes: 5 ns, 50 Ω RG58 A/U cable (017-0512-00); 10X, 50 Ω GR attenuator (017-0078-00); instruction manual (070-0763-00).

S-2

Dc to 4.6 GHz Bandwidth

Displayed Noise <6 mV (Unsmoothed)

Internal Trigger Pickoff

The S-2 Sampling Head is a 75 ps rise time unit with a 50 Ω input impedance. The S-2 can be plugged in or attached by a cable for remote use. A trigger pickoff within the S-2 provides a trigger signal output from the plug-in unit.

Rise Time — 75 ps or less.

Bandwidth — Equivalent to dc to 4.6 GHz at 3 dB down.

Transient Response — Aberrations as observed with the 284 Pulse Generator are +5%, −5% or less, total of 10% or less p-p, first 2.5 ns following a step transition; +2%, −2% or less total of 4% or less p-p after 2.5 ns.

Displayed Noise — Smoothed: 3 mV. Unsmoothed: 6 mV or less.

Signal Range — Variable dc offset allows signals between +1 V and −1 V limits to be displayed at 2 mV/div. Signals between +2 V and −2 V limits may be displayed at 200 mV/div. For best dot response with random-sampling sweep unit, signal amplitude should be <200 mV p-p.

Input Characteristics — Nominally 50 Ω. Safe overload is ±5 V. GR874 input connectors.

Weights — Net: 0.5 kg (1.0 lb). Shipping: 1.4 kg (3.0 lb).

ORDERING INFORMATION

S-2 Sampling Head **$1,635**

Includes: 50 Ω GR attenuator (017-0078-00); 5 ns, 50 Ω RG213/U Cable (017-0502-00); 10X, instruction manual (070-0764-00).

S-3A

Displayed Noise <3 mV (Unsmoothed)

Dc to 1 GHz Bandwidth

Compact, 4.5 ft, 100 kΩ, 2.3 pF Probe

The S-3A Sampling Head is an active sampling-probe unit with 100 kΩ, 2.3 pF input impedance. Up to 2 V of dc offset may be used while maintaining a 2 mV/div deflection factor.

Rise Time — 350 ps or less.

Bandwidth (Probe only) — Equivalent to dc to 1 GHz at 3 dB down.

Transient Response (Probe only) — Aberrations in the first 2 ns following a step are +8%, −2% or less, total of 10% or less p-p, +1%, −1% or less, total of 2% or less p-p after 2 ns, with 284 pulse displayed.

Displayed Noise (Probe only) — 3 mV or less referred to probe tip (includes 90% of dots).

Signal Range — Variable dc offset allows signals between +1 V, 1X range, or +2 V and −2 V, 2X range, to be displayed at 2 mV/div. The signal range may be increased 10X or 100X with the probe attenuators.

Weight — Net: 1.4 kg (3.0 lb). Shipping: 2.3 kg (5.0 lb).

ORDERING INFORMATION

S-3A Sampling Head **$2,120**

Includes: 10X attenuator head (010-0364-00); 100X attenuator head (010-0365-00); two test-point jacks (131-0258-00); coupling capacitor (011-0098-00); probe tip (206-0114-00); tip ground adaptor (013-0085-00); 5½ inch ground lead (175-1017-00); 12½ inch ground lead (175-1018-00); 3 inch cable assembly (195-6176-00); end cap (200-0834-00); three ground clips (344-0046-00); two end caps (200-0835-00); probe holder (352-0090-00); carrying case (016-0121-01); 6 inch elec lead (175-0849-00); 3 inch elec lead (175-0849-00); retractable hook tip (013-0097-01); 50 Ω voltage pickoff (017-0077-01); instruction manual (070-1148-00).

S-4

Displayed Noise <5 mV (Unsmoothed)

25 ps Rise Time

Internal Trigger Pickoff

The S-4 Sampling Head is a 25 ps rise time unit with a 50 Ω input impedance. The S-4 can be plugged into the sampling unit or attached by a sampling head extender for remote use. A trigger pickoff within the S-4 provides a trigger signal output from the plug-in unit.

Rise Time — 25 ps or less.

Bandwidth — Equivalent to dc to 14 GHz at 3 dB down.

Transient Response — Aberrations in the first 400 ps following a step from an S-52 Pulse Generator Head are −10%, +10% or less, total of 20% or less p-p. From 400 ps to 25 ns following a step from a 284 Pulse Generator, −0%, +10% or less, total of 10% or less, p-p with 284 pulse displayed; after 25 ns, −2%, +2% or less, total of 4% or less p-p.

Displayed Noise — Smoothed: 2.5 mV. Unsmoothed: 5 mV or less.

Signal Range — Variable dc offset allows signals between +1 V and −1 V limits to be displayed at 2 mV/div. For best dot-transient response with random-sampling sweep unit, signal amplitude should be less than 500 mV p-p.

Input Characteristics — Nominally 50 Ω. Safe overload is ±5 V. SMA (3 mm) input connector.

Weight — Net: 0.5 kg (1.0 lb). Shipping: 0.9 kg (2.0 lb).

ORDERING INFORMATION

S-4 Sampling Head **$3,195**

Includes: 10X 50 Ω SMA attenuator (015-1003-00); 2 ns cable with SMA connectors (015-1005-00); GR874 to SMA male adaptor (015-1007-00); SMA male-to-male adaptor (015-1011-00); 5/16 inch wrench (003-0247-00); instruction manual (070-0896-01).

S-5

Dc to 350 MHz Bandwidth

1 MΩ, 15 pF Input Impedance

Passive Probe

Internal Trigger Pickoff

The S-5 Sampling Head is a low-noise, 1 ns rise time sampling unit with a 1 MΩ, 15 pF input impedance. When used with the included P6010 Passive Probe, the input impedance increases to 10 MΩ, 10 pF while maintaining the 1 ns rise time at the probe tip. A switch on the sampling head selects either ac or dc coupling of the input.

Rise Time — S-5 Only: 1 ns or less. With 3.5 ft P6010: 1 ns or less.

Bandwidth — Equivalent to dc to 350 MHz at 3 dB down at input connector or probe tip.

Transient Response — S-5 Only (Driven with a 50 Ω Source Terminated in 50 Ω): Aberrations +2.5%, −5% or less, total of 7.5% or less p-p within 17 ns after step; +1%, −1% or less, total of 2% or less p-p thereafter.

S-5/P6010 (3.5 ft Probe, Properly Compensated): Aberrations +5%, −5% or less total of 10% or less p-p within 25 ns after step; +1%, −1% or less total of 2% or less p-p thereafter.

Displayed Noise — S-5 Only: 500 μV or less (includes 90% of dots). S5/P6010: 5 mV or less (includes 90% of dots).

Signal Range — S-5 Only: Dc coupled is 1 V p-p from +1 V to −1 V. Ac coupled is 1 V p-p. S5/P6010: Dc coupled (dc + peak ac) is 10 V p-p. Ac coupling, dc voltage is 100 V.

Input Characteristics — S-5 Only: 1 MΩ within 1% paralleled by 15 pF. S-5/P6010: 10 MΩ paralleled by ≈10 pF.

Attenuator Accuracy — Probe attenuation is 10X within 3%.

Weight — Net: 0.3 kg (0.6 lb). Shipping: 0.9 kg (2.0 lb).

ORDERING INFORMATION

S-5 Sampling Head **$1,595**

Includes: 50 Ω termination (011-0049-01); P6010 probe package (010-0188-00); instruction manual (070-0942-00).

S-6

30 ps Rise Time

Displayed Noise <5 mV (Unsmoothed)

Loop-Through Input

The S-6 Sampling Head is a 50 Ω feedthrough unit for high-speed applications.

Rise Time — 30 ps or less. 35 ps or less as observed with S-52 Pulse Generator.

Bandwidth — Equivalent to dc to 11.5 GHz at 3 dB down.

Transient Response — Pulse aberrations following the steps are +7%, −7%, total of 10% p-p within 1.8 ns of step with reference point at 1.8 ns from step; +2%, −2%, total of 4% p-p after first 2.5 ns with reference point at 300 ns from step.

Displayed Noise — 5 mV or less, measured tangentially.

Signal Range — +1 V to −1 V (dc + peak ac). 1 V p-p. Dc offset allows any portion of input signal to be displayed.

Input Characteristics — Nominally 50 Ω, loop-through system, unterminated. SMA (3 mm) connectors. Safe overload is ±5 V.

Weight — Net: 0.5 kg (1.0 lb). Shipping: 0.9 kg (2.0 lb).

ORDERING INFORMATION

S-6 Sampling Head **$2,750**

Includes: 50 Ω termination (015-1022-00); 1 ns 50 Ω cable (015-1019-00); SMA (3 mm) female-to-female adaptor (015-1012-00); combination wrench (003-0247-00); SMA male-to-GR874 adaptor (015-1007-00); instruction manual (070-1128-01).

TIMING HEAD CHARACTERISTICS

	Bandwidth	Rise Time	Application
S-51	1 GHz to 18 GHz trigger countdown	—	High Speed Sinewave Sampling
S-52	—	≤25 ps	High Resolution TDR
S-53	Dc to 1 GHz trigger recognizer	—	General Purpose Sampling
S-54	—	≤1 ns	Medium Resolution TDR

S-51

18 GHz Countdown

10 ps or Less Trigger Jitter

The S-51 Trigger Countdown Head is a free-running tunnel-diode oscillator designed to provide stable sampling displays of sinewaves from 1 GHz to 18 GHz. The S-51 has a front panel sync control that synchronizes the oscillator frequency to a subharmonic of the input signal. The output from the S-51 is available at a front panel trigger output connector and through a rear panel connector for internal triggering. The output signal is a direct countdown of the input and permits triggering by a standard sampling time base unit.

Input Signal — Frequency range is 1 GHz to 18 GHz. Stable synchronization on signals at least 100 mV p-p, as measured separately into 50 Ω, 5 V, p-p maximum.

Input Characteristics — 50 Ω SMA (3 mm) connector. Open termination paralleled by 1 pF.

Trigger Output — Front panel trigger output is at least 200 mV into 50 Ω, BSM type connector. Internal trigger output is at least 100 mV into 50 Ω, internally connected to sampling unit. Jitter is 10 ps or less with signals from 5 GHz to 18 GHz; 15 ps or less with signals from 1 GHz to 5 GHz. Kickout at signal input connector is 400 mV or less; kickout occurs between successive samples.

Weight — Net: 0.5 kg (1.0 lb). Shipping: 2.3 kg (5.0 lb).

ORDERING INFORMATION

S-51 Trigger Countdown Head **$1,695**

Includes: Instruction manual (070-0898-00).

S-52

25 ps Rise Time

200 mV Into 50 Ω

50 Ω Source

Pretrigger Output

The S-52 Pulse Generator Head is a tunnel-diode step generator designed for use with the 7S12 as a high resolution TDR (Time Domain Reflectometer). For TDR applications, it features automatic bias circuit control to eliminate effects of tunnel-diode and load changes. A 50 Ω reverse termination minimizes reflections. The pulse width is sufficient for distances up to 250 ft in any cable. A pretrigger output allows operation in sequential sampling systems without a delay line.

Pulse Output — Rise time is 25 ps or less. Amplitude into 50 Ω is at least 200 mV, positive-going. Pulse duration when used with the 7S12 in the TDR mode is typically 750 ms. Pulse duration when powered by the 7S11 is >800 ns. Pulse period 16 μs within 2 μs. Pulse aberrations following the step are +7%, −7%, total of 10% p-p within 1.8 ns of step with reference point at 1.8 ns from step, +2%, −2%, total of 4% p-p after first 2.5 ns with reference point at 300 ns from step.

Pretrigger Output — Rise time is 1 ns or less. Amplitude into 50 Ω is at least 1 V, positive going. Pretrigger pulse duration is 4 ns. Pretrigger occurs 85 ns (within 5 ns) before the pulse output. Pretrigger to pulse output jitter is 10 ps or less. Pretrigger output is also available at rear connector for internal triggering of the sampling sweep unit.

Output Connectors — Pulse output uses an SMA (3 mm) connector. Pretrigger output uses a BSM connector.

Weight — Net: 0.3 kg (0.8 lb). Shipping: 0.5 kg (1.0 lb).

ORDERING INFORMATION

S-52 Pulse Generator Head **$1,965**
Includes: 1 ns, 50 Ω semirigid coax delay line (015-1023-00); instruction manual (070-1101-01).

S-53

Dc-to-1 GHz Operation

10 mV Sensitivity

The S-53 Trigger Recognizer Head is intended for use with the 7S12 to permit operation as a general-purpose sampling system. The S-53 supplies triggering for the 7S12.

Input Characteristics — Frequency range is dc to 1 GHz. Sensitivity range is 10 mV to 2 V p-p into 50 Ω. Kickout at input, ±5 mV or less.

Output Characteristics — Rise time is 1 ns or less. Amplitude is at least 1.5 V positive-going into 50 Ω. Pulse duration is 3 ns within 2 ns at the 50% amplitude level. Pulse period is 27 μs minimum. Trigger-to-signal delay is 15 ns or less.

Connectors — Trigger input connector is BNC type. Front-panel trigger output connector is BSM type. Trigger output is also available at rear connector for internal triggering.

Weight — Net: 0.3 kg (0.8 lb). Shipping: 0.5 kg (1.0 lb).

ORDERING INFORMATION

S-53 Trigger Recognizer Head **$1,425**
Includes: 42 inch, 50 Ω cable (012-0057-01); 10X 50 Ω attenuator (011-0059-02); instruction manual (070-1147-00).

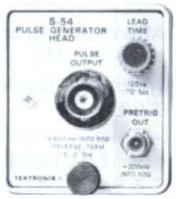
S-54

1 ns Rise Time

Low Aberrations

400 mV Into 50 Ω

Variable Pretrigger Lead Time



The S-54 Pulse Generator Head is a step generator designed for use with the 7S12 as a long line TDR unit.

For TDR applications, it S-54 is 50 Ω reverse terminated to minimize reflections and has a 0 V base line to eliminate base line shift with load changes. A continuously variable front-panel control enables adjustment of pretrigger lead time. The pretrigger output allows operation in sequential sampling systems without a delay line.

Pulse Output — Rise time is 1 ns or less. Amplitude into 50 Ω is +400 mV or greater. Pulse duration is 25 μs within 2 μs. Pulse aberrations following the step are +1.5%, −1.5%, total of 1.5% p-p, as displayed with S-1 Sampling Head. Base line level is 0 V within 20 mV, terminated in 50 Ω.

Pretrigger Output — Rise time is 5 ns or less. Amplitude into 50 Ω is at least 200 mV, positive-going. Pretrigger pulse duration is 20 ns or less at the 50% amplitude point. Pretrigger lead time is front panel adjustable from 120 ns or less to 1 μs or greater. Pretrigger-to-pulse-output jitter is 100 ps or less at 120 ns lead time to 1 ns or less at 1 μs lead time.

Output Connectors — Pulse output uses a BNC connector. Pretrigger output uses a BSM connector.

Weight — Net: 0.3 kg (0.8 lb). Shipping: 0.5 kg (1.0 lb).

ORDERING INFORMATION

S-54 Pulse Generator Head **$1,370**
Includes: BNC T connector (103-0030-00); 8 inch 50 Ω cable (012-0118-00); instruction manual (070-1093-00).

OPTIONAL SAMPLING ACCESSORIES

CT-1 Current Transformer —
With GR Cable. **$175**

Coupling Capacitor GR874-K —
Order 017-0028-00 **$115**

Power Divider GR874-TPD —
Order 017-0082-00 **$780**

Adaptors —
(GR to BNC) Order 017-0063-00 **$50**
(Probe Tip-to-BNC) Order 013-0084-01 **$9.75**
(Probe Tip-to-GR) Order 017-0076-00 **$65**
(Probe Tip-to-GR Terminated) Order 017-0088-00 **$60**

RECOMMENDED PROBES

P6056 — 10X Passive **$185**
P6057 — 100X Passive **$190**

OPTIONAL SAMPLING HEAD ACCESSORIES

With SMA (3 mm) Connectors

50 Ω Attenuators —
(2X) Order 015-1001-00 **$145**
(5X) Order 015-1002-00 **$145**
(10X) Order 015-1003-00 **$145**

50 Ω Termination — Order 015-1004-00 **$70**

50 Ω Signal Cables —
(2 ns) Order 015-1005-00 **$110**
(5 ns) Order 015-1006-00 **$175**

Adaptors —
(Male-to-GR874) Order 015-1007-00 **$120**
(Female-to-GR874) Order 015-1008-00 **$120**
(Male-to-N Female) Order 015-1009-00 **$31**
(Male-to-7 mm) Order 015-1010-00 **$215**
(Male-to-Male) Order 015-1011-00 **$24**
(Female-to-Female) Order 015-1012-00 **$10.50**

Coupling Capacitor — Order 015-1013-00 **$230**

50 Ω Power Divider T — Order 015-1014-00 **$250**

500 ps 50 Ω Semi-Rigid Cable —
Order 015-1015-00 **$30**

SMA Adaptors —
(T) Order 015-1016-00 **$41**
(Male-to-BNC Female) Order 015-1018-00 **$9.00**

1 ns 50 Ω Cable — Order 015-1019-00 **$140**

SMA Terminations —
(Male Short-Circuit) Order 015-1020-00 **$19**
(Female Short-Circuit) Order 015-1021-00 **$30**
(Male 50 Ω) Order 015-1022-00 **$39**

With 50 Ω BNC Connectors

Feed-Through Termination —
Order 011-0049-01 **$31**

Feed-Through (5 W) — Order 011-0099-00 **$50**

Attenuators —
(2X) Order 011-0069-02 **$43**
(2.5X) Order 011-0076-02 **$43**
(5X) Order 011-0060-02 **$43**
(10X) Order 011-0059-02 **$43**

Coaxial Cables —
(18 in) Order 012-0076-00 **$17.50**
(42 in) Order 012-0057-01 **$18.50**

5000 SERIES INSTRUMENTS

CONTENTS

5440/R5440 General Purpose 264
5441/R5441 Storage 264
5110/R5110 Single Beam 267
5111A/R5111A Single Beam Storage 267
5113/R5113 Dual Beam Storage 267
5116 Digital Storage 269
Plug-Ins 265, 270
High Performance Digitizing Mainframes . 351

- **Low Cost**
- **Seven Oscilloscope Models**
- **2 MHz, 10 MHz or 50 MHz Bandwidth**
- **10 μV/Div Sensitivity**
- **Wide Choice of Plug-Ins**
- **One to Eight Trace Capability**
- **Color, Digital, Dual-Beam & Storage Displays**
- **Large 6.5 Inch CRT (8 x 10 Div)**
- **CRT Readout (5400 Series and 5D10)**
- **Delayed-Sweep Time Bases**
- **Y-T or X-Y Operation**
- **Bench-to-Rack Convertibility**

The 5000 Series plug-in oscilloscope family is designed to provide maximum versatility and performance at the lowest possible price.

The seven 5100 Series mainframes provide realtime bandwidth to 2 MHz, sensitivity to 10 microvolts per division, CRT and digital storage, dual sweep operation, and more. The 5116, with the 5D10 digital storage, provides multicolor display of multitrace signals, scale factor readout, and cursor measurements.

The 5223 digitizing mainframe with the 5B25N time base provides digitization of signals to 10 MHz with optional GPIB interface.

The 5400 Series mainframes provide all of the capabilities of the 5100 Series mainframes plus 50 MHz bandwidth, variable persistence storage, and CRT readout of vertical and horizontal scale factors.

5000 SERIES SELECTION GUIDE

Features	5440/R5440 Nonstorage With Readout	5441/R5440 Variable Persistence Storage With Readout	5110/R5110 Nonstorage	5111A/R5111A Bistable Storage	5113/R5113 Dual Beam Bistable Storage	5116 Nonstorage Color*1
Bandwidth*2	50 MHz	50 MHz	2 MHz	2 MHz	2 MHz	2 MHz
Minimum Deflection Factor	5 mV/div at BW 10 μV/div 0.5 mA/div	5 mV/div at BW 10 μV/div 0.5 mA/div	1 mV/div at BW 10 μV/div 0.5 mA/div	1 mV/div at BW 10 μV/div 0.5 mA/div	1 mV/div at BW 10μV/div 0.5 mA/div	1 mV/div at BW 10μV/div 0.5 mA/div
Maximum Sweep Rate	5 ns	5 ns	100 ns	100 ns	100 ns	100 ns
Eight Traces	✓	✓	✓	✓	✓ Dual Beam	✓
Delayed Sweep	✓	✓	✓	✓	✓	✓
Page	264	264	267	267	267	269
Prices*3 begin at	$3,320/$3,385	$5,505/$5,560	$1,815/$1,890	$2,835/$2,900	$4,205/$4,335	$2,585

**1 The 5116 must be used with 5D10 to obtain color display.*
**2 Bandwidths are real time. Sampling plug-ins that extend bandwidths to 14 GHz are available for most mainframes.*
**3 Price does not include plug-ins.*

5100 SERIES OSCILLOSCOPES

Four 5100 Series oscilloscope mainframes are available: the 5110 single-beam nonstorage mainframe, the 5111A single-beam storage mainframe, the 5113 dual-beam storage mainframe, and the 5116 single-beam nonstorage mainframe with color shutter. All of these mainframes feature 2 MHz vertical systems with large 6½ inch CRTs.

Each of the 5000 Series mainframes houses up to three plug-in units. For conventional Y-T operation, the left and middle plug-ins are amplifier units and the right plug-in is a time base unit. An amplifier unit may be used in the right-hand plug-in compartment to provide X-Y operation to the full sensitivity of the amplifier unit used. A dual-trace amplifier unit in the right-hand compartment can provide fully independent dual X-Y displays.

When used with the 5D10 Waveform Digitizer, the 5116 mainframe provides a unique three color display, with scale factor and cursor readouts, in addition to the digital storage capabilities of the 5D10.

Detailed descriptions of the 5100 Series mainframes and plug-ins start on page 267.

5223 DIGITIZING OSCILLOSCOPE

You can get the benefits of digital storage, along with the time-tested advantages of a conventional analog scope, in the 10 MHz 5223 Digitizing Oscilloscope. Combined in one powerful, convenient oscilloscope are pushbutton ease, high quality waveform display, pretrigger signal manipulation, and optional GPIB interface, plus real-time analog display capability.

Use the 5223 in the digital storage mode to capture repetitive events up to 10 MHz in frequency or single-shot events up to 100 kHz in frequency. The maximum sample rate is 1 MHz; storage capacity is 1024 bits per vertical compartment.

The digitized display will never fade or bloom, so you get more accurate measurements, more conveniently. High 10-bit vertical resolution gives you an accurate representation of your signals.

For further information on the 5223 Digitizing Oscilloscope and its associated 5B25N time base unit, see page 351 in the Digitizer Section.

5400 SERIES OSCILLOSCOPES

Two 5400 Series display units are presently available: A single-beam, nonstorage display and a variable persistence storage display. Both feature CRT readout of plug-in scale factors, three plug-in compartments and benchmount-to-rackmount convertibility.

The 5400 Series offers 50 MHz bandwidth and is capable of satisfying a wide range of measurement needs. It features readout of plug-in scale factors on the CRT (except with plug-ins having a suffix N: 5A22N, 5B10N, etc.). This feature, previously available only on more sophisticated oscilloscopes, allows you to make measurements more quickly and conveniently. The CRT readout can also be externally accessed (Option 03). Detailed descriptions of the 5400 Series mainframes and associated plug-ins start on page 264.

PLUG-IN VERSATILITY

A wide choice of plug-ins is available in the 5000 Series family. All these plug-ins are compatible with the 5400 Series, and most are compatible with 5100 Series mainframes. Compatibility of 5000 Series mainframes and plug-ins are shown in the chart below.

The amplifier plug-ins include single, dual, and four trace units, and various differential amplifiers. The time base plug-ins include single, dual, and delaying sweep units, and a digital time base.

5000 SERIES MAINFRAME/PLUG-IN COMPATIBILITY

F=Full compatibility L=Limited compatibility 0=No compatibility

Plug-Ins	5110 2 MHz Nonstorage	5111A 2 MHz CRT Storage	5113 2 MHz Dual Beam CRT Storage	5116 2 MHz Nonstorage With Color*1	5223 10 MHz Digital Storage	5440 50 MHz Nonstorage With Readout	5441 50 MHz Variable Persistence With Readout	Page	Prices
5A14N Four Trace, 1 MHz, 1 mV/div	F	F	F	L*1	F	L*2	L*2	271	$1,660
5A15N Single Trace, 2 MHz, 1 mV/div	F	F	F	L*1	F	L*2	L*2	271	$400
5A18N Dual Trace, 2 MHz, 1 mV/div	F	F	F	L*1	F	L*2	L*2	271	$835
5A19N Single Trace Differential, 2 MHz, 1 mV/div	F	F	F	L*1	F	L*2	L*2	272	$480
5A21N Single Trace Differential, 1 MHz, 50 μV/div, 0.5 mA/div	F	F	F	L*1	F	L*2	L*2	272	$615
5A22N Single Trace Differential, 1 MHz, 10 μV/div	F	F	F	L*1	F	L*2	L*2	273	$1,220
5A26 Dual Trace Differential, 1 MHz, 50 μV/div	F	F	F	L*1	F	F	F	273	$1,335
5A38 Dual Trace, 35 MHz, 10 mV/div	0	0	0	0	F	F	F	265	$820
5A48 Dual Trace, 50 MHz, 1 mV/div	0	0	0	0	F	F	F	266	$1,170
5B10N Single Sweep Time Base/ Amplifier, 1 μs to 5 s	F	F	F	L*1	L*3	L*2	L*2	274	$600
5B12N Dual Sweep Time Base, A–1 μs to 5 s, B–2 μs to 0.5 s	F	F	F	L*1	L*3	L*2	L*2	274	$1,260
5B25N Digital Time Base for 5223, 0.2 μs to 5 s	0	0	0	0	F	L*2	L*2	352	$1,095
5B40 Single Sweep Time Base, 0.1 μs to 5 s	0	0	0	0	L*3	F	F	266	$810
5B42 Delaying Time Base, A–0.1 μs to 5 s, B–0.1 μs to 0.5 s	0	0	0	0	L*3	F	F	266	$1,470
5CT1N Semiconductor Curve Tracer	F	F	F	L*1	F	L*2	L*2	389	$1,075
5D10 Waveform Digitizer	F*1	F*1	F*1	F	L*1*3	F*1	F*1	270	$2,095

*1 *The 5116 must be used with 5D10 to obtain color display.*
*2 *Plug-ins with an "N" suffix do not implement the readout feature of the 5440 and 5441.*
*3 *Only 5B25N implements the digital storage feature of the 5223.*

Two special-purpose plug-ins are also available. The 5CT1N is a semiconductor curve tracer plug-in. It allows characteristic curves of transistors, FETs, diodes and other semiconductor devices to be displayed on the CRT.

The 5D10 is a dual channel digital storage unit with cursors, CRT scale factor readout, roll mode and plotter output.

Back-lighted knob skirts on the plug-ins provide scale-factor readout. The correct scale factor is automatically indicated when using the X10 magnifier and/or the recommended 1X and 10X probes. In addition, the 5400 Series automatically presents correct scale factors on the CRT when used with non-N suffix plug-ins. This feature helps reduce human errors and enables photographic recording of measurement conditions.

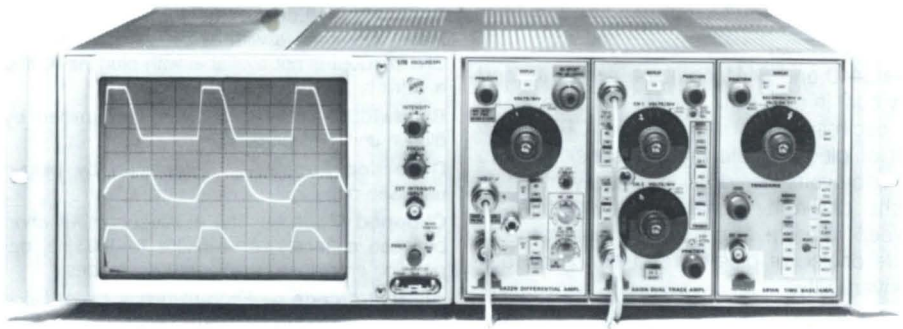
5000 SERIES PLUG-IN/PROBE COMPATIBILITY

Plug-In	Probe	Attenuation	Features
5A14N 5A15N 5A18N 5D10	P6101A P6102A P6062B	1X 10X 1X-10X	Full bandwidth Full bandwidth Switchable attenuation, ground-reference button
5A21N 5A22N 5A26	P6101A P6102A P6062B P6055	1X 10X 1X-10X 10X	Full bandwidth Full bandwidth Switchable attenuation, ground-reference button Variable attenuation for high CMRR in differential operation
5A38 5A48	P6101A P6105A P6062B	1X 10X 1X-10X	Reduced bandwidth Full bandwidth Switchable attenuation, ground-reference button, reduced bandwidth at 1X

See Probe Section for complete descriptions, page 463.

5000 SERIES MAINFRAMES AND PLUG-INS DIMENSIONS AND WEIGHTS

	5223				5100 and 5400 Series				Plug-Ins			
	Cabinet		Rackmount		Cabinet		Rackmount		Single Width		Double Width	
Dimensions	**mm**	**in**	**mm**	**in**	**mm**	**in**	**mm**	**in**	**mm**	**in**	**mm**	**in**
Width	213	8.4	483	19.0	213	8.4	483	19.0	66	2.6	132	5.2
Height	328	12.9	178	7.0	302	11.9	133	5.3	127	5.0	127	5.0
Depth	572	22.5	569	22.4	518	20.4	483	19.0	305	12.0	305	12.0
Weights ≈	**kg**	**lb**	**kg**	**lb**	**kg**	**lb**	**kg**	**lb**	**kg**	**lb**	**kg**	**lb**
Net	16.9	37.3	19.1	42.0	10.4	23.0	10.9	24.0	1.3	2.8	2.6	5.8
Shipping	20.5	45.0	23.6	52.0	14.5	32.0	19.5	43.0	4.5	10.0	4.9	10.8



5000 Series rackmount oscilloscopes and cabinet-to-rackmount kits include complete slideout tracks and mounting hardware interface with standard 19 inch racks.

APPLICATION NOTES FOR 5000 SERIES

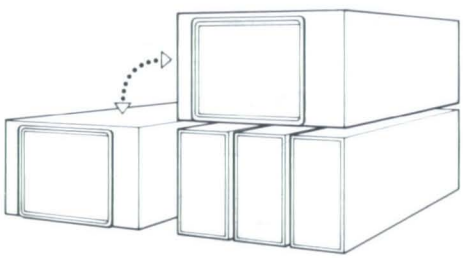
Title	Description	Order
Biophysical Data Retrieval, The Digitizing Approach	5223/5B25N/5A18N Roll mode, chart recorder output.	52-W-4462-1
Interpreting Mechanical Measurements With the Plug-In Oscilloscope	5111/5A22N/5A18N Transducer measurements and storage.	52-A-3533-1
Simultaneous Display of two Independent X-Y signal pairs	5111/5A15/5A15N/5A18N. Dual X-Y techniques, engine analysis.	52-AX-4114
Simultaneous X-Y, Y-T Displays	5111/5A15/5A15N/5B12N. X-Y, Y-T techniques. Biomedical application.	52-AX-4113
Custom Plug-In Ideas for 5000 Series Scopes	Recommended starter note for customers considering custom plug-in project.	52-AX-3758
A High Resolution 60 Hz Notch Filter	Construction project using a commercial module in our plug-in kit. Preconditions signals by removing 60 Hz hum.	52-AX-4031
A True RMS Converter	Construction project using thermal true RMS converter module in our blank plug-in kit. Measures true RMS up to 200 V RMS.	52-AX-4112

ORDERING INFORMATION

CONVERSION KITS

Cabinet-to-Rackmount —
Order 040-0583-03 **$215**
(5223) Order 040-0976-04 **$450**

Rackmount-to-Cabinet
Order 040-0584-04 **$190**
(R5223) Order 040-0975-01 **$330**



OPTIONAL ACCESSORIES

CART

K213 Lab Instrument Cart — For cabinet models. Plug-in storage available as Option 12. See page 462.

CAMERAS

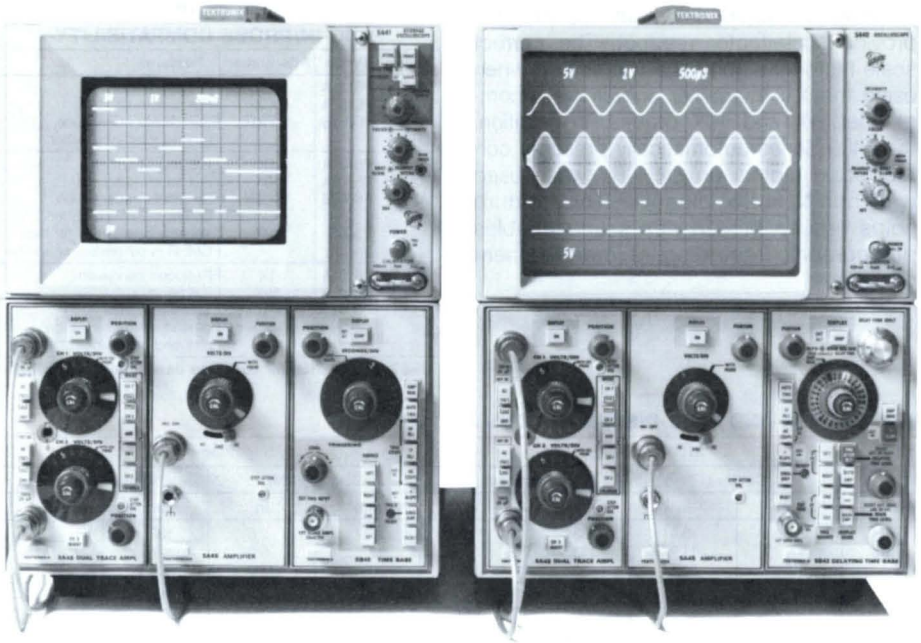
C-5C or C-4 Option 02 — For all 5100 Series. Suitable for repetitive or stored traces.

C-59A (G or P) — General Purpose. For 5100 Series storage scopes and 5400 Series.

For full details, see Camera Section on page 440.

Blank Plug-In Kit — Order 040-0818-03 **$130**
Blank Panel — Order 016-0452-00 **$23**
Viewing Hoods —
Order 016-0154-00 **$42**
Order 016-0260-00 (Folding) **$26**
Protective Cover — Order 016-0544-00 **$18**

For full details, see Accessories Section on page 439.



5440/R5440 General Purpose
5441/R5441 Storage

- Dc to 50 MHz
- CRT Readout
- Three Plug-In Flexibility
- Wide Choice of Plug-Ins
- Bench to Rack Convertibility
- Low Cost

See page 263 for available Application Notes.

TYPICAL APPLICATIONS 5440/R5440
Electrical Engineering Component Testing Ultrasonics

5441/R5441 Features:

- 5 Div/μs Stored Writing Speed
- Variable Persistence Storage

TYPICAL APPLICATIONS
Ultrasonics Low Power Laser Fiber Optics

The 5440 and 5441 combine versatility and low cost in a 50 MHz general-purpose, plug-in oscilloscope. They feature CRT readout of plug-in scale factors, sensitivities to 10 microvolts per division, display of up to eight different signals at two different sweep rates, a three plug-in mainframe, a wide choice of plug-ins and bench to rack convertibility.

Plug-in scale factors are displayed on the CRT, so measurement time and operator errors are reduced by taking into account magnifiers and probe attenuators. The CRT readout can also be accessed externally to allow the display of dates, times, test numbers, etc., along with displayed waveforms. (Order Option 03 User Addressable CRT Readout.)

The variable persistence of the 5441 provides the ideal means of viewing hard-to-observe signals such as fast single-shot transients and very low frequency phenomena that require a very slowly moving trace on the CRT. It may be used to completely eliminate the flicker inherent in low-rep-rate traces. With the 5441, the viewing time at normal intensity for any trace can be varied from a fraction of a second to more than five minutes. At lowered intensity (SAVE mode), signals may be viewed for up to an hour.

In addition to permitting convenient viewing of single-shot and low frequency phenomena, the variable persistence of the 5441 may also be used to suppress the random noise that obscures the true waveform in signals with low signal-to-noise ratio.

All the plug-ins in the 5000 Series are compatible with the 5440 and 5441.*1

The wide variety of plug-ins allows oscilloscope/plug-in configuration to meet your current and future needs: from a single-trace, single time-base configuration for production monitoring, to four-trace, delayed sweep for logic work, to four-trace differential amplifiers for transducer measurements, to dual-trace, delayed sweep for general purpose measurements.

*1 *Plug-ins with a suffix N (5B12N, etc.) do not provide CRT readout. The 5B10N and 5B12N Time Bases do not permit viewing the leading edge of a triggered waveform when used in the 5400 Series.*

CHARACTERISTICS

VERTICAL SYSTEM

Characteristics are common to the 5440/R5440 and 5441/R5441 unless otherwise indicated.

Channels — Left and center plug-in compartments. Compatible with all 5000 Series plug-ins. CRT readout is not available with plug-ins having a suffix N (5A18N, etc.).

Bandwidth — Up to 50 MHz, determined by plug-in unit. See page 262.

Deflection Factor — Determined by plug-in unit. See page 262.

Chopped Mode — The oscilloscope will chop between channels at ≈25 kHz to 100 kHz, depending on plug-ins and operating modes.

Alternate Mode — Each plug-in is swept twice before switching to the next. A single-trace amplifier is swept twice and each channel of a dual-trace amplifier is swept once before switching to the second amplifier.

HORIZONTAL SYSTEM

Channel — Right-hand plug-in compartment. Compatible with all 5000 Series plug-ins. CRT readout is not available for plug-ins with a Suffix N (5B10N, etc.).

Internal Trigger Mode — Left vertical, right vertical.

Fastest Calibrated Sweep Rate — 10 ns/div, determined by plug-in.

X-Y Mode — Phase shift is within 2° from dc to 20 kHz.

CRT AND DISPLAY FEATURES

CRT — 5440/R5440: Internal parallax-free 8 x 10 div (1.22 cm/div) illuminated graticule. Accelerating potential is 15 kV with GH (P31) phosphor standard. 5441/R5441: Internal, parallax-free, 8 x 10 div (0.9 cm/div) illuminated graticule. Accelerating potential is 8.5 kV. GH (P31) phosphor standard.

Autofocus — Reduces the need for manual focusing with changes in intensity after focus control has been set.

External Intensity Input — +5 V turns beam on from off condition. −5 V turns beam off from on condition. Frequency range is dc to 2 MHz. Input R and C is ≈10 kΩ paralleled by ≈40 pF. Maximum input is ±50 V (dc + peak ac).

Beam Finder — Brings offscreen into graticule area.

5440/R5440 FEATURES

Minimum Photographic Writing Speed — Using Polaroid film 20,000 ASA without film fogging. Writing speed can be increased with the Tektronix Writing Speed Enhancer. (See page 441 for more information.)

Writing Speed cm/μs				Camera	Lens
GH (P31) Phosphor		BE (P11) Phosphor			
20,000 ASA	3000 ASA	20,000 ASA	3000 ASA		
180	90	245	125	C-59P	f/2.8 0.67 mag
330	160	450	230	C-50P*1	f/1.9 0.7 mag

**1 Slight cropping of the graticule corners. Requires optional battery pack (016-0270-02) for operation with the 5440.*

Optional Phosphors (Specify) — GM (P7) or BE (P11).

5441/R5441 FEATURES

Persistence — Continuously variable, may be turned off when not needed, thus producing high-contrast stored displays without the characteristic fading of variable persistence.

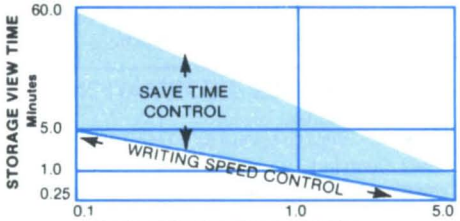
Maximum Stored Writing Speed — Writing speed >5 div/μs for a view time of 15 s.

Storage View Time — The view time is the amount of time the stored signal can be viewed before it fades away.

At the maximum writing speed the view time is 15 seconds with the writing speed control fully cw. Adjusting the stored instensity ccw will reduce the stored writing speed, but view time can be increased up to five minutes (refer to chart below).

Save Mode — Extends view time of stored displays up to one hour; prevents erasure of stored display and storage of unwanted displays.

Erase Time — 0.5 s ±10%.



STORED WRITING SPEED (Div/μs at Maximum Persistence)

CALIBRATOR

Voltage — 400 mV within 1%.

Current Output — 4 mA within 1%. Frequency is two times the line frequency.

POWER REQUIREMENTS

Line Voltage Ranges — 100, 110, 120, 200, 220, and 240 V ac ±10% (except that maximum input should not exceed 250 V ac) internally selected with quick change jumpers.

Line Frequency — 48 Hz to 440 Hz.

Maximum Power Consumption — 100 W at 120 V ac. 60 Hz.

ENVIRONMENTAL AND SAFETY

Ambient Temperature — Operating: 0°C to +50°C. Nonoperating: −40°C to +70°C.

Altitude — Operating: 5000 m (15,000 ft). Nonoperating: 15 000 m (50,000 ft).

Safety — UL listed (UL 1244) and CSA certified (CSA 556B).

PHYSICAL CHARACTERISTICS

	Cabinet		Rackmount	
Dimensions	**mm**	**in**	**mm**	**in**
Width	213	8.4	483	19.0
Height	302	11.9	133	5.3
Depth	518	20.4	483	19.0
Weights≈	**kg**	**lb**	**kg**	**lb**
Net	10.4	23.0	10.9	24.0
Shipping	14.5	32.0	19.5	43.0

ORDERING INFORMATION
(PLUG-INS NOT INCLUDED)

Ordering information is common to the 5440/R5440 and 5441/R5441 units unless otherwise noted.

5440 General Purpose Oscilloscope **$3,320**
Includes: Instruction manual (070-2139-01).

R5440 Rackmount Oscilloscope **$3,385**
Includes: Same as 5440.

5441 Storage Oscilloscope **$5,505**
Includes: Instruction manual (070-2140-01).

R5441 Rackmount Oscilloscope **$5,560**
Includes: Same as 5441.

OPTIONS

Option 01 — Without CRT Readout. **−$280**

Option 03 — User Addressable CRT Readout. Up to 20 user-selected characters may be displayed in the CRT readout for additional test information such as time, date, device tested, test number, etc. Especially useful for documenting photographs. Programming of characters is done by external resistors and switches. **+$150**

Option 04 — (5440/5441 only) Protective Panel Cover. **+$40**

Option 76 — (5440/R5440 only) GM (P7) Phosphor. **+$50**

Option 78 — (5440/R5440 only) BE (P11) Phosphor. **+$50**

CONVERSION KITS

CRT Readout — Order 040-0691-02 **$580**

Cabinet-to-Rackmount — Order 040-0583-03 **$215**

Rackmount-to-Cabinet — Order 040-0584-04 **$190**

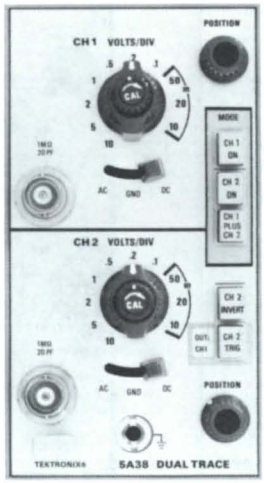
INTERNATIONAL POWER PLUG OPTIONS

Option A1 — Universal Euro 220 V, 50 Hz.
Option A2 — UK 240 V, 50 Hz.
Option A3 — Australian 240 V, 50 Hz.
Option A4 — North American 240 V, 60 Hz.

OPTIONAL ACCESSORIES

Recommended Plug-Ins — See page 262.
Recommended Probes — See pages 263 and 464.
Recommended Cameras — See page 441.
Recommended Cart — K213 Option 12. See page 462.

5A38



Dual Trace

5A38

Dc to 35 MHz Bandwidth

10 mV/Div to 10 V/Div Calibrated Deflection Factors

The 5A38 is a dual trace, 35 MHz plug-in amplifier for use only in the 5223 and the 5400 Series mainframes. It features 10 mV/div sensitivity and CRT readout of deflection factor.*1

CHARACTERISTICS

Bandwidth — Dc Coupled: To ⩾35 MHz. Lower End Response, Ac Coupled: ⩽10 Hz.

Deflection Factors — Calibrated: 10 mV/div to 10 V/div in a 1-2-5 sequence. Accuracy: is ⩽3% from 15°C to 35°C, 4% from 0°C to +50°C. Uncalibrated: Variable is continuous between steps to at least 25 V/div.

Input R and C — 1 MΩ paralleled by ≈20 pF.

Maximum Input Voltage — Dc Coupled: 250 V (dc + peak ac). Ac Coupled: 500 V (dc + peak ac). Ac Component: 500 V p-p maximum at 1 kHz or less.

Stability — ⩽0.3 mV vertical shift in any one minute after one hour warm-up, ambient temperature and line voltage held constant. ⩽0.2 mV/°C vertical shift with line voltage held constant.

Display Modes — Channel 1 only, Channel 2 only (normal or inverted), Dual Trace, and Added. Alternated or chopped operation determined by time base plug-in. Internal trigger selectable from Channel 1 or Channel 2.

Rise Time — ⩽10 ns.

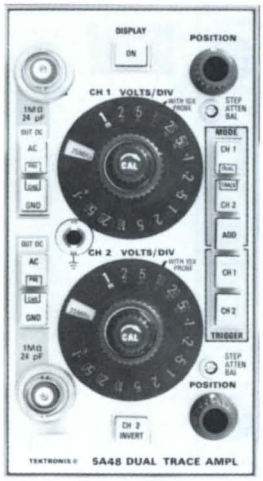
Channel Isolation — ⩾50:1 to 35 MHz with both traces displayed.

ORDERING INFORMATION

5A38 Dual Trace Amplifier **$820**
Includes: Instruction manual (070-1694-00).
For floating measurements, order A6902B Isolator. See page 479 for complete description.

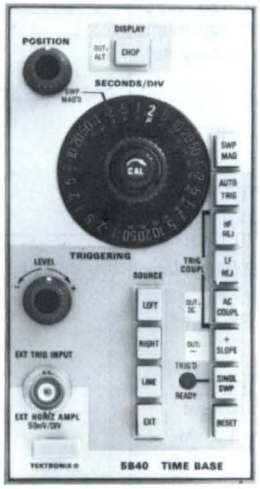
**1 CRT readout not functional in 5223.*

5A48



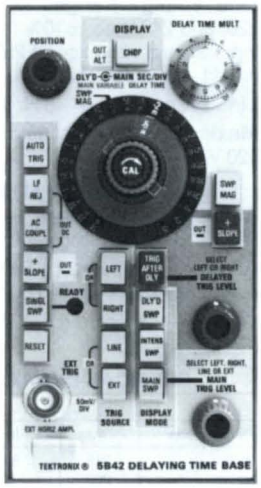
Dual Trace

5B40



Time Base

5B42



Delaying Time Base

5A48

Dc to 50 MHz Bandwidth

1 mV/Div to 10 V/Div Calibrated Deflection Factors

The 5A48 is a dual trace 50 MHz plug-in amplifier for use in the 5223 and the 5400 Series mainframes. The 5A48 features five operating modes, selectable trigger source, and CRT readout of deflection factor.*1

CHARACTERISTICS

Bandwidth — Dc Coupled: Dc to at least 50 MHz at 5 mV/div to 10 V/div, dc to at least 25 MHz at 1 mV/div and 2 mV/div (3 dB down). Ac coupled: 10 Hz or less (1 Hz with 10X probe) at all deflection factors (3 dB down).

Deflection Factors — Calibrated: 1 mV/div to 10 V/div in a 1-2-5 sequence. Accuracy: ⩽5% at 1 mV/div and 2 mV/div; ⩽3% from 5 mV/div to 10 V/div from +15°C to +35°C; ⩽4% from 5 mV/div to 10 V/div from 0°C to +50°C. Uncalibrated: Variable is continuous between steps to at least 25 V/div.

Input R and C — 1 MΩ within 1% paralleled by ≈24 pF.

Maximum Input Voltage — Dc Coupled: 250 V (dc + peak ac. Ac Coupled: 500 V (dc + peak ac). Ac Component: 500 V p-p maximum, 1 kHz or less.

Stability — ⩽0.3 mV vertical shift in any one minute after one hour warm-up, ambient temperature and line voltage held constant. ⩽0.2 mV/°C vertical shift with line voltage held constant.

Display Modes — Channel 1 only, Channel 2 only (normal or inverted), Dual trace, Added, Alternated, Chopped (determined by time base plug-in horizontal compartment). Internal Trigger Source: Selectable from Channel 1 or Channel 2.

**1 CRT readout not functional in 5223.*

Rise Time — 7 ns or less (5 mV/div to 10 V/div), 14 ns or less (1 mV/div and 2 mV/div).

ORDERING INFORMATION

5A48 Dual Trace Amplifier **$1,170**
Includes: Instruction manual (070-1450-00).
For floating measurements, order A6902B Isolator. See page 479 for complete description.

RECOMMENDED PROBES

See pages 263 and 464.

P6105A — 10X Passive. See page 468. **$93**

5B40/5B42

Single Sweep

10 ns/Div to 5 s/Div Calibrated Time Base

Triggering to 50 MHz

The 5B40/5B42 Time Bases are designed for use in 5400 Series mainframes. They feature sweep rates from 10 ns/div to 5 s/div and CRT readout of the sweep rate selected. The 5B42 also features delayed sweep rates up to 10 ns/div.

CHARACTERISTICS

The following characteristics are the same for the 5B40 and 5B42 unless otherwise noted.

Sweep Rate — 0.1 μs/div to 5 s/div in 24 calibrated steps (1-2-5 sequence). 10 ns/div is fastest sweep rate obtained with X10 magnifier. Uncalibrated, continuously variable between steps and up to 12.5 s/div.

Sweep Accuracy — Measured in 5400 Series oscilloscope over center eight graticule divisions. Valid for 100 div of magnified sweep after the first 30 ns.

Time/Div	Unmagnified		Magnified	
	+15°C to +35°C	0°C to +50°C	+15°C to +35°C	0°C to +50°C
1 s/div to 0.5 μs/div	3%	4%	4%	5.5%
5 s/div and 2 s/div, 0.2 μs/div and 0.1 μs/div	4%	5%	5%	6.5%

TRIGGERING

Triggering Sensitivity

Coupling	Frequency Range	Minimum Signal Required	
		Internal	External
Dc 5400 ampl	Dc to 10 MHz	0.4 div*1 0.4 div*2	60 mV*1 100 mV*2
5400 ampl	10 MHz to 60 MHz	1.0 div*1 1.0 div*2	150 mV*1 400 mV*2
5100 ampl	Dc to 2 MHz	0.4 div*2	100 mV*2
Ac	Trigger requirements increase below 50 Hz		
LF Rej	Trigger requirements increase below 7.5 kHz		
HF Rej	Trigger requirements increase above 50 kHz*1		

**1 5B40 only.*
**2 5B42 only.*

Single Sweep — Triggering requirements are the same as normal sweep. When triggered, sweep generator produces only one sweep.

Ext Trigger Input — Maximum Input Voltage: 350 V dc + peak ac, 350 V p-p ac at ⩽1 kHz. Input R and C: 1 MΩ paralleled by ≈24 pF. Trigger Level Range: ⩾±1.5 V (5B40) and ±2.5 V (5B42).

Ext Horizontal Input — Deflection Factor: 50 mV/div ±3%. Input R and C: 1 MΩ paralleled by ≈24 pF. Dc Coupled Bandwidth: Dc to ⩽2 MHz. Ac Coupled Lower Response: ⩽50 Hz. Maximum Input Voltage: 350 V (dc + peak ac) or 350 V p-p ac at ⩽1 kHz.

DELAYING SWEEP (5B42 ONLY)

Delay Time Multiplier Range — 0.2 to 10 times the Time/Div setting.

Differential Time Measurement Accuracy — Within 1% plus 0.2% of full scale from 1 μs to 0.5 s delay time. Within 2% plus 0.2% of full scale of 1 s to 5 s delay time.

Jitter — <0.05% of the time represented by one division of delaying sweep selected.

DELAYED SWEEP (5B42 ONLY)

Sweep Rate — 0.1 μs/div to 0.5 s/div in 21 calibrated steps (1-2-5 sequence). 10 ns/div is the fastest calibrated sweep rate obtained with the X10 magnifier.

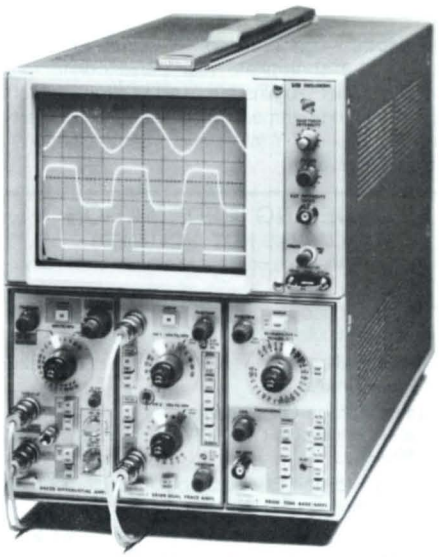
Sweep Accuracy — Measured over the center eight division. Same as undelayed sweep.

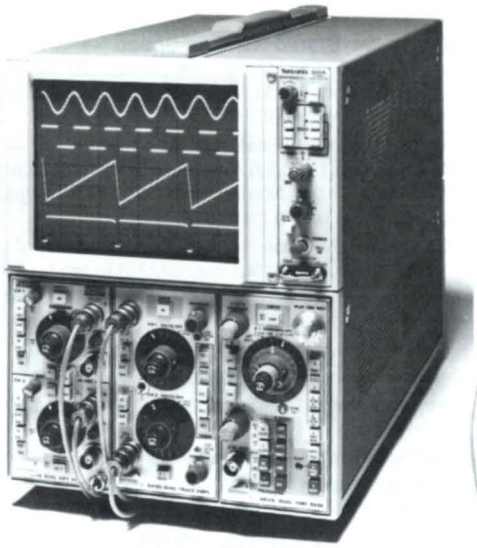
Triggering — The same as the internal triggering specifications in the table above.

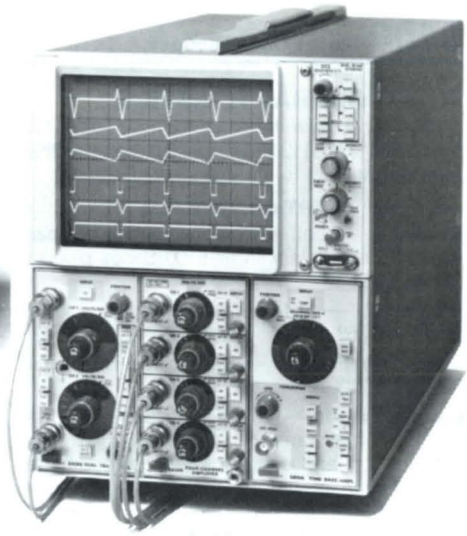
ORDERING INFORMATION

5B40 Time Base **$810**
Includes: Instruction manual (070-1742-00).

5B42 Delaying Time Base **$1,470**
Includes: Instruction manual (070-1447-00).







5100 Series Oscilloscopes

Low Cost

Dc to 2 MHz

Wide Choice of Plug-Ins

Rear Panel Signal Outputs Optional

See page 263 for available Application Notes.

5110/R5110

Lowest Cost Single Beam Nonstorage Oscilloscope With Plug-In Configurability

8 Channels at 1 mV/Div, 4 Channels at 50 μV/Div, 2 Channels at 10 μV/Div, With Appropriate Amplifiers

TYPICAL APPLICATIONS
Biomedical Research
Electromechanical Design and Test

The 5110 is a single beam nonstorage oscilloscope featuring a large diagonal 6½ inch (1.27 cm/div) CRT.

Tailor your measurement needs with the appropriate plug-in units to obtain high-gain differential (10 μV/div), four channel differential at 50 μV/div, eight-channel displays at 1 mV/div. Or choose from single-trace or dual-trace basic amplifiers and time-base plug-ins to suit the special needs of education and industry.

When using two amplifiers and the 5B12N dual time base in the dual-sweep mode, the two sweeps are slaved individually to the two amplifiers.

5111A/R5111A

Single Beam Bistable Storage Oscilloscope

Split-Screen Display

Stored Writing Speed to 800 Div/ms in Enhanced Mode (Option 03)

TYPICAL APPLICATIONS
Electromechanical Design and Test
Vibration Analysis

The 5111A is a single beam, split-screen, bistable storage oscilloscope with a large 6½ inch diagonal display. The 5111A extends measurement capability into areas requiring retention of single and multitrace displays for long-term examination and/or photography. It is particularly useful for recording low and medium frequency signals.

The standard 5111A provides writing speeds to 50 div/ms; Option 03 extends the writing speed to 800 divisions per millisecond, suitable for capturing a single-shot display of a 60 kHz sinewave four divisions in amplitude.

Up to eight traces can be displayed and stored simultaneously, with two 5A14N amplifier plug-in units. When using two amplifiers and the 5B12N dual time base in the dual-sweep mode, the two sweeps are slaved individually to the two amplifiers.

5113/R5113

Dual Beam Bistable Storage Oscilloscope

Split-Screen Dispaly

Two Independent Vertical Systems

Two Single-Shot Display Signals

Display Without Time-Sharing

Stored Writing Speed ⩾20 Div/ms

TYPICAL APPLICATIONS
Biomedical Research
Low Repetition Rate Observation

The 5113 is a dual beam bistable storage oscilloscope featuring easy-to-use split-screen storage. Stored writing speed is at least 20 div/ms. View time is at least one hour at normal intensity and can be increased to ten hours at reduced intensity.

The 5113 can display two simultaneous events, either single-shot or repetitive, against a common time base within the bandwidth and writing rate limits of the system. Both beams are driven by one set of horizontal deflection plates.

The 5113 is particularly useful in biomedical research where low-repetition-rate stimulus/response potentials need to be simultaneously observed and recorded.

5100 Series Oscilloscopes

CHARACTERISTICS

Characteristics are the same for the 5110/R5110, 5111A/R5111A, 5113/R5113 and 5116 unless otherwise indicated.

VERTICAL SYSTEM

Channels — Left and center plug-in compartments. Compatible with all 5100 Series plug-ins. See page 263.

Bandwidth — 2 MHz, determined by plug-in. See page 263.

Deflection Factor — Determined by plug-in. See page 263.

Chopped Mode — (5110/R5110, 5111A/R5111A, 5116) The mainframe vertical amplifier will chop between left and center plug-in compartments, and/or between two or more amplifier channels. The total time segment per channel is ≈5 μs, consisting of ≈4 μs displayed, ≈1 μs blanked. Chop or alternate mode is selected at the time base unit.

Chopped Mode — (5113/R5113) The left and right mainframe vertical amplifiers are dedicated to the left and center plug-in compartments. Each mainframe vertical amplifier will chop between two or more channels in their associated plug-in compartments. No channel switching is necessary between left and center plug-in compartments. The total time segment per channel is ≈5 μs, consisting of 4 μs displayed, ≈1 μs blanked. Chop or alternate mode is selected at the time base unit.

Alternate Mode — (5110/R5110, 5111A/R5111A, 5116) Each amplifier plug-in is swept twice before switching to the next. Single-trace amplifiers are swept twice. Each channel of a dual-trace amplifier is swept once before switching to the second amplifier.

Alternate Mode — (5113/R5113) Single-trace amplifiers are swept full time. Each channel of a multitrace amplifier is swept once before switching to the next channel. No channel switching is necessary between left and center plug-in compartments.

HORIZONTAL SYSTEM

Channel — Right-hand plug-in compartment. Compatible with all 5100 Series plug-ins. See page 263.

Fastest Calibrated Sweep Rate — 0.1 μs/div (X10 mag) with 5B10N or 5B12N; 10 μs/div (X10 mag) with 5D10.

X-Y Mode — Phase shift is within 1° from dc to 100 kHz.

CRT AND DISPLAY FEATURES

CRT — Internal 8 x 10 div (1.27 cm/div) parallax-free, nonilluminated graticule. Illuminated graticule available at extra cost. (Illuminated graticule standard on 5116.)

Accelerating Potential — 5110/R5110, 5111A/R5111A, 5113/R5113: 3.5 kV. 5116: 4.5 kV.

Standard Phosphor — 5110/R5110: GH (P31). 5111A/R5111A, 5113/R5113: Equivalent to GJ (P1).

Optional Phosphors (Specify) — (5110/R5110 only) GM (P7) or BE (P11).

Beam Finder — Aids in locating an off-screen signal.

Maximum Stored Writing Speed — (5111A and 5113 only) 5111A/R5111A: At least 20 div/ms in the Normal Mode and 50 div/ms in the Enhanced Mode. 5113/R5113: At least 20 div/ms.

With Option 03, Fast Writing Speed CRT — (5111A and 5113 only) At least 200 div/ms (center 6 x 8 div) in the Normal Mode and 800 div/ms (center 6 x 8 div) in the Enhanced Mode.

Storage View Time — (5111A and 5113 only) At least one hour at normal intensity; up to ten hours at reduced intensity, after which time it may be increased to original level.

Erase Time — (5111A and 5113 only) ≈250 ms.

CALIBRATOR

Voltage Output — Squarewave, positive-going from ground.

Voltage Range — 400 mV within 1%.

Current Output — 4 mA with current loop. Frequency is two times the line frequency.

OUTPUTS/INPUTS

External Intensity Input — +5 V turns beam on from off condition. −5 V turns beam off from on condition. Frequency range is dc to 1 MHz. Input R and C is ≈10 kΩ paralleled by ≈40 pF. Maximum input is ±50 V (dc + peak ac).

POWER REQUIREMENTS

Line Voltage Ranges — 100, 110, 120, 200, 220, and 240 V ac ±10% (except that maximum input should not exceed 250 V ac). Internally selected with quick change jumpers.

Line Frequency — 48 Hz to 440 Hz.

Maximum Power Consumption — 110 W.

ENVIRONMENTAL

Ambient Temperature — 5110/5111A/5113: Operating, 0°C to +50°C; nonoperating, −40°C to +70°C. 5116: Operating, 0°C to +45°C; nonoperating, −55°C to +75°C.

PHYSICAL CHARACTERISTICS

	Cabinet		Rackmount	
Dimensions	**mm**	**in**	**mm**	**in**
Width	213	8.4	483	19.0
Height	302	11.9	133	5.3
Depth	518	20.4	483	19.0
Weights≈	**kg**	**lb**	**kg**	**lb**
Net	10.4	23.0	10.9	24.0
Shipping	14.5	32.0	19.5	43.0

Option 07
Rear Panel Signal Outputs

CHARACTERISTICS

Left and Center Compartments — Two BNC connectors provide access to the CRT related signals from the left and center plug-in amplifiers. Sensitivity: 0.5 V/CRT division. Output impedance: 1 kΩ.

Right Compartment — Sweep: One BNC connector provides access to the CRT-related sweep waveform. Sensitivity is 0.5 V/CRT division; positive-going sawtooth, ⩾5 V. Output Impedance is 1 kΩ. Gate: One BNC connector provides access to TTL compatible gate. Positive-going, coincident with displayed sweep.

X-Y Mode — CRT-related X-Y signals are available at the appropriate rear panel connectors when amplifier plug-ins are used in either the left or center compartment and the right compartment to display X-Y information. Sensitivity (X-Y): 0.5 V/CRT division.

ORDERING INFORMATION
(PLUG-INS NOT INCLUDED)

Ordering information is common to all units unless otherwise noted.

5110 Oscilloscope **$1,815**
Includes: Instruction manual (070-2134-01).

R5110 Oscilloscope **$1,890**
Includes: Same as 5110.

5111A Storage Oscilloscope **$2,835**
Includes: Power cord (161-0066-00); instruction manual (070-3934-00).

R5111A Storage Oscilloscope **$2,900**
Includes: Same as 5111A.

5113 Storage Oscilloscope **$4,205**
Includes: Instruction manual (070-2137-01).

R5113 Storage Oscilloscope **$4,335**
Includes: Same as 5113.

5116 Oscilloscope **$2,585**
Includes: Power cord (161-0066-00); instruction manual (070-4544-00).

OPTIONS

Option 02 — (5110, 5111A, 5113, 5116 only) Protective Panel Cover. The cover protects the front panel and knobs during transportation and storage. **+$40**

Option 03 — Fast Write CRT increases stored writing speed to 200 div/ms (center 6 x 8 div).
(5111A/R5111A) **+$205**
(5113/R5113A) **+$150**

Option 07 — Add Rear Panel Signals Out. **+$130**

Option 76 — (5110, R5110 only) GM (P7) Phosphor. **+$50**

Option 78 — (5110, R5110 only) BE (P11) Phosphor. **+$50**

CONVERSION KITS

Cabinet-to-Rackmount Conversion Kit — Order 040-0583-03 **$215**

Rackmount-to-Cabinet Conversion Kit — Order 040-0584-04 **$190**

Protective Panel Cover Kit — (5110, 5111A, 5113, 5116 only) Order 040-0620-00 **$40**

Rear Panel Signal Outputs — Order 040-0915-02 **$325**

INTERNATIONAL POWER PLUG OPTIONS

Option A1 — Universal Euro 220 V, 50 Hz.
Option A2 — UK 240 V, 50 Hz.
Option A3 — Australian 240 V, 50 Hz.
Option A4 — North American 240 V, 60 Hz.
Option A5 — Switzerland 220 V, 50 Hz.

OPTIONAL ACCESSORIES

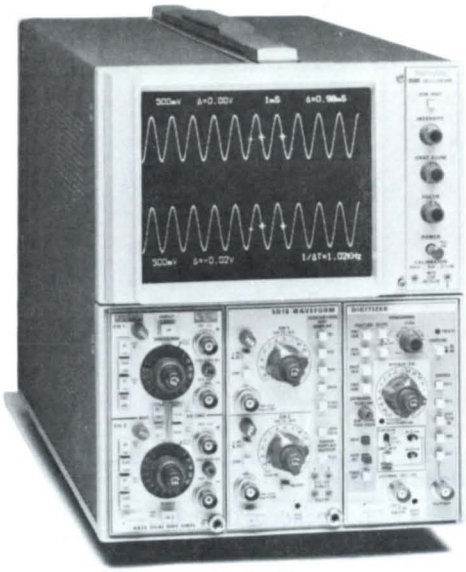
Recommended Plug-Ins — See page 262.
Recommended Probes — See pages 263 and 464.
Recommended Cart — K213 Option 12. See page 462.

RECOMMENDED CAMERAS

C-5C — Low cost. See page 445. **$495**

C-59AP — General purpose for 5100 Series. See page 453. **$1,335**

C-7 — AutoFilm Eject. See page 448. **$595**



5116

Three Color, High Resolution Digital Storage Display With 5D10

Convergence Not Required, Single Beam Design

Accepts Full Range of 5100 Series Amplifiers for Preconditioning or Noncolor Applications

The 5116 Oscilloscope, when used with the 5D10 digital storage plug-in unit, provides a unique three-color display of the digital storage capabilities and features of the 5D10.

Color enhances individual trace and readout identification, thereby providing a much improved user interface. The coding capabilities afforded by color allow for interpretation and differentiation of data more quickly, reduced measurement time, fewer errors, and improved resolution by using the full screen for overlapping signals. See page 48 for a color photo of the 5116 with the 5D10.

Permanent color records may be obtained with either a Tektronix camera (see pages 440–453) or with the 5D10 plotter output.

The 5D10 occupies the center and right plug-in compartments of the mainframe with which it is used. The left-hand plug-in compartment may be used to house an additional 5100 Series amplifier plug-in whose signal may be displayed through the unique Channel 2 left plug-in display capability of the 5D10. In this mode of operation, the signal from the additional amplifier plug-in unit is digitized and displayed on screen in place of Channel 1 of the 5D10. In this way, the 10 μV/div 5A22N may be used to provide a digitally stored display of a very low level differential signal. Or, a dual trace amplifier such as the 5A26, may be used in the left-hand plug-in compartment to permit the simultaneous color display of three signals, with color-coded cursor measurements available on each of the three.

In addition to its color operation with the 5D10 digital storage unit, the 5116 mainframe may also be used with any of the other 5100 Series plug-in units, with exactly the same functionality as the 5110 mainframe (see mainframe/compatibility chart on page 262).

CHARACTERISTICS

The following characteristics are in addition to those listed previously.

CRT AND DISPLAY FEATURES

Standard CRT — Internal 8 x 10 div (1.27 cm/div) parallax-free, illuminated graticule.

Accelerating Potential — 4.5 kV.

Color Shutter — With 5D10: Three-color display of blue-green, orange, and neutral. Without 5D10: Blue-green display.

Beam Finder — Positions beam on screen regardless of vertical and horizontal position control settings.

ORDERING INFORMATION

(PLUG-INS NOT INCLUDED)

5116 Digital Storage Oscilloscope **$2,585**

Includes: Power cord (161-0066-00); instruction manual (070-4544-00).

OPTIONS

Option 02 — Protective Panel Cover. The cover protects the front panel and knobs during transportation and storage. **+$40**

Option 07 — Add Rear Panel Signals Out. **+$130**

CONVERSION KITS

Cabinet-to-Rackmount Conversion Kit — Order 040-0583-03 **$215**

Rackmount-to-Cabinet Conversion Kit — Order 040-0584-04 **$190**

Protective Panel Cover Kit — Order 040-0620-00 **$40**

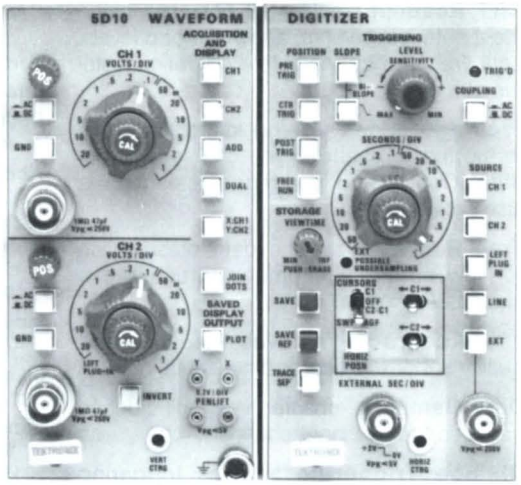
Rear Panel Signal Outputs Conversion Kit (Option 07) — Order 040-0915-02 **$325**

INTERNATIONAL POWER PLUG OPTIONS

Option A1 — Universal Euro 220 V, 50 Hz.
Option A2 — UK 240 V, 50 Hz.
Option A3 — Australian 240 V, 50 Hz.
Option A4 — North American 240 V, 60 Hz.
Option A5 — Switzerland 220 V, 50 Hz.

For recommended cameras, see page 442.

For a description and photos of color display technology, see page 47.



5D10 Digital Storage Unit

Compatible With All 5000 Series Mainframes

Digital Storage

CRT Readout

Powerful Triggering Capability

1% Accuracy

Dual Channel

1 MHz Sample Frequency

Save Reference Waveforms

X-Y Recorder Output

Signal Conditioning via Left Vertical Plug-In

Color Signal Source for 5116 Oscilloscope

The 5D10 enhances all Tektronix 5000 Series mainframes by providing digital storage for transient events with frequency components up to 100 kHz for a single channel acquisition and up to 50 kHz for dual channel acquisition, all in a compact two-wide plug-in.

Color/Waveform Digitizing System

Together, the 5D10 and the Tektronix 5116 Oscilloscope create a system of high resolution color*[1] and digital storage for superior trace and readout clarity. Digital storage provides clear, crisp, bright displays which can be viewed indefinitely. And also the following additional features:

Cursors permit convenient single-point and point-to-point measurement of time, amplitude, and frequency for fast, accurate, and reliable answers.

*[1] *Three-color display requires a 5D10 with serial number B020000 or higher. A field installable kit is available to upgrade earlier 5D10s. Contact your local Tektronix Sales Representative for details.*

CRT Readout displays all pertinent instrument settings, cursors, and waveform levels. Lets you read out complete operational status at a glance.

Pretrigger allows viewing information prior to the trigger event so you can see all your data. Center and posttrigger selection is also provided.

Free Run optimizes the data presentation for low speed phenomena, much like a stripchart recorder.

1% Accuracy improves measurement quality in both vertical and horizontal modes.

Dual Samplers ensure time coincidence between the two input channels.

Bislope Triggering assures triggering when the slope of a transient event is not known.

1 MHz Sample Frequency stores single-shot events to approximately 100 kHz in bandwidth with 8-bit vertical resolution.

Storage View-Time control from 1 second to infinity.

Save Reference permits comparisons of signals stored at different times.

X-Y Displays provide less than 1° phase shift up to 100 kHz of parametric related signals.

X-Y Recorder Output provides inexpensive, archivable hard copies complete with readout, graticule, and displayed waveforms in full color.

Preconditioning of up to two signals for Channel 2 by using the left vertical plug-in (when used in 5100 Series mainframes only).

For example, plug-ins such as the 5A21N, 5A22N and 5A26 can provide differential performance with sensitivities ranging to 10 μV/div (5A22N). The 5D10 can acquire a total of three signal channels when using the Channel 2 left plug-in acquisition feature.

CHARACTERISTICS

VERTICAL

Vertical Modes — CH 1, CH 2, Add, Dual, X-Y.

Channel 2 Modes — V/div, Left plug-in.

Deflection Factor — 1 mV/div to 20 V/div in 14 calibrated steps (1-2-5 sequence).

Accuracy — Input to Readout Numbers: 5 mV/div to 1 V/div ±1%; 1 mV/div to 2 mV/div ±2%; 2 V/div to 20 V/div ±2%; Input to CRT graticule ±2%. From Left Vertical Plug-in: Add ±1% to above specifications. Add Mode: Add ±1% to above specifications.

Input R and C — 1 MΩ ±0.5% paralleled by ≈47 pF.

Maximum Input — 250 V (dc + peak ac); 250 V p-p ac at 1 kHz or less.

Bandwidth — Single Channel: Suitable from dc to 100 kHz. Dual Channel: Suitable from dc to 50 kHz. Ac Coupling: 3 dB point—10 Hz or less (1 Hz with 10X probe).

Common-Mode Rejection — At least 50:1, dc to 100 kHz.

Resolution — Vertical: X-Y or Y-T; 0.04 div (8-bit digitizer). Horizontal: Y-T; 0.01 div (1024 memory locations shared among all traces displayed).

Phase Shift — ≤1.0° phase shift between CH 1 and CH 2, dc to 100 kHz.

Display Output (to X-Y Recorder) — Amplitude: 0.2 V/div ±2%. Speed: Compatible with X-Y recorders with 20 in/s slew rate, or faster. Pen Lift: Isolated switch contacts, SPST (floating); normally open or normally closed selected by internal jumper.

TIME BASE

Sweep Rates — 0.1 ms to 50 s/div in 18 calibrated steps 1-2-5 sequence (to 10μs/div with 10X magnifier).

Accuracy — Within ±1% of readout numbers.

External Input — Allows external pulse generator to determine acquisition rate. Accepts TTL levels up to 1 MHz rate.

Possible Under-Sampling Indicator — Indicator lights when fewer than eight sample pulses occur during interval between successive threshold crossing of triggering signals.

TRIGGERING

Sources — CH 1, CH 2, left plug-in (via mainframe), line, external.

Coupling — Dc, ac.

Sensitivity — External: 100 mV; dc to 50 kHz or pulsewidth >5 μs; 250 mV 50 kHz to 250 kHz or pulsewidth >1 μs. CH 1, CH 2, Left Plug-in: 0.4 div, dc to 50 kHz or pulsewidth >5 μs; 1.0 div, 50 kHz to 250 kHz or pulsewidth >1 μs.

Bislope Trigger — Amplitude, frequency, and pulsewidth specifications apply to absolute value of signal (rectified).

External Trigger Input — Input R and C: 1 MΩ ±2% paralleled by ≈47 pF. Maximum input 250 V (dc + peak ac). 250 V p-p ac at 1 kHz or less.

ORDERING INFORMATION

5D10 Waveform Digitizer **$2,095**

Includes: Diagnostics manual (070-4323-00); operator manual (070-3696-01); service manual (070-3697-00).

P6102A 10X Probe

Dc to 60 MHz

Scale Factor Readout Coding

Fully Compatible With All 5100 Series

The P6102A is a miniature 10X passive probe specially designed for use with all 5100 Series amplifier plug-ins, TM 500 Series SC 501, SC 502, and SC 503 plug-in oscilloscopes, and other scopes having nominal 47 pF inputs. Compensation range is 38 pF to 55 pF.

The P6102A automatically codes CRT readout-equipped scopes to show the correct scale factor and the knob-skirt readout on plug-ins with this feature. A ground reference button is included to provide easy location of ground position on the CRT and an easy means of identifying channels on multichannel displays.

The P6102A employs modular construction featuring just three snap-together modules. This means easy user repair and low maintenance costs.

CHARACTERISTICS

Length — 2 m.

Attenuation — 10X ±3%.

Input R and C — 10 MΩ, 13.2 pF.

Bandwidth — Dc to >60 MHz.

Rise Time — <5.9 ns.

Aberrations — ±3%, 5% p-p.

Compensation Range — 38 pF to 55 pF.

Maximum Nondestructive Input Voltage — 500 V (dc + peak ac).

ENVIRONMENTAL

Ambient Temperature — Operating: −15°C to +75°C. Nonoperating: −62°C to +85°C.

Humidity — Five cycles (120 hours total) at 95% to 97%.

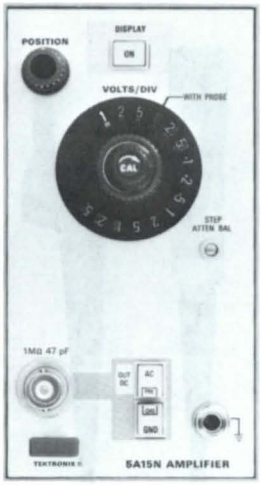
Altitude — Operating: To 4600 m (15,000 ft). Nonoperating: To 15 000 m (50,000 ft).

ORDERING INFORMATION

P6102A Miniature 10X Probe **$75**

Includes: Retractable hook tip (013-0107-05); ground cover sleeve (166-0404-01); 130 mm ground lead (175-0124-01); 300 mm ground lead (175-0125-01); miniature alligator clip (344-0046-00); IC testing tip (015-0201-06); black marker band (334-2794-00); white marker band (334-2794-01); silver-gray marker band (334-2794-02); adjusting tool (003-1364-00); accessory pouch (016-0708-00); instruction manual (070-5824-00).

5A15N



Single Trace Amplifier

5A15N

Dc to 2 MHz Bandwidth

1 mV/Div to 5 V/Div

The 5A15N is the simplest of the 5A Series plug-in amplifiers to use. It provides a bandwidth of dc to 2 MHz in any 5000 Series mainframe at sensitivities to 1 mV/div. Two 5A15Ns may be used in a mainframe to provide dual-trace operation, or to provide 1 mV/div X-Y operation if one of the amplifiers is inserted in the right-hand mainframe compartment.

CHARACTERISTICS

Bandwidth — Dc Coupled: Dc to at least 2 MHz at all deflection factors. Ac Coupled: 2 Hz or less to at least 2 MHz at all deflection factors.

Deflection Factor — Calibrated: 1 mV/div to 5 V/div in 12 steps (1-2-5 sequence). Accuracy is within 2%. Uncalibrated: Variable is continuous between steps to at least 12.5 V/div.

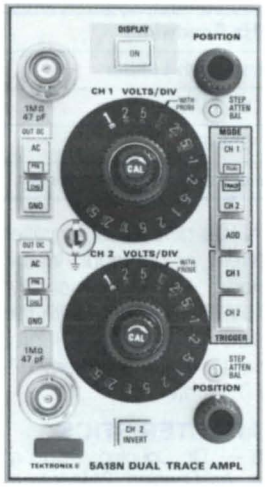
Input R and C — 1 MΩ within 1% paralleled by ≈47 pF.

Maximum Input — Dc Coupled: 350 V (dc + peak ac). Ac Coupled: 350 V dc.

ORDERING INFORMATION

5A15N Single Trace Amplifier **$400**
Includes: Instruction manual (070-1136-00).

5A18N



Dual Trace Amplifier

5A18N

Dc to 2 MHz Bandwidth

1 mV/Div to 5 V/Div

The 5A18 is essentially a dual-trace 5A15N. Bandwidth is dc to 2 MHz in any 5000 Series mainframe at sensitivities to 1 mV/div. The Channel 2 signal may be inverted by means of a front panel switch to provide difference measurements of two signals in the ADD mode. The internal trigger signal is selectable from Channel 1 or Channel 2 by means of front-panel pushbuttons.

Dual trace X-Y operation may be obtained with a 5A18N in the right-hand compartment of any 5000 Series mainframe.

CHARACTERISTICS

Bandwidth — Dc Coupled: Dc to at least 2 MHz at all deflection factors. Ac Coupled: 2 Hz or less to at least 2 MHz at all deflection factors.

Deflection Factor — Calibrated: 1 mV/div to 5 V/div in 12 steps (1-2-5 sequence). Accuracy is within 2%. Uncalibrated: Variable is continuous between steps to at least 12.5 V/div.

Input R and C — 1 MΩ within 1% paralleled by ≈47 pF.

Maximum Input — Dc Coupled: 350 V (dc + peak ac). Ac Coupled: 350 V dc.

Chopping Rate — 25 kHz to 100 kHz depending upon plug-in combinations and number of traces displayed.

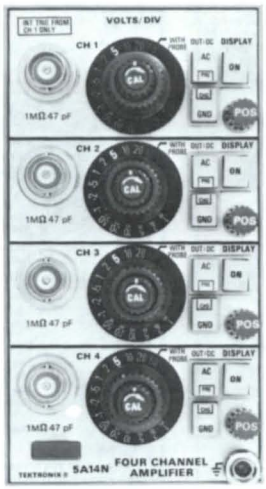
ORDERING INFORMATION

5A18N Dual Trace Amplifier **$835**
Includes: Instruction manual (070-1137-00).

RECOMMENDED PROBES

P6101A — 1X Passive. See page 468. **$53**
P6102A — 10X Passive. See page 468. **$75**
P6062B — 1X/10X Passive. See page 470. **$175**

5A14N



Four Trace Amplifier

5A14N

Dc to 1 MHz Bandwidth

1 mV/Div to 5 V/Div

The 5A14N is a four-trace amplifier unit which provides 1 MHz bandwidth and sensitivity to 1 mV/div in any 5000 Series mainframe. Each channel may be displayed separately, or the channels may be alternated or chopped in any combination. The internal triggering signal is available from Channel 1 only. Two 5A14Ns may be combined to provide eight-trace operation in any 5000 Series mainframe.

CHARACTERISTICS

Bandwidth — Dc Coupled: Dc to at least 1 MHz at all deflection factors. Ac Coupled: 2 Hz or less to at least 1 MHz at all deflection factors.

Deflection Factor — Calibrated: 1 mV/div to 5 V/div in 12 steps (1-2-5 sequence). Accuracy is within 2%. Uncalibrated: Variable is continuous between steps to at least 12.5 V/div.

Input R and C — 1 MΩ within 1% paralleled by ≈47 pF.

Maximum Input — Dc Coupled: 350 V (dc + peak ac). Ac Coupled: 350 V dc.

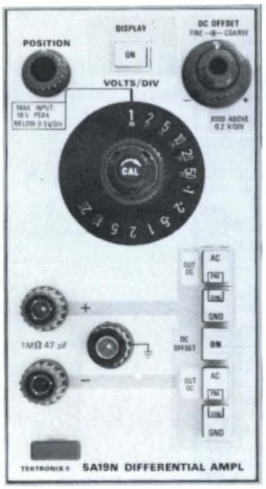
Chopping Rate — 25 kHz to 100 kHz depending upon plug-in combinations and number of traces displayed.

ORDERING INFORMATION

5A14N Four Trace Amplifier **$1,660**
Includes: Instruction manual (070-1229-00).

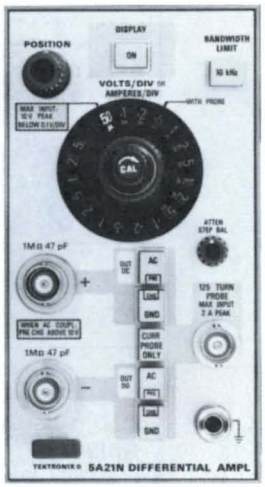
For recommended probes, see pages 263 and 464.

5A19N



Differential Amplifier

5A21N



Differential Amplifier

5A19N

Dc to 2 MHz Bandwidth

1 mV/Div to 20 V/Div

Dc Offset

The 5A19N is a low-cost differential amplifier featuring variable dc offset and simplicity of controls. It is ideal for monitor and systems applications. It operates in the left or middle plug-in compartment of the 5000 Series mainframe for Y-T displays, or in the right compartment for X-Y displays.

CHARACTERISTICS

Bandwidth — Dc Coupled: Dc to at least 2 MHz at all deflection factors. Ac Coupled: 2 Hz or less to at least 2 MHz at all deflection factors.

Deflection Factor — Calibrated: 1 mV/div to 20 V/div in a 1-2-5 sequence. Accuracy is within 2%. Uncalibrated: Variable is continuous between steps to at least 50 V/div.

Input R and C — 1 MΩ within 0.3% paralleled by ≈47 pF.

Signal and Offset Range

Deflection Factor Settings	1 mV/div to 200 mV/div	500 mV/div to 20 V/div
Common-Mode Signal Range	±16 V	±350 V
Maximum Dc Coupled Input (Dc + Peak Ac at 1 kHz or Less)	±350 V	
Maximum Ac Coupled Input (Ac Voltage)	±350 V	
Dc Offset Range	+15 V to −15 V	+350 V to −350 V

Common-Mode Rejection Ratio — Dc Coupled: 1 mV/div to 200 mV/div, at least 1000:1 from dc to 10 kHz; decreasing to 100:1 at 500 mV/div to 20 V/div.

ORDERING INFORMATION

5A19N Differential Amplifier **$480**
Includes: Instruction manual (070-1328-00).

For recommended probes, see pages 263 and 464.

5A21N

Dc to 1 MHz Bandwidth

10 kHz Bandwidth Limiter

50 μV/Div to 5 V/Div

100,000:1 CMRR

Voltage and Current Probe Inputs

The 5A21N is a differential amplifier with a current probe input. In the voltage mode, it provides sensitivities of 50 μV/div to 5 V/div; with the optional P6021 Current Probe, it provides current sensitivities from 0.5 mA/div to 0.5 A/div.

CHARACTERISTICS

Bandwidth — Dc Coupled: Dc to at least 1 MHz. Ac Coupled: 2 Hz less at least 1 MHz. Bandwidth may be limited to 10 kHz.

Deflection Factor — Calibrated: 50 μV/div to 5 V/div in 16 steps (1-2-5 sequence). Accuracy is within 2%. Uncalibrated: Variable is continuous between steps to at least 12.5 V/div.

Input R and C — Voltage Mode: 1 MΩ within 0.15% paralleled by ≈47 pF.

Maximum Input Voltage

	Dc Coupled	Ac Coupled
50 μV/div to 50 mV/div	10 V (dc + peak ac)	350 V dc (coupling cap precharged), 10 V peak ac
10 mV/div to 5 V/div	350 V (dc + peak ac)	

Input Gate Current — 100 pA or less (equivalent to 100 μV or less, depending on external loading, at +25°C.

Displayed Noise — 30 μV or less, tangentially measured.

Common-Mode Rejection Ratio — Ac Coupled: 50 μV/div to 0.5 mV/div, at least 20,000:1 at 5 kHz and above decreasing to 400:1 at 10 Hz. Dc Coupled: at least 100,000:1 dc to 30 kHz at 50 μV/div and 100 μV/div with up to 20 V p-p sinewave, decreasing by <20 dB/decade on sensitivity ranges up to 50 mV/div. From 100 mV/div to 5 V/div, CMRR is at least 400:1 with up to 100 V p-p sinewave.

CURRENT PROBE INPUT (WITH P6021 CURRENT PROBE)

Bandwidth — 15 Hz or less, to at least 1 MHz. Bandwidth may be limited to 10 kHz.

Deflection Factor — Calibrated: 0.5 mA/div to 0.5 A/div in 10 steps (1-2-5 sequence). Accuracy is within 3%. Uncalibrated: Variable is continuous between steps to at least 1.25 A/div.

Maximum Input Current — 4 A p-p (at probe loop) with 125-turn P6021 Current Probe.

Displayed Noise — 300 μA or less, tangentially measured. Performance characteristics are valid for the 5A21N from 0°C to +50°C.

ORDERING INFORMATION

5A21N Differential Amplifier **$615**
Includes: Instruction manual (070-1139-01).
Option 01 — P6021 5 ft current probe. **+$315**

The 5A21N and 5A22N Differential Amplifiers are available with CRT readout at additional cost (CRT readout functional in 5400 Series mainframes only). Contact your local Tektronix Sales Engineer for details.

P6055 Differential Probes

20,000:1 CMRR

Compact Size

Low Capacitance

Dc to 60 MHz

The P6055 is a miniature, low-capacitance, 10X probe designed for use with Tektronix differential amplifiers with nominal input capacitances from 20 pF to 47 pF. The attenuation ratio is adjustable to compensate for differences in input resistance of the amplifier (amplifier input resistance must be 1 MΩ ±2%). A special locking type readout connector allows use with instruments with or without readout capability.

When a matched probe pair is used to drive the two inputs of a differential amplifier, the ability to change the attenuation ratio of one probe versus the other is helpful in maintaining the CMRR of the system. The use of a matched pair of P6055 differential probes provide the best possible system CMRR.

CHARACTERISTICS

CMRR — 20,000:1 from dc to 1 kHz derating to 100:1 at 20 MHz.

Attenuation — Adjustable to 10X.

Input Resistance — 1 MΩ ±0.5%.

Input Capacitance — ≈10 pF when used with instrument that has 20 pF input capacitance; 12.5 pF when used with instrument that has 47 pF input capacitance.

Maximum Useful Bandwidth — 60 MHz.

Typical Probe Rise Time — 5.8 ns.

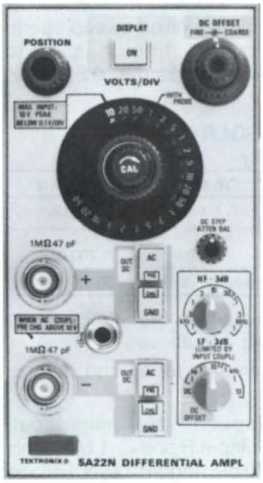
Maximum Voltage — 500 V (dc + peak ac) from dc to 12 MHz, p-p V derated to 100 V at 70 MHz.

ORDERING INFORMATION

P6055 Matched Pair of 10X, 3.5 ft Differential Probes **$535**
Includes: Retractable hook tip (BB, 013-0107-05); 13 cm (5 inch) ground lead (175-0124-01); probe holder (352-0090-00); two electrical insulating sleeves (BP, 166-0404-01); two alligator clips (AS, 344-0046-00); adjustable tool (CP, 003-0675-01); hook tip (BU, 206-0114-00); 13 cm (6 inch) electrical ground lead (DF, 175-1256-00); 30 cm (12 inch) ground lead (175-0125-01); instruction manual (070-1115-00).
Option 01 — Single probe with accessories. **−$260**

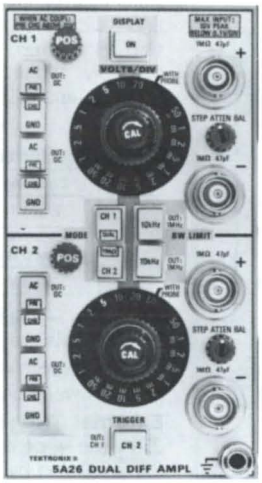
See page 487 for probe accessories.

5A22N



Differential Amplifier

5A26



Dual Differential Amplifier

5A22N

Dc to 1 MHz Bandwidth

10 μV/Div to 5 V/Div

100,000:1 CMRR

Selectable Upper and Lower −3 dB Points

Dc Offset

The 5A22N is the most versatile of the 5000 Series differential amplifiers. It features front panel selectable filtering which enables reduction of undesirable displayed noise; both upper and lower 3 dB points are selectable. Dc offset at full bandwidth is available for viewing signals riding on a dc component, such as low-level ripple and noise on a power supply.

These features, together with its high common-mode rejection, make the 5A22N well suited for measurements in difficult low-amplitude, low-frequency areas.

CHARACTERISTICS

Bandwidth — HF −3 dB Point: Selectable in 9 steps (1-3 sequence) from 100 Hz to 1 MHz. 100 Hz to 0.3 MHz, accuracy is within 20% of selected frequency; at 1 MHz, bandwidth is down 3 dB or less. LF −3 dB Point: Selectable in 6 steps (1-10 sequence) from 0.1 Hz to 10 kHz accuracy is within 20% of selected frequency. Ac Coupled: 2 Hz or less.

Deflection Factor — Calibrated: 10 μV/div to 5 V/div in a 1-2-5 sequence. Accuracy is within 3%. Uncalibrated: Variable is continuous between steps to at least 12.5 V/div.

Input R and C — 1 MΩ within 0.15% paralleled by ≈47 pF.

Maximum Input Gate Current — 200 pA or less.

Displayed Noise — 20 μV at maximum bandwidth, source resistance 25 Ω or less, measured tangentially.

Overdrive Recovery — 10 μs or less to recover within 99.5% of reference level after removal of a test signal applied for 1 s. Signal amplitude not to exceed common-mode signal range.

Drift With Temperature — 100 μV/°C or less.

Common-Mode Rejection Ratio — Ac Coupled: 10 μV/div to 0.5 mV/div, at least 20,000:1 at 5 kHz and above, decreasing to 400:1 at 10 Hz. Dc Coupled: At least 100,000:1, dc to 30 kHz from 10 μV/div to 100 μV/div with up to 20 V p-p sinewave, decreasing by <20 dB/decade on sensitivity ranges up to 50 mV/div. From 100 mV/div to 5 V/div, CMRR is at least 400:1 with up to 100 V p-p sinewave.

Signal and Offset Range

Deflection Factor Settings	10 μV to 50 mV/Div	0.1 V to 5 V/Div
Common-Mode Signal Range	±10 V	−350 V
Maximum Dc Coupled Input (dc + peak ac at 1 kHz or less)	±12 V	±350 V
Maximum Ac Coupled Input (dc voltage)	±350 V Dc rejection, at least 4 x 10^5:1	
Dc Offset Range	+0.5 V to −0.5 V	+50 V to −50 V

ORDERING INFORMATION

5A22N Differential Amplifier **$1,220**
Includes: Instruction manual (070-1230-00).

The 5A21N and 5A22N Differential Amplifiers are available with CRT readout at additional cost (CRT readout functional in 5400 Series mainframes only). Contact your local Tektronix Sales Engineer for details.

5A26

Dc to 1 MHz Bandwidth

50 μV/Div Sensitivity at 1 MHz

100,000:1 CMRR

2 Differential Amplifiers in One Plug-In

CRT Readout

The 5A26 Dual Differential Amplifier combines two independent differential amplifiers in one plug-in. It adds no-compromise differential measurement capability to the line of low-cost, high-performance 5000 Series laboratory oscilloscopes.

The 5A26 provides 50 μV/div sensitivity at 1 MHz, high common-mode rejection ratio, *CRT readout in any standard 5400 Series mainframe,* trigger-source selection and bandwidth limit on each channel. With two 5A26s, it is possible to observe up to four differential channels at one time.

The 5A26 has many applications in areas that require dual differential performance, especially in biomedical and electromechanical fields, education, and component manufacturing.

CHARACTERISTICS

Number of Differential Channels — Two.

Bandwidth — Dc Coupled: Dc to at least 1 MHz. Ac Coupled: 2 Hz or less to at least 1 MHz. Bandwidth may be limited to 10 kHz.

Deflection Factor — Calibrated: 50 μV/div to 5 V/div in 16 steps (1-2-5 sequence). Accuracy is within 2%. Uncalibrated: Variable is continuous between steps to at least 12.5 V/div.

CRT Readout — CRT readout of deflection factors. Functional in CRT readout-equipped 5400 Series oscilloscopes, nonfunctional in 5100 Series oscilloscopes.

Input R and C — 1 MΩ within 0.15% paralleled by ≈47 pF.

Maximum Input Voltage

	Dc Coupled	Ac Coupled
50 μV/div to 50 mV/div	10 V (dc + peak ac)	10 V ac, 350 V (coupling cap precharged)
100 mV/div to 5 V/div	350 V (dc + peak ac)	350 V (dc + peak ac)

Maximum Input Gate Current — 100 pA or less (equivalent to 100 μV or less, depending on external loading) at +25°C.

Displayed Noise — 30 μV or less, tangentially measured.

Common-Mode Rejection Ratio

Dc Coupled	
50 μV/div to 50 mV/div	At least 100,000:1 from dc to 30 kHz with up to 20 V p-p sinewave
100 mV/div to 5 V/div	At least 300:1 from dc to 30 kHz with up to 100 V p-p sinewave
Ac Coupled	
50 μV/div to 50 mV/div	At least 20,000:1 at 5 kHz to 30 kHz, decreasing to not less than 2000:1 at 60 Hz

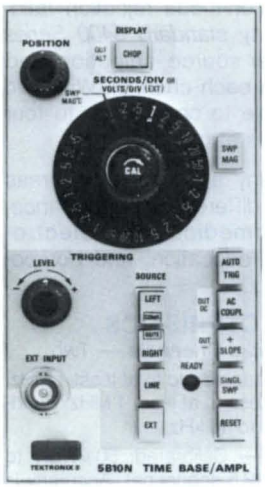
ORDERING INFORMATION

5A26 Dual Differential Amplifier **$1,335**
Includes: Instruction manual (070-1947-00).

High CMRR Differential Probes
P6055 Matched pair for maximum CMRR performance. See page 272. **$535**

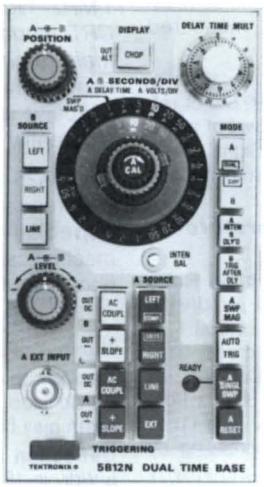
For recommended probes, see pages 263 and 464.

5B10N



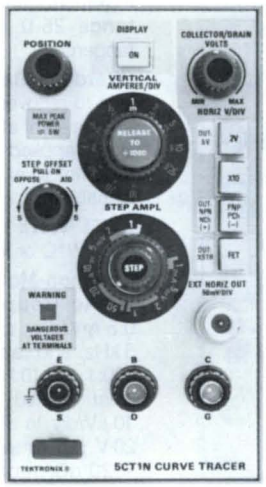
Time Base/Amplifier

5B12N



Dual Sweep Time Base

5CT1N



Curve Tracer

5B10N/5B12N

100 ns/Div to 5 s/Div Calibrated Time Base

Single Sweep Operation

X10 Magnifier

Alternate and Chopped Displays

50 mV/Div and 500 mV/Div External Input

Dual and Delayed Sweep (5B12)

The 5B10N and the 5B12N time base units are designed for use with the Tektronix 5100 Series oscilloscope mainframes. They can also be used with the Tektronix 5400 Series mainframes, although they do not activate the scale factor readout in the 5400 Series. The 5B10N and the 5B12N both provide 1 μs/div to 5 s/div calibrated sweep rates; a X10 magnifier extends the fastest sweep rate to 100 ns/div.

The 5B12N is a dual time base unit which provides both delayed and dual sweeps. When the 5B12N is used in the delayed sweep mode, both the delaying and delayed sweeps may be displayed on screen, with all displayed signals being shown at both sweep rates. The delayed sweep may be made to run immediately after the expiration of a selected delay time, or may be made to wait for the next suitable triggering signal after the expiration of the selected delay time. Precise delay time is selected by means of a ten-turn potentiometer. Delayed sweep is used primarily for obtaining extremely high magnification of some portion of the displayed signal. It also provides a means of making more precise timing measurements on a displayed signal.

When the 5B12N is used in the dual-sweep mode, the two time bases are used independently of each other. The signal or signals from the vertical amplifier in the left hand compartment are displayed at the A time base rate, and the signal or signals from the vertical amplifier in the center compartment are displayed at the B time base rate. (When used with the dual-beam 5113 mainframe, the signals from both amplifiers are displayed at both sweep rates.)

Both the 5B10N and the 5B12N may be triggered from internal signals from either vertical amplifier, from an external triggering signal, or internally at the power line frequency. Autotriggering provides a bright base line in case of loss of triggering signal.

Both units have a single sweep mode which allows the user to set the time base to sweep once upon receipt of a triggering signal and then to remain locked out from producing further sweeps until manually reset. This mode is particularly useful in capturing single transients on one of the 5100 or 5400 storage mainframes.

An external signal input connector on both the 5B10N and the 5B12N allows their use as a conventional amplifier to provide X-Y operation of the oscilloscope without the need for switching plug-in units.

CHARACTERISTICS

The following specifications are the same for the 5B10N and the A sweep of the 5B12N. B sweep specifications are identical except where indicated.

MAIN SWEEP

Sweep Rates — Calibrated: 1 μs/div to 5 s/div in 21 steps (1-2-5 sequence). X10 Magnifier extends displayed sweep time/div to 100 ns. Uncalibrated: Continuously variable between steps and to 12.5 s/div. B Sweep: 0.2 μs/div to 0.5 s/div in 20 calibrated steps.

Sweep Accuracy — Unmagnified: Within 3% from 1 μs/div to 1 s/div and within 4% at 2 s/div and 5 s/div. Add 1% for magnified sweep operation. B Sweep: Within 3% from 1 μs/div to 0.1 s/div. Within 4% at 0.2 μs/div, 0.5 μs/div, 0.2 s/div, and 0.5 s/div.

TRIGGERING

Triggering Sensitivity

	Coupling	To 1 MHz	At 2 MHz
Dc	Internal	0.4 div	0.6 div
	External (A sweep only)	200 mV	200 mV
Ac	Requirements increase below 50 Hz		

Auto Trig — Same as above except signal rate requirements are 15 Hz and above.

Single Sweep — Same as for ac and dc coupled (A sweep only).

External Trigger Input — Maximum Input: 350 V (dc + peak ac). Input R and C: 1 MΩ within 2% paralleled by ≈70 pF. Trigger Level Voltage Range: +5 V to −5 V.

EXTERNAL HORIZONTAL MODE

Deflection Factor — Calibrated: 50 mV/div and 500 mV/div. Accuracy is within 3%. X10 variable extends range to at least 5 V/div.

Bandwidth — Dc Coupled: Dc to at least 1 MHz. Ac Coupled: 50 Hz or less to at least 1 MHz.

Input R and C — 1 MΩ within 2% paralleled by ≈70 pF.

Maximum Input Voltage — 350 V (dc + peak ac).

DELAYING SWEEP (5B12N)

Delay Time — Accuracy: 1 μs/div to 0.5 s/div, within 1%. 1 s/div to 5 s/div, within 2%. Multiplier Range: 0.2 to 10.2 times the time/division setting. Multiplier Incremental Linearity: Within 0.2%.

Differential Time Measurement Accuracy — Within 1% plus 2 minor dial div for 1 μs to 0.5 s delay times. Within 2% plus 2 minor dial div for 1 s to 5 s delay times.

Jitter — <0.05% of the time represented by one division of the delaying sweep selected.

ORDERING INFORMATION

5B10N Time Base/Amplifier **$600**
Includes: Instruction manual (070-1140-00).

5B12N Dual Sweep Time Base **$1,260**
Includes: Instruction manual (070-1141-00).

5CT1N Curve Tracer

Test Semiconductor Devices to 0.5 W

10 nA/Div to 20 mA/Div Vertical Deflection Factors

0.5 V/Div to 20 V/Div Horizontal Deflection Factors

See page 389 for complete description.

PORTABLE OSCILLOSCOPES

Tektronix offers the widest selection of portable scopes so you'll be able to choose the specific instrument that best suits your needs.

28 portable scopes with many optional features are available with bandwidths from 500 kHz to 350 MHz.

All Portable Oscilloscopes listed in this section are available through the National Marketing Center by calling toll free 1-800-426-2200. In addition to being able to give you direct order entry, the NMC Sales Engineers are available to offer you immediate technical assistance about product specifications, capabilities, and applications. They can send you literature, discuss available accessories, tell you about payment terms and options, or help you contact your local sales and service office.

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PORTABLE REAL TIME OSCILLOSCOPE SELECTION GUIDE

Product	Band-Width (MHz)	Sensi-tivity (mV/div)	Number of Channels	Delayed Sweep	Fastest Sweep (ns/div)	Features	Size mm (in) H x W x D	Weight kg (lb)	Power Requirements	Page	Prices Begin at
2467	350	2	4	✓	500 ps	4 div/ns visual writing speed, CRT readout, ΔVolts, ΔTime cursors	190 x 330 x 467 (7.5 x 13 x 18.4)	10.9 (24)	Line (90–132/180–250 V ac, 48–440 Hz)	278	$11,900
2465A*1 2465A CT*2 2465A DM*2 2465A DV*2	350	2	4	✓	500 ps	CRT Readout, ΔVolts, ΔTime Cursors	190 x 338 x 434 (7.5 x 13.3 x 17.1)	10.2 (22.4)	Line (90–132/180–250 V ac, 48–440 Hz)	278	$5,350 $7,150 $8,400 $9,200
2455A*1	250	2	4	✓	1	CRT Readout, ΔVolts, ΔTime Cursors	190 x 338 x 434 (7.5 x 13.3 x 17.1)	10.2 (22.4)	Line (90–132/180–250 V ac, 48–440 Hz)	278	$5,150
2445A*1	150	2	4	✓	1	CRT Readout, ΔVolts, ΔTime Cursors	190 x 338 x 434 (7.5 x 13.3 x 17.1)	10.2 (22.4)	Line (90–132/180–250 V ac, 48–440 Hz)	278	$3,590
2335	100	5	2	✓	5	Rugged, compact, lightweight	140 x 270 x 430	7.7	Line (100–132/200–250 V ac,	290	$3,650
2336	100	5	2	✓	5	B Trigger, ΔTime	(5 x 11 x 17) 140 x 270 x 430 (5 x 11 x 17)	(17) 7.7 (17)	48–440 Hz) Line (100–132/200–250 V ac, 48–440 Hz)	290	$3,965
2336YA	100	5	2	✓	5	B Trigger, ΔTime, elapsed time indicator, Extra probes and manual	140 x 270 x 430 (5 x 11 x 17)	7.7 (16.5)	Line (100–132/200–250 V ac, 48–440 Hz)	290	$4,175
2337	100	5	2	✓	5	B Trigger, ΔTime, DMM	140 x 270 x 430 (5 x 11 x 17)	7.7 (17)	Line (100–132/100–250 V ac, 48–440 Hz)	290	$4,275
2245	100	2	4	✓	2	HF/LF, Rej, TV Line, TV Field, triggers on all channels for A or B Sweep plus line trigger, CRT readout of scale factors, delay time	176 x 360 x 445 (7 x 14.2 x 17.5)	7.5 (16.5)	Line (90–250 V ac, 48–440 Hz)	300	$1,875
2246	100	2	4	✓	2	HF/LF, Rej, TV Line, TV Field, triggers on all channels for A or B Sweep plus line trigger, CRT readout of scale factors, delay time, plus cursor for voltage, time frequency phase, Smart-Cursors™, voltmeter functions, Δtime	176 x 360 x 445 (7 x 14.2 x 17.5)	7.5 (16.5)	Line (90–250 V ac, 48–440 Hz)	300	$2,400
2235	100*3	2	2	✓	5	Dual Time Base, Single Sweep Trigger View, BW Limit	137 x 360 x 440 (5.4 x 14.2 x 17.3)	6.1 (13.5)	Line (90–250 V ac, 48–440 Hz)	296	$1,575
2235 Opt 01	100*3	2	2	✓	5	Dual Time Base, Single Sweep Trigger View, BW Limit, Scale Illumination, HF/LF Rej	137 x 360 x 440 (5.4 x 14.2 x 17.3)	6.1 (13.5)	Line (90–250 V ac, 48–440 Hz)	296	$1,995
2236	100*3	2	2	✓	5	Dual Time Base, BW Limit with Counter, Timer, Multimeter	137 x 360 x 440 (5.4 x 14.2 x 17.3)	7.4 (16.3)	Line (90–250 V ac, 48–440 Hz)	294	$2,650
2225	50	0.5 5 @ 50 MHz	2		5	Alternate magnification, p-p auto X10 vert mag, HF/LF rej single sweep, TV trigger	138 x 380 x 438 (5.4 x 15.0 x 17.2)	7.7 (17.0)	Line (95–128/185–250 V ac 48–440 Hz)	303	$995
305	5	5	2		100	Autoranging DMM battery power	110 x 240 x 370 (4.4 x 9 x 15)	4.8 (10.6)	Built-in battery, line (90–132/ 180–264 V ac, 48–440 Hz), or external dc	311	$2,765
221	5	5			100	5 MHz hand-held	80 x 130 x 230 (3 x 5 x 9)	1.6 (3.5)	Built-in battery, line (90–250 V ac, 48–62 Hz)	312	$2,315
213	1	20			400	DMM/scope at <4 lb (1.7 kg)	70 x 130 x 230 (3 x 5 x 9)	1.7 (3.7)	Built-in battery, line (90–136/ 180–250 V ac, 48–62 Hz), or external dc	313	$2,900
212	0.5 (500 kHz)	10	2		1000 (1 μs/div)	Integral 1 MΩ probe	80 x 130 x 240 (3 x 5 x 10)	1.6 (3.5)	Built-in battery, line (104–126 V ac 58–62 Hz)	315	$2,095

PORTABLE STORAGE OSCILLOSCOPE SELECTION GUIDE

Product	Band-width (MHz)	Sensi-tivity (mV/div)	Dual Trace	Delayed Sweep	Fastest Sweep (ns/div)	Features	Size mm (in) H x W x D	Weight kg (lb)	Power Requirements	Page	Prices Begin at
2430	150	2	✓	✓	5	Digital Storage, 100 MS/s with 8-bit resolution and dual channel acquisition	190 x 330 x 479 (7.5 x 13 x 18.8)	11.1 (24.4)	Line (90–132/180–250 V ac, 48–440 Hz)	326	$8,900
2230	100	2	✓	✓	5	Digital Storage 20 MS/s at 5 μs/div and faster	137 x 237 x 440 (5.4 x 9.3 x 17.3)	8.3 (18.0)	Line (90–250 V ac, 48–440 Hz)	330	$5,150
466	100	5	✓	✓	5	Fast transfer and variable persistence. 3,000 div/μs stored writing speed at reduced scan.	160 x 330 x 550 (6 x 13 x 22)	11.8 (26)	Line (99–132/198–264 V ac, 48–440 Hz) or battery pack	317	$7,940
2220	60	2	✓		5	Digital Storage 20 MS/s at 5 μs/div and faster	137 x 237 x 440 (5.4 x 9.3 x 17.3)	8.3 (18.0)	Line (90–250 V ac, 48–440 Hz)	330	$4,150
336	50	5	✓	✓	100	Digital Storage 1 MS/s Microprocessor control and menu driven*4	112 x 237 x 482 (4.4 x 9.3 x 14.6)	5.1 (11.3)	Line (90–132/180–250 V ac, 48–440 Hz)	334	$5,060
314	10	1	✓		100	Bistable. Stored viewing time to 4 hr 400 div/ms stored writing speed	110 x 240 x 350 (4.4 x 9 x 14)	4.7 (10.3)	Line (90–132/180–264 V ac, 48–440 Hz) or external dc	320	$4,550
214	0.5 (500 kHz)	10	✓		1000 (1 μs/div)	Bistable. 500 div/μs stored writing speed. Fully self-contained.	80 x 130 x 240 (3 x 5 x 10)	1.6 (3.5)	Built-in battery, line (104–126 V ac, 58–62 Hz)	321	$2,865

*1 *The 2467, 2445A, 2455A and 2465A offer as options: 4½ digit DMM, 150 MHz Counter/Timer/Trigger, 17-Bit Word Recognizer, TV Trigger and GPIB Interface.*
*2 *Special Edition 2465A.*
*3 *The 2235 and 2236 are specified 100 MHz for sensitivities from 5 mV to 5 V/div and 90 MHz in 2 mV.*
*4 *See specifications in Digitizer Section.*

To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext. 99

PORTABLE SCOPE PRODUCT LITERATURE AND APPLICATION NOTES

Tektronix product literature is readily available from your local Tektronix Sales Office.

For data sheets and product brochures, just ask for literature on the specific instrument. Additional related publications also available are listed below.

Title	Description	Order
Portable Oscilloscope Selection Guide	A helpful aid for choosing the right portable scope for your needs	38-W-5158-2
2000 Series Warranty Brochure	Describes Tek's 3-year warranty on 2000 Series scopes and 5-year *Warranty-Plus* Service	81-W-5258
2300 Brochure	Describes 2300 Series	40-W-5070-1
2235/2236 Oscilloscopes	Brochure describes 2235/36	46-W-5144-2
Using the 2336	Pocket Reference Guide	46-W-5732
2245/65 TDR	Application Note	38-W-5221-1
Quick and Easy Phase Measurement	Application Note	38-W-5223-1
Chip CRT and Assembly	Article Reprint	38-W-5312
400 Series Portable CRT Storage Scopes	Describes of the 466, 464, and 434 portable storage scopes	40-W-3793-2
Spotlight Hidden Pulses With High Speed Storage	Three-page application note that features the 466	40-AX-3225
The Digital Storage Oscilloscope	A primer that describes digital storage concepts and the 468	40-W-4319-2
Basic Oscilloscope Measurements	Period and Frequency Amplitude Setup and Analysis Dual-Trace and X-Y Phase Rise Time	41-AX-3839-1 41-AX-3840-1 41-AX-3841-1 41-AX-3928 41-AX-3929
336 Brochure	Describes 336	53-W-5426-1
XYZs Of Using a Scope	A basic primer that features the 2200 Series	46-W-6428
XYZs Instructor's Aid		46-W-5169-2
XYZs Workbook		46-W-5170-2
Using Delayed Sweep In Measuring Digital Word Trains	Application Note	41-AX-3349
VITS Analysis for TV Servicing	Application Note	41-AX-4047-1 46-W-5207
Basic Video System Measurements	Describes TV measurements using 2445A/2465A Option 05 scopes	38-W-5511
Pulse Parameters	Application Note	46-W-5205-1
Frequency Measurements	Application Note	46-W-5206-1
Pulse Ringing and Overshoot	Application Note	46-W-5209
Swept Frequency Filter and Amplifier	Application Note	46-W-5210

Title	Description	Order
Power Supply Testing	Application Note	46-W-5211
General Troubleshooting	Application Note	46-W-5212
TDR Measurements with a scope	Application Note	46-W-5215 46-W-5216
Pulse Rise Time	Application Note	46-W-5217-1
Integrating a Scope	Article Reprint	46-W-5337
Catch Glitches on Slow Sweep	Article Reprint	41-AX-4765
Portables Storage	Selection Guide	41-W-5546
Your Direct Line to the World's Best Instruments and Technical Expertise	Find out about the Tektronix National Marketing Center and Tek's Service Offices	60A-4873-1
Waveform Storage—Waveform storage using the 2230	Operation Note	46-W-6392
Peak Detect—Peak Detect feature of the 2230	Operation Note	46-W-6393
2230 Cursor Measurements	Operation Note	46-W-6394
2245/2246 VITS Analysis for TV Servicing	Application Note	46-W-6311
Single Fiber Muscle Research Using the 2230	Application Note	46-W-6395
Muscle Fatigue Research Using the 2230	Application Note	46-W-6396
Computer Disk Drive Repair With the 2230	Application Note	46-W-6397
Capture of Transient Events With the 2230	Application Note	46-W-6398
See, Measure, Automate at the Touch of a Button With the 2445A/2465A Family	Applications-oriented brochure and data sheet	38-W-6267
Bring Invisible Signals to Light With the Tek 2467	Applications-oriented brochure and data sheet	38-W-6130-1
2225: Setup and Analysis Rise Time Dual Trace & X-Y Phase Amplitude Period and Frequency	Technique Brief Technique Brief Technique Brief Technique Brief Technique Brief	46-W-6425 46-W-6427 46-W-6424 46-W-6426 46-W-6423

PORTABLE SCOPE/ACCESSORIES COMPATIBILITY GUIDE

	PROBES*5			CAMERAS			CARTS	MISCELLANEOUS ACCESSORIES
	Passive	Active	Current	Single Shot or Low Rep Rate	Stored/Stable or Repetitive	Low Cost		
2430 **2445A** **2455A** **2465A** **2465A DV** **2465A CT** **2465A DM** **2467**	P6101A P6009 P6015 P6133 (2445A, 2430) P6136	P6201 P6202A P6230	P6021/P6022 A6302/AM 503 A6303/AM 503	C-31B Opt 01 016-0269-03 adaptor*1	C-30B Opt 01 016-0269-03 adaptor*1	C-5C Opt 02 016-0359-01 adaptor*1 C-4 122-0894-01	K212	Folding Polarized Viewing Hood 016-0180-00; Collapsible Viewing Hood (Binocular) 016-0566-00; 1105 Power Supply; 1106 Battery Pack; 1107 Dc Inverter Power Supply; Protective Cover 016-0720-00.
2335 **2336** **2336YA** **2337**	P6130 P6009 P6063B P6015 P6108A P6101A (2336YA)	P6202A P6201 P6230	P6022 A6302/AM 503 A6303/AM 503 P6021	NA	NA	C-5C Opt 04 016-0359-01 adaptor*1 (with flash)	K212	2335 Rack Adaptor Kit 016-0468-00.
2245 **2246** **2220** **2230** **2235** **2236**	P6101A P6009 P6130 P6015 P6062B P6230 P6122 P6121 (2236, 2230) P6109	P6201 P6202A	P6021 P6022 A6302/AM 503 A6303/AM 503	C-31B Opt 01 016-0269-03 adaptor*4	C-31B Opt 01 016-0269-03 adaptor*4	C-5C Opt 04 016-0359-01 adaptor*1*3 (with flash) C-4 Option 02*4 C-7 Opt 02*4, Opt 03*4 C-5C Opt 02*4	K212	Clear CRT Light Filter 337-2775-01; CRT TV Graticule Custom Mod; Accessories Pouch 016-0677-02; Front Cover 200-2520-00; RM Kit: 016-0466-00 for 2235; 016-0833-00 for 2235 Opt 01; 016-0015-00 for 2236; RM Kit: F2240R for 2245/2246; P6602 Temperature Probe.
466	P6101A P6015 P6105A P6009 P6062B P6130	P6201 P6202A P6230	P6022 A6302/AM 503 A6303/AM 503 P6021	C-31B Opt 01 016-0269-03 adaptor*1	C-30B Opt 01 016-0269-03 adaptor*1	C-5C Opt 02 016-0359-01 adaptor*1 C-4 122-0894-01 adaptor*1	K212	Folding Polarized Viewing Hood 016-0180-00; Collapsible Viewing Hood (Binocular) 016-0566-00; Protective Cover 016-0365-00; Mesh Filter 378-0726-01; 1105 Battery Power Supply; Rack Adaptor 016-0675-00.
314, 305 **336**	P6101A P6149A P6148A (336)		P6021 P6022 A6302/AM 503 A6303/AM 503	C-31B Opt 01 016-0327-01 adaptor*2	C-30B Opt 01 016-0327-01 adaptor*2		NA	Viewing Hood 016-0297-00; Mesh Filter 378-0063-00; 1105 Battery Power Supply; Rain Cover (314, 335) 016-0612-00.

*1 *Mounting adaptor comes with camera/option listed, others are optional.*

*2 *Mounting adaptor must be ordered in addition to the camera/option listed.*

*3 *2235 Opt 01 Order C-5C Opt 02 or C7 Opt 03.*

*4 *Camera listings recommended for 2235 Opt 01, 2245, and 2246.*

*5 *Highlighted probes are preferred for typical general purpose use and/or are shipped as included accessory to the instrument.*

New Standard of Excellence in Portable Oscilloscopes

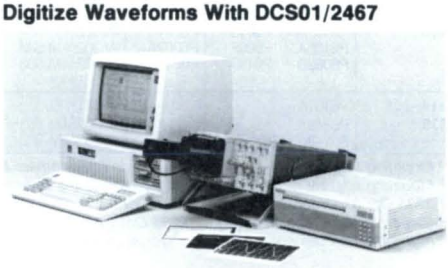
See what you've never seen with a portable scope

2467/2465A/2445A

- 4 div/ns Visual Writing Speed (2467)
- 1 ns Rise Time (2467, 2465A)
- 350 MHz Bandwidth (2467, 2465A)
- On-Screen Trigger Level Readout
- Volts and Time Cursors With On-Screen Readout
- Cursors After Delay
- Auto Setup
- Save and Recall Setups
- Set-Up Sequencing
- 500 MHz Trigger Bandwidth (2467, 2465A)
- Four Independent Channels
- 500 ps/Div Time Base (2467, 2465A)
- Switchable 1 MΩ and 50 Ω Inputs
- 20 ps Time Interval Resolution
- 2 mV/Div Vertical Sensitivity at 350 MHz
- On-Screen Scale-Factor Readout
- Lightweight and Rugged

Specifications begin on page 284.

Digitize Waveforms With DCS01/2467



DCS01 Digitizing Camera System captures repetitive waveforms from analog scopes and transients according to a scope's CRT writing speed (350 MHz for 2467).

NEW 2467

GPIB IEEE-488 The 2467 Option 10 complies with IEEE Standard 488-1978 and with Tektronix *Standard Codes and Formats.*

Transient Intensifying Oscilloscope

Crisp Display of Single-Shot Events at 500 ps/Div in Normal Room Light

Digitize to 350 MHz With DCS01

Same Options as 2465A (Except DMM)

Specifications begin on page 284.

Now Expose Invisible Signals That Cause the Most Difficult Problems in Troubleshooting

From occasional glitches and fast transients to metastability and jitter in high repetition rate signals, the *NEW* Tek 2467 instantly reveals events that escape detection and measurement by any other portable instrument. You now can see high speed, single shot phenomena and low repetition rate digital and analog signals as they occur, at sweep speeds to 500 ps/div—in normal room light!

At the Heart of the 2467's Extraordinary Capabilities is an Exclusive Microchannel-Plate (MCP) CRT

It brings the invisible to light by amplifying the intensity of infrequent and transient events while concurrently moderating the intensity of highly repetitive signals.

The result: an instrument able to display everything that happens in your circuit, whether it occurs once or repetitively. The technology that was pioneered by the 1 GHz Tek 7104 plug-in oscilloscope is available for a new range of applications in this portable, 350 MHz instrument.

With the 2467 you'll benefit from an approximate 100-fold increase in *visual* writing rate over that found in the fastest conventional CRT. Just being able to see unexpected transients, even when masked by highly repetitive events, makes the critical difference in many troubleshooting situations.

Now Digitize Even Single-Shot Events to 350 MHz Bandwidth

Digitize waveforms and analyze them on your IBM PC. The DCS01 easily and cost-effectively adds digitizing and signal processing capability to the 2467. The microchannel plate (MCP) CRT allows the capture of repetitive and transient signals at the full 350 MHz bandwidth of the 2467 (for a full description, see page 353.)

Making Single-Shot and Low-Repetition Rate Measurements

Even at 500 ps/div sweep speed, the 2467's 4 div/ns visual writing rate displays the lowest repetition rate signals, even single shots, in normal room light. Its 350 MHz bandwidth faithfully reproduces your signal's high-frequency details. And for documentation, a C-30 Series oscilloscope camera produces high contrast photographs of single-shot signals at 500 ps/div using only ISO 3000 film.

Using the trigger-level readout feature, you can set the proper trigger point for your experiment the first time—no more guessing where the trigger point is set. And there's no wasted time and materials repeating the experiment just to properly set the trigger level.

Excellent EMI protection means reliable operation even in the high fields generated by high power lasers, ESD testing, or NMR equipment.

Finding Circuit Problems in Digital Systems

When troubleshooting a digital system, you want to see a fault immediately. In digital circuits, violations of either timing margins or noise margins can result in faulty operations, such as low-amplitude (runt) pulses, slivers, or metastability. If the margin violations are infrequent, faulty outputs are even less frequent.

A real time oscilloscope with an MCP-enhanced CRT, such as the Tektronix 2467, can display intermittent variations as they happen, making them instantly visible, even though they may be masked by thousands of normal traces. Other instruments either can't display infrequent faults at all or they may take several minutes to build up a display that shows an occasional fault.

With 30 ns pretrigger display, you can examine the inputs to a logic device prior to the output transition. Seeing the inputs when a fault occurs can point to the real problem.

Determining Actual Noise Margins

With its ability to clearly display transient events in the presence of numerous signals, the 2467 shows designers actual noise margins. Adequate noise margins are essential for reliable system operation. With the 2467, no matter how infrequently noise pulses occur, they are clearly displayed. Even if the noise is asynchronous to the monitored signal, the 2467 will highlight it—so you can see the worst-case noise.

Even if a prototype performs correctly, manufacturing tolerances can induce errors in marginal systems. Correcting marginal circuit conditions not only yields more reliable products but also shortens product design cycles. Crosstalk and other intermittent noises are easily identified and fixed.

Measuring Random Noise and Jitter in Communication Systems

Eye patterns are often used as a performance measure in a digital communication channel. The use of eye patterns is enhanced by the 2467's high visual writing rate, which permits viewing the worst-case effects of random or erratic noise, jitter and other channel impairments. And when making eye-pattern measurements, cursors can be applied in either the voltage-ratio or time-ratio mode. Employed in this way, they indicate degradation as a percentage of the normal eye opening, thus simplifying and quantifying the measurement.

Plus all the Performance and Productivity Benefits Found in the 2465A

See page 280 for complete details.

PRODUCT SELECTION GUIDE

	Standard Models				Special Edition Models		
	2467	**2465A**	**2455A**	**2445A**	**2465A CT**	**2465A DM**	**2465A DV**
Bandwidth	350 MHz	350 MHz	250 MHz	150 MHz	350 MHz	350 MHz	350 MHz
GPIB	Option 10	Option 10	Option 10	Option 10	Included	Included	Included
Counter/Timer/Trigger, Word Recognizer	Option 09	Option 09	Option 09	Option 09	Included	Included	Included
DMM		Option 01	Option 01	Option 01		Included	Included
Video Measurement System	Option 05	Option 05	Option 05	Option 05			Included
Counter/Timer/Trigger, No Word Recognizer	Option 06	Option 06	Option 06	Option 06			
Two Additional Probes	Included	Option 22	Option 22	Option 22	Included	Included	Included
Rackmount	Option 1R	Option 1R	Option 1R	Option 1R	Option 1R		
Probe Power	Option 11	Option 11	Option 11				

See, Measure, Automate at the Touch of a Button

NEW 2465A/2445A

GPIB IEEE-488

The 2465A/2445A Option 10, 2465A CT, 2465A DM and 2465A DV comply with IEEE Standard 488-1978 and with Tektronix *Standard Codes and Formats.*

NEW 2465A CT/ 2465A DM/2465A DV

Special Editions

The Tek 2467/2465A/2445A Family: High Performance Capabilities to Match Your Tough Assignments

Start with the standard setting performance of Tek's top portable analog scopes. Add new productivity enhancing features for fast operation. Increase the probe tip bandwidth to 350 MHz. The result: six new four channel, dual time base oscilloscopes that bring unprecedented efficiency to your design lab, production line or field service site.

Built on High Performance That Set the Industry Standard

New preamplifier circuits make possible the increased bandwidth—350 MHz in the 2465A, even at 2 mV/div sensitivity. New probes take the full bandwidth to the probe tip—where you need it.

Timing measurements are possible with 20 ps resolution at sweep speeds to 500 ps/div in the 2467/2465A and to 1 ns/div in the 2445A. Trigger on signals to at least 500 MHz with the 2467/2465A and to at least 250 MHz with the 2445A, which extends the usefulness of each scope well beyond its vertical bandwidth.

Trigger from any one of the four input channels or on four asynchronous signals. Tek's Auto-Level Trigger mode keeps your scope triggered even as the input signal changes. You can choose to trigger at the 10, 50, or 90% level of the signal. On-screen trigger level readout eliminates trial-and-error triggering, saving you time and frustration.

CRT readout of the vertical scale factors and input coupling, sweep speeds, trigger level and source, and indicators such as Bandwidth Limit and Holdoff give you complete status information at a glance. These settings are recorded on film in your waveform photos.

Dual, delaying time bases, each with an independent trigger system, allow for precise measurements on details embedded in complex waveforms.

Time and Voltage Cursors With CRT Readout for Immediate, Effortless Measurements of Waveform Parameters

Use the cursors to obtain quick readouts of voltage, time, frequency, ratio and phase with no interpretation or CRT linearity errors. Readouts are in units of volts, time, percent and degrees.

And now the cursors can even be applied to delayed sweep displays, improving timing measurement flexibility.

Tailor Your 2467/2465A/2445A for Special Needs, or Choose a Specially Configured Measurement Package

To fit specialized performance requirements, the 2467/2465A/2445A Family offers five integral and combinable enhancements: GPIB Interface, Digital Multimeter, Counter/Timer functions with Enhanced Triggering, 17-bit Word Recognition, and Video Measurement capabilities.

You can also select one of three 2465A Special Editions. As packages, they are offered at a significant savings over the separately ordered measurement options.

The Tek 2465A CT is designed especially for use with communications, office and computer related equipment. The 2465A DM adds a digital multimeter for applications in government/military electronics, avionics and ATE stations. Finally there's the fully optioned 2465A DV for even more extensive applications including the design, manufacture and service of raster scan devices and high resolution video equipment. Easily the most powerful portable available.

New Auto Setup, Instant Recall, Set-Up Sequencing: For Easy Answers Fast!

Now you can attach up to four probes to signal points, press AUTO-SETUP, and within seconds a stable, automatically triggered display of the probed waveforms appears on screen for quick viewing or advanced parametric characterization. With AUTO-SETUP, users of any experience level gain increased speed and ease of use in making day-to-day waveform observations and measurements.

Digital design and test personnel are sure to appreciate Tek's proprietary Pulse Mode for viewing narrow pulses in detail. AUTO-SETUP calculates the duty factor and properly displays either the low duty cycle pulse or several cycles of symmetrical waveforms. Input channel selection is also sensed, and display positioning adjusted for up to four waveforms with appropriate scaling.

Measure Signal Parameters Quickly, With Instant Access to Complex Setups
For closer examination of your signals and for more specialized setups, such as delayed sweep displays or ones using the extended measurement options, front panel controls are still necessary. But now you only need to create these setups once. Nonvolatile memory for 30 setups stores *all* front panel information, including cursor locations and control settings for the extended measurement options.

The SAVE/RECALL utility is a tremendous time-saver for designers, evaluators and production test operators who need several setups for measurements at multiple test points in a circuit or system. Switching between measurements is fast, just two buttons for a complete setup. And operator attention is focused on answers, not on control adjustments.

Measurements are highly reliable as well as efficient. Vertical and horizontal accuracy are tightly specified for a wide range of environmental conditions. Pulse response is optimized for flatness and speed so the waveform measurement is a true representation of the signal. With the advanced feature set, including waveform cursors, the 2467/2465A/2445A Family minimizes errors and maximizes your confidence in measurement results.

Automate Repetitive Measurement Sequences Without an External Controller
Now systematic verification procedures for engineering prototypes, final production test or field service can easily be set up, stored and sequenced without a computer. Step through up to 30 of the stored setups in the order you choose. Just press the STEP button once for each sequence step. Or plug a foot switch into the rear panel audio jack for hands-free operation.

As a further aid, seven-character alphanumeric labels can be stored with each setup. The labels can be test titles or operator prompts for test point connections. You can protect the saved setups and sequences by write-protecting the memory.

Built-in sequencing and screen message capabilities are standard throughout the 2467/2465A/2445A Family. With a single, standalone portable oscilloscope you can implement extensive automated or semiautomated procedures. This provides an excellent, price-competitive entry into automated testing. The 2467/2465A/2445A family offers complete upward mobility from the 2445A through the 2467 and its options.

Add the GPIB option and take advantage of no-controller setup and sequence transfers, too. Create or modify stored setups on one scope, for example, then update the other scopes in a production test area with a simple transfer procedure.

The GPIB option opens even more possibilities for automating measurement procedures. All front panel controls on the 2467/2465A/2445A scopes are programmable and can be set up by an external controller. It also can send messages to the operator for semiautomated tests and read back measurement results for storage and analysis.

Personal Computers Assist Hardware Development and Evaluation Taskwork
For many single-step and multistep tests during product development, characterization and evaluation, the 2467/2465A/2445A's internal sequencer provides all the automation you need.

Further automation is accomplished by simply linking the scope with a PC, or other controller, via the GPIB. Use this configuration to debug prototypes, efficiently manage experiments, and record measurement results for documentation or analysis.

Test program generators such as EZ-TEK 2400 PC are designed so that developing your procedures involves little more than setting the scope's front panel controls and making selections from a screen menu. *You* don't need to write code.

Decrease a product's time to market by using the same scope/controller system and software throughout the development cycle. Tests that were designed during the engineering phase can be used for evaluation, then adapted for production. Consistency will be maintained in methods and results.

Ideal for Production Test Systems
Configuring 2467/2465A/2445A oscilloscopes for semiautomated operation takes advantage of the strengths of both humans and computers. The controller can record measurement results, make arithmetic-based pass/fail decisions, set the scope for each step of the procedure, and write prompting messages on the CRT. The operator's time is used efficiently to adjust cursors to the signal, compare waveforms against references marked by the controller with the cursors, and decide whether the visual criteria for each test has been met.

Combining the DMM, Video Measurement and CTT options with a 2467/2465A/2445A oscilloscope provides multi-instrument capabilities while reducing rack space, equipment cost and programming complexity. The self-diagnostic capabilities and self-calibration functions of the 2467/2465A/2445A scopes make them excellent candidates for installation in large and small test systems. A built-in run time counter assists in recordkeeping for preventative maintenance and calibration. The 2400 Series instruments offer proven reliability and are all backed by Tek's three year warranty.

A Powerful Yet Portable System
A GPIB- and DMM-equipped 2467/2465A/2445A, plus a 4041 controller are all a service technician needs to carry into the field for maintenance or troubleshooting. The controller leads the technician through the steps of a diagnostic test or calibration procedure. Measurement results are recorded on magnetic tape for later analysis or use in statistical recordkeeping.

The 2467/2465A/2445A Family—Portable and Rugged
The 2467/2465A/2445A and Special Editions are easy to carry to any field service site. And when you get there, they perform—even in extreme conditions—with environmental characteristics including a low EMI profile and rugged construction per MIL-T-28800C, Type III, Class 3, Style C.

Channels 1 and 2 vertical input couplings can be independently selected as ac, dc or ground. Or terminate your circuit outputs and controlled impedance transmission lines into 50 Ω. To protect against overload while using the internal 50 Ω terminations, the scopes automatically switch to 1 MΩ coupling when an overload is detected, and a readout indicates the change.

The Assurance of Error-Free Operation is Backed by Tek's Three Year Warranty
The warranty includes the CRT and can be easily extended to five years (in most countries) through a variety of optional service plans.

This, plus Tek quality and proven reliability, means you can expect outstanding value and long life from your oscilloscope investment. With new productivity-enhancing features to minimize training and operating time, the 2467/2465A/2445A Family offers economical solutions to your needs in waveform observation, measurement and automation. High performance at its affordable best.

Choose From a Complete Range of Options That Extend the Capabilities of the 2467, 2465A, 2455A, and 2445A

Option 09

Counter/Timer/Trigger (CTT) With Word Recognizer (WR)

Crystal-Controlled Time Base

0.001% Accuracy

Totalize Up to 9,999,999 Events

Delay-by-Events Triggering Up to a Total of 4,194,303 Events

Boolean Logic Triggering on Both Digital and Analog Signals

17-Bit Word Recognizer Probe

Option 09 delivers the crystal-controlled timing accuracy and the extra triggering power you need for digital systems. Frequency and period are measured directly from any vertical channel. Time intervals can also be measured by the counter, with ease. And the delayed sweep (B sweep) trigger has been expanded to select independent signal sources, slopes, and levels for the beginning and ending of a time interval. This allows precise time measurements between two events, each with different characteristics—either the same or separate channels. This new capability provides for measurement of propagation delay through a level shifter or an amplifier, as well as rise time, fall time, or microprocessor power-up delay.

Once configured, these measurement set-ups can be saved in the scope's set-up memory, either to be recalled later or used as part of a sequence. With the CTT, these recalled measurements are completely automatic and require no operator intervention.

With the Word Recognizer, any pattern of up to 17 digital bits can act as an input to the counter or as a trigger for the A or B sweep.

Pinpointing the "needle-in-a-haystack" signal in a digital system becomes feasible with the Word Recognizer and Delay-by-Events functions. These advanced triggering capabilities eliminate extraneous signals.

To characterize or unravel system operation, the CTT also can measure the frequency or period of recognized words, and it can delay the scope trigger by a selected number of words.

And with the Totalize function, you can record the passing of unusual events or verify a burst of events on any vertical input or recognized word.

The Boolean logic trigger allows triggering on either the logical AND or OR of any two input channels. Logical OR triggering lets you trigger on either the positive or negative slope of any input signal. This function is known as bislope triggering and allows you to catch events reliably—even if you don't know whether the transition will be high-to-low or low-to-high.

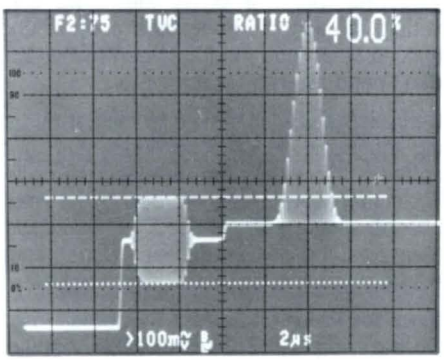
The Counter/Timer/Trigger also is available without the Word Recognizer probe as Option 06.

Specifications begin on page 286.

Option 06

Counter/Timer/Trigger (CTT)

The Counter/Timer/Trigger is available without the word recognizer probe as Option 06. Specifications and included accessories (except WR probe) are the same as Option 09. The word recognizer cannot, however, be added to Option 06 after delivery (field retrofit kits are not available).



This sample waveform and CRT readout show a 2445A's high-fidelity display and measurement of the color subcarrier amplitude on Line 75, Field 2 of an NTSC signal with the television blanking-level clamp (TVC) engaged. The cursor readout of 40% is interpreted as 40 IRE units with appropriate adjustment of the vertical gain.

Option 05

Video Waveform Measurement System

Television Waveform Analysis Capabilities

Selectable System-M and Nonsystem-M Protocols

Selectable Triggering on Any Line Within a Field, With Line-Number Readout

Compatible With Composite Video Having 13.1 kHz to 77 kHz Line Rates

TV Blanking-Level Clamp (Back-Porch)

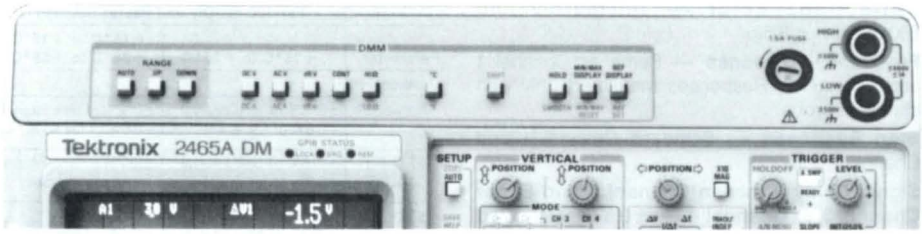
Optimized Vertical Response Comparable to High Performance TV Waveform Monitors

Video measurement capabilities extend the 2467/2465A/2445A's power and versatility to meet the challenges in broadcast and cable television, graphics displays and raster scan systems. The Video Waveform Measurement System makes quality measurements convenient during every stage of a product's life cycle: design, production, system calibration, quality assurance, maintenance and service.

With CRT readout of the line number and field selected for triggering, an operator knows precisely what the display represents. Any line can be selected from Field 1, Field 2, or Field 1 alternating with Field 2. The fourth video trigger selection is Lines, which superimposes all the lines in both fields. Systems with up to 1280 lines can be accommodated.

The back-porch clamp locks the video black level to a fixed point, so the display is stable and clean, even when the composite video contains low frequency hum or when the average picture level changes with ac coupling. Controls are provided for compatibility with a wide variety of system protocols.

Specifications begin on page 287.



Option 01 Digital Multimeter

4 1/2 Digit Autoranging Digital Multimeter

True RMS Ac Volts From 20 Hz to 100 kHz

True RMS Ac Current From 20 Hz to 10 kHz

10 μV Resolution on Dc Volts

Continuity Beeper

UL Listed, CSA Certified

Temperature Probe −62°C to +230°C

Calibration via Front Panel Without Removing Instrument Covers

Convenience Features Include:
Set Reference, Hold, Smooth, Minimum/Maximum, dBV, and dBm

The 2467/2465A/2445A's Digital Multimeter (Option 01) makes it possible to measure dc and ac (RMS) volts and current, dBm, dBV, resistance, and temperature at your workbench, with no added space requirements. Carry everything you need into the field for maintenance and repair, all in one rugged, portable package. The DMM and scope meet the same tough requirements for environmental conditions including temperature, humidity and shock. Calibration of the DMM is accomplished from the front panel, without removing any covers. Plug a DMM-equipped 2467/2465A/2445A into your system (rackmounting is optional as a modified product) to take advantage of its fully programmable measurements and screen prompts.

Blocks of accumulated measurements can be averaged and smoothed. Minimum and maximum values can also be displayed. Set a reference function if, for example, you need to compare deviations from a norm. Audible continuity checking is useful for applications in service, production and design/development. Troubleshoot circuit board hot spots with the temperature probe. It registers temperature variations with 0.1°C or F resolution.

Combining the DMM and CTT options allows direct measurement of system frequency, period or time interval while monitoring ac or dc volts, current or temperature. Use just one instrument to characterize voltage-to-frequency converters and temperature drift of crystal oscillators. Add the GPIB interface for a powerful measurement system to run tests and verification procedures and log measurement results with your controller.

Specifications begin on page 288.

Option 10 GPIB Interface

GPIB IEEE-488 Bus Interface complies with IEEE Standard 488-1978 and with Tektronix *Standard Codes and Formats*.

Remote Control of Front Panel Functions

Selectable at Front Panel:
Device Address, Talk/Listen Mode, Message Terminator

Front Panel Status Indicators:
REM (Remote), SRQ (Service Request), LOCK (Local Lockout)

Compatible With All Other 2467/2465A/2445A Options

User-Generated SRQ: To Signal Controller During Program Control

RQS Control: Optional Enable or Disable of SRQ Reporting

Network the 2467/2465A/2445A With Your Other Equipment on the General Purpose Interface Bus

Option 10 adds the ability to communicate over the IEEE-488 General Purpose Interface Bus. Contents of set-up memory can be transferred between 2467/2465A/2445A units without an external controller. Or use a host controller to assist the oscilloscope operator in performing a series of checks and measurements. Front panel settings can be remotely set or changed, and the results of cursor, DMM and CTT measurements communicated back over the bus to the controller, as well as appearing on the scope's CRT.

It is possible not only to display scope parameters and settings on the CRT, but also to read them back over the GPIB to the controller.

The ability to display prompting messages (by embedding them in control programs) reduces the chance of operator error at critical points in a test procedure.

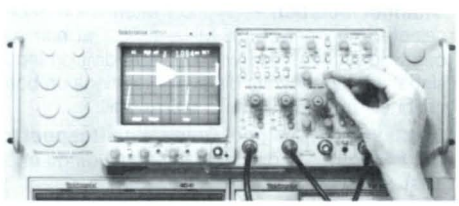
The 2467/2465A/2445A GPIB-message structure conforms to Tektronix *Standard Codes and Formats*, ensuring that all GPIB messages are "human readable" and consistent in format. Selectable message termination characters allow scope use with most types of controllers. The new 2445A and 2465A are compatible with programs for their predecessors, the 2445 and 2465.

New Tektronix software development packages provide an environment for quickly and easily generating automated and semi-automated test procedures. Not only are they easy for nonprogrammers to use, they substantially reduce the amount of time it would take to create a test program using previous programming methods and languages.

TEK EZ-TEST and EZ-TEK 2400 are automatic test program generators designed for use with the Tek 4041 controller. EZ-TEK 2400 PC runs on the IBM PC, XT and AT. The TEK EZ-TEST generator programs the 4041 to drive a wide variety of GPIB-compatible equipment. Both EZ-TEK 2400 and EZ-TEK 2400 PC are designed for systems that need only the capabilities found in 2467/2465A/2445A oscilloscopes and their options. None of these generators require previous GPIB programming experience since they use simple, multilevel menus to develop sophisticated test programs.

The Tek GPIB User's Resource Utility (GURU II) is a utility package for IBM PCs. It includes a GPIB interface board for the PC, GPIB cable, software and instruction manual.

Specifications begin on page 288.



Option 1R Rackmounting

The 2467/2465A/2445A instruments are available in standard 19-inch rackmount configuration, complete with slide-out chassis tracks.

Specifications begin on page 288.

CHARACTERISTICS

Characteristics are common to the 2467, 2465A, 2455A, 2445A and 2465A Special Editions except where indicated.

VERTICAL SYSTEM

Display Modes — CH 1, CH 2, CH 3, CH 4, Add (CH 1 + CH 2); Invert (CH 2 only); Alternating and Chopped display switching for all channels, and 20 MHz bandwidth limiting.

CHANNEL 1 AND CHANNEL 2

Deflection Factor — 2 mV/div to 5 V/div in a 1-2-5 sequence of 11 steps.

Deflection Factor Basic Accuracy — ±2%. Measured at a volts/div setting with a four or five division signal centered on screen.

ΔV Accuracy — ±(1.25% of reading + 0.03 div + signal aberrations). Basic accuracies apply for temperatures from +15°C to +35°C. Add ±2% of reading for temperatures from −15°C to +15°C and from +35°C to +55°C. Add 1% of reading when 50 Ω input coupling is used. Add 1% of Channel 2 reading when inverted. Measured with cursors anywhere on the graticule.

ΔV Range — ±8 times the Volts/div switch setting.

Variable Range — Continuously variable between Volts/div switch settings. Extends deflection factor to at least 12.5 V/div.

Frequency Response (−3 dB Bandwidth)

Instrument	+15°C to +35°C	−15°C to +15°C +35°C to +55°C
2467/2465A	350 MHz	300 MHz
2455A	250 MHz	200 MHz
2445A	150 MHz	150 MHz

All responses measured with standard accessory probe or internal 50 Ω termination.

Ac Coupled Lower −3 dB Point — With 1X Probe: 10 Hz or less. With 10X Probe: 1 Hz or less.

Step Response — **2467/2465A:** ⩽1 ns. **2455A:** ⩽1.4 ns. **2445A:** ⩽2.33 ns. Rise times calculated from $t_r = 0.35/BW$.

Common-Mode Rejection Ratio (Add Mode With Channel 2 Inverted) — At least 20:1 at 50 MHz for common-mode signals of 8 div or less, with Var Volts/div control adjusted for best CMRR at 50 kHz at any Volts/div setting ⩾5 mV.

Channel Isolation — ⩾100:1 attenuation of deselected channel at 100 MHz; ⩾50:1 at nominal bandwidth. Measured with an eight-division input signal and equal Volts/div switch settings on both channels from 2 mV/div to 500 mV/div.

Displayed CH 2 Signal Delay With Respect to CH 1 Signal — Adjustable through a range of at least ±500 ps.

Input Z (1 MΩ) — 1 MΩ ±0.5% shunted by 15 pF, ±2 pF. Maximum Input Voltage: 400 V (dc + peak ac); 800 V p-p ac at 10 kHz or less, for ac, dc, and ground-coupled signals.

Input Z (50 Ω) — 50 Ω ±1%. **VSWR (2467/2465A):** ⩽1.3:1 from dc to 300 MHz; ⩽1.5:1 from 300 MHz to 350 MHz. **VSWR (2455A/2445A):** ⩽1.3:1 from dc to nominal bandwidth. Maximum Input Voltage: 5 VRMS, averaged for 1 s; ±50 V peak.

Cascaded Operation — Deflection Factor: 200 μV/div ±10%. For 200 μV/div sensitivity, use 20 MHz bandwidth limit.

CHANNEL 3 AND CHANNEL 4

Deflection Factor — 100 mV/div and 500 mV/div ±10%.

Frequency Response — Same as Channel 1 and Channel 2. Responses measured only with standard probe.

Step Response — Same as Channel 1 and Channel 2.

Signal Delay Between Channel 1 and Either Channel 3 or Channel 4 — ±0.5 ns. Measured at 50% points.

Input Z — 1 MΩ ±1%, shunted by 15 pF ±3 pF. Maximum Input Voltage: 400 V (dc + peak ac); 800 V p-p ac at 10 kHz or less.

Channel Isolation — ⩾50:1 attenuation of the deselected channel at 100 MHz. Measured with an 8 div input signal.

ALL CHANNELS

Low Frequency Linearity — 0.1 div or less compression or expansion of a 2 div, center-screen signal when positioned anywhere within the graticule area.

Bandwidth Limiter — Reduces upper 3 dB bandpass to a limit of 13 MHz to 24 MHz.

Vertical Signal Delay — At least 30 ns of sweep is displayed before triggering event is displayed with Sec/div settings ⩾10 ns/div. At least 10 ns of sweep is displayed before triggering event is displayed with Sec/div settings at 5 ns.

CHOP Mode Switching Rate — 2.5 MHz ±0.2% for sweep speeds ranging from 20 μs/div to 2 μs/div. 1 MHz ±0.2% for all other sweep speeds. The complete display cycle rate equals the CHOP mode switching rate divided by the number of channels displayed. The CHOP mode switching rate is modulated slightly to minimize waveform breaks with repetitive signals.

HORIZONTAL SYSTEM

Display Modes — A (main sweep), A INTENsified, ALTernate A Intensified with B (delayed sweep), and B. In X-Y mode, Channel 1 provides X-axis (horizontal) deflection.

A Sweep Time Base Range — **2467/2465A:** 500 ms/div to 5 ns/div in a 1-2-5 sequence of 25 steps. X10 magnification extends fastest sweep rate to 500 ps/div. **2455A and 2445A:** 500 ms/div to 10 ns/div in a 1-2-5 sequence of 24 steps. X10 magnification extends fastest sweep rate to 1 ns/div.

B Sweep Time Base Range — **2467/2465A:** 50 ms/div to 5 ns/div in a 1-2-5 sequence of 22 steps. X10 magnification extends fastest sweep rate to 500 ps/div. **2455A/2445A:** 50 ms/div to 10 ns/div in a 1-2-5 sequence of 21 steps. X10 magnification extends fastest sweep rate to 1 ns/div.

Variable Timing Control — Continuously variable and calibrated between Sec/div settings. Extends slowest A sweep speed to 1.5 s/div. Affects the A Sec/div setting with the A display mode; affects the B Sec/div setting with INTEN, ALT, and B modes. The VAR control sets one signal cycle to five divisions for RATIO and PHASE measurements with cursors.

Timing Accuracy

Parameter	For 100 ms/Div and Faster Settings: +15°C to +35°C	For 100 ms/Div and Faster Settings: −15°C to +15°C +35°C to +55°C
Unmagnified		
A Sweep*1	±(0.7% of time interval +0.6% of full scale)	±(1.2% of time interval +0.6% of full scale)
ΔT Using Cursors*2	±(0.5% of time interval +0.3% of full scale)	±(0.7% of time interval +0.3% of full scale)
ΔT Using Sweep Delay*3	±(0.3% of time interval +0.1% of full scale)	±(0.5% of time interval +0.1% of full scale)
Delay*4	±(0.3% of delay setting +0.6% of full scale) +(0 to −25 ns)	±(0.5% of delay setting +0.6% of full scale) +(0 to −25 ns)
Magnified		
A Sweep*5	±(1.2% of time interval +0.6% of full scale)	±(1.7% of time interval +0.6% of full scale)
ΔT Using Cursors*5	±(1.0% of time interval +0.3% of full scale)	±(1.2% of time interval +0.3% of full scale)

For the A Sec/div settings of 200 ms and 500 ms, add ±0.5% of time interval or delay setting to preceding specifications.

**1 Intervals are measured on center horizontal graticule line, and 0.6% of full scale is 0.06 division.*

**2 Intervals are measured anywhere on the graticule.*

**3 Intervals are measured with both delays at 1% or more of full scale from minimum delay (no ? displayed in readout).*

**4 Delay is from A Sweep trigger point to start of B Sweep.*

**5 Exclude the first 0.5 division after sweep starts (first 0.5% of the full 100 division sweep).*

B Sweep Timing Accuracy—Add ±0.3% of time interval to the A Sweep Timing accuracy specifications for Sweep and for ΔT Using Cursors.

Variable Timing Accuracy—Add 2% of time interval to Timing Accuracy specifications for sweep when VAR control is out of detent.

ΔT Readout Resolution — **2467/2465A:** Either 10 ps or 0.025% of full scale, whichever is greater. **2455A/2445A:** Either 20 ps or 0.025% of full scale, whichever is greater.

ΔT Range — **With Cursors:** ±10 times the A Sec/div setting. **With Sweep Delay:** ±9.95 times the A Sec/div setting.

Sweep Delay Range — 0 to 9.95 times the A Sec/div setting, for settings from 500 ms/div to 10 ns/div (2467/2465A) or from 500 ms/div to 20 ns/div (2455A/2445A). With A Sec/div settings of 50 μs and faster, the A Sweep triggering event is observable on the B Sweep with zero delay setting.

Delay Jitter — **2467:** Within 0.01% (one part or less in 10,000) of maximum available delay, plus 100 ps. **2465A/2455A/2445A:** Within 0.004% (one part or less in 25,000) of maximum available delay, plus 50 ps.

Position Control Range — Start of the 1 ms/div sweep can be positioned from right of graticule center to at least 10 division left of graticule center. Some portion of the sweep is always visible with X10 magnification off.

TRIGGERING

Trigger Sensitivity From CH 1 or CH 2 Source — Dc Coupled: 0.35 div. Noise Reject Coupled: ≤1.2 div. HF Reject Coupled: 0.5 div from dc to 30 kHz. LF Reject Coupled: 0.5 div from 80 kHz. Ac Coupled: 0.35 div from 60 Hz.

Above 50 MHz, triggering signal requirement increases to 1.5 div at 500 mHz (for 2467, 2465A, and 2455A) and at 250 MHz (for 2445A) with dc, LF Reject, and ac coupling. For Noise Reject coupling above 50 MHz, triggering signal requirement increases to 4.5 div at 500 MHz (for 2467, 2465A, and 2455A) and at 250 MHz (for 2445A).

Trigger Sensitivity From ADD Source — 2467/2465A/2455A: Add 0.5 div to CH 1 or CH 2 source requirements at 500 MHz.

Trigger Sensitivity From CH 3 or CH 4 Source — 2467/2465A/2455A: One-half the CH 1 or CH 2 source requirements.

Trigger Sensitivity From Multiple-Channel Composite Source — 2467/2465A/2455A: Add 1.0 div to CH 1 or CH 2 source requirements.

Maximum P-P Signal Rejected by Noise Reject Coupling Within Vertical Bandwidth — CH 1 or CH 2 Source: ≥0.4 div with Volts/div settings of 10 mV/div and higher. Maximum noise amplitude rejected is reduced at 2 mV/div and 5 mV/div settings. **CH 3 or CH 4 Source:** ≥0.2 div.

Jitter — 2467/2465A: ≤100 ps with 5 div of 300 MHz at 500 ps/div. **2455A/2445A:** ≤100 ps with 5 div of nominal bandwidth at 1 ns/div.

Level Control Range — CH 1 or CH 2: ±18 times the Volts/div setting. CH 3 or CH 4: ±9 times the Volts/div setting.

Level Readout Basic Accuracy — CH 1 or CH 2 Source: ±[3% of Level setting +3% of p-p signal +0.2 div + 0.5 mV + (0.5 mV x probe attenuation factor)]. **CH 3 or CH 4 Source:** ±[3% of setting +4% of p-p signal +0.1 div +(0.5 mV x probe attenuation factor)].

Basic accuracies apply from +15°C to +35°C and are measured with triggering signals having transition times greater than 20 ns and dc trigger coupling. Add (1.5 mV x probe attenuation factor) for temperatures from −15°C to +15°C and from +35°C to +55°C. Add ±1% of setting from 50 Ω input coupling. Add ±1% of setting with Channel 2 Inverted. Add ±0.6 div for CH 1 or CH 2 Source with Noise Reject trigger coupling. Add ±0.3 div for CH 3 or CH 4 Source with Noise Reject trigger coupling.

Maximum Triggering Signal Period

A Sec/div Setting	AUTO LVL Mode	AUTO Mode
<10 ms	≥20 ms	≥80 ms
10 ms to 50 ms	≥4 times A Sec/div	≥16 times A Sec/div
>50 ms	≥200 ms	≥800 ms

X-Y OPERATION

X-Axis Deflection Factor Range, Variable Range, and Accuracy — Same as Channel 1.

X-Axis Bandwidth — Dc to 3 MHz.

Input Z — Same as Channel 1.

Phase Difference Between X and Y (With Bandwidth Limiting Off) — ≤1° from dc to 1 MHz. ≤3° from 1 MHz to 2 MHz.

X-Axis Low Frequency Linearity — 0.1 div or less compression or expansion of a 2 div, center-screen signal when positioned within the graticule area.

CURSOR AND FRONT PANEL DISPLAY

Cursor Position Range — ΔVolts: At least the center 7.6 vertical divisions. ΔTime: At least the center 9.6 horizontal divisions.

Z-AXIS INPUT

Sensitivity — From Dc to 2 MHz: Positive voltage decreases intensity. +2 V blanks a maximum intensity trace. 2 MHz to 20 MHz: +2 V p-p modulates a normal intensity trace.

Input Resistance — 9 kΩ ±10%.

Maximum Input Voltage — ±25 V peak; 25 V p-p ac at 10 kHz or less.

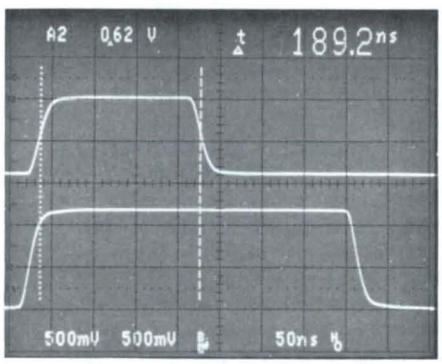
SIGNAL OUTPUTS

Calibrator — Measured with the Sec/div setting at 1 ms/div. **Voltage Into 1 MΩ Load:** 400 mV ±1%. **Voltage Into 50 Ω Load:** 200 mV ±1.5%. **Short Circuit Load Current:** 8 mA ±1.5%. **Repetition Period and Accuracy:** Two times the A Sec/div switch setting for settings from 100 ns/div to 100 ms/div ±0.1%, during the sweep time.

CH 2 Signal Out — **Voltage:** 20 mV/div ±10% into 1 MΩ. 10 mV/div ±10% into 50 Ω. **Offset:** ±10 mV into 50 Ω after dc balancing within ±5°C of the operating temperature.

A Gate Out and B Gate Out — **Voltage:** 2.4 V to 5 V positive going pulse, starting at 0 V to 400 mV. **Drive:** Supplies 400 μA during HI state; sinks 2 mA during LO state.

CRT READOUT AND WAVEFORM INFORMATION



Your eyes never have to leave the screen to obtain front panel settings and measurement results. In the CRT example above, the top area of the display provides trigger source, trigger voltage level, and Δtime results. The lower area displays the selected volts/div and seconds/div scale factors and that bandwidth limit and holdoff are activated.

CRT AND DISPLAY FEATURES

Standard CRT — 2467: 68 mm x 85 mm. **2465A/2455A/2445A:** 80 mm x 100 mm (8 cm x 10 cm). Markings: Eight major div vertically and 10 major div horizontally, with auxiliary markings.

Trace Rotation Range — Adequate to align trace with center horizontal graticule line.

Standard Phosphor — GH (P31).

Visual Writing Speed — (2467) With 20 ft-cd. Illumination Normal to CRT Faceplate (typical room light): ≥4 div/ns at maximum INTENSITY control setting. No more than five bright spots will be visible at maximum INTENSITY control setting. Additional bright spots may be visible after displaying a high intensity trace. These spots will extinguish when INTENSITY control is set to minimum.

Photographic Writing Speed — (2467) ≥10 div/ns with C-30 Series camera and ISO 3000 film, without prefogging. A single-shot trace of instrument rise time at 500 ps/div is recorded with high contrast at f/1.9.

Display Intensity Limitation — (2467) Display intensity is automatically reduced and eventually extinguished after periods of no front panel control activity. The time elapsed before intensity reduction is shortened by high intensity settings and high duty factor/sweep speed/trigger rate combinations. Operating any switch or the INTENSITY control restores the selected intensity setting.

POWER REQUIREMENTS

Line Voltage Ranges — 115 V: 90 V to 132 V ac. 230 V: 180 V to 250 V ac.

Line Frequency — 48 Hz to 440 Hz.

Maximum Power Consumption — 120 W (180 V ac) for fully optioned instrument.

Fuse Rating — Either 2 A, 250 V, AGC/3AG, fast-blow or 1.6 A, 250 V, 5 x 20 mm, quick-acting. Each fuse type requires a different cap.

Primary Circuit Dielectric Voltage Withstand Test — 1500 V rms, 60 Hz, for 10 s without breakdown.

Primary Grounding — Type test to 0.1 Ω maximum. Routine test to check grounding continuity between chassis ground and protective earth ground.

ENVIRONMENTAL AND SAFETY

Environmental requirements qualify the electrical and mechanical specifications. When not rack-mounted, the instrument meets the environmental requirements of MIL-T-28800C for Type III, Class 3, Style C equipment, with humidity and temperature requirements defined in paragraphs 3.9.2.2, 3.9.2.3, and 3.9.2.4.

Ambient Temperature — Operating: −15°C to +55°C. Nonoperating: −62°C to +85°C.

Altitude — Operating: To 4600 m (15,000 ft). Maximum operating temperature decreases 1°C for each 1,000 ft above 1500 m (5,000 ft). Nonoperating: To 15 000 m (50,000 ft).

Vibration — Operating: 15 minutes along each of three axes at a total displacement of 0.025 inch p-p (4 g's at 55 Hz), with frequency varied from 10 Hz to 55 Hz in one-minute sweeps. Held 10 minutes at each major resonance, or if none existed, held 10 minutes at 55 Hz (75 minutes total test time).

Packaged Transportation Vibration — Meets the limits of the National Safe Transit Association Test Procedure 1A-B-1; excursion of 1 inch p-p at 4.63 Hz (1.1 g) for 30 minutes per Tektronix Standard 062-2858-00.

Humidity — Operating and Nonoperating: Stored at 95% relative humidity for 5 cycles (120 hours) from +30°C to +60°C, with operational performance checks at +30°C and +55°C.

Shock — Operating and Nonoperating: 50 g's, half-sine, 11 ms duration, three shocks on each face, for a total of 18 shocks.

Electromagnetic Compatibility — Meets requirements of the following standards: MIL-T-28800C; MIL-STD-461B Part 4 (CE-03 and CS-02), Part 5 (CS-06 and RS-02), and Part 7 (CS-01, RE-02, and RS-03), limited to 1 GHz; VDE 0871 Category B; FCC Rules and Regulations Part 15, Subpart J, Class A; and Tektronix Standard 062-2866-00.

Electrostatic Discharge Susceptibility — Instrument does not change control states with discharges of less than 10 kV. Meets requirements of Tektronix Standard 062-2862-00.

Radiation — Meets requirements of Tektronix Standard 062-1860-00.

Safety — UL listed (UL 1244) and CSA certified (CSA 556B).

Drip Proof — With Cover On: Meets MIL-T-28800C para 4.5.5.5.3.

Transit Drop — Not in Shipping Package: 12-inch drop on each corner and each face (MIL-T-28800C, para 4.5.5.4.2).

Packaged Transportation Drop — Meets the limits of the National Safe Transit Association Test Procedure 1A-B-2; 10 drops of 36 inches per Tektronix Standard 062-2858-00.

Bench Handling — With and Without Cabinet Installed: MIL-STD-810C, Method 516.2, Procedure V (MIL-T-28800C, para 4.5.5.4.3).

Topple — Operating and Cabinet Installed: Set on rear feet and allowed to topple over onto each of four adjacent faces per Tektronix Standard 062-2858-00.

PHYSICAL CHARACTERISTICS

	2465A/2467		2455A/2445A		Rackmount	
Dimensions	**mm**	**in**	**mm**	**in**	**mm**	**in**
Width						
With handle	330	13.0	338	13.3	483	19.0
Height						
With feet, pouch	190	7.5	190	7.5	178	7.0
Without pouch	165	6.5	160	6.3		
Depth						
With front cover	467	18.4	434	17.1	419	16.5
handle extended	533	21.0	505	19.9		
Weights≈	**kg**	**lb**	**kg**	**lb**	**kg**	**lb**
Net						
With accessories and pouch	10.9	24.0	10.2	22.2	4.0*1	8.8*1
Without accessories and pouch	9.7	21.3	9.3	20.5		
Shipping	14.6	32.1	12.8	28.2	6.3*1	13.8*1

**1 Weight of conversion kit only. Rear support kit weight is an additional 6.3 kg (13.8 lb).*

Cooling — Forced air circulation.

Construction — Sheet aluminum-alloy chassis; plastic-laminate front panel; glass-laminate circuit boards.

Ordering Information — See page 289.

CHARACTERISTICS (OPTION 09)

The set of characteristics is the same as specified for standard 2467/2445A/2465A oscilloscopes and includes the following additions:

Sensitivity — Signal input requirements for Frequency, Period, Totalize, Delay-by-Events and Logic Trigger.

Input	Displayed Signal	Frequency Range
CH 1, CH 2	1.5 div	Dc (0.5 Hz for Frequency and Period) to 50 MHz
CH 3, CH 4	0.75 div	
CH 1, CH 2	4.0 div	50 MHz to ⩾150 MHz
CH 3, CH 4	2.0 div	

Source — A trigger or word recognizer for Frequency, Period, and Totalize.

FREQUENCY

Range — Autoranging over input frequency from 0.5 Hz to 150 MHz.

Resolution — $\pm\left[\text{LSD} + 1.4 \times \frac{\text{TJE}}{\text{N}} \times (\text{F})^2\right]$

Display — Seven digits, updates twice per second or every two periods, whichever is slower.

Accuracy — Resolution ±0.001% of reading over entire temperature range of −15°C to +55°C.

PERIOD

Range — Autoranging over an input period from 6.666667 ns to 2 s.

Resolution — $\pm\left(\text{LSD} + 1.4 \times \frac{\text{TJE}}{\text{N}}\right)$

Display — Seven digits, updates twice per second or every two periods, whichever is slower.

Accuracy — Resolution ±0.001% of reading over entire temperature range of −15°C to +55°C.

ACCURACY AND RESOLUTION DEFINITIONS

F=Input Frequency in Hz

LSD=Least Significant Digit (0.1 ppm of full scale)

TJE=Trigger Jitter Error

N=Number of cycles of measured frequency during measurement interval (0.5 s or 1 period of the input signal, whichever is greater)

TJE (Trigger Jitter Error)=

$$\sqrt{\frac{(\text{en1})^2 + (\text{en2})^2}{\text{Input Slew Rate}}}$$

Where: en1=RMS noise of vertical system in div on screen

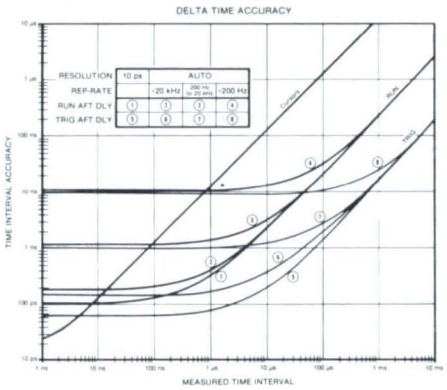
en2=RMS noise voltage of input signal in divs

Volts/div	en1	
	Trigger Coupling Dc and Noise Rej	Trigger Coupling HF Reject
2 mV	0.15 div	0.05 div
5 mV to 5 V	0.1 div	0.05 div

ΔTIME, 1/ΔTIME

TRIG AFT DLY Accuracy — ±(LSD +0.01 x B Time/div) + (0.001% x A Sec/div +0.001% of reading +50 ps). Measured with visually superimposed signal transitions, >0.1 div/ns trigger-signal slew rates, and with channel-to-channel delay mismatch corrected by the CH 2 DLY match adjustment from the front panel. Independent SLOPE and LEVEL settings for ΔREF and ΔB triggers allow visual superposition of any pair of points within the center 80% of transitions having at least 5 div amplitude.

RUN AFT DLY Accuracy — ±(LSD +0.0008 x A Sec/div) + (0.01 x B Time/div + 83 ps). B Time/div includes 10X mag.



Notes: Input Signal is five vertical div with a 2 ns rise time.

Measured times are four horizontal div.

TJE is negligible for Slew Rates >0.1 div/ns.

ΔTime TRIG AFT DLY assumes visual superposition.

Display Update Rate — Auto resolution, twice per second or every four sweeps, whichever is slower. Depends on trigger and sweep rates with selectable resolution.

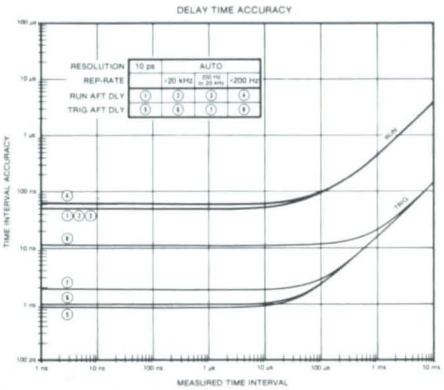
DELAY TIME

TRIG AFT DLY Accuracy — ±(LSD +0.001% of reading +0.5 ns +A trigger slew error +B trigger slew error). Add 0.5 ns for dual channel measurements.

Where: Trigger slew error equals trigger level control readout accuracy÷trigger signal slew rate at the trigger point.

RUN AFT DLY Accuracy — ±(LSD +0.0012 x A Sec/div +0.03 x B Time/div +50 ns). (B Time/div includes 10X mag.)

TRIG AFT DLY and RUN AFT DLY Accuracies Using Word Recognizer on the B Trigger — Add 100 ns, if using external clock. Add 200 ns, if not using external clock.



Notes: Input Signal is five vertical div with a 2 ns rise time.

Measured times are four horizontal div.

TJE is negligible for Slew Rates >0.1 div/ns.

ΔTime TRIG AFT DLY assumes visual superposition.

Display Update Rate — Auto, twice per second or once for each sweep, whichever is slower. Depends on trigger and sweep rate for selectable resolution.

Selectable Resolution

A Sec/Div	Selected Resolution	LSD
10 ns to 1 s	AUTO	See Auto Resolution below
10 ns to 5 μs	10 ps 100 ps 1 ns	10 ps 100 ps 1 ns
10 μs to 50 μs	10 ps or 100 ps 1 ns	100 ps 1 ns
100 μs to 500 μs	10 ps to 1 ns	1 ns
1 ms to 5 ms	10 ps to 1 ns	10 ns
10 ms to 50 ms	10 ps to 1 ns	100 ns
100 ms to 500 ms	10 ps to 1 ns	1 μs
1 s	10 ps to 1 ns	10 μs

Auto Resolution

A Sec/Div	Trigger Repetition Rate	LSD
10 ns to 2 μs	>20 kHz	100 ps
10 ns to 2 μs	200 Hz to 20 kHz	1 ns
5 μs to 200 μs	>200 Hz	1 ns
10 ns to 200 μs	<200 Hz	10 ns
500 μs to 5 ms	Any	10 ns
10 ms to 50 ms	Any	100 ns
100 ms to 500 ms	Any	1 μs
1 s	Any	10 μs

Note: 2445A Sec/div settings range from 20 ns to 1 s. 2465A Sec/div settings range from 10 ns to 500 ms.

TOTALIZE

Maximum Count — To 9,999,999 events.

DELAY BY EVENTS

A or B Sweep — The A trigger or 17-bit word recognizer defines start events. The B trigger or 17-bit word recognizer defines delay events. With A sweep in the delayed by events mode, the B sweep is delayable by time.

Maximum Delay Count — Up to 4,194,303.

Minimum Time From Start Event to Any Delay Event — ⩾4 ns.

Minimum Pulse Width — ⩾3.3 ns.

LOGIC TRIGGER

Combination Trigger — A sweep can be triggered from logical combinations of A and B triggers (A and B) or (A or B), or the word recognizer. B sweep can be triggered from the word recognizer.

Minimum Time to Satisfy Logic Combinations — ⩾4 ns.

WORD RECOGNIZER

Input — P6407 Word Recognizer Probe, 17 bits plus clock. (No CRT display from P6407.)

All Inputs	Threshold	Load	Safe Limit
High	<2.0 V	<20 μA	5.5 V
Low	>0.6 V	>−0.6 mA	−0.5 V

Display Radix — Hexadecimal, octal, binary.

Data Rate — 0 MHz to ⩾20 MHz with clock, 0 MHz to ⩾10 MHz without clock.

Data Set-Up Time — 25 ns.

Data Hold Time — 0 ns.

GPIB Compatibility for Semiautomatic Measurement Systems — When combined with Option 10 the CTT/WR (Option 09) Oscilloscope combination is fully programmable. Complies with Tektronix *Standard Codes and Formats.*

Ordering Information — See page 289.

CHARACTERISTICS (OPTION 05)

The set of characteristics is the same as specified for standard 2467/2445A/2465A oscilloscopes and includes the following additions:

VERTICAL SYSTEM (CHANNEL 1 AND CHANNEL 2)

Frequency Response — Applicable for volt/div settings between 5 mV and 0.2 V with Var volt/div control in calibrated detent and using a 5 div, 50 kHz reference signal from a 50 Ω or 75 Ω system.

Range	With Full BW	With BW Limiting
50 kHz to 5 MHz	±1%	+1%, −4%
>5 MHz to 10 MHz	+1%, −2%	*1
>10 MHz to 30 MHz	+2%, −3%	*1
>30 MHz	*1	*1

**1 Same as basic instrument.*

Squarewave Flatness — 1% p-p for both 60 Hz and 15 kHz squarewaves, from a 50 Ω or 75 Ω system using a 1.0 V input with a 50 mV/div setting and using a 0.1 V input at 20 mV/div setting. 1.5% p-p using a 0.1 V input with 5 mV/div and 10 mV/div settings. Exclude first 50 ns following step transition. For signals with rise times ⩽10 ns, add 2% p-p between 155 ns and 165 ns after step transition.

Television Blanking-Level Clamp (Back-Porch) 60 Hz Rejection (Channel 2 Only) — ⩾18 dB at 60 Hz; with calibrated Volt/div settings between 5 mV and 0.2 V, and a 6 div reference signal.

Television Blanking-Level Clamp (Back-Porch) Reference — Within 1.0 div of ground reference.

TRIGGERING

Sync Separation — Stable sync separation from sync-positive or sync-negative composite video on systems with 525 to 1280 lines/frame, 50 Hz or 60 Hz field rate, interlaced or noninterlaced scan.

Trigger Modes — LINES, FLD 1, FLD 2, and ALT (FLD 1–FLD 2).

Input Signal Amplitude for Stable Triggering — Channel 1 and Channel 2: 1.0 div for composite video and 0.3 div for composite sync signals (dc + peak video-signal amplitude must be within 18 div of input ground reference).

Channel 3 and Channel 4: 0.5 div for composite video and 0.25 div for composite sync signals (dc peak video-signal amplitude must be within 9 div of input ground reference).

GPIB Compatibility for Semiautomatic Measurement Systems — When combined with Option 10, the TV Waveform Measurement Systems (Option 05)/oscilloscope combination is fully programmable. Complies with Tektronix *Standard Codes and Formats.*

Ordering Information — See page 289.

CHARACTERISTICS (OPTION 01)

This option is unavailable for the 2467. The set of characteristics is the same as specified for all other standard 2445A/2465A oscilloscopes and includes the following additions:

All accuracy specifications are stated with an operating temperature range of +18°C to +28°C and a relative humidity of 95% or less.

DC VOLTAGE

Ranges — 200 mV, 2 V, 20 V, 200 V, 500 V.

Resolution — 10 μV (4½ digits).

Accuracy — ±(0.03% of reading +0.01% of full scale). For 500 V range ±(0.03% of full scale).

Input Resistance — >100 GΩ on the 200 mV and 2 V ranges, 10 MΩ on the higher ranges. Resistance can be changed to 10 MΩ on all ranges.

Normal-Mode Rejection Ratio — ⩾60 dB at 50 Hz and 60 Hz.

Common-Mode Rejection Ratio — 100 dB at dc; >80 dB at 50 Hz and 60 Hz with 1 kΩ imbalance.

Maximum Input Voltage — 500 V RMS; 700 V peak between inputs and ground.

Response Time — <2 s in Auto, <1 s in Manual.

AC RMS VOLTAGE

Ranges — 200 mV, 2 V, 20 V, 200 V, 500 V.

Resolution — 10 μV (4½ digits).

Accuracy — ±(% of reading +% of full scale).

Input Frequency	200 mV to 200 V	500 V
20 Hz to 40 Hz	±(0.7% +0.1%)	±(0.7% +0.2%)
40 Hz to 10 kHz	±(0.3% +0.1%)	±(0.3% +0.2%)
10 kHz to 20 kHz	±(0.7% +0.1%)	±(0.7% +0.2%)
20 kHz to 100 kHz	±(5% +0.1%)	±(5% +0.2%)

Crest Factor — ⩽4 at full scale.

Common-Mode Rejection Ratio — ⩾60 dB at 50 Hz and 60 Hz with 1 kΩ imbalance.

Response Time — <3 s in Auto, <2 s in Manual.

Input Impedance — 1 MΩ in parallel with <100 pF.

Maximum Input Voltage — 500 V RMS; 700 V peak between inputs and ground, not to exceed 10^7 V-Hz product.

dBV, dBm — Calculated reading of ac voltage measurements. dBV equals 20 Log (V_{UNK}/1 V). dBm is referenced 1 mW into 600 Ω.

HI Ω RESISTANCE

Ranges — 2 kΩ, 20 kΩ, 200 kΩ, 2 MΩ 20 MΩ.

Accuracy — ±(0.1% of reading +0.01% of full scale) for 2 kΩ to 2 MΩ. ±(0.4% of reading) for 20 MΩ. Add 2% of reading for each 10% Relative Humidity above 70% when in 2 MΩ and 20 MΩ ranges.

Maximum Input Voltage — 500 V RMS; 700 V peak.

Full Scale Voltage — 2 V.

Open Circuit Voltage — <6 V.

Resolution — 0.1 Ω (4½ digits).

Response Time — <2 s in Auto, <1 s in Manual. <5 s in 20 MΩ range.

LO Ω RESISTANCE

Ranges — 200 Ω, 2 kΩ, 20 kΩ, 200 kΩ, 2 MΩ.

Accuracy — ±(0.1% of reading +0.1% of full scale) for 200 Ω range. Subtract (0.09% of full scale) for 2 kΩ to 200 kΩ ranges. Add (0.15% of reading) and subtract (0.09% of full scale) for 2 MΩ range. Add 2% of reading for each 10% Relative Humidity above 70% when in 200 kΩ and 2 MΩ ranges.

Maximum Input Voltage — 500 V RMS; 700 V peak.

Full Scale Voltage — 0.2 V.

Open Circuit Voltage — <6 V.

Resolution — 0.01 Ω

Response Time — <2 s in Auto; <1 s in Manual.

Continuity — An audible tone indicates <10 Ω. Reponse time is ≈0.1 s.

DC CURRENT

Ranges — 100 μA, 1 mA, 10 mA, 100 mA, 1 A.

Accuracy — ±(0.1% of reading +0.02% of full scale).

Burden Voltage — <150 mV up to 100 mA increasing to <500 mV at 1 A.

Resolution — 10 nA.

Response Time — <2 s in Auto; <1 s in Manual.

AC (RMS) CURRENT

Ranges — 100 μA, 1 mA, 10 mA, 100 mA, 1 A.

Accuracy — ±(0.6% of reading +0.1% of full scale) from 20 Hz to 10 kHz.

Burden Voltage — <150 mV up to 100 mA increasing to <500 mV at 1 A.

Resolution — 10 nA.

Response Time — <3 s in Auto; <2 s in Manual.

TEMPERATURE

Range — −62°C to +230°C.

Accuracy — ±(2% of reading +1.5°C).

Resolution — 0.1°.

Readout — Selectable in either °C or °F.

OTHER CHARACTERISTICS

Reading Rate — Three readings/s nominal except 1.5 readings/s on 20 MΩ range.

Temperature Coefficient — ⩽0.1 x the accuracy specification/°C from −15°C to +18°C and from +28°C to +55°C.

GPIB Compatibility for Semiautomatic Measurement Systems — When combined with Option 10, the DMM (Option 01) oscilloscope combination is fully programmable. Complies with Tektronix *Standard Codes and Formats*.

Ordering Information — See page 289.

CHARACTERISTICS (OPTION 10)

The set of characteristics is the same as specified for standard 2467/2445A/2465A oscilloscopes and includes the following additions:

Standard Interface Functions Implemented — SH1, AH1, T6, L3, SR1, RL1, DC1, E1 DTØ CØ, PPØ.

Vertical Position Accuracy —

Channel 1 and Channel 2 (Noninverted): ±[0.3 div +3% of distance (in divisions) from center screen +0.5 mV divided by the Volt/div setting]. For −15°C to +55°C (excluding +15°C to +35°C) add 1.5 mV divided by the Volt/div setting. For Channel 2 Inverted add 0.2 div.

Channel 3 and Channel 4: ±[0.7 div +3% of distance (in div) from center screen].

Ordering Information — See page 289.

CHARACTERISTICS (OPTION 1R)

ENVIRONMENTAL

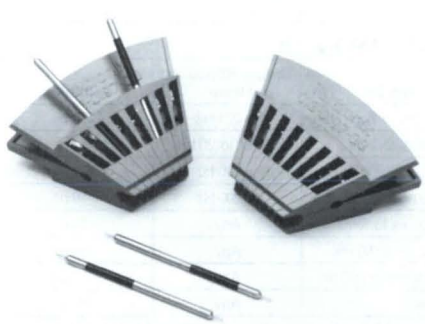
Rackmounting changes the temperature, vibration, and shock capabilities. The rackmounted oscilloscope meets or exceeds the requirements of MIL-T-28800C with respect to Type III, Class 5, Style C equipment, when installed as directed. It also meets or exceeds Tektronix Standard 062-2853-00, Class 5 requirements.

Ambient Temperature — Operating: −15°C to +55°C. Measured at the instrument's air inlet, fan exhaust temperature should not exceed +65°C.

Vibration — Operating: Same as standard instrument, except total displacement is 0.015 inch p-p (2.3 g's at 55 Hz).

Shock — Operating and Nonoperating: Same as standard instrument, except shocks are 30 g's.

K212 Portable Insturment Cart. See page 461.



KLIPKIT makes high speed IC testing easy. For use directly with P6130 family probes or others via the included signal pins. See page 472.

ORDERING INFORMATION

2467*4 350 MHz Oscilloscope $11,900
Includes: MCP CRT; four P6136 10X 1.3 m probes with accessories; 2 A, 250 V fuse (159-0021-00); zip lock accessory pouch (016-0537-00); blue plastic CRT filter (378-0199-03); clear plastic CRT filter; snap accessory pouch (016-0692-00); front cover; power cord (161-0104-00); operator manual (070-5854-00).

2465A 350 MHz Oscilloscope $5,350
Includes: Two P6136 10X 1.3 m probes with accessories (P6136); 2 A, 250 V fuse (159-0021-00); zip lock accessory pouch (016-0537-00); blue plastic CRT filter (378-0199-03); clear plastic CRT filter; snap accessory pouch (016-0692-00); front cover; power cord (161-0104-00); operator manual (070-6014-00).

2455A 250 MHz Oscilloscope $5,150
Includes: Same as 2465A.

2445A 150 MHz Oscilloscope $3,590
Includes: Same as 2465A, except two P6133 10X 2 m probes (P6133).

2465A DV 350 MHz Oscilloscope $9,200
Includes: Same as 2465A, plus DMM (Option 01), TV (Option 05), CTT/WR (Option 09), GPIB (Option 10), and two additional P6136 probes (Option 22). Provides most cost-effective combination of these options.

2465A DM 350 MHz Oscilloscope $8,400
Includes: Same as 2465A, plus DMM (Option 01), CTT/WR (Option 09), GPIB (Option 10), and two additional P6136 probes (Option 22). Provides most cost-effective combination of these options.

2465A CT 350 MHz Oscilloscope $7,150
Includes: Same as 2465A, plus CTT/WR (Option 09), GPIB (Option 10), and two additional P6136 probes (Option 22). Provides most cost-effective combination of these options.

INSTRUMENT OPTIONS

Option 01*3*4 — Digital Multimeter. **+$1,500**
Includes: Same as standard instruments, plus probe set (012-0941-00); temperature probe (P6602); probe set accessories (020-0087-00).

Option 05 — TV Waveform Measurement System. **+$1,050**
Includes: Same as standard instruments, plus CCIR graticule CRT filter (378-0199-01); NTSC graticule CRT filter (378-0199-02); polarized collapsible viewing hood (016-0180-00).

Option 06 — Counter/Timer/Trigger. **+$1,000**
Includes: Same as standard instruments, plus 20 grabber tips (206-0222-00); two 10 inch 10 wide comb (012-0747-00).

Option 09*1*2 — Counter/Timer/Trigger and Word Recognizer. **+$1,400**
Includes: Same as standard instruments, plus a word recognizer probe (010-6407-01); 20 grabber tips (206-0222-00); two 10 inch 10 wide comb (012-0747-00).

Option 10 — IEEE-488 GPIB Interface. **+$900**
Includes: Same as standard instruments, plus Instrument Interface Guide.

MULTIPLE OPTION ALLOWANCE (MOA)

When a 2467 or 2465A instrument is ordered with more than two of the above options, a special price allowance is applied. This allowance is not applicable to the 2465A DV, 2465A DM, or the 2465A CT.

Option 2A — MOA for combining two of the above options. **−$250**

Option 3A — MOA for combining three of the above options. **−$500**

Option 4A — MOA for combining four of the above options. **−$750**

OTHER INSTRUMENT OPTIONS

Option B1 — Service manual.
(For 2445A/2455A/2465A/2467) Standard manual. **+$50**
(For Options/Special Editions) Includes standard manual plus options manual. **+$50**

Option 1R*3 — Configure Oscilloscope for Rackmount. **+$320**
Includes: Same as bench model instrument (except pouch) plus rackmount hardware and slide-out assemblies.

Option 1T — Transit Case. **+$340**

Option 11*1 — Rear Panel Probe Power. **+$165**

Option 22 — Two additional probes.
(2467/2465A/2455A) P6136 probes. **+$265**
(2445A) P6133 probes. **+$205**

**1 Option 11 may not be ordered with Option 09 or the 2445A.*
**2 Option 09 includes Option 06.*
**3 Option 1R may not be ordered with Option 01, 2465A DM, or 2465A DV. For rackmounting instruments equipped with Option 01, contact your local Sales Engineer.*
**4 Option 01 is not available with the 2467.*

NOTE: Options are not retrofittable with field upgrade kits.

INTERNATIONAL POWER OPTIONS

Option A0 — 115 V, 60 Hz, US plug.
Option A1 — 220 V, 50 Hz, Universal Euro plug.
Option A2 — 240 V, 50 Hz, UK plug.
Option A3 — 240 V, 50 Hz, Australian plug.
Option A4 — 240 V, 60 Hz, North American plug.
Option A5 — 220 V, 50 Hz, Switzerland plug.

WARRANTY-PLUS SERVICE PLANS
SEE PAGE 497

M1 — (2467/2465A/2455A and Special Editions) 2 Calibrations. **+$265**
M1 — (2445A) 2 Calibrations. **+$255**
M2 — (2467) 2 Years Service. **+$370**
M2 — (2455A/2465A and Special Editions) 2 Years Service. **+$270**
M2 — (2445A) 2 Years Service. **+$215**
M3 — (2467) 2 Years Service and 4 Calibrations. **+$845**
M3 — (2465A/2455A and Special Editions) 2 Years Service and 4 Calibrations. **+$695**
M3 — (2445A) 2 Years Service and 4 Calibrations. **+$645**
M4 — (2467/2465A/2455A and Special Editions) 5 Calibrations. **+$670**
M4 — (2445A) 5 Calibrations. **+$660**
M5 — (2467) 9 Calibrations + 2 Years Service. **+$1,495**
M5 — (2465A/2455A and Special Editions) 9 Calibrations + 2 Years Service. **+$1,350**
M5 — (2445A) 9 Calibrations + 2 Years Service. **+$1,295**

OPTIONAL ACCESSORIES

Rackmount Conversion Kit — Not compatible with Option 01. Order 016-0825-01 **$365**

Probe Power Extender Cable for Rackmount Instrument With Option 11 — Order 020-0104-00 **$475**

Word Recognizer Extender Cable for Rackmount Instrument With Option 09 and 2465A CT — Order 020-0103-00. **$335**

GPIB Cables — Double shield, low EMC.
(1 m) Order 012-0991-01 **$135**
(2 m) Order 012-0991-00 **$150**
(4 m) Order 012-0991-02 **$175**

Viewing Hoods —
(Polarized Collapsible) Order 016-0180-00 **$50**
(Folding Light Shield) Order 016-0592-00 **$14**
(Folding Binocular) Order 016-0566-00 **$18.75**

Protective Waterproof Vinyl Cover — Order 016-0720-00 **$24**

Carrying Case — Order 016-0792-01 **$355**

Carrying Strap — Order 346-0199-00 **$17**

Dc Power — For more information, see page 306.
(1105) **$1,690**
(1106) **$1,265**

Dc Inverter — 1107. For more information, see page 307. **$525**

RECOMMENDED PROBES

P6133 — 10X Passive Probe for use with 2445A. **$115**

P6136 — 10X Passive Probe for use with 2467, 2465A, 2455A. **$150**

P6202A — 10X FET Probe. **$680**

P6230 — 10X Bias/Offset Probe. **$395**

P6057 — 100X, 5000 Ω passive probe for 50 Ω input. **$190**

P6602 — Temperature Probe. **$225**

Current Probes — A6302, A6303, P6021, P6022. See pages 483 and 482 respectively.

A6901 Gound Isolation Monitor — See page 478 for complete description. **$650**

A6902B Voltage Isolator — For floating measurements; see page 479 for complete description. **$1,795**

DIGITIZING CAMERA SYSTEM

DCS01 Option 2A — Digitize waveforms from scope screen. **$5,395**

See page 353 for complete description.

DCS01 Digitizing Camera System captures repetitive waveforms from analog scopes and transients according to a scope's CRT writing speed (350 MHz for 2467).

RECOMMENDED CAMERAS

C-30BP Option 01 — General Purpose. See page 450. **$1,524**

C-5C Option 02 — Low Cost. See page 445. **$465**

RECOMMENDED CART

K212 — For on-site mobility. See page 461. **$330**

SERVICE MANUALS

(2467/2465A) Order 070-6019-00 **$50**
(2455A/2445A) Order 070-6017-00 **$50**
(Options) Order 070-5857-00 **$25**

SOFTWARE

EZ-TEK 2400 Test Program Generator — For instruments with GPIB; used with 4041 controller. Order S49F101 **$250**

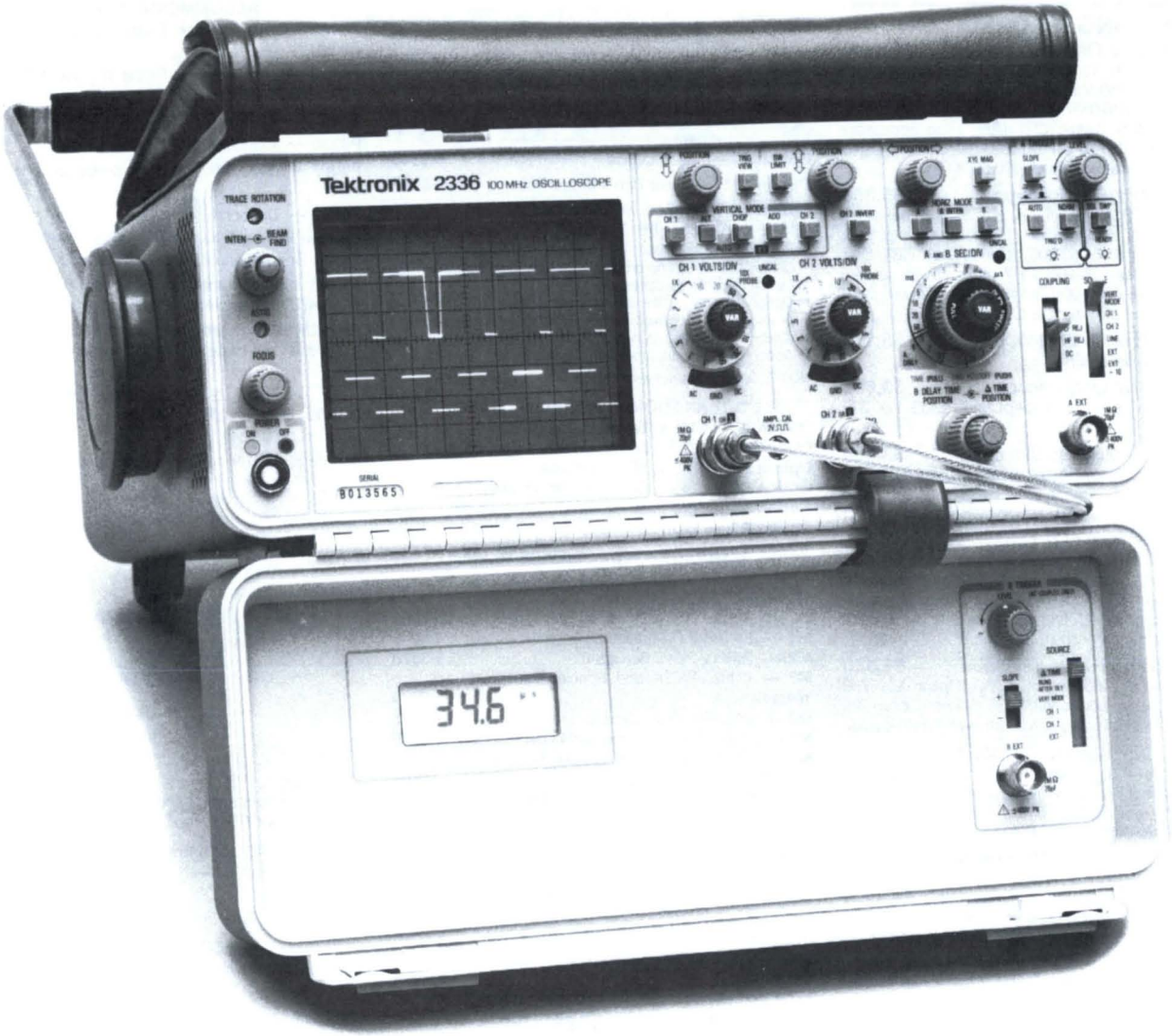
EZ-TEK 2400 PC Test Program Generator — For instruments with GPIB; used with IBM PC/XT/AT and compatibles. Requires GURU hardware. Order S49F103 **$250**

GPIB User's Resource Utility (GURU) — Includes GPIB-PC interface board, GPIB cable, software, and documentation.
Order 021-0396-00 **$595**

Additional accessories begin on page 439.

TRAINING

For each 2467/2445A/2465A oscilloscope purchased, one operation and application training seat, applicable to the product, will be made available to the purchaser at 50% of the normal fee. Other restrictions apply. Workshop content is on pages 195-196. For further information, or to enroll, call 1-800-225-7802. For international orders, contact your local Sales Office.



2335/2336/ 2336YA/2337

Dc to 100 MHz Bandwidth

5 mV/Div to 5 V/Div

5 ns/Div Sweep Rate

Three Year Warranty—Five Year Option

TYPICAL APPLICATIONS
Rugged Field Service
Computer Peripheral Service
Communication Equipment Service

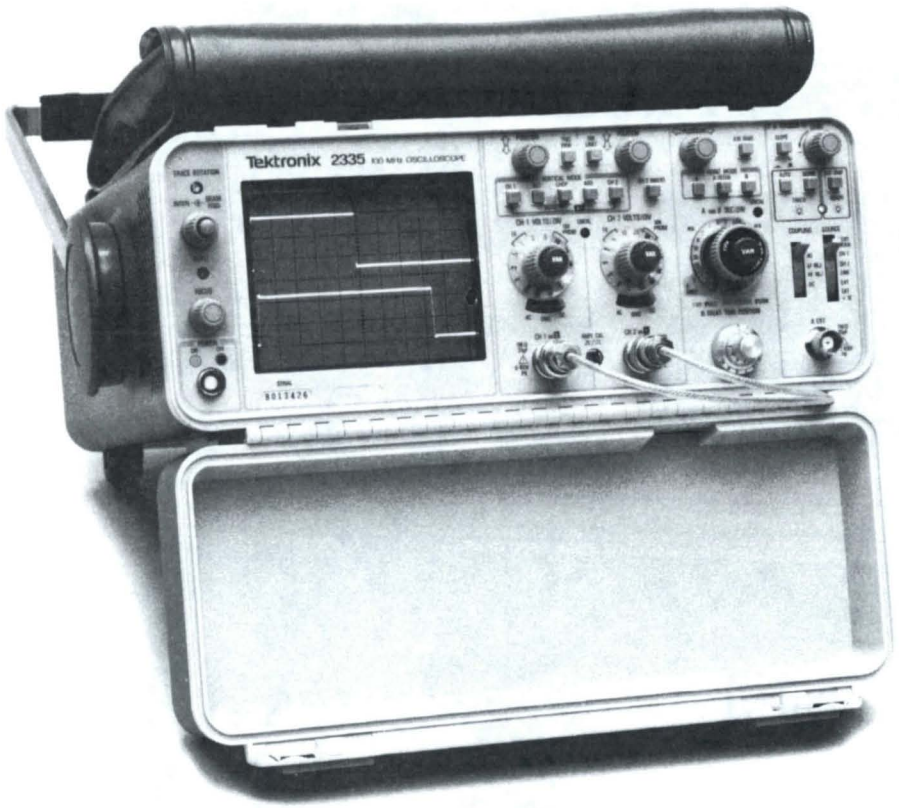
See page 277 for available Application Notes.

Compact and lightweight for ultra portability, these oscilloscopes are designed and built for on-site troubleshooting. The 2335, 2336, 2336YA and 2337 are useful for high speed logic and digital applications. They feature an innovative and protective fliptop cover that doubles as a front panel with ΔTime on the 2336, 2336YA and ΔTime/DMM on the 2337 versions. The entire outside case of all four instruments is made of durable, one-piece aluminum and the front panels are coated with scratch resistant plastic. When the fliptops are latched shut, the entire scope can withstand the abuse and heavy usage of field service environments.

Vertical channels have calibrated deflection factors from 5 mV/div to 5 V/div with a variable gain control to increase the sensitivity to at least 2 mV/div. An internal delay line permits observation of the leading edge of a waveform. Variable sweep speeds range from 0.5 s/div to 50.0 ns/div and a 10X magnifier can increase the sweep rate to 5 ns/div. An autotrigger mode allows triggering on waveforms with repetitive rates down to approximately 10 Hz. The sweep rate will run freely and provide a baseline trace in the absence of an adequate trigger signal.

Many exterior features have been incorporated into these new ultra portable scopes to make them fast and convenient to use. The CRT produces bright, high resolution traces that are readily visible in most light conditions. The ΔTime/DMM readouts are distinct, backlighted LCD (Liquid Crystal Displays) for clear viewing in any lighting condition. All knobs and switches have been located in logical groupings to avoid errors and delays during operation. And for the 2336, 2336YA and 2337 models, ΔTime and DMM display and controls are in the hinged, fliptop cover.

All four oscilloscopes come with detachable power cord, integral EMI shielding, and an accessories pouch. They are manufactured to withstand impact shocks of 50 g's, almost twice that of other portable scopes from Tektronix. This ruggedness meets MIL-T-28800C, Class 3 environmental requirements for aerospace and military qualification.



2335

In strong testimony of the incomparable reliability of the 2000 Family oscilloscopes, Tek offers a three year warranty: All labor and parts, including CRT, excluding probes. And then, beyond the "basic three years" of warranty coverage, Tek will extend your service coverage up to five years, offering you a choice of three practical service plans to meet your specific service needs.

The 2336YA version of the standard 2336 100 MHz Portable Oscilloscope has a 5000 hour elapsed time indicator installed, and also includes additional accessories and an extra set of manuals. The 2336YA has been accepted and specified by the U.S. Navy. 2300 Series products have National Stock Numbers. Check the Logistics Data Book for information.

CHARACTERISTICS

The following characteristics are common to the 2335, 2336, 2236YA, and 2337 oscilloscopes except where indicated.

VERTICAL SYSTEM (TWO IDENTICAL CHANNELS)

Bandwidth and Rise Time

−15°C to +40°C	+40°C to +55°C
Dc to at least 100 MHz, 3.5 ns	Dc to at least 85 MHz, 4.15 ns

Bandwidth Limit — 20 MHz by bandwidth limit switch.

Lower −3 dB Point Ac Coupling — 1X Probe: 10 Hz or less. 10X Probe: 1 Hz or less.

Deflection Factor — 5 mV/div to 5 V/div. 1-2-5 sequence. Accuracy: ±3%. Uncalibrated: Continuously variable between steps and to at least 2 mV/div.

Display Modes — CH 1, CH 2, Add CH 2 (normal and inverted), Alternate, Chopped (≈275 kHz rate).

Common-Mode Rejection Ratio — For common-mode signals of 6 div or less. 2335, 2336, 2337: At least 10:1 at 50 MHz. 2336YA: At least 25:1 at 10 MHz; 10:1 at 100 MHz.

Channel Isolation — >100:1 at 25 MHz.

Input R and C — 1 MΩ ±2% paralleled by 20 pF ±10%.

Maximum Input Voltage — Ac or dc coupled, 400 V (dc + peak ac) or 500 V p-p ac at 1 kHz or less.

HORIZONTAL SYSTEM

Time Base A — 0.05 μs/div to 0.5 s/div (1-2-5 sequence). X10 magnified extends maximum sweep rate to 5 ns/div.

Time Base B — 0.05 μs/div to 50 ms/div (1-2-5 sequence). X10 magnified extends maximum sweep rate to 5 ns/div.

Variable Time Control — Time base A provides continuously variable uncalibrated sweep rates between steps and to at least 1.25 s/div.

Time Base A and B Accuracy[*1]

	+20°C to +30°C	−15°C to +55°C
Unmagnified	±2%	±3%
Magnified	±3%	±4%

*[*1] Full ten divisions.*

Display Modes — A, A intensified by B, B delayed.

CALIBRATED SWEEP DELAY

Delay Time Range — Continuous from 50 ns to at least 5 s after start of delaying sweep.

Differential Time Measurement Accuracy[*1]

	+15°C to +35°C	−15°C to +55°C
2335	0.75% +0.015 major dial div	1.5% +0.015 major dial div
2336/2336YA/ 2337	±1% of reading ±1 count	±2.5% of reading ±1 count

*[*1] 2336YA only: +10°C to +55°C is 2% of reading ±1 count.*

Jitter — One part or less in 20,000 (0.005%) of 10 times the A Sweep Time/Div setting.

TRIGGERING

A Trigger Mode — Normal (sweep runs when triggered). Automatic (sweep free runs in absence of a triggering signal and for signals below 30 Hz). Single Sweep (sweep runs once on first triggering event after reset selector is pressed). LED indicates when sweep is triggered and when single sweep is ready.

A and B Trigger Sensitivity

2335, 2336, 2337	Internal	External[*1]	External ÷10[*1]
20 MHz	0.3 div	50 mV	500 mV
100 MHz	1.1 div	150 mV	1.5 V
2336YA			
25 MHz	0.3 div	50 mV	500 mV
100 MHz	1.0 div	150 mV	1.5 V
150 MHz	1.1 div	300 mV	3 V

*[*1] External B Trigger sensitivity is not applicable to the 2335.*

Trigger Coupling — Ac (−3dB 20 Hz), dc, LF REJ attenuates signals above 50 kHz. B Trigger coupling is ac only.

A Trigger Holdoff — Adjustable control permits a stable presentation of repetitive waveforms.

ΔTime B Trigger Modes — (2336, 2336YA and 2337 only) Provides two intensified zones on the CRT trace for differential time measurements. Time difference between the two intensified zones is determined by B Delay Time Position and ΔTime Position controls, and is displayed on the LCD readout.

Runs After Delay — B Sweep starts immediately after the delay time selected by the Delay Time Position control and is independent of B trigger signal.

Triggerable After Adjustable Delay Time — The B Sweep Trigger is sourced from a composite of CH 1 and CH 2; CH 1 only, 2 only or from the Ext Trigger input connector.

Jitter — 2335, 2336, 2337: 1.0 ns or less at 100 MHz. 2336YA: 0.5 ns at 100 MHz.

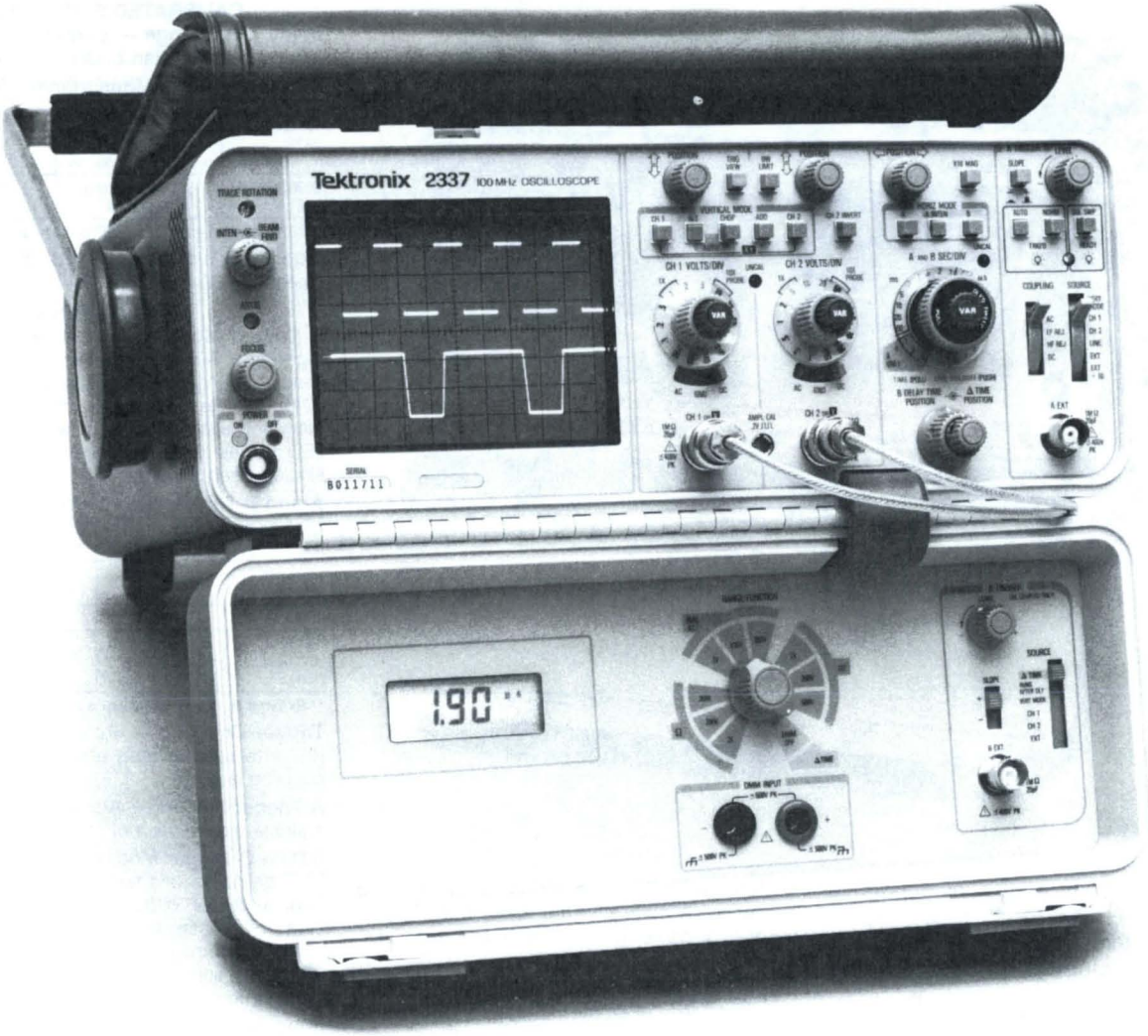
A Trigger View — A spring loaded pushbutton overrides other vertical controls to display the signal used to trigger the A Sweep. This control provides quick verification of the (trigger) signal and permits a time comparison between the vertical input signal and the trigger signal. Deflection Factor is 100 mV/div ±40% (1 V/div with Ext÷10).

Level and Slope — Internal, permits selection of triggering at any point on positive or negative slope of vertical input signal. Level adjustment through at least ±1 V in Ext, through at least ±10 V in Ext÷10.

A Sources — Vertical Mode, CH 1, CH 2, Line, Ext, Ext÷10.

B Sources — (2336, 2336YA and 2337 only) ΔTime runs after delay, Vertical Mode, CH 1, CH 2, Ext (all modes ac coupled).

External Inputs — R and C 1 MΩ ±10%, 20 pF ±30%. 400 V (dc + peak ac) or 500 V ac p-p at 1 kHz or less.



X-Y OPERATION

Full Sensitivity X-Y (CH 1 Horizontal, CH 2 Vertical) — 5 mV/div to 5 V/div (1-2-5 sequence), accurate ±5% from 0°C to +40°C, accurate ±8% from −15°C to +55°C. X-axis bandwidth is dc to at least 2 MHz. Y-axis bandwidth is dc to at least 100 MHz. Phase difference between amplifiers is 3° or less from dc to 200 kHz.

CRT AND DISPLAY FEATURES

CRT — 8 x 10 div (8 mm/div) display. Horizontal and vertical centerlines further marked in 0.2 div increments. Accelerating potential is 18 kV. GH (P31) phosphor.

Graticule — Internal, nonparallax, nonilluminated; markings for measurement of rise time.

Beam Finder — Compresses trace to within graticule area to locate an offscreen signal.

Z-Axis Input — Positive-going, dc coupled signal decreases intensity; 5 V p-p signal causes noticeable modulation at normal intensity; dc to 20 MHz.

OTHER CHARACTERISTICS

Amplitude Calibrator — 0.2 V accurate ±1% from 0°C to +40°C, ±1.5% from −15°C to +55°C.

POWER REQUIREMENTS

Line Voltage Ranges — 100 V ac to 132 V ac and 200 V ac to 250 V ac. Option 03 provides 90 V ac to 115 V ac or 180 V ac to 230 V ac.

Line Frequency — 48 Hz to 440 Hz.

Maximum Power Consumption — 35 W at 115 V, 60 Hz.

ENVIRONMENTAL

The 2335 Oscilloscope meets all environmental requirements of MIL-T-28800C, Class 3. The 2336, 2336YA and 2337 Oscilloscopes meet the environmental requirements of MIL-T-28800, Class 3 except as indicated herein to avoid potential damage to the LCD readout.

Temperature — Forced air ventilation during normal operation.

2335: Operating is −15°C to +55°C. Nonoperating is −62°C to +85°C.

2335 Option 1R (Rackadapted): Operating temperature inside equipment rack must be between −15°C to +55°C and exhaust fan temperature must not exceed +65°C. Nonoperating is −62°C to +85°C.

2236/2237: Operating is −15°C to +55°C. Nonoperating is −40°C to +80°C.

Altitude — Operating: Sea level to 4600 m (15,000 ft). Nonoperating: Sea level to 15 000 m (50,000 ft).

Vibration — Test samples were subjected to sinusoidal vibration in the X, Y, and Z-axes with the frequency varied from 10 Hz to 55 Hz to 10 Hz in one minute cycles for a duration of 15 minutes. Total displacement was 0.025 in p-p at (4 g's at 55 Hz).

Humidity — 2335: Operating and nonoperating is 95%, five cycles (120 hours), referenced to MIL-T-28800B Paragraph 3.9.2.2.

2336, 2336YA and 2337: Operating is 90% (72 hours) at +55°C.

2336, 2336YA and 2337 and DMM: Operating is 90% (24 hours) at +35°C and 70% (24 hours) at +50°C.

2336, 2336YA and 2337 and DMM: Nonoperating is 90% (72 hours) at +60°C.

Shock — Operating 50 g's, ½ sine, 11 ms duration, 3 shocks per axis along each major axis. Total of 18 shocks.

Electromagnetic Compatibility (EMC) — Test samples were found in compliance with the Class 3 requirements of MIL-STD-461B using procedural steps outlined in MIL-STD-462. Increase RS03 requirements from 1 V/m to 10 V/m. For RE01, use 500 Hz to 30 kHz in place of 30 Hz to 30 kHz.

PHYSICAL CHARACTERISTICS

2337	2335, 2336 2336YA, Cabinet		2335 Option 1R Rackmount	
Dimensions	**mm**	**in**	**mm**	**in**
Width	274	10.8	483	19.0
with handle	315	12.4		
Height			133	5.2
with feet/pouch	210	8.3		
without pouch	135	5.3		
Depth			378	14.9
with front cover	430	17.0		
handle extended	528	20.8		
Weights≈ (2335)	**kg**	**lb**	**kg**	**lb**
Net, without accessories or pouch	7.7	17.0	11.7	25.8
Net, with accessories and pouch	8.6	19.0	12.6*1	27.8*1
Shipping	10.6	23.5	16.9	37.3
Weights≈ (2336, 2336YA, 2337)	**kg**	**lb**	**kg**	**lb**
Net, without accessories and pouch	8.0	17.6		
Net, with accessories and pouch	8.9	19.6		
Shipping	10.9	24.1		

*1 No pouch for 2335 Option 1R.

2337 With Digital Multimeter

DC VOLTAGE

Full Scale Ranges — 2 V (autoranging to 200 mV); 200 V (autoranging to 20 V); and 500 V.

Resolution — 100 μV at 200 mV full scale.

Accuracy

+15°C to +35°C	Within ±0.15% of reading ±1 count
−15°C to +15°C	Add 0.01% for every °C below +15°C
+35°C to +55°C	Add ±0.01% for every °C above +35°C
>80% Relative Humidity	Add ±0.25% of reading ±3 counts

Input Resistance — 10 MΩ ±0.25%.

Rejection Ratio — Normal-Mode: 60 dB minutes at 50 Hz and 60 Hz. Common-Mode: 100 dB minutes at dc, 60 dB minutes at 50 Hz and 60 Hz.

Response Time — Within 3 s (no autorange); within 9 s (up range); within 7 s (down range).

Maximum Input Voltage — 500 V (dc + peak ac) at 60 Hz (between positive and negative inputs or between either input and ground).

AC VOLTAGE

Full Scale Ranges — 2 V (autoranging to 200 mV); 200 V (autoranging to 20 V); and 350 V.

Crest Factor — (When peak voltage input is <3 times full scale) Six.

Accuracy*1

+15°C to +35°C	Within ±3%, ±6 counts*1, 20 Hz to 20 kHz
−15°C to +15°C	Add ±0.05% for every °C below +15°C
+35°C to +55°C	Add ±0.05% for every °C above +35°C

*1 Nonsinewaves: Derate below 50 Hz. For crest factors >3, add +0, −1% of reading.

Input Impedance — Resistance 10 MΩ ±0.25% in series with input blocking cap. Capacitance (20 V, 200 V, and 350 V range) <150 pF; (200 mV, 2 V range) <220 pF.

Common-Mode Rejection Ratio — 60 dB minimum at 50 Hz and 60 Hz, 2 V range; 53 dB minimum at 50 Hz and 60 Hz, 200 V and 300 V range.

Response Time — Within 3 s (no autorange); within 9 s (up range); within 7 s (down range).

Maximum Input Voltage — 500 V (dc + peak ac) at 60 Hz (between positive and negative inputs or between either input and ground).

RESISTANCE

Full Scale Ranges — 2 kΩ (autoranging to 200 Ω); 200 kΩ (autoranging to 20 kΩ); 20 MΩ (autoranging to 2 MΩ).

Resolution — 0.1 Ω.

Accuracy

+15°C to +35°C	Within ±0.5% ±2 count +0.4 Ω
−15°C to +15°C	Add 0.05% for every °C below +15°C
+35°C to +55°C	Add 0.05% for every °C above +35°C
>80% Relative Humidity	Add ±1% of reading ±8 counts

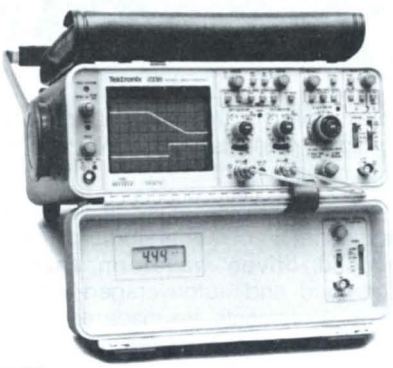
Response Time — <4 s.

Maximum Input Voltage — 500 V (dc + peak ac) at 60 Hz (between positive and negative inputs or between either input and ground).

ORDERING INFORMATION

2335 Oscilloscope **$3,650**
Includes: Two P6108A 10X probes; accessory pouch (016-0674-00); zip lock accessory pouch (016-0537-00); clear CRT implosion shield (337-2781-00); installed, blue CRT implosion shield (337-2760-00); two 1 A fuses (159-0022-00); ½ A fuse (159-0025-00); power cord (161-0104-00); operator manual (070-4115-00).

2336 Oscilloscope With ΔTime **$3,965**
Includes: Same as 2335, instruction manual (070-4117-00) instead.



2336YA
The 2336YA has been accepted and specified by the U.S. Navy. Also see page 299.

2336YA Oscilloscope With ΔTime, Elapsed Time Meter, Extra Accessories and Manuals **$4,175**
Includes: Same as 2336 plus P6101A probe; three probe tip adaptors (103-0051-01); three spring tip adaptors (206-0060-00); operator manual (070-5010-00); service manual (070-5011-00).

2337 Oscilloscope With ΔTime and DMM **$4,275**
Includes: Same as 2335, instruction manual (070-4119-00) instead.

OPTIONS

Option 03 — 100 V/200 V, ac nominal, 48 Hz to 440 Hz. **NC**

Rackmount 2335 Option 1R.

Option 1R — (2335 only) Rack Conversion. **+$325**

CONVERSION KIT

Rackmount Conversion — 2335 only. Order 016-0468-00 **$310**

INTERNATIONAL POWER PLUG OPTIONS

Option A1 — Universal Euro 220 V, 50 Hz.
Option A2 — UK 240 V, 50 Hz.
Option A3 — Australian 240 V, 50 Hz.
Option A4 — North American 240 V, 60 Hz.
Option A5 — Switzerland 220 V, 50 Hz.

WARRANTY-PLUS SERVICE PLANS

SEE PAGE 497

M1 — (2335) 2 Calibrations. **+$145**
M1 — (2336/2336YA) 2 Calibrations. **+$160**
M1 — (2337) 2 Calibrations. **+$180**
M2 — (2335) +2 Years Service. **+$140**
M2 — (2336/2336YA) +2 Years Service. **+$160**
M2 — (2337) +2 Years Service. **+$180**
M3 — (2335) +2 Years Service & 4 Calibrations. **+$410**
M3 — (2336/2336YA) 2 Years Service & 4 Calibrations. **+$470**
M3 — (2337) 2 Years Service & 4 Calibrations. **+$510**
M4 — (2335) 5 Calibrations. **+$390**
M4 — (2336/2336YA) 5 Calibrations. **+$445**
M4 — (2337) 5 Calibrations. **+$480**
M5 — (2335) 9 Calibrations +2 Years Service. **+$825**
M5 — (2336/2336YA) 9 Calibrations +2 Years Service. **+$940**
M5 — (2337) 9 Calibrations +2 Years Service. **+$1,025**

OPTIONAL ACCESSORIES

Battery Pack — Order 1106 **$1,265**
Dc Power — Order 1107 **$525**

RECOMMENDED PROBES

See Probe Section for complete descriptions, page 463.

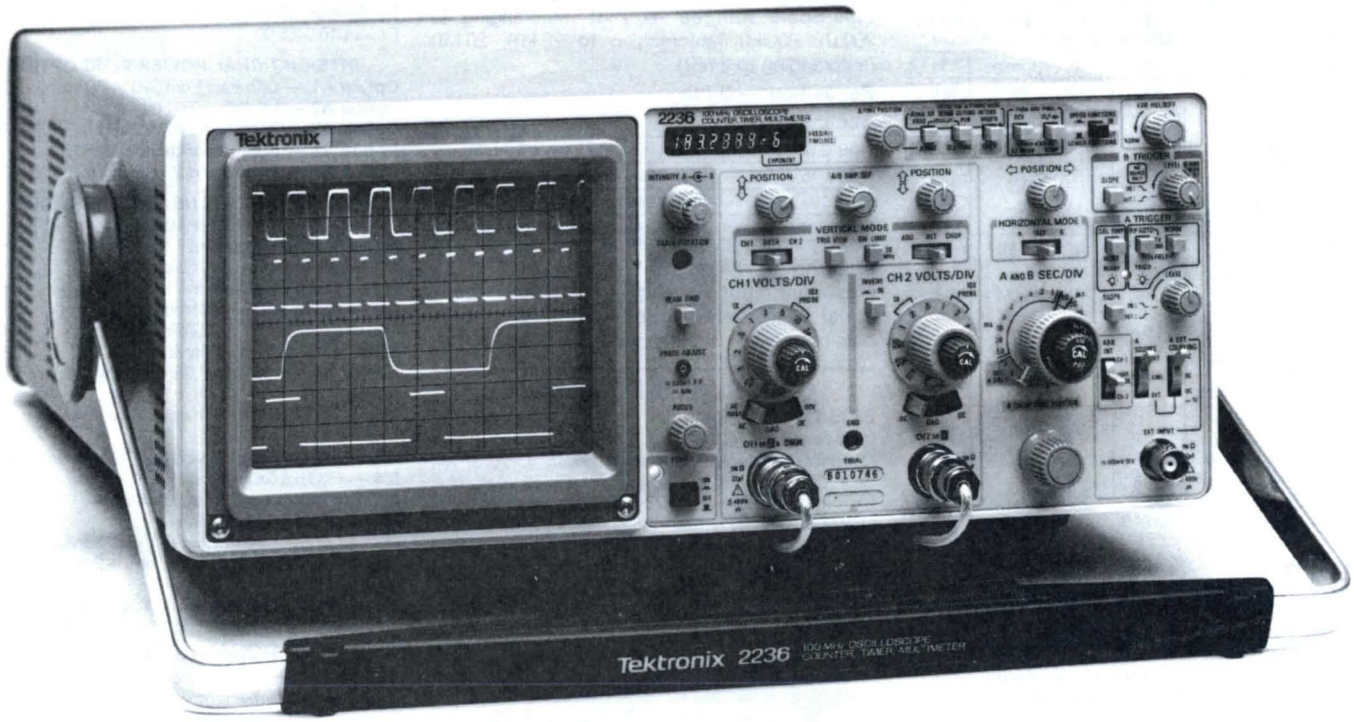
P6108A — 10X probe. **$75**
P6202A — 10X FET probe. **$680**
P6022 — Current probe. **$475**
A6902B Voltage Isolator — For floating measurements see page 479 for complete description. **$1,795**

RECOMMENDED CAMERA

C-5C Option 04 — Includes 016-0359-01 adaptor and flash (camera mount not provided). See page 445. **$495**

RECOMMENDED CART

K212 Portable Instrument Cart — For on-site mobility. See page 461. **$330**



2236

Dc to 100 MHz Bandwidth

Integrated Counter/Timer/DMM

Lightweight, Easy to Use

2 mV Sensitivity

5 ns/Div Sweep Rate

100 MHz Counter

Gated Counter Measurements

ΔTime

Channel 1 Ac and Dc Volts

Three Year Warranty—Five Year Option

TYPICAL APPLICATIONS
Digital Design and Testing
Field Service
Amplifier Design and Testing

See page 277 for available Application Notes.

The 100 MHz 2236 introduces a new concept in waveform measurement: a 100 MHz counter/timer/DMM, integrated into the scope's vertical, horizontal and trigger systems. This convenient feature simplifies setup (by allowing consolidated set-ups and combinations of measurements), heightens measurement confidence and expands scope versatility. The 2236 replaces mental gymnastics and roundabout problem-solving with simple, direct, accurate, digital readouts that supplement your analog measurements.

The Tek 2236 provides easy, accurate, and versatile measurements through microprocessor-driven waveform analysis. Autoranged and autoaveraged counter/timer measurements are made on the signal triggering the A sweep, or in gated modes on the signal triggering the B sweep. Autoranged DMM measurements are made through floating DMM side inputs and up-range at 5000 counts. Channel 1 voltage measurements made on Channel 1 signal include: dc, relative dc, relative and true ac RMS voltage. Self-testing includes power-on and user interactive routines.

The 2236 uses intensified markers on-screen to define the area to be measured on a burst or short duration pulse train. Gated counter measurements are made via the B trigger with operator prompting and automatic, digital readout of results (see Figures 1, 2, 3). With period averaging the 2236 can make low frequency measurements instantly, in contrast to the several seconds delay encountered on conventional counter/timers.

The scope and DMM can be applied simultaneously, with concurrent CRT and digital readout displays. The same probe feeds data to the scope and provides information to the DMM, thus eliminating tangled leads and extra set-up time required to obtain true ac RMS or dc voltage readings (see Figure 6).

DMM autoranging simplifies set-up. An ohmmeter range of 2 GΩ—a hundred times the range of most such devices—allows service technicians to quickly pinpoint even small amounts of transformer leakage, or designers to accurately check the insulating property of capacitors (see Figure 9).

Frequency, period and width measurements are pushbutton simple, with accuracies to 0.001% and beyond. On-screen operator prompts further ensure failsafe set-up (see Figure 7).

An audible, automatic diode/junction detection and continuity signal saves both time and interpretation errors by allowing the operator to concentrate on probing rather than on observing the front panel (see Figure 8).

In strong testimony of the incomparable reliability of the 2000 Family of oscilloscopes, Tek offers a three year warranty: All labor and parts, including CRT, excluding probes. And then, beyond the "basic three years" of warranty coverage, Tek will extend your service coverage up to five years, offering you a choice of three practical service plans to meet your specific service needs.

See page 297 for Characteristics.

Gated Frequency Measurement

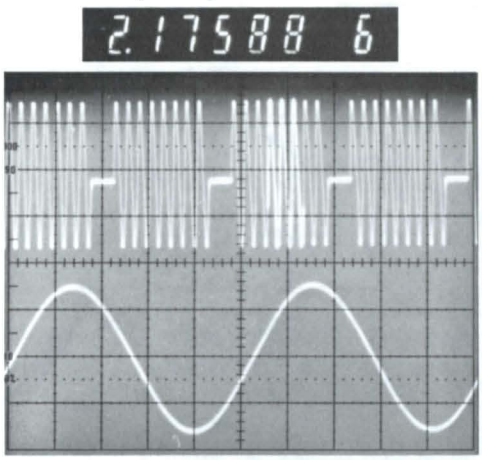


Figure 1. With the B sweep triggered, the frequency within the intensified zone on the A sweep is measured.

Gated Period Measurement

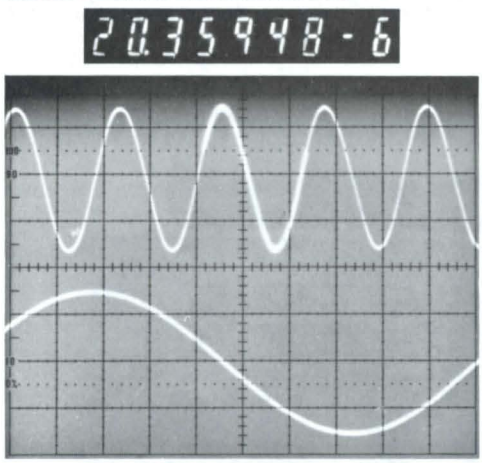


Figure 2. With the B sweep triggered, the period within the intensified zone on the A sweep is measured.

Gated Width Measurement

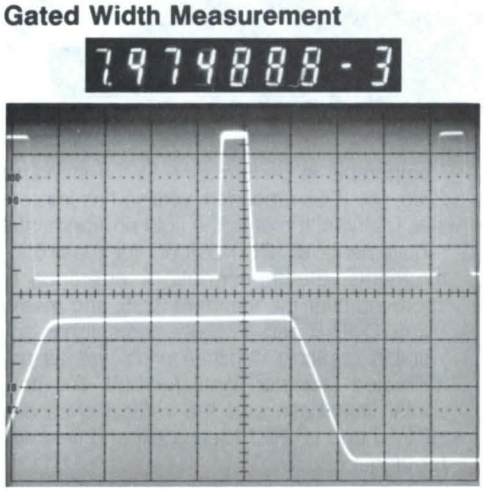


Figure 3. With the B sweep triggered, the width to be measured is within the intensified zone and polarity is selected by the B trigger slope control.

Gated Totalize Measurement

With the B sweep triggered, the events within the intensified portion of the A sweep are totalized. A single events count can be made using single sweep.

Delay Time Measurement

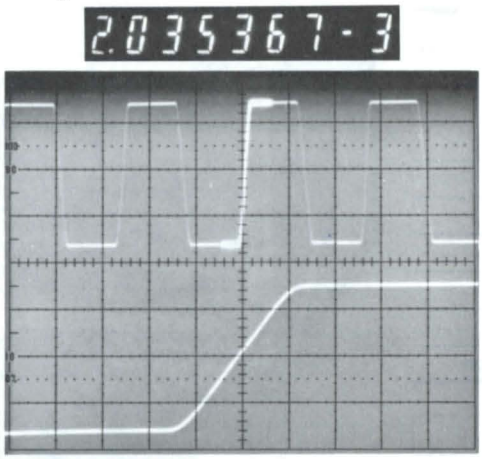


Figure 4. Delay time is measured from the start of the A sweep to the start of the intensified zone.

Delta Time Measurement

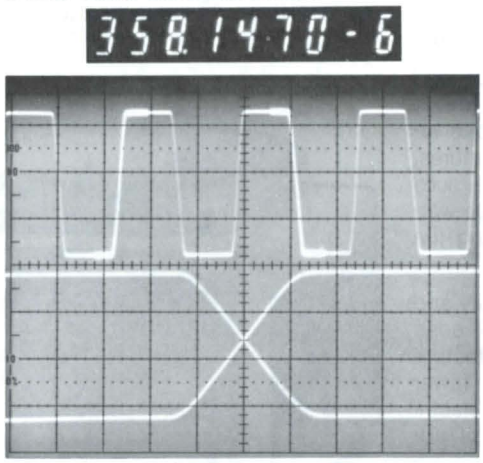


Figure 5. The time between the two intensified zones on the A sweep is measured with up to 10-picosecond resolution.

Channel 1 Volts Measurement

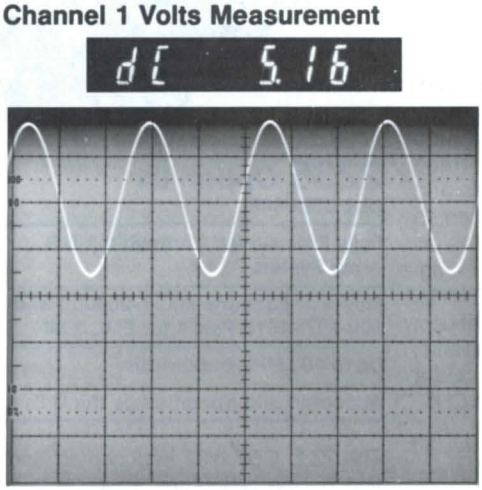


Figure 6. The average dc or true ac RMS component of a waveform is measured directly through channel 1 or from the floating DMM input.

Continuity Measurement

Resistances >5 Ω, the message "OPEN" is displayed. <5 Ω, a tone is generated and the message "SHORT" is displayed.

Operator Prompting

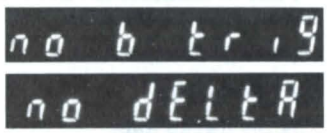


Figure 7. Error messages and prompts make counter/timer/DMM measurements easier.

Diode Detection and Test

Figure 8. Automatic junction detection during normal resistance measurements first displays "DIODE" and then the forward voltage drop to 1%.

Extended Range Resistance Measurement

Figure 9. 0 Ω (with 0.01 Ω resolution) to 1.99 GΩ, to find hard-to-trace problems like leaky caps or bad transformers.

Temperature Measurement

With optional P6602 Probe: From −62°C to +230°C (−80°F to +446°F); resolution to 0.1° (either range).

Microprocessor Diagnostics

Automatic power-up and user-interactive diagnostic routines simplify CTM service.

Accurate Time Measurement

Time base error only 10 ppm (0.001%) standard, and only 0.5 ppm (0.00005%) with optional temperature compensated crystal oscillator.

Measurement Ease and Accuracy

See the measurement you make on the CRT, read the result with digital accuracy on the 9-digit display.

For further information and characteristics, see page 297.

2235

Dc to 100 MHz Bandwidth

Lightweight, Easy to Use

2 mV Sensitivity

5 ns/Div Sweep Rate

Advanced Trigger System

Trigger View

Delayed Sweep Measurements

Large, Bright CRT

10X Probes Included

Three Year Warranty—Five Year Option

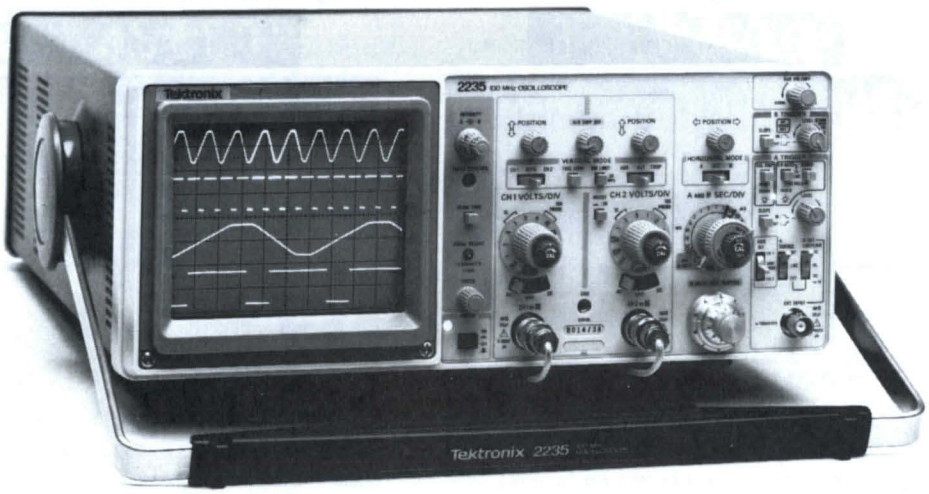
TYPICAL APPLICATIONS
Field Service
Design
Component Testing

See page 277 for available Application Notes.

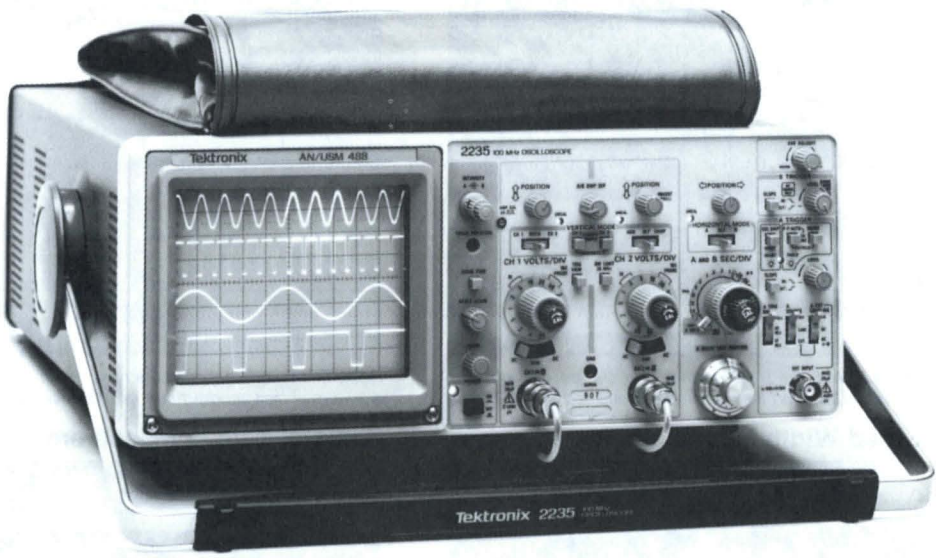
The 100 MHz 2235 offers high value and high performance. The low price is made possible by the 2200 Series innovative architecture. Yet it has the needed features, operational simplicity and—not least—solid reliability. All backed by a three year warranty on all parts and labor, including the CRT, excluding probes.

The 2235 ensures measurement quality and reliability while reducing instrument cost. Tek started with the innovative architecture of the 2200 Series: fewer boards, fewer mechanical parts, less cabling and electrical connectors. This approach, plus advanced circuit design and a focus on essential features, has led to a scope that's more accurate, more reliable, lighter and more serviceable—and simpler to use—than any other 100 MHz scope.

The 2235 delivers 2% vertical and horizontal accuracy in normal operation. Accuracy of 3% or better is maintained across a wide range of environmental extremes. Trace noise, chop noise, vertical aberrations and sweep interference have been reduced to a minimum. Delay jitter of 1:20,000 ensures excellent timing measurement resolution. Triggering is sensitive to 0.3 div at 10 MHz. There's a trigger view for simplifying set-ups; single sweep for photographing transients; bandwidth limit for noisy environments; and a bright, high resolution 14 kV dome mesh CRT.



Features like rugged design, lightweight and an easy-to-learn front panel make the 2235 an ideal service scope. In both service and design, it offers the sensitivity for low level measurements and sweep rates for fast logic families, plus 10:1 variable holdoff range for complex word triggering. And at the bottom line, it offers the price and reliability to significantly lower the cost of owning a quality scope.



2235 Option 01
(AN/USM-488)

Fully Provisioned Through the U.S. Army System

Meets or Exceeds MIL-T-28800C and MIL-STD-461B Part 4 for EMC/EMI

Dc to 100 MHz Bandwidth

Accepted and Specified by the U.S. Army

The 2235 Option 01 is accepted and specified by the U.S. Army. If you're involved in designing and specifying systems for the U.S. Army, here is a 100 MHz oscilloscope that should top your support equipment lists.

Comparable in performance to the standard 2235, the 2235 Option 01 version has impressive features. It meets the rigid environmental requirements of MIL-T-28800C for Class 5 instruments. Electromagnetic interference is improved over the standard 2235, and meets MIL-STD-461B part 4 requirements. It has adjustable graticule illumination as well as uncalibrated indicator lights for both the horizontal time base and the vertical channels. HF REJ and LF REJ filtering expand flexibility for trigger coupling.

For your convenience we've also included a protective front-panel cover, accessory pouch, P6101A 1X 2-meter probe, binocular viewing hood, BNC T connector, BNC male-to-binding post, two IC grabber tips and a service manual.

CHARACTERISTICS

The following electrical characteristics are common to the 2236, 2235, and 2235 Option 01 except where noted.

VERTICAL SYSTEM (TWO IDENTICAL CHANNELS)

Bandwidth (−3dB) and Rise Time — 100 MHz and 3.5 ns, derated to 90 MHz at 2 mV/div and outside 0°C to +35°C. Bandwidth Limit: 20 MHz ±10%.

Deflection Factor — 2 mV to 5 V/div at ±2%. Accuracy derated ±3% outside +15°C to +35°C (+10°C to +35°C, 2235 Option 01). Continuously variable between steps by at least 2.5:1.

Step Response Aberrations — 2235 and 2235 Option 01: +4%, −4%, 4% p-p (2 mV to 0.5 V/div).
2236: +4%, −4%, 4% p-p (5 mV to 0.5 V/div), +5%, −5%, 5% p-p (2 mV/div).

Display Modes — CH 1, CH 2, CH 2 Invert, Add, Alternate, Chop (500 kHz).

Common-Mode Rejection Ratio — At least 10:1 at 50 MHz for signals of 6 div or less (10:1 at 80 MHz 2235 Option 01).

Input R and C — 2235 and 2235 Option 01: 1 MΩ, 20 pF. 2236: 1 MΩ, 22 pF.

Maximum Input Voltage (Ac and Dc Coupled) — 400 V (dc + peak ac) or 800 V (p-p to 10 kHz).

Channel 1/Channel 2 Isolation — 100:1 at 50 MHz.

HORIZONTAL SYSTEM

Sweep Rate — A Time Base: 0.05 μs to 0.5 s/div in 1-2-5 sequence. 10X Mag: 5 ns/div. B Time Base: 0.05 μs to 50 ms/div in 1-2-5 sequence. 10X Mag: 5 ns/div.

Sweep Linearity — ±5% over any two of center eight divisions.

Accuracy

	+15°C to +35°C*1	0°C to +50°C
Unmagnified	±2%	±3%
Magnified	±3%	±4%

**1 +10°C to +35°C for 2235 Option 01.*

Display Modes — A, Alternate (A Intensified and B Delayed) and B.

CALIBRATED SWEEP DELAY

Delay Time Range — Continuously variable with 10-turn control from <0.5 +300 ns to >10 div.

Differential Delay Time Accuracy — (2235 and 2235 Option 01) ±1% (+15°C to +35°C); ±2% (0°C to +50°C).

ΔTime Measurement Accuracy — (2236) Max accuracy equal to time base accuracy ±50 ps. Time Base Accuracy With Standard Oscillator: 10 ppm (0.001%); with Option 14 TCXO (Temperature-Compensated Crystal Oscillator): 0.5 ppm (0.00005%).

Delay Jitter — 2236: 10,000:1 (0.01%). 2235 and 2235 Option 01: 20,000:1 (0.005%).

TRIGGERING

A Trigger Sensitivity

2235 & 2235 Opt 01	Internal	External (p-p volts)
10 MHz	0.3 div*1	35 mV
60 MHz	1.0 div	120 mV
100 MHz (2235)	1.5 div	200 mV
100 MHz (2235 Opt 01)	1.5 div	150 mV
2236		
10 MHz	0.35 div	40 mV
60 MHz	1.2 div	150 mV
100 MHz	1.5 div	250 mV
2236 CTM		
10 MHz	0.5 div	50 mV
60 MHz	1.5 div	160 mV
100 MHz	2.0 div	300 mV

B Trigger (Internal Only) Sensitivity

	10 MHz	60 MHz	100 MHz
2235 & 2235 Opt 01	0.35 div	1.0 div	1.5 div
2236	0.4 div	1.2 div	1.5 div
2236 CTM	0.5 div	1.5 div	2.0 div

**1 0.35 for 2235 Option 01.*

TV Trigger Sensitivity — TV Field: 1.0 div of composite sync. TV Line: 0.3 div (2235); 0.35 div (2236 and 2235 Option 01).

Bandwidth Limiting — 20 MHz when bandwidth limit switch depressed.

High Frequency Reject — (2235 Option 01 only) Attenuates signals above 40 kHz.

Low Frequency Reject — (2235 Option 01 only) Attenuates signals below 40 kHz.

Trigger System Operating Modes — Normal, p-p automatic, TV line, TV field, and single sweep.

Trigger View System — Same deflection factors as vertical channels with internal sources; 100 mV/div with ac and dc external, and 1 V/div with dc÷10 external. Accuracy is ±20%. Delay difference between trigger view (EXT input) and either vertical channel is <2.0 ns.

External Trigger Input — Coupling: Ac, dc, or dc÷10.

Variable Holdoff Control — Increases A sweep holdoff time at least 10:1.

X-Y OPERATION

Deflection Factors — Same as scope's vertical system with the V/div switch in calibrated detent.

Accuracy

	Y-Axis	X-Axis
+15°C to +35°C	±2%	±3%
0°C to +50°C	±3%	±4%

Bandwidth — Y-Axis: same as scope's vertical system. X-Axis: 2.5 MHz.

Phase Difference Between X-Axis and Y-Axis Amplifiers — ±3° from dc to 150 kHz with dc coupled inputs.

CRT AND DISPLAY FEATURES

CRT — 8 cm x 10 cm display; internal unilluminated graticule (2235 Option 01 is illuminated). Accelerating potential is 14 kV. GH (P31) phosphor standard.

Controls — Beam Finder, Focus, Separate A and B Sweep Intensity, Trace Rotation. 2235 Option 01 also has Variable Scale Illumination.

Z-Axis Input — Dc coupled, positive-going signal decreases intensity; 5 V p-p signal causes noticeable modulation; dc to 20 MHz.

OTHER CHARACTERISTICS

Probe Adjust Signal — (2235/2236) Squarewave, 0.5 V ±5%, 1 kHz ±20%.

Amplitude Calibrator — (2235 Option 01 only) Squarewave, 0.5 V ±2%, 1 kHz ±20%.

POWER REQUIREMENTS

Line Voltage Range — 90 V ac to 250 V ac. (No line switches or fuse changes needed.)

Line Frequency — 48 Hz to 440 Hz.

Maximum Power Consumption — 2235: 40 W, 70 VA. 2236: 60 W, 110 VA.

Dc Operation — 12 V to 30 V available with 1105, 1106, and 1107.

ENVIRONMENTAL

Ambient Temperature — Operating: 0°C to +50°C (except 2236 CTM ac RMSV, DCV, and Ω Modes: 0°C to +40°C). Nonoperating: −55°C to +75°C.

Altitude — Operating: To 4600 m (15,000 ft). Maximum operating temperature decreased 1°C/1,000 ft (5,000 ft to 15,000 ft). Nonoperating: To 15 000 m (50,000 ft).

Vibration — Operating: 15 minutes along each of the major axes. 0.015 in p-p displacement 10 Hz to 55 Hz to 10 Hz in one minute cycles. Held for 10 minutes at 55 Hz (2.4 g's at 55 Hz).

Humidity — Operating and Nonoperating: 95%, five cycles (120 hours) referenced to MIL-T-28800C, Paragraph 4.5.5.1.2.2.

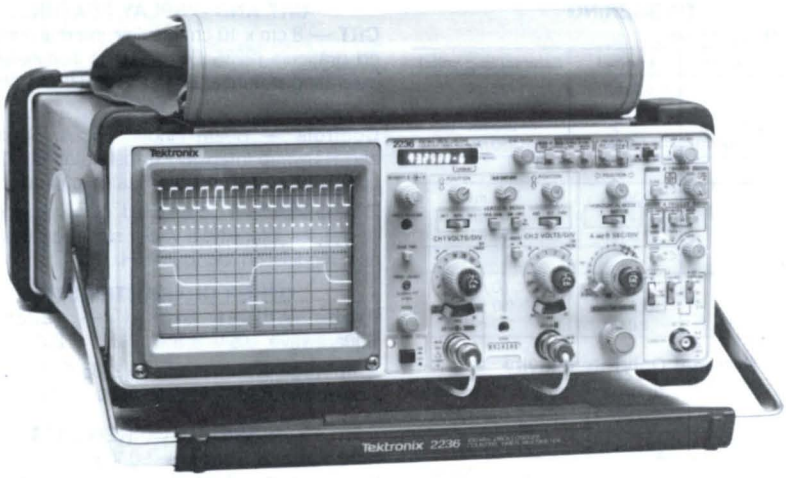
Shock — Operating: 30 g's, ½ sine, 11 ms duration, 3 shocks per axis along each major axis. Total of 18 shocks.

EMC — Meets Class B requirements per VDE 0871B for radiated and conducted emission. 2235 Option 01 AN/USM 488 Only: Meets requirements of MIL-STD-461B Part 4, CE03, CS01, CS02, CS06, RE02 (to 1 GHz), and RS03 (1 V/meter to 1 GHz).

PHYSICAL CHARACTERISTICS

	2235 and 2235 Opt 01		2236	
Dimensions	**mm**	**in**	**mm**	**in**
Width*1	328	12.9	328	12.9
Height*3	137	5.4	137	5.4
Depth*2	440	17.3	440	17.3
Weights≈	**kg**	**lb**	**kg**	**lb**
Net	6.1	13.5	7.3	16.2

**1 Without handle.*
**2 Without front cover.*
**3 2235 Option 01 height with pouch is 150 mm (5.9 in).*



2236 Counter/Timer/Multimeter

CHARACTERISTICS

The following characteristics are unique to the 2236.

Time Base Accuracy — Standard: 10 ppm (0.001%). With Option 14 TCXO: 0.5 ppm (0.00005%).

Frequency — Range: ≤0.2 Hz to ≥100 MHz. Maximum Resolution: 0.00001 Hz. Maximum Accuracy: Equal to time base accuracy. Can be gated.*1*2

Period — Range: ≥5 s to ≤10 ns. Maximum Resolution: 10 ps. Maximum Accuracy: Equal to time base accuracy. Can be gated.*1*2

Width — Range: ≥5 s to ≤5 ns. Maximum Resolution: 10 ps. Maximum Accuracy: Equal to time base accuracy ±10 ns. Can be gated.*1*2

Delay Time — Range: ≥2.5 s to ≤500 ns. Maximum Resolution: 10 ps. Maximum Accuracy: Equal to time base accuracy ±20 ns.*2

ΔTime — Range: ≥2.5 s to ≤1 ns. Maximum Resolution: 10 ps. Maximum Accuracy: Equal to time base accuracy ±50 ps.*2

Totalize — Over 8,000,000 events. Can be gated.

Dc Volts — Range: 0 V to 500 V. Maximum Resolution: 100 μV. Accuracy: ±0.1%. Input: Through side DMM leads.*2

RMS Ac Volts — Ac Coupled: True RMS with 20 Hz to 20 kHz frequency range. Range: 0 V to 350 V. Maximum Resolution: 100 μV. Accuracy: ±1.0%. Input: Through side DMM leads.*2

CH 1 Volts — Measures average dc voltage (with CH 1 dc coupling) or true RMS voltage (with CH 1 ac coupling); 1X/10X ranged by coded probes: Single Sweep button zeros display and permits relative dc and ac RMS measurements. Range, Dc and Ac Volts: 0 V to 50 V (500 V dc/350 V ac with P6121 10X Probe). Maximum Resolution, Dc and Ac Volts: 100 μV (1 mV with P6121). Maximum Accuracy, Dc Volts (18°C to 28°C): ±0.3% with 1X probe, ±0.5% with 10X probe. Maximum Accuracy, Ac Volts with 1X probe (18°C to 28°C): ±2%, 50 Hz to 100 Hz, ±1%, 100 Hz to 20 kHz. Maximum Accuracy, Ac Volts with 10X Probe: ±2%, 20 Hz to 20 kHz, with proper probe compensation.*2

Resistance — Range: 0 Ω to 1.99 GΩ. Maximum Resolution: 0.01 Ω. Accuracy: To 0.15%. Automatic diode detection displays forward voltage drop to ±1%; continuity mode activates tone if resistance is <5 Ω.*2

Temperature — Uses Optional Tektronix P6602 Temperature Probe. Temperatures in C or F selected with Freq/ΔTime button. Range: −62°C to +230°C (−80°F to +446°F). Resolution: To 0.1° (either range). Accuracy: To ±2% of reading ±1.5°C; ±2% of reading ±2.70°F.

Multimeter Inputs — Isolated from oscilloscope ground. Input Z: 10 MΩ. Maximum Input Voltage: 500 V (dc + peak ac), for all functions.

**1 Ranges, resolutions, and accuracies can be degraded due to gating errors and a smaller number of automatic averages made during a gated frequency, period, or width measurement. For complete formula specifications see operator's manual.*

**2 For complete accuracy and resolution error formula specifications see operator's manual.*

ORDERING INFORMATION

2236 Oscilloscope With Counter/Timer/Multimeter **$2,650**
Includes: Two P6121 10X voltage probes; DMM leads; reference guide; operator manual (070-4205-00).

2235 Oscilloscope **$1,575**
Includes: Two P6122 10X voltage probes; operator manual (070-4207-00).

2235 Option 01 Oscilloscope (AN/USM-488) Order 2235L **$1,995**
Includes: Two P6122 10X Voltage Probes; P6101A 1X Voltage Probe; viewing hood (016-0566-00); BNC T-connector; BNC male to binding post; front panel cover; accessory pouch; two grabber tips; operator manual (070-4976-00); service manual (070-4977-00).

OPTIONS

Option 02 — (2235, 2236 only) Front panel cover and accessory pouch. **+$47**

Option 14 — (2236 only) TCXO Temperature-Compensated Crystal Oscillator, 0.5 ppm accuracy. **+$295**

Option 33 — (2235, 2236 only) Travel Line Package. See page 305. **+$200**

CONVERSION KITS

Rackmount Adaptor — See page 305
(2335) Order 016-0466-00 **$115**
(2235 Option 01) Order 016-0833-00 **$170**
(2236) Order 016-0015-00 **$255**

Travel Line Package Retrofit Kit — See page 305.

TCX0 Retrofit Kit — (2236 only) Temperature compensated crystal oscillator, 0.5 ppm accuracy. Order 040-1136-00 **$365**

INTERNATIONAL POWER PLUG OPTIONS

Option A1 — Universal Euro 220 V, 50 Hz. Order 020-0859-00.

Option A2 — UK 240 V, 50 Hz. Order 020-0860-00.

Option A3 — Australian 240 V, 50 Hz. Order 020-0861-00.

Option A4 — North American 240 V, 60 Hz. Order 020-0862-00.

Option A5 — Switzerland 220 V, 50 Hz. Order 020-0863-00.

WARRANTY-PLUS SERVICE PLANS

SEE PAGE 497

M1 — (2235/2235 Option 01) 2 Calibrations. **+$135**
M1 — (2236) 2 Calibrations. **+$160**
M2 — (2235/2235 Option 01) +2 Years Service. **+$125**
M2 — (2236) +2 Years Service. **+$150**
M3 — (2235/2235 Option 01) 2 Years Service & 4 Calibrations. **+$380**
M3 — (2236) 2 Years Service & 4 Calibrations. **+$450**
M4 — (2235/2235 Option 01) 5 Calibrations. **+$385**
M4 — (2236) 5 Calibrations. **+$425**
M5 — (2235/2235 Option 01) 9 Calibrations +2 Years Service. **+$805**
M5 — (2236) 9 Calibrations +2 Years Service. **+$900**

OPTIONAL ACCESSORIES

Front Panel Cover and Accessory Pouch*1 — Order 020-0672-02 **$55**

Front Panel Cover*1 — Order 200-2520-00 **$6.25**

Accessory Pouch*1 — Order 016-0677-02 **$48**

Viewing Hoods —
(Collapsible) Order 016-0592-00 **$14**
(Binocular) Order 016-0566-00*1 **$18.75**
(Polarized) Order 016-0180-00 **$50**

Carrying Strap — Order 346-0199-00 **$17**

Carrying Case — Order 016-0792-01*2 **$355**

Rackmount Adaptor Kits —
(2235) Order 016-0466-00 **$115**
(2235 Option 01) Order 016-0833-00 **$170**
(2236) Order 016-0015-00 **$255**

CRT Light Filter —
(Clear*1) Order 337-2775-01 **$1.95**
(Blue) Order 337-2775-00 **$3.75**

1107 Mounting Kit — Order 016-0785-00 **$50**

1107 DC Inverter — See page 307. **$525**

1106 Battery Pack — See page 306. **$1,265**

1105 Power Supply — See page 306. **$1,690**

RECOMMENDED PROBES

See Probe Section for additional probes, page 464.

P6121 — 10X Probe. **$100**

P6122 — 10X Probe. **$58**

P6420 — DMM RF. **$145**

40 kV DMM — Order 010-0277-00 **$180**

P6602 Temperature Probe — For use with 2236 CTM. **$225**

A6901 Ground Isolation Monitor — See page 478. **$650**

A6902B Voltage Isolator — See page 479. **$1,795**

RECOMMENDED CAMERAS

C-5C — See page 450.
(2235 Option 01) C-5C Option 02 **$465**
(2235, 2236) C-5C Option 04 **$495**

C-7 — See page 448.
(2235, 2236) C-7 Option 02 **$595**
(2235 Option 01) Option 03 **$565**

C-4 — (2235 Option 01) See page 446. **$370**

RECOMMENDED CART

K212 — For on-site mobility. See page 461. **$330**

SERVICE MANUALS

(2235) Order 070-4206-00 **$25**
(2236) Order 070-4204-00 **$25**

**1 Standard with the 2235 Option 01 (AN/USM-488).*
**2 Recommend use with front panel cover (200-2520-00).*

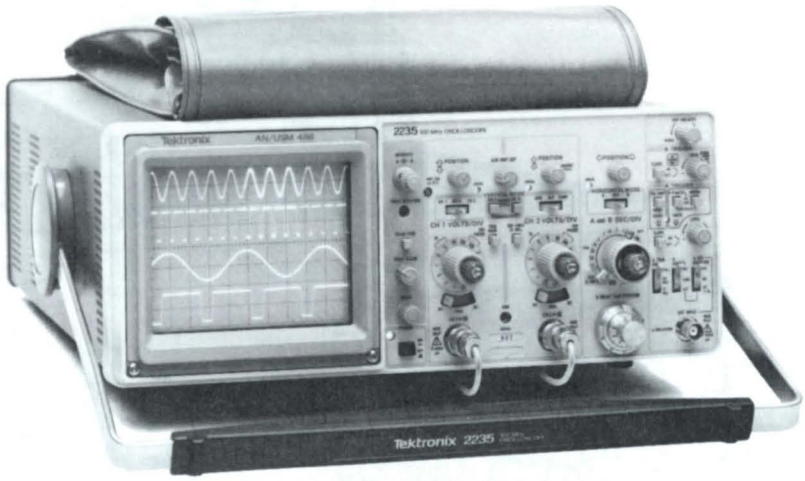
To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext. 99

MILITARY AND SPECIAL SERVICE OSCILLOSCOPES

2235 Option 01 (AN/USM-488)

- Dc to 100 MHz Bandwidth
- Fully Provisioned Through the U.S. Army System
- Meets or Exceeds MIL-T-28800C and MIL-STD-461B Part 4 for EMC/EMI
- Three Year Warranty—Five Year Option
- Accepted and Specified by the U.S. Army
- National Stock Number 6625-01-187-7847

For complete description see page 296.



2336YA

- Dc to 100 MHz Bandwidth
- 5 mV/Div to 5 V/Div
- 5 ns/Div Sweep Rate
- Rugged for Field Service
- Three Year Warranty—Five Year Option
- Accepted and Specified by the U.S. Navy
- National Stock Number 6625-01-172-6119

For complete description see page 290.

NEW 2430M

Digital Oscilloscope

GPIB IEEE-488

The 2430M complies with IEEE Standard 488-1978 and with Tektronix *Standard Codes and Formats.*

- Imbedded CILL/MATE Capabilities
- 150 MHz Bandwidth at Probe Tip
- 5 ns/Div Sweep Speed
- 100 MS/s Sample Rate
- Simultaneous Acquisition of Two Channels
- Envelope Mode With 2 ns Glitch Capture
- 8 Bit Resolution Over 10 Divisions
- Save on Delta (Tek Patented Feature) Provides Unattended Pass/Fail Testing and Babysitting Against a User Defined Reference or Envelope

For a complete description see page 326.

NEW 2246/2245

- Bright, Crisp Display With High Writing Rate
- Four Independent Channels
- 100 MHz Bandwidth With 2 ns/Div Time Base
- On-Screen Scale Factor Readouts
- Flexible Triggering
  - Auto Level and Auto HF, LF, Noise Reject, TV Line and TV Field
- Delayed Sweep
- Control Status Lights
- 2% Vertical and Horizontal Accuracy
- 2 mV/Div Vertical Sensitivity at Full Bandwidth
- New Specially Designed Probe
  - Improved, Rugged Tip
  - Hybrid Circuitry for Improved Performance
- Simple, Rugged Construction
- New Labeled Volts Cursors With Ground-Referenced Readings and On-Screen Readouts
- New Hands-Off Voltmeter Measurements
  - +Peak and −Peak
  - Peak-to-Peak
  - Gated Peaks
  - Gated Peak-to-Peak
  - Dc
- New SmartCursors™
  - Track Voltmeter Measurements
  - Visually Indicate Trigger Level and Ground
- Time Measurements With Cursors or Alternate Delayed Sweep ΔTime
- Three Year Warranty—Five Year Option

TYPICAL APPLICATIONS

Logic Design and Repair
Communications
Power Supply Design

See page 277 for available Application Notes.

Higher Performance, Lower Price

The performance/price ratio for portable oscilloscopes has been substantially upgraded. No other portable scope can offer the range of productivity enhancing features and performance characteristics at a comparably low price than the Tektronix *NEW* 2245 and 2246.

Features That Promote Productivity

Four independent channels speed troubleshooting and design tasks by allowing simultaneous observation of multiple test points. Front panel set-ups are simplified by pushbutton activated functions and on-screen scale factor readouts. And with buttons that light up, settings can be verified at a glance.

NEW

More Triggering Flexibility

Hands-free triggering, made possible by the Auto-level mode, automatically places a stable display of almost any waveform on screen. The LF, HF, and Noise Reject modes, together with a 10-to-1 holdoff range, deliver stable triggering on complex waveforms. The built-in TV Line and TV Field triggering capability extends measurements to most video-related applications.

Performance Plus

The *NEW* 2245 and 2246 oscilloscopes have low noise vertical systems that produce sharp, bright traces. Their 2 ns time base and 100 MHz bandwidth bring out the details on high speed signals and render measurements with good timing resolution.

Low level signal measurements are easily managed by the 2 mV/div vertical sensitivity, even at full bandwidth, and by trigger sensitivity that extends to 0.25 div at 50 MHz (0.5 div at 100 MHz).

Voltage Measurements With the Push of a Button

A pushbutton activated measurement system on the 2246 enhances productivity even more. This scope turns out virtually hands-off measurements quickly of +peak, −peak, peak-to-peak, dc, and gated volts, all with convenient on-screen readout of values.

If more visual indication is desired, the unique cursor system can provide feedback showing exactly where on the waveform an automatic measurement is being made. These feedback cursors, when selected, even show ground and trigger level locations.

There is also the ability to use cursors in the conventional manual mode for making point-to-point time and voltage measurements, including time interval measurements between a point on the reference waveform and a point on any of four other displayed waveforms.

Three Year Warranty

As with all of our high quality 2000 Series Oscilloscopes, the 2245 and 2246 (including the CRT) are covered by the Tektronix three year warranty, making ownership more cost effective than ever.

CHARACTERISTICS

Characteristics are common to both instruments, except where indicated.

VERTICAL SYSTEM

Display Modes — CH 1, CH 2, CH 3, CH 4, Add (CH 1+CH 2), Invert (CH 2), Alternate and Chopped display switching for all channels, and 20 MHz bandwidth limiting.

CHANNEL 1 AND CHANNEL 2

Frequency Response (−3dB Bandwidth) — 100 MHz for temperatures from 0°C to +35°C. 90 MHz for temperatures from +35°C to +50°C.

Ac Coupled Lower −3dB Frequency — 10 Hz or less with 1X probe. 1 Hz or less with standard accessory 10X probe.

Step Response — ≤3.5 ns for temperatures from 0°C to +35°C. ≤3.9 ns for temperatures from +35°C to +50°C. Rise times calculated from: $t_r = 0.35/BW$.

Deflection Factor Range — 2 mV/div to 5 V/div in a 1-2-5 sequence of 11 steps.

Maximum Error — ±2% for temperatures from +15°C to +35°C. Add ±1% for temperatures from 0°C to +15°C and from +35°C to +50°C.

Variable Range — Continuously variable between VOLTS/DIV step settings. Increases step setting by at least 2.5 V/div.

Uncalibrated Indicators — A > symbol appears on-screen when deflection factor is between calibrated VOLTS/DIV step settings.

Channel Isolation — 50 dB or more attenuation of deselected channel at 10 MHz. 34 dB or more at 100 MHz. Measured with an eight div input signal and equal VOLTS/DIV settings on both channels from 2 mV/div to 0.5 V/div.

Channel 2 Signal Delay With Respect to Channel 1 — <100 ps difference.

Input Characteristics — 1 MΩ ±0.15% shunted by 20 pF ±0.5 pF. Maximum Input Voltage: 400 V (dc + peak ac); 800 V ac p-p at 10 kHz or less.

Common Mode Rejection Ratio (ADD Mode With Channel 2 Inverted) — At least 10:1 at 50 MHz. For common-mode signals of eight div or less and with VAR VOLTS/DIV control adjusted for best CMRR at 50 kHz at any VOLTS/DIV setting.

Trace Drift — Between VOLTS/DIV Step Settings: 0.2 div or less. With VAR VOLTS/DIV Rotated Between Extremes: 1 div or less. Inverting Channel 2: 1 div or less. Between GND and Dc Input Coupling: <0.5 mV for temperatures from 0°C to +35°C. <2 mV for temperatures from +35°C to +50°C.

Position Range — At least ±11 div from graticule center.

CHANNEL 3 AND CHANNEL 4

Frequency Response — Same as Channel 1 and Channel 2.

Step Response — Same as Channel 1 and Channel 2.

Deflection Factor — Settings: 0.1 V/div and 0.5 V/div.

Maximum Error — Same as Channel 1 and Channel 2.

Channel Isolation — 34 dB or more attenuation of deselected channel at 100 MHz. Measured with an eight div input signal.

Channel 4 Signal Delay With Respect to Channel 3 — <100 ps difference.

Input Characteristics — 1 MΩ ±1% shunted by 2 pF ±0.5 pF. Maximum Input Voltage: 400 V (dc + peak ac); 800 V p-p ac at 10 kHz or less.

Trace Shift — Between VOLTS/DIV Settings: 1 div or less.

Position Range — Same as Channel 1 and Channel 2.

ALL CHANNELS

Low Frequency Linearity — 0.06 div or less compression or expansion of a 2 div, center-screen signal when positioned anywhere within the graticule area.

Bandwidth Limiter — Reduces upper −3dB bandpass to a limit of 17 MHz to 23 MHz.

Trace Separation Range — ±4 div.

Chop Mode Switching Rate — 625 kHz ±10%.

Channel 3 or Channel 4 Signal Delay With Respect to Either Channel 1 or Channel 2 — <200 ps difference.

HORIZONTAL SYSTEM

Display Modes — A (main sweep), A ALTernate with B (delayed sweep), and B. In X-Y mode, Channel 1 provides X-axis (horizontal) deflection.

A Sweep Time Base Range — 0.5 s/div to 20 ns/div in a 1-2-5 sequence of 24 steps. X10 magnification extends fastest sweep rate to 2 ns/div.

B Sweep Time Base Range — 5 ms/div to 20 ns/div in a 1-2-5 sequence of 21 steps. X10 magnification extends fastest sweep rate to 2 ns/div.

Variable Timing Range — Continuously variable between SEC/DIV calibrated step settings. Extends slowest A sweep and B sweep speeds by a factor of a least 2.5 times. Affects the A SEC/DIV setting with the A display mode; affects the B SEC/DIV setting with the ALT and B modes.

A Sweep Timing Accuracy — Applies over the center eight div. Excludes the first 0.25 div of the magnified sweep and sweep beyond the 100th magnified div.

Range	Unmagnified	Magnified
+15°C to +35°C	±2%	±3%
0°C to +15°C +35°C to +50°C	±3%	±4%

Linearity — ±5% over any two of the center eight div, or both unmagnified and magnified displays.

Delay Time — Range: <0.1 div to >9.9 div of the A sweep. Maximum value does not exceed end of the A sweep. Jitter: 1:20,000 p-p (0.005%) viewed over two seconds.

ΔTime — (2246) Range: 0 to >10 div to right of the delay time setting, but does not exceed end of the A sweep. Accuracy: ±(0.5% of reading +1% of one A sweep div +20 ns).

TRIGGERING

Trigger Sensitivity from CH 1, CH 2, CH 3, CH 2 Source.

Dc Coupled — 0.35 div or greater triggers from dc to 50 MHz, increasing to 1 div at 150 MHz.

Noise Reject Coupled — 0.8 div or more triggers; 0.5 div or less does not trigger.

HF Reject Coupled — 0.35 div or greater triggers from dc to 50 kHz; 0.25 div or less does not trigger above 500 kHz.

LF Reject Coupled — 0.35 div or greater triggers from 100 kHz to 50 MHz; 0.35 div or greater does not trigger from dc to 10 kHz.

Ac Coupled — 0.35 div or greater triggers from 50 Hz and 50 MHz; 0.35 div or less does not trigger from dc to 5 Hz.

For dc, LF Reject, and ac coupling above 50 MHz, triggering signal requirement increases to 1.0 div at 150 MHz.

Trigger Sensitivity From TV Line or TV Field Source — 0.5 div or less of composite sync achieves stable display.

Lowest Usable Frequency With Auto Level Function — 10 Hz.

Level Control Range — ±20 div referenced to the selected source.

Level Readout Accuracy — ±(0.3% of reading +0.1 div).

Variable Holdoff Range — Increases the A sweep holdoff time by at least a factor of 10.

X-Y OPERATION

Deflection Factors — Same as Vertical System, with VAR VOLTS/DIV in calibrated detent.

Maximum Error

Range	Y-Axis	X-Axis
+15°C to +35°C	±2%	±3%
0°C to +15°C +35°C to +50°C	±3%	±4%

X-Axis −3dB Bandwidth — 3 MHz or more.

Phase Difference Between X and Y — ⩽3° for dc coupled signals from dc to 50 kHz with bandwidth limiter off.

CURSOR AND FRONT PANEL DISPLAY

Controls — Separate A Intensity, B Intensity, Readout Intensity, Focus, Beam Finder, Trace Rotation, and Scale Illumination.

CRT — 8 x 10 cm internal graticule. Markings: 8 major div vertically and 10 major div horizontally, with auxiliary markings.

Standard Phosphor — GH (P31).

Y-Axis Orthogonality — ⩽0.1 div over eight vertical div; no adjustment.

Cursor Functions — (2246)

Function	Accuracy
SEC; 1/SEC; PHASE; ΔTIME; Δ1/TIME; ΔPHASE	±(0.5% of reading + 0.02 horizontal div)
VOLTS; GND VOLTS	±(0.5% of reading + 0.02 vertical div + HF display errors)

Function	Position Accuracy *1
Track Measurement, Trig Level, Ground	±0.05 vertical div

*1 *Cursor position on waveform vs readout displayed value.*

EXTERNAL Z-AXIS INPUT

Active Region Lower Threshold — ⩽1.8 V.

Signal Required to Blank Sweep-Related Trace — ⩾3.8 V.

Input Resistance to Ground — 10 kΩ ±10%.

Maximum Input Voltage — 30 V (dc + peak ac) or ⩽30 V ac p-p at 1 kHz.

CALIBRATOR OUTPUT

Voltage Into 1 MΩ Load — 0.5 V ±2%.

Repetition Range — 1 kHz ±10%.

Overshoot — ⩽0.1%.

POWER REQUIREMENTS

Line Voltage Range — 90 V to 250 V.

Line Frequency — 48 Hz to 445 Hz.

Fuse Rating — 2 A, 250 V, slow-blow.

Maximum Power Consumption — 80 W (110 V ac).

ENVIRONMENTAL

Environmental requirements qualify the electrical and mechanical specifications. When not rack-mounted, the instrument meets the environmental requirements of MIL-T-28800C for Type III, Class 5, Style D equipment.

Ambient Temperature — Operating: 0°C to +50°C. Nonoperating: −50°C to −75°C.

Altitude — Operating: To 4500 m (15,000 ft). Maximum operating temperature decreases 1°C for each 300 (1,000 ft) above 1500 m (5000 ft). Nonoperating: to 15 250 m (50,000 ft).

Vibration — Operating: 15 minutes along each of three axes, 0.015 inch p-p displacement. 10 Hz to 55 Hz in one minute sweeps. Held for 10 minutes at 55 Hz (2.4 g's at 55 Hz).

Humidity — Operating and Nonoperating: 95%, five cycles (120 hours) referenced to MIL-T-28800C, Paragraph 4.5.5.1.2.2 for Type III, Class 5.

Shock — Operating and Nonoperating: 30 g, half sine, 11 ms duration; three shocks on each face, for a total of 18 shocks.

Bench Handling Test — 4 inch drop per Tektronix Standard 062-2858-00.

Transportation Drop and Vibration — Meets the limits of Tektronix Standard 062-2858-00.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width, With handle	361	14.2
Height		
With feet and pouch	177	7.0
Without pouch	164	6.4
Depth		
With front cover	445	17.5
With handle extended	519	20.4
Weight≈	**kg**	**lb**
Net		
With accessories and pouch	8.9	19.6
Without accessories and pouch	7.9	17.4

2246 With Voltmeter

Dc Volts — Accuracy: ±(0.3% of reading +0.02 div). Normal Mode Rejection Ratio: >50 dB at 50 Hz and 60 Hz.

+Peak and −Peak Volts — Accuracy: ±(2% of reading +0.1 div) for signals from 20 Hz to 30 MHz. −3dB at 100 MHz. Gated Region Minimum Width: ⩽(0.2 div + 50 ns).

P-P Volts — Accuracy: ±(2% of reading +0.1 div) for signals from 20 Hz to 30 MHz. −3 dB from 30 MHz to 100 MHz. Gated Region Minimum Width: ⩽(0.2 div + 50 ns).

ORDERING INFORMATION

2245 100 MHz Oscilloscope **$1,875**

Includes: Two 10X, 1.5 m probes with accessories (P6109 Opt 01); clear accessories pouch with ziploc fastener (016-0537-00); blue plastic CRT filter (337-2775-00); 2A, 250 V fuse (159-0023-00); operator manual (070-6083-00); user reference guide (070-6082-00).

2246 100 MHz Oscilloscope with Voltmeter, ΔTime, and SmartCursors™ **$2,400**

Includes: Same as 2245.

OPTIONS

Option 02 — Protective front panel cover and accessory pouch. **+$47**

Option 1C — C-5C Option 02 Camera. **+$465**

Option 1K — K212 Portable Instrument Cart. **+$330**

Option 1T — Transit Case. **+$185**

Option 22 — Two additional P6109 probes. **+$130**

Option 23 — Two 1X/10X P6062B, 6 ft probes. **+$350**

INTERNATIONAL POWER PLUG OPTIONS

Option A1 — Universal Euro 220 V, 50 Hz.
Option A2 — UK 240 V, 50 Hz.
Option A3 — Australian 240 V, 50 Hz.
Option A4 — North American 240 V, 60 Hz.
Option A5 — Switzerland 220 V, 50 Hz.

WARRANTY-PLUS SERVICE PLANS

SEE PAGE 497

M1 — (2245) 2 Calibrations. **+$145**
M1 — (2246) 2 Calibrations. **+$160**
M2 — (2245) 2 Years Service. **+$175**
M2 — (2246) 2 Years Service. **+$185**
M3 — (2245) 2 Years Service and 4 Calibrations. **+$290**
M3 — (2246) 2 Years Service and 4 Calibrations. **+$320**
M4 — (2245) 5 Calibrations. **+$385**
M4 — (2246) 5 Calibrations. **+$410**
M5 — (2245) 9 Calibrations + 2 Years Service. **+$1,005**
M5 — (2246) 9 Calibrations + 2 Years Service. **+$1,095**

OPTIONAL ACCESSORIES

Service Manual
(2245/2246) Order 070-6081-00 **$25**
Front Panel Cover — Order 200-3232-00 **$5.00**
Accessory Pouch — Order 016-0857-00 **$15**
Accessory Pouch and Cover*2
Protective Waterproof Vinyl Cover — Order 016-0848-00 **$15**
Viewing Hoods —
(Collapsible) Order 016-0592-00 **$14**
(Binocular) Order 016-0566-00 **$18.75**
(Polarized) Order 016-0180-00 **$50**
Clear Implosion Shield — Order 337-2775-01. **+$1.95**
Carrying Strap — Order 346-0199-00 **$17**
Carrying Case — Order 016-0792-01*1 **$355**
Clear Graticule Filter — Order 337-2775-01 **$1.95**
1107 Mounting Kit — Order 016-0785-00 **$50**
1107 DC Inverter — See page 307. **$525**
1106 Battery Pack — See page 306. **$1,265**
1105 Power Supply — See page 306. **$1,690**

*1 *Recommend use with front panel cover (200-2520-00).*
*2 *To order, contact your local Tektronix Sales Office.*

RECOMMENDED PROBES

See Probe Section for additional probes, page 464.

The P6062B allows switching between 1X and 10X attenuation. Readout display changes with attenuation switching. See page 470.

P6109 — 10X Probe. **$58**
P6062B — 1X-10X Probe. **$175**
P6008 — Environmental Probe. **$240**
P6009 — High Voltage Probe. **$195**
P6202A — Active Probe. **$680**
1101A — Active Probe Power Supply. **$425**
A6302 — Current Probe. **$565**
A6303 — Current Probe. **$1,070**
AM 503 — Current Probe Amplifier. **$1,125**
A6901 Ground Isolation Monitor — See page 478. Order A6901 **$650**
A6902B Isolator — See page 479. **$1,795**

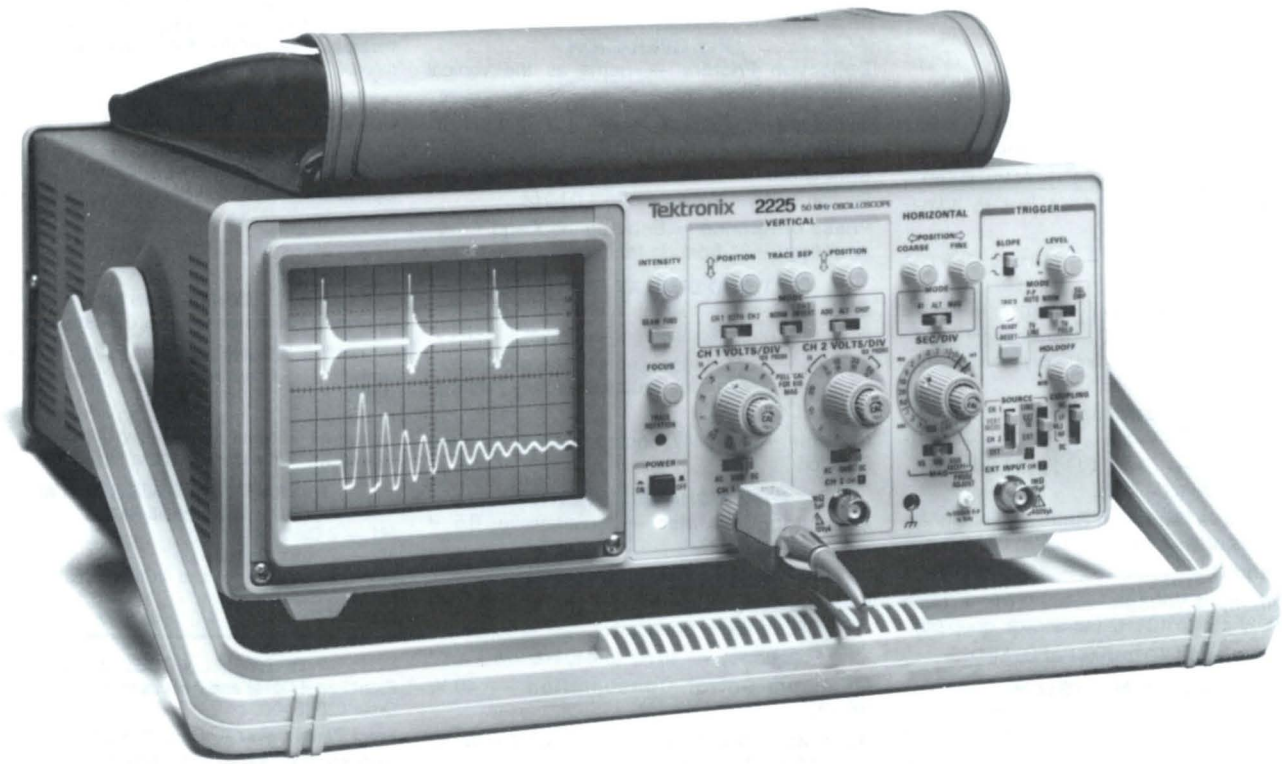
RECOMMENDED CAMERAS

C-5C Option 02 — See page 445. **$465**
C-7 Option 03 — See page 448. **$565**
C-4 — See page 446. **$370**

RECOMMENDED CART

K212 — For on-site mobility. See page 461. **$330**

To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext. 99



NEW 2225

- Dc to 50 MHz Bandwidth
- Alternate Magnification
- 500 μV/Div Sensitivity
- HF/LF Reject Trigger Filters
- Lightweight—Easy to Use
- P-P Auto Triggering
- 5 ns/Div Maximum Sweep Rate
- Front Panel Z-Axis Input
- Three Year Warranty—Five Year Option

TYPICAL APPLICATIONS
Field Service
Education
Production Test
Television Service
Communications

See page 277 for available Application Notes.

Tektronix' innovation redefines the meaning of value with the *NEW* 50 MHz 2225. The 2225 continues in the 2200 Series tradition of high performance, reliability and quality.

The technology that made the 2200 Series the most successful oscilloscopes in the world has been utilized in the *NEW* 2225. The use of fewer mechanical parts, cables, connectors, and components contributes to improved reliability, serviceability, and cost. The result is a high performance easy-to-use scope that costs less to build, buy and own. You will significantly improve your utility while lowering your cost-of-ownership.

In this day and age when everything is becoming more complex, the 2225 has made strides to increase operational simplicity. This is a big plus in education, field service, and manufacturing production test environments.

All this and new features too. Features like Alternate Magnification, 500 μV/div vertical sensitivity with X10 magnification, independent trigger coupling, high and low frequency reject, front panel Z-Axis input, and a new improved bright, crisp CRT.

Alternate Magnification is an exciting new concept in performing waveform expansion and detailed signal analysis. Dual time base types of measurements can be performed with a simple flip of a switch. The CRT alternately displays both the unmagnified and magnified sweeps. Magnification can be selected in three levels: X5, X10, and X50. Measurements like digital signal timing can be performed with little effort, quickly and accurately.

The new low noise vertical system can operate at 500 μV/div which is 4 times the maximum sensitivity of the previous 2200 Series. X10 vertical magnification provides similar benefits that have been associated with the horizontal, but in the vertical axis. Vertical waveform expansion is made easy with a pull of a knob. Independent channel bandwidth limiting (5 MHz) is performed with this function. Now you can selectively limit either channel's bandwidth without affecting the other.

All the features and performance you come to expect in more expensive instruments is found on the 2225. The flexibility and high sensitivity of the trigger system will be well received. The convenience of hands free triggering with Peak-to-Peak Auto. Independent selection of TV Line or Field triggering at any sweep speed. Variable Holdoff that makes triggering on complex waveform periods easy. And a 5 ns/div (maximum) horizontal system that is accurate as well as linear.

The 2225 also includes two new P6103 10X modular probes that complement the performance of the 2225. They incorporate a new ruggedized probe tip and eliminate the bulky compensation box at the front of the scope.

Also consider the world-renowned Tektronix service and support organization. You can find support in any area you need from expert sales support, training materials, application assistance, service and calibration, as well as long term support for a minimum of 6 years after the product is discontinued.

Tektronix backs the reliability of the 2225 with a three year warranty that includes all parts and labor including the CRT. And then beyond the "basic three years," offers you a choice of five practical service plans to further reduce your cost-of-ownership.

CHARACTERISTICS

All specifications are rated over all environmental extremes except where noted.

VERTICAL SYSTEM (Two Identical Channels)

Bandwidth (−3 dB) and Rise Time

	5°C to 35°C	0°C to 40°C
5 V to 5 mV/div	50 MHz (7.0 ns)	40 MHz (8.8 ns)

Bandwidth in X10 MAG is reduced to 5 MHz ±20%.

Bandwidth Limit (−3dB) — 5 MHz ±20% (via X10 MAG).

Deflection Factor Accuracy — (0°C to 40°C) 5 mV to 5 V/div: ±3%. X10 Magnification: ±5%. Uncalibrated Variable: Continuously variable between steps by at least 2.5:1.

Step Response Aberrations — +5%, −5%, 5% p-p (5 mV to 0.5 V/div).

Display Modes — CH 1, CH 2, CH 2 INVERT, ADD, ALT, CHOP (500 kHz).

Common-Mode Rejection Ratio — For signals of 6 divisions or less, at least 10:1 at 20 MHz.

Input R and C — 1 MΩ, 25 pF.

Maximum Input Voltage — 400 V (dc + peak ac) or 800 V p-p to 10 kHz (ac and dc coupled).

Channel Isolation — >100:1 at 20 MHz.

HORIZONTAL SYSTEM

Time Base — 0.05 μs to 0.5 s/div in 1-2-5 sequence. Maximum Sweep Rate: 5 ns/div (X10 magnification). Uncalibrated Variable: Continuously variable between steps by at least 2.5:1.

Sweep Accuracy

	15°C to 35°C	0°C to 40°C
Unmagnified X1	±3%	±4%
Magnified X5, X10	±4%	±5%
Magnified X50	±5%	±8%

Sweep Linearity — Specified over any 2 of the center eight divisions. Unmagnified X1: ±5%. Magnified X5, X10: ±7%. Magnified X50: ±9%.

Display Modes — X1, Alternate Magnification, and Magnified.

Alternate Magnification — Display alternates between the unmagnified sweep (X1) and the magnified sweep. Magnification Levels: X5, X10, and X50. Magnifier Registration: Expansion occurs at the center vertical graticule line.

Magnification Range — Magnification can be performed over any portion of the X1 (unmagnified) sweep.

TRIGGERING

Trigger Sensitivity

	Internal	External
5 MHz	0.3 div	40 mV
50 MHz	1.0 div	150 mV

TV Trigger Sensitivity — TV Field: 1.0 div of composite sync. TV Line: 0.3 div or 40 mV p-p external.

Trigger Operating Modes — Peak-to-Peak Automatic, Normal, TV Field, TV Line, Single Sweep.

Trigger Sources — Internal CH 1, CH 2, Vert Mode, Line, External, and External÷10.

Trigger Coupling — Ac, dc, HF REJ (attenuates signals above 40 kHz), LF REJ (attenuates signals below 40 kHz).

Variable Holdoff — Increases X1 Sweep holdoff time by at least 10:1.

X-Y OPERATION

Deflection Factors — Same as the vertical deflection system.

Accuracy — (0°C to +40°C) Y-Axis: ±3%. X-Axis: ±5%.

Bandwidth — Y-Axis: Same as the vertical deflection system. X-Axis: Dc to 1.0 MHz.

Phase Difference — Between the X and Y axis. Amplifiers: ±3° from dc to 50 kHz.

CRT AND DISPLAY FEATURES

CRT — 8 cm x 10 cm; internal graticule; GH (P31) phosphor. Accelerating potential is 12.6 kV.

Z-Axis — 5 V causes noticeable modulation, positive voltage decreases intensity. Usable Range: Dc to 5 MHz.

Controls — Intensity, Focus, Beam Find, Trace Rotation.

OTHER CHARACTERISTICS

Amplitude Calibrator — Squarewave, 0.5 V ±5%, 1 kHz ±20%.

POWER REQUIREMENTS

Line Voltage Range — One line switch 95 to 128 V/190 to 250 V operation.

Line Frequency — 48 Hz to 440 Hz.

Maximum Power Consumption — 40 W (60 VA).

Dc Power Operation — 12 V to 30 V with optional 1107, 1106, and 1105.

ENVIRONMENTAL AND SAFETY

Ambient Temperature — Operating: 0°C to 40°C (+32°F to +104°F). Nonoperating: −55°C to +75°C (−67°F to +167°F).

Altitude — Operating: 4 500 m (15,000 feet). 1°C per 1,000 feet above 5,000 feet. Nonoperating: 15 000 m (50,000 feet).

Vibration — Operating: 15 minutes along each of 3 major axes. 0.015 inch p-p displacement. 10 Hz to 55 Hz to 10 Hz in one minute sweeps. Held for 10 minutes at 55 Hz in each of the 3 major axes (2.4 g's at 55 Hz).

Humidity — Operating and Nonoperating: 95% relative humidity. 5 cycles (120 hours) spec may be referenced to MIL-T-28800C paragraph modified 4.5.5.1.2.2.

Shock — Operating and Nonoperating: 30 g's, half-sine, 11 ms duration, 3 shocks per axis each direction, for a total of 18 shocks.

EMC — Meets Class B requirements per VDE 0871 for radiated and conducted emissions.

Safety — UL Listed, CSA Certified.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width		
With handle	385	15.2
Without handle	327	12.9
Height	138	5.4
Depth	443	17.4
With handle	511	20.3
Weight≈	**kg**	**lb**
Net	6.5	14.3
Shipping	8.5	18.7

ORDERING INFORMATION

2225 50 MHz Oscilloscope **$995**
Includes: Two P6103 X10 voltage probes; operator manual.

OPTIONS

Option 02 — Front panel cover and accessory pouch. **+$55**
Option 1C — C-5C Camera Option 04. **+$495**
Option 1K — K212 Portable Instrument Cart. **+$330**
Option 1R — Rackmount Version. **+$150**
Option 24 — P6062B X1/X10 probe (replaces P6103). **+$350**

CONVERSION KIT

Rackmount Adaptor — Order 016-0819-00 **$150**

INTERNATIONAL POWER PLUG OPTIONS

Option A1 — Universal Euro 220 V, 50 Hz.
Option A2 — UK 240 V, 50 Hz.
Option A3 — Australian 240 V, 50 Hz.
Option A4 — North American 240 V, 60 Hz.
Option A5 — Switzerland 220 V, 50 Hz.

***WARRANTY-PLUS* SERVICE PLANS**
SEE PAGE 497

M1 — 2 Calibrations. **+$85**
M2 — 2 Years Service. **+$150**
M3 — 2 Years Service and 4 Calibrations. **+$290**
M4 — 5 Calibrations. **+$270**
M5 — 9 Calibrations + 2 Years Service. **+$595**

OPTIONAL ACCESSORIES

Front Panel Cover and Accessory Pouch — Order 020-1514-00 **$55**
Front Panel Cover — Order 200-3397-00 **$7.00**
Accessory Pouch — Order 016-0677-02 **$48**
Viewing Hoods —
(Collapsible) Order 016-0592-00 **$14**
(Polarized) Order 016-0180-00 **$50**
(Binocular) Order 016-0566-00 **$18.75**
Carry Case — Order 016-0792-01 **$355**
CRT Light Filters — (Clear) Order 337-2775-01 **$1.95**
1107 Dc Inverter — See page 307. **$525**
1107 Mounting Kit — See page 307. Order 016-0785-00 **$50**
1106 Battery Pack — See page 306. **$1,265**
1105 Power Supply — See page 306. **$1,690**

RECOMMENDED PROBES

P6103 — 10X Probe. **$35**
P6062B — Switchable Attenuation Probe. **$175**
P6130 — 10X Subminiature Probe. **$130**
P6008 — 10X Environmental Probe. **$240**
P6009 — 100X High Voltage Probe. **$195**
P6015 — 1000X High Voltage Probe. **$695**
P6202A — 10X FET Probe. **$680**
P6021 — Current Probe. **$430**
P6022 — Current Probe. **$475**
1101A — Accessory Power Supply. **$425**
A6302 — Current Probe. **$565**
A6303 — Current Probe. **$1,070**
AM 503 — Current Probe Amplifier. **$1,125**
A6901 Ground Isolation Monitor — See page 478. **$650**
A6902B Voltage Isolator — See page 479. **$1,795**

RECOMMENDED CAMERAS

C-5C — Option 04. See page 445. **$495**
C-7 — Option 02. See page 448. **$595**

RECOMMENDED CARTS

K212 — For on-site mobility. See page 461. **$330**

To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext. 99

Added Value for Your 2200 Series Oscilloscope

Travel Line Package

Impact Resistant Packaging

Impact Protection

Cord Wrap

Pouch and Cover

Carrying Strap

Now give your 2200 Series instrument the added protection often necessary when used in rough environments. This package provides protection from impacts along the front and rear of the instrument. The rear bumper is designed to provide a wider base to set the instrument on and reduces the potential of tip over when standing vertically. The rear also has integrated in it a power cord wrap.

The high quality rubber moldings offer long life and are resistant to cracking and becoming brittle with age. This composition provides excellent desk/bench and inclined plane grab, so there is no worry about instrument slippage.

A front panel protective cover and an accessory pouch for carrying probes and documentation is also included, plus a convenient carrying strap for hands free operation and transport.

The Travel Line Package is available for the 2235/2236 and 2220/2230. It can be ordered at the time of purchase or as a field retrofit kit.

ORDERING INFORMATION

Travel Line Package — Order Option 33 for specific instrument.
(2235/2236) Includes rubber molding, accessory pouch, front panel cover, carrying strap. **$200**
(2220/2230) Includes rubber molding, carrying strap. **$150**

Travel Line Package Conversion Kits —
Includes: Replacement cabinet and rear cover with the rubber moldings installed.
(2213/A, 2215/A, 2235) Order 040-1188-00 **$260**
(2236) Order 040-1187-00 **$260**
(2220/2230) Order 040-1202-00 **$110**

Rackmount Adaptor

Standard 19 Inch Mount

Rack Depth Extenders

Easy Assembly

Rack Height Only 5.14 Inches

The low cost rack adaptor provides the means to rackmount the high performance high value 2200 Series oscilloscope family. The rackmount is very space efficient, requiring only 5.14 inches of rack height. Rack extenders are provided to allow mounting to virtually any depth rack main frame. A mounting hole is provided for a BNC connector to route the Z-axis input to the front face of the rack. All hardware is supplied for complete mounting into your mainframe.

Kits are available for all 2200 Series products. It can be ordered at any time and is customer installable. For the 2220 and 2230 Digital Storage Oscilloscopes the kit also provides access for the optional GPIB or RS-232C interface connections for automated systems.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	483	19.0
Mount Width	464	18.3
Height	131	5.1
Depth*1	458	18.1
Weight≈	**kg**	**lb**
Net, Kit	1.5	3.2
Net, Additional to instrument mount	.7	1.6

**1 Does not include extenders.*

ORDERING INFORMATION

Rackmount Adaptor Kit —
Includes: Rackmount depth extenders, all mounting hardware, labels, instruction manual.
(2213/A, 2215/A, 2235) Order 016-0466-00 **$115**
(2235 Opt 01) Order 016-0833-00 **$170**
(2220/2230) Order 016-1003-00 **$130**
(2236) Includes DMM connector.
Order 016-0015-00 **$255**

OPTIONAL ACCESSORIES

BNC Female to BNC Female Connector —
Order 103-0070-00 **$6.00**
50 Ω RF Coaxial Cable — Order 012-0117-00 **$17**

Shown (from left) are the 1105 Power Supply, the 1106 Battery Pack, and the 1107 Dc Inverter.

Portable Power

Tektronix power accessories offer true field-use-portability and operating freedom at service and maintenance sites where conventional ac power sources are not available. They let your scopes go where you need them—and have enough power for your testing and troubleshooting tasks.

The following table outlines the preferred power accessory (or accessory combination) for Tektronix portable oscilloscopes. Note that for many instruments, the 1105 Power Supply is a compatible alternate dc power source.

Instrument	Recommended Power Accessory
2213*2, 2213A*1, 2215*2, 2215A*1, 2220*1, 2225*1, 2230*1, 2235 Option 01*1, 2235*1, 2236*1, 2335*1, 2336YA*1, 2337*1, 2467, 2465A*1, 2465A CT, 2465A DV, 2465A DM, 2445A*1	1107/1106 Inverter Battery Pack Combination or 1107 Dc Inverter with Auxiliary Dc Source
464*3, 465B*3, 466*3, 475*3, 475A*3	1106 Battery Pack or 1105 Power Supply
314, 335, 336, 434, 465M, 468*4, 485	1105 Power Supply

**1 The 1105 Power Supply is also compatible with these instruments.*

**2 Some lower serial-numbered units are not compatible for use with the 1107 Dc Inverter and the 1105 Power Supply. Neither the 1107 Dc Inverter nor the the 1105 Power Supply are compatible with the following instruments, unless Option 48 is installed:*
US-built 2213 below Serial Number B020100
US-built 2215 below Serial Number B022000
UK-built 2213 below Serial Number 200239
UK-built 2215 below Serial Number 200307

**3 These instruments require Option 07 for operation with the 1106 Battery Pack. Field conversion kits are available. Contact your local Tektronix Sales Engineer. But when the 1105 Power Supply is used with these 400 Series instruments, Option 07 is not required.*

**4 Because of limited instrument operating time available when running from the internal batteries, it is recommended that an external dc power source be used.*

1105 Power Supply

CHARACTERISTICS

ELECTRICAL

Internal Battery Voltage Range — +22 V to +28 V.

External Dc Input Voltage Range — +24 V to +30 V. Maximum elevation for the positive and the negative power leads is 60 V with respect to chassis ground.

Output — Waveform: Squarewave. Frequency: 60 Hz ±10%. Amplitude: See following table.

Dc Power Source	Peak Ac Output	
	Standard Configuration and 0.9 A Load	Option 01 Configuration and 0.45 A Load
+22 V Internal +24 V External	108 V ±7%	216 V ±7%
+28 V Internal +30 V External	138 V ±7%	276 V ±7%

Maximum Recommended Output Current — Standard: 0.9 A. Option 01: 0.45 A.

Minimum Battery Operating Time — 50 W hours from full charge.

Battery Charging Time — 14 hours to 16 hours from full discharge at temperatures from 0°C to +40°C (+32°F to +104°F).

Battery Charging Rate — Full: 600 mA ±10%. With Thermal Cutout Open: 254 mA ±10%.

Ac Charging Power Frequency Range — 50 Hz to 60 Hz.

Ac Charging Voltage Rates — See following table.

Line Voltage Selection Wiring	Ac Voltage Ranges	
	Standard Configuration	Option 01 Configuration
From Factory	100 V to 132 V	200 V to 264 V
With Internal	90 V to 120 V	90 V to 120 V
Connection	180 V to 240 V	100 V to 132 V
Changes	200 V to 264 V	180 V to 240 V

Maximum Power Consumption From Ac Source — 40 W.

ENVIRONMENTAL

Ambient Temperature — Operating: 0°C to +40°C (+32°F to +104°F). Nonoperating (with battery installed): −40°C to +60°C (−40°F to +140°F). Nonoperating (without battery): −55°C to +75°C (−67°F to +167°F).

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	165	6.5
Height	250	9.8
Depth	216	8.5
Weight≈	**kg**	**lb**
Net	8.8	19.4

ORDERING INFORMATION

1105 Power Supply **$1,690**
Includes: Dc power cord, 915 mm (36 in), for external dc input (161-0094-00); instruction manual (070-1479-01).

OPTION

Option 01 — 230 V Operation. **NC**
Includes: 2.1 m (7 ft) IEC power cable (161-0098-00).

1106 Battery Pack

CHARACTERISTICS

ELECTRICAL

Dc Power Output — +22 V to +24 V for 7 ampere-hour with maximum current of 5 A.

Minimum Battery Operating Time — 75 W hours from full charge.

Battery Charging Time — 14 hours to 16 hours, from full discharge, at temperatures from 0°C to +40°C (+32°F to +104°F).

Battery Charging Rate — Full: 620 mA. With Thermal Cutout Open: 60 mA.

Ac Charging Power Frequency Range — 50 Hz to 400 Hz.

Ac Charging Voltage Ranges — Standard: 100 V to 132 V; 200 V to 264 V. With Internal connection change: 90 V to 120 V; 180 V to 240 V.

Maximum Ac Charging Power Consumption — 40 W at 115 V, 60 Hz.

ENVIRONMENTAL

Ambient Temperature — Operating: 0°C to +40°C (+32°F to +104°F) Nonoperating (with battery installed): −40°C to +60°C (−40°F to +140°F). Nonoperating (without battery): −55°C to +75°C (−67°F to +167°F).

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width, Latches in latched position	292	11.5
Height, With feet and latches	66	2.6
Depth	432	17.0
Weight≈	**kg**	**lb**
Net	7.3	16.0

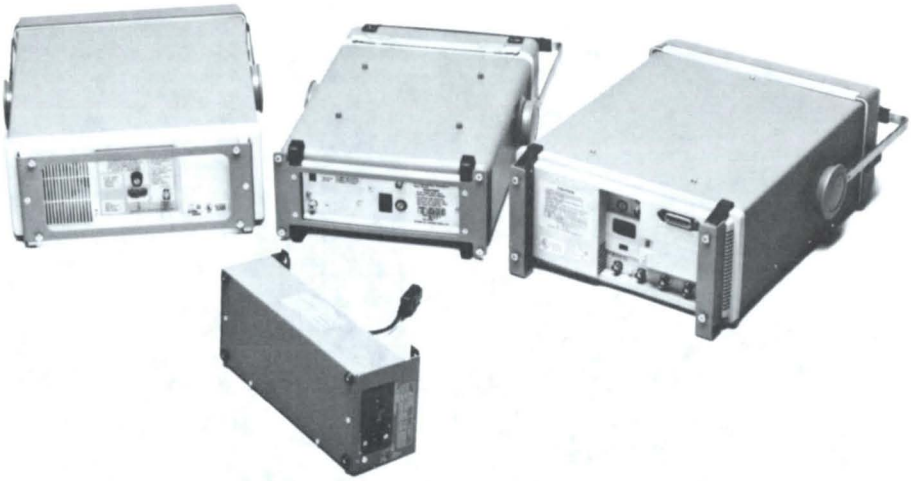
ORDERING INFORMATION

1106 Battery Pack **$1,265**
Includes: Instruction manual (070-1713-00).

Mounting kits are not available to attach the 1106 to 2200 or 2300 Series Oscilloscopes.

Mounting Kit for 2445A, 2465A, 2467 Oscilloscopes — Order 016-0797-00 **$50**

To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext. 99



The 1107 Dc Inverter can be quickly attached to or detached from the rear of Tektronix 2000 Series oscilloscopes via easily installed adaptor kits. Shown here with adaptors installed are (from left) the Tektronix 2236, 2336 and 2465A Oscilloscopes.

1107 Dc Inverter

CHARACTERISTICS

ELECTRICAL

Output Frequency — Approximately 60 Hz.

Output Voltage and Timing (+12 V Mode) — Measured with a 200 Ω resistive load (approximately 60 W).

Output Parameter	Output	
	With +12.3 V Dc Input	With +14.2 V Dc Input
Peak Voltage	160 V ±10%	160 V ±10%
Table Voltage	130 V ±10%	140 V ±10%
Turn-on Time	6.2 ms ±15%	6.2 ms ±15%
Dead Time	2.2 ms ±15%	2.2 ms ±15%

Output Voltage and Timing (+24 V Mode) — Measured with a 166 Ω resistive load (approximately 100 W).

Output Parameter	Output	
	With +22.5 V Dc Input	With +28.5 V Dc Input
Peak Voltage	150 V ±10%	160 V ±10%
Table Voltage	135 V ±10%	150 V ±10%
Turn-on Time	6.2 ms ±15%	6.2 ms ±15%
Dead Time	2.2 ms ±15%	2.2 ms ±15%

Rated Output Power in +12 V Mode — 70 W (−15°C to +35°C); 50 W (−15°C to +55°C). Dc source must be 117 VA +11.7 V or greater.

Rated Output Power in +24 V Mode — 100 W.

Output Overload Protection — Ouput is disabled and audible tone generated when the ac load exceeds 100 W.

Input Voltage Range Selection — Selection between +12 V mode and +24 V mode is automatic.

Operating Inputs — Measured at input of supplied dc power cord.

	Dc Volts	
	+12 V Mode	+24 V Mode
Turn-on Range	+11.7 to 15.9 ±5%	+22.2 to +30.0 ±5%
Battery Protection Shut-down Limit*[1]	+10.0 ±5%	+21.0 ±5%
Difference Between Minimum Turn-on Range and Battery Protection Shut-down Limit*[1]	⩾1.2	⩾0.85

*[1] *Tested with a variable dc supply without a load on the output.*

ENVIRONMENTAL

The 1107 Dc Inverter meets environmental requirements of MIL-T-28800C for Type III, Class, 3, Style C equipment with humidity and temperature requirements defined in paragraphs 3.9.2.2, 3.9.2.3, and 3.9.2.4, except Electromagnetic Compatibility.

Ambient Temperature — Operating: −15°C to +55°C (+5°F to +131°F). Nonoperating: −62°C to +85°C (−80°F to +185°F).

Altitude — Operating: To 4600 m (15,000 ft). Maximum operating temperature decreases 1°C for each 300 m (1,000 ft) above 1500 m (5,000 ft). Nonoperating: To 15 250 m (50,000 ft).

Humidity — Operating and Nonoperating: 5 cycles (120 hours) referenced to MIL-T-28800C par 4.5.5.1.2.2. for Type III, Class 3 Instruments.

Electromagnetic Compatibility — Meets radiated emission requirements per VDE 0871 Class B, Meets MIL-STD-461B for the following tests: Part 4 (CE01, CE03, and CS02); Part 5 (CS06 and RS02); and Part 7 (CS01, RE02, and RS03). Conducted emissions measurements are performed on the dc input power cord.

Vibration — Operating: 15 minutes along each of three major axes at a total displacement of 0.025 inch p-p (4 g at 55 Hz), with frequency varied from 10 Hz to 55 Hz to 10 Hz in one minute sweeps. Held 10 minutes at 55 Hz in each of the three major axes.

The Tektronix 2465 Oscilloscope with attached 1106 Battery Pack and 1107 Dc Inverter becomes a completely independent measurement package—readily transportable to remote sites where conventional ac power sources are not available.

Shock — Operating and Nonoperating: 50 g, ½ sine, 11 ms duration, three shocks per axis each direction, for a total of 18 shocks.

Note: The following 1107 Dc Inverter and oscilloscope combinations meet or exceed MIL-T-28800C Class 3 requirements for vibration and shock when attached together with designated mounting hardware:

1107/2445A
1107/2465A
1107/2455A
1107/1106/2467
1107/1106/2465A
1107/1106/2445A
1107/2335
1107/2336
1107/2337

Transportation Package Vibration — Meets the limits of National Safe Transit Association Test Procedure 1A-B-1.

Transportation Package Drop — Meets the limits of National Safe Transit Association Test Procedure 1A-B-2 with a 914 mm (36 inch) drop.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	276	10.9
Height	119	4.7
Depth	84	3.3
Weight≈	**kg**	**lb**
Net	1.6	3.5
Shipping	1.8	4.0

ORDERING INFORMATION

1107 Dc Inverter **$525**

Includes: 559 mm (22 in), dc power cord (161-0095-00); instruction manual (070-5056-00).

OPTIONAL ACCESSORIES

OSCILLOSCOPE MOUNTING KITS

1106 — (2445A, 2465A, and 2467)
Order 016-0797-00 **$50**

1107 — (2445A and 2465A)
Order 016-0783-00 **$50**

1107 — (2335, 2336, 2336YA and 2337)
Order 016-0786-00 **$50**

1107 — (2200 Series) Cannot be used with Travel Line Package. Order 016-0785-00 **$50**

1107 — (2235/2236, 2220/2230)
Order 016-0785-00 **$50**

TEKTRONIX IN THE CLASSROOM

To take the guess work out of classroom equipment selection, pages 308 and 310 describe test instruments and other classroom materials that many schools and training facilities, worldwide, are using. Listed below are instruments from the Portable Oscilloscope group and TM 500 Series. These units have been designed to be "student proof" and reliable. You can count on them to withstand the intensive use test equipment receives in the lab, day after day.

EQUIPMENT AND MATERIALS

Lab Stations

Tektronix is often asked by educators to recommend equipment for teaching electrical and electronic theories and concepts. We have worked with many schools over the years to develop effective lab stations. We suggest the following configurations of test and measurement equipment from the Portable Oscilloscope group and TM 500 Series. For a complete description of the oscilloscopes listed see pages 294, 300, 303, and 330. TM 500 equipment is fully described on pages 404 through 438.

Products	Beginning Labs	Intermediate Labs	Advanced Labs	Advanced Digital Labs*1
2225	✓			
2235 or 2245		✓		
2236 or 2246			✓	
2220 or 2230				✓
TM 503	✓			
TM 504		✓	✓	✓
PS 503A	✓	✓	✓	
FG 503	✓	✓	✓	✓
DM 501A	✓			
DM 502A		✓	✓	✓
PG 501		✓	✓	✓
DC 504A*2		✓	✓	✓
SG 502*2		✓	✓	✓

*1 *A primer, an "Introduction to Digital Storage" (46-W-6051) can be used to introduce or review digital concepts. It is available from the Tektronix Sales Office.*

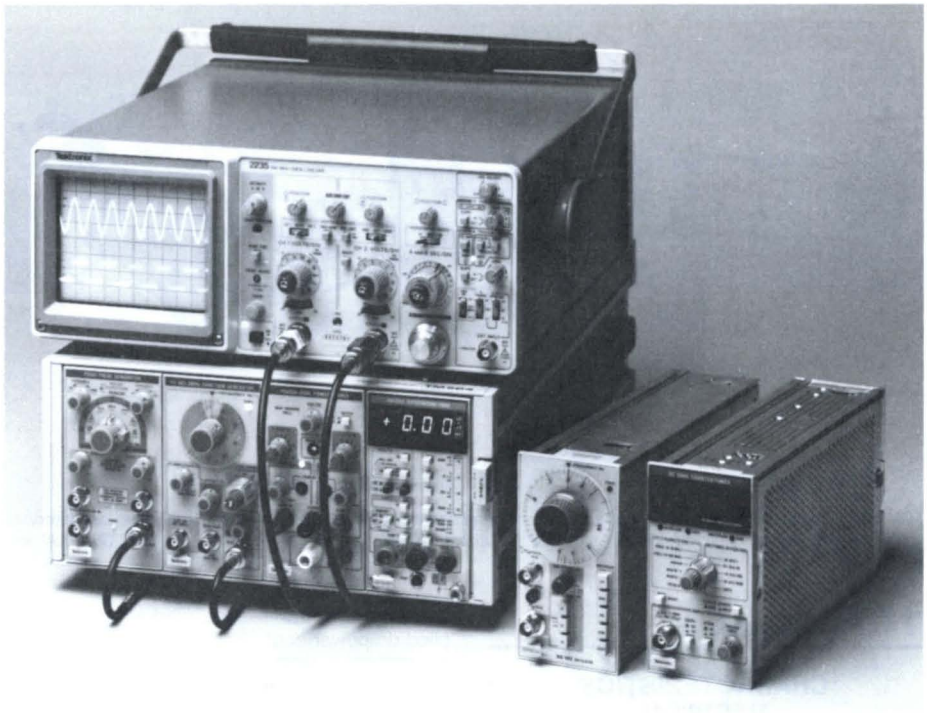
*2 *Optional.*

Warranty/Service

The recommended oscilloscopes come with a three year warranty. After the warranty period you can still get replacement parts, when they're needed, because service documentation is complete and accurate. There are also a variety of service options available which can give you years of minimum-cost maintenance.*1 Service is available through your local Tektronix Sales Office. The overall cost of ownership over the life of these instruments is excellent. See pages 494–497 for further information, contact your Tektronix Sales Representative or call the National Marketing Center at 1-800-426-2200.

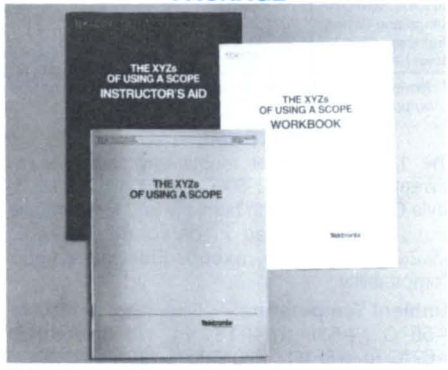
Safety

Having safe equipment in the classroom is especially important when there are inexperienced equipment operators. The oscilloscopes recommended for classroom use are listed by UL, CSA (Canada), VDE (Germany) and have been approved for use under the building codes of major municipalities.



Intermediate Lab Station with optional plug-ins.

OSCILLOSCOPE ORIENTATION PACKAGE



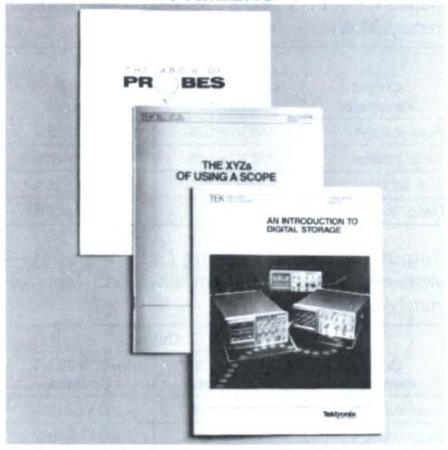
XYZs Primer set for quantity purchases.

For basic analog oscilloscope orientation, we recommend the following equipment. This equipment can also be used as part of the lab stations for beginning and intermediate electrical, electronics, and physics lab courses.

- Oscilloscope (2225, 2235, or 2245)
- Basic Training Lab, CRS101 (includes CRS10 Power Unit, plus the CRS30 General Purpose Board)
- Primer, XYZs of Oscilloscopes (quantity package 062-6731-00)
- Video Tape, 2200 Series Operation (068-0146-00)
- Poster (46-TTA-528)

See the video tapes listed on the next page for supplementary oscilloscope programs for beginning students.

PRIMERS



Shown above: ABCs of Probes, XYZs of Scopes, An Introduction to Digtal Storage.

Single complimentary copies are available from your local Tektronix Sales Office.

An Introduction to Digital Storage — Request 46-W-6051

The ABCs of Probes — Request 60-W-6053

XYZs of Using an Oscilloscope — Request 46-AX-4758-2

(Instructor's Aid) — Request 46-W-5169-2

(Workbook) — Request 46-W-5170-2

XYZs of Using an Oscilloscope Quantity Package — Includes: 50 primers; one instructor's aid, and one student workbook. (The student workbook may be reproduced for educational use without permission from Tektronix.)

Order 062-6731-00 **$120**

NEW

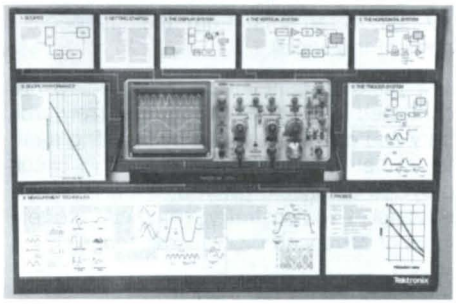
GRADUATE CLASSES AND RESEARCH

Your Tektronix Sales Representative can consult with you about recommendations for advanced classes in special technical areas, or to discuss special equipment requirements for research projects.

SPECIFIC TEKTRONIX PRODUCT TRAINING

Specific product training seminars can be held at your site or at nearby Tektronix facilities. For specific arrangements contact Customer Training at 1-800-225-7802.

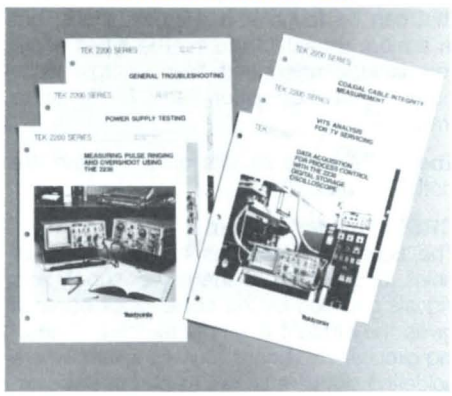
POSTER



The full color poster (2 ft x 3 ft) shows a 2215A oscilloscope front panel with call-outs of functions.

The poster follows the *XYZs of Oscilloscopes* primer (46-TTA-528) format. Complimentary copies are available from your local Tektronix Sales Office.

APPLICATION NOTES



Application Notes are available for many basic measurement concepts. Please refer to the list on page 277. New Application Notes are available throughout the year. Check with your local Tektronix Sales Engineer or call the National Marketing Center for new or existing complimentary copies.

VIDEO TAPES

The following list of video tapes is rated for beginning, intermediate or advanced students.

Beginning — Assumes little knowledge of electronics, electronic terms or related subjects. A beginning audience would be beginning physics, electronics, general science or vocational classes.

Intermediate — Assumes a basic knowledge of electronics, electronic terms, and related subjects, or introduces specialized concepts, such as frequency domain measurement. Suitable for second year, physics or electronics classes or advanced science classes.

Advanced — Assumes a specialized knowledge of electronics, electronic terms, and related subjects. Suitable for advanced classes, specifically those addressing the subject.

2200 Series Operation, Part I (Beginning) — Addresses operation of the 2213 and 2215 Portable Oscilloscopes. Follows the format of the *XYZs of Oscilloscopes* primer. (26 min).

2200 Series Operation, Part II (Intermediate) — Covers operation of the 2235 and 2236 Oscilloscopes. Covers the differences and additional features of the 2235 over the 2213. Additional features of the 2235 are demonstrated in detail using typical analog and digital waveforms (18 min).

2245/2246 GPS Operation (1986, Intermediate) — Front panel controls and typical applications using those controls are demonstrated. Advanced features section makes use of signals from the CRS101 Basic Training Lab. 22 min).

Boolean Logic, A Lighthearted Look At (1983, Intermediate) — The logical relationships between sets (AND, OR, NOT) is developed in a nontechnical fashion using mimes (8 min).

Color Video Concepts (1979, Advanced) — Explains basic principles of color television. Describes and illustrates relevant characteristics of human vision, light colorimetry. Explains primary and complementary colors. Describes and illustrates camera operation, receiver operation, color cathode-ray tubes. Demonstrates vectorscope operation (38 min).

Monochrome Video Concepts (1981, Intermediate) — Explains and graphically demonstrates concepts of monochrome video transmission and reception (30 min).

Ink Jet Copier Concepts (1983, Beginning) — Provides an overview of operation of ink jet color graphics copiers. Discusses subtractive color and presents the functional parts of the copier system and how they interrelate (10 min).

Fundamentals of Oscilloscopes: A Functional Overview (1986, Intermediate) — Designed for students with prior electronics knowledge and/or some familiarity with oscilloscopes. Functional blocks and their relation to front panel controls are graphically illustrated in four parts: Overview, Vertical Section, Horizontal Section, and Cathode Ray Tube (15 min).

Oscillo-What? What Is An Oscilloscope (1986, Beginning) — Explains what an analog oscilloscope does, how and where it is used. Introduces digitizing oscilloscopes (18 min).

Spectrum Analyzer Concepts (Intermediate) — Contrasts time domain and frequency domain frames of reference. Describes effects of spectrum analyzer construction on performance. Defines terms associated with spectrum analysis. Demonstrates typical applications (12 min).

AM Measurement (1978, Advanced) — Explains basic amplitude modulation parameters. Contrasts time domain and frequency domain measurement techniques. Discusses essential formulas and calculations. Demonstrates measurements (9 min).

FM Measurement (1979, Advanced) — Examines basic frequency modulation parameters, their appearance in the frequency domain, and their measurement with a spectrum analyzer (10 min).

Pulsed RF Measurement (1979, Advanced) — Investigates basic pulsed radio frequency characteristics and their measurement in both time and frequency domains (10 min).

Operating the 2230 Digital Storage Oscilloscope (1986, Intermediate) — 2230 operation is demonstrated by showing front panel controls and each measurement mode using typical analog and digital signals (35 min).

ORDERING INFORMATION

Video tapes are available in ¾ inch U-MATIC, Beta, or VHS. Order any tape as follows:

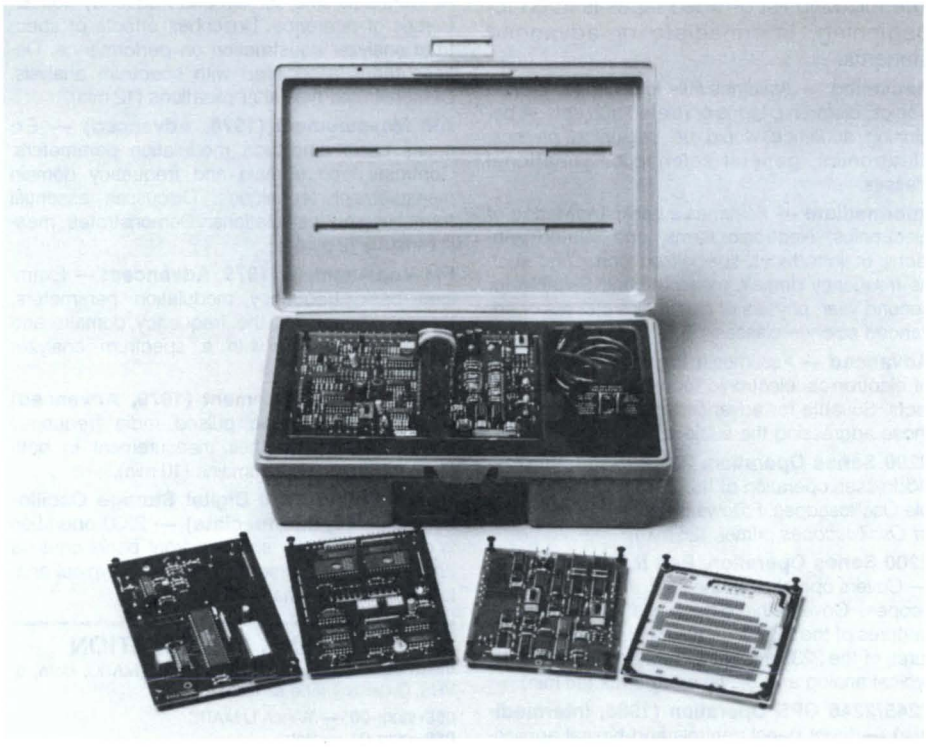
068-xxxx-00 — ¾ inch U-MATIC.
068-xxxx-01 — Beta.
068-xxxx-02 — Beta II.
068-xxxx-03 — Beta III.
068-xxxx-04 — VHS.

2200 Series Operation —	
(Part I) Order 068-0146-xx	**$175**
(Part II) Order 068-0151-xx	**$175**
2245/2246 GPS Operation —	
Order 068-0224-xx	**$60**
Boolean Logic, A Lighthearted Look At —	
Order 068-0199-xx	**$175**
Video Concepts —	
(Color) Order 068-0101-xx	**$260**
(Monochrome) Order 068-0128-xx	**$260**
Ink Jet Copier Concepts —	
(English) 068-0158-xx	**$200**
(English/German) 068-0174-xx	**$175**
Fundamentals of Oscilloscopes: A Functional Overview — Order 068-0217-xx	**$60**
Oscillo-What? What is an Oscilloscope? — Order 068-0218-xx	**$60**
Spectrum Analyzer Concepts — Order 068-0070-xx	**$200**
AM/FM/Pulsed RF Measurements —	
(AM) Order 068-0072-xx	**$200**
(FM) Order 068-0089-xx	**$200**
(Pulsed RF) Order 068-0097-xx	**$200**
Operating the 2230 Digital Storage Oscilloscope — Order 068-0209-xx	**$60**
Video Sampler — A video sampler containing previews of six education video tape programs on using oscilloscopes and test and measurement concepts to help in your selection. Call the National Marketing Center at 1-800-426-2200 and request 40-W-6468.	**NC**

Quotes for quantity purchases of one title are available from the National Marketing Center, 1-800-426-2200.

A complete list of video programs is available from Tektronix TV/Media Services 1-503-627-1586.

TRAINING LABS



CRS101 and CRS50, CRS70, CRS72, CRS90 signal boards.

CRS10 Power Unit

The CRS10 provides an integrated source of signals to teach concepts such as rise time, pulse width, frequency, digital troubleshooting, and video measurements. It is suitable for beginning through advanced courses in electrical engineering, electronics, engineering technology, or physics.

It can be invaluable for both laboratory demonstrations and student lab stations. It can be useful for in-house product training, especially in oscilloscopes. It has easily accessed test-points pins to reliably capture and measure the signals.

The Power Unit consists of a power/clock board, powered from an external transformer. The transformer*[1] provides 24 V ac centertapped, below the voltage levels considered hazardous by U.L. The transformer, power/clock board and one other board (several are available, see following) are stored and operated in a tray in the carrying case. There is additional storage room below the tray.

The power/clock board converts the transformer voltage to three regulated dc voltages (+12, −12, +5). Any combination of these voltages is used to power a signal board. The power section also provides a number of line related power supply signals for observation.

The clock section provides three fixed crystal controlled digital signals (10 MHz, 5 MHz, 1 MHz) and a variable rate triangular waveform. All clock and power signals are connected to the signal board through a 10-pin harmonica connector and jumper cable.

CRS30 General Purpose Board

This board is designed to exercise most oscilloscope functions by providing a variety of digital and analog signals.

Digital signals are available at ECL, TTL, and CMOS levels. Digital signals include logic, a variable pulse train, a low frequency squarewave, a variable stairstep generator (D to A converter) and fast trigger pulses.

Analog signals include a sinewave with glitch, a voltage to frequency converter, a waveform whose frequency, amplitude and slope are set by one control, and a low frequency triangle. All signals are brought out to probe test points around the board edge.

CRS50 Video Signal Board

This board is designed primarily for understanding video measurement signals and techniques. The board generates an NTSC interlaced video signal which demonstrates TV triggering capabilities of oscilloscopes. It will also make pictures on a video monitor. It should be extremely valuable for facilities that do not have NTSC generators available.

CRS70 Digital Pattern Board

This board was designed specifically to teach how to use the functions of the Word Recognizer, Delay by Events, and Boolean Trigger of the Tektronix Counter/Timer/Trigger optioned 2445A and 2465A. See page 278.

The circuitry on this board generates a repeating series of 16-bit wide digital pattern, words. These patterns can be single stepped or driven by the 1 MHz clock. A series length can be set in multiples of 256 bits, to a maximum of 4096. Both the starting and ending addresses can be set in 256 bit increments, from their respective ends of the series.

The patterns generated on this board are contained in EPROMs, they are entirely arbitrary and can be changed by installing a different set of EPROMs. An additional circuit provides a variable glitch at a 1 kHz rate. It is useful in demonstrating glitch capture features of advanced digital oscilloscopes.

CRS72 Digital Fault Board

The Digital Fault Board was designed as a demonstration aid for the 2467 Oscilloscope, which has a microchannel-plate CRT. Most oscilloscopes will not be able to display the signal faults found on this board. It will be helpful primarily for teaching the use of the 2467 in training labs.

The board induces timing errors in its circuits. These errors replicate timing errors that can be found in real-life situations, but in a more repeatable form. The types of errors include noise and timing-margin violations, clock corruption, and faulty state transitions.

The six separate circuits on this board are both ECL and TTL.

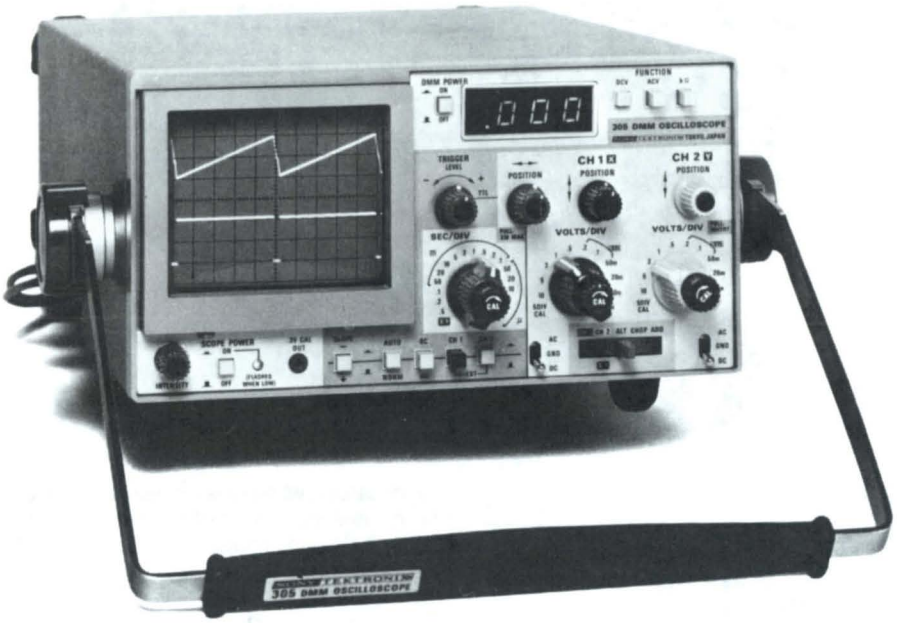
CRS90 Builder's Board

The Builder's Board has a grid pattern of holes, and access to the power supply and signals provided by the power/clock board. It gives the student a simple method of building circuits. This board is useful in labs where soldering skills are taught as part of basic circuit building and measurement course.

ORDERING INFORMATION

CRS101 Basic Training Lab **Includes:** CRS10 Power Unit; CRS30 General Purpose Board; manual.	**$385**
CRS10 Power Unit*[1] **Includes:** Instruction manual. Each of the following boards require a CRS10 Power Unit for operation.	**$255**
CRS30 General Purpose Board	**$200**
CRS50 Video Signal Board	**$115**
CRS70 Digital Pattern Board	**$180**
CRS72 Digital Fault Board	**$225**
CRS90 Builder's Board	**$135**
Instruction Manual — Order 070-5391-00	**$25**

[1] For information about international transformer availability for the CRS10, contact your Tektronix Sales Representative.



305

5 MHz at 5 mV/Div

Dual Trace/DMM

Internal Battery Pack

Full X-Y

Weighs ≈10.6 lb

TYPICAL APPLICATIONS

Electromechanical Measurements
Medical Electronics Maintenance
Automotive/Motor Vehicle

See page 277 for available Application Notes.

The 305 DMM/Oscilloscope is the ideal oscilloscope for those who demand portability and multifunction versatility in their test instrumentation.

The SONY®/TEKTRONIX® 305 combines a 5 MHz oscilloscope with a precise integral autoranging DMM and a built-in rechargeable battery pack. Take the 305 instead of multiple instruments when you climb the ladder to maintain your in-plant industrial controls. Or leave the extension cord at your bench when you go on location to service medical instrumentation.

The 305 features a dual-trace 5 MHz oscilloscope with a large 8 x 10 div (0.6 cm/div) CRT display and an autoranging DMM with dc and ac volts, and resistance measurement functions—all in a 10.6 lb (4.8 kg), 4.4 x 9.3 x 14.6 inch (11.2 x 23.6 x 37.1 cm) package. The front panel TTL marker presets the trigger generator for optimum level control on TTL signals.

CHARACTERISTICS

VERTICAL SYSTEM

Bandwidth — Dc to at least 5 MHz. For ac coupling, the lower 3 dB point is ≈10 Hz.

Deflection Factor — 5 mV/div to 10 V/div (1-2-5 sequence) accurate ±3% from 0°C to +40°C, ±4% through remainder of operating range. Uncalibrated, continuously variable between steps and to at least 25 V/div.

Display Modes — CH 1, CH 2, Chopped, Alternate, Added, Invert CH 2 and X-Y. Bandwidth in Add mode is dc to at least 4.5 MHz.

Input R & C — 1 MΩ ±2%, paralleled by ≈47 pF.

Maximum Input Voltage — Ac or dc coupled, 250 V (dc + peak ac), or 250 V p-p at <1 kHz.

HORIZONTAL SYSTEM

Time Base — 500 ms/div to 1 μs/div (1-2-5 sequence). X10 magnifier extends sweep rate to 0.1 μs/div.

Variable Time Control — Uncalibrated, continuously variable between steps and to at least 1.25 s/div.

Time Base Accuracy*1

	0°C to +40°C	−15°C to +55°C
Unmagnified	±3%	±4%
Magnified	±5%	±6%

1 Center 8 divisions (excludes first 10 divisions and all sweep past 90 divisions in X10 magnifier).

TRIGGERING

Modes — Normal and Auto (p-p).

TTL Triggering — TTL position of trigger level control presets for optimum triggering from TTL levels, in 50 mV, 0.1 V and 0.2 V/div or external trigger signals.

Trigger Sources — Internal CH 1, internal CH 2, external. TTL Threshold voltage, internal (with 10X probe) 1.4 V within ±0.3 V, External (with 10X probe) 1.4 V within ±0.2 V.

Trigger Sensitivity in Normal Mode

Coupling	To 0.5 MHz	At 5 MHz
Dc Internal	0.3 div	0.75 div
Dc External	15 mV	50 mV
Ac	Requirements increase below 60 Hz	

P-P Auto Operation Sensitivity

Coupling	500 Hz to 0.5 MHz	0.5 MHz to 5 MHz
Dc, Ac Internal	0.5 div	1.0 div
Dc, Ac External	35 mV	70 mV

External Trigger — Maximum Input Voltage: 250 V (dc + peak ac) at 1 kHz or less (same as vertical). Input R and C: ≈1 MΩ paralleled by ≈47 pF.

X-Y OPERATION

Input — X-axis input is via the CH 1 connector; Y-axis input is via the CH 2 connector.

X-Y Characteristics — Same as stated for vertical deflection, except deflection factor accuracy is ±4% from 0°C to +40°C over the center 8 div.

X-Axis Bandwidth — Dc to 150 kHz.

CRT AND DISPLAY FEATURES

CRT — 8 x 10 div (0.632 cm/div) display. Accelerating potential is 2 kV. GH (P31) phosphor standard.

Graticule — Internal, nonilluminated.

DMM

DC VOLTAGE

Ranges — 2 V, 20 V, 200 V, 1000 V (autoranging).

Accuracy — Within 0.1% of reading, ±2 counts.

Common-Mode Rejection — >100 dB at dc, 80 dB at 60 Hz with 1 kΩ imbalance.

Normal-Mode Rejection — >30 dB at 60 Hz increasing 20 dB per decade to 2 kHz.

Response — <1 s plus range step time (<1 s/step).

Input R — 10 MΩ ±2%.

Maximum Input Voltage — ±1000 V (dc + peak ac) between HI and LO inputs or between HI and chassis. ±500 (dc + peak ac) between LO and chassis (LO Floating Voltage).

AC VOLTAGE

Ranges — 2 V, 20 V, 200 V, 700 V, (autoranging).

Accuracy — Within 0.5% of reading, ±10 counts, 40 Hz to 500 Hz.

Response Time — <5 s plus range step time (<1 s/step).

Input Impedance — 10 MΩ paralled by ≈70 pF.

Maximum Input Voltage — 700 V RMS if sinusoidal. ±1000 V (dc + peak ac) between HI and LO inputs or between HI and chassis. ±500 V (dc component) between HI and LO inputs. ±500 V (dc + peak ac) between LO and chassis (LO Floating Voltage).

RESISTANCE

Ranges — 2 kΩ, 20 kΩ, 200 kΩ, 2000 kΩ.

Accuracy — Within 0.6% of reading ±3 counts.

Response Time — <5 s plus range step time (<1 s/step).

Maximum Input Voltage — ±100 V (dc + peak ac) between HI and LO inputs. 500 V (dc + peak ac) between LO and chassis (LO Floating Voltage).

OTHER CHARACTERISTICS

Amplitude Calibrator — 0.3 V accurate ±1% from 20°C to 30°C ±2% from −15°C to +55°C.

POWER REQUIREMENTS

Line Voltage Range — 90 V ac to 132 V ac or 180 V ac to 250 V ac.

Line Frequency — 48 Hz to 440 Hz.

Maximum Power Consumption — 17 W.

External Dc Source — +9 V to +32 V.

Charge Time — At least 16 hours for full charge.

Operating Time — Internal NiCad batteries provide ≈1.6 hours of scope and DMM operation, 10 hours of DMM alone operation, or two hours of scope alone operation at maximum trace intensity and 20°C to 25°C operating temperature.

ENVIRONMENTAL

Ambient Temperature — Operating: −15°C to +55°C (Oscilloscope), 0°C to +55°C (DMM). Nonoperating: −25°C to +75°C.

Altitude — Operating: To 9000 m (30,000 ft) maximum, decrease maximum temperature by 1°C/1000 ft from 5,000 ft to 30,000 ft. Nonoperating: To 15 000 m (50,000 ft) maximum.

Vibration — 15 minutes along each of the 3 major axes, 0.025 in (0.06 cm) p-p displacement (4 g's at 55 Hz) 10 Hz to 55 Hz to 10 Hz in 1 minute cycles.

Humidity — Nonoperating: 5 cycles (120 hours) of MIL-E-16400G. Omit freezing and vibration and allow a post-test drying period at +25°C, ±5°C and 20% to 80% relative humidity.

Shock — Operating and Nonoperating: 30 g's, ½ sine, 11 ms duration. Total of 12 shocks.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width, with handle	236	9.3
Height	112	4.4
Depth, handle not extended	371	14.6
Depth, handled extended	458	18.0
Weight≈	**kg**	**lb**
Net, without accessories	4.8	10.6
Shipping	7.8	17.1

ORDERING INFORMATION

305 DMM/Oscilloscope **$2,765**

Includes: Two P6149A 10X probes; carrying case (016-0401-00); carrying case cover (200-2260-00); carrying strap assembly (346-0131-02); DMM probe package; clear CRT filter (331-0394-01); blue CRT filter (378-2016-01); external dc cable assembly (012-0406-00); service manual (070-2423-01); operator manual (070-2424-00).

The SONY®/TEKTRONIX® 305 DMM/Oscilloscope is manufactured and marketed in Japan by Sony/Tektronix Corporation, Tokyo, Japan. Outside of Japan the 305 is available from Tektronix, Inc., its marketing subsidiaries and distributors.

OPTIONAL ACCESSORIES

Viewing Hood — Order 016-0297-00 **$2.10**

Adaptor Connector — BNC to binding post. Order 103-0033-00 **$5.95**

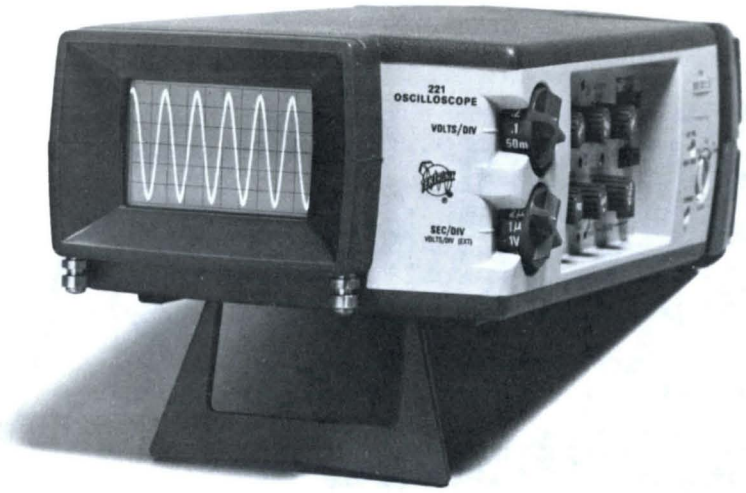
RECOMMENDED CAMERA

C-30BP Option 01 — General purpose camera. See page 450. **$1,480**

Camera Adaptor — Required to mount the C-30BP Camera to the 305. Order 016-0327-01 **$170**

RECOMMENDED CART

K212 Portable Instrument Cart — For on-site mobility. See page 461. **$330**



221

5 MHz, 5 mV/Div to 100 V/Div

0.1 μs/Div Sweep Rate With X10 Sweep Magnifier

Internal Battery Pack

Integral 1 MΩ Probe

Weighs ≈1.6 kg (3.5 lb)

TYPICAL APPLICATIONS

Communication Equipment Service
Electromechanical Measurements
Industrial Plant Maintenance

See page 277 for available Application Notes.

The 221 Miniscope weighs just 3.5 pounds and measures only 3 x 5.2 x 9 inches. It easily fits into a tool box or brief case, yet has the capability needed for on-site service of much of today's complex equipment. This versatile miniscope has a 5 MHz bandwidth, 5 mV/div sensitivity, and 0.1 μs/div sweep rate (using X10 magnifier) packaged in an impact-resistant case.

Internal rechargeable batteries allow at least two hours operation away from external power sources. And the 221 will operate and charge from practically all the world's principal line voltages: 90 V to 250 V, 48 Hz to 62 Hz ac, or 80 V to 250 V dc (all without making any change to the instrument).

The 1 MΩ low-capacitance probe minimizes circuit loading. And because it's attached, it's always there when you need it. Vertical deflection factors extend from 5 mV/div, allowing on-screen measurement of signals up to 600 V dc + peak ac. The 1 μs/div to 200 ms/div time base is enhanced by a X10 magnifier that extends the fastest range to 0.1 μs/div. A variable control will slow the sweep to about 0.5 s/div.

A single rotary control on the 221 is used for all trigger level and slope functions. Controls are side mounted and recessed for protection, yet are easily accessible.

In applications where it is necessary to "float" the oscilloscope to make your measurements, 200 Series miniscopes can be elevated to 700 V (dc + peak ac) above ground when operated from batteries. Although insulated, caution should be observed when connecting the probe to test points.

The 221 is used in a wide assortment of service applications. For example, in data transmission systems, the 221 is preferred for maintenance and testing of modems because of its ability to see higher frequency noise. It can even help in building roads by spot checking motors in a road grader's closed loop servo system that controls blade angle, depth of cut and machine direction.

CHARACTERISTICS

VERTICAL SYSTEM

Bandwidth (−3 dB point) — Dc to 5 MHz at all calibrated deflection factors. Lower −3 dB point ac coupled is ≈2 Hz.

Deflection Factor — 5 mV/div to 100 V/div, accurate ±3% from 0°C to +40°C and ±5% from −15°C to 0°C and +40°C to +55°C. Uncalibrated; Continuously variable between steps to at least 300 V/div.

Input R and C — ≈1 MΩ paralleled by ≈29 pF via attached signal acquisition probe.

Maximum Input Voltage — 600 V (dc + peak ac), 600 V p-p ac, 5 MHz or less.

HORIZONTAL SYSTEM

Time Base — 1 μs/div to 200 ms/div, accurate ±3%.

Magnifier — Increases all sweep speeds X10 with a maximum sweep speed of 0.1 μs/div.

Variable Time Control — Extends minimum sweep rate to ≈0.5 s/div. Continuously variable between calibrated settings.

TRIGGERING

Modes — Automatic or manual. Level and slope selected with a single control. Automatic operation minimizes trigger adjustment and provides a bright baseline with no input.

Trigger Sensitivity

Source	To 1 MHz	At 5 MHz
Internal	0.5 div	1 div
External	0.5 V	1 V

To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext. 99

X-Y OPERATION

Input — X-axis input is via the external trigger or the external horizontal input.

X-Axis Deflection Factor — 1 V/div ±10%, dc to 500 kHz. Sensitivity is increased by a factor of 10 (0.1 V/div) using horizontal magnifier.

Maximum External Horizontal Input Voltage — 200 (dc + peak ac), 200 V (p-p ac) to 500 kHz, decreasing to 20 V p-p ac at 5 MHz.

Input Impedance — ≈0.5 MΩ paralleled by ≈30 pF.

CRT AND DISPLAY FEATURES

CRT — 6 x 10 div (0.52 cm/div) display. Accelerating potential is 1 kV. GH (P31) phosphor standard.

Graticule — Internal, black line, nonilluminated.

OTHER CHARACTERISTICS

Insulation Voltage — 500 V RMS or 700 V (dc + peak ac) when operated from internal batteries, with the line cord stored and the plug protected. When operated from an external line, line voltage plus floating voltage not to exceed 250 V RMS; or 1.4 times line + (dc + peak ac) not to exceed 350 V.

Power Sources — Internal NiCad batteries provide at least 2 hours operation at maximum trace intensity for a charging and operating temperature between +20°C and +30°C. Internal charger charges the batteries when connected to an ac line with instrument turned on or off. Dc operation is automatically interrupted when battery voltage drops to ≈10 V to protect batteries against deep discharge. Full recharge requires ≈16 hours. Extended time charges will not damage the batteries. An expanded scale battery meter indicates full, low, and recharge.

POWER REQUIREMENTS

Line Voltage Range — 90 V ac to 250 V ac or 80 V ac to 250 V ac.

Line Frequency — 48 Hz to 62 Hz.

Maximum Power Consumption — 5 W.

ENVIRONMENTAL

Ambient Temperature — Operating (Battery only): −15°C to +55°C. Charging or Operating from Ac Line: 0°C to +40°C. Nonoperating: −40°C to +60°C.

Altitude — Operating: 7600 m (25,000 ft), decrease maximum temperature by 1°C/1000 ft above 15,000 ft. Nonoperating: 15 000 m (50,000 ft).

Vibration — Operating and Nonoperating: 15 minutes along each of the 3 major axes, 0.06 cm (0.025 in) p-p displacement (4 g's at 55 Hz) 10 Hz to 55 Hz to 10 Hz in 1 minute cycles. Held for 3 minutes at 55 Hz.

Humidity — 5 days at +50°C, 95% humidity.

Shock — Operating and Nonoperating: 100 g's, ½ sine, 2 ms duration each direction along each major axis. Total of 12 shocks.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	133	5.2
Height	76	3.0
Depth	228	9.0
Weight≈	**kg**	**lb**
Net, without accesssories	1.6	3.5
Shipping	3.6	8.0

ORDERING INFORMATION

221 Oscilloscope **$2,315**

Includes: Integral probe, batteries, viewing hood (016-0199-01); carrying case (016-0512-00); neck strap (346-0104-00); two spare fuses (159-0080-00); service manual (070-1573-01); operator manual (070-1572-00).

OPTIONAL ACCESSORIES

Alligator Clip Kit — A pair of alligator clips that allow connecting the probe and ground lead to large (up to ⅜ inch) conductors. Includes: red clip (015-0229-00); yellow clip (015-0230-00); 6-32 to probe adaptor (103-0051-01). Order 015-0231-00 **$9.50**

Probe Tips — (To BNC Panel Connector Adaptor) Order 013-0084-01 **$9.75**

(To BNC Cable Adaptor) Order 103-0096-00 **$13.50**

Power Cable Adaptor Assembly — A short length of two-wire power cord. One end has a female NEC socket fitting the 200 Series power cords; the other end is left open so that the wires can be attached to a non-NEC male power plug. Plugs not supplied. Order 161-0077-01 **$9.00**

213

1 MHz at 20 mV/Div

0.4 μs/Div Sweep Rate With X10 Sweep Magnifier

DMM and Miniscope in One Unit

Rugged Construction

Internal Battery Pack

Compact, Weighs ≈1.7 kg (3.7 lb)

True RMS Voltage & Current Measurements

TYPICAL APPLICATIONS

Power Equipment Measurements
Medical Electronics Maintenance
Industrial Control Systems

See page 277 for available Application Notes.

The 213 combines a precision 3½ digit digital multimeter and a 1 MHz oscilloscope in one instrument. It is a compact (3 x 5.2 x 8.9 inches) and lightweight (only 3.7 pounds) package that will fit easily into your briefcase or tool kit.

In operation, the lightweight 213 can be hand held, rested on the equipment being tested or carried conveniently on a neck-strap. Operating controls are designed for speedy measurements and easy understanding.

Rugged construction enables the 213 to withstand hostile industrial or transportation environments.

In applications where it is necessary to "float" the oscilloscope to make your measurements, 200 Series miniscopes can be elevated to 700 V (dc + peak ac) above ground when operated from batteries. Although insulated, caution should be observed when connecting the probe to test points.

The 213, combining both oscilloscope and DMM functions, fits many on-site service applications. As an example, the 213 is used extensively for preventive maintenance on industrial control systems.

CHARACTERISTICS

VERTICAL SYSTEM (VOLTAGE)

Bandwidth — Dc to 1 MHz (−3 dB point) for 20 mV/div to 100 V/div deflection factors. Dc to 400 kHz (−3 dB point) for 5 mV/div and 10 mV/div. Lower −3 dB point for ac coupling is ≈1 Hz.

Deflection Factor — 5 mV/div to 100 V/div (1-2-5 sequence). Accuracy: ±3%. Uncalibrated: Continuously variable between steps to at least 250 V/div.

Input R and C — 10 MΩ paralleled by 150 pF for 5 mV/div through 1 V/div and 100 pF for 2 V/div through 100 V/div.

Maximum Input Voltage

Input Condition	Maximum Input Voltage
Dc coupled, 5 mV/div to 1 V/div	500 V (dc + peak ac) at 1 MHz or less
Ac coupled, 5 mV/div to 1 V/div	800 V (dc + peak ac) 500 V peak ac component
Ac, Dc coupled, 2 V/div to 100 V/div	800 V (dc + peak ac) at 1 MHz or less

VERTICAL SYSTEM (CURRENT)

Bandwidth — Dc to at least 400 kHz (−3 dB point) for 20 μA/div through 100 mA/div deflection factors. Dc to at least 200 kHz (−3 dB point) for 5 μA/div and 10 μA/div.

Deflection Factor — 5 μA/div to 100 mA/div (1-2-5 sequence). Accuracy: ±3%. Uncalibrated: Continuously variable between steps to at least 250 mA/div.

Maximum Input Current — 2 A RMS or 3 A peak for any range (fuse and diode protection).

HORIZONTAL SYSTEM

Time Base — 2 μs/div to 500 ms/div (1-2-5 sequence). Accuracy: ±5%.

Variable Magnifier — Increases all sweep speeds to at least X5 with a maximum sweep speed of 0.4 μs/div.

TRIGGERING

Modes — Normal (sweep runs when triggered). Automatic (sweep free-runs in absence of trigger signal or for frequencies below 7 Hz).

Trigger Sensitivity and Coupling — Ac Internal: (Auto and Normal 1 MHz) 0.5 div. Dc External: 1 MHz, 1 V.

CRT AND DISPLAY FEATURES

CRT — 6 x 10 div (0.52 cm/div) display. GY (P43) phosphor.

Graticule — Internal, black line, nonilluminated.

OTHER CHARACTERISTICS

Insulation Voltage — 500 V RMS or 700 V (dc + peak ac) when operated from internal batteries with line cord and plug stored. When operated from ac, line voltage plus floating voltage not to exceed 250 V RMS or 1.4X line + (dc + peak ac) not to exceed 350 V.

Power Sources — Internal NiCad batteries provide three to five hours operation at maximum trace intensity for a charging and operating temperature between +20°C and +30°C. Internal charger charges batteries when connected to an ac line with instrument turned on or off. Dc operation is automatically interrupted when battery voltage drops below 2 V to protect batteries against deep discharge. Full recharge requires ≈16 hours.

POWER REQUIREMENTS

Line Voltage Range — 90 V ac to 136 V ac. Option 01 is 180 V ac to 250 V ac.

Line Frequency — 48 Hz to 62 Hz.

Maximum Power Consumption — 8 W.

ENVIRONMENTAL

Ambient Temperature — Operating (Battery Only): −15°C to +55°C. Charging or Operating from Ac Line: 0°C to +40°C. Nonoperating: −40°C to +60°C.

Altitude — Operating: To 7500 m (25,000 ft), decrease maximum temperature by 1°C/1,000 ft above 15,000 ft. Nonoperating: 12 500 m (40,000 ft).

Vibration — Operating and Nonoperating: 15 minutes along each of the 3 major axes, 0.06 cm (0.025 in) p-p displacement (4 g's at 55 Hz) 10 Hz to 55 Hz to 10 Hz in 1 minute cycles. Held for 3 minutes at 55 Hz.

Humidity — +40°C or less, 80% or less relative humidity.

Shock — Operating and Nonoperating: 150 g's, ½ sine, 2 ms duration in each direction along each major axis. Total of 12 shocks.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	133	5.2
Height	76	3.0
Depth	226	8.9
Weight≈	**kg**	**lb**
Net (without accessories)	1.7	3.7
Shipping	3.9	8.6

DMM

Provides true RMS readings of voltage and current.

DC AND AC VOLTAGE

Range — 0.1 V to 1000 V full scale in five ranges.

Resolution — 100 μV at 0.1 V full scale.

Accuracy in Dc Mode — For +25°C ±5°C.

Range*1

0.1 V	±0.1% of reading ±3 counts. Temp coef is (±0.015% of reading +0.04% of full scale)/°C
1 V	±0.1% of reading ±1 count. Temp coef is (±0.01% of reading +0.01% of full scale)/°C
10 V and 100 V	±0.15% of reading ±1 count. Temp coef is (±0.015% of reading +0.01% of full scale)/°C
1000 V	±0.2% of reading ±1 count. Temp coef is (±0.02% of reading +0.01% of full scale)/°C

1 Full scale.

Accuracy in RMS Mode — For 25°C ±5°. Temperature coefficient (±0.05% of reading +0.1% of full scale)/°C.

Range	Within % of reading shown ±5 counts*1		
	Dc	40 Hz to 4 kHz	4 kHz to 40 kHz
0.1 V	2.5%	1.5%	3.5%
1 V, 10 V, & 100 V	2%	1%	1%
1000 V	2%	1%	2%

1 Accuracy limit increases linearly for crest factor >2 up to twice indicated limit for crest factor of five.

Input Resistance — 10 MΩ.

Input Capacitance — 150 pF on 0.1 V to 10 V ranges, 100 pF on 100 V and 1000 V ranges.

Settling Time — Dc: 1.5 s to 0.1% of reading. RMS: 2 s to 1% of reading.

Maximum Input Voltage

Range	Dc Coupled	Ac Coupled
0.1 V to 10 V	500 V*1	800 V*1
100 V to 1000 V	800 V*1	

1 Dc + peak ac.

DC AND AC CURRENT

Range — 0.1 mA to 1000 mA full scale in five ranges.

Resolution — 100 nA at 0.1 mA full scale.

Accuracy in Dc Mode — For +25°C ±5°C.

Temperature Coef — (±0.02% of reading ±0.04% of full scale) per °C. 0.1 mA ±0.5% ±3 counts. 1 mA to 1000 mA ±0.25% ±3 counts.

Accuracy in Ac Mode

Range	Within % of reading shown ±5 counts*1		
	Dc	40 Hz to 4 kHz	4 kHz to 40 kHz
0.1 mA	2.5%	1.5%	4.5%
1 mA to 1000 mA	2.5%	1.5%	3.5%

1 Accuracy limit increases linearly for crest factor >2 up to twice the indicated limit for crest factor of five.

Settling Time — 1.5 s to 0.1% of reading.

Maximum Input Current — 2 A RMS or 3 A peak on any scale (fuse and diode protection).

RESISTANCE

Ranges — 1 kΩ to 10 MΩ full scale in five ranges.

Resolution — 1 Ω on 1 kΩ scale.

Accuracy — For 25°C ±5°C.

Range	% of Reading
1 kΩ	0.5% ±3 counts
10 kΩ to 1 MΩ	0.5% ±1 count
10 MΩ	1% ±1 count

Settling Time — Two seconds ±2 counts.

READOUT

Number of Digits — 3½ digits plus decimal point and sign.

Display Size — 1 cm high by 4 cm wide (five characters).

Over-Range Capability — At least 200% of full scale.

Over-Range Indication — Displays scrambled characters.

ORDERING INFORMATION

213 Miniscope/DMM **$2,900**

Includes: Integral probe, batteries, viewing hood (016-0199-01); carrying case (016-0512-00); two alligator clip to banana jack test leads (red 012-0015-00, black 012-0014-00); neck strap (346-0104-00); two power line fuses (159-0080-00); identification tag (334-2614-00); identification tag (000-7983-00); service manual (070-1481-00); operator manual (070-1480-00).

Option 01 — 180 V ac to 250 V ac (48 Hz to 62 Hz) or dc. **NC**

Includes: In addition to above, power line plug (161-0077-01).

OPTIONAL ACCESSORIES

Alligator Clip Kit — A pair of alligator clips that allow connecting the probe and ground lead to large (up to ⅜ in) conductor. Includes: red clip (015-0229-00); yellow clip (015-0230-00); 6-32 to probe adaptor (103-0051-01).
Order 015-0231-00 **$26**

Probe Tips — (To BNC Panel Connector Adaptor) Order 013-0084-01 **$9.75**
(To BNC Cable Adaptor) Order 103-0096-00 **$13.50**

Power Cable Adaptor Assembly — An 11 inch two-wire power cord. One end has a female NEC socket fitting the 200 Series power cords; the other end is left open so that the wires can be attached to a non-NEC male power plug. Plugs not supplied.
Order 161-0077-01 **$9.00**

PORTABLE OSCILLOSCOPES

To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext. 99

212

500 kHz, 1 mV/Div to 50 V/Div

Internal Battery Pack

Integral 1 MΩ Probe

Weighs ≈1.6 kg (3.5 lb)

TYPICAL APPLICATIONS

Electromechanical Measurements
Biomedical

See page 277 for available Application Notes.

The 212 features these signal acquisition capabilities: bandwidth to 500 kHz with deflection factors from 1 mV/div to 50 V/div. It is lightweight (only 3.5 pounds) and compact (3 x 5.25 x 9.5 inches).

Built of impact-resistant plastic and fully self-contained, this miniature portable is perfect for applications in severe environments. And it permits "floating" measurements since it is double insulated and can be elevated to 700 V (dc + peak ac) above ground when operated from batteries. Although insulated, normal caution should be observed when connecting the oscilloscope probe to the test point.

The 212 features integral probes that are color matched with the vertical deflection controls to minimize measurement error. The probes have their own storage space and are part of the instrument—you can't forget and leave them behind. Clip-on 10X attenuators are available for higher voltage applications.

Trigger level and slope functions are simplified to one rotary control on the side of the unit. A convenient neckstrap is an included accessory, freeing both hands to perform other tasks.

CHARACTERISTICS

VERTICAL SYSTEM

Bandwidth — Dc to at least 500 kHz from 10 mV/div to 50 V/div, reducing to at least 100 kHz at 1 mV/div. Lower −3 dB point ac coupled is ≈2 Hz.

Deflection Factors — 1 mV/div to 50 V/div (1-2-5 sequence). Accuracy: ±5%. Uncalibrated: Continuously variable between steps to at least 125 V/div.

Display Modes — CH 1 only, CH 2 only, or CH 1 and CH 2 Chopped (chop rate ≈50 kHz) from 500 ms/div to 2 ms/div of time base, alternate from 1 ms/div to 5 μs/div of time base.

Input R and C — ≈1 MΩ paralleled by ≈160 pF from 1 mV/div to 50 mV/div; and 140 pF from 100 mV/div to 50 V/div.

Maximum Input Voltage[*1]

1 mV/div to 50 mV/div	600 V (dc + peak ac) ac not over 2 kHz.
0.1 V/div to 50 V/div	600 V (dc + peak ac) 600 V p-p ac 5 MHz or less

*[*1] 1X probe only.*

HORIZONTAL SYSTEM

Time Base — 5 μs/div to 500 ms/div, accurate ±5%.

Variable Magnifier — Increases each sweep rate X5 with a maximum sweep speed of 1 μs/div.

External Horizontal Input — (CH 1) 1 mV/div to 50 V/div ±10%; dc to 100 kHz: X-Y phasing to 5 kHz <3°. Input characteristics same as CH 1.

Maximum External Horizontal Input Voltage and Impedance — Same as for vertical inputs.

TRIGGERING

Modes — Automatic or normal. Level and slope selected with a single control. Automatic operation minimizes trigger adjustment and provides a bright baseline with no input. In dual-channel operation at a setting of 1 mV/div, a bright baseline may not appear in the Auto Trigger Mode.

Trigger Sensitivity and Coupling

Dc Coupling	To 500 Hz
Internal with composite trigger source	0.2 div
Internal with CH 2 trigger source	0.2 div
External	1 V

Maximum External Trigger Input Voltage — 8 V (dc + peak ac), 16 V (p-p ac) at 500 kHz or less.

Input Impedance — R and C, 1 MΩ paralleled by ≈30 pF.

CRT AND DISPLAY FEATURES

CRT — 6 x 10 div (0.52 cm/div) display. GH (P31) phosphor standard.

Graticule — Internal, black line, nonilluminated.

OTHER CHARACTERISTICS

Insulation Voltage — 500 V RMS or 700 V (dc + peak ac) when operated from internal batteries, with the line cord and plug stored. When operated from ac, line voltage plus floating voltage not to exceed 250 V RMS; or 1.4X line + (dc + peak ac) not to exceed 350 V.

Power Sources — Internal NiCad batteries provide ≈three to five hours operation for a charging and operating temperature between +20°C and +30°C. Internal charger charges the batteries when connected to an ac line with instrument turned off. Battery operation is automatically interrupted when battery voltage drops to ≈10 V to protect batteries against deep discharge. Full recharge requires ≈16 hours. Extended charge times will not damage the batteries.

A pilot light battery-charge indicator light will extinguish when oscilloscope has about ten minutes of operating time remaining in the batteries.

POWER REQUIREMENTS

Line Voltage Range — 110 V ac to 126 V ac. Can be operated at 104 V ac to 110 V ac with resulting slow discharge of internal batteries. Option 01 is 220 V to 250 V. Option 02 is 90 V to 110 V.

Line Frequency — 58 Hz to 62 Hz. Options 01 and 02 are 48 Hz to 52 Hz.

Maximum Power Consumption — 3 W.

ENVIRONMENTAL

Ambient Temperature — Operating (Battery only): −15°C to +55°C. Charging or Operating from Ac Line: 0°C to +40°C. Nonoperating: −40°C to +60°C.

Altitude — Operating: 7500 m (25,000 ft), decrease maximum temperature by 1°C/1000 ft above 15,000 ft. Nonoperating: 15 000 m (50,000 ft).

Vibration — Operating and Nonoperating: 15 minutes along each of the three major axes. 0.06 cm (0.025 in) p-p displacement (4 g's at 55 Hz) 10 Hz to 55 Hz to 10 Hz in 1 minute cycles. Held for 3 minutes at 55 Hz.

Humidity — 95%, five cycles (120 hours). Referenced to MIL-T-28800C, par 4.5.5.1.2.2.

Shock — Operating and Nonoperating: 150 g's, ½ sine, 2 ms duration in each direction along each major axis. Total of 12 shocks.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	133	5.3
Height	76	3.0
Depth	241	9.5
Weight≈	**kg**	**lb**
Net, without accessories	1.6	3.5
Shipping	3.2	7.0

ORDERING INFORMATION

212 Dual Trace Oscilloscope **$2,095**
Includes: Integral probes, batteries, viewing hood (016-0199-01); carrying case (016-0512-00); two 4-A fuses (159-0121-00); identification tags (000-7983-00); identification tag (334-2614-00); carrying strap (346-0104-00); service manual (070-5053-00); operator manual (070-5052-00).

OPTIONS

Option 01 — For 220 V to 250 V (48 Hz to 52 Hz). **NC**
Includes: Batteries.

Option 02 — For 90 V to 110 V (48 Hz to 52 Hz). **NC**
Includes: Batteries.

OPTIONAL ACCESSORIES

10X Attenuator Package — A slip-on tip to provide lower circuit loading (4.4 MΩ, ≈20 pF) and higher maximum input voltage 1000 V (dc + peak ac) includes: 10X attenuator (010-0378-01); pincher tip (013-0071-00); flex tip (206-0060-00); banana tip (134-0013-00); IC adaptor (206-0203-00). Order 010-0378-01 **$70**

Alligator Clip Kit — A pair of alligator clips that allow connecting the probe (or optional 10X attenuator) and ground lead to large ⅜ in) conductors. Includes: 6-32 to probe adaptor (103-0051-01); red clip (015-0229-00); yellow clip (015-0230-00). Order 015-0231-00 **$26**

Probe Tips — (To BNC Panel Connector Adaptor) Order 013-0084-01 **$9.75**
(To BNC Cable Adaptor) Order 103-0096-00 **$13.50**

Power Cable Adaptor Assembly — A short length of two-wire power cord. One end has a female NEC socket fitting the 200 Series power cords; the other end is left open so that the wires can be attached to a non-NEC male power plug. Plugs not supplied. Order 161-0077-01 **$9.00**

To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext. 99

PORTABLE STORAGE OSCILLOSCOPES

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Now Tektronix gives you five choices in portable digital storage oscilloscopes
They build on the high value, high performance standards that Tektronix is famous for. And they set some standards of their own—in performance, price and ease of use.

2430/*NEW* 2430M

Digital Storage Oscilloscopes

GPIB IEEE-488 The 2430/2430M comply with IEEE Standard 488-1978 and with Tektronix *Standard Codes and Formats.*

- **150 MHz Bandwidth at Probe Tip**
- **5 ns/Div Sweep Speed**
- **100 MS/s Sample Rate**
- **Simultaneous Acquisition of Two Channels**
- **Envelope Mode With 2 ns Glitch Capture**
- **8 Bit Resolution Over 10 Divisions**
- **Save on Delta (Tek Patented Feature) Provides Unattended Pass/Fail Testing and Babysitting Against a User Defined Reference or Envelope**
- **Extensive Trigger Capability Such as Delay by Time, Delay By Events; Two External Trigger Inputs Provide Flexibility for Use in TTL, ECL, and Analog Circuit Applications**
- **Save Up to Six Waveforms for Later Display, Analysis and Comparison**
- **Full Screen Readout and Extensive Cursor Functions for Easy Operation and Measurements**
- **Fully GPIB Programmable for Systems and Automated Test Applications**
- **Three Year Warranty—Five Years Optional**

The Tek 2430/2430M features 150 MHz bandwidth, a 100 MS/s digitizing rate and dual channel acquisition
It's a powerful combination that lets you digitize, view and store high bandwidth and complex signals. Also offering 8-bit vertical resolution, 1K record length per channel and a .001% crystal controlled time base, the 2430 is an advanced measurement package with many sophisticated capabilities including 2 ns glitch capture at any sample rate.

2230/2220

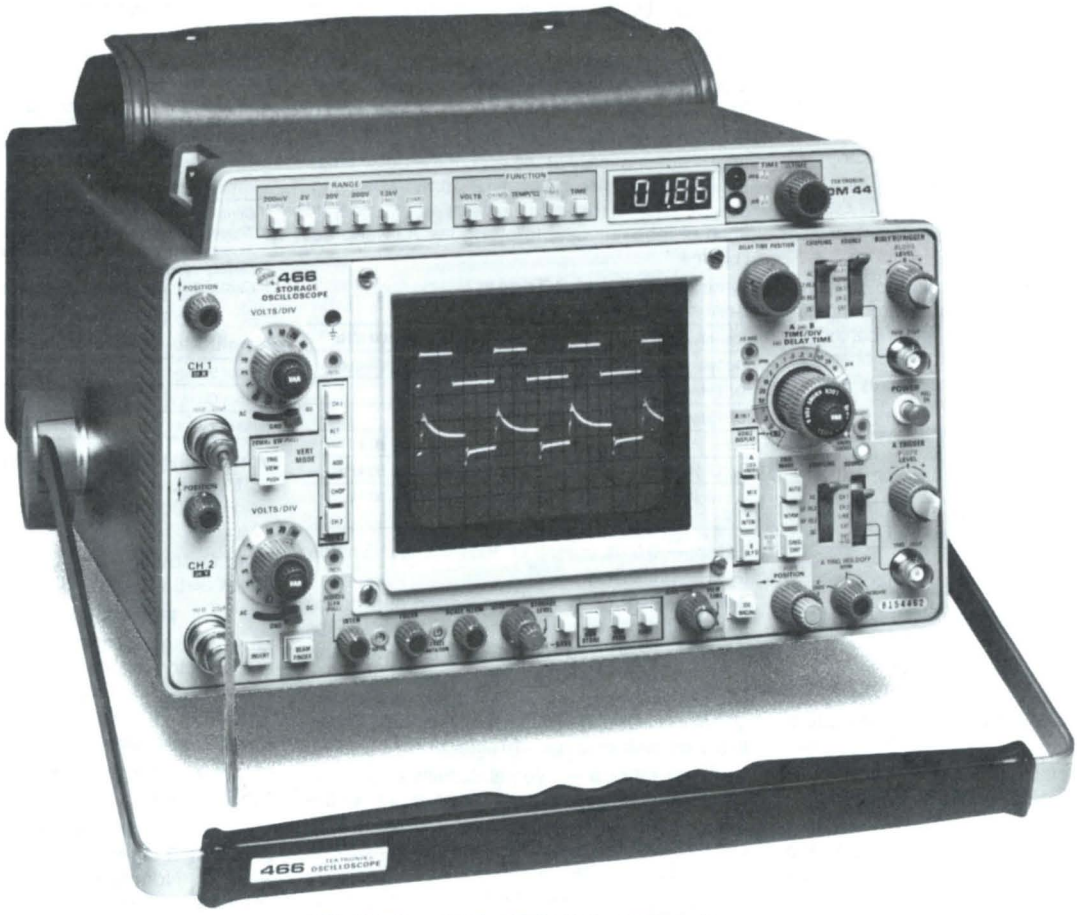
Digital Storage Oscilloscopes

GPIB IEEE-488 The 2230 Option 10 and 2220 Option 10 comply with IEEE Standard 488-1978 and use Tektronix *Standard Codes and Formats.* The 2230 Option 12 and 2220 Option 12 feature Standard RS-232C and use Tektronix *Standard Codes and Formats.*

- **100 MHz Digital Storage and Nonstorage (2230)**
- **60 MHz Digital Storage and Nonstorage (2220)**
- **100 ns Glitch Capture at Any Sweep Speed**
- **Cursors and CRT Readout for Time and Voltage Measurements (2230)**
- **Point Selectable Pre/Post Triggering**
- **4K Record Length**
- **Scan/Roll-Scan Mode for Capture of Transient Events**
- **Post Acquisition Expansion, Compression, and Positioning**
- **GPIB or RS-232C Optional**
- **26K Battery-Backed Save Reference Memory (2230 Option 10 or 12)**
- **Three Year Warranty—Five Years Optional**

If it's economy you want, for performance that's best in its class, the Tek 2230 and 2220 offer solid features at exceptional prices
Included: storage and nonstorage bandwidth of 100 MHz in the 2230 and 60 MHz in the 2220. Sampling at 20 MS/s with 8-bit vertical resolution with 100 ns glitch capture at any sweep speed. Plus 4K record length with save reference memory and expansion, compression, and positioning of save reference waveforms.

For complete descriptions see page 324.



466 with Differential Time/DMM Option (466 DM 44).

466

100 MHz at 5 mV/Div

5 ns/Div Sweep Rate With X10 Sweep Magnifier

Variable Persistence and Fast Mesh Transfer Storage Modes

3000 Div/μs Stored Writing Speed

Battery Operation (Optional)

Third Channel Trigger View

Weighs ≈11.8 kg (26 lb)

TYPICAL APPLICATIONS
Disk/Tape Drive Logic Design
Laser Pulse Analysis
Low Rep Rate Radar Pulse Analysis
Destructive Test Monitoring

See page 277 for available Application Notes.

The 466 Portable Storage Oscilloscope is designed to display nonrepetitive or slow moving signals.

Operating in a reduced scan mode, the stored writing speed is 3000 div/μs (1350 cm/μs). This instrument features two modes of storage—variable persistence and fast transfer.

The bright 8 x 10 div CRT has 0.90 cm divisions. A reduced scan 8 x 10 div graticule is superimposed over the center of the main graticule, with 0.45 cm divisions. The graticules is etched onto the inner face of the CRT to eliminate parallax problems.

A third channel trigger view allows the simultaneous display of channels 1 and 2 with the external A trigger.

Tektronix P6062B Probes provide operator convenience of 1X or 10X input attenuation at the probe tip. The correct deflection factor is automatically indicated on the front panel when the probe attenuation factor is switched.

Lightweight plus the ability to use optional, external dc power makes the 466 sufficiently portable for virtually all field measurement applications. The snap-on 1106 Battery Pack is also useful in isolating these oscilloscopes from noisy or intermittent power sources.

CHARACTERISTICS

VERTICAL SYSTEM (2 IDENTICAL CHANNELS)

Bandwidth*[1] and Rise Time — At all deflection factors from 50 Ω terminated source.

−15°C to +40°C	+40°C to +55°C
Dc to 100 MHz, ≤3.5 ns	Dc to 85 MHz, ≤4.15 ns

*[1] *Measured at −3 dB down. Bandwidth may be limited to ≈20 MHz by bandwidth limit switch. Lower −3 dB point, ac-coupling 1X probe; 10 Hz or less. 10X probe; 1 Hz or less.*

Deflection Factor — 5 mV/div to 5 V/div (1-2-5 sequence). Accuracy: ±3%. Uncalibrated: Continuously variable between steps and to ≈12.5 V/div. In cascade mode sensitivity is ≈1 mV/div. Cascaded bandwidth is at least 50 MHz when signal out is terminated in 50 Ω.

Display Modes — CH 1, CH 2 (normal or inverted), Alternate, Chopped (≈250 kHz), added, X-Y.

Common-Mode Rejection Ratio — At least 20 dB at 20 MHz for common-mode signals of 6 div or less.

Automatic Scale Factor — Probe tip deflection factors for 1X or 10X coded probes are automatically indicated by two readout lights behind the knob skirts. All lights are off when the channel is not displayed. Ground reference display selectable at probe (when dc coupled).

Input R and C — 1 MΩ ±2% paralleled by ≈20 pF.

Maximum Input Voltage

Dc Coupled	250 V (dc + peak ac) 500 V (p-p ac at 1 kHz or less)
Ac Coupled	500 V (dc + peak ac) 500 V (p-p ac at 1 kHz or less)

Delay Line — Permits viewing leading edge of displayed waveform.

HORIZONTAL SYSTEM

Time Base A — 0.05 μs/div to 0.5 s/div (1-2-5 sequence). X10 magnifier extends sweep rate to 5 ns/div.

Time Base B — 0.05 μs/div to 50 ms/div (1-2-5 sequence). X10 magnifier extends sweep rate to 5 ns/div.

Variable Time Control — Time Base A: Provides continuously variable uncalibrated sweep rates between steps and to at least 1.25 s/div. Warning light indicates uncalibrated setting.

Time Base A and B Accuracy*1

	+20°C to +30°C	−15°C to +55°C
Unmagnified	±2%	±3%
Magnified	±3%	±4%

1 Full 10 divisions.

Display Modes — A, mixed sweep, A intensified, B delayed. B ends A for increased intensity in the delayed mode.

Calibrated Mixed Sweep — Displays A sweep for period determined by Delay-Time Position control, then displays B sweep for remainder of horizontal sweep.

CALIBRATED SWEEP DELAY

Delay Time Range — 0.2 to X10 delay Time/div settings of 200 ns to 0.5 s (minimum delay time is 200 ns).

Differential Time Measurement Accuracy

Delay Time Setting	+15°C to +35°C	−15°C to +55°C
Over one or more major dial div	±1%	±2.5%
Less than one major dial div	±0.01 major dial div	±0.025 major dial div

Jitter — One part or less in 50,000 (0.002%) of X10 the A sweep time/div setting.

TRIGGERING

A Trigger Modes — Normal (sweep runs when triggered), automatic (sweep free-runs in the absence of a triggering signal and for signals below 30 Hz). Single Sweep (sweep runs one time on the first triggering event after the reset selector is pressed). Lights indicate when sweep is triggered and when single sweep is ready.

A Trigger Holdoff — Adjustable control permits a stable presentation of repetitive complex waveforms. At least 10:1 variation.

B Trigger Modes — B starts after delay time (starts automatically at the end of the delay time). B triggerable after delay time (runs when triggered). The B (delayed) sweep runs once, in each of these modes, following the A sweep delay time.

Time Base A and B Trigger Sensitivity and Coupling

Coupling	To 25 MHz	At 100 MHz
Dc Internal	0.3 div deflection	1.5 div deflection
Dc External	50 mV	150 mV
Dc External ÷ 10	500 mV	1.5 V
Ac	Requirements increase below 60 Hz	
Ac LF Reject	Requirements increase below 50 kHz	
Ac HF Reject	Requirements increase below 30 Hz and above 50 kHz	

Jitter — 0.5 ns or less at 100 MHz and 5 ns/div (X10 magnifier).

A Trigger View — A spring-loaded pushbutton overrides other vertical controls and displays the external signal used for A sweep triggering. This provides quick verification of the signal and time comparison between a vertical signal and the trigger signal. The deflection factor is ≈50 mV/div (0.5 V/div with external ÷ 10 source).

Level and Slope — Internal, permits selection of triggering at any point on the positive or negative slope of the displayed waveform. Level adjustment through at least ±2 V in external, through at least ±20 V in external ÷ 10.

A Sources — Normal, CH 1, CH 2 line, external and external ÷ 10.

B Sources — Starts after delay, normal, CH 1, CH 2 and external.

External Inputs — R and C ≈1 MΩ paralleled by ≈20 pF. 250 V (dc + peak ac) maximum input.

Third Channel Trigger View — Deflection Factor (Dc Trigger Coupling Only). Ext is: 100 mV/div ±5%. Ext ÷ 10 is: 1 V/div ±5%. Delay Difference: 5.0 ns ±0.5 ns after vertical display. Trigger Point: ≈ center screen. Rise time: ≤5 ns. Aberration: <10% p-p.

X-Y OPERATION

Full Sensitivity X-Y (CH 1 Horizontal, CH 2 Vertical) — 5 mV/div to 5 V/div. Accuracy: ±4%. Bandwidth: Dc to at least 4 MHz. Phase Difference Between Amplifiers: 3° or less from dc to 50 kHz.

CRT AND DISPLAY FEATURES

CRT — 8 x 10 div display, each div is 0.9 cm (normal); 0.45 cm/div reduced scan. Accelerating potential is 8.5 kV (normal), 10 kV (reduced scan). GH (P31) phosphor standard.

Graticule — Internal, nonparallax; variable edge lighting; markings for measurement of rise time.

Beam Finder — Compresses trace to within graticule area for ease in determining the location of an off-screen signal. A preset intensity level provides a constant brightness.

Z-Axis Input — Dc coupled, positive-going signal decreases intensity; 5 V p-p signal causes noticeable modulation at normal intensity; dc to 50 MHz.

STORED WRITING SPEEDS

Full Scan*1	Stored Writing Speed	Storage*2 View Time
Fast Transfer	67.5 cm/μs	>15 s
Variable Persistence	.225 cm/μs	>15 s
Reduced Scan*3		
Fast Transfer	135 cm/μs	>15 s
Variable Persistence	1.35 cm/μs	>15 s

1 Center 6 x 8 division; 0.9 cm/division.
2 These times are at full-stored display intensity; they can be extended at least 25 times using reduced intensity in Save Display Mode.
3 Center 8 x 10 division; 0.45 cm/division.

OTHER CHARACTERISTICS

Amplitude Calibrator

Output Voltage	0.3 V	1% +0°C to +40°C
Output Current	30 mA	2% +20°C to +30°C
Frequency	≈1 kHz	

Vertical Signal Output — CH 1 vertical signal is dc to at least 50 MHz and ≈25 mV/div terminated into 50 Ω, and ≈50 mV/div terminated into 1 MΩ.

Gate Outputs — Positive gates from both time bases (≈5 V).

POWER REQUIREMENTS

Line Voltage Range — Quick change, line voltage selector provides 110 V, 115 V, 120 V, 220 V, 230 V, and 240 V ac, each ±10%. Option 07 is 12 V dc to 24 V dc.

Line Frequency — 48 Hz to 440 Hz.

Maximum Power Consumption — 100 W at 115 V and 60 Hz.

ENVIRONMENTAL

Ambient Temperature — Operating: −15°C to +55°C. Nonoperating: −55°C to +75°C. Forced air ventilation is provided.

Altitude — Operating: To 4600 m (15,000 ft); maximum allowable ambient temperature decreased by 1°C/1000 ft from 5,000 ft to 15,000 ft. Nonoperating: To 15 000 m (50,000 ft).

Vibration — Operating: 15 minutes along each of the three axes, 0.06 cm (0.025 in) p-p displacement (4 g's at 55 Hz) 10 Hz to 55 Hz to 10 Hz in 1 minute cycles.

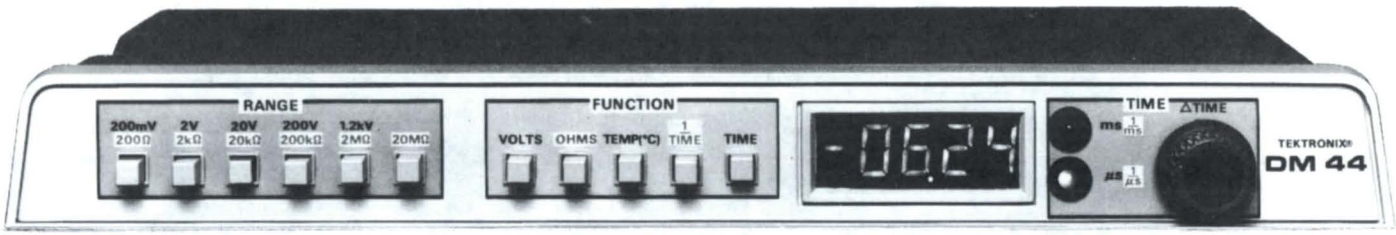
Humidity — Operating and Nonoperating: 95%, 5 cycles (120 hours). Referenced to MIL-T-28800C, par. 4.5.5.1.2.2.

Shock — Operating and Nonoperating: 30 g's, ½ sine, 11 ms duration, 2 shocks per axis in each direction for a total of 12 shocks.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width, with handle	330	13.1
Height, without pouch	159	6.2
Depth, with panel cover	550	21.7
Depth, handle extended	597	23.8
Weight≈	**kg**	**lb**
Net, without panel cover or accessories	11.8	26.0
Net, with panel cover and accessories	13.5	29.8
Shipping	18.8	41.5

See ordering information on next page.



DM 44

Differential Time/DMM Option for 466

3½ Digit LED Display
Time Intervals Accurate to 1%

Frequency Accurate to 2%

Dc Voltage Measurements Accurate to 0.1%

Resistance Accurate to 0.3%

Temperature From −55°C to +150°C

One percent timing measurements were never this easy! With the DM 44 Option time intervals can be read directly from the 3½ digit LED screen. Simply use the Delay Time control and the ΔTime Dial to superimpose the end of the interval on the beginning. Then read its differential time or frequency from the 3½ digit LED panel. It's that simple. Time intervals are accurate to 1% and the frequency of periodic waveforms can be read out with 2% accuracy by simply pushing the 1/Time button.

Compare the DM 44 sequence with the measurement technique you may now be using. Calculating the interval from the CRT may take 10 times as long.

Voltage, resistance, and temperature measurements are also much easier with a DM 44. It measures dc voltage with 0.1% accuracy, resistance with 0.3% accuracy, and temperature from −55°C to +150°C. Previously, you would have needed a separate DMM and digital thermometer in addition to your oscilloscope. Now, these features are combined in one small, inexpensive, integral package.

CHARACTERISTICS

TIMING MEASUREMENTS

Differential Time Delay Accuracy

+15°C to +35°C	−15°C to +55°C
Within 1% of reading ±1 count	Within 2.5% of reading ±1 count

1/Time Accuracy

+15°C to +35°C	−15°C to +55°C
Within 2% of reading ±1 count	Within 3.5% of reading ±1 count

DC VOLTAGE

Ranges — 0 to 200 mV, 0 to 2 V, 0 to 20 V, 0 to 200 V, 0 to 1.2 kV.

Resolution — 100 μV.

Accuracy — Within 0.1% of reading ±1 count.

Input Resistance — 10 MΩ for all ranges. Removal of an internal strap increases resistance to ≈1000 MΩ on 200 mV and 2 V ranges.

Normal-Mode Rejection Ratio — At least 60 dB at 50 Hz and 60 Hz.

Common-Mode Rejection Ratio — At least 100 dB at dc, 80 dB at 50 Hz and 60 Hz.

Recycle Rate — ≈3.3 measurements/s.

Response Time — Within 0.5 s.

Maximum Safe Input Voltage — ±1200 V dc + peak ac between + and common inputs or between + and chassis. ±500 V (dc + peak ac) common floating voltage between common and chassis.

RESISTANCE

Ranges — 0 to 200 Ω, 0 to 2 kΩ, 0 to 20 kΩ, 0 to 200 kΩ, 0 to 2 MΩ and 0 to 20 MΩ.

Resolution — 0.1 Ω.

Accuracy

Range	Accuracy
200 Ω	Within 0.25% ±1 count + probe resistance
2 kΩ, 20 kΩ, 200 kΩ, 2 MΩ	Within 0.25% ±1 count
20 MΩ	Within 0.3% ±1 count

Recycle Rate — ≈3.3 measurements/s.

Response Time

200 Ω through 200 kΩ ranges	Within 1 s
2 MΩ through 20 MΩ ranges	Within 5 s

Maximum Safe Input Voltage — 120 V RMS between + and common inputs.

TEMPERATURE USING P6430 PROBE

Range — −55°C to +150°C.

Accuracy

DM 44 Temperature	P6430 Tip Temperature	Accuracy (Probe Calibrated to DM 44)
+15°C to +35°C	−55°C to +150°C	±2°C
−15°C to +55°C	−55°C to +125°C +125°C to +150°C	±3°C ±4°C

ORDERING INFORMATION

466 Storage Oscilloscope **$7,940**
Includes: Two P6105A probes; blue accessory pouch (016-0535-02); clear pouch (016-0537-00); CRT light filter (337-1674-01); two 1½ A fuses (159-0016-00); one ¾ A fuse (159-0042-00); ground wire adaptor (134-0016-01); viewing hood (016-0592-00); operator manual (070-2037-00).

466 DM 44 Storage Oscilloscope/DMM **$8,675**
Includes: Same as 466 plus, one pair test leads (003-0120-00); one P6430 Temperature Probe (010-6430-00); service manual (070-2036-01); operator manual (070-4796-00).

OPTIONS

Option 01 — Delete DM 44 Temperature Probe (466 DM 44 only). **−$90**
Option 04 — EMC Capability. **+$220**
Option 05 — TV Sync Separator (Provides Triggering on TV Field). **+$385**
Option 07 — External Dc Operation (Not for DM 44). **+$330**

INTERNATIONAL POWER PLUG OPTIONS

Option A1 — Universal Euro 220 V, 50 Hz.
Option A2 — UK 240 V, 50 Hz.
Option A3 — Australian 240 V, 50 Hz.
Option A4 — North American 240 V, 60 Hz.

OPTIONAL ACCESSORIES

1106 — Battery Pack (used with Option 07). (See page 306.) **$1,265**
1105 — Battery Power Supply (see page 306). **$1,690**
Mesh Filter — Improves display contrast in high ambient light. Order 378-0726-01 **$80**
Protective Cover — Waterproof vinyl. Order 016-0365-00 **$26**
Viewing Hoods —
(Folding) Order 016-0592-00 **$14**
(Folding Binocular) Order 016-0566-00 **$18.75**
(Polarized Collapsible) Order 016-0180-00 **$50**
Rack Adaptor — Not for DM 44. Order 016-0676-00 **$445**
A6902B Voltage Isolator — For floating measurements see page 479 for complete description. **$1,795**

RECOMMENDED PROBES

See pages 277 and 464.
P6105A — 10X Probe. **$93**

RECOMMENDED CAMERA

C-30BP Option 01 — General Purpose Camera. Includes 016-0301-01 mounting adaptor/corrector lens. See page 450. **$1,480**

RECOMMENDED CART

K212 — For on-site portability. See page 461. **$330**

Modification kits for field conversion of existing 466s to Option 07 or DM 44 equipped scopes are available. These are typically more expensive than when the option is ordered with the instrument. Contact your Tektronix Sales Engineer, distributor, or representative for information.

To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext. 99

SONY/TEKTRONIX® 10 MHz DUAL TRACE STORAGE OSCILLOSCOPE

314

10 MHz at 1 mV/Div

100 ns/Div Sweep Rate With X10 Sweep Magnifier

Stored Viewing Time to 4 Hours

Integrate Mode for Intensifying Fast Rise Time, Low Repetition Rate Signals

Operates From Ac Line, 12 V Dc, or 24 V Dc

Small Size, Weighs ≈4.7 kg (10.5 lb)

TYPICAL APPLICATIONS
Industrial Control Systems
Biophysical Instrumentation
Communication Equipment Service

See page 277 for available Application Notes.

The 10.5 pound, bistable storage 314 provides 1 mV/div sensitivity at 10 MHz, with a four hour viewing time. With long term storage, you can use the 314 to monitor signal lines where undesired transients are suspected.

For fast rise time, low repetition rate signals, an integrate mode increases the intensity of the stored trace.

Compact size and operation from ac or external dc source mean that the 314 will easily go wherever you need a storage oscilloscope.

Combined function controls, color coding, and functional front panel layout make the 314 easy to use. Probes mount on the side, permitting an uncrowded front panel and large CRT.

The 1 mV/div sensitivity is particularly useful for measurement of transducer signals such as those from magnetic recording heads. An autoerase mode, with variable erase period from 1 second to 5 seconds, enhances the ability of the 314 to make measurements on slowly changing analog signals such as those from a pressure transducer. Other applications for the 314 occur in industrial control systems, biophysical instrumentation, communication terminals, POS terminals, computer peripherals, and communication systems.

CHARACTERISTICS

VERTICAL SYSTEM

Bandwidth and Rise Time — Dc to at least 10 MHz. Rise time: 35 ns or less for a 4 div step input. For ac coupling, the lower 3 dB point is 10 Hz or less.

Deflection Factor — 1 mV/div to 10 V/div (1-2-5 sequence), accurate ±3%. Uncalibrated: Continuously variable between steps to at least 25 V/div.

Display Modes — CH 1, CH 2 (normal or inverted), chopped, alternate, added, and X-Y.

Input R and C — 1 MΩ paralleled by ≈47 pF.

Maximum Input Voltage — Ac or dc coupled, 300 V (dc + peak ac).

Delay Line — Permits viewing leading edge of displayed waveform.

Amplitude Calibrator — 0.5 V accurate ±1% from 20°C to 30°C, ±2% from −15°C to +55°C.

HORIZONTAL SYSTEM

Time Base — 1 μs/div to 5 s/div. X10 magnifier extends sweep rate to 100 ns/div.

Variable Time Control — Uncalibrated, continuously variable between steps and to at least 12.5 s/div.

Time Base Accuracy*[1]

Unmagnified	
1 μs/div to 0.2 s/div	±3%
0.5 s/div to 5 s/div	±4%
Magnified	
50 ms/div to 0.5 s/div	±5%
0.5 μs/div to 20 ms/div	±4%
0.1 μs/div and 0.2 μs/div	±5%

[1] Center 8 divisions.

TRIGGERING

Modes — Normal (sweep generator requires a trigger to generate a sweep). Automatic (minimizes trigger adjustment). Sweep generator free-runs in the absence of a trigger. Single sweep (one sweep is initiated by the first trigger after a reset).

Trigger Sources — Internal: CH 1, CH 2 or composite, external.

Sensitivity and Coupling

Coupling	1 MHz	10 MHz
Dc Internal	0.3 div deflection	1 div deflection
Dc External	150 mV	500 mV
Ac	Requirements increase below 30 Hz	
Ac LF Reject	Requirements increase below 50 kHz	

X-Y OPERATION

Input — X-axis input is via the external horizontal input connection. Both CH 1 and CH 2 provide vertical inputs. Using chopped mode, two simultaneous X-Y displays can be obtained.

X-Axis Deflection Factors — Continuously variable from 20 mV/div to 2 V/div. Bandwidth, dc to at least 200 kHz.

Input Impedance — 1 MΩ ±2% paralleled by ≈62 pF.

CRT AND DISPLAY FEATURES

CRT — 8 x 10 div (0.6 cm/div) display. Accelerating potential is 2 kV. GX (P44) phosphor.

Graticule — Internal, nonilluminated. Vertical and horizontal centerlines marked in 5 minor div per major 0.6 cm/div.

Z-Axis Input — Range +5 V to +20 V (dc coupled) with a 100 kHz or greater usable frequency range. Maximum input voltage, 50 V (dc + peak ac).

STORAGE FEATURES

Display Modes — Direct view, bistable storage, and nonstore modes. Enhance mode to increase stored writing rate in the single sweep mode. Autoerase mode to automatically erase stored display after each sweep. Viewing time before autoerase can be varied from 1 s or less to at least 5 s. Integrate mode increases stored brightness of very fast repetitive signals.

Stored Writing Speed — Normal, at least 80 div/ms. Enhanced, increases to at least 400 div/ms (250 cm/ms) in enhanced mode.

Erase Time — 300 ms.

POWER REQUIREMENTS

Line Voltage Ranges — 90 V ac to 130 V ac or 180 V ac to 264 V ac.

Line Frequency — 48 Hz to 440 Hz.

Power Consumption — 29 W maximum at 115 V ac.

External Dc Source — +11 V dc to + 14 V dc or +22 V dc to +28 V dc.

Dc Current Drain — 1.6 A at +12 V or 0.8 A at +24 V.

ENVIRONMENTAL

Ambient Temperature — Operating: −15°C to +55°C. Nonoperating: −40°C to +75°C.

Altitude — Operating: 6000 m (20,000 ft) maximum, decrease maximum temperature by 1°C/1000 ft from 5000 ft to 20,000 ft. Nonoperating: 15 000 m (50,000 ft) maximum.

Vibration — Operating: 15 minutes along each of the three major axes, 0.06 cm (0.025 in) p-p displacement (4 g's at 55 Hz) 10 Hz to 55 Hz to 10 Hz in 1 minute cycles.

Humidity — Nonoperating: 5 cycles (120 hours) of MIL-Std-202D, Method 106C. Omit freezing and vibration and allow a post-test drying period at 25°C ±5°C and 20% to 80% relative humidity.

Shock — Operating and Nonoperating: 30 g's, ½ sine, 11 ms duration each direction along each major axis. Total of 12 shocks.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width, with handle	236	9.3
Height, without pouch	112	4.4
Depth, handle not extended	347	13.6
Depth, handle extended	448	17.6
Weight≈	**kg**	**lb**
Net, without accessories	4.7	10.5
Shipping	7.6	17.0

ORDERING INFORMATION

314 Storage Oscilloscope **$4,550**

Includes: Two P6149A 10X probes; carrying case and pouch (016-0612-00); strap (346-0131-02); external dc cable assembly (012-0406-00); two 1.6-A fuses (159-0098-00); two 0.8-A fuses (159-0132-00); two 0.15-A fuses (159-0130-01); three 0.16-A fuses (159-0131-00); service manual (070-1824-00); operator manual (070-1823-00).

The SONY®/TEKTRONIX® 314 is manufactured and marketed in Japan by Sony/Tektronix Corporation, Tokyo, Japan. Outside of Japan, the 314 is available from Tektronix, Inc., its marketing subsidiaries and distributors.

OPTIONAL ACCESSORIES

RECOMMENDED PROBES

See pages 277 and 464.

P6149A — 10X Probe **$110**

RECOMMENDED CAMERA

C-30BP Option 01 — General Purpose Camera. See page 450. **$1,524**

Camera Adaptor — Required to mount the C-30BP to the 314. Order 016-0327-01 **$170**

To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext. 99

214

500 kHz, 1 mV/Div to 50 V/Div

Internal Battery

Integral 1 MΩ Probe

Weighs ≈1.6 kg (3.5 lb)

TYPICAL APPLICATIONS
Industrial Control Systems
Electromechanical Measurements

See page 277 for available Application Notes.

The 214 features these signal acquisition capabilities: bandwidth to 500 kHz with deflection factors from 1 mV/div to 50 V/div. It is lightweight (only 3.5 pounds) and compact (3 x 5.3 x 9.5 inches). The 214 offers bistable storage capabilities. This is useful for viewing nonrepetitive or slow moving signals.

Built of impact-resistant plastic and fully self contained, this miniature portable is ideal for applications in severe environments. And it permits "floating" measurements since it is double insulated and can be elevated to 700 V (dc + ac) above ground when operated from batteries. Although insulated, normal caution should be observed when connecting the oscilloscope probe to the test point.

The 214 features integral probes that are color matched with the vertical deflection controls to minimize measurement error. The probes have their own storage space and are part of the instrument—you can't forget and leave them behind. Clip-on 10X attenuators are available for higher voltage applications.

Trigger level and slope functions are simplified to one rotary control on the side of the unit. A convenient neckstrap is an included accessory, freeing both hands to perform other tasks.

In the single sweep mode the 214 can be set to wait for, then record, a single event. With this feature, the scope's sweep circuit is armed and will wait for the signal to arrive before it runs. When the signal occurs, the sweep runs once. When combined with storage, this provides the unique capabilities of automatically waiting for an event and then storing it for subsequent viewing.

CHARACTERISTICS

VERTICAL SYSTEMS

Bandwidth — Dc to at least 500 kHz from 10 mV/div to 50 V/div, reducing to at least 100 kHz at 1 mV/div. Lower −3 dB point ac coupled is ≈2 Hz.

Deflection Factors — 1 mV/div to 50 V/div (1-2-5 sequence), accurate ±5%. Uncalibrated: Continuously variable between steps to at least 125 V/div.

Display Modes — CH 1 only. CH 2 only, or CH 1 and CH 2 chopped (≈chop rate—40 kHz) from 500 ms/div to 2 ms/div of time base, alternate from 1 ms/div to 5 μs/div of time base.

Input R and C — ≈1 MΩ paralleled by ≈160 pF from 1 mV/div to 50 mV/div; and 140 pF from 100 mV/div to 50 V/div.

Maximum Input Voltage[*1]

1 mV/div to 50 mV/div	600 V (dc + peak ac) ac not over 2 kHz
0.1 V/div to 50 V/div	600 V (dc + peak ac) 600 V p-p ac; 5 MHz or less

*[*1] 1X Probe only.*

HORIZONTAL SYSTEMS

Time Base — 5 μs/div to 500 ms/div, accurate ±5%.

Variable Magnifier — Increases each sweep rate X5 with a maximum sweep speed of 1 μs/div.

External Horizontal Input — (CH 1) 1 mV/div to 50 V/div ±10%; dc to 100 kHz: X-Y phasing to 5 kHz <3°. Input characteristics same as CH 1.

Maximum External Horizontal Input Voltage and Impedance — Same as for vertical inputs.

Input Impedance — R and C, 1 MΩ paralleled by ≈30 pF.

TRIGGERING

Trigger Modes (Automatic or Normal) — Level and slope selected with a single control. Automatic operation minimizes trigger adjustment and provides a bright baseline with no input.

Trigger Sensitivity and Coupling

Dc Coupling	To 500 Hz
Internal (w/composite trigger source)	0.2 div
Internal (w/CH 2 trigger source)	0.2 div
External	1 V

Maximum External Trigger Input Voltage — 8 V (dc + peak ac), 16 V (p-p) at 500 kHz or less.

Single Sweep — Sweep generator produces one sweep when trigger is received.

CRT AND DISPLAY FEATURES

CRT — Bistable storage, 6 x 10 div (0.52 cm/div) display. GX (P44) phosphor.

Graticule — Internal, black line, nonilluminated.

STORAGE FEATURES

Stored Writing Speed — Normal, at least 80 div/ms. Enhanced, increases single-sweep storage writing speed to at least 500 div/ms. Enhance is automatic from 0.1 ms to 5 μs/div in single sweep.

Stored Luminance — At least 8 fL at 25°C.

Storage Viewing Time — ≈1 hour.

OTHER CHARACTERISTICS

Insulation Voltage — 500 V RMS or 700 V (dc + peak ac) when operated from internal batteries, with the line cord and plug stored. When operated from ac, line voltage plus floating voltage not to exceed 250 V RMS; or 1.4 times line voltage + dc + peak ac not to exceed 350 V.

Power Sources — Internal NiCad batteries provide ≈3.5 to 5 hours operation (≈2.5 to 3.5 hours in 214 stored mode) for a charging and operating temperature between +20°C and +30°C. Internal charger charges the batteries when connected to an ac line with instruments turned off. Battery operation is automatically interrupted when battery voltage drops to ≈10 V to protect batteries against deep discharge. Full recharge requires ≈16 hours. Extended charge times will not damage the batteries.

A pilot light battery-charge indicator light will extinguish when oscilloscope has about 5 minutes of operating time remaining in the batteries.

POWER REQUIREMENTS

Line Voltage Range — 110 V ac to 126 V ac. Can be operated at 104 V to 110 V with resulting slow discharge of batteries. Option 01 is 220 V to 250 V. Option 02 is 90 V to 110 V.

Line Frequency — 58 Hz to 62 Hz. Options 01 and 02 are 48 Hz to 52 Hz.

Maximum Power Consumption — 3 W.

ENVIRONMENTAL

Ambient Temperature — Operating (Battery Only): −15°C to +55°C. Charging or Operating From Ac Line: 0°C to +40°C. Nonoperating: −40°C to +60°C.

Altitude — Operating: 7600 m (25,000 ft), decrease maximum temperature by 1°C/1000 ft above 15,000 ft. Nonoperating: 15 000 m (50,000 ft).

Vibration — Operating and Nonoperating: 15 minutes along each of the 3 major axes, 0.06 cm (0.025 in) p-p displacement (4 g's at 55 Hz) 10 Hz to 55 Hz to 10 Hz in 1 minute cycles. Held for 3 minutes at 55 Hz.

Humidity — 95%, 5 cycles (120 hours). Referenced to MIL-T-28800C, par. 4.5.5.1.2.2.

Shock — Operating and Nonoperating: 150 g's, ½ sine, 2 ms duration in each direction along each major axis. Total of 12 shocks.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	133	5.3
Height	76	3.0
Depth	241	9.5
Weight≈	**kg**	**lb**
Net, without accessories	1.6	3.5
Shipping	3.2	7.0

ORDERING INFORMATION

214 Dual Trace Storage Oscilloscope **$2,865**
Includes: Integral probe, batteries, viewing hood (016-0199-01); carrying case (016-0512-00); two 4-A fuses (159-0121-00); identification tags (000-7983-00); identification tag (334-2614-00); carrying strap (346-0104-00); service manual (070-5055-00); operator manual (070-5054-00).

OPTIONS

Option 01 — For 220 V to 250 V (48 Hz to 52 Hz). **NC**

Option 02 — For 90 V to 110 V (48 Hz to 52 Hz). **NC**

OPTIONAL ACCESSORIES

10X Attenuator Package — A slip-on tip to provide lower circuit loading (4.4 MΩ, ≈20 pF) and higher maximum input voltage 1000 V (dc + peak ac). Includes: flex tip (206-0060-00); 10X attenuator (010-0378-01); pincher tip (013-0071-00); banana tip (134-0013-00); IC adaptor (206-0203-00). Order 010-0378-01 **$70**

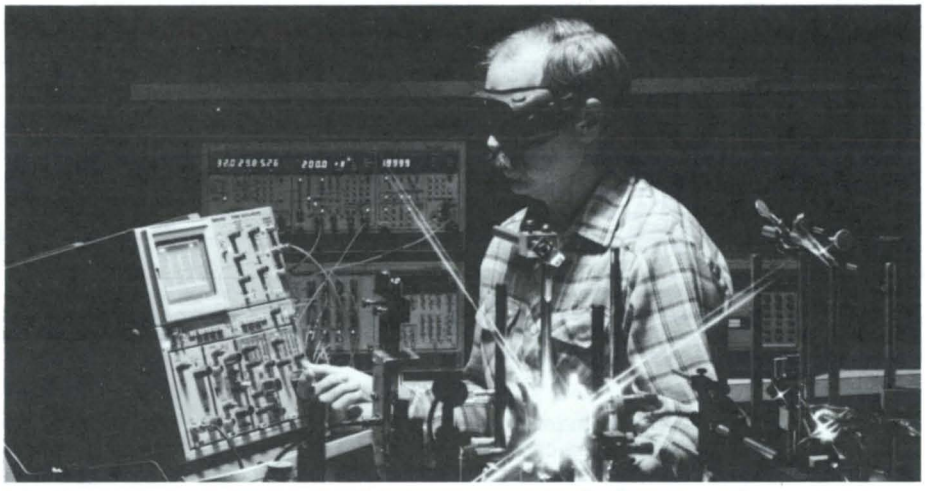
Alligator Clip Kit — A pair of alligator clips that allow connecting the probe (or optional 10X attenuator) and ground lead to large (up to ⅜ in) conductors. Includes: 6-32 to probe adaptor (103-0051-01); red clip (015-0229-00); yellow clip (015-0230-00). Order 015-0231-00 **$26**

Probe Tips
(To BNC Panel Connector Adaptor)
Order 013-0084-01 **$9.75**
(To BNC Cable Adaptor) Order 103-0096-00 **$13.50**

Power Cable Adaptor Assembly — A short length of two-wire power cord. One end has a female NEC socket fitting the 200 Series power cords; the other end is left open so that the wires can be attached to a non-NEC male power plug. Plugs not supplied.
Order 161-0077-01 **$9.00**

To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext. 99

AUTOMATED TEST SYSTEMS AND INSTRUMENTS



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Tektronix offers a variety of programmable instruments to meet your measurement needs. Starting with a wide performance base of GPIB compatible waveform digitizers, with capabilities up to 14 GHz. And, with the 7D20 digitizer plug-in, your existing Tektronix 7000 Series oscilloscope can become a GPIB programmable waveform digitizer—another example of our designed-in commitment to expandability.

Plus, we have a broad range of other GPIB programmable instruments to complete your system—signal and power sources, measurement devices, switchers, spectrum analyzers, multifunction interface units. And they are all supported by a selection of instrument controllers, peripherals, and software.

We provide extensive and ongoing documentation—hardware and software manuals, controller programming guides, instrument interfacing guides, application notes, even a regular newsletter on signal processing and instrument control. In addition, an instrumentation software library provides programs to help you develop software to solve your measurement problems.

Configurability

Tek systems offerings afford maximum flexibility, right down to the number of ways in which they can be configured.

1. Individual systems components are available separately and include instrument interfacing guides, documentation, and in some specific cases, application software available through the Tektronix Instrument Software Library.
2. Preconfigured measurement packages (MP) make it easy to purchase the most needed components in a packaged system that you integrate and install yourself. Instruments contained in measurement packages carry the normal, standalone instrument warranty and do not include on-site installation.
3. Custom systems are generally modified/expanded versions of our standard packages and include integration, checkout software, on-site installation and warranty. They do not include device-specific application software.

Whatever your needs, from a single GPIB instrument to a complete measurement system, we're sure you'll find the right measure of performance in the pages that follow. Take the time to evaluate your own unique needs—and our uniquely personal solutions. You'll be making an investment in performance that will pay dividends for years.

Programming Ease

With Tektronix programmable instruments, compatibility is the key. And it's more than just IEEE Standard 488 compatibility; it's total system compatibility, from configuring to programming. This higher level of compatibility is achieved through conformance to the additional standard of Tektronix *Standard Codes and Formats*. For more information on this important standard, refer to the GPIB section, page 14, or contact a Tektronix Sales Representative.

DIGITIZERS

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DIGITAL OSCILLOSCOPES AND WAVEFORM DIGITIZERS

Type	Analog Digitizing BW	Maximum Digitizing Rate	Vertical Resolution	Data Words per Waveform	Maximum Stored Waveforms	Useful*1 Storage BW (SS)	Equiv*2 Storage BW (rep)
11401	500 MHz	20 MS/sec	10-bits	Up to 10,240	100K pts	2 MHz	500 MHz
11402	1 GHz	20 MS/sec	10-bits	Up to 10,240	100K pts	2 MHz	1 GHz
5223	10 MHz	1 MHz	10-bits	1016/plug-in	2 to 4	100 kHz	10 MHz
336	50 MHz	1 MHz	8-bits	1024 each channel	2 (16 with option)	100 kHz	50 MHz
2220	60 MHz	20 MHz	8-bits	2048 dual channel 4096 single channel	2	2 MHz	60 MHz
2230	100 MHz	20 MHz	8-bits	2048 dual channel 4096 single channel	8 (52 with option)	2 MHz	100 MHz
7854	400 MHz*3	500 kHz Ext Clock	10-bits	Up to 1024	Up to 40	50 kHz	400 MHz
7D20/ 7D20T	70 MHz	40 MHz	8-bits	Up to 1024	6	10 MHz	70 MHz
2430	150 MHz	100 MHz	8-bits	1024	6	40 MHz	150 MHz
390AD	15 MHz	30 MHz dual channel 60 MHz CH 1	10-bits	2048 dual channel 4096 CH 1 only	2	15 MHz	15 MHz
7612D	80 MHz	200 MHz	8-bits	Up to 2048	2 to 16	80 MHz	80 MHz
7912AD	500 MHz	100 GHz	9-bits	512	1	500 MHz	500 MHz
DCS01/ 7104	1 GHz	250 GHz	12-bits rep. 9-bits sing.	512	26	1 GHz	1 GHz

*1 *Useful Storage Bandwidth is a measure of the highest frequency sinewave that can be stored in a single sweep and displayed in a visually useful manner. This is dependent on both the maximum digitizing rate as well as the display reconstruction technique used.*

*2 *Equivalent Storage Bandwidth indicates the highest frequency repetitive signal that can be stored and displayed with less than 3 dB loss of signal amplitude using equivalent time digitizing techniques.*

*3 *14 GHz with sampling.*

IEEE STANDARD 488 COMPATIBLE

This section contains high performance digitizing mainframes, standalone digitizers and portable digital storage oscilloscopes designed for precise automatic waveform measurements in demanding applications in R&D and production environments.

Digital Storage

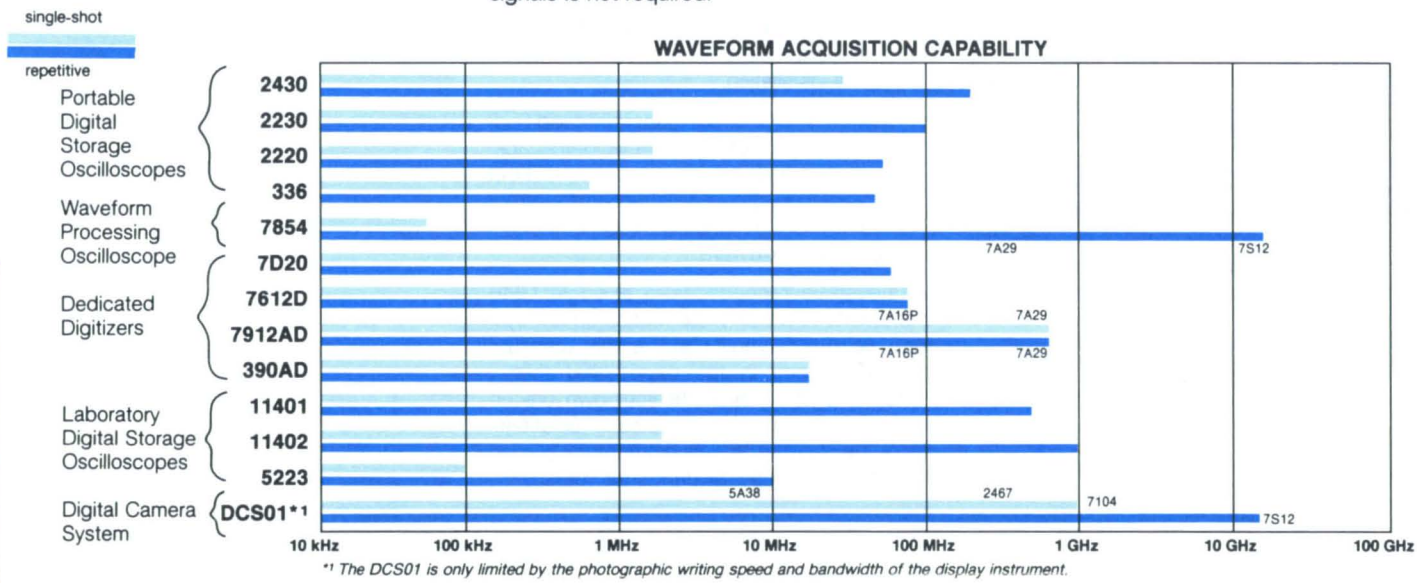
Digital storage utilizes a digitizing and reconstruction process. "Digitizing" consists of "sampling" and "quantizing." Sampling is the process of obtaining the value of an input signal at discrete points in time; quantizing is the transformation of that value into a binary number by the analog-to-digital converter (ADC). The digitizing rate (or sample rate) is determined by the time base which uses a digital clock to time the analog-to-digital (A/D) conversion and to store the data in memory. Stored data can be read and reconstructed for display or further waveform processing.

The high performance digitizing mainframes offer a wide choice of performance capabilities to capture high or low speed signals that are repetitive or single shot. Configure mainframes to your needs from a choice of plug-ins. The *NEW* 11401 and 11402 set new standards in performance and excellence. Five new plug-ins and four new probes provide outstanding versatility. The measurement system and waveform functions lead to quick solutions to a variety of measurement problems. The 7854 combines outstanding analog and digital performance with microprocessor-based waveform processing, whereas the 7612D and 7912AD combine outstanding analog and digital performance with full programmability. The 7D20T incorporates a 7D20 into its own power module but without a display. The 7D20T is the ideal high performance digitizer in automated systems applications where visual display of the acquired signals is not required.

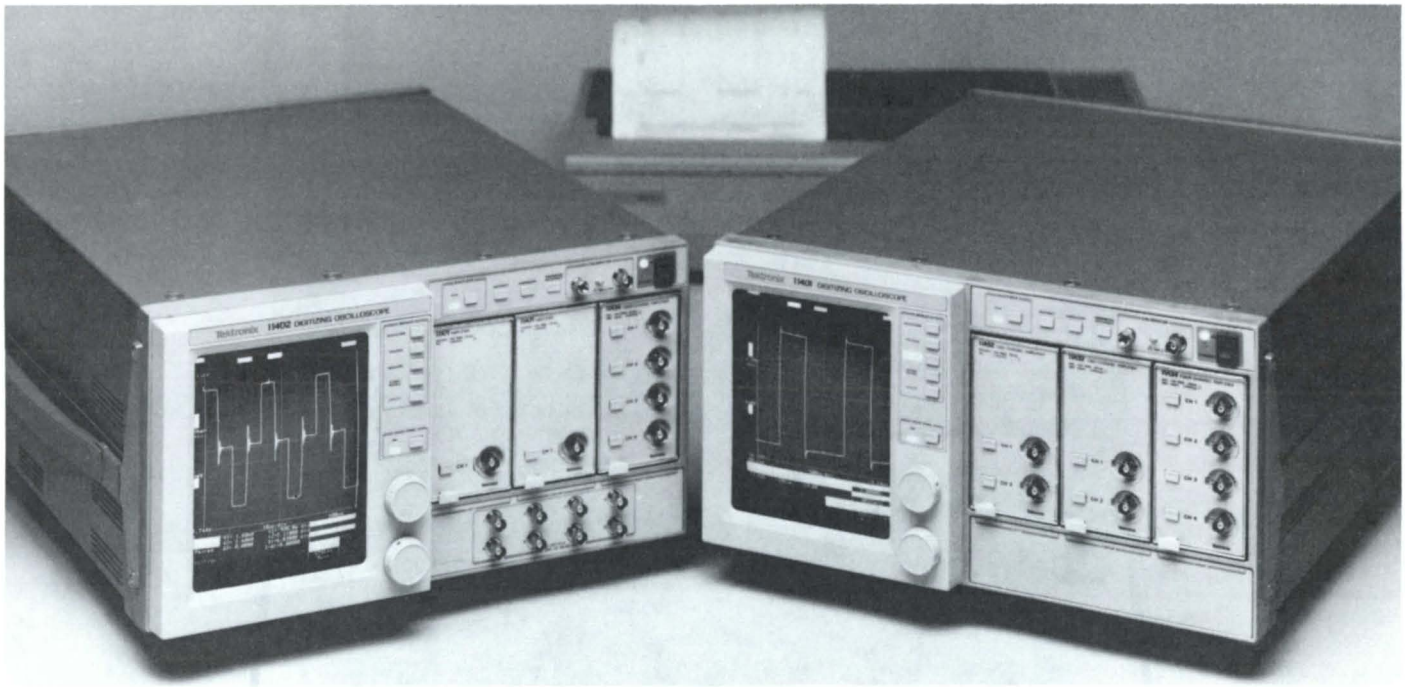
SONY/TEKTRONIX offers two portable digitizers, the 390AD and 336. The 390AD features dual-channel and dual-time base operation. The 336 displays both analog and digitized waveforms simultaneously and can store up to 16 digitized waveforms for recall and display. It is microprocessor controlled and incorporates alphanumeric CRT readouts of the scale factors and cursor positions.

The 5223 Digitizing Oscilloscope is capable of displaying real time and stored waveforms simultaneously and accesses the digital storage functions by using the 5B25N Time Base.

The 2230 and 2220 each feature 4K record lengths, 100 ns peak detection, and optional GPIB or RS-232C interfaces. The 2430 brings the best features of the industry standard 2400 Series into a digital storage oscilloscope. Tek's new patented feature "Save on Delta" provides unattended pass/fail testing.



*1 *The DCS01 is only limited by the photographic writing speed and bandwidth of the display instrument.*



NEW 11400 Series
Digitizing Oscilloscopes

GPIB IEEE-488 The 11400 Series complies with IEEE Standard 488-1978 and with Tektronix *Standard Codes and Formats.*

1 GHz and 500 MHz Bandwidths

8 Channels of Display and Acquisition

Plug-In Modularity

Waveform Processing and Automatic Pulse Parameters

Multiple 10,240 Point Waveform Records

Differential, High Impedance and 50 Ω Input Amplifiers

Greatly Simplified Access to Features

The 11401 and 11402 are the first in a new line of programmable digitizing oscilloscopes. These versatile scopes, along with the array of new plug-ins and probes that support them, solve measurement problems equally well on a designer's bench or in a programmable test system. Digital designers will benefit from flexible triggering features and an eight channel display. Analog and power supply designers can apply extensive waveform processing to signals acquired through high performance differential and single-ended amplifiers. 11000 Series digitizing scopes can follow your designs into production. Full programmability via either IEEE-488 or RS-232C, and features like a DMA controller for fast waveform transfers make these scopes a perfect fit for systems. 11000 Series Digitizing Oscilloscopes set new standards in performance and excellence.

Live Display of Up to Eight Traces
The 11401/402 each support three vertical amplifier plug-ins. This means you can acquire up to eight channels of data at 300 MHz, up to six channels of data at 500 MHz or up to three channels of data at 1 GHz. You can, of course, mix and match the plug-ins to design the system that works best for you. Eight traces can be displayed at any one time so that you can get the whole picture on one screen. The update rate is so fast that the 11401/402 have the look and feel of analog scopes.

High Vertical and Horizontal Resolution
The 11401 and 11402 uniquely combine wide bandwidth with 10 ps horizontal resolution and 10-bit vertical resolution. Other vendors have made a tradeoff: bandwidth for vertical resolution or vertical resolution for bandwidth. The 11401/402 give you both for making demanding voltage and timing measurements in one box. In addition, the 11401/402's trigger-to-trigger measurement feature delivers 200 ps resolution on single shot time A→B measurements and can even get down to 10 ps resolution with averaging. Trigger-to-trigger measurements of this nature are only available on the 11401/402 and a few expensive standalone counter timers. Also, window records can be used to increase horizontal resolution on specific segments of main records providing a clear picture of signal details.

Long Multiple Record Lengths
The 11401/402 can acquire multiple records of up to 10,240 points each. No other scope can capture as much data at once on repetitive waveforms. The mainframes can contain up to 100K points of waveform memory. Long records and large storage capacity combine to let users gather data over relatively long periods of time with high resolution and improved measurement accuracy. One doesn't need a computer to log waveform data. Waveforms can be stored on-board the scope for later analysis.

Versatility for a Wide Range of Applications
Five new plug-ins and four new probes bring outstanding versatility to the 11401/402. The measurement system and waveform processing functions lead to quick solutions to a wide variety of voltage, time, area and energy problems. The 11401 can process and measure signals from high bandwidth 50 Ω amplifiers, high impedance amplifiers and differential amplifiers. 1 mV sensitivity and 500 V maximum input voltage let users capture small signals from transducers or monitor ac power lines.

See page 207 for complete description and specifications.

11000 SERIES BANDWIDTH/RISE TIME MATRIX

Plug-In	11402	11401
11A71 Single Channel, 10 mV/div, 50 Ω	1 GHz/350 ps	500 MHz/700 ps
11A52 Dual Channel, 1 mV/div, 50 Ω	600 MHz/540 ps	500 MHz/700 ps
11A32 Dual Channel, 1 mV/div, 1 MΩ/50 Ω	350 MHz/1 ns	350 MHz/1 ns
11A34 Four Channel, 1 mV/div, 1 MΩ/50 Ω	300 MHz/1.2 ns	300 MHz/1.2 ns
11A33 Differential Comparator, 1 mV/div, 1 MΩ/1 GΩ	150 MHz/2.4 ns	150 MHz/2.4 ns

TEK 150 MHz DUAL TRACE DIGITAL STORAGE OSCILLOSCOPE

2430/*NEW* 2430M

Digital Oscilloscope

GPIB IEEE-488 The 2430/2430M comply with IEEE Standard 488-1978 and with Tektronix *Standard Codes and Formats.*

- **150 MHz Bandwidth at Probe Tip**
- **5 ns/Div Sweep Speed**
- **100 MS/s Sample Rate**
- **Simultaneous Acquisition of Two Channels**
- **Envelope Mode With 2 ns Glitch Capture**
- **8 Bit Resolution Over 10 Divisions**
- **Save on Delta (Tek Patented Feature) Provides Unattended Pass/Fail Testing and Babysitting Against a User Defined Reference Envelope**
- **Extensive Trigger Capability Such as Delay by Time, Delay By Events, Two External Trigger Inputs Provide Flexibility for Use in TTL, ECL, and Analog Circuit Applications**
- **Save up to Six Waveforms for Later Display, Analysis and Comparison**
- **Full Screen Readout and Extensive Cursor Functions for Easy Operation and Measurements**
- **Fully GPIB Programmable for Systems and Automated Test Applications**
- **Three Year Warranty—Five Years Optional**

TYPICAL APPLICATIONS

Analog and Digital Design
Repetitive Test
Power Supply Development
T1 Carrier Test/Verification

See page 277 for available Application Notes.

Power and Flexibility in an Easy-To-Use Portable Digital Oscilloscope

With the Tek 2430 we've brought the best features of our industry standard 2400 Series into the digital world. Capture complex wideband signals for TTL, ECL, and analog research, design and test.

With on-screen readout, cursor functions, and front panel layout similar to other Tek 2400 Series instruments, the 2430 provides an easy to use tool.

The 2430 has a 150 MHz bandwidth, 5 ns/div maximum sweep speed, a digitizing rate of 100 Megasamples/sec with 8 bit resolution, and dual channel simultaneous acquisition. With its advanced feature set, the 2430 can meet your general purpose measurement needs while offering the advantages of a digitized waveform—including long term storage for future reference, data transfer, and waveform analysis—making the 2430 a powerful systems component.

Features of the 2430 include: 1024 point per channel record length, Average Mode for increased resolution and noise reduction on repetitive signals, Envelope Mode to provide the unique ability to capture events as fast as 2 ns at any sample rate, Save on Delta to capture and save events that deviate from user selected limits, Delay by Time and Delay by Events for detailed examination of complex waveforms.

NEW 2430M With MATE/CIIL Capabilities

The 2430M digital oscilloscope offers Control Intermediate Interface Language (CIIL) capability that is essential for operation in Modular Automatic Test Equipment (MATE) used in testing military avionics and weapons systems. A CIIL interface allows communication between an ATLAS 716 host computer and the 2430M via the IEEE 488 bus. This interface is embedded in the 2430M. Upon a GAL (go to alternate language) command, the 2430M is essentially transparent to the IEEE bus until a CIIL command is received. When a CIIL command appears on the bus, the CIIL interface is automatically invoked and acts as a translator between the ATLAS host computer and the IEEE 488 bus.

The 2430M was designed to the Proposed MATE System Control Interface Standard No. 2806763 Rev. B and has been accepted as a candidate for MATE qualification. All 2430 options and optional accessories are also available on the 2430M.

Due to the method of processing messages, software written for the 2430 may not be entirely compatible with the 2430M when using SRQs and when sending long messages. Contact your local Sales Representative for more detailed information.

CHARACTERISTICS

VERTICAL SYSTEM

The following characteristics are common to both instruments.

Bandwidth — Dc: to 150 MHz (−3 dB). Ac: <10 Hz to 150 MHz.

Bandwidth Limit — 20 MHz and 50 MHz; selectable (reduces −3 dB point to between 13 MHz to 24 MHz and 40 MHz to 55 MHz respectively).

Channels — Two with simultaneous acquisition.

Vertical Accuracy — ±2% + 1 DL (DL=digitizing level. 25 DLs per CRT division).

Deflection Factor — 2 mV/div to 5 V/div in 1-2-5 sequence, continuously variable between ranges.

Auto Scale Factor — Probe tip deflection factors for 1X, 10X, 100X, and 1000X indicated by on-screen readout. Scale factor available over GPIB Bus. Probe identification available via on-screen readout.

Delay Matching — ±250 ps.

Channel Isolation — 100:1 or greater attenuation of the deselected channel at 100 MHz, 50:1 or greater at 150 MHz for a 10 div input signal from 2 mV/div to 500 mV/div with equal VOLTS/DIV switch settings on both channels.

Maximum Input Voltage —
1 MΩ: Dc, Ac, GND Coupled: 400 V (dc + peak ac); 800 V p-p ac at 10 kHz or less.
50 Ω: 5 V RMS; 0.5 W sec for any 1 second interval for instantaneous voltages from 5 V to 50 V.

Input R and C — 1 MΩ ±0.5% paralleled by 15 pF ±2 pF. 50 Ω ±1%.

VSWR — ≤1.3:1 (Dc to 150 MHz).

Vertical Postion Range — ±(10, +0.4, −0.7) divisions.

CMRR — At least 10:1 at 50 MHz for common-mode signals of 10 div or less, with VAR VOLTS/DIV adjusted for best CMRR at 50 kHz at any VOLTS/DIV setting from 5 mV to 5 V.

HORIZONTAL SYSTEM

Display Modes — A, A Intensified, B.

A and B Delayed Sweep Range — 5 ns/div to 5 s/div in 1-2-5 sequence.

Clock Accuracy — .001%.

External Clock Repetition Rate — Min: 1 MHz. Max: 100 MHz. Events Max Rep Rate: 100 MHz.

Signal Levels Required for EXT Clock or Events

Coupling	CH 1 or CH 2 Source	EXT 1 or EXT 2 Source Gain=1
Dc	0.70 div from dc to 20 MHz increasing to 2.0 div at 100 MHz 3.0 div at 100 MHz in ADD mode	35 mV from dc to 20 MHz increasing to 100 mV at 100 MHz
Noise Rej	≥2.4 div from dc to 20 MHz; increasing to 6.0 div at 100 MHz. 9.0 div at 100 MHz in ADD mode	≥120 mV from dc to 20 MHz; increasing to 300 mV at 100 MHz
Ac	0.7 div from 60 Hz to 20 MHz; increasing to 2.0 div at 100 MHz; 3.0 div at 100 MHz in ADD mode. Attenuates signals below 60 Hz	35 mV from 60 Hz to 20 MHz; increasing to 100 mV at 100 MHz; Attenuates signals below 60 Hz
HF Rej	2.0 div from dc to 30 kHz. Attenuates signals above 30 kHz.	50 mV from dc to 30 kHz
LF Rej	2.0 div from 60 kHz to 20 MHz; increasing to 4.0 div at 100 MHz; 3.0 div at 100 MHz in ADD mode. Attenuates signals below 80 kHz	50 mV from 80 kHz to 20 MHz; increasing to 100 mV at 100 MHz

Signal Levels Required for EXT clock or EVENTS; GAIN=+5: Amplitudes are 5 times those specified for Ext. Gain=1.

Delay By Time and Delta Delay — On-screen readout will display time delay between measured events.

Delay By Time and Delta Delay Maximum Delay — (0.04 x B sec/div) to (65,536 x 0.04 B sec/div).

Delay Time Resolution — The greater of (0.04 x B sec/div) or 20 ns.

Delay By Events — Delays the A or B sweep by a user selected number of B trigger events after the normal A trigger occurs. On-screen readout indicates number of events selected. the maximum number of events selectable is 65,536 with one event resolution.

ACQUISITION SYSTEM

Maximum Single Event Useful Storage Bandwidth — 40 MHz (using internal Modified Sine X/X interpolator).

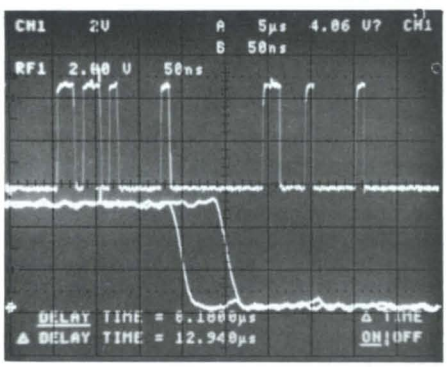
Maximum Sample Rate — 100 MS/s on two simultaneous channels.

Vertical Resolution — 8 bits (1 to 256 over 10.24 vertical div).

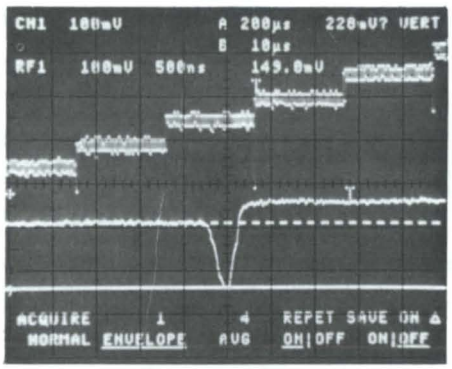
Record Length — 1024 points per channel.

ACQUISITION MODES

Normal Mode — Repetitive and nonrepetitive acquisitions.



When you have to measure time intervals within complex sequences, as in disk drive applications, the 2430's DELAY BY EVENTS, DELAY BY TIME and DELTA DELAY enable you to simplify and measure intervals buried in long sequences.



Once you've found a DAC glitch, the 2430 lets you take a good look. (Top) The 2430's envelope mode displays a DAC OUTPUT WITH THE GLITCH highlighted by an intensified zone. (Bottom) The glitch has been expanded and stored in a display reference memory for comparison and cursor measurement.

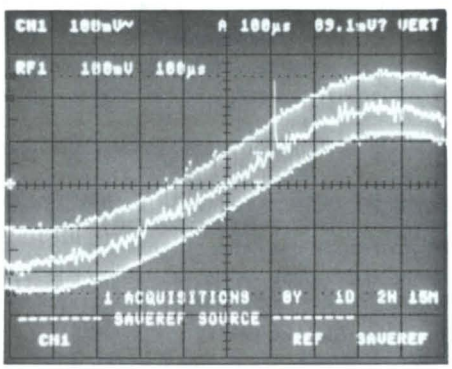
Envelope Mode — Records and displays minimum and maximum waveform values over 1 or more sweeps. Number of waveforms recorded before reset is user selectable in binary sequence from 1 to 256 or continuous.

Envelope Mode Pulse Response (glitch capture)

Pulse Duration	% of Amplitude Capture	Confidence Level
2 ns	50%	> 85%
4 ns	50%	100%
8 ns	>80%	100%

Average Mode — Averages continuously for a number of acquisition from 2 to 256 in binary sequence (user selectable from front panel). Averaging of 256 acquisition effectively increases vertical resolution to 11 bits and vertical sensitivity to 200 µV/div (for signals containing sufficient noise component). Average mode will do Stable Averaging for the user selected number of acquisitions, then switch to Exponential averaging for a weighted averaging of the display until there is a control change or other reset of the instrument.

Save on Delta Mode — Incoming waveforms will be compared against a user definable waveform envelope and SAVED if the waveform is outside reference limits. When event is SAVED it is horizontally positioned at center screen for examination.



A new Tek patented feature, SAVE ON DELTA instructs the 2430 to compare incoming acquisitions against a user defined reference and save it in the event of a difference. You can catch intermittent failures automatically and implement automatic tests with improved repeatability.

MEMORY

Save Memory — 8K of waveform memory. Four display waveforms (1K each), and four Reference waveforms (1K each). Reference memory number 4 is user-selectable for waveform data storage or to store four user-definable front panel settings. Capacitor backed waveform data retention time from last power off more than 120 hours at 26°C, 24 hours at 50°C.

Nonvolatile Memory — Approximately 2K of memory containing calibration data, readout information, an initial front panel setting, power down front panel setting, and 1 user definable front panel setting. Nonvolatile memory retention time of more than 3 years using a Lithium battery backup.

DISPLAY

Display Modes — CH 1, CH 2, Invert, Add, Multiply, X/Y (CH 1 vs CH 2, Ref 1 vs Ref 2) Reference displays 1 through 4.

Ground Reference Display — A plus symbol (+) is displayed at left of screen, tracking ground location. If ground is located off screen, plus (+) remains at screen perimeter indicating off screen location.

Trigger Reference Display — A "T" symbol appears on waveform displays, tracking location of trigger. If trigger point is located off screen in any direction, "T" symbol remains on screen at perimeter. "T" symbol is user selectable.

Waveform Expansion — 10X vertical expansion of SAVED waveforms, in 1-2-5 sequence. 100X horizontal expansion of SAVED waveforms, in 1-2-5 sequence. Expanded waveforms can be positioned vertically and horizontally to examine any area of interest.

Readout — Readout characters are displayed on screen to indicate instrument's current vertical channel selection, input coupling and termination, volts/div, time base and sec/div, trigger level and trigger source configuration, as well as menu selections and cursor functions.

ON SCREEN CURSORS

Functions — Volts, Time, Volts at Time, 1/Time, Slope. These settings can be selected for delta or absolute time/volts with reference to trigger point or ground respectively. Delta delay will make differential time measurements by utilizing dual delayed sweep.

Units — Volts, Percent, dB in absolute or delta time, percent, degrees in absolute or delta slope, percent.

TRIGGERING

Following is a summary of triggering functions.

A Mode — Auto Level, Auto/Roll, Normal, Single Sequence.

B Mode — Triggerable After Delay, Runs After Delay.

A and B Source — Vertical, CH 1, CH 2, Line (A only), Ext 1, Ext 2, A B (A sweep only), Word (17-bit word recognizer probe optional accessory).

A and B Coupling — Dc, Noise Reject, HF Reject, LF Reject, Ac, TV (option: A coupling only).

A and B Trigger Position — Pre>post.

A and B Slope (±), A and B Level, External Clock, Manual Trigger, Variable Holdoff, Trigger Status.

Minimum P-P Signal Amplitude for Stable A Trigger from CH 1, CH 2, or ADD Source —
Dc Coupled: 35 div from dc to 50 MHz increasing to 1 div at 150 MHz; 1.5 div at 150 MHz with ADD.
Noise Reject Coupled: ≤1.2 div from dc to 50 MHz increasing to 3 div at 150 MHz; 4.5 div at 150 MHz with ADD source.
Ac Coupled: 35 div from 60 Hz to 50 MHz increasing to 1.0 div at 150 MHz; 1.5 div at 150 MHz with ADD source.
LF Reject: 0.5 div from 80 kHz to 50 MHz increasing to 1.0 div at 150 MHz; 1.5 div at 150 MHz with ADD source.
HF Reject: 0.50 div from dc to 30 kHz. Attenuates signals above 30 kHz.

Minimum P-P Signal for Stable Trigger from Ext 1 or Ext 2 Source — Ext Gain: 1.
Dc Coupled: 17.5 mV from dc to 50 MHz, increasing to 50 mV at 150 MHz.
Noise Reject Coupling: ≤60 mV from dc to 50 MHz, increasing to 150 mV at 150 MHz.
Ac Coupled: 17.5 mV from 60 Hz to 50 MHz, increasing to 50 mV at 150 MHz.
LF Reject Coupled: 25 mV from 80 kHz to 50 MHz, increasing to 50 mV at 150 MHz.
HF Reject Coupled: 25 mV from dc to 30 kHz.
Ext÷5: Amplitudes are five times those given for Ext Gain=1.

Minimum P-P Signal for Stable B Trigger — Two times those required for stable A trigger.

Ext 1 and Ext 2 Inputs —
Resistance: 1 MΩ ±1%.
Capacitance: 15 pF ±3 pF.
Maximum Input Voltage: 400 V (dc + peak ac), 800 V p-p ac at 10 kHz or less.

Trigger Level Control Range —
CH 1 and CH 2 Source: ±18 div x V/div.
Ext 1 and Ext 2 Source Gain=÷1: ±0.9 V.
Ext 1 and Ext 2 Source Gain=÷5: ±4.5 V.
A and B Trigger Position: (pre>post) 1/8 to 7/8 of acquisition record, user selectable in 1/8-1/4-1/2-3/4-7/8 sequence. User selectable in 32 sample intervals using GPIB.

REAR PANEL OUTPUTS/INPUTS

Channel 2 Output Voltage — 20 mV/div ±10% into 1 MΩ. 10 mV/div ±10% into 50 Ω. −3 dB bandwidth is dc to >50 MHz.

A Trigger, Record Trigger, and Word Recognizer Output —
Logic Polarity: Negative true trigger occurrence indicated by a HI to LO transition.
Output Voltage HI: ≤400 μA load is 2.5 V to 3.5 V. 50 Ω Load to Ground is ≥0.45 V.
Output Voltage LO: <4 mA Load is ≤0.5 V. 50 Ω Load to Ground is ≤0.15 V.

Direct Hard Copy Output — Sends waveform data, cursor measurements, and instrument configuration over GPIB to a Hewlett Packard HP 2225A printer. In Save On Delta mode, when discrepancy is detected, send hard copy output and then reinitialize Save On Delta Mode.

Plotter Output —
X Output and Y Output: Output resistance is 1 kΩ ±10%.
Output Range/Scale Factors: Y is 390 mV/div. X(Y-T) is 195 mV/div. X(X-Y) is 390 mV/div.
Effective slew rate is <8 V/s.

Pen Lift, SPST Relay — Contact to Ground: Polarity is Menu selectable.
Maximum applied open-circuit voltage is ±25 V.
Maximum closed-circuit resistance is ≤0.25 Ω.
Maximum closed-circuit current is ≤0.25 A.

POWER REQUIREMENTS

Line Voltage Ranges — 115 V: 90 V to 132 V. 230 V: 180 V to 250 V.

Line Frequency — 48 Hz to 440 Hz.

Power Consumption — Typical (standard instruments): 160 W (250 VA). Maximum (fully optioned instrument): 200 W (300 VA).

GPIB PROGRAMMABILITY

Standard on all instruments. Full talk-listen modes available, control all front panel settings. Transmit and receive waveform data. Sixteen lines of prompting messages or computed results can be displayed on screen via GPIB (40 characters per line) using Tek *Codes and Formats*.

Data Transfer Rate — 65 Kbytes per sec maximum typical in Fast Transmit Mode.

IEEE Standard 488-1978 Interface Function Subsets Implemented — SH1, AH1, T5, L3, SR1, RL1, DC1, DT0, PP0, C0.

ENVIRONMENTAL AND SAFETY

The 2430 meets the environmental requirements of MIL-T-28800C for Type III, Class 3, Style D equipment, with humidity and temperature requirements defined in paragraphs 3.9.2.2, 3.8.2.3, and 3.9.2.4.

Electromagnetic Interference (EMI) — Meets MIL-T-28800C; MIL-STD-461B, Part 4 (CE-03 and CS-02), Part 5 (CS-06 and RS-02), and Part 7 (CS-01, RE-02, and RS-03—limited to 1 GHz); VDE 0871, Category B; Part 15 of FCC Rules and Regulations, Subpart J, Class A; and Tektronix Standard 062-2866-00.

Ambient Temperature — Operating: −15°C to +55°C. Nonoperating: −62°C to +85°C.

Altitude — Operating: To 4600 m (15,000 ft). Maximum operating temperature decreases 1°C for each 1,000 ft above 5,000 ft. Nonoperating: To 15 000 m (50,000 ft).

Vibration — Operating: 15 minutes along each of three axes at a total displacement of 0.025 inch p-p (4 g at 55 Hz), with frequency varied from 10 Hz to 55 Hz in one-minute sweeps. Held ten minutes at each major resonance, or if none existed, held ten minutes at 55 Hz (75 minutes total test time).

Humidity — Operating and Nonoperating: Stored at 95% relative humidity for five cycles (120 hours) from +30°C to +60°C, with operational performance checks at +30°C and +55°C.

Shock — Operating and Nonoperating: 50 g's, half-sine, 11 ms duration, three shocks on each face, for a total of 18 shocks.

Drip Proof — Front cover meets MIL-T-28800C paragraph 4.5.5.5.3.

Safety — Certified by CSA, Electronic Bulletin No. 556B and UL 1244 and complies with IEC 348.

PHYSICAL CHARACTERISTICS

	Cabinet		Rackmount	
Dimensions	**mm**	**in**	**mm**	**in**
Width (with handle)	330	13.0	483	19.0
Height			178	7.0
(with feet & pouch)	190	7.5		
(without feet & pouch)	160	6.3		
Depth			419	16.5
(with front cover)	479	18.9		
(with handle extended)	550	21.7		
Weights≈	**kg**	**lb**	**kg**	**lb**
Net			4.0	8.8
(w/accessories & pouch)	12.8	28.1		
(w/o accessories & pouch)	10.9	23.9		
Shipping	16.4	36.0		

Option 05

TV Waveform Measurement System

GPIB IEEE-488 The Option 05 complies with IEEE Standard 488-1978 and with Tektronix *Standard Codes and Formats.*

All of the High-Performance Characteristics of the Standard 2430 Oscilloscope Plus Television Waveform Assessment Capabilities

Selectable System-M and Nonsystem-M Protocols

Selectable Triggering on Any Line Within a Field, With Line-Number Readout

GPIB-Controllable Functions for Use in Automatic Measurement Systems

Compatible With Composite Video

Television Blanking-Level Clamp (Back-Porch)

Optimized Vertical Response Comparable to High-Performance Television Waveform Monitors

CHARACTERISTICS

The set of characteristics is the same as specified for the standard 2430 Oscilloscope and includes the following additions:

VERTICAL SYSTEM (Channel 1 and Channel 2)

Frequency Response — For Volts/Div switch settings between 5 mV and 0.2 V, with Var Volts/Div calibrated and using a five-division, 50 kHz reference signal from a 50 Ω system, with external 50 Ω termination on 1 MΩ input.

	Frequency Response	
Frequency Range	With Full BW	With BW Limiting
50 kHz to 5 MHz	±1%	+1%, −4%
>5 MHz to 10 MHz	+1%, −2%	—
>10 MHz to 30 MHz	+2%, −3%	—

Squarewave Flatness — ±1%, 1% p-p for both 60 Hz and 15 kHz squarewaves, using a 0.1 V input with Volts/Div settings between 5 mV and 20 mV and using a 1.0 V input with Volts/Div setting of 50 mV. Setup with 1 MΩ dc input coupling, external 50 Ω termination, Var Volts/Div in calibrated and fast-rise input signal (rise time ≤1 ns). Exclude first 20 ns following step transition and exclude first 30 ns when 20 MHz BW LIMIT is set. For signals with rise times ≤10 ns, add 2% p-p between 155 ns and 165 ns after step transition.

Note: Although flatness and frequency response are verified using a 50 Ω system, similar performance can be expected when using 75 Ω systems.

Television Blanking-Level Clamp (Back-Porch) 60 Hz Rejection (Channel 2 Only) — ≥18 dB at 60 Hz, with Volts/Div settings between 5 mV and 0.2 V, Var Volts/Div control set to calibrated and a six-division reference signal.

Television Blanking-Level Clamp (Back-Porch) Reference — Within 1.0 division of ground reference.

TRIGGERING

Sync Separation — Stable sync separation from sync-positive or sync-negative compositive video on systems with 525 to 1280 lines per frame, 50 Hz or 60 Hz field rate, interlaced or non-interlaced scan.

Trigger Modes — LINES, FLD 1, FLD 2, AND ALT (FLD 1, FLD 2) coupling.

Input Signal Amplitude for Stable Triggering Channel 1 and Channel 2 — 2.0 division for composite video and 0.6 division for composite sync signals (dc + peak video-signal amplitude must be within 18 divisions of input ground reference).

External 1 and External 2 — 60 mV division for composite video and 30 mV division for composite sync signals (dc + peak video-signal amplitude must be within 9 divisions of input ground reference).

ORDERING INFORMATION

2430 150 MHz Digital Oscilloscope **$8,900**
Includes: Two P6133 10X, 1.3 m probes with accessories; snap accessory pouch (016-0692-00); ziploc accessory pouch (016-0537-00); 5 A, ACG/3AG, 250 V fuse (159-0014-00); blue plastic CRT filter, installed (378-0199-00); clear plastic CRT filter (378-0208-00); front cover (200-2742-00); user reference guide (070-5497-00); operator manual (070-4918-00); users GPIB interface guide (070-5705-00).

2430M 150 MHz Digital Oscilloscope with MATE/CIIL **$20,000**
Includes: Same as 2430.

OPTIONS

Option 05 — TV Waveform Measurement System. **+$1,050**
Includes: Same as 2430 plus CCIR graticule CRT filter (378-0199-01); NTSC graticule CRT filter.
Option 1R — Configure scope for rackmount. **+$320**
Option 1T — Transit case. **+$340**
Option 11 — Probe Power. **+$165**

INTERNATIONAL POWER PLUG OPTIONS

Option A1 — Universal Euro 220 V, 50 Hz.
Option A2 — UK 240 V, 50 Hz.
Option A3 — Australian 240 V, 50 Hz.
Option A4 — North American 240 V, 60 Hz.
Option A5 — Switzerland 220 V, 50 Hz.

WARRANTY-PLUS SERVICE PLANS

SEE PAGE 497

M1 — 2 Calibrations **+$240**
M2 — 2 Years Service **+$240**
M3 — 2 Years Service and 4 Calibrations **+$785**
M4 — 5 Calibrations **+$610**
M5 — 9 Calibrations +2 Years Service **+$1,430**

OPTIONAL ACCESSORIES

Service Manual — Order 070-4917-00 **$30**
Rackmount Conversion Kit — Order 016-0825-00 **$365**
Protective Cover — Blue vinyl. Order 016-0720-00 **$24**
Carrying Strap — Order 346-0058-00 **$17**

P6407 WORD RECOGNIZER PROBE

A 17-bit Word Recognizer provides a triggering from a variety of TTL-compatible logic families. Operable up to 20 MHz with an external clock, and up to 10 MHz without, the Word Recognizer enables the 2430 to trigger the A or B triggers on word occurrences.

Input — P6407 Word Recognizer Probe, 17 bits plus clock. (No CRT display from P6407.)

All Inputs	Threshold	Load	Safe Limit
Hi	<2.0 V	<20 μA	5.5 V
Lo	>0.6 V	> −0.6 mA	−0.5 V

Display Radix — Hexadecimal, octal, binary.
Data Rate — 0 MHz to ≥20 MHz with clock, 0 MHz to ≥10 MHz without clock.
Data Setup Time — 25 ns.
Data Hold Time — 0 ns.

GPIB Compatibility for Semiautomatic and Automated Measurement Systems when used in combination with 2430 Digital Oscilloscope.

P6407 — Word Recognizer Probe **$435**
Includes: 20 grabber tips (206-0222-00); two 10 inch 10 wide comb (012-0747-00); operator's manual.

RECOMMENDED PROBES

P6230 — ECL Probe **$395**
Current Probes — See page 483.
P6021 — 5 ft **$430**
P6022 — 5 ft **$475**
A6302 — 2 m **$565**
A6303 — 2 m **$1,070**
High Voltage Probe — P6009, 100X. **$195**

DCS01/350 MHz DIGITIZING CAMERA SYSTEM

DCS01 350 MHz Digitizing Camera System — Coupling a DCS01 Digitizing Camera System with a 2467 Oscilloscope provides a fully programmable system for digitizing repetitive or single shot events to a full 350 MHz bandwidth. The 2467/DCS combination also provides Save-On-Delta capability to detect and save that one-in-a-million deviation in a high repetition rate signal.

The 2467/DCS01 combination is a very cost effective data acquisition system for either lab or ATE use where 350 MHz single shot digitization or one-in-a-million Save-On-Delta operation is important.

See page 353 for a complete description of the Digitizing Camera System.

See page 278 for complete description of 2467 oscilloscope.

RECOMMENDED CAMERAS

HC100 Plotter*1 — Four pen color plotter. See page 445
C-53P — See page 451. **$1,940**

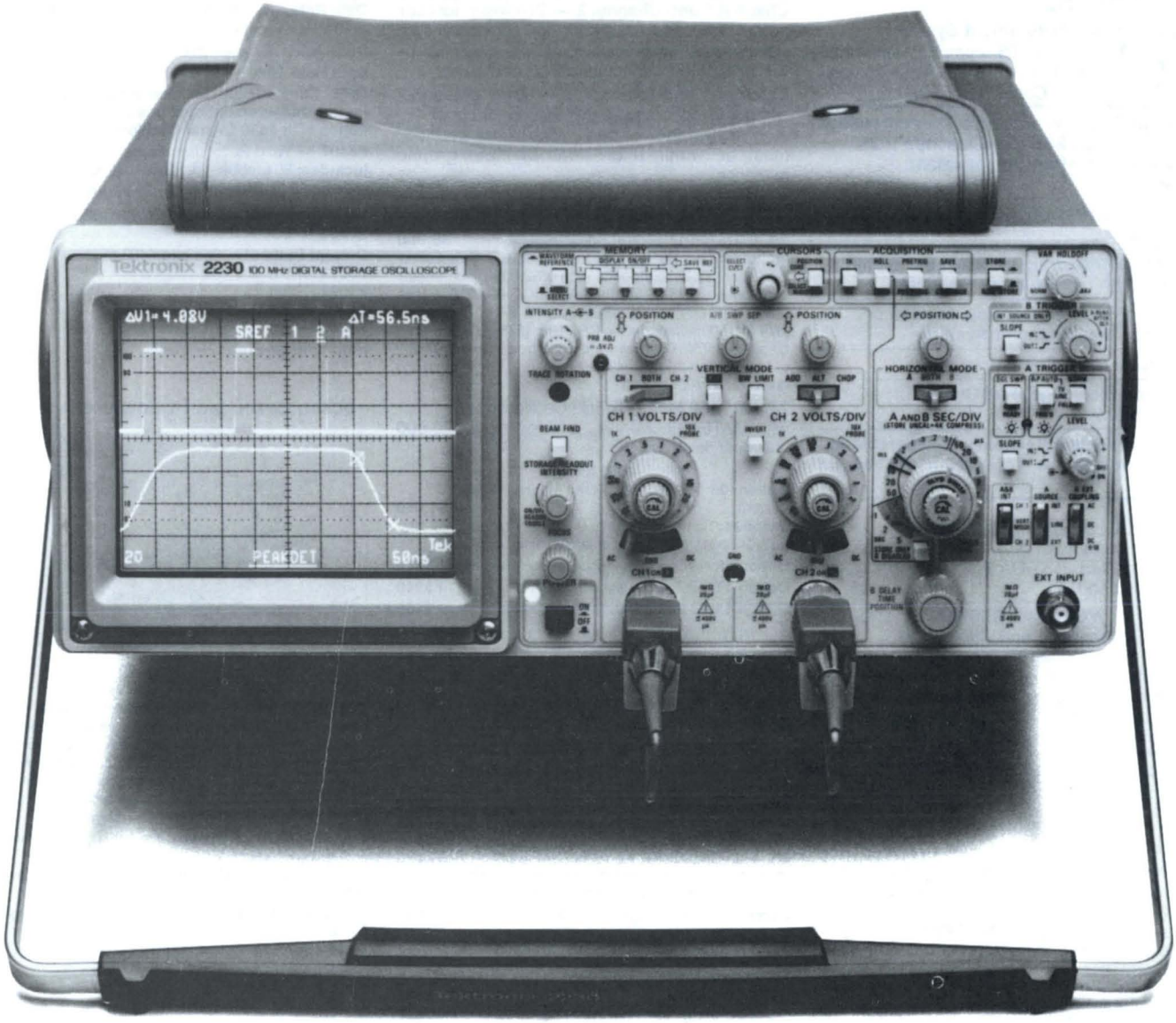
RECOMMENDED CARTS

K212 — Portable Instrument Cart. See page 461. **$330**
K213 — Lab System Cart. See page 462. **$595**

**1For ordering, contact your local Tektronix Sales Office.*

TRAINING

Operation and application training workshops applicable to this product are available to the purchaser at 50% off the normal fee, for one seat only for each product purchased. Certain other restrictions apply. Workshop content information is on pages 195-196. For further information, or to enroll, call us at 1-800-225-7802. For international orders, contact your nearest Sales Office.



2230/2220

GPIB IEEE-488

The 2230 Option 10/2220 Option 10 comply with IEEE Standard 488-1978 and use Tektronix *Standard Codes and Formats*. The 2230 Option 12/2220 Option 12 feature Standard RS-232C and use Tektronix *Standard Codes and Formats*.

100 MHz Digital Storage/Nonstorage (2230)

60 MHz Digital Storage/Nonstorage (2220)

100 ns Glitch Capture at Any Speed

Cursors for Time and Voltage Measurements (2230)

Pre/Posttriggering (2220)

Point Selectable Triggering (2230)

4K Record Length

Post Acquisition Expansion, Compression, and Positioning

GPIB or RS-232C Optional

26K Battery-Backed Save Reference Memory (2230 Option 10 or 12)

Three Year Warranty—Five Years Optional

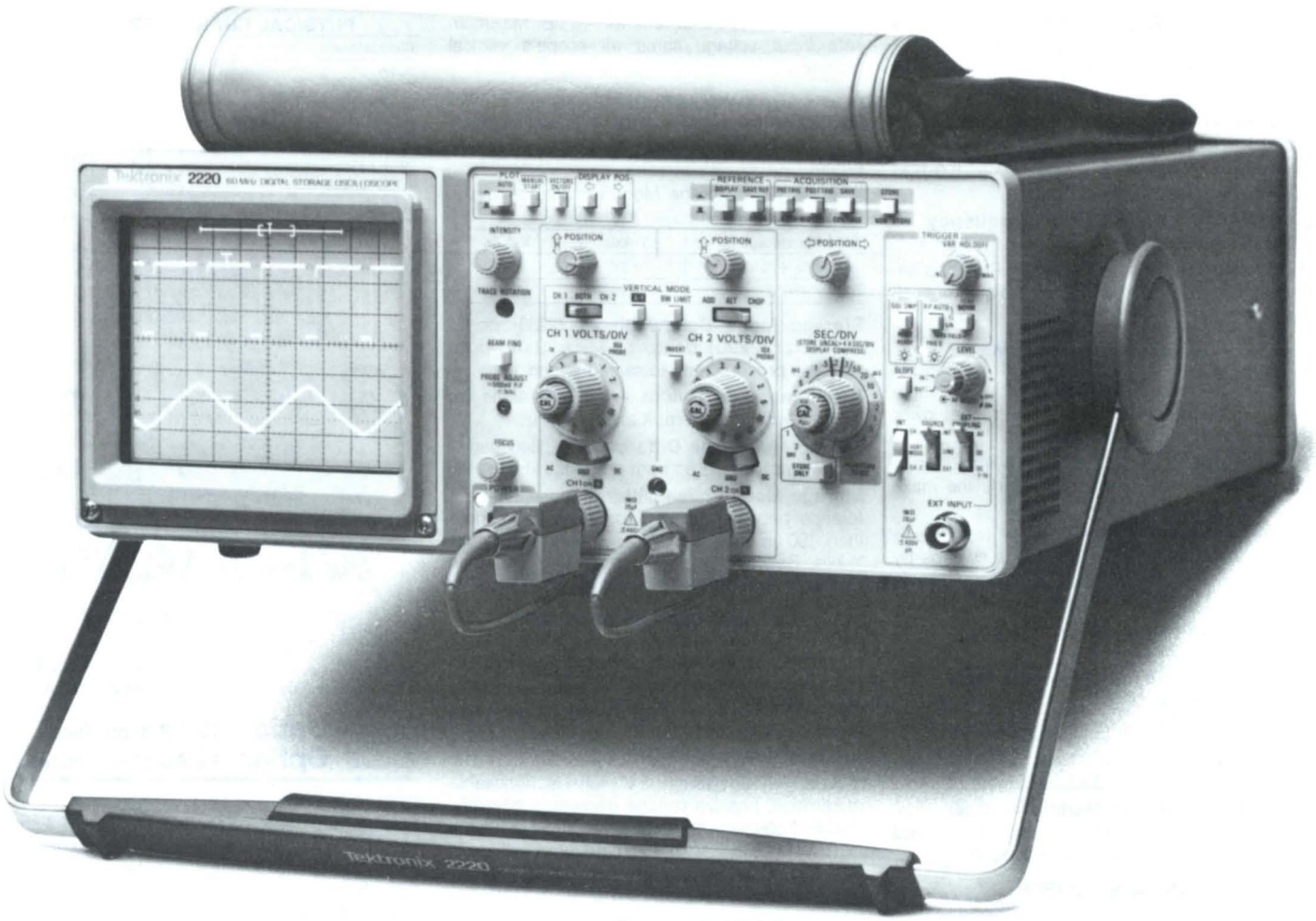
TYPICAL APPLICATIONS
Medical Equipment Servicing
Digital Design and Troubleshooting
Power Supply Design and Troubleshooting
Electromechanical
Stress/Vibration Analysis

See page 277 for available Application Notes.

The 2230 and 2220 are the answer for general and special purpose storage needs. These high performance portable scopes have storage and nonstorage bandwidths of 100 MHz (2230) and 60 MHz (2220).

Both scopes have been designed with many features which enhance their usefulness in your applications. The 2230 offers cursors and CRT readout enabling you to measure time or voltage differences easily and accurately. The multiple Save Reference memories allow you to view both stored and current waveform acquisitions onscreen simultaneously. Weighted signal averaging can be used to remove random noise from a signal and improve measurement accuracy.

Peak detection makes 100 ns glitch capture possible at any sweep speed. This mode digitizes and stores, in acquisition memory as a data pair, the minimum and maximum levels of the input signal. The resulting display can be used to catch glitches, as narrow as 100 ns, view frequency drift and amplitude modulation, or detect aliasing.



Unlimited storage time; expandable, compressible, repositionable stored traces; save reference memory; pre/post trigger viewing; roll mode; standard X-Y plotter output; and optional interfaces make the 2230 and 2220 the most sensible digital storage oscilloscopes to own.

CHARACTERISTICS

The following characteristics are common to the 2230 and 2220 except where indicated.

DIGITIZER AND MEMORY

Speed — Digitizing rates from 20 MS/s at 5 μs/div and faster to 20 samples/s at 5 s/div. CHOP/ALT modes effectively halves the digitizing rate/waveform. The effective sampling rate in Repetitive Storage mode is 2 GS/s.

Useful Storage Bandwidth — Single Shot: Useful storage bandwidth is defined as the maximum sampling rate (20 MS/s) divided by the desired points/signal period. Repetitive Storage Mode: Dc to 100 MHz (2230); Dc to 60 MHz (2220).

Resolution — Vertical: 8 bits, 25 levels/division. Horizontal: 10 bits.

Acquisition/Process Modes — Sample, Peak Detect, Accumulated Peak Detect, Average, Smoothing.

Peak Detect (Enhanced Envelope) Mode — 100 ns minimum pulse width for 100% probability of 50% signal amplitude capture. 10 MS/s sampling rate.

Average Mode — (2230) Normalized Average weight is selectable from 1/1, 1/2, 1/4, 1/8, 1/16, 1/32, 1/64, 1/128, 1/256. Number of sweeps averaged is adjustable from 1 to 2047 or to an unlimited number. (2220) Average is active from 2 μs/div and faster. Normalized weight of average is 1/4.

Pre/Posttrigger — (2230) 7/8 (PRETRIG) or 1/8 (POSTTRIG) of waveform acquisition is prior to the trigger event. Trigger position is menu selectable over the entire record. (2220) PRETRIG: 7/8 of waveform acquisition window prior to the trigger event. POSTTRIG: 1/8 of waveform acquisition window prior to the trigger event. MIDTRIG: 1/2 of the waveform acquisition window prior to the trigger event.

Record Length — (2230) 4K or 1K record length selectable. (2220) 4K record length.

Save Reference Memory — (2230) One 4K or three 1K acquisitions may be saved in reference memory. Options 10 and 12 offer 26K of battery-backed reference memory, allowing 26 waveform sets to be saved. (2220) One 4K acquisition may be saved in reference memory.

Total Cursor Accuracy — Voltage: ±3% of delta voltage reading. Time difference is within ±[1 display interval (+1 display interval if in ACC PEAK)] from 5 s to 5 μs/div and within ±[(2 display intervals + (2 display intervals if in ACC PEAK) +500 ps)] from 2 μs/div to 0.05 μs/div.

X-Y Plotter Output — Standard on both the 2230 and 2220. The oscilloscopes plot all displayed waveform(s) and readout information. The plotting of the graticule is selectable on the 2230. Plotter pen lift is adjustable with a relative speed range of 1 div/s to 10 div/s.

External Clock — Provides an input for EXT CLOCK signals, dc to 1 kHz, to the storage acquisition system.

VERTICAL SYSTEM (2 Identical Channels)

Bandwidth (−3 dB) and Rise Time (Nonstore) — (2230) 100 MHz and 3.5 ns, derated to 80 MHz and 4.4 ns at 2 mV/div and outside 0 °C to +35°C. (2220) 60 MHz and 5.8 ns, derated to 50 MHz and 7.0 ns at 2 mV/div and outside 0°C to +35°C.

Bandwidth Limit — (2230) 20 MHz ±10%. (2220) 10 MHz ±15%.

Nonstore Deflection Factor and Accuracy — 2 mV to 5 V/div 1-2-5 sequence, accuracy is ±2% (0°C to +35°C). Uncalibrated: Continuously variable between steps to at least 2.5:1.

Store Deflection Factor and Accuracy — 2 mV to 5 V/div. Displayed signal amplitude is within ±3% of the input voltage over the dynamic range of the A/D converter.

Vertical System Operating Modes — CH 1, CH 2, CH 2 Invert, ADD, ALT, CHOP (500 kHz nonstore).

Common-Mode Rejection Ratio — For signals of 6 div or less, at least 10:1 (at 50 MHz).

Input R and C — 1 MΩ, 20 pF.

Maximum Input Voltage (Ac and Dc Coupled) — 400 V (dc + peak ac) or 800 V (p-p to 10 kHz).

Channel 1/Channel 2 Isolation — 100:1 at 50 MHz.

Ac-Coupled Lower Cutoff Frequency — 10 Hz or less at −3 dB.

Automatic Scale Factor — (2230) Probe tip deflection factors for coded probes are automatically indicated in the CRT readout.

HORIZONTAL SYSTEM

A Time Base — 0.05 μs to 0.5 s/div in 1-2-5 sequence. 10X magnifier extends the maximum sweep speed to 5 ns/div. In STORE mode, lower sweep speed is extended to 5 s/div.

B Time Base — (2230) 0.05 μs to 50 ms/div in 1-2-5 sequence. 10X magnifier extends the maximum sweep speed to 5 ns/div.

Variable Sec/Div Control — In Nonstorage mode, uncalibrated variable extends sweeps by at least 2.5:1. In storage mode, a 4K acquisition is compressed to 1K for on-screen viewing.

Sweep Linearity — ±5% over any two of the center eight divisions.

Time Base Accuracy — Storage mode: 0.1% over full 10 cm (or div).

Nonstorage Mode	+15°C to +35°C	0 to +50°C
Unmagnified	±2%	±3%
Magnified	±3%	±4%

Horizontal Operating Modes — (2230) Nonstorage: A, Alternate with A intensified by B, and B; Storage: A, A intensified by B, and B.

DELAYED SWEEP

Delayed Sweep Delay Times — (2230) Continuously variable with 10-turn control from less 0.5 div plus 300 ns to greater than 10 div.

Differential Delay Time Accuracy — (2230) ±1% (0°C to +35°C, ±2% (0°C to +50°C).

Delay Jitter — (2230) 5,000:1 (0.02%), nonstore mode only.

TRIGGERING

A Trigger Sensitivity

2230	Internal	External
10 MHz	0.35 div	40 mV
100 MHz	1.5 div	200 mV
2220	**Internal**	**External**
5 MHz	0.3 div	40 mV
60 MHz	1.0 div	120 mV

B Trigger (Internal Only) Sensitivity — (2230) 0.35 div at 10 MHz, 1.5 div at 100 MHz.

Trigger System Operating Modes — Normal, P-P Automatic, TV Line, TV Field, and Single Sweep. HF REJ triggering attenuates signals above 40 kHz. Lowest usable frequency for P-P Automatic is 20 Hz.

Trigger Coupling — Automatic coupling with internal signal sources: Ac with P-P Automatic and TV Field; Dc with Normal and Single Sweep.

Trigger Sources — A trigger: Internal, external, and line. B trigger (2230): Internal only.

External Trigger Input — Input Coupling: Ac, dc, or dc divide by 10. Bandwidth: 100 MHz (2230), 60 MHz (2220); Ac-coupled lower cutoff frequency is 10 Hz or less at −3 dB. Maximum safe input voltage same as scope's vertical channels.

X-Y MEASUREMENTS

Deflection Factors — Same as scope's vertical system with the Volts/div switch in calibrated detent.

Accuracy — Storage Mode is same as digital storage vertical deflection system.

2230 Nonstorage	Y-Axis	X-Axis
+15°C to +35°C	±2%	±3%
0°C to +50°C	±3%	±4%

Storage Mode Bandwidth — (2230) dc to 100 MHz. (2220) dc to 60 MHz. Bandwidth changes proportionate to sweep speed.

Nonstorage Bandwidth — Y-axis same as scope's vertical system, X-axis: 3.0 MHz.

Nonstorage Phase Difference — Between X and Y amplifiers: ±3° from dc to 150 kHz.

Storage Mode Phase Difference — Time difference between Y-axis and X-axis is no more than 100 ns. The X-axis is sampled before the Y-axis. Between X and Y amplifiers: Less than ±2° referenced to a 10 division signal period.

CRT AND DISPLAY FEATURES

CRT — 8 x 10 cm display; internal graticule, nonilluminated, accelerating potential is 14 kV, GH (P31) phosphor standard.

Controls — Beam finder, focus, separate A and B sweep intensity (2230), Storage/Readout intensity (2230), trace rotation.

Z-Axis — Sensitivity: 5 V causes noticeable modulation, positive voltage decreases intensity. Usable frequency range is dc to 20 MHz (2230), to 10 MHz (2220). Maximum safe input voltage is 30 V (dc + peak ac) or 10 V ac p-p at 1 kHz or less. Input resistance is approximately 10 kΩ.

OTHER CHARACTERISTICS

Probe Adjustment Signal — 0.5 V ±5% squarewave at 1 kHz ±20%.

POWER REQUIREMENTS

Line Voltage Range — 90 V ac to 250 V ac.

Line Frequency — 48 Hz to 440 Hz.

Maximum Power Consumption — 85 W, 2.0 A, at 250 V (slow blow).

ENVIRONMENTAL

Temperature — Operating: 0°C to +50°C; Nonoperating: −55°C to +75°C.

Altitude — Operating: to 4 500 meters (15,000 ft), maximum operating temperature decreased 1°C per 1,000 ft above 5,000 ft. Nonoperating: to 15 000 m (50,000 ft).

Humidity — Operating and Nonoperating: 5 cycles (120 hours) referenced to MIL-T-28800C, for Type III, Class 5 instruments.

Radiated and Conducted Emission — Requirements per VDE-0871. Meets Class B.

Vibration — Operating: 15 minutes along each of three axes at a total displacement of 0.015 inch p-p (2.4 g's at 55 Hz) with frequency varied from 10 to 55 to 10 Hz in one minute sweeps; hold for 10 minutes at 55 Hz in each axis; all major resonances must be above 55 Hz.

Shock — Operating and Nonoperating: 30 g's, half-sine, 11 ms duration, 3 shocks per axis for a total of 18 shocks.

PHYSICAL CHARACTERISTICS

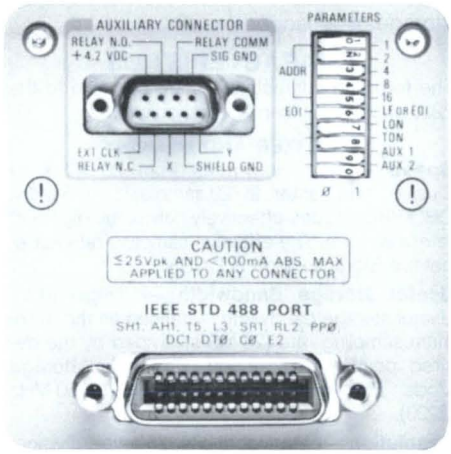
Dimensions	mm	in
Width		
With handle	360	14.2
Without handle	328	12.9
Height, with feet and handle	137	5.4
Depth		
With front cover	445	17.5
With front cover	440	17.3
With front cover	511	20.1
Weight≈	**kg**	**lb**
Net, without cover, accessories, and pouch	8.3	18.0

GPIB IEEE-488 Option 10 GPIB Interface
Option 12 RS-232C Interface

GPIB (Option 10) and RS-232C (Option 12) interfaces are available for the 2230 and 2220. Either interface can transmit and receive waveform data. Most front panel settings can be queried and many functions can be controlled via the interface; e.g., single sweep reset.

2230 Option 10 or 12 interfaces also allow messages or computed results to be displayed on screen, and include a battery-backed reference memory (minimum lifetime 3 years) for storage of up to 26 additional waveform sets.

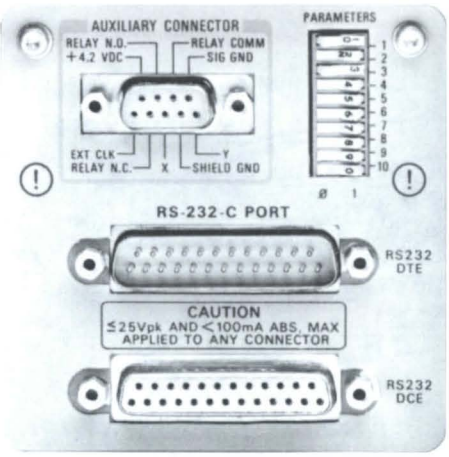
Option 10 GPIB Interface



The Option 10 GPIB interface conforms to IEEE Standard 488-1978. It is fully compatible with Tektronix *Standard Codes and Formats*. Primary address (0-30), message terminator (EOI or LF/EOI), and talk/listen mode are selected by a switch on the oscilloscope side panel. Maskable interrupts for RQS and OPC can be programmed.

IEEE Standard 488-1978 Interface Function Subsets Implemented — SHI, AHI, T6, L3, SRI, RL2, PPØ, DCI, DTØ, CØ.

Option 12 RS-232C Interface



The Option 12 RS-232C interface has both DCE and DTE connectors. It is compatible with an extension of Tektronix *Standard Codes and Formats*. Baud rate (50–4800), parity (Odd, Even, Mark, Space, or none), line termination (CR or CR-LF), and SRQ generation on parity error (ON or OFF) are selected by a switch on the oscilloscope side panel. Number of bits per character (7 or 8), number of stop bits (1 or 2), and CTRL-S/CTRL-Q handshaking (enable/disable) may be changed by remote commands. The interface automatically senses the presence of Clear to Send (CTS)/Request to Send (RTS) or Data Set Ready (DSR)/Data Terminal Ready (DTR) handshaking lines.

Option 12 for the 2230 also includes 26K of battery-backed reference memory for the storage of up to 26 waveform sets.

Direct Connection to Printers and Plotters via GPIB or RS-232C.

A 2230 or 2220 equipped with either Option 10 or Option 12 interface is fully compatible with any Digital X-Y plotter that uses Hewlett-Packard Graphics Language (HPGL). The GPIB interface is also compatible with the HP ThinkJet 2225A printer. The RS-232C interface also supports any Epson FX-Series format printer or the HP Thinkjet 2225D printer. Plotter output is directed to the interface if its control switches are set for the appropriate plotter or printer. Otherwise, plotting is directed to the X-Y outputs.

ORDERING INFORMATION

2230 100 MHz Dual Time Base Digital Storage Oscilloscope **$5,150**
Includes: Two P6121 10X voltage probes, front panel cover (200-2520-00), accessory pouch (016-0677-02), operator manual (070-4998-01), user's reference card (070-5370-00).

2220 60 MHz Single Time Base Digital Storage Oscilloscope **$4,150**
Includes: Two P6122 10X voltage probes, front panel cover (200-2520-00), accessory pouch (016-0677-02), operator manual (070-5301-00), user's reference card (070-5681-00).

OPTIONS

Option 10 — (2230) GPIB IEEE-488 Interface. **+$850**
Includes: 26K of Battery-Backed Reference Memory.

Option 12 — (2230) RS-232C Interface **+$850**
Includes: 26K of Battery-Backed Reference Memory.

Option 10 — (2220) GPIB IEEE-488 Interface. **+$550**

Option 12 — (2220) RS-232C Interface. **+$550**

Option 33 — Travel Line Package. See page 305. **+$150**

FIELD RETROFIT KITS

2230F10 — Field Retrofit Kit for Option 10. **$350**
2230F12 — Field Retrofit Kit for Option 12. **$850**
2220F10 — Field Retrofit Kit for Option 10. **$550**
2220F12 — Field Retrofit Kit for Option 12. **$550**

INTERNATIONAL POWER PLUG OPTIONS

Option A1 — Universal Euro 220 V, 50 Hz.
Option A2 — UK 240 V, 50 Hz.
Option A3 — Australian 240 V, 50 Hz.
Option A4 — North American 240 V, 60 Hz.
Option A5 — Switzerland 220 V, 50 Hz.

WARRANTY-PLUS SERVICE PLANS

SEE PAGE 497

M1 — (2230) 2 Calibrations. **+$215**
M1 — (2220) 2 Calibrations. **+$205**
M2 — (2230) + 2 Years Service. **+$250**
M2 — (2220) + 2 Years Service. **+$235**
M3 — (2230) 4 Calibrations & 2 Years Service. **+$640**
M3 — (2220) 4 Calibrations & 2 Years Service. **+$610**
M4 — (2230) 5 Calibrations. **+$555**
M4 — (2220) 5 Calibrations. **+$535**
M5 — (2230) 9 Calibrations & 2 Years Service. **+$1,240**
M5 — (2220) 9 Calibrations & 2 Years Service. **+$1,185**

OPTIONAL ACCESSORIES

Service Manuals —
(2230) Order 070-4999-00 **$25**
(2220) Order 070-5302-00 **$25**

Rackmount Adaptor Kit —
Order 016-1003-00 **$130**

Carrying Strap — Order 346-0199-00 **$17**

Carrying Case — Order 016-0792-01 **$355**

Rain Cover — Order 016-0848-00 **$xxx**

Viewing Hoods —
(Binocular) Order 016-0566-00 **$18.75**
(Collapsible) Order 016-0592-00 **$14**
(Polarized) Order 016-0180-00 **$50**

A6902B Isolator — For floating measurements see page 479 for complete description. **$1,795**

CRT Light Filter — (Clear) Order 337-2775-01 **$1.95**

1107 Dc Inverter — See page 307. **$525**

1107 Mounting Kit — Order 016-0785-00 **$50**

RECOMMENDED PROBES

See Probe Section for additional probes, page 463.
Current Probes — A6302/AM 503. See page 483.

RECOMMENDED CART

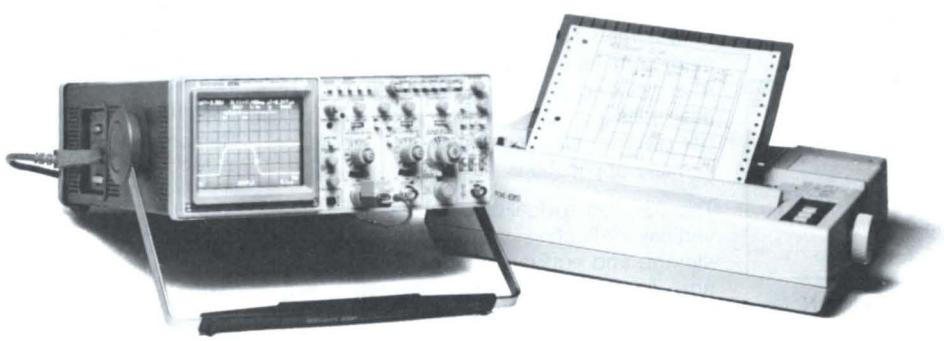
K212 — Portable Instrument Cart. See page 461. **$330**

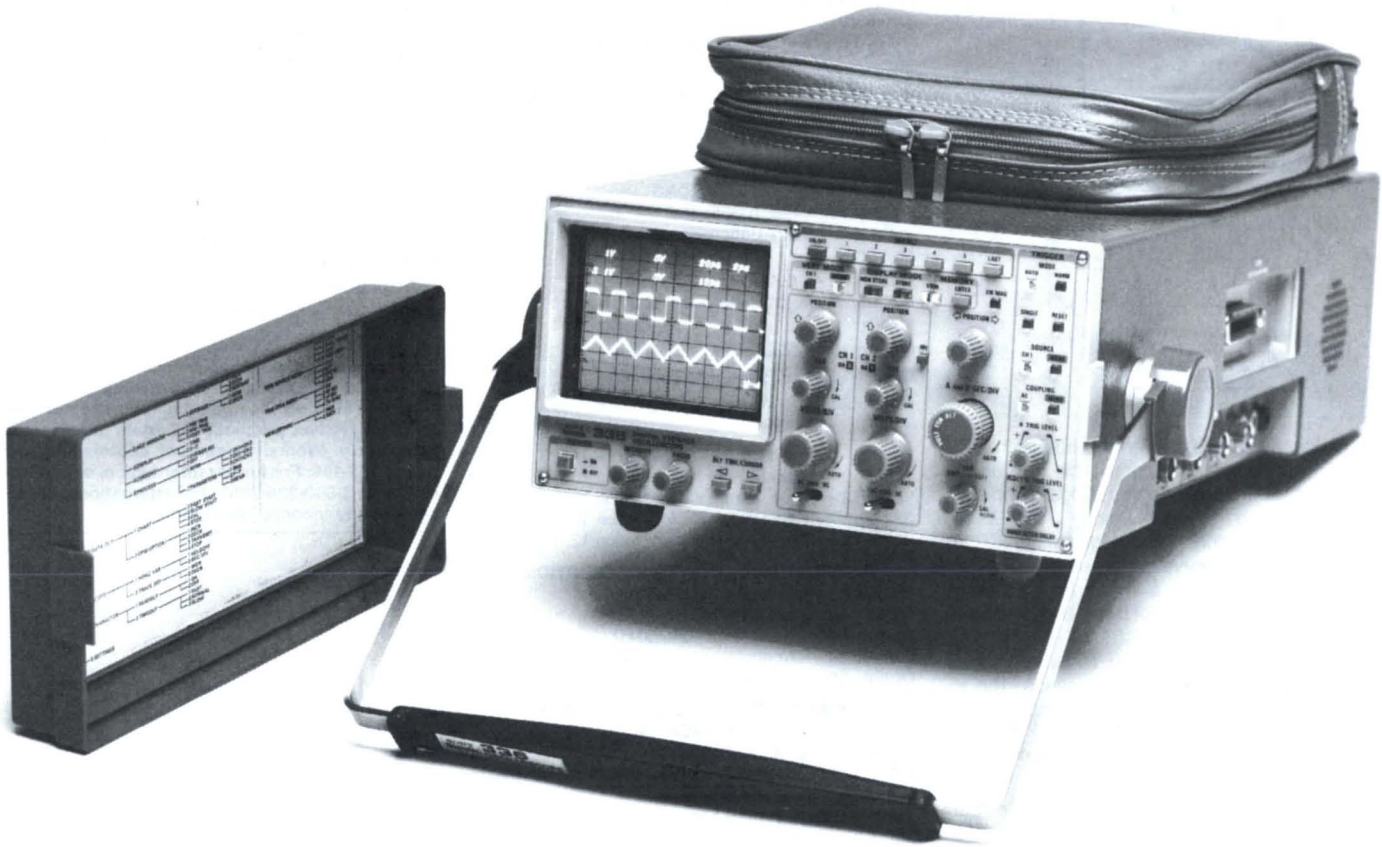
RECOMMENDED CAMERAS

C-5C Option 04 — See page 445. **$495**
C-7 Option 02 — See page 448. **$595**
C-30BP — See page 450. **$1,480**

TRAINING

Operation and application training workshops applicable to this product are available to the purchaser at 50% off the normal fee, for one seat only for each product purchased. Certain other restrictions apply. Workshop content information is on pages 195-196. For further information, or to enroll, call us at 1-800-225-7802. For international orders, contact your nearest Sales Office.





336

GPIB IEEE-488

The 336 with Option 01 complies with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats.*

1 MS/s, 140 kHz Useful Storage Bandwidth

Cursors for Time and Voltage Measurements

Signal Averaging

Envelope Mode

GPIB and Eight Screen Memory Option (16K)

50 MHz Nonstorage Bandwidth

CRT Readout

TYPICAL APPLICATIONS

Medical Systems
Communication Equipment Service
Electronic Design
X-Ray Equipment Maintenance

See page 277 for available Application Notes.

The SONY/TEKTRONIX 336 is a combination nonstorage and digital storage portable oscilloscope. It is capable of displaying analog and digitized waveforms simultaneously, and can store up to 18 digitized waveforms for recall and display. The 336 is a microprocessor controlled instrument that incorporates alphanumeric CRT readouts of the vertical and horizontal scale factors, the delay time position, and voltage and time readouts of the cursor positions. Many of the oscilloscope features and modes are chosen from a menu displayed on the CRT rather than from hardwired front panel switches. Also included is an Auto mode for both vertical volts per division and horizontal time per division, allowing "hands off" operation in many applications.

The 336 has a dual-channel, dc-to-50 MHz vertical deflection system for both nonstorage and equivalent time digitizing. Storage bandwidth for single sweep events (waveforms acquired as the result of a single triggering event) is dc-to-140 kHz. The vertical channels have calibrated deflection factors from 5 mV to 10 V per division with a choice of either ac or dc input coupling. In the Nonstore mode, the 336 operates like a conventional oscilloscope.

GPIB (talker only) is optional on the 336. Included in the option is a memory back-up of up to eight screens (two 1K waveforms each) of information.

CHARACTERISTICS

DIGITIZER AND MEMORY

Speed — Digitizing rates up to 1 megasample/s.

Useful Storage Bandwidth — Real Time Sampling: Dc to 140 kHz (−3 dB). Equivalent Time Sampling: Dc to 50 MHz (−3 dB).

Resolution — Vertical: 8-bit. Horizontal: 10-bit.

Memory Size — Standard: 2 Kbyte (one frame of two waveforms). Option 01: 16 Kbyte (up to eight frames of two 1K waveforms each storage capacity). Data Retention: At least 3 days (after eight hours of operation).

VIEW DISPLAY MODE

This is the saved "store" waveform (saved from Store display mode). Process functions are the same as Store display mode.

NONSTORED AND STORED DISPLAY MODES

The following characteristics apply to both modes unless otherwise indicated.

VERTICAL SYSTEM (2 IDENTICAL CHANNELS)

Bandwidth and Rise Time*[1]

0°C to +40°C	+40°C to +55°C
Dc to at least 50 MHz	Dc to at least 40 MHz

[1] At all deflection factors from a 50 Ω source.

Deflection Factor — Range: 5 mV/div to 10 V/div. Accuracy is ±3%. Uncalibrated, continuously variable between steps, and to at least 25 V/div.

Vertical Modes — Stored Mode: CH 1, CH 2, Chop, Dual and Trigger View. Nonstored Mode: CH 1, CH 2, Chop and Dual.

Normal Mode (Store Mode Only) — Acquired displayed signal.

Envelope Mode (Store Mode Only) — 1, 8, 16, 32, 64, 128, 256 sweeps, or continuous at s/div settings of 2 ms/div to 0.2 s/div.

Average Mode (Store Mode Only) — 8, 16, 32, 64, 128 or 256 sweep averages.

Process Mode (Store and View Mode Only) — Waveform: CH 1 + CH 2 is within 6%. CH 1 − CH 2 is within 6%. CH 1 x CH 2 is within 7%. Parameters (Selectable): RMS is within 3% + 6% of V/div setting. Mean is within 3% + 4% of V/div setting. P-p is within 3% + 4% of V/div setting. Store or view waveforms must acquire initial ground reference level.

Common-Mode Rejection Ratio — At least 10:1 at 10 MHz (5 MHz storage).

Input R and C — 1 MΩ ±2% paralleled by 33 pF.

Maximum Input Voltage — 200 V (dc + peak ac) or 200 V p-p ac to 1 kHz.

HORIZONTAL SYSTEM (NONSTORE MODE ONLY)

Time Base A — 0.2 s/div to 0.1 μs/div in a 1-2-5 sequence. X10 MAG extends the maximum sweep rate to 10 ns/div. (At sweep speeds slower than 0.2 s the scope automatically goes to Roll mode.)

Time Base B — 50 ms/div to 0.1 μs/div in a 1-2-5 sequence. X10 MAG extends the maximum sweep rate to 10 ns/div.

Variable Time Control — Continuously variable between calibrated settings of the A s/div switch. Extends the slowest sweep rate to at least 0.5 s/div.

Time Base Accuracy

	+20°C to +30°C	0°C to +55°C
Unmagnified	±2%	±3%
Magnified	±3%	±4%

DIGITAL STORAGE HORIZONTAL ACQUISITION

Resolution — Ten bit. 1024 data points.

Range — Equivalent Time Sampling: 50 ns/div to 0.1 ms/div. Single Sweep Storage: 0.2 s/div to 0.1 ms/div. Roll Mode: 20 s/div to 0.5 s/div. Envelope Mode: 0.2 s/div to 2 ms/div.

Accuracy — 3% from +20°C to +30°C; 4% from 0°C to +55°C.

Horizontal Display Modes — Nonstore: A sweep, B delay, alternate, X-Y. Storage: A sweep, B delay, X-Y.

CALIBRATED SWEEP DELAY

Differential Time Measurement Accuracy (Nonstore Mode)

+15°C to +35°C	Within 1% of indicated value
0°C to +55°C	Within 2.5% of indicated value

Delay Time Jitter (Nonstore Mode) — ≤1 part in 10,000.

Delay Time Resolution (Store Mode) — 14-bit.

Cursor Accuracy (Store Mode) — ΔV: Within 3%. ΔT: Real time sampling is ±0.1% of full scale. Equivalent time sampling from +20°C to +30°C is ±3%; from 0°C to +55°C is ±4%.

TRIGGERING A AND B

A Trigger Modes — Normal: Sweep generator requires a trigger to generate a sweep. Automatic: Sweep generator free runs in the absence of a trigger. Single sweep: One sweep is initiated by the first trigger after reset.

Trigger Sources — Internal, CH 1, CH 2, composite or external.

Sensitivity and Coupling

Coupling	To 10 MHz	To 50 MHz
Ac	0.3 div above 30 Hz	1.5 div
LF Rej	0.5 div above 50 kHz	1.5 div
HF Rej	0.5 div, 30 Hz to 50 kHz	—
Dc	0.3 div	1.5 div
External	70 mV	350 mV
TV	Stable video rejection and sync separation from sync-negative NTSC or PAL composite video	

Trigger Jitter — Nonstore Mode: 1 ns or less at 50 MHz. Storage Mode: ±1 sample period.

External Trigger View — Deflection Factor: Ext is 100 mV/div. Ext÷10 is 1 V/div.

External Trigger Input — R and C = 1 MΩ paralleled by 33 pF (200 V dc + peak ac) maximum input.

Acquisition Window Trigger Point — Pretrigger: 7/8 of waveform occurs before trigger point. Midtrigger: 1/2 of waveform occurs before trigger point. Posttrigger: 1/8 of waveform occurs before trigger point.

X-Y OPERATION (NONSTORE)

Full Sensitivity X-Y (CH 1 Horizontal, CH 2 Vertical) — 5 mV/div to 5 V/div with bandwidth of dc to 1 MHz. Phase difference is 3° from dc to 50 kHz.

CRT AND DISPLAY FEATURES

CRT — 8 x 10 div (0.6 cm/div) display, GH (P31) phosphor. 12 kV operating potential.

Graticule — Internal. Vertical and horizontal centerlines marked in 5 minor div/major 0.6 cm/div.

Z-Axis Input — Range +3 V to +25 V with 1 MHz usable frequency range. Input resistance of at least 10 kΩ.

ENVIRONMENTAL

Ambient Temperature — Operating: 0°C to +55°C. Nonoperating: −25°C to +75°C. Option 01: −20°C to +55°C.

Altitude — Operating: To 4600 m (15,000 ft). Decrease maximum operating temperatures 1°C for each 1,000 ft above 5,000 ft. Nonoperating: To 15 000 m (50,000 ft).

Vibration — 0.025 p-p (4 g's at 55 Hz) displacement, 15 minutes along each axis from 10 Hz to 55 Hz.

Humidity — 120 hrs of MIL-STD-202D, method 106°C, minus freezing and vibration.

Shock — 30 g's half sine, 11 ms duration on each axis.

OTHER CHARACTERISTICS

Chart Output — Clock Rate: Fast or slow. Amplitude: 500 mV/div. Output Impedance: 220 Ω.

Calibrator — Output Voltage: 0.3 V ±1%. Output Resistance: 5 Ω. Frequency: ≈1 kHz.

Ac Power Requirements — Line Voltage Ranges: 90 V ac to 132 V ac, 180 V ac to 250 V ac. Line Frequency: 48 Hz to 440 Hz. Power Consumption: 50 W maximum.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	237	9.3
Height	112	4.4
Depth		
Handle Not Extended	370	14.6
Handle Extended	482	19.0
Weight≈	**kg**	**lb**
Net	5.0	11.1
Shipping	10.5	23.1

GPIB IEEE-488 Option 01

GPIB Interface/Extended Memory

Option 01 provides a GPIB interface (talk only) and extended memory. The GPIB interface transfers waveforms and scale factor information to a listener or controller. 16K total extended memory stores 16 additional waveforms at 2 waveforms per screen.

IEEE Standard 488-1978 Interface Function Subsets Implemented — SH1, AH1, T1, LØ, SR1, RLØ, DC2, DTØ, PPØ, CØ.

ORDERING INFORMATION

336 Digital Storage Portable Oscilloscope **$5,060**

Includes: Two 10X P6148A attenuator probes; accessory pouch (016-0718-00); front panel cover (016-0719-00); CRT filter (378-0225-00); operator manual (070-4421-00) and service manual (070-4420-00).

Option 01 — GPIB Interface/Extended Memory. **+$875**

OPTIONAL ACCESSORIES

HC100 Plotter*[1] — Works through GPIB. See page 454.

RECOMMENDED PROBES

P6148A — 10X Probe. Order 010-6148-13 **$130**

A6303 — Current Probe. **$1,070**

AM 503 — Current Probe Amplifier. **$1,125**

RECOMMENDED CAMERA

C-30BP Option 01 — See page 450. **$1,524**

Camera Mounting Adaptor — Order 016-0327-01 **$170**

RECOMMENDED CART

K212 — For on-site mobility. See page 461. **$330**

[1] To order, contact your local Tektronix Sales Office.

The SONY®/TEKTRONIX® 336 is manufactured and marketed in Japan by Sony/Tektronix Corporation, Tokyo, Japan. Outside of Japan, the 336 is available from Tektronix, Inc., its marketing subsidiaries and distributors.

The 7D20 is used with 7000 Series oscilloscopes, such as the R7603, shown above in a rackmount configuration. See page 216 for details.

7D20/7D20T

GPIB IEEE-488 The 7D20 and 7D20T comply with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats.*

Digital Storage for 7000 Series Mainframe (7D20)

70 MHz Bandwidth for Repetitive Signals

10 MHz Single-Shot Bandwidth

Two Channels Simultaneous Acquisition

Totally Programmable

Storage of Six Independent Waveforms

Enveloping and Signal Averaging

Cursor Measurements

Pretrigger and Posttrigger

TYPICAL APPLICATIONS
Ultrasonics
Digital Design
RF Modulation
Automated Production Testing

See page 220 for available Application Notes.

The 7D20 is a GPIB programmable plug-in that is compatible with all 7000 Series mainframes (including the USM 281C) except the 7104. When combined with a 7000 Series mainframe, this plug-in creates a fully programmable, digitizing oscilloscope.

The 7D20 can accurately measure the amplitude of a 50 ns wide transient event. Dual samplers simultaneously acquire two channels as if it were a "dual beam" scope.

Beyond basic acquisition, the 7D20 offers signal averaging to reduce uncorrelated noise, envelope displays to compare dynamic characteristics of changing signals, pretrigger for viewing prior to the trigger event, storage of six independent waveforms plus a reference waveform, cursors for more accurate two-dot measurements, and user prompting and menu displays to improve user interface effectiveness.

Digital Storage

A 40 MHz maximum sampling rate provides approximately 10 MHz single-shot bandwidth and up to 70 MHz bandwidth with repetitive signals.

Storage and Recall Front Panel Settings

Up to six different front panel set-ups can be stored and recalled as desired. These settings, plus the last panel set-up, are saved in nonvolatile memory and are restored automatically when power is applied.

Fully Automated Measurements

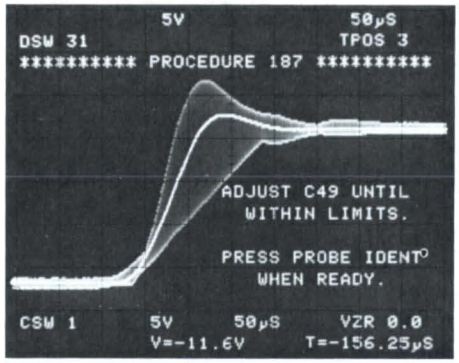
Since the 7D20 is completely programmable, fully automated measurement and testing is possible. Tektronix programmable signal sources, multifunction interface, and RF scanner provide and control the test signals while the 7D20 acquires waveforms for the computer or controller.

TekMAP Software Support

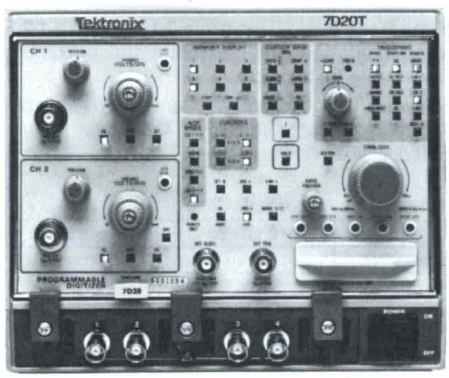
For the Tek 4041, IBM PC or HP Series 200 computers, Tektronix Measurement and Application Programs (TekMAP) help you to tap the full potential of the 7D20. The 7D20/Tek 4041 software package supports the 7D20 when used in conjunction with the Tek 4041 Controller. It provides automated pulse parameter analysis and storage and retrieval of waveforms on DC-100 tape. Data results are available in graphic or tabular form.

The 7D20/HP Series 200 software package supports the 7D20 when used with the HP Series 200 (216, 226, 236) Technical Computers. It provides automated pulse parameter analysis, propagation delay measurements, FFT, and storage and retrieval of front panel settings and waveforms. Data results are available in graphic or tabular form.

Automated Testing



Interactive test procedures, text messages, waveforms, and front panel set-ups may be transmitted and received from the 7D20 to a controller or computer. The procedure in this display informs the operator of the next task. Upper and lower tolerance limits are displayed as a single envelope. This envelope was initially constructed using the 7D20's envelope feature while a test signal was varied to its allowable limits. The waveform was then transferred and saved by the controller to serve as the test reference or overlay.



The 7D20T consists of the 7D20 and its own dedicated power module, for use in applications not requiring local visual display of acquired signals.

CHARACTERISTICS

VERTICAL SYSTEM

Input — Two channels, simultaneous sampling, BNC connectors.

Acquire Modes — CH 1, CH 2, Add, Both (dual channel).

Sensitivity — 5 mV to 5 V/div; 1-2-5 sequence.

Bandwidth — 70 MHz maximum. (Ac Coupled Low Frequency Response: 10 Hz or less.)

Step Response — 5 ns or less.

Input Impedance — 1 MΩ paralleled by ≈20 pF.

Maximum Input Voltage — Dc Coupled: 250 V, 1 kHz or less (dc + peak ac). Ac Coupled: 400 V, 1 kHz or less (dc + peak ac).

Signal Isolation — 100:1 dc to 20 MHz.

Vertical Resolution — 8 bits, 256 levels, 0.04 div/level.

Gain Ratio Accuracy — <2%. Maximum error throughout the V/div range with acquire gain calibrated at 10 mV/div. Measurement valid with Cursors or GPIB.

Noise — Mean value of 50 measurements taken at 0.02 div increments.

Volts/Div	Full Scale*1/RMS Noise	% of Full Scale*1
5 mV	52 dB	0.25
10 mV to 5 V	55 dB	0.18

*1 Full scale = 10.24 divisions.

Phase Match X-Y — <2° from dc to 10 MHz.

HORIZONTAL SYSTEM

Time/Division Range — External Clock, 20 s/div to 50 ns/div in 1-2-5 sequence.

Digitizing Technique vs Time/Division — Real Time (Rolling Display): External Clock, 20 s/div to 0.1 s/div. Real Time: 50 ms/div to 500 μs/div. Extended Real Time: 200 μs/div to 2 μs/div. Equivalent Time: 1 μs/div to 50 ns/div.

Note: Single events can be captured as fast as 2 μs/div. For 1 μs/div to 50 ns/div, repetitive events are required to build a complete waveform.

Time Measurement Accuracy — One Cursor: 0.1% of reading +0, −1 sample interval ±300 ps. Two Cursors: 0.1% of reading ±600 ps.

Horizontal Resolution

Time/Division	Points/ Waveform	Resolution Points/Division
External, 20 s to 500 μs	1024	100
200 μs to 2 μs	820*1	80*1
1 μs to 50 ns	1024	100

*1 Waveform interpolation to 1024 points is available for transfer over the GPIB Interface.

Trigger Position

Pretrigger: 0 to 10 div in 1 div increments. Posttrigger (delay): 0 to 1500 div in 1 div increments (disabled during Roll with Envelope or Average).

	Frequency Range*1	Sensitivity	
		Internal	External
Normal (Dc Coupling)	dc to 30 MHz	0.4 div	60 mV
	30 MHz to 70 MHz	1.0 div	150 mV
P-P and Auto	30 Hz to 200 Hz	2.0 div	300 mV
	200 Hz to 30 MHz	0.6 div	90 mV
	30 MHz to 70 MHz	1.2 div	200 mV

1 The ac coupling low frequency limit is 30 Hz. In Time/Div settings of 1 μs to 50 ns, when using P-P or Auto, low-frequency limit is 300 Hz.

SIGNAL PROCESSING

Cursors Readout — With one cursor (ΔOff), vertical and horizontal coordinate values are referenced to zero volts and the trigger position as zero time. With two cursors (ΔOn), vertical and horizontal coordinate values are the difference between the two cursors.

Signal Averaging

AVE N: A self-terminating, stable average processes "N" number of waveforms and then holds the result in memory. The "N" value may be selected using the SET N function (N=8, 16, 32, 64, 128, 256).

AVE: A continuous, stable averaging process. N waveforms are averaged as in AVE N, then additional waveforms are weighted at 1/N. In Roll mode a running average (smooth) is available to provide high frequency filtering.

Enveloping

ENV N: A self-terminating recording of waveform maxima and minima. When N waveforms are processed, the result is held in memory.

ENV: A continuous (infinite) recording of waveform maxima and minima.

Waveform Modifiers

VPUP ↑ (Vertical Position Up), VPDN ↓ (Vertical Position Down): Provide vertical positioning control of any stored waveforms.

VCMP ↕ (Vertically Compress), VXPD ↕ (Vertically Expand): Provide vertical display expansion or compression. Two expansions or compressions in 1-2-5 calibrated steps, from the original V/div are available.

HMAG (Horizontal Magnify): Displays the cursor waveform horizontally magnified by a factor of 10.

HMAG ALL (Horizontally Magnify All Waveforms): Displays all waveforms at 10 times horizontal magnification.

VS (Versus): Creates a Y versus X display of any two waveforms.

GPIB INTERFACE

Interface Function Subsets Implemented:

SH1	Complete source handshake
AH1	Complete acceptor handshake
T5	Complete talker—no secondary address
L3	Complete listener—no secondary address
SR1	Complete service request
RL1	Complete remote local
DC1	Complete device clear
DT1	Complete device trigger
PP0	No parallel poll
C0	No controller
E2	Three state

Programmable Functions — All instrument settings and operating modes are programmable except for Variable V/div and Horizontal Position. However, these uncalibrated controls can be overridden and forced into the "CAL" position on command from the GPIB Interface. The display of Menu and ID is selectable from the front panel only.

Format — Device dependent commands in ASCII. Waveform data points selectable as BINARY or ASCII.

Waveform Output Time — 250 ms minimum for BINARY and 2.5 s minimum for ASCII. Actual transfer times depend upon the speed of the receiving device.

INPUTS

External Trigger (Front Panel) — Maximum Input Voltage: 250 V (dc + peak ac).

Signal Input Impedance — 1 MΩ, paralleled by ≈20 pF.

Hold Next (Mainframe Rear Panel) — Initiates Hold Next condition; connected to Single Sweep Reset connector.

OUTPUTS

Hold Next Ready — High level indicates unit is in Hold Next condition; output level remains low when unit is not in Hold Next condition; connected to Single Sweep Ready connector.

+Gate Out — Provides high level output signal for duration of waveform/character readout.

PLUG-IN COMPATIBILITY

The 7D20 is compatible with all 7000 Series mainframes with the exception of the 7104. Use with the 7104 will void the 7104 warranty.

PHYSICAL CHARACTERISTICS

	7D20		7D20T	
Dimensions	**mm**	**in**	**mm**	**in**
Width	206	8.1	216	8.5
Height	127	5.0	183	7.2
Depth	371	14.6	566	22.3
Weights≈	**kg**	**lb**	**kg**	**lb**
Net	3.6	8.1	10.4	23.0
Shipping	8.0	17.8	12.0	26.6

ORDERING INFORMATION

7D20 Programmable Digitizer (Plug-In) $7,445
Includes: Instruction manual (070-3857-01); pocket reference guide (070-3205-01).

7D20T Programmable Digitizer $8,865

7D20T Option 01 Power Module (Converts Existing 7D20 to 7D20T) −$7,445

TekMAP SOFTWARE

S42P201 7D20/IBM PC Software $450
Includes: Operator manual.
Option 01 — 5¼ in double-sided, dual density. **NC**

S42H201 7D20/HP Series 200 Software $950
Includes: Operator manual.
Option 01 — 5¼ in double-sided, dual density. **NC**
Option 02 — 3½ in double-sided, dual density. **NC**

7D20/Tek 4041 Software DC-100 Tape. Order 062-7732-00 **$150**
Includes: Operator manual.

UTILITY SOFTWARE

(7D20/7D20T/4041) Order 062-6959-01 **$150**
(7D20/7D20T/4052A) Order 062-6961-01 **$150**
See page 359 for description and ordering information.

INTERNATIONAL POWER PLUG OPTIONS

Option A1 — Universal Euro 220 V, 50 Hz.
Option A2 — UK 240 V, 50 Hz.
Option A3 — Australian 240 V, 50 Hz.
Option A4 — North American 240 V, 60 Hz.
Option A5 — Switzerland 220 V, 50 Hz.

RECOMMENDED PROBE

P6053B Identify Probe — For remote service request via probes "Identify" button. 10X attenuation; 200 MHz bandwidth; scale factor coding; 6 ft. **$170**

RECOMMENDED MAINFRAME FOR 7D20

R7603 Option 20 — The R7603 mainframe provides a 6-inch diagonal CRT display and three-wide plug-in compartment in a 5¼ inch high rackmount configuration. Option 20 permits rear panel access to the 7D20's GPIB Interface and includes cable 175-7151-00 required inside 7D20. See page 229 for further information. **$4,265**

CONVERSION KITS

Cabinet-to-Rackmount — Equipped with slide-out assembly to rackmount a 7D20T to the left of a 4041 or another 7D20T. Order 016-0827-01 **$395**

Cabinet-to-Rackmount — Equipped with slide-out assembly to rackmount a 7D20T to the left of a TM 5003. Order 040-0984-01 **$215**

Cabinet-to-Rackmount — Equipped with slide-out assembly to rackmount a 7D20T to the left of a blank plug-in compartment. Order 016-0806-00 **$410**

OPTIONAL ACCESSORIES

R7603 Field Kit — Adds Option 20 to a previously purchased standard R7603. This kit provides parts to connect the 7D20's GPIB Interface to the R7603 mainframe. Order 040-1093-00 **$470**

HC100 Plotter*1 — See page 454.
1 To order, contact your local Tektronix Sales Office.

7854

GPIB IEEE-488 The 7854 is designed to support other products which comply with IEEE Standard 488-1975.

Waveform Parameters at the Touch of a Key

Dc to 400 MHz Real Time Bandwidth at 10 mV/Div

Calibrated Sweep Rates to 500 ps/Div

Stores Repetitive Waveforms Up to 14 GHz With Sampling Plug-Ins

Signal Averaging

Resolution Up to 0.01 Div on Stored Data (10-Bits)

Choose 128, 256, 512, 1024 Points/ Waveform

Keystroke Programming (Up to 2000 Keystrokes With Option 2D)

GPIB Interface (Standard)

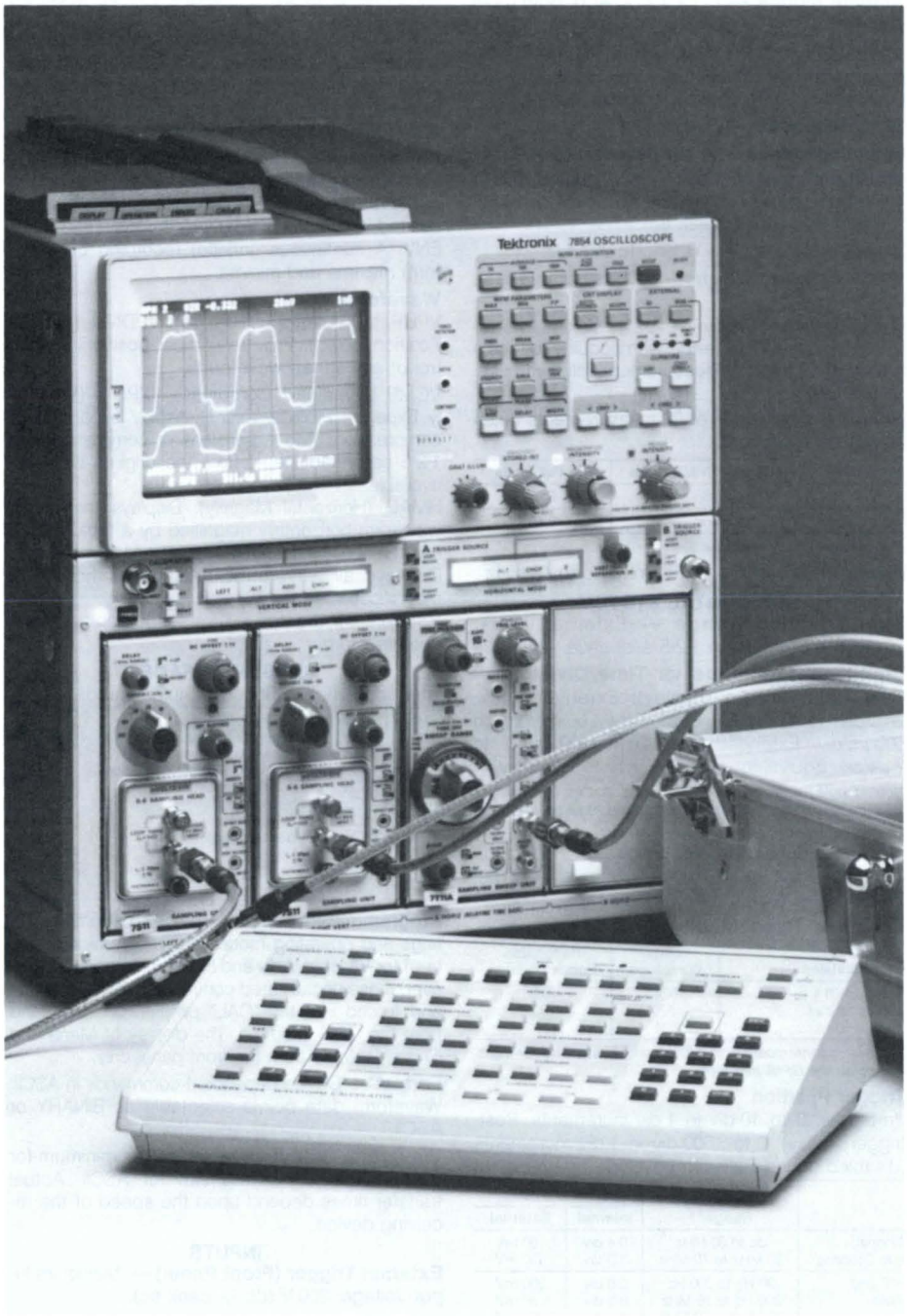
TYPICAL APPLICATIONS
Power Supplies Switching
Semiconductors
Fiber Optics

See page 220 for available Application Notes.

The 7854 Waveform Processing Oscilloscope represents a unique approach to today's test and measurement problems. It combines the features of a high performance real time oscilloscope with digital storage and waveform processing. When integrated with any of a wide variety of 7000 Series plug-ins, it becomes a very powerful measurement system. The 7854 offers programmable measurement routines, GPIB interface for mass data and program storage plus simultaneous display of real time and stored waveforms. The 7854's on-board memory can store up to 40 waveforms and 2000 keystrokes.

Mainframe and calculator keyboard functions provide cursor control and waveform parameter information at the touch of a button, e.g., maximum, minimum, peak-to-peak, risetime. Additional features on the calculator keyboard enable arithmetic manipulation of waveforms such as differential, integral, log, and absolute value.

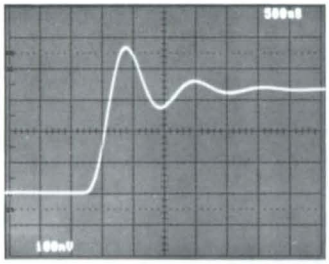
Signal averaging can recover signals buried in random noise and improve measurement accuracy. One or two cursors are selectable for voltage and time measurements. One cursor provides voltage measurements referenced to ground and time measurements referenced to time zero. Two cursors enable Δtime and Δvoltage measurements. Cursors may also be used to bracket an area of interest for measurement consideration.



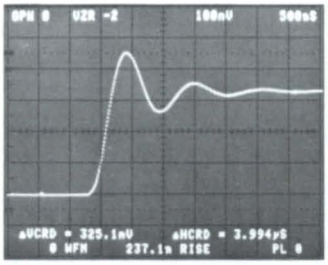
The 7854's keystroke programming (simply storing a series of keystrokes to be executed) assures repeatable measurement results and lowers the skill level needed to operate the system. Measurement loops can be written to save time, log results and make pass/fail decisions. Full subroutine and conditional branching capabilities are provided.

TekMAP Software Support

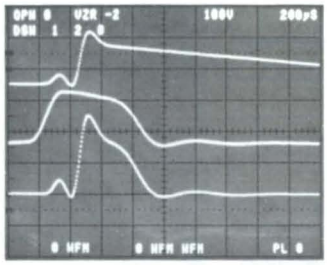
The TekMAP (Tektronix Measurement Application Programs) library of software products support the Tektronix 7000 Series GPIB Programmable Digitizers in automated engineering or research environments.



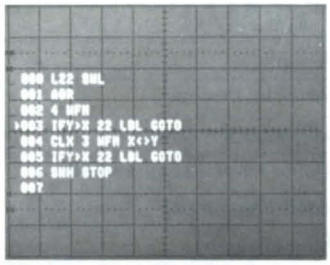
Conventional Scope: In the SCOPE mode, the 7854 provides a complete plug-in scope giving standard displays like other Tektronix high performance scopes.



Storage Scope: Rise time is calculated by pushing a single key. Time and voltage differences between cursors are shown on the line above rise time.



Multiple Storage and Calculation: Volts, current, and power are all shown on the display. Power is a simple two or three keystroke calculation.



Waveform Processing: Keystroke Programming enables the user to design measurement routines tailored to individual tests or experiments.

CHARACTERISTICS

VERTICAL REAL TIME SYSTEM

Input — Two plug-in compartments; compatible with 7000 Series plug-ins.

Modes — Left, Alt, Add, Chop, Right.

Mainframe Bandwidth — 400 MHz with 7A29 or 7A19 Amplifier plug-ins.

Mainframe Step Response — 0.9 ns or less with 7A29 or 7A19 Amplifier plug-ins.

Chopped Mode — Chop rate is ≈1 MHz.

Trace Separation Range — In dual-sweep modes, B trace can be positioned 4 div above or below the A trace.

CRT AND DISPLAY FEATURES

CRT Display Modes — Scope (conventional display); Stored (digital data display); Both (stored display plus real time waveforms); Program Entry (user program text display).

HORIZONTAL REAL TIME SYSTEM

Input — Two plug-in compartments; compatible with 7000 Series plug-ins.

Modes of Operation — A, Alt, Chop, B.

Fastest Calibrated Sweep Rate — 0.5 ns/div.

Chopped Mode — Rep rate is ≈200 kHz.

X-Y Mode — Phase shift between vertical and horizontal channels is within 2° from dc to 35 kHz without phase correction (dc to 1 MHz with phase correction, B horizontal only, Option 02).

DIGITAL STORAGE

Equivalent Time Bandwidth — 400 MHz. See 7000 Series system bandwidth specifications.

Accuracy — Refer to plug-in specifications.

Acquisition Channels — One or two simultaneous channels (Plug-in Chop mode not valid).

Acquisition Window — ±5 div from center screen both vertical and horizontal.

Resolution — Vertical: 0.01 div. Horizontal: Selectable points/waveform on remote keyboard.

Horizontal Resolution (divs)	Points/Waveform
0.01	1024
0.02	512
0.04	256
0.08	128

PLUG-IN COMPATIBILITY

All 7000 Series plug-ins are compatible in the standard oscilloscope display mode. The 7L5 and 7L18 Spectrum Analyzers require factory modification for optimum use with digital storage operation. The 7D01, 7D02 and 7T11 are not compatible in Stored mode.

OUTPUTS/INPUTS

+Sawtooth — Positive-going with baseline at 0 V ±1 V into 1 MΩ. Voltage is 1 V/div (±10%) into 1 MΩ, 50 mV/div (±15%) into 50 Ω. Output R is ≈950 Ω.

+Gate — Positive pulse of the same duration and coincident with sweep. Output voltage is 10 V (±10%) into 1 MΩ, 0.5 V (±10%) into 50 Ω. Output R is ≈950 Ω. Source is selectable from A gate, B gate, or Delayed gate.

Vertical Signal Out — Selected by A Trigger Source switch. Output voltage is 0.5 V/div into 1 MΩ, 25 mV/div into 50 Ω. Output R is ≈950 Ω. Bandwidth depends upon vertical plug-in.

Remote Single Sweep Reset — Rear panel BNC, ground closure activated.

TTL Output — Rear panel BNC, TTL output under remote keyboard control (SWH and SWL).

External Z-Axis Input — 2 V p-p for full intensity range from dc to 1 MHz. Positive signal blanks the trace. Maximum input voltage is 15 V (dc plus peak ac).

Camera Power Output — Three-prong connector to the left of the CRT provides power, ground, and remote single-sweep reset access for the C-50 Series cameras.

GPIB Interface Subsets Implemented — SH1, AH1, T5, L3, SR1, RL1, DC1, DT1, PPØ, CØ.

CALIBRATOR

Voltage Output — Squarewave, positive-going from ground. Ranges are 40 mV, 0.4 V, and 4 V into 100 kΩ; 4 mV, 40 mV, and 0.4 V into 50 Ω. Amplitude accuracy is within 1%; rep rate is 1 kHz within 0.25%.

Current Output — 40 mA available through Calibrator output with optional BNC to current loop adaptor.

POWER REQUIREMENTS

Line Voltage Ranges — 90 V to 132 V. 180 V to 250 V.

Line Frequency — 48 Hz to 440 Hz.

Maximum Power Consumption — 230 W.

PHYSICAL CHARACTERISTICS

	Mainframe		Waveform Calculator	
Dimensions	**mm**	**in**	**mm**	**in**
Width	305	12.0	277	10.9
Height	348	13.7	69	2.7
Depth	627	24.7	165	6.5
Cord Length ±76 mm			1420	56.0
Weights≈	**kg**	**lb**	**kg**	**lb**
Net	20.4	45.0		
Shipping	28.2	62.0		

ORDERING INFORMATION
(PLUG-INS NOT INCLUDED)

7854 Oscilloscope, Including Waveform Calculator **$16,220**

Includes: Power cord (161-0066-00); BNC-to-BNC cable (012-0208-00); instruction manual (070-2873-00).

OPTIONS

Option 02 — X-Y Phase Correction. **+$260**

Option 03 — EMC Modification. **+$395**

Option 78 — BE (P11) Phosphor. **+$100**

CONVERSION KIT

4K Expanded Memory — Order 040-0941-00 **$330**

TekMAP SOFTWARE

S42P101 7854 IBM PC Software **$450**

Includes: Software operator manual.

S42H202 7854 HP Series 200 Software **$950**

Includes: Software operator manual.

OPTIONS

Option 01 — 5¼ inch media. **NC**

Option 02 — 3½ inch media. **NC**

INTERNATIONAL POWER PLUG OPTIONS

Option A1 — Universal Euro 220 V, 50 Hz.
Option A2 — UK 240 V, 50 Hz.
Option A3 — Australian 240 V, 50 Hz.
Option A4 — North American 240 V, 60 Hz.
Option A5 — Switzerland 220 V, 50 Hz.

OPTIONAL ACCESSORIES

Recommended Plug-Ins — See page 218.

Recommended Probes — See page 464.

Recommended Cameras — See page 442.

Recommended Cart — The K213 Lab Instrument Cart is recommended for all 7000 Series mainframes. A keyboard tray for the 7854 and a storage area for plug-ins are available as Options 10 and 12 respectively, Option 22 for both. See page 462.

SYSTEMS

The 7854 is also available as an MP 2501 Acquisition/Processing Package.

TRAINING

Tektronix offers service training classes on the 7854 Waveform Processing Oscilloscope.

For further training information, contact your local Sales Office or request a copy of the Tektronix Service Training Catalog.

Tektronix Instrument Group Customer Training offers operation and application training to help you get full value out of your instrumentation investment. Information is on pages 195-196. For further information, or to enroll, call us at 1-800-225-7802. For international orders, contact your nearest Sales Office.

TekMAP

Graphics

Archival Storage

Pulse Parametrics

Delay Time Measurements

Hard Copy Dump

Menu Driven

The TekMAP (Tektronix Measurement Application Programs) library of software products supports the Tektronix 7854 and 7D20/7D20T GPIB programmable digitizers in automated engineering or research environments.

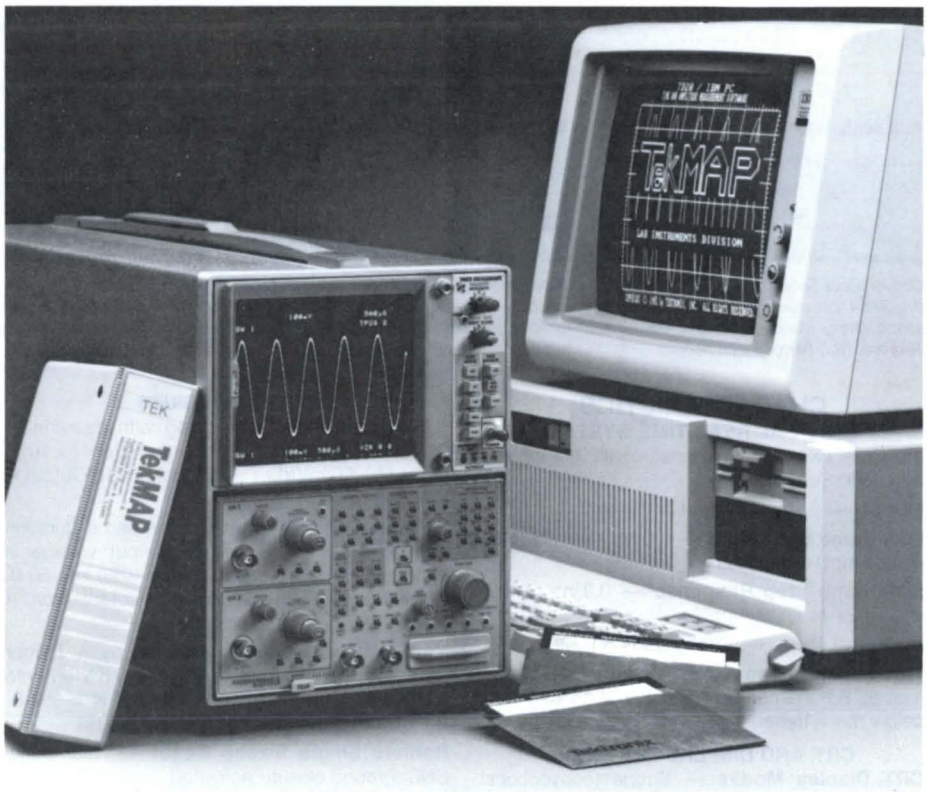
TekMAP software extends the versatility of Tektronix digitizers by integrating them with Tektronix controllers, IBM personal computers or HP-Series 200 technical computers.

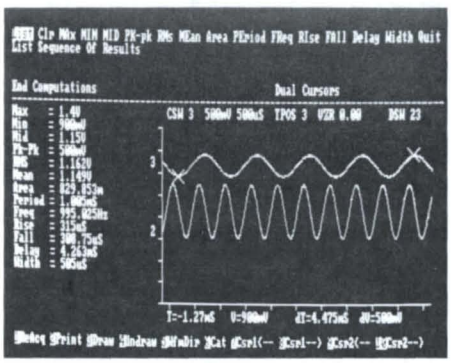
Basic communication utilities, accessible through friendly, menu-driven user interfaces are available through Communication and Control Utility Software.

Extended measurement capabilities, such as automated pulse parameter analysis, Fast Fourier transformation and propagation delay measurements, are provided by the Time and Amplitude Measurement Software products.

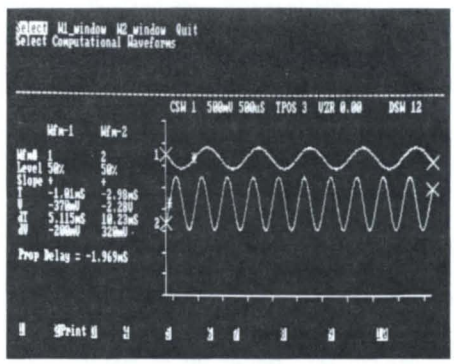
The TekMAP software is a continuing series of applications programs developed and supported by Tektronix applications engineers.

Please contact your local Tektronix Sales Engineer or representative regarding hardware configuration requirements and current software offerings.

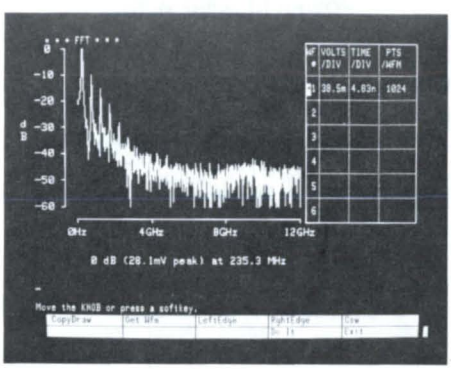




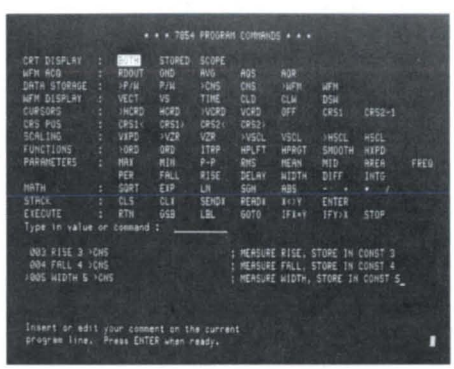
Automatic Pulse Parameter Analysis using the 7D20/IBM PC Time and Amplitude Measurement Software.



Delay Time Measurement using an IBM PC/XT/AT as controller with Tek's Time and Amplitude Measurement Software, plus 7D20 Programmable Digitizer and Tek 7603 oscilloscope.



Computing and displaying frequency domain data using an HP Series 200 Controller and Tek 7854 or 7D20 digitizing oscilloscope.



Editing a Tek 7854 RPN program, incuding downloading to the 7854 or archiving to disk available in S42H202.

TekMAP SOFTWARE SELECTION GUIDE

	062-7732-00 7D20/Tek 4041 Time and Amplitude Measurement Software	S42P101 7854/IBM PC Communications and Control Software	*NEW* S42P201 7D20/IBM PC Time and Amplitude Measurement Software	S42H201 7D20/HP Series 200 Time and Amplitude Measurement Software	*NEW* S42H202 7854/HP Series 200 Time and Amplitude Measurement Software
Required Hardware	Tek 4041 Controller 512K Memory RØ1, RØ2, RØ3, RØ4 ROM Packs Tek 4105A Terminal (or equivalent)	IBM PC, XT or AT 128K memory Dual floppy or hard drive IBM color graphics board National Instruments PC2, PC-2A GPIB board*[1] (Rev C Drivers)	IBM PC, XT or AT 640K memory Dual floppy or hard drive IBM color graphics board National Instruments PC2, PC-2A GPIB board*[1] (Rev C Drivers) 8087 or 80287 coprocessor	HP 216, 226, 236, or 236C 640K memory 5¼ in or 3½ in disk	HP 216, 226, 236 or 236C 640K memory 5¼ in or 3½ in disk
Media	DC-100 Tape	5¼ in DS/DD	5¼ in DS/DD	5¼ in or 3½ in disk (9121, 9122 compatible)	5¼ in or 3½ in disk (9121, 9122 compatible)
Operating System	4041 BASIC	DOS 2.0/2.1/3.0/3.1	DOS 2.0/2.1/3.0/3.1	BASIC 3.0	BASIC 3.0
Language	Commented source code 4041 BASIC	Source code for IBM compiled BASIC (for program modification and recompilation)	Executable code only supplied	AUTOST, plus fully commented source code BASIC 3.0	AUTOST, plus fully commented source code BASIC 3.0
Data Acquisition	Remote acquisition (multichannel)	Waveform transfer Manual/Automatic measurement results data logging to disk	Remote acquisition (multichannel) Autoranging for rise, fall, period measurements Acquire from stored settings	Remote acquisition (multichannel) Autoranging for rise, fall, period measurements Acquire from stored settings	Remote acquisition (multichannel)
Measurements	Pulse Parametrics Automatic Histogram: Max, Min, Mid, P-P, 100%, 90%, 50%, 10%, 0%, Overshoot, Undershoot, Rise, Fall, Width, Period, RMS Selectable measurement region and crossing levels	Provided by 7854	Pulse Parametrics Automatic Histogram: Max, Min, Mid, P-P, 100%, Distal, Center, Prox, 0%, +OS, −OS, Rise, Fall, Width, Delay, Period, Freq, RMS List Mode: Mean, Area, Max, Min, Mid, P-P, Rise, Fall, Width, Delay, Period, Freq, RMS Prop Delay Waveform Operations: +, −, *, ÷, Scale, Offset, Diff, Integ, Smooth Cursor (V, T, ΔV, ΔT) Selectable measurement region and crossing levels	Pulse Parametrics Automatic Histogram: Max, Min, Mid, P-P, 0%, 100%, RMS, Rise, Fall, Width, Freq, % Overshoot, Period, % Undershoot Prop Delay FFT Cursor (V, T, ΔV, ΔT) Selectable measurement region and crossing levels	Pulse Parametrics Automatic Histogram: Max, Min, Mid, P-P, 0%, 100%, RMS, Rise, Fall, Width, Freq, % Overshoot, Period, % Undershoot Prop Delay FFT Cursor (V, T, ΔV, ΔT) Selectable measurement region and crossing levels
Hard Copy	Tek 4695 Color Copier	Graphics dump	Graphics dump	ThinkJet (Text and Graphics)	ThinkJet (Text and Graphics)
Disk Storage	Waveforms (tape storage)	Waveforms; Programs (7854); Logged Data	Waveforms; Settings	Waveforms; Settings	Waveforms; Programs (7854); Logged Data
Utilities	File (Catalog)	File (Catalog, Delete, Drive)	File (Catalog, Delete, Drive)	Copy; File (Catalog, Delete)	Copy; File (Catalog, Delete); 7854 Program Editor

[1] Available in Tek GURU II package.

ORDERING INFORMATION

062-7732-00 7D20/Tek 4041 Time and Amplitude Measurement Software DC-100 Tape **$150**
Includes: Software, operator manual and license agreement.

S42P101 7854/IBM PC Communication and Control Software **$450**
Includes: Software, operator manual and license agreement.

S42P201 7D20/IBM PC Time and Amplitude Measurement Software **$450**
Includes: Software, operator manual and license agreement.

S42H201 7D20/HP Series 200 Time and Amplitude Measurement Software **$950**
Includes: Software, operator manual and license agreement.

S42H202 7854/HP Series 200 Time and Amplitude Measurement Software **$950**
Includes: Software, operator manual and license agreement.

OPTIONS

Option 01 — 5¼ in flexible disk. **NC**

Option 02 — (S42H201/S42H202) 3½ in single-sided micro disk. **NC**

ASYST Scientific Software

Automatic Graphics With Modifiable Defaults

High Resolution and Color Graphics Support

Comprehensive Data Analysis

Integrated GPIB/IEEE-488 Hardware Support

Built-In Functions Plus Full Programmability

ASYST is a fully integrated software tool that provides the user with the most commonly used data acquisition, statistical, graphing and analysis capabilities required in engineering and scientific applications. Operating on the IBM PC/XT/AT, ASYST is designed so novice users can start carrying out complicated operations with a minimum of introduction, while allowing the advanced user to take full advantage of a powerful programming language that supports all of the features of the IBM PC.

Most mathematical or graphics operations can be performed by using a single predefined word describing that operation; e.g., MATRIX.INV, FFT, INTEGRATE.DATA, 2WAY.ANOVA or Y.AUTO.PLOT. New words can be defined to perform any sequence of actions.

```
: PLOT.IT!
PRESSURE
TEMPERATURE
XY.AUTO.PLOT;
```

PLOT.IT! now automatically plots two data arrays when invoked: PRESSURE and TEMPERATURE.

The Analysis module contains most of the common operations used to treat experimental data. These include integration, differentiation, base line correction, peak finding, digital smoothing, FFT, IFT, matrix manipulation, Eigen system analysis,...

Instrument specific application programs such as the 7000 Series Driver Software for ASYST are also available. Written in the ASYST language, this driver provides the user with a function-key-driven program that allows for the acquisition and storage of waveforms, storage and retrieval of settings or programs, zoned pulse parametric analysis (max, min, mid, p-p, rise time, fall time, overshoot, undershoot, pulsewidth, period, crossing levels) and frequency domain analysis. Data may be acquired from the Tek 7D20 or 7854.

MODULE 1
SYSTEM/GRAPHICS/STATISTICS

Data Types — Single or double precision, real, integer, or complex values (80-bit double precision); strings; named scalars or arrays. Automatic or user-controlled conversions in mixed expressions between integers, reals, and complex data types. Arrays may have up to 16 dimensions and be as large as 64 Kbytes apiece.

Arithmetic Operations and Special Functions — +,−,*,/,**, min, max, neg, abs, inv, sqrt, ln, exp, conj, sin, cos, tan, sec, csc, cot, sinh, cosh, tanh, sech, csch, coth, asin, acos, atan, asec, acsc, acot, asinh, acosh, atanh, asech, acsch, acoth. All arithmetic operators work directly (without loops) on all elements of an array. Mixed expressions of arrays and scalars, or arrays of differing dimensionality are permitted.

Statistical Functions — Mean; variance; mode; median; moments; standard deviation; cumulative distributions; Gaussian, Chi-square, Student-T distributions; random number generation; sort, sort and index.

Array Handling Functions — Subarrays, reversal of indices, transposition of dimension, lesser dimension subsets, individual elements, catenation, lamination, auto entry of array data, scrolling, format control of array data display, generalized inner and outer product, matrix multiplication.

Built-In Full Screen Text Editor and Array Editor

Graphics — Automatic line graphs, scatter plots, bar and pie charts, plotting with error bars. Options include: color graphics superposition of plots, multiple graphics windows, polar plots, autoscaling and data fitting, linear or logarithmic display along either axis, strip chart recorder emulation, replotting data subsets with a single keystroke, and support for digital plotters and high resolution graphics.

Graphics Readout and Cursors — On screen graphics cursors controlled by arrow keys, labeling at any location within the graphics area.

Control Structures — If...else...then, Begin...until, Begin...while...repeat, Case...of...endcase, Do ...loop; Comparisons: =,<,>,≤,≥,≶, not, and, or, xor.

Input/Output — Loading from standard text or arbitrary user-defined files, saving and loading workspace images to disk, direct array I/O to packed-binary disk files, ASCII, BASIC, and DIF format files.

String Handling — String-to-number conversion, number-to-string conversion, string arrays.

GAMMA, BESSEL and ERROR Functions

RS-232 Support

MODULE 2
ANALYSIS

Polynomial Mathematics and Evaluation — Polynomial multiplication, synthetic division, integration, differentiation, shifting, root extraction.

Advanced Graphics — Axonometric and contour plots. Plotting with hidden lines removed.

Vectors and Matrices — Matrix inversion, determinants, QR factorization and Gram-Schmidt orthogonalization.

Solutions to Simultaneous Equations

Eigenvalues and Eigenvectors — Eigen systems of Hermitian matrices, spectral slicing, reduction of a general matrix to Hessenberg and triangular form.

Curve Fitting — Least squares polynomials, multilinear regressions, parametric and nonlinear curve fitting, weighted least squares, exponential and logarithmic fits, orthogonal polynomials, R^2 (cross-correlation).

Nonlinear Regression

Advanced Statistics — One- and two-way analysis of variance (ANOVA), F-tests.

Data Manipulation — Data smoothing, differentiation and integration, peak detection, convolutions and filtering.

Fast Fourier Transform, 2D FFT, and Inverse FFT

MODULE 4
GPIB/IEEE-488

Interface Boards Supported — National Instruments GPIB-PC, GPIB-PC2, GPIB-PC2A; IBM Capital Equipment PC-488 model 01000-00300; MetraByte IEEE-488.

Complete IEEE-488 Protocol — Device-dependent and device-independent commands, parallel and serial polling, synchronous and asynchronous operation, DMA acquisition.

Buffering — Array buffering of data. Buffering of device-dependent commands.

Real Time Synchronization — Triggering, clock-initiated acquisition, software synchronization.

HARDWARE

Required Hardware

IBM PC/XT/AT or DOS 2.0/2.1/3.0/3.1 compatible; two or more drives (including one double-sided floppy drive); 512K memory (640K recommended); 8087 or 80287 coprocessor; IBM Color Graphics Board; IBM Enhanced Color Graphics Card (with 64K to 256K graphics memory); or Hercules Graphics Card.

Optional Hardware

IBM graphics printer; Hewlett-Packard 7470, 7475, or Gould Colorwriter plotters, Interface board(s) required for GPIB interface.

S42P301 Option 01 ASYST Scientific Software **$1,995**
Includes: Software (Modules 1, 2 and 4) on 5¼ DS/DD disk, manuals and license agreement.

S42P302 Option 01 7000 Series Driver Software for ASYST (Requires S42P301 or equivalent software) **$395**
Includes: Software source on 5¼ DS/DD disk, hardware driver for Tek 7D20 and 7854, manual and license agreement.

NEW

GPIB

SPD

Signal Processing and Display Programs

Support 196 Processing, Analysis and Data-to-Display Functions on IBM PC, PC/XT, PC/AT

Fast Fourier Transforms (FFT)

Correlation, Convolution, FIR Filters

Extract Pulse Parameters Fast, 13 Functions for Pulse Characterization

Designed for scientific and engineering users, this package of seven disks, keyboard overlay and program reference manual includes complete mathematical functions, plus waveform data, I/O utilities, analysis, processing and graphic display functions. Access is via menu, or C or BASIC for user programmability. Data entry is via disk or GPIB port, using popular waveform digitizers.

Fast Fourier Transforms (FFT)

Based on the Cooley-Tukey algorithm, the FFT is exceptionally useful for extracting frequency components, such as harmonics, from time domain data.

Six Windowing Functions via TAPER Before Using an FFT

This is a commonly accepted method of reducing frequency leakage in time domain data caused by sampling a non-integer number of cycles. This is necessary because an FFT assumes periodicity within the data record.

Extract Pulse Parameters Fast; 13 Functions for Pulse Characterization

These functions yield useful information on distal, mesial and proximal point rise times plus overshoot. SPD also reveals more detailed attributes; e.g., period, amplitude, and duty factor on pulse trains.

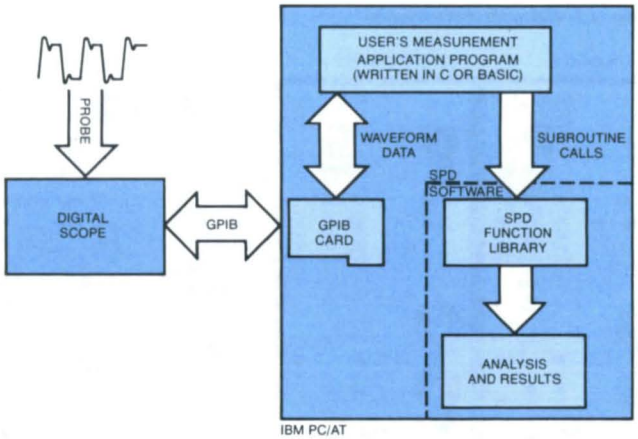
Choose Your Most Productive Access: For Fast Solutions, Without Programming, Use SPD's Friendly Menu

You perform sophisticated functions quickly. For example, only three program-prompted keystrokes will window and perform an FFT on time domain data.

For Productive Programming, Turn to C and BASIC Compilers

SPD is callable from IBM Compiled BASIC 1.0—ideal for automated data collection applications requiring extra processing to extract detailed information on correlation, harmonics, pulse parameters and other specifics. Note: This is the *compiled,* not interpretive, BASIC language.

Users who prefer C programming efficiency can readily implement SPD functions in this high level language that is easy to use and compatible with the Lattice C compiler. Contact Tektronix for more information on compatible compilers.



SPD MAKES DATA ANALYSIS EASY

1. *A probe acquires real time data from a device under test and sends it to a digital storage scope like the Tek 2430.*
2. *The oscilloscope digitizes the waveform and stores it at a 1024 x 8 bit record, then transfers that record via GPIB to the PC/AT.*
3. *The GPIB IEEE-488 bus transfers data values, scale factors, offsets and units to and from the PC/AT and the oscilloscope.*
4. *On the IBM PC with GPIB card, SPD processes, analyzes and displays the record with 196 functions available. SPD may be invoked via menu for ease or C or BASIC for speed and programmability. SPD is aided by optionally available 2430 Driver Utility Software, which acquires the data record.*

At Your Fingertips: Automatically Programmed PC Function Keys

To simplify menu use, each SPD package includes a keyboard overlay with easy-to-follow labeling. The "HELP" key, <F1>, provides basic information. <F3> always returns you to the main menu.

IBM PC Color Graphics

To assure users crisp easy-to-read displays, Signal Processing and Display software is fully compatible with the popular standard IBM color display monitor as well as displays used with IBM's Enhanced Graphics Adaptor and IBM Professional Graphics Adaptor.

Graphics Without "Jaggies"

A Tek patented anti-aliasing algorithm overcomes the annoying "pixel staircase" look of waveforms and is compatible with IBM Professional Graphics Adaptors.

Store and Describe Multidimensional Data Arrays—With Each Dimension Independent of the Others

You can readily look at data from more directions and in greater detail—down to the tuple level (a tuple is a single datum—a single quantity at a single point in a single dimension).

For Fast Program Development, SPD Provides Full Compatibility of C and BASIC

Programming in C: Efficient, easy, and Lattice compiler compatible.

Programming in BASIC: Ideal for extracting details from automatically collected data; compatible with IBM compiled BASIC 1.0. Users can invoke virtually all necessary operations by means of function calls to maximize BASIC programming capability.

With SPD, C and BASIC programs share many procedures and data. Most C macros that provide read/write access to waveform data structure elements are available to BASIC programmers through function calls. The few exceptions are confined to the most detailed data structure manipulations.

What is more, only two routines are needed in the BASIC interface to coordinate memory management between C and BASIC, BASIC and SPD C interface libraries, and special versions of C libraries that are compatible with BASIC memory management.

Required Hardware

IBM PC, Portable PC, PC/XT, PC/AT; 256 Kbytes memory (640 Kbytes recommended); 1 double-sided, double-density disk drive; 10 Mbyte hard disk drive (highly recommended).

Optional Hardware

8087 or 80287 math coprocessors; IBM Plotter.

Graphics Requirements

IBM PC color graphics display and either an IBM Color Graphics Adaptor, or IBM Enhanced Graphics Adaptor, or IBM Professional Graphics Adaptor.

Required Software

IBM PC DOS 2.1 or higher.

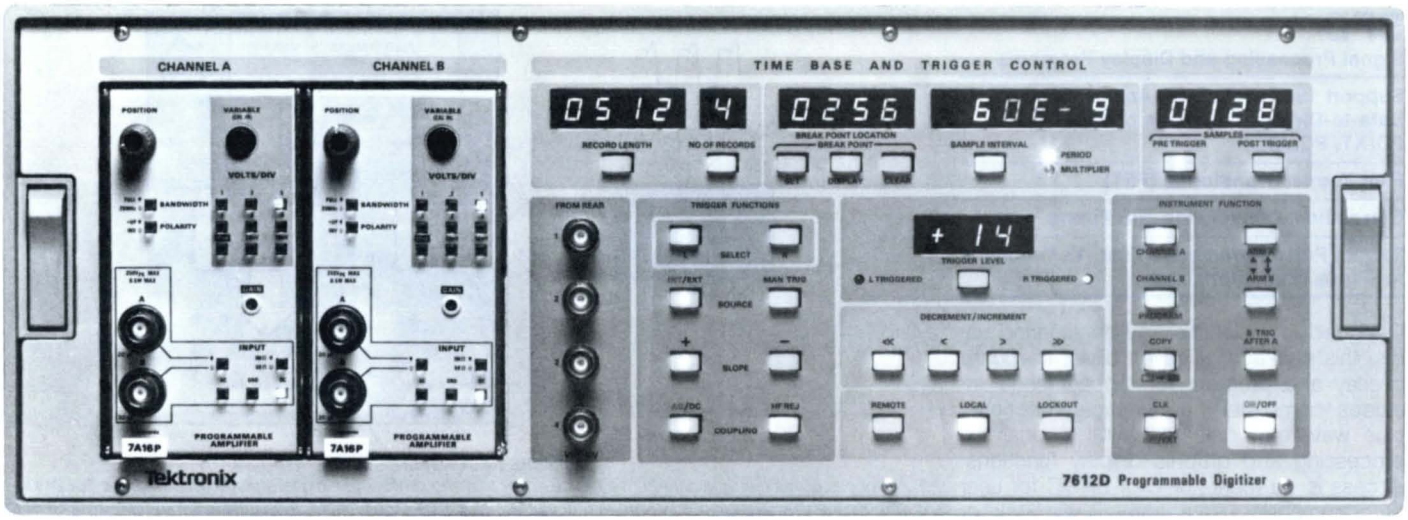
Optional Software

Lattice C, IBM Compiled BASIC, Version 1.0; Tektronix Driver Utilities.

ORDERING INFORMATION

10Z210 Signal Processing and Display (SPD) Programs Software Package **$950**

Includes: Detailed operator manual; IBM function key overlay; and seven disks formatted to be compatible with IBM PC, PC/XT or PC/AT.



7612D

GPIB IEEE-488 The 7612D complies with IEEE Standard 488-1975, and with Tektronix *Standard Codes and Formats.*

200 MHz Maximum Sampling Rate

Two Channels, Two Time Bases

8-Bit Resolution

2048 Words of Memory per Channel

5 ns to 1 s Selectable Sampling Intervals With Interval Switching Allowed During Waveform Acquisition

Pretrigger and Posttrigger Operation

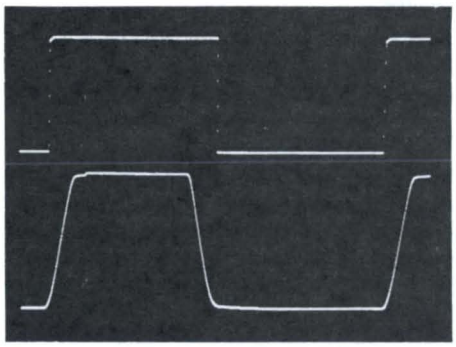
Fully Programmable Over GPIB for System Oriented Operation

TYPICAL APPLICATIONS
Automated Testing
LIDAR
EMP
Nondestructive Testing

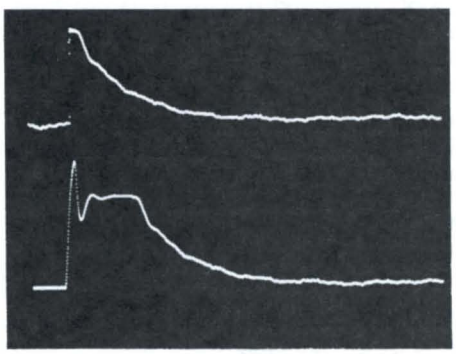
The 7612D Programmable Digitizer is a dual-channel, dual time base waveform digitizer for use under computer control. Extracting information from medium speed signals is a typical application. The 7612D has a maximum sampling rate of 200 MHz. Each channel has its own analog-to-digital converter, for accurate, high speed waveform digitizing, plus its own time base operating from a single 200 MHz crystal controlled clock. The result . . . two fully independent channels capable of capturing one waveform each, simultaneously, with the same or different vertical sensitivities and time base settings.

And there's still more flexibility available. The number of samples per waveform (record length) can be selected, from 256 to 2048. The sample rate can be changed during waveform digitizing, for example, using dense sampling on fast transitions and switching to sparser sampling for slow decays. Also, each channel's local memory can be partitioned into one to eight equal-length records. Waveforms can be viewed before the triggering event (pretrigger), immediately after the trigger, or delayed from the trigger (posttrigger). Channels can be operated dependently by triggering one after the other.

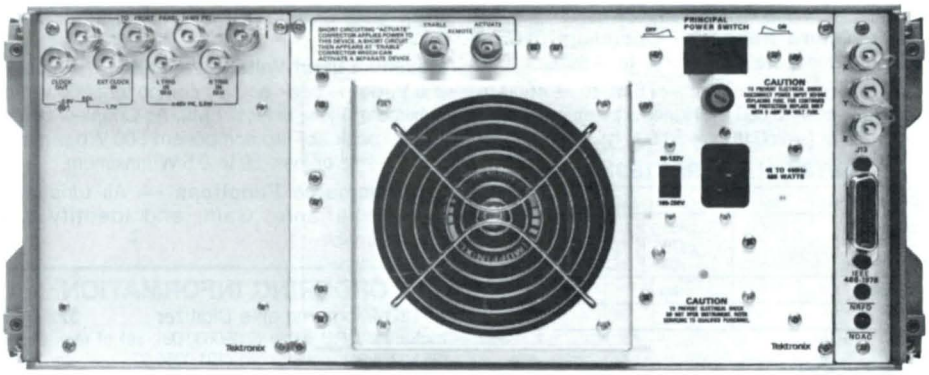
All 7612D functions can be selected manually or operated under program control over the GPIB. Add two 7A16P Programmable Amplifier plug-ins, one for each channel, and you have program control over every waveform acquisition function.



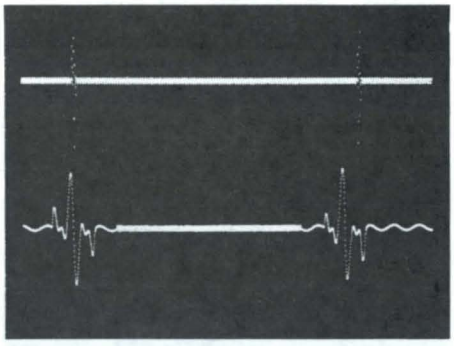
The complete period of a signal (top trace) is recorded at 200 ns; by changing the sample rate to 10 ns during rise times and fall times and 800 ns during the plateau (bottom trace), you can measure rise time, fall time, pulse width and interval accurately on a single-shot signal.



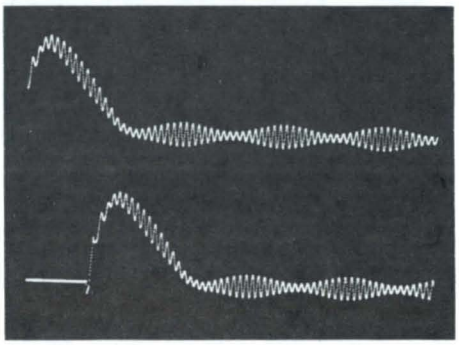
A decaying signal recorded at a 10 µs sampling rate (top trace); the same signal can be recorded at a 100 ns sampling rate during the initial portion and switched back to a 10 µs sampling rate (bottom trace), to capture all information on a single-shot signal.



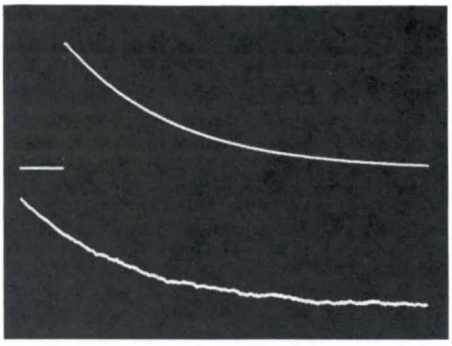
7612D rear panel: the GPIB connector and outputs for an X-Y-Z monitor (right); clock input/output, trigger inputs, and BNC connectors to feed signals to the front panel (left); remote power ON/OFF is also provided through the two central BNC connectors.



A signal with two echoes recorded at a uniform sampling rate (top trace), the same signal recorded at an increased sampling rate during each echo (bottom trace), to capture each echo with increased resolution.



A transient response of a system at power-up recorded with no pretrigger (top trace); by using the pretrigger the complete response can be digitized (bottom trace).



The initial portion of an exponential decay is recorded on Channel A (top trace); Channel B, set at a higher sensitivity and triggered to record after Channel A has finished, captures the remaining pulse tail with increased vertical resolution (bottom trace).

CHARACTERISTICS

VERTICAL SYSTEM

Channels — Two left-hand plug-in compartments compatible with all 7000 Series amplifier plug-ins. Fully programmable when 7A16P plug-ins are used.

Bandwidth — 80 MHz with 7A16P plug-in.

Modes of Operation — Left channel with Time Base A and right channel with Time Base B.

TIME BASES A AND B

Type — Two built-in digital time bases with a common crystal-controlled clock.

Clock — Internal: 200 MHz ±0.0035%. Stability: Within 10 ppm/year. External: From signal source ≤200 MHz.

Sample Interval — With Internal Clock: Selectable from 5 ns to 1 s in a 1, 2, 3 . . . 9 sequence (excluding 6, 7, 8 and 9 ns). With External Clock: Selectable from 1 to 200 x 10^6 times the external clock period in a 1, 2, 4, 6 . . . 20 sequence.

Interval Switching — Sample interval can be changed up to 13 times/waveform record with preservation of time relationships.

Time Measurement Accuracy — 0.0035% (stability 10 ppm/year).

Modes of Operation — Time Base A with left channel and Time Base B with right channel. Independent or B triggerable after A completes its acquisition.

TRIGGERING A AND B

Source — Left or right plug-in, external, manual by pushbutton.

Mode — Single sweep.

Coupling — Ac, dc, ac HF Rej, dc HF Rej.

Slope — Positive or negative.

Level Range — Internal: At least ±128 LSB in 256 steps. External: At least ±1.28 V in 256 steps.

Trigger Jitter (Internal) — 0.1 ns or less, dc to 100 MHz.

Triggering Error — ±1 sample ambiguity in recognizing the trigger, 1 sample maximum recognition error between channels (using same trigger channel for both time bases).

Trigger Sensitivity

Coupling	Triggering Frequency Range	Min Signal Required	
		Internal	External
Ac	40 Hz to 50 MHz	20 LSB	100 mV
	50 MHz to 100 MHz	44 LSB	100 mV
Ac HF Rej	40 Hz to 50 kHz	20 LSB	100 mV
Dc	Dc to 50 MHz	20 LSB	100 mV
	50 MHz to 100 MHz	44 LSB	100 mV
Dc HF Rej	Dc to 50 kHz	20 LSB	100 mV

ARMING A AND B

Pushbutton or computer control.

DIGITIZING AND STORAGE

Method — Continuous, sequential digitizing of the input signals with storage of samples selected by instrument settings.

Resolution — Eight bits.

Dynamic Accuracy*[1]

Signal Frequency	S/N Ratio	Effective Bits
300 kHz	42.0 dB	7.8
20 MHz	32.0 dB	6.0
80 MHz	20.0 dB	4.0

*[1] *Signal to noise ratio performance at 25°C for a half-scale sinewave input signal (an ideal 8-bit digitizer would give a S/N ratio of 43.8 dB). For further information, refer to HANDSHAKE VOL 5 NO 1, 33-A-4463.*

Internal Memory — Type: ECL. Size: 2048 8-bit/channel, total of 4096 8-bit words.

Record Length, A or B — 256, 512, 1024, or 2048 samples. Number of Stored Records: Up to eight 256-word, four 512-word, two 1024-word, or one 2048-word records/channel (each requires a trigger). Trigger is automatically rearmed after each record acquisition.

Pretrigger Delay Range — Selectable in multiples of eight samples. Without Sample Interval Switching: From 0 up to 16 samples less than the record length. With Sample Interval Switching: From 0 up to 16 samples less than the position of the first sample interval change.

Posttrigger Delay Range — Selectable in multiples of eight samples from eight to the record length (requires selection of only one record).

OUTPUTS/INPUTS

X, Y, Z Analog Output — Provides for analog display of data in memory. X and Y level is 1 V p-p into 100 kΩ or greater; adjustable from 0.75 V to 1.3 V. Z level is 0 to 1 V (full white) into 100 kΩ or greater.

Clock Out — Provides internal clock signal at ECL level.

External Clock In — ECL levels. ≤1 ns rise time and fall time. 2.5 ns minimum pulse width and ≤200 MHz.

L and R Trig In — Provide external trigger input to the left and right trigger channels (50 Ω terminated).

1, 2, 3, 4 — Four feed-through connections to the front panel.

Digital Interface — Conforms to IEEE Standard 488-1975.

GPIB INTERFACE

Standard — Conforms to IEEE Standard 488-1975.

Interface Function Subsets Implemented:

SH1	Complete source handshake
AH1	Complete acceptor handshake
TE6	Extended talker function
LE4	Extended listener function
SR1	Complete service request capability
RL1	Complete remote/local function
PP0	No parallel poll
DC1	Complete device clear capability
C0	No controller function
DT0	No device trigger

Response to Interface Control Messages — The 7612D responds to the following interface control messages:

GTL	Go to local
LLO	Local lockout
SDC-DCL	Selected device clear and device clear
SPE-SPD	Serial poll enable and disable
IFC	Interface clear

GPIB Addresses — Mainframe and programmable plug-ins share a common primary address and are differentiated through the use of secondary addresses.

Programmable Functions — All instrument settings and operating modes are programmable.

Format — Commands in ASCII, waveform data in binary (range 0 to 377_8).

Transfer Rate — 710 Kbytes/s maximum.

Waveform Transfer Time — To an Infinitely Fast Controller: 8.35 ms for one 2048 points record. Actual transfer time depends on controller and software speed.

POWER REQUIREMENTS

Line Voltage Range — 90 V ac to 132 V ac, 180 V ac to 250 V ac.

Line Frequency — 48 Hz to 440 Hz.

Power Consumption (Including Plug-Ins) — Maximum 400 W, 5 A at 115 V 60 Hz.

Remote Control — Power On/Off capability is provided.

ENVIRONMENTAL

Temperature Range — Operating: 0°C to +40°C. Nonoperating: −62°C to +85°C.

Altitude — Operating: −76 m to +4600 m (−250 ft to +15,000 ft). Nonoperating: −76 m to +15 000 m (−250 ft to +50,000 ft).

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	483	19.0
Height	178	7.0
Depth	703	27.7
Weight≈	**kg**	**lb**
Net	25.0	55.0

7A16P

Fully Programmable Plug-In for 7912AD or 7612D Digitizers Only

10 mV/Div to 5 V/Div Calibrated Deflection Factors

200 MHz Bandwidth (7900 Family)

50 Ω or 1 MΩ Input Selectable

The 7A16P is designed for use in Tektronix 7000 Series programmable digitizers. All of the normal operational features of a high-quality, wide-band 7000 Series plug-in amplifier are provided in the 7A16P. These are available at the front panel for manual selection, or they can be set under program control via a programmable mainframe and the GPIB. Whether operated manually or under program control, the front panel pushbuttons light to indicate plug-in status. Plug-in status can also be read over the GPIB by an external controller for input to instrument set-up and control routines.

Two switch selected input connectors are also provided for selecting input signal source.

CHARACTERISTICS

Bandwidth — Plug-in only: 225 MHz. With the 7912AD: 200 MHz. Bandwidth may be limited to 20 MHz ±3 MHz by bandwidth limit switch.

Ac Coupled Lower Bandwidth — 10 Hz or less.

Step Response — 50 Ω input plug-in only, 1.8 ns rise time.

Deflection Factor — 10 mV/div to 5 V/div, 9 steps in a 1-2-5 sequence. Accuracy is ±2% of indicated deflection factor with Gain adjusted at 10 mV/div. Uncalibrated Variable is continuous between steps and extends selected deflection factor to at least 2.5 times the calibrated value.

Input R and C — Selectable: 1 MΩ within 2% and paralleled by ≈20 pF or 50 Ω ±1 Ω with VSWR ≤1.5:1 at 200 MHz or less.

Inputs — Selectable A or B signal input connectors.

Maximum Input Voltage — 1 MΩ, Dc Coupled: 250 V (dc + peak ac), ac component 500 V p-p maximum, 1 kHz or less. 1 MΩ, Ac Coupled: 500 V (dc + peak ac), ac component 500 V p-p maximum, 1 kHz or less. 50 Ω: 0.5 W maximum.

Programmable Functions — All functions except Variable, Gain, and Identify are programmable.

ORDERING INFORMATION

7612D Programmable Digitizer **$28,075**

Includes: GPIB cable (012-0630-03); set of rack slides (351-0375-01); power cord (161-0066-00); operator manual (070-2386-00).

INTERNATIONAL POWER PLUG OPTIONS

Option A1 — Universal Euro 220 V, 50 Hz.
Option A2 — UK 240 V, 50 Hz.
Option A3 — Australian 240 V, 50 Hz.
Option A4 — North American 240 V, 60 Hz.
Option A5 — Switzerland 220 V, 50 Hz.

7A16P Programmable Amplifier **$2,395**

RECOMMENDED CART

K217 — Rack Instrument Cart. See page 462. **$495**

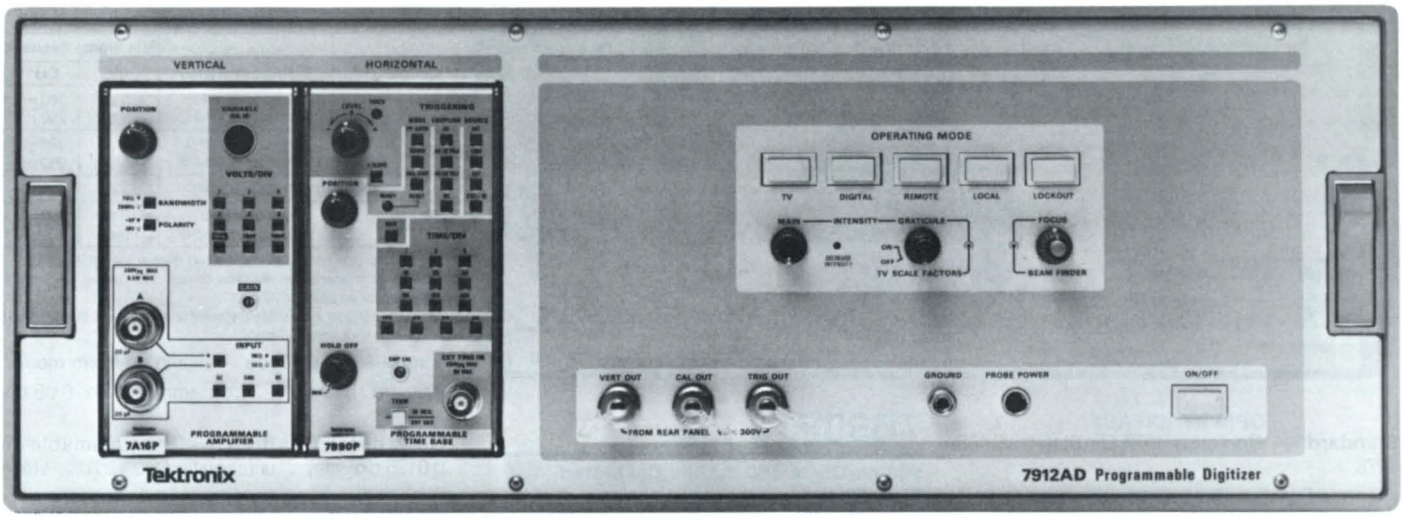
SYSTEMS

The 7612D is also available in MP 1201/MP 2201 Measurement Packages.

TRAINING

Tektronix offers service training classes on the 7612D Programmable Waveform Digitizer. For further training information, contact your local Sales/Service Office or request a copy of the Customer Service Training Catalog.

Tektronix Instrument Group Customer Training offers operation and application training to help you get full value out of your instrumentation investment. Information is on pages 195-196. For further information, or to enroll, call us at 1-800-225-7802. For international orders, contact your nearest Sales Office.



7912AD shown with the 7A16P and 7B90P programmable plug-ins.

7912AD

GPIB IEEE-488 The 7912AD complies with IEEE Standard 488-1975, and with Tektronix *Standard Codes and Formats.*

Digitize and Store Single-Shot or Repetitive Signals From Millisecond to Subnanosecond Duration

500 MHz Bandwidth at 10 mV/Div

500 ps/Div Fastest Calibrated Sweep Rate

Waveform Digitizing to 9-Bit Vertical and 9-Bit Horizontal Resolution

Built-In Signal Averaging Capability

Fully Programmable Over GPIB for System Oriented Operation

TYPICAL APPLICATIONS
Destructive Testing
Laser Research
LIDAR
Automated Testing

Capturing high-speed waveforms is the 7912AD's *forte*. Each waveform can be sampled up to 512 times within a selectable time window, ranging from ten milliseconds to five nanoseconds (50 kHz to 100 GHz equivalent sampling rate).

This performance is accomplished by a Tektronix scan converter which writes the signal onto a silicon-diode target array. In TV mode, the signal information is read from the target and converted to composite video for a bright display on a television monitor. However, in the Digital mode the waveform data is read into an internal memory. From this memory, the digitized waveform can be transferred via the GPIB to an external controller for processing.

The 7912AD mainframe is also programmable over the GPIB. When the programmable plug-ins (one 7A16P Programmable Amplifier and one 7B90P Programmable Time Base) are used, the 7912AD becomes a fully programmable digitizer with a bandwidth of 200 MHz. This is a significant step toward fully automated test and measurement in disciplines such as laser and energy-related research, component or subassembly testing, and other areas requiring information extraction from high-speed waveforms.

CHARACTERISTICS

VERTICAL SYSTEM

Channels — Single plug-in compartment accepts any 7000 Series amplifier plug-in. Fully programmable when 7A16P is used.

Bandwidth (Determined by Amplifier Plug-In) — 7A16P: 200 MHz. 7A29: 500 MHz.

Delay Line — Permits viewing of leading edge of acquired waveform.

HORIZONTAL SYSTEM

Channels — Single plug-in compartment accepts any 7000 Series time base. Fully programmable with 7B90P.

Fastest Calibrated Sweep Rate — 500 ps/div with the 7B90P or 7B92A Time Bases.

Slowest Recommended Sweep Rate — 1 ms/div in Digital mode.

DIGITIZING AND STORAGE

Method — Scan conversion.

Resolution — 9-bits. In the Digital mode, the target is scanned in a 512 x 512 point matrix offering at least 400 discrete horizontal elements, each with a range of at least 320 discrete vertical values. In the TV mode, the target is scanned in a standard TV format with a resolution of at least 400 lines at 50% response.

Writing Rate (+10°C to +40°C) — TV Mode: Writes an 8 div sinewave of at least 500 MHz in a single sweep. Digital Mode: Stores a single 8 div pulse with a rise time of 1 ns or less.

Target Defects — No more than six points digitized other than those written by input waveform. Built-in firmware allows for defect removal by an external controller.

Memory — Type: Semiconductor. Size: 4096 10-bit words for data from target and two 512 16-bit word areas for internally processed and reduced data. Record Length: 512 samples/waveform maximum.

ELECTRONIC GRATICULE

8 x 10 div dot matrix written onto the scan converter target immediately after waveform acquisition. Can be displayed simultaneously with the input signal on the TV monitor or digitized and stored.

OUTPUTS/INPUTS

X, Y, Z Analog Output — Provides for analog display of data in memory. X and Y level is 1 V p-p into 100 kΩ or greater; adjustable from 0.75 V to 1.3 V. Z level is 0 V to 1 V (full white) into 100 kΩ or greater.

Composite Video Output — Only available in TV mode. Used to drive a TV monitor for displaying signal written on scan-converter target as an aid to setting intensity for complete digitizing. Linear Output: Replica of the signal read from the target with sync added. Binary Output: Two-level output derived from the linear composite video output. Used to indicate on the TV monitor how well a waveform will be digitized. Scale factor readout included in both linear and binary.

Sync Output — At least 4 V into 75 Ω. Conforms to EIA RS-170.

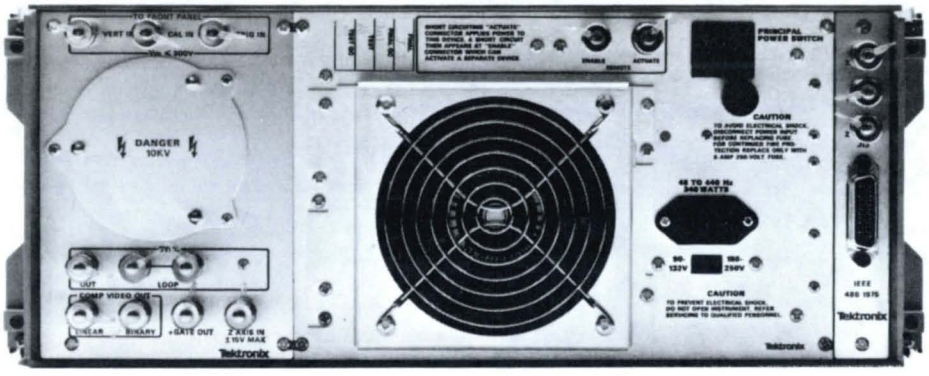
Sync Loop — Allows TV mode to be synchronized with external EIA RS-170 sync waveform.

+Gate Output — Provides a positive pulse with a duration equal to and coincident with the time base sweep.

Z-Axis Input — ±1 V input modulates the writing gun intensity over its full range.

Vert In, Cal In, Trig In — Three internal 50 Ω coaxial cables connect signals from the rear panel to the front panel to ease system configuration in rackmounts.

Probe Power — Provides power for Tektronix active probes.



GPIB INTERFACE

Standard — Conforms to IEEE Standard 488-1975.

Interface Function Subsets Implemented:

SH1	Complete source handshake
AH1	Complete acceptor handshake
TE6	Extended talker function
LE4	Extended listener function
SR1	Complete service request capability
RL1	Complete remote/local function
PP0	No parallel poll
DC1	Complete device clear capability
C0	No controller function
DT1	Device trigger complete

ENVIRONMENTAL

Temperature Range — Operating: 0°C to +40°C. Nonoperating: −55°C to +75°C.

Altitude — Operating: Up to 4600 m (15,000 ft). Nonoperating: Up to 15 000 m (50,000 ft).

EMC (Plug-Ins Inserted) — Meets MIL-STD-461A and 462 radiated and conducted interference from 30 Hz to 1 GHz.

POWER REQUIREMENTS

Line Voltage Range — 90 V ac to 132 V ac and 180 V ac to 250 V ac.

Line Frequency — 48 Hz to 440 Hz.

Power Consumption (Including Plug-Ins) — 360 W maximum.

Remote Control — Remote power On/Off capabilities provided.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	483	19.0
Height	178	7.0
Length	679	26.8
Weight≈	**kg**	**lb**
Net	24.7	54.6

7A16P

Fully Programmable Plug-In for 7912AD or 7612D Digitizers Only

10 mV/Div to 5 V/Div Calibrated Deflection Factors

200 MHz Bandwidth (7900 Family)

50 Ω or 1 MΩ Input Selectable

For complete specifications on 7A16P see page 346.

7B90P

500 ps/Div to 500 ms/Div Calibrated Time Base

Fully Programmable Plug-In 7912AD Digitizer Only

400 MHz Trigger Bandwidth

Single-Sweep Operation

The programmable 7B90P is designed for use with a Tektronix 7912AD Programmable Digitizer. Its operating functions can be manually selected at the front panel or selected under program control via the GPIB. The only nonprogrammable functions are the Sweep Calibration adjustment and the External Trigger Input Terminator Switch.

CHARACTERISTICS

Sweep Rates — 500 ms/div to 10 ns/div in 24 steps. Magnifier extends fastest calibrated sweep rate to 500 ps/div.

Sweep Accuracy — Measured over center 8 div, +15°C to +35°C, with any 7000 Series programmable mainframe. Derate accuracies by an additional 1% for 0°C to +50°C.

Time/Div	Unmagnified	Magnified
500 ms/div to 100 ns/div	2%	3%
50 ns/div to 10 ns/div	3%	4%
500 ps/div	—	5%

Trigger Holdoff — Programmable in 62 steps between minimum and maximum.

Time/Div	Min (ccw)	Max (cw)
500 ps/div to 2 µs/div	≤3.5 µs	≥90 µs
5 µs/div to 20 µs/div	≤35 µs	≥900 µs
50 µs/div to 200 µs/div	≤350 µs	≥9 ms
500 µs/div to 2 ms/div	≤3.5 ms	≥90 ms
5 ms/div to 500 ms/div	≤35 ms	≥900 ms

Triggering Sensitivity

P-P AUTO MODE

Triggering Frequency Range	Min Signal Required	
	Int	Ext
At least 50 Hz to 200 Hz	2.0 div	500 mV
200 Hz to 50 MHz	0.5 div	125 mV
50 MHz to 400 MHz	1.5 div	375 mV

NORM MODE

Coupling	Triggering Frequency Range	Min Signal Required	
		Int	Ext*1
Ac	30 Hz to 50 MHz 50 MHz to 400 MHz	0.3 div 1.5 div	100 mV 250 mV
Ac LF Rej*2	30 kHz to 50 MHz 50 MHz to 400 MHz	0.3 div 1.5 div	100 mV 250 mV
Ac HF Rej*3	30 Hz to 50 kHz	0.3 div	100 mV
Dc	Dc to 50 MHz 50 MHz to 400 MHz	0.3 div 1.5 div	100 mV 250 mV

*1 *Ext÷10 operation attenuates ext trigger signal 10 times.*
*2 *Will not trigger on sinewaves or <8 div Internal, or 3 V External, at or below 60 Hz.*
*3 *Will not trigger on 50 MHz sinewaves 1.5 div or less Internal, or 0.15 V or less External.*

Single-Sweep Mode — Same as Norm mode.

Trigger Level — Programmable in 0.05 div steps.

Horizontal Position — Programmable in 0.0125 div steps unmagnified, 0.125 div steps magnified.

Internal Trigger Jitter — 0.1 ns or less at 400 MHz.

External Trigger Input — Selectable: 1 MΩ ±5%, 20 pF ±10% or 50 Ω ±5% with 1.22:1 maximum vswr at 400 MHz. Maximum input is 250 V (dc + peak ac) for 1 MΩ or 1 W for 50 Ω. The level range (excluding p-p Auto) for a 1 kHz sinewave input is at least ±3 V in Ext and at least ±30 V in Ext÷10.

ORDERING INFORMATION

(PLUG-INS NOT INCLUDED)

7912AD*1 Programmable Digitizer **$27,025**

Includes: Power cord (161-0066-00); set of rack slides (351-0375-01); GPIB cables (012-0630-03); operator manual.

OPTIONS

Option 13 — Change TV Scan to 625 lines at 50 Hz. **NC**

Option 30 — Delete GPIB Cable. **−$90**

INTERNATIONAL POWER PLUG OPTIONS

Option A1 — Universal Euro 220 V, 50 Hz.
Option A2 — UK 240 V, 50 Hz.
Option A3 — Australian 240 V, 50 Hz.
Option A4 — North American 240 V, 60 Hz.
Option A5 — Switzerland 220 V, 50 Hz.

7A16P Programmable Amplifier **$2,395**

7B90P Programmable Time Base **$2,885**

*1 *It is recommended that 7912ADs not be purchased or operated without an accompanying 634 Raster Scan Display Monitor. Contact your local Sales Engineer for details.*

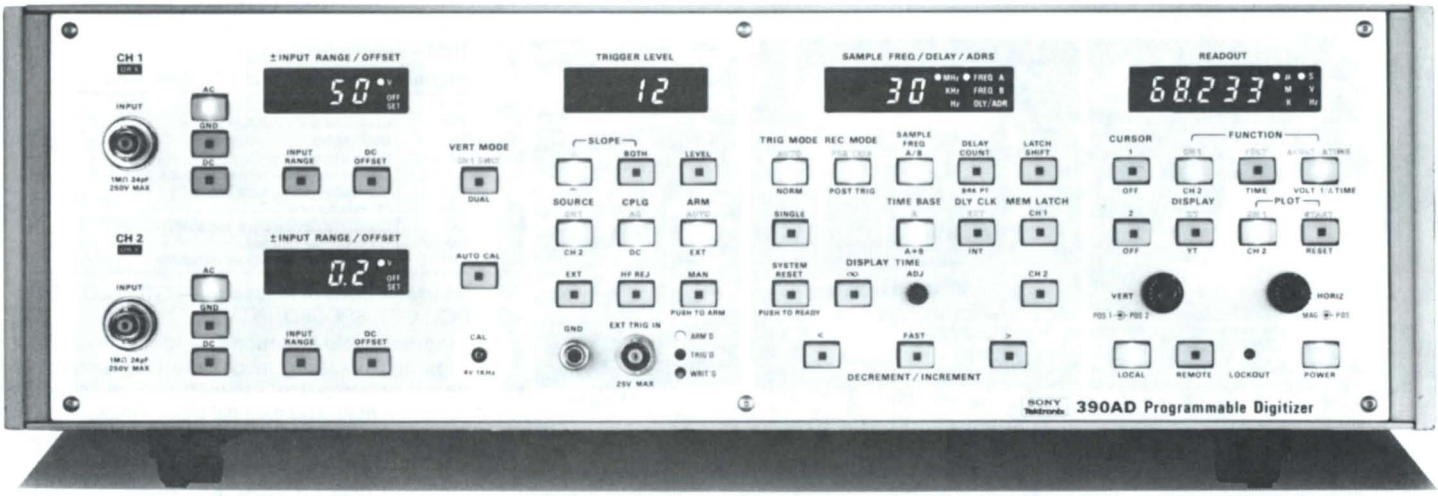
SYSTEMS

The 7912AD is also available in MP 1101/MP 2101 Measurement Package. See page 374.

TRAINING

Tektronix offers service training classes on the 7912AD Programmable Transient Waveform Digitizer. For further training information, contact your local Sales/Service Office or request a copy of the Customer Service Training Catalog.

Tektronix Instrument Group Customer Training offers operation and application training to help you get full value out of your instrumentation investment. Information is on pages 195-196. For further information, or to enroll, call us at 1-800-225-7802. For international orders, contact your nearest Sales Office.



390AD

GPIB IEEE-488

The 390AD complies with IEEE Standard 488-1978 and with Tektronix *Standard Codes and Formats.*

True Dual Channel 30 MHz Sampling Rate (60 MHz in Single Channel Mode)

10-Bit Resolution

2048 Word Memory per Channel (4096 Single Channel Mode)

Cursor-Based Measurements

Sample-Rate Switching

Direct Plotter Output Capability

TYPICAL APPLICATIONS

Extracting Information From Signals Containing Components From dc to 15 MHz
Ultrasonics/Stress/Strain
Mechanical/Vibration
Audio
ATE
Laser Spectroscopy
Biomedical Research
LIDAR
Geo-Seismic

Used for low-to-medium-speed signals, the 390AD Programmable Waveform Digitizer provides crystal-controlled, 30 MHz sampling on two channels. Or, a single channel of data can be digitized at up to 60 megasamples per second.

Features include 10-bit vertical resolution, dual-channel synchronized digitizing, pretriggering and posttriggering, sample-rate switching during acquisition, internal cursors for two-point time or voltage measurements and 2048 words of memory per channel. Excellent dynamic accuracy is achieved using a two-stage flash-conversion process.

The X versus Y display mode coupled with the shift mode function provides a powerful tool for visual comparison of related phenomena.

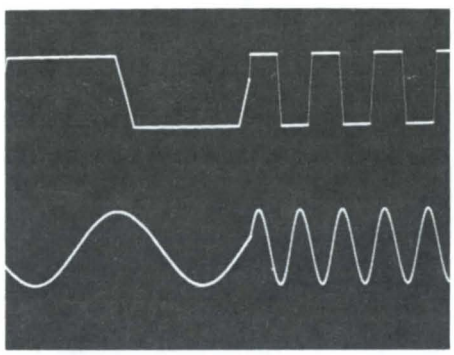
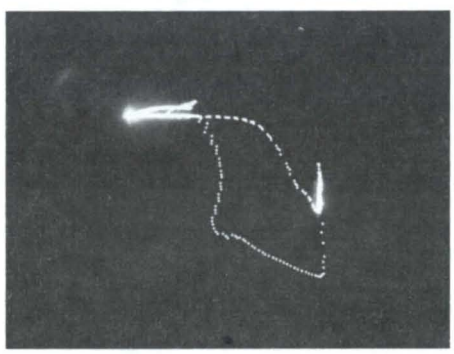
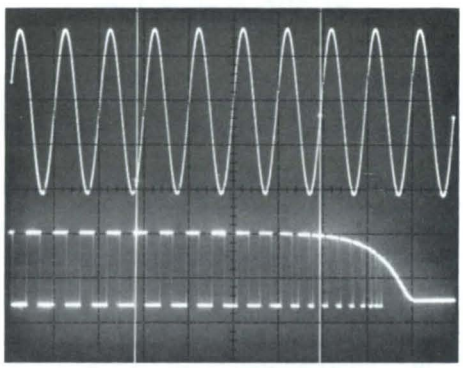


Photo showing sample of Rate Switching. In this example switching occurs at the 1024th sample, to extend the display window. The sample rate can be either increased or decreased at the trigger point. A minor time discontinuity may occur at the trigger point under some conditions.

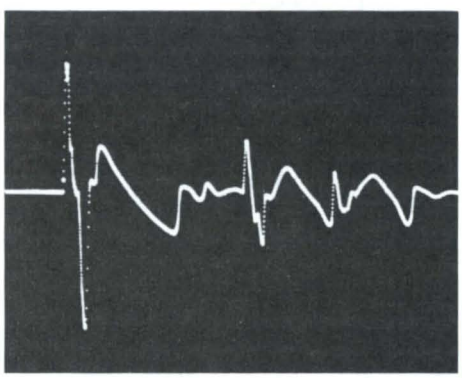


The 390AD display is set to X vs Y mode.

To ensure reliable operation and high accuracy, the 390AD includes Auto Cal (self-calibration) and self-test features during operation.



Two cursors can be positioned by the user or controller, at points of interest on either waveform. The voltage difference, time difference, or 1/time difference, as well as the absolute values can be directly read from the LED display, or sent to a controller. Positioning can be precisely accomplished with the aid of the "zoom" feature.



Complex manual set-ups can be avoided by recording the desired instrument settings for a particular measurement on a system peripheral device, then sending the English-like command string to the 390AD.

The 390AD can be easily integrated into wide range of GPIB systems. Shown above is a 4695 Color Hard Copy Unit and a 4205 Color Graphics Terminal which is connected to a Tektronix 4041 System Controller.

CHARACTERISTICS

VERTICAL

Input Channels — Two, single ended.

Sensitivity — ±100 mV to ±50 V full scale (200 mV p-p to 100 V p-p); 9 steps, 1-2-5 sequence.

Input R and C — 1 MΩ ±2%; paralleled by ≈24 pF.

Maximum Input Voltage — Dc Coupled: 250 V (dc + peak ac). Ac Coupled: 500 V (dc + peak ac).

Bandwidth — Dc to 15 MHz (−3 dB). Lower −3 dB point, Ac Coupled: 10 Hz.

Input Dc Offset Voltage — 0 to ±99% full scale, 1% step. Accuracy: <0.5%.

Automatic Calibration — Gain Accuracy: ±0.4%. Dc Drift Accuracy: <±0.1%.

TIME BASE A AND B

Sample Rate — Internal: CH 1 only: 5 Hz to 60 MHz, 23 steps, 1-2-5 sequence except 30 MHz and 60 MHz. Dual: 5 Hz to ≈30 MHz, 22 steps. External: Dc to 60 MHz.

Clock — 60 MHz ±10 ppm, crystal-controlled.

TRIGGERING

Sources — Internal CH 1 and CH 2 or external.

Coupling — Ac, dc, HF Rej.

Slope — Positive, negative, both.

Level Range — Internal: 0 to ±99% full scale, 1% step. External: ±4.95 V, 0.05 V step.

Trigger Sensitivity

Coupling	Trigger Frequency Range	Minimum Signal Required	
		Internal	External
Ac	25 Hz to 15 MHz	30 LSB	300 mV p-p
HF Rej	25 Hz to 50 kHz	30 LSB	300 mV p-p
Dc	Dc to 15 MHz	30 LSB	300 mV p-p

Arming — Auto, Manual, External.

DIGITIZING

Vertical Resolution — 10-bits (1/1024).

Sample Rates — Dual Channel Mode: 30 MHz. CH 1 Only Mode: 60 MHz.

Aperture Jitter (Including Internal Clock) — 150 ps, nominal.

Dynamic Accuracy*[1]

Signal Frequency	Effective Bits
≤1 MHz	≥8.75
≤10 MHz	≥8.25
≤14 MHz	≥7.75

[1] Sampling frequency at 30 MHz. For further information refer to HANDSHAKE Vol 5 No 1, 33-A-4463.

Record Length — Dual Channel Mode: 2048 words/channel. CH 1 Only Mode: 4096 words.

Modes — Auto, Norm, Single.

Pretrigger Range — CH 1 Only Mode: 0 to 4092. Dual Channel Mode: 0 to 2046.

Posttrigger Range

Time Base	Vertical Mode	Range
A	Dual	0 to 9998
	CH 1 only	0 to 9998
A+B	Dual	0 to 2046
	CH 1 only	0 to 4092

A Time Base — Recording is taken at one rate (sample frequency A) continuously.

A+B Time Base — Pretrigger Mode: Sample frequency A is switched to B at trigger. Recording stops at delayed trigger. The transition point (switch point) is well defined. Posttrigger: Sample frequency A is switched to B at delayed trig and recording stops after total of 2048 (or 4096) samples.

Stored digital data are addressable by key entry while monitoring cursors on the waveform.

Readout Display — Five digit LED (Reads voltage difference on the same waveform or between CH 1 and CH 2, absolute voltage, time interval, and 1/T.

OUTPUTS

CRT Display — X: 1 V p-p Ramp (changeable to 5 V p-p by internal strap). 8 ms: Dual. 16 ms: CH 1 only. Mag gain X1 to X10 variable. Y: 1 V p-p (changeable to 5 V p-p by internal strap). Z: 0 to 1 V (changeable to 0 to 5 V by internal strap), selectable polarity. X-Y Plot: Output Voltage is 0 to 5 V. Plot Speed is 20, 50, 100 ms/word: Auto Slow, or Auto Fast modes. (Modes are selected by internal strap.)

Voltage Calibrator — Rectangular 1 kHz (±10^{-5}), 4 V (±1%).

Rear Panel Connectors — CRT-X, CRT-Y, CRT-Z, INT CLK-OUT, EXT CLK-IN, EXT ARM-IN, EXT DLY CLK-IN, PLOT-X, PLOT-Y, PLOT-PEN, WRITE END, GPIB.

GPIB INTERFACE

Standard — Conforms to IEEE Standard 488-1978.

Interface Function Subsets Implemented:

SH1	Complete source handshake
AH1	Complete acceptor handshake
T6	Basic talker
L4	Basic listener
SR1	Complete service request capability
RL1	Complete remote/local capability
PP0	No parallel poll
DC1	Complete device clear capability
C0	No controller function
DT1	Complete device trigger capability

Interface Control Message — GTL, LLO, SDC-DCL, GET, SPE-SPD, IFC.

Programmable Functions — All instrument settings and operating modes are programmable, except power switch, vertical/horizontal position, horizontal mag, and external clock switch.

Format — Commands in ASCII, Waveform data in 2 byte/point high byte first.

POWER REQUIREMENTS

Line Voltage Range — 90 V ac to 132 V ac (115 V); 180 V to 250 V ac (230 V).

Line Frequency — 48 Hz to 440 Hz.

Maximum Power Consumption — 240 W.

ENVIRONMENTAL

Temperature Range — Operating: 0°C to +40°C. Nonoperating: −25°C to +70°C.

Altitude — Operating: Sea level to 4600 m (15,000 ft). Nonoperating: Sea level to 15 000 m (50,000 ft).

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	446	17.6
Height	152	6.0
Depth	540	21.3
Weight≈	**kg**	**lb**
Net, without accessories	15.5	34.0

ORDERING INFORMATION

390AD Programmable Digitizer **$11,400**

Includes: Power cord (161-0066-00); two 4 A fast-blow fuses (159-0017-00); GPIB cable (012-0630-03); 390AD Programming Aid (070-4467-00); operator manual (070-4450-00).

The 620 monitor is recommended for use with the 390AD.

OPTION

Option 10 — Rackmount 390AD. **+$250**

UTILITY SOFTWARE

(390AD/4041) Order 062-6959-01 **$150**
(390AD/4052A) Order 062-6960-01 **$150**

See page 359 for description and ordering information.

INTERNATIONAL POWER PLUG OPTIONS

Option A1 — Universal Euro 220 V, 50 Hz.
Option A2 — UK 240 V, 50 Hz.
Option A3 — Australian 240 V, 50 Hz.
Option A4 — North American 240 V, 60 Hz.
Option A5 — Switzerland 220 V, 50 Hz.

OPTIONAL ACCESSORIES

GPIB Cables — Low EMI.

(1 m) Order 012-0991-01 **$135**
(2 m) Order 012-0991-00 **$150**
(4 m) Order 012-0991-02 **$175**

For floating measurements, order A6902B Isolator. See page 479 for complete description. Contact your local Sales Engineer for details.

Recommended Probes — See page 464.

Service Manual — To order, contact your local Sales Office.

The SONY®/TEKTRONIX® 390AD is manufactured and marketed in Japan by Sony/Tektronix Corporation, Tokyo, Japan. Outside of Japan, the 390AD is available from Tektronix, Inc., its marketing subsidiaries and distributors.

5223

GPIB IEEE-488

The 5223 Option 10 complies with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats.*

Digital Storage (With 5B25N)
10 MHz Bandwidth Repetitive Store

100 kHz Bandwidth Single Shot Store

Pretrigger

10-Bit Vertical Resolution

Stored X Versus Y Display

Roll Mode

X-Y Plotter Output With Pen Lift

The Tektronix 5223 Digitizing Oscilloscope has a real time bandwidth of 10 MHz. It is capable of displaying real time and stored waveforms simultaneously (four real time waveforms and four stored waveforms, if dual channel amplifier units are used); the real time waveforms need not be related to the stored waveforms. Stored waveforms can be expanded vertically and horizontally up to a factor of ten, using front panel controls. The left and right stored vertical signals can be displayed against each other in the X-Y mode, using the L vs R front panel display function. The roll mode is useful for viewing low frequency signals. Rear panel connectors provide access to the internal analog and control signals to record stored waveforms using associated equipment (e.g., X-Y plotter). The 5223 accepts most 5000 Series plug-in units; the flexibility of the plug-in feature, and variety of plug-in units available, allows the system to be used for many measurement applications. The digital storage functions can only be accessed or enabled by using the 5B25N Time Base.

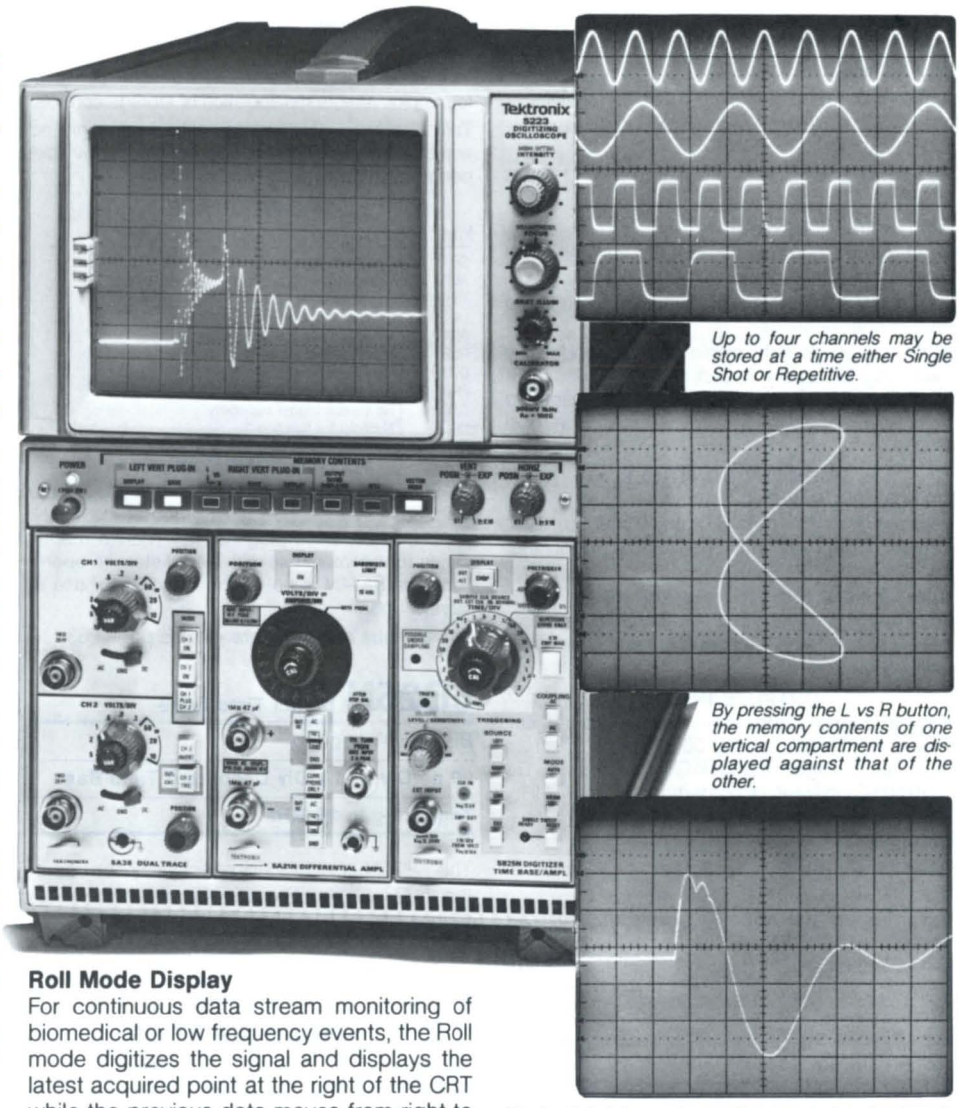
Display and Save Functions

The Display buttons allow digitization of signals originating from the corresponding vertical compartments (left and right). The digitized display is continuously updated as long as a triggered sweep occurs, or until a Save button is pushed. The Save buttons freeze the memory contents. Up to four channels may be displayed and saved simultaneously.

L vs R Display

This function displays the memory contents of the left compartment versus the right compartment. The left defines the vertical axis and the right defines the horizontal axis.

Since the X-Y display is from memory, the real time sweep is still in the standard Y-time format and may be displayed simultaneously.



Up to four channels may be stored at a time either Single Shot or Repetitive.

By pressing the L vs R button, the memory contents of one vertical compartment are displayed against that of the other.

Single-shot data can be captured and stored automatically without the operator's presence. Pretrigger signal portion has an intensified trace for easy reference.

Roll Mode Display

For continuous data stream monitoring of biomedical or low frequency events, the Roll mode digitizes the signal and displays the latest acquired point at the right of the CRT while the previous data moves from right to left. The display appears much like a strip chart recorder. Roll mode is available on the sweep range of 5 s/div to 0.1 s/div.

Vector Display

When Vector Display is selected, a continuous trace connects the discrete data points into a clear and comprehensive display. This eliminates perception problems of scattered data and reduces interpretation errors.

Output Saved Displays

When pressed, an analog output of the displayed/saved waveforms is activated for driving conventional X-Y analog plotters. Pen lift is also provided and is activated before and after each waveform is output. Up to four waveforms may be output.

Display Out Speed Control (Rear Panel)

The Display Out Speed control adjusts the X-Y plotter output speed to compensate for differences in plotter speeds and response.

CHARACTERISTICS

VERTICAL REAL TIME SYSTEM

Channels — Two plug-in compartments; compatible with 5000 Series plug-ins.

Mainframe Bandwidth — 10 MHz with 5A38, 5A45 or 5A48.

Mainframe Step Response — 35 ns.

Chop Mode — 100 chopped segments/div unexpanded with 5B25N Time Base.

Delay Line — Permits viewing leading edge of displayed waveform.

HORIZONTAL REAL TIME SYSTEM

Channel — Single compartment compatible with 5000 Series time bases and amplifiers. 5B25N must be used in storage modes.

Fastest Calibrated Sweep Rate — 20 ns/div.

X-Y Mode — <2° phase shift, dc to 20 kHz between either vertical compartment and horizontal compartment.

DIGITAL STORAGE (WITH 5B25N)

Vertical Resolution — 10-bits (100 pts/div unexpanded).

Display Memory Size — 1K points/vertical compartment, shared by multiple trace plug-ins.

Sample Rate — Maximum of 1 MS/s (1 µs/pt). Actual sample rate depends on time base setting.

Fastest Single Shot Sweep Speed — 100 µs/div.

External Clock In — Maximum of 1 MS/s (1 µs/pt). TTL compatible.

Equivalent Time Bandwidth — 10 MHz.

Acquisition Window — ±4 div vertically and ±5 div horizontally from center screen.

Accuracy — Determined by plug-ins. Refer to plug-in specifications.

X-Y — (Left vs right single channel mode only excluding 100 µs/div sweep range). Maximum of 5° phase shift between vertical compartments up to 10 MHz using two identical 5400 Series vertical plug-ins.

MEMORY CONTROLS

Display and Save — Controls for each vertical compartment. X-Y (left vs right), Data Out, Roll, Vector mode, Horizontal and Vertical positioning, and expansion (⩾10:1).

Data Out — Analog voltage of stored signal. 200 mV/div ±5%. Output rate variable with rear panel control. Pen lift available on rear panel (normally open).

OUTPUTS/INPUTS

Plug-In Signal Outputs — Left, Right Vertical, Horizontal Compartments: 50 mV/div ±5% from 50 Ω. Left, Right Vertical Compartments: Dc ⩾10 MHz. Horizontal Compartment: Dc ⩾7 MHz.

Time Base Gate — TTL compatible, positive going.

Remote Single Sweep Reset — Rear panel BNC closure to ground resets sweep.

External Z-Axis Input — Usable, dc ⩾5 MHz voltage swing of 5 V will fully modulate beam dc ⩾1 MHz. Negative voltage will blank trace. Maximum input voltage is 40 V (dc + peak ac).

Calibrator — Voltage Output: Squarewave, positive going from ground. Amplitude is 300 mV ±1%. Current Output: 3 mA ±1% available through calibrator output with optional BNC to current loop adaptor.

CRT AND DISPLAY FEATURES

CRT — 8 x 10 div with 1.22 cm/div. Internal illuminated graticule.

Phosphor — GH (P31) standard.

Acceleration Potential — 15 kV.

Camera Power — Compatible with Tektronix C-59 Camera.

POWER REQUIREMENTS

Line Voltage Range — 90 V to 117 V ac, 102 V to 132 V ac, 191 V to 249 V ac, 204 V to 250 V ac maximum.

Line Frequency — 48 Hz to 62 Hz (48 Hz to 440 Hz, Option 05).

Maximum Power Consumption — 145 W at 120 V, 60 Hz.

OPTIONS

Option 05 Line Frequency Change (48 Hz to 440 Hz) — Converts the R5223 to 48 Hz to 440 Hz operation.

Option 10 GPIB Interface — For I/O of stored waveforms and control of 5223 digital storage functions (except vertical and horizontal expansion and position controls). Waveform output format is selectable through the interface for Binary or ASCII.

I/O Records — Waveforms.

Device Address — Selectable via rear panel switch.

Talk/Listen — Full bi-direction transfer of waveforms plus remote manipulation of storage controls.

Talk Only — Continuous output of digitized waveform to maximum sweep of 20 ms/div (dependent on other instruments on bus).

GPIB INTERFACE

Interface Function Subsets Implemented:

SH1	Complete source handshake
AH1	Complete acceptor handshake
T5	Talker function
L4	Listener function
SR1	Complete service request capability
RL2	Remote/local capability
DC1	Complete device clear capability
PP0	No parallel poll
DT0	No device trigger capability
C0	N controller function

PLUG-IN COMPATIBILITY

All 5000 Series plug-ins are compatible in the standard oscilloscope display mode. The 5L4N, 5A18N, 5A26, 5A48 plug-ins may require modification for optimum use with digital storage operation. The 5A14N is not recommended for use in storage mode.

Dimensions and Weights — See page 263.

5B25N Digital Time Base

Bislope Triggering

20 ns/Div to 5 s/Div Calibrated Time Base

Triggering to 15 MHz

The 5B25N is designed specifically for use in the 5223 Digital Storage Oscilloscope. Pretrigger is only available with the 5223. However, the standard analog sweep features including Bislope Triggering and X10 Mag are compatible with 5400 Series mainframes.

CHARACTERISTICS

Modes — Auto, Normal, Single Sweep.

Single Sweep — Triggering requirements are the same as normal sweep. When triggered, sweep generator produces only one sweep.

External Trigger Input — Maximum input voltage is 350 V-peak. Input R and C is 1 MΩ paralleled by ≈24 pF.

External Horizontal Input — Deflection factor is 50 mV/div ±3%. Dc coupled bandwidth is dc to 2 MHz.

Sweep Rate — 0.2 µs/div to 5 s/div in 24 calibrated steps (1-2-5 sequence). 20 ns/div is fastest sweep rate obtained with X10 magnifier. Uncalibrated, continuously variable between steps and up to 12.5 s/div.

TRIGGERING

Slope	Frequency Range	Minimum Signal Required	
		Internal	External
+ or −	Dc to 1 MHz 1 MHz to 15 MHz	0.4 div 0.6 div	50 mV 200 mV
± (Bislope)	Dc*1 to 1 MHz	±0.5 div	±50 mV

*1 30 Hz when ac coupled.

Bislope Triggering — Will trigger on either a positive or negative slope and the threshold or sensitivity is controlled by the trigger level knob. This eliminates the uncertainty of which slope is selected.

CHARACTERISTICS
(WHEN USED WITH THE 5223 MAINFRAME)

Accuracy

Time/Div	Sweep*1	Digitized*2	Digitized to Real Time*3
50 µs/div to 0.2 µs/div	3%	3%	3%
1 s/div to 0.1 ms/div	3%	3%	3%
2 s/div and 5 s/div	4%	3%	4%

*1 *Accuracy is specified over the center eight graticule divisions, in 5223 or 5400 Series oscilloscopes. Derate accuracy by 1% for 0°C to +50°C, or when using X10 magnifier.*

2 Digitized signal accuracy is specified over center eight graticule divisions in 5223 Oscilloscope, excluding first 200 ns or 0.2 div of each waveform.

3 The digitized signal will match the real time signal within the specified tolerance.

Pretrigger — For viewing events that occur prior to the trigger and is continuously variable from 0% to 100% of full screen. An intensified zone is generated which corresponds to the amount of pretrigger selected. This intensified zone remains with the saved waveform. Pretrigger is available from 5 s/div to 0.1 ms/div.

Possible Undersampling Indicator — To aid in eliminating aliasing, an LED indicator illuminates when the ratio of sampling frequency to trigger frequency is less than eight.

Sampling Rate — For single shot acquisition, the 5B25N has a maximum sample rate of 1 MHz at 0.1 ms/div.

Repetitive Store — For repetitive signals, the 5B25N controls the equivalent time sampling feature of the 5223 to allow digitizing from 50 µs/div to 0.2 µs/div.

External Clock Input — Clock-In pin jack allows the user to introduce an external sampling clock. Maximum input frequency of 1 MHz, with TTL threshold, and 5 V peak input voltage.

ORDERING INFORMATION

5223 Digitizing Oscilloscope **$6,165**
Includes: Power cord (161-0066-00); instruction manual (070-2933-00).

R5223 Rackmount **$6,340**
Includes: Instruction manual (070-2933-00).

OPTIONS

Option 05 — Line Freq Change (R5223 only). **+$210**
Option 10 — GPIB Interface. **+$790**

CONVERSION KITS

Rackmount-to-Cabinet — Order 040-0975-01 **$330**
Cabinet-to-Rackmount — Order 040-0976-04 **$450**
Adds GPIB Interface to Standard 5223 — Order 040-0996-01 **$1,360**

INTERNATIONAL POWER PLUG OPTIONS

Option A1 — Universal Euro 220 V, 50 Hz.
Option A2 — UK 240 V, 50 Hz.
Option A3 — Australian 240 V, 50 Hz.
Option A4 — North American 240 V, 60 Hz.
Option A5 — Switzerland 220 V, 50 Hz.

5B25N Digital Time Base **$1,095**
Includes: Instruction manual (070-2814-00).

OPTIONAL ACCESSORIES

RECOMMENDED CART

K213 — The K213 Lab Instrument Cart is recommended for all 5000 Series oscilloscopes. A storage area for plug-ins is available as Option 12. See page 462. **$595**

RECOMMENDED CAMERAS

C-59A — General purpose. See page 453. **$1,335**
C-5C — Low Cost. See page 445. **$495**

The Digitizing Camera System consists of C1001 Camera, frame store board inside the PC, DCS software, and cables. The system is shown with an IBM AT and HC02 Hard Copy Unit.

NEW DCS01

Digitizing Camera System

Adapts to Many Analog Scopes

1 GHz Single Shot With 7104

Works in IBM PC or Compatible

12 Bits Nominal Resolution

Menu Driven Displays

Waveform Analysis Software

Save on Delta™ Feature

TYPICAL APPLICATIONS (DCS01)

High Energy Physics, Telecommunications, Laser Research, High Speed Logic, Imaging, Manufacturing QA and QC Waveforms for Manual Production

TYPICAL APPLICATIONS (C1001)

Presentations and Training, Monitoring of Displays, Documentation, (when used with a video copier), Television Work

The Digitizing Camera System (DCS) bridges the gap between the analog scope and PC. On scopes with microchannel plate (MCP) CRTs, you can acquire repetitive events at the scope's full bandwidth, and transient events according to the *photographic* writing speed of the oscilloscope.

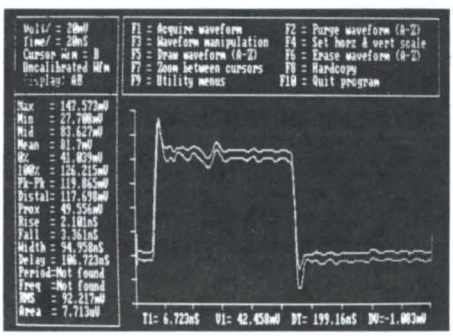
Tek merges leading edge technologies to provide the engineering edge in productivity and reliability

Blending significant advances in optics, signal processing hardware and software, with Tektronix' long-standing leadership in CRT technology, the DCS bridges the gap between acquisition tools such as the 11302, 2467, 7104 and other oscilloscopes, and processing and analysis tools, such as the PC. When coupled with the Tek 1 GHz bandwidth 7104/R7103 microchannel plate oscilloscope the DCS can acquire and digitize transient waveforms at an effective sampling rate of 250 gigasamples/sec (4 ps per sample).

The DCS's charged coupled device (CCD) video camera captures a CRT waveform in digital format, and sends a video signal to the frame/store (a printed circuit board slotted in the PC mainframe). Menu-driven software included with the DCS package, lets you easily manipulate the waveform for instant display, signal processing and analysis, hard copy output, magnetic storage in binary or ASCII converted formats, or porting to a mainframe via RS-232C or GPIB.

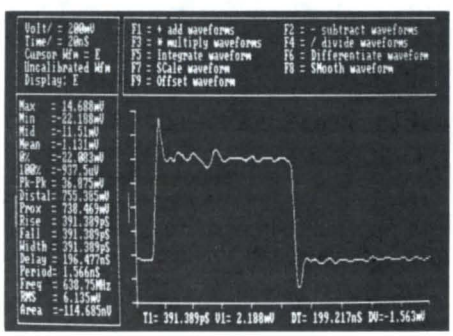
DCS Software is fully MS-DOS compatible (2.1 or greater), and included in the DCS system package

Easy menu driven commands provide instant control of many signal analysis and processing functions. You can display waveforms on the PC together with parametric measurements in another window; zoom in between cursor points for detailed waveform viewing; perform calibration on oscilloscope-camera set-ups—and much more. Future optional software will offer customized waveform acquisition and digitization functions, plus enhanced parametric and signal processing analysis, including FFTs.



Save-on-delta—Easy-to-use software sequences let you create three types of delta masks. This shows a mask created from two waveforms.

Trademark, Tektronix, Inc.



Math operations—Manipulate waveforms mathematically by using such procedures as integration and differentiation, scalar, smoothing and offsetting (shown on top of the screen).

DCS hardware/software bring exceptional resolution and accuracy
Resolution is derived from three dimensions—for the most reliable waveform characterization available. This is a significant advance over the two dimensional, horizontal/vertical or X-Y counterpart. The third dimension, the Z axis, measures intensity to a resolution of 8 bits. To determine the exact trace center to a degree never before possible.

Vertical and horizontal resolution are 9 and 9 bits, respectively
When combined with the 8-bit Z axis (intensity) by a proprietary Tektronix algorithm, overall nominal resolution of the DCS is 12 bits. This exceeds the resolving power of the unaided human eye by at least one order of magnitude.

This illustrates how the DCS will be compatible with future state-of-the-art advances, and continue to enhance scope performance.

DCS software makes calibration accurate and simple
In conjunction with a calibration signal port on the bottom rear of the DCS camera, you can calibrate both camera and scope from a known signal generated by the frame/store card. Via bar graphs on the PC screen, you adjust for trace intensity, trace width, ground reference, trace rotation and noise threshold (CCD sensitivity). Under software control, calibration parameters pertaining to voltage and time are established for the measurements you need to make.

Uses Tek C-30 Series camera swing-away bezel adaptors, for compatibility with most analog scopes
Adjustable magnification allows you to adapt the DCS camera for either 7.2 x 9.0 cm or 8.0 cm x 10.0 cm CRT formats.

A fast f/1.3 lens assures virtually distortion-free imaging
Specifically designed for the DCS, this spectrally coupled 7-element lens incorporates proprietary optics technology to achieve resolving power of 100 lines/mm at the center and 20 lines/mm at the edge, with a ±.31% distortion factor. Therefore, imaging without keystoning or other geometric distortion problems is possible. The 10 mm lens allows the rugged DCS camera to be compressed to a compact 22.86 cm (9 in) length.

Optically coupled CCD Video Camera uses 490 by 384 photosensitive elements to capture CRT waveform image
CCD technology maintains the quality image captured by the lens. There is no image blooming, lagging, "burning", or geometric distortion. Saturation recovery is immediate.

NTSC standard, RS-170 (video) Camera-to-PC image transmission
Within the PC, the signal is stored in video RAM on the DCS frame/store circuit board. The frame/store processes the video signal, stores two frames of video information, and reduces selected data to a 512-point waveform array. IBM AT acquisition rate to mass storage is 150–350 ms, depending on the waveform amplitude. Acquisition rate to the PC monitor is approximately 600 ms.

The circuit board also contains hardware for system calibration via internal signal generator, camera power, remote triggering, single-sweep reset and video monitor and hard copy interfaces. The board also supports real time direct-to-disk writing of event-triggered waveforms (calibrated or uncalibrated), processed waveform data, "raw video," and real time comparison and summing of video data. The board displays both direct-camera video and previously stored video frames.

DCS software provides a comprehensive, windowed, menu-driven toolset that is single-keystroke easy, yet handles a variety of measurement and analysis tasks
Complete on one floppy disk, the software is completely compatible with MS-DOS 2.1 or higher. Menu-driven functions get you up and running fast—starting you off with basics like acquisition settings, scope settings and system focus. You can also invoke commands for graphing and drawing waveforms, as well as windowing parametric functions such as rise time, fall time, and frequency area under the curve.

Included are tools for implementing the Save-On-Delta feature used to set comparative tolerances for capturing and analyzing transient waveforms, plus single sweep and/or auto-log, and self-diagnostics. Signals can be stored on hard or floppy disk and hard copies can be made quickly (about 21 seconds with a video copier).

Graphics routines for manipulating displayed waveforms include a zoom function for more precise viewing, and a text function for affixing on-screen titles to copied waveforms.

Future advanced applications libraries will support enhanced waveform acquisition and digitization routines and signal processing and display functions, including Fast Fourier Transforms. Device drivers for waveform analysis will include SPD™ and ASYST™.

Image Storage
The raw video image stored on the frame store board can be saved just as the digitized waveform is saved. The 512 x 512 x 8 raw video image can be transferred to a floppy or hard disk*1 or it can be saved on video tape.

The C1001 can be used by itself as a video camera
This system does not require an IBM PC or the frame store board, but it does require the use of a power supply. This is available with Option 04 which provides camera power and a video output from the camera. The video output can then be fed to a TV screen, video tape machine or one of the video copiers.

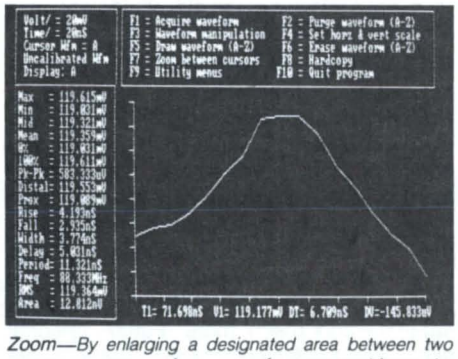
**1 The 1.2 Mb floppy is recommended for this application since a 360K disk may not have enough space.*

CHARACTERISTICS

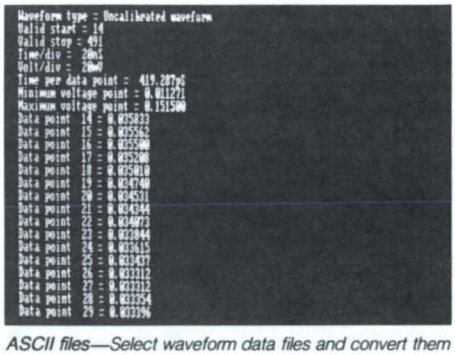
For characteristics see page 444.

ORDERING INFORMATION

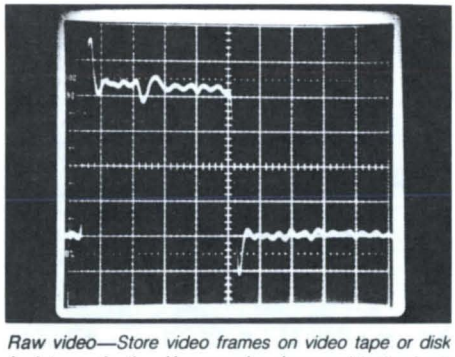
For Ordering Information see page 444.



Zoom—By enlarging a designated area between two cursors, you can analyze a waveform segment in greater detail. This is a zoom of part of the waveform shown on the bottom of page 353.



ASCII files—Select waveform data files and convert them to ASCII data files for printing, reviewing or transferring to other software programs.



Raw video—Store video frames on video tape or disk for later evaluation. You can also document test set-ups or written materials onto disks. One video image uses about 12K to 250K of a disk.

SYSTEM SUPPORT

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4041 System Controller

GPIB IEEE-488 The 4041 complies with IEEE Standard 488-1978 and with Tektronix *Standard Codes and Formats.*

Easy to Use Extended BASIC

512 Kbytes Memory Standard

Add-on ROM Enhances the 4041 in the Areas of Graphics and Signal Processing, Other Utilities are Also Available

Easy to Configure With any IEEE Standard 488 Instrument

Execute Only Mode for Program Security on the Production Floor

Detachable Keyboard (Option)

Modular Design—Rackmount or Portable

Flexible and Hard Disk Support With the 4041 Disk Drive Unit

The one common element that binds both large and small instrumentation systems together is the system controller. The system, or instrument controller, is in reality just a computer that has been designed to optimize the interaction and communication between the controller and a wide variety of programmable instruments and peripherals. This interaction is enhanced by instrument control commands in a high level programming language such as BASIC, eliminating the need for the user to understand the IEEE Standard 488 Interface protocol in detail. The user only needs to supply the instrument address and the function to be performed. The controller automatically takes care of the rest—interface handshaking, bus states and transitions, etc.

The Tektronix 4041 System Controller is a powerful and flexible IEEE Standard 488 (GPIB) Controller, designed to work with Tektronix and other GPIB instruments. The 4041 System Controller standard configuration has an Execute Only mode that enhances program security in a production environment. Interface, port, and ROM options increase the flexibility of the 4041. The standard 4041 is equipped with a GPIB interface port and an RS-232C serial interface port that is compatible with most terminals, including the full line of Tektronix graphics and alphanumeric terminals. The Extended BASIC Language, also included with the 4041, is easy to use while maintaining the required depth needed for complex programs.

4041 Hardware

The 4041's main processor is the powerful 16-bit 68000 with 512 Kbytes of standard memory. The versatile front panel of the 4041 is ideal for standalone applications. It includes a 20-character alphanumeric display, 18 key keyboard, DC-100 tape drive, and 20-character thermal printer. On the rear panel is the standard GPIB interface port and an RS-232C serial port.

Several options are available to increase the 4041's capabilities. Option 01 adds another RS-232C serial interface and a second GPIB interface port that can be configured for DMA transfers, allowing fast data transfers across the GPIB bus. Option 03 provides an interface to the 4041 Disk Drive Unit and a second RS-232C interface. The 4041DDU provides additional mass storage, operating efficiency and flexibility.

Optional ROM expands the existing Basic language by providing commands for creating graphics and processing digitized waveforms—capabilities ideal for signal processing systems.

Option 30 is required for program development. Its inclusion as a ROM pack makes it easy for a test engineer or system developer to convert an execute only 4041 into a development station for debugging, editing, or adding program statements, and then converting back to an execute only system for operation after the desired program changes have been made.

For extensive program development, the 4041 can be configured so that its RS-232C port is the console. This allows a separate terminal to be used for program development and execution. The 4041 has a complete line editor to allow insertion, deletion and movement in the line.

The mechanical package of the 4041 is ideal for integration into a system environment. Its small size and ability to be rackmounted allows for easy installation into a system. Combining a 4041 with a TM 5003, 7D20T, or 4041 Disk Drive Unit into a standard 19 inch wide rackmount package results in a compact system with powerful capabilities.

4041 BASIC

4041 BASIC is a powerful language, optimized for instrument control. It has easy-to-use high level GPIB commands in addition to low-level commands required for the most complex applications. English-like syntax and interpreted environment are combined to provide a friendly programming language. To improve self-documentation, the 4041 has the following features:

- Variable names up to eight characters
- FORTRAN-like subprogram calls
- Variable passing from main programs to subprograms
- Local and global variables

Other powerful features include optional data types (integer, short floating point and long floating point); a proceed mode which allows I/O and processing operations to run independently for maximum speed; logical unit number and stream specifications to define and characterize I/O-oriented tasks; and 512 Kbytes of directly addressed memory (without use of expensive overlays or paging techniques).

4041 ROM Packs

Option 10 incorporates the function of the ROM packs (4041R01, 4041R02, 4041R03, and 4041R04) internally, allowing the ROM tray to be used as a ROM program loader.

The 4041R01 Graphics ROM provides high-level commands to easily construct graphic images, symbols, charts and diagrams into system applications.

The 4041R02 Plotting ROM plots data, draws the axes and tic marks, and draws and scales graphs. Very little programming knowledge is required.

The 4041R03 Signal Processing ROM provides high-level commands for signal processing applications, including the following functions:

- Fast Fourier Transforms (FFT)
- Inverse Fourier Transforms (IFT)
- Integration
- Differentiation
- Correlation
- Convolution

Combine these capabilities with those of the graphics and plotting ROM and processing and displaying complex waveforms becomes easier and faster. Because the commands are in machine language, they run much faster than the equivalent Basic programs.

The 4041R04 adds even more capabilities to the 4041. It is a general purpose ROM with the following capabilities:

- One line error messages
- Timers
- Loading Soft ROMs
- Using a ROM as a read only storage device for fast program loading
- Listing ROM commands

CHARACTERISTICS

FRONT PANEL KEYBOARD

SYSTEM KEYS

AUTO-LOAD — Causes the internal magnetic tape to rewind and find the "AUTOLD" program. This program is then loaded into memory and execution begins.

ABORT — Halts program execution if no user-specified handler routine is called by the program. If a handler routine is specified for the ABORT key, program control is passed to that routine.

PROCEED — Performs one of the following functions depending on equipment or program state:

1. Causes program execution to start at the next program line if a Pause is encountered.
2. Resumes execution after an ABORT. If a program is loaded from the tape, execution starts from the first program line.
3. Delimits user input when requested from an Input statement.

CLEAR — Clears the alphanumeric display. Does not clear user-defined prompts or the input cursor from an INPUT statement.

EEX — Causes the number requested by an INPUT statement to be entered in scientific notation. Numbers entered after pressing the EEX (Enter Exponent) key are considered part of the exponent.

PAUSE — Halts the program after executing the current line. If the current program line is an INPUT statement, the program stops before the execution of INPUT.

USER-DEFINABLE FUNCTION KEYS

Numeric user-definable function keys, 0-9, can be assigned subroutines by the applications program. The keys can be redefined by the program during execution to allow for unlimited user routines. The function keys can be enabled or disabled under the control of a program.

Numeric values are assigned to these keys for entering information requested by an INPUT statement. When input has been completed, user functions assigned to these keys are re-enabled.

The other two keys on the front-panel keyboard are the decimal key (".") and the minus ("−") key. The decimal key is provided for decimal point entry associated with numeric and the minus key is used to enter negative numbers associated with numeric.

Keyboard overlays can be used for labeling the function keys with a number or an abbreviation of the user routines.

FRONT-PANEL DISPLAY

The front-panel display communicates test procedures and operator prompts, and displays intermediate or final program results. The display is fully programmable.

ALPHANUMERIC DISPLAY

Alphanumeric Line — Twenty characters.
LED — Sixteen segments.
Size — Height: 3.8 mm (0.15 in). Width: 2.8 mm (0.11 in).
Character Density — 1.6 characters/cm (4 characters/in).
Character Symbols — 64
Message Viewing Time — Programmable.
Scrolling Rate — Programmable.

SYSTEM INDICATORS

LEDs — Located on the display front panel indicate the status of the system.
BUSY — Indicates that a program is running. A blinking BUSY light indicates that the system has PAUSED (temporarily halted).
POWER — Indicates the machine is on.
I/O — Indicates that an Input/Output operation is being performed.
FUNCTION — Indicates that the user-definable function keys are enabled.

MAGNETIC TAPE DRIVE

Magnetic tape drive is used to store user's programs and data. The tape is the primary means of loading programs, particularly for execute-only applications; in addition, the tape drive provides for long-term unattended data logging.

File Structure — 48 named files (maximum).
Capacity (Physical Records) — 650 typical (600 minimum).
Physical Record — 256 bytes (typical tape capacity is 166,400 bytes).
Average Transfer Rate — 13,324 bits/s.
Search Speed — 1520 mm/s (60 in/s).
Tape Rewind — 1520 mm/s (60 in/s).
Tape Cartridge — 100A Certified Data Cartridge from Tektronix (equivalent to Scotch DC-100A).

PRINTER

The printer produces hard copies of the intermediate or final program results, operator prompts, and changes in variables or system status. Messages longer than 20 characters are printed on succeeding lines where the user can specify the appropriate indentation for better delineation and readability.

Printing Method — Thermal, fixed head.
Capacity — 20-character alphanumeric line.
Font — 5 x 7 dot matrix printhead.
Character Size — 2.5 mm high x 1.8 mm wide (0.10 in high x 0.07 in wide).
Line Spacing — 4.23 mm (6 lines/in).
Printing Speed — 2.0 lines/s.
Feed Speed — 8.46 mm/s (0.34 in/s).
Character Set —
26 Uppercase letters
26 Lowercase letters
10 Numeric digits
34 Special characters
32 Control characters
128 Total
Paper Size — 60 mm x 25 m (2.36 in x 82 ft).

CONTROLLING THE BUS

When using BASIC high level print and input commands, the 4041 automatically controls all bus management signals in the proper sequence for the desired interface task and instrument interaction. A bus management function program uses direct IEEE Standard 488 mnemonic commands to accommodate differences in implementation of GPIB on other equipment. Virtually all legal bus states can be programmed this way, which affords a high degree of flexibility for addressing various system applications.

BUS INTERRUPTS

The 4041 has the ability to detect and respond to various types of interrupt conditions that can be generated on the GPIB. User-specified software handlers can be written to perform various tasks when these conditions occur. Interrupts can be programmably enabled or disabled.

Interrupt Conditions

Mnemonic	Message
SRQ	Service Request
EOI	End or Identify
IFC	Interface Clear
DCL	Device Clear
TCT	Take Control
MTA	My Talk Address
MLA	My Listen Address

BUS COMMUNICATION

Interface and bus device addressing are programmable. This allows the user to direct message and data flow to and/or from the appropriate interface and GPIB peripheral. Information such as primary and secondary addressing, along with pertinent device-dependent information, can be attached to a specific Logical Unit number. Subsequent communication with that GPIB device can be directed to the Logical Unit, eliminating the need for redundant or repetitious statement programming.

TRANSFER RATES (IEEE STANDARD 488)

Transfer Rates for the Standard Interface

	Input	Output
Normal Mode	Exceeds 5 Kbytes/s	Exceeds 5 Kbytes/s
Fast Mode	Exceeds 16.5 Kbytes/s	Exceeds 19.5 Kbytes/s

SERIAL INTERFACE

The 4041 comes with a standard serial asynchronous RS-232C interface. The 4041 can support applications requiring terminals, modem/host communication, or instrumentation with this interface protocol.

In addition to standard transmission rates from 75 to 9600 baud, transmission rates are programmable to any integer ranging from 2 to 9600 baud.

Full Duplex — Full capability (half duplex not supported).
Transmit/Receive — Matched rate only.
Bits Per Character — 5, 6, 7, or 8 bits.
Stop Bits — 1 or 2.
Parity — Even, Odd, High, Low, None.

ERRORS AND INTERRUPTS

Conditions such as parity, framing and overrun errors can all be programmably captured. User routines or handlers can then direct what action should be taken, depending on the particular condition.

The end of message delimiter (EOM) can be programmed to any one or two character ASCII string. This enables the 4041 to communicate with most hosts or peripherals via the serial interface.

CLOCK/TIMER

One clock provides date and time of day which is programmably set. The timer clock returns the time in seconds since power up. The timer has 10 millisecond resolution.

SELF-TEST

An integral part of the 4041 is the self-test feature, which assures the user of reliable operation. Self-test is executed automatically on power-up and performs extensive hardware and operating system tests.

DYNAMIC RANGE

Short Floating Point — Maximum ±3.40282 E+38; Minimum ±2.93874 E−39.

Long Floating Point — Maximum ±1.7976931348623 E+308; Minimum ±5.562684646269 E−309.

Integer — −32768 to +32767.

Character String Length (Maximum) — 32767.

Array Elements (Real, Integer or Character Arrays) — 32767 elements maximum per row (or column); limited by total memory installed.

POWER REQUIREMENTS

Line Voltage — 100 V ac to 120 V ac, 200 V ac to 240 V ac ±10%.

Line Frequency — 48 Hz to 66 Hz.

Power Consumption — 120 W (maximum).

ENVIRONMENTAL

Operating Temperature — Without Data Cartridge or Printer Paper: 0°C to +55°C (+32°F to +131°F). With Data Cartridge or Printer Paper: 0°C to +45°C (+32°F to +113°F).

Storage Temperature — Without Data Cartridge or Printer Paper: −40°C to +75°C (−40°F to +167°F).

Humidity — Relative noncondensing 0°C to +45°C (+32°F to +113°F) −20% to 80% condensing.

Altitude — Operating: 4600 m (15,000 ft). Nonoperating: 15 000 m (50,000 ft).

EMC — Meets FCC Part 15, Subpart J, Class A and VDE 0871 Class B.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	213	8.5
Height	180	7.2
Depth	520	20.8
Weight≈	**kg**	**lb**
Net	7.8	17.3
Net (with options)	8.7	19.3

See ordering information at right.

4041DDU Disk Drive Unit

Contains Hard Disk/Flexible Disk Drive

10.6 Mbyte Hard Disk Formatted Capacity

5¼ Inch, High Capacity Flexible Disk Drive

320 Kbyte Flexible Disk Formatted Capacity

Interface Directly to 4041 With Option 03

Benchtop, Rackmount or Stack With 4041

The 4041DDU (Disk Drive Unit) package includes a 10.6 Mbyte hard disk drive and a 320 Kbyte flexible disk drive that can be optionally rackmounted. The 4041DDU provides additional mass storage, operating efficiency, and flexibility for the 4041 System Controller equipped with Option 03 disk interface.

The 4041DDU provides local access to high volume mass storage that adds capacity for a large number of applications programs and a high degree of program flexibility. The high capacity Winchester hard disk lowers the cost per Mbyte and provides the level of local data storage and fast access time that interactive graphics, waveform processing and instrumentation systems require. The maximum number of directory entries defaults to 256 and can be expanded to over 1,000 entries. Sealed drive heads provide improved reliability, environmental protection and reduced maintenance.

The 4041DDU can be used in conjunction with the 4041's DC100 tape drive, or can operate as the primary mass storage device for your instrument system controller. The flexible disk media is the standard 48 tracks per inch, double sided, and double density diskette. The 4041DDU is enclosed in a cabinet and contains two disk drives, a power supply, controller card, and interface hardware.

CHARACTERISTICS

Capacity — Hard Disk: Formatted 10.6 Mbytes. Flexible Disk: Formatted 320 Kbytes including directories.

Recording Format — 512 bytes/sector.

Tracks — (Flexible Disk only) 40 tracks per side, double-sided, 48 tracks per inch.

Track Density — Hard Disk: 17 sectors per track. Flexible Disk: 8 sectors per track.

Interfacing — Interfaces directly to the 4041 with Option 03 (disk interface and RS-232C) installed.

POWER REQUIREMENTS

Line Voltage Ranges — 90 V ac to 132 V ac at 2 A. 180 V ac to 264 V ac at 1 A.

Line Frequency — 47 Hz to 63 Hz.

Maximum Power Consumption — 140 W, 510 BTU/hour.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	214.3	8.4
Height	195.3	7.7
Depth	539.8	21.3
Weight≈	**kg**	**lb**
Net	8.2	20.0

ORDERING INFORMATION

4041 System Controller **$4,950**

Includes: Power cord (161-0066-00); blank overlays for FP keyboard (334-4074-00); system verification tape (062-5828-03); blank DC-100 Tape Cartridge (119-1350-00); RS-232C male loopback connector (013-0198-00); roll of printer paper (006-3557-00); Controller (GPIB) Programming Guide (070-3917-00); operator manual (070-3917-01).

OPTIONS

Option 01 — Second GPIB and RS-232C ports. **+$1,200**

Option 02 — TTL Interface (8-bit Parallel Interface). **+$800**

Option 03 — Disk Interface and RS-232C port. **+$1,000**

Option 10 — Combination of 4041R01 through 4041R04 ROMs. **+$1,500**

Option 30 — Program Development ROMs and ROM Carrier. **+$995**

Option 31 — Program Development Keyboard. **+$550**

4041DDU Disk Drive Unit **$2,995**

Includes: Power cable (161-0066-00); disk interface cable (012-1117-00); DDU checkout DC100 tape (062-8554-00); 5¼ flexible diskette (119-1870-00); instruction manual.

CONVERSION KITS

Cabinet-to-Rackmount — (4041) Equipped with slide-out assembly to rackmount a 4041 to the left of a TM 5003. Order 040-0984-01 **$215**

Cabinet-to-Rackmount — (4041) Equipped with slide-out assembly to rackmount a 4041 to the right of a 7D20T. Order 016-0827-01 **$395**

Cabinet-to-Rackmount — (4041) Slide-out assembly to rackmount a 4041DDU. Order 016-0806-00 **$410**

Cabinet-to-Rackmount — (4041DDU) Slide-out assembly to rackmount a 4041 to the right of a 4041DDU. Order 016-0827-01 **$395**

4041 ROM PACKS

4041R01 — Graphics ROM Pack. **$495**

4041R02 — Plotting ROM Pack. **$495**

4041R03 — Signal Processing ROM Pack. **$795**

4041R04 — Utility ROM Pack. **$295**

Accessory Package Kit — For use with 4041R04's PROM file system. Order 020-0102-00 **$205**

EPROM Kit — For 4041R04. Order 020-0101-00 **$75**

INTERNATIONAL POWER PLUG OPTIONS

Option A1 — Universal Euro 220 V, 50 Hz.

Option A2 — UK 240 V, 50 Hz.

Option A3 — Australian 240 V, 50 Hz.

Option A4 — North American 240 V, 60 Hz.

Option A5 — Switzerland 220 V, 50 Hz.

4041 FIELD INSTALLED MODIFICATIONS

4041F01 — Same as Option 01 **$1,400**

4041F02 — Same as Option 02 **$1,000**

4041F03 — Same as Option 03 **$1,200**

4041F30 — Same as Option 30 **$995**

4041F31 — Same as Option 31 **$550**

Note: Contact your local Tektronix Sales Engineer before ordering field memory additions.

OPTIONAL ACCESSORIES

Blank ROM Carrier — (4041) Order 013-0215-00 **$230**

Diskettes — (4041DDU) Package of ten. Order 119-1583-01 **$36**

TRAINING

Operation and application training workshops applicable to this product are available to the purchaser at 50% off the normal fee, for one seat only for each product purchased. Certain other restrictions apply. Workshop content information is on pages 195-196. For further information, or to enroll, call us at 1-800-225-7802. For international orders, contact your nearest Sales Office.

TEK EZ-TEST

Generate Complex Test Programs Without Programming Skills

Multilevel Menus Guide You Through Test Development Procedures

Color Graphics Plotting of Test and Waveform Data

Translates Generated Procedures into an Easily Modified BASIC Program

TEK EZ-TEST is a Tektronix 4041 software package designed to help users without computer programming skills quickly and easily produce automated test and measurement programs. The 4041 "learns" the test procedure as it is manually implemented through front panel instrument control. The software queries the instruments involved for their settings, then includes these settings in the program for recall and use during execution. TEK EZ-TEST also checks for instrument command errors as the procedure is being developed, and keeps incorrect settings from being entered.

TEK EZ-TEST software comprises two programs: a GENERATOR and a TRANSLATOR. The GENERATOR produces the test procedures, using programmable test instruments physically attached to the IEEE Standard 488 Bus (GPIB). Once a procedure has been entered into the computer, it can be run and data results obtained. The procedure can be stored on tape (or disk) as a data base and retrieved later for re-execution or modification by the GENERATOR.

All interaction with the system when using the GENERATOR is through menus. This simplifies procedure generation and execution. Software development time and cost are reduced, since there are no complicated codes or key words to learn. Most menus include a HELP key to provide instructions on the use of the various keys and functions.

The TRANSLATOR program is used to convert the GENERATOR-created procedure into an executable 4041 BASIC program. This standalone program will execute faster, is more efficient and more modifiable, and requires less 4041 memory than the procedure from which it was translated.

Translated programs provide the flexibility required by most users who need to implement special functions not provided by the GENERATOR, such as special math functions to operate on acquired data, or acquiring waveforms and operating on them via utilities from the Tektronix Instrumentation Software Library.

Instrument Support

TEK EZ-TEST supports a wide variety of IEEE Standard 488 programmable test and measurement instruments from Tektronix. This includes full support for all TM 5000 modular instruments, and limited support for: 2400 Series portable scopes; 7D20/7D20T, 7854, 7612D, 7912AD, and 390AD digitizing scopes; 490P Series spectrum analyzers; and DAS 9100 Series logic analyzers. Most non-Tektronix, IEEE 488 compatible instruments that use ASCII coded commands and LF/EOI message termination are also supported. When the 4041's Option 01 second GPIB port is installed, up to 28 instruments can be supported.

Required Hardware

4041 System Controller with Version 2.1 Firmware, 512 Kbytes Memory, Program Development ROMs (Option 30); Tek 4105A (or equivalent) Terminal (RS-232C) or ANSI 3.64 Compatible Terminal.

Optional Hardware

4041 Option 01 (Dual IEEE Standard 488 and RS-232C Ports); 4041 Option 10 (RØ1, RØ2, RØ3, and RØ4, ROM); 4696 Color Ink-Jet Printer.

ORDERING INFORMATION

TEK EZ-TEST 4205 Terminal Software. Order S45F010 Option 04 **$500**

TEK EZ-TEST ANSI 3.64 Standard Terminal Software. Order S45F020 Option 04 **$500**

NEW GURU II

Store/Recall Waveforms

Calculate Waveform Parameters

Library of Commonly Used Subroutines

Graphics Capability

Flexible Peripheral Handling

Tutorial Manual

Instructional GPIB Programming Examples

Tektronix GURU II (GPIB User's Resource Utility) is a low cost hardware/software package for instrument control, waveform acquisition, and display. GURU II supplies the important communication link between an IBM PC (or compatible) and GPIB instrumentation.

The GURU II software is written in IBM's Advanced BASIC (Microsoft's BASICA language), thus providing maximum flexibility to customize for a specific application. GURU II saves data to disk in a format compatible with many popular programs (e.g., LOTUS 1-2-3).

The software includes a TEST PROCEDURE GENERATOR (TPG), a useful tool for users who want fast results but do not want to learn to program their own test software. The TPG is a self-explanatory menu-driven program.

GURU II also includes a waveform acquisition and pulse analysis program that supports many popular Tek digitizers. This program allows waveform segmenting, graphics, and storage. The pulse parameters include rise time, fall time, pulse width, max and min voltages, and others.

Library of Commonly Used Subroutines

This library contains subroutines to do low level communications with GPIB devices, store/recall waveforms on a floppy disk, calculate waveform parameters, and graph the waveform on the terminal. The subroutines are written in assembly language to facilitate maximum performance when sending or receiving commands or data. Waveform acquisition performance is further enhanced by the DMA transfer of waveforms to the controller's memory.

Tutorial Manual

The User's Manual is a valuable GPIB reference. It includes many GPIB program examples, which are useful when interfacing to various types of new GPIB instrumentation.

Required Hardware

GURU runs on an IBM PC, PC XT, Portable PC, PC AT, or compatible. Minimum requirements: 128K memory, 1 DSDD floppy disk drive, and a parallel or serial printer port.

GURU also requires one of the following graphics display card combinations:

1. IBM Color/Graphics Adaptor (or compatible card) and the IBM Color Display, Model 5153 (or equivalent, such as the Princeton Graphics system HX-12), or a composite video monitor (color or monochrome).
2. Hercules Graphics Card (or equivalent), and IBM Monochrome Display Model 5151 (or equivalent, such as the Amdek 310/310A). For the Hercules Graphics card, the GRAPH X utility from Hercules Computer Technology is required to obtain printer copies of screen graphics.

Optional Hardware

Multifunction card with clock/calendar, serial/parallel ports, and up to 384 Kbytes of RAM, such as the AST SixPak Plus or the QUADRAM Quadboard; or I/O and clock/calendar card such as the AST I/O Plus II with serial/parallel ports and clock/calendar functions.

Additional Hardware Requirements

If the 062-8369-00 GURU II Software and Documentation only package is ordered (see below), one of the following National Instruments interfaces is needed: GPIB-PC, GPIB-PC2, GPIB-PC2A, or IBM PC GPIB adaptor.

Required Software

IBM PC DOS 2.0/2.1/3.0 or higher with Advanced BASIC (BASICA), or MS-DOS 2.0x/2.1x or higher with BASICA.

Printers Supported

IBM Graphics Printer or equivalent (e.g., Epson RX/FX family, Toshiba P1340/P1350 Series); for Toshiba P1340/P1350, the Paper Screen utility from MAP Systems, Inc. is needed to get printer copies of screen graphics.

ORDERING INFORMATION

S45G100 GURU II Package **$850**
Includes: Software/manual (062-8943-00); National Instruments PC2A board; cable.

S45G110 Upgrade Kit **$650**
For users with existing PC2A board and cable.
Includes: Software/manual (062-8943-00).

020-1459-00 Upgrade Kit **$250**
For users with existing PC2 board and cable.
Includes: Software/manual (062-8943-00); user's manual (070-6242-00).

TEKTRONIX INSTRUMENTATION SOFTWARE LIBRARY

The Tektronix Instrumentation Software Library provides software and application information to aid in the planning, design, and implementation of measurement solutions using programmable measurement instruments and systems. Currently it contains three types of software—and more are planned.

Measurement Software
Provides solutions to measurement problems using programmable measurement instruments or systems. Measurement Software is user-friendly and ready to run, requiring minimal software integration or modification. Measurement Software is provided only on media.*1

Instrument Utility Software
This is a set of subroutines and subprograms that perform common instrument functions. A single instrument/controller combination is addressed by each subroutine or subprogram. Instrument Utility Software is well documented and presented in a consistent format so it can be easily modified and integrated into application programs that you develop. Instrument Utility Software is provided only on media.*1

User-Exchange Software
Developed by users to perform specific measurements or functions with programmable measurement instruments or systems. User-Exchange Software is available either on media*1 or as listings at no charge.

The Tektronix Instrumentation Software Library Catalog
Contains abstracts and ordering information for available software. For a copy of the latest catalog, ask your Tektronix Sales Representative for Tektronix Literature 45-W-5570-1.

*1 *Contact your local Tektronix Sales Representative for complete ordering information and prices.*

INTERFACING AND OPERATING SUPPORT

Tektronix provides documentation to help build and use your measurement system. Whether it's interfacing, programming, operation, or maintenance, you'll find what you need in documentation from Tektronix.

Instrument Interfacing Guides
These serve as a system integration guide by aiding in instrument configuration, connection, and operation with a controller. Specific information on the GPIB operation of the instrument along with programming examples are provided. Designed to supplement the operator's manual, they are supplied free of charge with the instrument.

Controller Programming Guides
Supplying an additional aid to GPIB system integration, these programming guides provide specific information and guidelines on a controller's GPIB operating capabilities, as well as suggestions for getting the best performance from your instrument/controller combination. Sample programs are used to demonstrate various aspects of GPIB operation and to show the processing power of the controller.

Operator's and Service Manuals
A standard accessory with each Tektronix instrument and system, these documents provide complete and comprehensive information so you can operate and service your Tektronix measurement system.

PROGRAMMABLE INSTRUMENTS NEWSLETTER

HANDSHAKE
This applications newsletter is for signal processing and programmable instrument control. Published quarterly, it contains technical articles on measurement processes, techniques, and instruments. Subscriptions to *HANDSHAKE* are free upon request from your Tektronix Sales Representative.

ONGOING SUPPORT

Tek's system support doesn't stop when you receive your programmable measurement instrument or system. Our support continues throughout its lifetime through training, application assistance, software support, and service.

Training
To help operators better understand their equipment and get the most out of their systems, training is available both at the home office and at selected sites around the world. In addition, in-depth service training is available for those companies who want to learn to service their own Tek equipment.

Application Assistance
To help solve unique measurement problems our applications assistance is as near as your telephone. If your measurement needs are not answered by our standard software and documentation, Tektronix applications assistance is available in many areas of the U.S. and around the world to help design a solution just to fit your need.

Software Support
To keep your software current and up-to-date, our software support is available at no charge during the warranty period. Post-warranty software support is available on a subscription basis.

Service
For your programmable measurement instrument or system, service is available from Tektronix Service Centers at strategic locations throughout the world. You'll always receive expert assistance from some of the most highly trained and qualified personnel in the world.

For more information on any of the support available for Tektronix programmable measurement instruments or systems, contact your local Tektronix Sales Representative for details.

SIGNAL ROUTING/ DUT INTERFACING PRODUCTS

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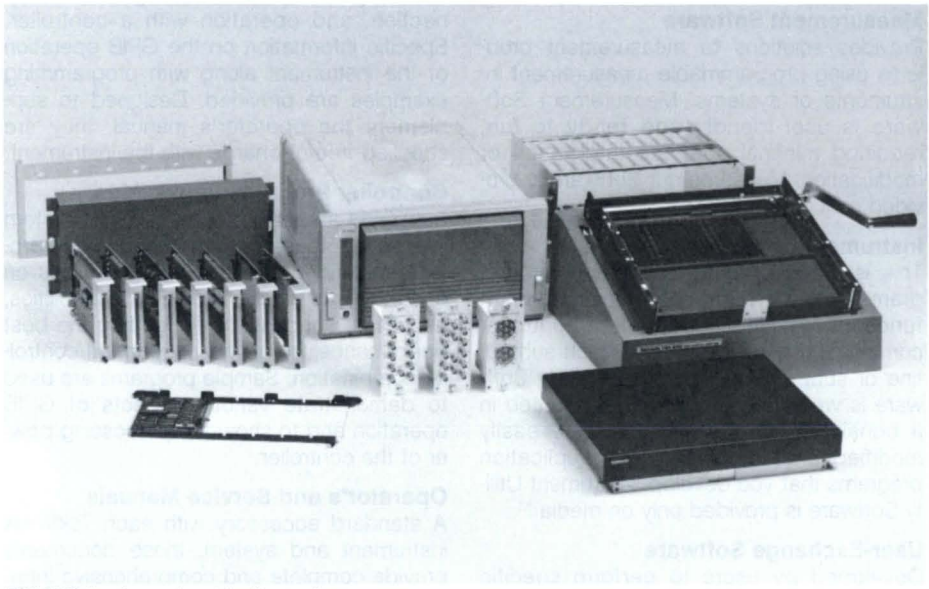
COMPLETE SIGNAL SWITCHING/DUT INTERFACING SOLUTIONS IN A SINGLE PACKAGE

The Test System Interface (TSI) family of off-the-shelf components can be easily and affordably configured to fit a majority of signal switching and DUT interfacing needs. The TSI 8150 Test System Interface is *the* complete price/performance solution for your needs.

Systems can range in complexity from a mainframe and a single switching assembly, to DUT interfacing adapters and multiple card/module switching configurations for up to 900 channels. DUT physical interfacing is accomplished with the Test System Adapter (TSA). Cards and modules are available for switching signals ranging from microvolts to 400 volts, from microamps to 10 amps, and from dc to 18 GHz.

Rackmounting is a standard feature as well as IEEE-488 bus operation. Along with this you get conformity with Tek *Codes and Formats*, Tektronix' high quality documentation and after-sales support, and a commitment to quality.



TSA 8150 (center rear) and family members.

SYSTEM CONTROL/SIGNAL ROUTING IN A TM 5000 PACKAGE

A wide range of system control and signal routing capabilities are available in the popular TM 5000 line of fully programmable instruments. The MI 5010 Multifunction Interface and MX 5010 Multifunction Interface Extender can provide functions such as: D/A and A/D converters, 32 channel digital I/O, 16 channel relay scanner, 10 channel low level scanner (with a choice of signal conditioning modules), 16K memory and a user-configurable development card. The MI 5010 and MX 5010 are also part of the MP 2901 Inspection Test Station package (see the Measurement Packages Section).

The SI 5010, another instrument from the TM 5000 line, offers fully programmable, 50 Ω scanning of high frequency signals (to 350 MHz for four channels). The SI 5010 also has built-in intelligence that can free your GPIB controller for activities elsewhere on the bus. The MI 5010/MX 5010 and SI 5010 are UL Listed, as are all TM 5000 instruments.

For economical multiplexing of signals up to 250 MHz in a standalone package, the 1360P/1360S is the answer. This microprocessor-controlled combination can be operated locally or controlled over the GPIB, and offers a variety of switch configurations.

Tektronix offers the complete solution for your physical DUT interfacing/signal switching/multiplexing requirements.

NEW TSI 8150

GPIB IEEE-488

The TSI 8150 complies with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats.*

Complete Line of Scanner Cards and Modules

Complete Line of Accessories for Switch Mounting and DUT Interfacing Requirements

Flexible Mechanical Architecture Permits Signal Access From Front, Rear, or Both

Low Noise Linear Power Supply and Remote Switching (at the DUT) for Signal Integrity

Intelligent Mainframe and Control Assemblies Free System Controller for Other Tasks

Real Time Sequencing Maximizes Throughput

In applications where DUTs span a wide range of bandwidth, power, signal routing, and physical interfacing requirements, most test interfaces have had to be custom designed and built. In addition to being time-consuming and expensive, these custom fabrications were difficult and costly to maintain, and documentation was a problem.

Now, Tektronix offers the solution! The TSI 8150 family of off-the-shelf components can be easily and affordably configured to fit a majority of signal switching and DUT interfacing needs. And the documentation is clear and comprehensive, a Tektronix tradition.

Whatever your signal routing needs, the TSI 8150 has the answer: digital or analog; front or rear signal access (or both); remote switching; signal levels from microvolts to 400 volts; currents from microamps to 10 amps; and frequency ranges to 18 GHz (with less than 0.5 dB insertion loss and VSWR better than 1.5:1). Two custom driver cards are available for routing specialty signals or controlling devices such as actuators, solenoids, stepper motors, and robotics.

Physical interface to the DUT is provided by the TSA 8140 Test System Adaptor. The TSA can be mounted horizontally, vertically, or in a system rack with optional rack slides. An extensive offering of interchangeable test adaptors lets you test a wide variety of device types, such as hybrids, circuit boards, and components. Test adaptors can be easily modified to accept various Zero Insertion Force (ZIF) sockets and adaptors. An optional Test Head Receiver (021-0435-00) is Virginia Panel Corporation Series 3200 compatible, which opens the door to a large selection of vacuum bed-of-nails test adaptors for circuit board testing.

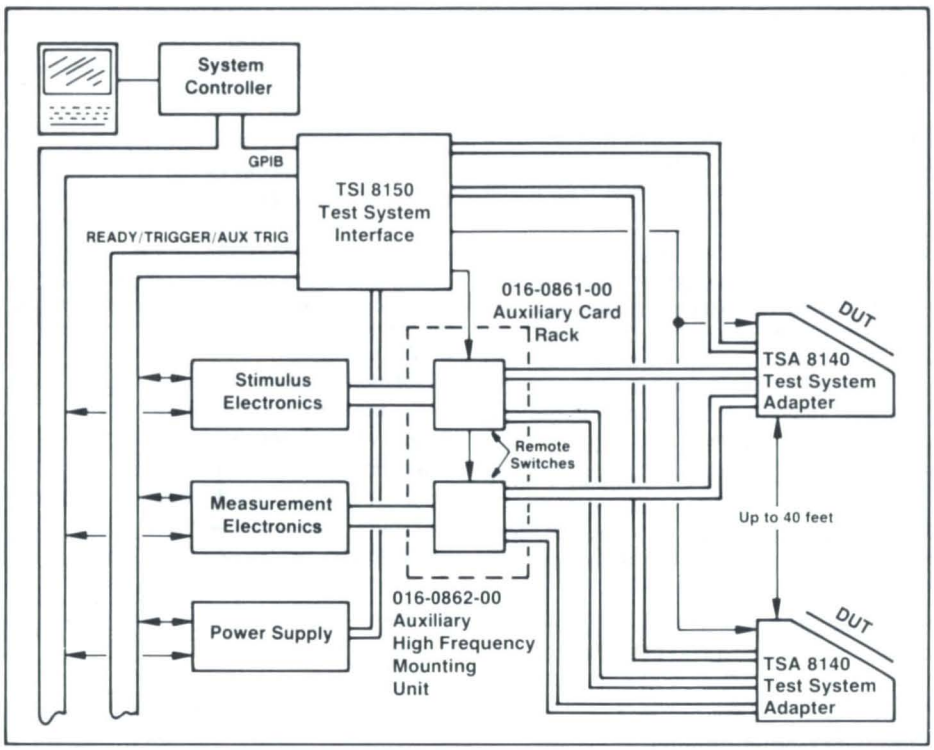
Scanner cards and modules can be mounted in the mainframe, in the auxiliary mounting units, or in the test system adaptor, up to 40 feet away from the mainframe. Mounting the assemblies in the test system adaptor puts the switching as close to the DUT as possible, helping the TSI 8150 to ensure signal integrity. Numerous other techniques are used to make sure your signals stay clean, such as individually shielded function cards, and a low noise linear power supply.

Each scanner card, or each two identical scanner modules, has a dedicated control card that provides real time control for up to 32 switches in any closure pattern, with storage of up to 500 test sequences. Add programmable make-before-break (MBB) or break-before-make (BBM) for each switch, and you have unparalleled control over your switches.

Expandability is another of the TSI 8150's strong points. With a maximum configuration, utilizing an optional second main interface in the mainframe, an expansion chassis, and 016-0861-00 Auxiliary Card Racks or 016-0862-00 Auxiliary Mounting Units, up to 900 channels can be scanned.

The Basic Building Block

The TSI 8150 Test System Interface mainframe is the basic building block of the Tektronix TSI 8150 Test System Interface family. It is an intelligent and flexible interface mainframe that provides power, control, timing, and housing for TSI 8150 family scanner cards and modules.



A wide variety of scanner cards and modules are available: low frequency cards; low and high voltage cards; power switches; and microwave switches. (Refer to the individual card and module specifications and ordering information sheets.)

The TSI 8150 family mechanical architecture provides flexible front or rear access to installed cards and modules.

With the TSI 8150 family, one test set-up can combine total physical interfacing with the complete switching solution offered by the TSI 8150 line of scanner cards and modules. The result is a test system interface qualified for many automated test applications.

Test engineers will benefit from the flexibility and versatility of the TSI 8150 mainframe and other family members. The TSI 8150 family is especially well suited for complex test requirements and for applications requiring periodic test set-up changes. Examples of these applications include testing of components, hybrids, circuit board, subassemblies, and complete products.

In some test systems, the controllers don't lend themselves to real time operation. For these systems, combining TSI 8150 mainframe local intelligence with its timing capability produces a powerful team. The TSI 8150 mainframe's handling of switch sequencing and timing frees the controller for other tasks.

The TSI 8150 mainframe provides scanner timing and control information through the TSS40 Scanner Control Assembly. This plug-in assembly controls TSI family scanner cards and modules.

Real Time Execution, Higher Throughput

The TSI 8150 mainframe receives instructions from the system controller over the GPIB, storing up to 500 test steps on each TSS40 Scanner Control Assembly. Each TSS40, in turn, passes the instructions to the scanners (one card or up to two modules of the same type) that it controls. The system can then use external triggers, internal triggers, or a single command, to increment each test sequence step. Using stored settings and either a trigger or a single bus command, a test system can change the state of hundreds of switches at the same time.

TSI 8150 family control commands conform to the simple, English-like Tektronix *Standard Codes and Formats* guidelines. These commands are easy to remember and use. Each command performs a function, such as opening or closing a specific switch, opening or closing a combination of switches, or opening all switches. For example:

- The command **0CLOSE.F2 A3 . . A6** closes switches A3, A4, A5, and A6 on the second front scanner and opens all other contacts.

- The command **OPENALL** opens all switches—a useful software panic button. It can also serve as a "warm reset" without clearing sequence buffers.

Two independent programmable timers provide flexible control for sequencing and delay generation, thus offloading these tasks from the system controller.

The TSI 8150 also includes a 24-bit up/down totalizer. The timers and the totalizer can be tied to an extensive trigger system. This connection provides flexible real time control of scanners. Unlike other scanning systems which have only one trigger, the TSI 8150 mainframe contains 10 general purpose and three dedicated trigger lines.

Test system engineers can program individual relays for Make-Before-Break or Break-Before-Make operation. The two capabilities can be mixed on the same card or module.

Signal integrity is maintained by features such as remote mounting of scanners to reduce noise induced in long cable lengths, and a low noise linear power supply.

Variety of Configurations

With suitable options, the TSI 8150 mainframe can simplify test system configuration by providing connections to the scanners from the front of the mainframe, the rear, or both.

In its standard configuration, the TSI 8150 mainframe holds up to six cards or seven modules or a combination of cards/modules. Scanner cards and modules are accessible from the rear of the unit. By repositioning the interface board, the user can make the cards and modules accessible from the front. Using an optional second interface board, the user can access some cards and modules from the front and rear. A cableway allows convenient routing of cables between the front and rear of the test system.

Remote mounting is available for a variety of configurations. To maximize signal integrity, the user can place scanner modules in the TSA 8140 Test System Adaptor or in Auxiliary Mounting Units (AMU), close to the DUT itself. The user can also rackmount scanner and switch cards in the 016-0861-00 Auxiliary Card Rack and modules in the 016-0862-00 Auxiliary High Frequency Mounting Unit. These units can be placed anywhere in the test system up to 12 meters (40 feet) from the TSS40 Scanner Control Assemblies.

CHARACTERISTICS

TOTALIZER

General — Programmable gate, preload, reset, and source select. Can send SRQ on underflow/overflow.

Maximum Count — 16,777,215 (24 bits).

Minimum Pulse Width — 250 ns.

Maximum Repetition Rate — 1 kHz.

TIMER

General — Two independent pulse generators, source and destinations are trigger lines; programmable source, destination, period, width, delay, burst pulse count, and gate; can generate an SRQ at end of last pulse count.

Resolution — 10 ms.

Delay Accuracy — 0.01% +10, −0 ms.

Period, Width Accuracy — 0.01% +100, −0 μs.

Minimum Period — 20 ms.

Maximum Delay, Period, Width — 655.35 s.

Maximum Burst Count — 66535 or continuous.

Input/Output — TTL compatible.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	483	19.0
Height	237	10.4
Depth	641	25.3
Weight≈	**kg**	**lb**
Net	23.9	52.5
Shipping	35.4	78.0

POWER REQUIREMENTS

Line Voltage Ranges — 100 V, 110 V, 120 V, 200 V, 220 V, or 240 V ±10%.

Line Frequency — 48 Hz to 66 Hz.

Maximum Power Consumption — 525 W (567 VA).

ENVIRONMENTAL

Ambient Temperature — Operating: 0°C to +50°C. Nonoperating: −40°C to +75°C.

For ordering information, see page 367.

NEW TSA 8140

Test System Adaptor

Configurable Top Panel for Dedicated Applications

Optional Test Head Receiver, Allowing Easy Interfacing to a Wide Range of Devices Under Test

Interchangeable Test Adaptors Provide for Custom Interfacing (Hybrids, Components, etc.) plus Commercially Available Bed-of-Nails Test Heads

Accepts the Entire TSI 8150 Family of Scanners, to Maintain Signal Integrity by Minimizing Cable Lengths

Rugged Steel Construction for Low Frequency Noise Shielding

Complete Link to Your DUT

The TSA 8140 Test System Adaptor provides system builders with the basic building blocks for designing the direct link between the device under test (DUT) and the test system.

One-of-a-kind DUT interface designs are often expensive to build, inadequately documented, and difficult to service. When the original system builders change jobs, they take their design concepts with them. Another problem is that one-of-a-kind designs are difficult (or impossible) to adapt to changing test system needs.

Using the TSA 8140's commercially available test heads cuts DUT adaptor development time and materials costs.

The TSA 8140 ensures excellent signal integrity by allowing system builders to place switching and custom signal conditioning circuits very near the DUT. Steel construction shields tests circuits from low frequency magnetic fields.

The removable top panel allows system builders to configure the TSA 8140 for a dedicated application.

The TSA 8140 can be mounted horizontally or vertically. In either configuration, rack slide rails can be added.

A Member of the TSI Family

The TSA 8140 is a fully compatible member of the Tektronix test system inteface family. The TSA 8140 accepts the same series of scanner cards and modules that can be mounted in the TSI 8150 Test System Interface mainframe. The modules mounted in the TSA 8140 are controlled by TSS40 Scanner Control Assemblies in the TSI 8150 mainframe.

For test configuration changes, an optional test head receiver can be added to make the TSA 8140 compatible with Interchangeable Test Adaptors (ITA). This receiver is also compatible with Virginia Panel Corporation's 3200 Series bed-of-nails test heads.

Optional test head adaptors and a rackmounting kit are also available.

PHYSICAL CHARACTERISTICS

	TSA 8140	
Dimensions	**mm**	**in**
Width		
Total	558	22.0
Usable Area	482	19.0
Height		
Front	115	4.5
Back	222	8.8
Depth	470	18.5
Weight≈	**kg**	**lb**
Net	11.8	26.0
Shipping	14.0	31.0

PHYSICAL CHARACTERISTICS

	Test Head Receiver		Full Size Interchangeable Test Adaptor		Half Size Interchangeable Test Adaptor	
Dimensions	**mm**	**in**	**mm*1**	**in**	**mm*1**	**in**
Width	597	23.5	450	17.7	450	17.7
Height	110	4.8	376	14.8	182	7.2
Depth	419	16.5	46*2	1.8	46*2	1.8

**1 Usable area, top panel.*
**2 Inside depth.*

For ordering information, see page 367.

NEW

Auxiliary Card Rack
Auxiliary High Frequency Mounting Unit

Fit Into Standard 19 Inch Racks for Convenient Placement

Accept Up to 12 Scanner Cards (Card Racks) or 6 Scanner Modules (HF Mounting Units)

Can be Mounted in a Vertically or Horizontally Configured TSA 8140 Test System Adaptor for Greater Flexibility

Remote Location

In large ATE systems, system builders must sometimes distribute switching functions: some switches near the DUT, some near the stimulus instruments, and some near the measurement instruments. The Auxiliary Card Rack (016-0861-00) and the Auxiliary High Frequency Mounting Unit (016-0862-00) solve this problem by providing the hardware that system builders need to physically mount scanners in remote locations. The TSI 8150 mainframe provides the power and control for remotely mounted scanner cards and modules.

The 016-0861-00 and 016-0862-00 can be placed in standard 19 inch racks. They can be attached to either the front or back of a standard rack cabinet.

The 016-0861-00 accepts all TSI 8150 family scanner cards and can be placed in the back of a horizontally mounted TSA 8140 Test System Adaptor. Two can be placed in the back of a vertically mounted TSA 8140.

The 016-0862-00 accepts all TSI 8150 family scanner modules. One 016-0862-00 can be mounted inside the TSA 8140.

PHYSICAL CHARACTERISTICS

	016-0861-00 Auxiliary Card Rack		016-0862-00 Auxiliary High Frequency Mounting Unit	
Dimensions	**mm**	**in**	**mm**	**in**
Width	483	19.0	483	19.0
Height	178	7.0	222	8.8
Depth	267	10.5	86	3.4
Weights≈	**kg**	**lb**	**kg**	**lb**
Net	4.8	10.5	2.3	5.0
Shipping	5.5	12.0	2.7	6.0

For ordering information, see page 367.

NEW TSS40

Scanner Control Assembly

Real Time Control of Up to 32 Switches for a Variety of Operations

Storage of Up to 500 Test Steps for Higher System Throughput

Programmable Trigger Sources for Flexible System Timing Coordination

Switch Programming for Make-Before-Break or Break-Before-Make Switch Control

Low Cost 32-Bit Output and 5-Bit Input Interface

Intelligent Control of Switches

The TSS40 Scanner Control Assembly simplifies the system builder's task of controlling switches. In the Tektronix TSI 8150 family of scanners, each TSS40 controls one scanner card or up to two modules of the same type.

Switch control can be immediate or stored by use of either scan or sequence mode. In the immediate mode, commands from the host GPIB controller directly program the switches. In the stored mode, the switches can be scanned one relay at a time or a sequence of up to 500 steps can be preprogrammed. With this buffer, the sequence can open or close more than one switch with each step.

In either storage mode, a single command or one of 12 hardware triggers can increment the test sequence. The *output latch* provides a TTL latched output to drive the scanners. In the immediate or in the stored mode, TSI 8150 mainframe hardware synchronizes all switch state changes at each step. A single command can change the state of up to 900 switches.

The *control section* performs timing functions, senses the scanner type that the TSS40 is controlling, and provides programmable make-before-break or break-before-make control. The *trigger line select* block is a programmable matrix that selects the lines that will trigger the TSS40.

Though designed to control scanners in the TSI 8150 family, the TSS40 can be used in a variety of special applications. In standalone applications, the TSS40 provides a TTL-compatible, 32-bit digital output and a 5-bit digital input interface. Typical applications are 32-bit pattern generation and reading an encoded word on interchangeable test heads (to assure installation of the proper test head).

Ready and Sequence-Done Outputs

The TSS40 includes two program-maskable output signals. Both are wire-ORed with the outputs of other scanner control assemblies.

The *ready line* signals a change in the switch pattern and then starts a timer preset for the switch closure and bounce time. After the preset time has passed, the Ready line signals the establishment of a new path. The *sequence done* line signals completion of the last pattern in the switch storage buffer.

Configuration Check

At power-up, the TSS40 reads a relay code from the scanner card that it controls. From this code, the TSS40 checks an internal table to determine the switch settling time and card configuration. When driving custom relays, the user can program the TSS40 with the switch settling time.

CHARACTERISTICS

PHYSICAL CHARACTERISTICS

Dimensions	**mm**	**in**
Width	35	1.4
Height	177	7.0
Depth	442	17.4
Weight≈	**kg**	**lb**
Net	0.5	1.1
Shipping	1.9	2.2

ENVIRONMENTAL

Ambient Temperature — Operating: 0°C to +15°C. Nonoperating: −40°C to +75°C.

POWER REQUIREMENTS

The TSI 8150 mainframe provides power to the TSS40.

For ordering information, see page 367.

TSI Family Scanner/Switch Cards

The TSI 8150 family of scanner cards are controlled by a TSS40 Scanner Control Assembly mounted in a TSI 8150 Test System Interface mainframe. Each card can be mounted in a TSI 8150 mainframe or mounted outside and connected to the TSI 8150 mainframe with a mass terminated ribbon cable, up to 12 meters (40 ft) long.

PHYSICAL CHARACTERISTICS

	TSS41		TSS42/ TSS43/TSS48	
Dimensions	**mm**	**in**	**mm**	**in**
Width	35	1.4	35	1.4
Height	178	7.0	178	7.0
Depth	308	12.1	308	12.1
Weights≈	**kg**	**lb**	**kg**	**lb**
Net	.7	1.5	.5	1.1
Shipping	.9	2.0	.7	1.5

NEW TSS41

Low Level Scanner Card

One 1 × 20 or Two 1 × 10 Switch Trees

Multiplexes Signals With Differential Thermal Offset Down to 40 μV (1 μV With Option 01)

Offers Fast Settling Time for High Throughput

Switches High, Low and Guard

A Selection of Switch Trees

The TSS41 Low Level Scanner Card answers the system builder's need for multiplexing low level signals. The differential thermal EMF (electromotive force) is ≤40 μV (1 μV with Option 01). In its standard configuration, the TSS41 offers two 1 x 10 switch trees. Moving a jumper creates a 1 x 20 tree. An additional tree switch relay prepares the TSS41 for use in larger multiplexed systems by reducing parasitic capacitance when no channel in the 1 x 20 branch is selected.

The TSS41's ability to simultaneously switch two lines per channel enables the user to drive balanced inputs to DUTs. The guard line isolates capacitance around the signal channels and thereby improves bandwidth.

The standard TSS41 is well suited for applications as diverse as checking balanced transmission lines in audio testing and making transducer measurements in mechanical stress testing. The optional 1 μV differential thermal offset makes the TSS41 especially useful for many transducer measurements and most differential signal test set-ups designed to eliminate common mode problems.

Board layout optimizes matching of parasitic capacitances of high and low signal paths to provide well balanced quality routing for critical signals.

For ordering information, see page 367.

TSI 8150 FAMILY CARD SELECTION GUIDE

Features	TSS41	TSS42	TSS43	TSS48
Thermal Offset	Std: <40 μV differential (<80 μV with tree switch); Opt 01: <1 μV (<2μV with tree switch)	<100 μV	<100 μV	<100 μV
Maximum Switched Current	500 mA dc or peak ac	1.0 A dc or peak ac	10 A dc; 60 A surge for 2 ms	1.0 A, dc or peak ac
Maximum Carry Current	1.0 A	2.0 A	10 A	2.0 A (through screw terminals) 1.0 A (through square pin header)
Maximum Switched Voltage	250 V dc or peak ac 175 V RMS	400 V dc or peak ac (250 V Opt 01)	150 V dc 250 V RMS	400 V dc or peak ac (250 V Opt 01)
Maximum Switched Power	10 W	50 V A	2000 V A	50 W
Dieletric Standoff	300 V RMS, 400 V dc or peak ac	300 V RMS, 400 V dc or peak ac	300 V ac or 400 V peak dc	300 V RMS, 400 V dc or peak ac
Settling Time	4 ms	4 ms	51 ms	4 ms
Switch Life	10^8 @ signal level 10^6 @ rated load	10^9 @ signal level 10^7 @ rated load 10^8 @ signal level*1 10^6 @ rated load*1	3 x 10^7 mechanical 10^5 @ rated load	10^9 @ signal level 10^7 @ rated load 10^8 @ signal level*1 10^6 @ rated load*1
Switch Closures	20 3PST (High, low, guard)	30 SPST	10 SPDT	30 SPST
Channel Resistance	<2 Ω (each wire)	<150 mΩ <250 mΩ*1	<150 mΩ	<150 mΩ <250 mΩ*1
Power Requirements	24 V dc supplied from TSI 8150 mainframe or external source			
Environmental	Operating: 0°C to +50°C; Nonoperating: −40°C to +75°C			

*1 Option 01.

NEW TSS42

General Purpose Scanner Card

30 Cost-Effective Channels for Configuration Flexibility

Bounceless Mercury-Wetted Contacts for Long Switch Life

Consistent Channel Resistance (±20 mΩ Typical) Over Switch Life for Greater Test Reliability

Dry-Reed Version (Option 01)

A Selection of Switch Trees

The TSS42 General Purpose Scanner Card is a highly configurable, long-life switch assembly. It performs the many routine but essential multiplexing chores that complex test systems require. This versatile card arranges the channels in one group of 1 x 8, four groups of 1 x 4, and three groups of 1 x 2. Each channel is a single wire.

The TSS42 uses long life mercury-wetted switches, minimizing system down time for switch replacement.

Printed circuit pads near the switches allow users to attach snubber networks for switching inductive loads.

The TSS42's many special features make it suited to a variety of applications. The long life, bounceless operation, consistent channel resistance over switch life and configuration flexibility qualify the TSS42 for many demanding manufacturing ATE test set-ups.

Multiple channels permit such uses as functional board testing. Other special uses include: audio switching; low current power supply switching into the DUT; bias voltage control; and operations such as component testing that require high repetition, long life operations.

For users concerned about operating in mercury-prohibited environments or about mechanical positioning, Option 01 offers dry-reed switches in the same switch configuration.

For ordering information, see page 367.

NEW TSS43

Power Switch Card

10 Independent Power Channels for Primary and Secondary Power Switching

Transient Suppressors for Switch Protection With Inductive Loads

Switches dc Through 400 Hz for Applying Power to a DUT

High Power Switch Applications (250 V, 10 A, 2000 VA)

Useful for System Power-Up Sequencing

A Versatile Power Switch Card

The TSS43 Power Switch Card provides 10 independent switch lines designed to allow the user to switch primary or secondary suppies to the DUT.

Each channel consists of one normally open (NO) and one normally closed (NC) contact. Transient suppressors are wired between each NO and common and each NC and common. These suppressors protect the contacts when the card switches inductive loads.

The TSS43 can switch up to 10 A or 250 V (RMS), and is useful for switching power to the DUT. The most common use is dc or 60 Hz, but similar applications exist in 400 Hz avionic set-ups.

A special use is switching miscellaneous units such as device handlers, solenoids, and other line-operated fixturing actuators. The TSS43 has a 60 A inrush surge rating, enabling it to switch loads such as a one-quarter horsepower 120 V ac motor.

For ordering information, see page 367.

NEW TSS48

Matrix Switch Card

30 Switches, in Five Rows by Six Columns, for Matrix Configuration Flexibility

Bounceless Mercury-Wetted Switches for Long Switch Life

Consistent Channel Resistance (±20 mΩ Typical) Over Switch Life for High Repeatability

Dry-Reed Version (Option 01)

A Versatile Matrix Switch Card

The TSS48 Matrix Switch Card is designed to route a variety of signals. The switch matrix contains five rows by six columns. Each crosspoint is a single wire.

The switches are long-life mercury-wetted relays. These relays minimize system down time for switch replacement.

Each switch trace on the printed circuit board includes blank pads. The user may install snubber networks to allow switching inductive loads.

The TSS48's many special features make it suited to a variety of applications. The long life, bounceless operation, consistent channel resistance over the life of the switch, and configuration flexibility qualify the TSS48 for many demanding manufacturing ATE test set-ups.

The large number of channels available supports applications such as functional board testing. Other special uses include: Audio switching; low current power supply switching to the DUT; bias voltage control; operations that require high repetition and long life operations, such as component testing.

Each row and column is connected to two connectors, allowing easy expansion of the matrix in a row dimension, the column dimension, or both dimensions by adding TSS48 cards.

Option 01 incorporates the same matrix configuration but substitutes dry-reed switches in place of the mercury-wetted contacts. This substitution allows operation in environments which prohibit the use of mercury or in mechanical position-sensitive applications.

The TSS42 General Purpose Scanner Card offers the same switches, but in a configuration suited to single purpose test set-ups. The TSS48 is better suited to testing a varied series of DUTs. An example application is universal device test systems, which mix stimulus and measurement instruments on the same pins.

For ordering information, see page 367.

NEW

High Current Driver Card/60 mA Driver Card

Controls Up to 24 User-Supplied Relays for Custom Applications

Open Collector, NPN Darlington Drivers

Allows 24 Channels of Control for Solenoids, Actuators, Handlers, and Other Devices

Low Voltage Detection Circuit Generates Error Message If Power Supply Fails

Blank Prototype Area for User Wiring

Back EMF Diodes for Switching Inductive Loads

Two Current Driver Cards

The High Current Driver Card (021-0417-00) and the 60 mA Driver Card (021-0418-00) are functionally identical.

Each driver card provides printed circuit board prototyping features for users who want to interface their own relays into the TSI 8150 Test System Interface family. Uses for these cards include special relays such as optical switches, microwave transfer switches, and picoamp low current switches.

Other uses include driving dc devices such as air valves, solenoids, handlers, and actuators. These cards provide easy interface of the devices to the General Purpose Interface Bus (GPIB) IEEE Standard 488.

The card's output drivers contain internal diodes that clamp the back EMF generated by a relay coil opening to the coil supply voltage. Coil voltage for the relays passes through a limiting fuse. The return path connects to chassis ground.

Command Functions Available

All of the TSS40 command functions are available for the driver cards. The configuration command always returns 1 of 24. On the 021-0417-00, multiple switch channels can be closed simultaneously, providing the total current does not exceed 4 A. Other features available on these prototype cards include: sequence storage, break-before-make and make-before-break capability, timing control, and user-programmable bounce timing.

A TSI Family Member

The 021-0417-00 and 021-0418-00 driver cards conveniently interface user-supplied relays and other devices to the TSI 8150 Test System Interface mainframe. The 021-0417-00 switches up to 1 Amp per channel; the 021-0418-00 switches up to 60 mA per channel.

The driver cards are controlled by a TSS40 Scanner Control Assembly mounted in a TSI 8150 mainframe. The cards can be mounted in the TSI 8150 mainframe or mounted outside and connected to the TSI 8150 mainframe with a mass-terminated ribbon cable, up to 12 meters (40 ft) long.

PHYSICAL CHARACTERISTICS

	021-0417-00 High Current Driver Card		021-0418-00 60 mA Driver Card	
Dimensions	**mm**	**in**	**mm**	**in**
Width	356	1.4	356	1.4
Height	178	7.0	178	7.0
Depth	307	12.1	307	12.1
Weights≈	**kg**	**lb**	**kg**	**lb**
Net	0.4	0.8	0.3	0.7
Shipping	0.6	1.0	.5	1.1

ENVIRONMENTAL

Ambient Temperature — Operating: 0°C to +50°C. Nonoperating: −40°C to +75°C.

For ordering information, see page 367.

TSI Family Scanner Modules

The TSI Family of scanner modules are controlled by a TSS40 Scanner Control Assembly mounted in a TSI 8150 Test System Interface mainframe. Each module contains an expansion connector that allows the user to connect additional units without requiring an additional TSS40.

The modules can be mounted in a TSI 8150 mainframe or mounted outside and connected to the TSI 8150 mainframe with a mass terminated ribbon cable, up to 12 meters (40 ft) long.

CHARACTERISTICS

PHYSICAL CHARACTERISTICS

	TSS44		TSS45		TSS46	
Dimensions	**mm**	**in**	**mm**	**in**	**mm**	**in**
Width	74	2.9	74	2.9	74	2.9
Height	184	7.3	184	7.3	184	7.3
Depth	89	3.5	89	3.5	89	3.5
Weights≈	**kg**	**lb**	**kg**	**lb**	**kg**	**lb**
Net	0.5	1.0	0.5	1.0	0.4	1.0
Shipping	0.6	1.4	0.6	1.4	0.6	1.4

TSI 8150 FAMILY SCANNER MODULES SELECTION GUIDE

Features	TSS44	TSS45*1	TSS46
Insertion Loss (any port to common)	<0.1 at 100 kHz <0.25 at 50 MHz <1.0 at 200 MHz	<0.75 at 800 MHz <1.0 at 1.2 GHz <3.0 at 2.0 GHz	<0.1 at 3.0 GHz <0.3 at 12 GHz <0.5 at 18 GHz
Isolation (any port to common)	>80 dB at 100 kHz >45 dB at 50 MHz 40 dB at 200 MHz	>60 dB at 800 mHz >50 dB at 1.2 GHz >40 dB at 2.0 GHz	>90 dB at 3.0 GHz >70 dB at 12 GHz >60 dB at 18 GHz
Crosstalk (between any two ports with common and all unused ports terminated)	>80 dB at 100 kHz >45 dB at 50 MHz >40 dB at 200 MHz	>50 dB at 800 MHz >40 dB at 1.2 GHz >30 dB at 2.0 GHz	>90 dB at 3.0 GHz >70 dB at 12 GHz >60 dB at 18 GHz
VSWR (any port to common)	<1.05:1 at 100 kHz <1.2:1 at 50 MHz <2.1:1 at 200 MHz	<1.3:1 at 800 MHz <1.5:1 at 1.2 GHz <3.5:1 at 2.0 GHz	<1.1:1 at 3.0 GHz <1.3:1 at 12 GHz <1.5:1 at 18 GHz
Maximum Switched Current	500 mA dc or peak ac	10 mA dc or peak ac	50 mA dc or peak ac
Maximum Switched Voltage	150 V dc or peak ac	24 V dc or peak ac	15 V dc or peak ac
Maximum Carry Current	1.0 A	100 mA	3.0 A
Maximum Switchable Power	10 W (resistive) 200 mW (RF into 50 Ω)	200 mW (RF into 50 Ω)	125 mW (RF into 50 Ω)
Maximum Carry Power	500 mW (RF into 50 Ω)	500 mW (RF into 50 Ω)	450 W to 100 MHz 200 W to 700 MHz 100 W to 3.5 GHz 50 W to 1.8 GHz (all into 50 Ω)
Dielectric Standoff	250 V dc or peak ac	50 V dc or peak ac	50 V dc or peak ac
Switch Life	5×10^7	10^6	10^6
Settling Time	4 ms	31 ms	41 ms
Power Requirements	24 V dc coil supply in TSI 8150 mainframe or from external source		
Environmental	Operating: 0°C to +50°C; Nonoperating: −40°C to +75°C		

*1 *Two 1 x 6 binary trees (only one port can be connected to common at once).*

NEW TSS44

Coax Scanner Module

Two Independent 1 × 6 Trees

Shield Common Isolated From Chassis Ground, Preventing Low Frequency Ground-Loop Problems

High Level of Isolation and Low Crosstalk for Low Level Measurements

BNC Connectors for Easy and Economical Interconnections

A Versatile Coax Scanner Module

The TSS44 Coax Scanner Module multiplexes moderate bandwidth signals through shielded conductors.

The TSS44 uses coaxially shielded relays arranged in two 1 x 6 trees. Each channel consists of one switched signal wire and an unswitched shield that is common to the other shields in the same tree.

To eliminate low frequency ground loops, the shield common is isolated from chassis ground.

The TSS44 fits into TSI 8150 mainframe and 016-0862-00 Auxiliary High Frequency Mounting Unit slots. This module also contains corner holes that permit the user to directly mount the TSS44.

For ordering information, see page 367.

NEW TSS45

RF Scanner Module

Two Independent 1 × 6 50 Ω Trees

Wide Bandwidth for TDR and Communication Frequency Tests

BNC Connectors for Easy and Economical Interconnections

A Versatile RF Scanner Module

The TSS45 RF Scanner Module multiplexes VHF/UHF signals in 50 Ω systems. Binary tree switching eliminates unterminated stubs and equalizes path length through all channels. Two independent 1 x 6 trees contain the switches.

The TSS45 provides an additional port—TERM—for terminating the common line when no channel is selected. TERM does not have the same path as the six ports.

Connecting A TERM to B COM forms a 1 x 12 tree with reduced specifications. Each channel consists of one switched signal wire and an unswitched shield that is common to the other shields and chassis ground.

The TSS45 can be used in areas such as: time domain and frequency domain testing through the UHF range; HF and VHF testing of frequency domain devices without switch characterization in the high frequency and very high frequency range; routing single-ended logic signals (for example, for GaAs testing; testing of general communications equipment.

The TSS45 fits into TSI 8150 mainframe and 016-0862-00 Auxiliary High Frequency Mounting Unit slots.

For ordering information, see page 367.

NEW TSS46

Microwave Scanner Module

18 GHz Bandwidth (−0.5 dB) for Microwave Test Set-Ups

Two Independent 1 × 6 Switch Trees

SMA Connectors for Attaching Flexible and Semirigid Coaxial Signal Paths

A Versatile Microwave Scanner Module

The TSS46 Microwave Scanner Module is designed to multiplex extremely high bandwidth signals. The module's 18 GHz bandwidth and flat frequency response allow use in reduced bandwidth systems without concern for insertion loss or rise time degradation.

The TSS46 contains two independent 1 x 6 switch trees. Each channel consists of one switched signal wire and an unswitched shield that is common to the other shields and chassis ground.

This versatile high frequency scanner module is useful in applications such as: UHF and low-end microwave testing without switch characterization; mulitplexing of TDR tests for hybrid, stripline, microstrip, and controlled-impedance board testing; broadband parametric testing that requires closing two switches simultaneously.

The TSS46 fits into TSI 8150 mainframe and 016-0862-00 Auxiliary High Frequency Mounting Unit slots.

For ordering information, see page 367.

ORDERING INFORMATION

TSI 8150 Test System Interface **$2,995**
Includes: Rackmounting hardware; user's manual (070-5765-00); configuration manual (070-5766-00); programming reference guide (070-6038-00); power cord.

OPTIONS

Option 01 — Replace standard configuration with front switch access. **NC**

Option 02 — Configuration for front and rear switch access. **+$595**

INTERNATIONAL POWER PLUG OPTIONS

Option A1 — Universal Euro 220 V, 50 Hz.
Option A2 — UK 240 V, 50 Hz.
Option A3 — Australian 240 V, 50 Hz.
Option A4 — North American 240 V, 60 Hz.
Option A5 — Switzerland 220 V, 50 Hz.

TSA 8140 Test System Adaptor **$495**

CONVERSION KIT

Rackmount[*1] — Includes hardware for slide rails. Order TSA8140F01

016-0861-00 Auxiliary Card Rack **$245**

016-0862-00 Auxiliary High Frequency Mounting Unit **$145**

TSS40 Scanner Control Assembly **$220**

TSS41 Low Level Scanner Card **$545**

TSS42 General Purpose Scanner Card **$595**

TSS43 Power Switch Card **$395**

TSS48 Matrix Switch Card **$645**

021-0417-00 High Current Driver Card **$345**

021-0418-00 60 mA Driver Card **$245**

TSS44 Coax Scanner Module **$595**
Includes: .91 m (36 in) connection cable.

TSS45 RF Scanner Module **$895**
Includes: .91 m (36 in) connection cable.

TSS46 Microwave Scanner Module **$1,995**
Includes: .91 m (36 in) connection cable.

OPTIONS

Option 01 — (TSS41) For 1 μV thermal differential relays (2 μV with tree switch). **+$400**

Option 01 — (TSS42/TSS48) Dry-reed relays. **NC**

OPTIONAL ACCESSORIES

TSI 8150

System Service Manual — Order 070-5767-00 **$150**

Additional Main Interconnect Board — Order 670-9137-00 **$595**

Function Card Service Extender Package — (TSI 8150) Order 067-0162-00 **$150**

TSA 8140

Test Head Receiver[*1] — Compatible with test fixtures from Virginia Panel Corporation. Order 021-0435-00

Interchangeable Test Adaptors[*1] — (Full Size) Order 021-0434-00 (Half Size) Order 621-0436-00

SCANNER/SWITCH DRIVER CARDS/ SCANNER MODULES

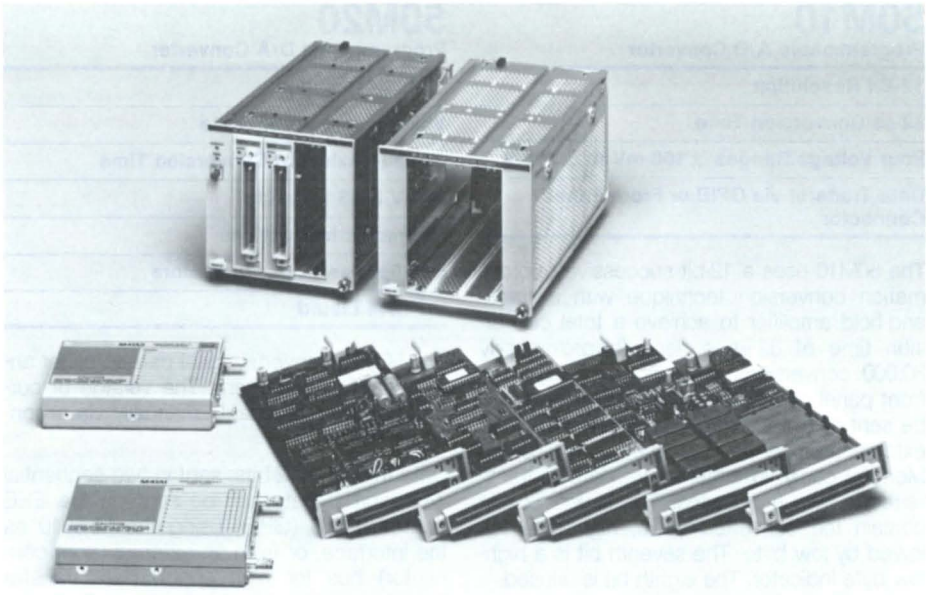
Auxiliary Card Mounting Rack — (TSS41/TSS42/TSS43/TSS48) Order 016-0861-00 **$245**

Extension Cable Kit — 30.5 m (100 ft) cable and 24 connectors. Order 198-5579-00 **$395**

Cable Assembly — Six preassembled 2 m (6.5 ft) extension cables. Order 198-5581-00 **$24**

Auxiliary High Frequency Mounting Unit — (TSS44/TSS45/TSS46) Order 016-0862-00 **$145**

*[*1] To order, contact your local Tektronix Sales Office.*



Multifunction Interface System

MI 5010/MX 5010

GPIB IEEE-488

The MI 5010 and MX 5010 comply with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats.*

Wide Range of System Interfacing Functions

Up to Six Functions at One Address

D-to-A, A-to-D Conversion

Low-Level Signal Scanning

Digital I/O

Digital Word Acquisition and Generation

Built-In Time-of-Day and Pacing Clock

Command Buffer for Controller-Free Operation

Thermocouple Scanning

The MI 5010/MX 5010 Multifunction Interface System consists of the MI 5010 Multifunction Interface, the MX 5010 Multifunction Interface Extender, and seven different types of function cards. These cards are capable of a variety of functions typically required in automated test system interfacing, data acquisition and generation, and process control.

The MI 5010 and MX 5010 each house up to three function cards, in any combination. The MI 5010 provides the communication between the system controller and the function cards. The MX 5010 is always used with an MI 5010, extending its control to six function cards at one GPIB address.

The function cards presently available for the MI 5010/MX 5010 Multifunction Interface System are: 50M10 Analog-to-Digital Converter, 50M20 Digital-to-Analog Converter, 50M30 Digital I/O, 50M40 Relay Scanner, 50M41 Low-Level Scanner (with M41A1 through M41A8 Signal Conditioners), 50M50 Memory, and 50M70 Development card. Each function card contains its own ROM with the specific firmware and its own unique set of commands required for its particular function. Each card can be operated in any slot of the MI 5010 and/or MX 5010 regardless of the other cards in the system.

In addition to providing the interface between the function cards and the system controller, the MI 5010 also has its own intelligence and a built-in command buffer. This buffer is capable of storing up to 300 system commands and executing them in sequence, paced by the on-board time-of-day and pacing clock or by signals from the system under test. It requires no interference from the system controller, thus freeing the controller to direct activity elsewhere in the system.

IEEE Standard 488-1978 Interface Function Subsets Implemented — SH1, AH1, T6, L4, SR1, RL0, PP0, DC1, DT1, C0.

ORDERING INFORMATION

MI 5010 Multifunction Interface **$1,760**
Includes: Instruction manual (070-3712-00); instrument interface guide (070-5187-00); reference guide (070-3882-00).

MX 5010 Interface Extender **$740**
Includes: Same as above.

Utility Software
For TM 5000/4041 Order 062-6958-01 **$150**
See page 359 for description and ordering information.
This utility software supports all of the 50Mxx Series function cards also.

50M10

Programmable A/D Converter

12-Bit Resolution

32 μs Conversion Time

Four Voltage Ranges ±100 mV to ±100 V

Data Transfer via GPIB or Front Panel Connector

The 50M10 uses a 12-bit successive approximation conversion technique with a track-and-hold amplifier to achieve a total conversion time of 32 μs or less (approximately 30,000 conversions per second). Using the front panel connector, conversion values can be sent over the GPIB (via the MI 5010) or to external memory devices (such as the 50M50 Memory card). In either case, data is transferred in two 8-bit bytes. The lower six bits contain the converted value, high byte followed by low byte. The seventh bit is a high-low byte indicator. The eighth bit is unused.

Four voltage ranges are provided, manually selectable by on-board jumpers: +100 mV, +1 V, +10 V and +100 V. The total span for each range is divided into 4096 parts (12-bits). The front panel analog input connections (high and low) can be elevated to a potential of +340 volts, dc plus peak ac.

Two handshaking modes are provided, one for communication with devices faster than the 50M10 (the device can accept data as fast as the 50M10 can provide it), and the other for communication with devices slower than the 50M10 (the 50M10 must be clocked by the external receiving device). Front panel control lines permit the 50M10 conversions to be triggered, gated, or triggered within a gate. Through the use of a gateable function generator, such as the Tektronix FG 501A, and a digital delay generator, such as the Tektronix DD 501, a counted burst of conversions at a selected rate can be gated.

CHARACTERISTICS

Maximum Conversion Rate — 32 μs.

Maximum Aperture Time — ≤400 ns.

Accuracy

Range	+18°C to +28°C	0°C to +50°C
100 mV	±0.15%*1	±0.25%*1
1 V and 10 V	±0.075%*1	±0.125%*1
100 V	±0.125%*1	±0.2%*1

*1 Full scale.

Amplifier Settling Time — 100 mV Range: ≤150 μs. 1 V Range: ≤25 μs. 10 V Range: ≤10 μs. 100 V Range: ≤30 μs.

Input Impedance — 100 mV, 1 V and 10 V Ranges: $\geq 10^{10}$ Ω. 100 V Range: ≥1 MΩ.

Digital Data Transfer Format — 12-bit word transferred in two bytes, high byte first. Lower six bits of each byte contain data, seventh bit is high byte/low byte indicator, eighth bit is unused.

ORDERING INFORMATION

50M10 Analog-to-Digital Converter Card **$895**
Includes: Interfacing cable (015-0430-00); instruction manual (070-4495-00); reference guide (070-4491-00).

50M20

Programmable D/A Converter

12-Bit Resolution

Voltage or Current Mode

20 μs (Maximum) Conversion Time

250 V RMS Isolation

Mnemonic Instructions

Self-Test and Error Indicators

UL 1244 Listed

The 50M20 converts digital data to either analog voltage or current. The voltage or current mode is selectable manually via an on-board switch.

Data format is 12 bits, sent in two sequential 7-bit words. Data can be sent via the IEEE Standard 488 (GPIB) using the MI 5010 as the interface, or from an external (front connector) bus for high speed data transfer (with appropriate handshake lines). On-board firmware will convert commands and data to the proper format to perform the required digital-to-analog conversion. Two lines at the front panel connector are provided to handshake data into the 50M20 from the user's external system.

Programming of the 50M20 is via the IEEE Standard 488 (GPIB) Bus. System commands sent to the MI 5010 microprocessor, along with specialized programming commands unique to the 50M20, control the source and the format of the digital data. The 50M20 can be programmed to respond to either external or internal system triggers.

CHARACTERISTICS

VOLTAGE MODE

Range — −10.240 V to +10.235 V.

Accuracy — ±10.0 mV (+20°C to +30°C) ±15 mV (0°C to +50°C).

Resolution (1 LSB) — 5 mV.

Total Conversion Time (Maximum) — 20 μs.

Output Ripple and Noise — <5 mV p-p at 5 MHz BW.

Output Current Range — 0 mA to ±5 mA.

CURRENT MODE

Range — −20.48 mA to +20.47 mA.

Accuracy — ±20 μA (+20°C to +30°C) ±40 μA (0°C to +50°C).

Resolution (1 LSB) — 10 μA.

Total Conversion Time (Maximum) — 20 μs.

Output Ripple and Noise — <15 μA, p-p, at 5 MHz BW.

Compliance Voltage — ±11 V.

Isolation — 250 V RMS maximum to ground.

Digital Data Transfer Format — 12-bit word transferred in two bytes, high byte first. Lower six bits of each byte contain data, seventh bit is high byte/low byte indicator, eighth bit is unused.

ORDERING INFORMATION

50M20 Digital-to-Analog Converter Card **$910**
Includes: Interfacing cable (015-0430-00); instruction manual (070-3724-01); reference guide (070-3883-00).

50M30

Programmable Digital Input/Output Card

16 Digital Input and 16 Digital Output Lines

Data Entry/Output Formats in Decimal, Binary, or Hex

Triggered Externally or On Command

Mnemonic Instructions

Self-Test and Error Indicators

UL 1244 Listed

The 50M30 provides 16 digital input and 16 digital output lines. The digital inputs accept data from pushbuttons, switches, contact closures, and most digital devices capable of supplying TTL output levels. The digital outputs provide TTL levels to control various types of test and measurement instruments, relays, indicators, etc. The digital outputs can be configured for open-collector outputs by positioning internal jumpers and using power supplied by the user.

Programming of the 50M30 is via the IEEE Standard 488 (GPIB) Bus. System commands sent to the MI 5010 Microprocessor, along with specialized programming commands unique to the 50M30, control the selection of the data input/output channels and the arming/trigger functions of the card.

Four lines at the front panel connector operate as input/output pairs to handshake data with the user's external system. One handshake pair allows the user's data source to be synchronized with the 50M30 data input register and the other handshake pair allows the user's data storage device to be synchronized with the 50M30 data output register.

CHARACTERISTICS

Data Outputs Using Internal Supply — 16 open-collector TTL with 2 kΩ pullup resistors. Logical "1": +5 V ±2% (open circuit). Source current is −2.5 mA ±7% maximum. Logical "0": 0.2 V. Sink current is −40 mA maximum.

Data Outputs Using External (User) Supply — Maximum Voltage: +15 V. Pullup Resistors: 2 kΩ. Logical "1" equal to external supply voltage (open circuit). Source current is 7.5 mA ±5% plus external supply tolerance. Logical "0": 0.2 V. Sink current is 40 mA maximum.

Data Inputs — Input Buffers: 16 Schmitt triggers. Logical "1" (+V Threshold): +1.6 V ±25%. Source current is −0.14 mA nominal, −0.16 mA maximum. Logical "0" (−V Threshold): +0.8 V ±40%. Source current is −0.18 mA nominal, −0.21 mA maximum.

ORDERING INFORMATION

50M30 Digital Input/Output Card **$495**
Includes: Interfacing cable (015-0430-00); instruction manual (070-3722-00); reference guide (070-3884-00).

To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext. 99

50M40

Programmable Relay Scanner Card

16 Mercury Wetted Relay Contacts

User Configurable 1, 2, 4 Groups

Triggered Externally or On Command

Mnemonic Instructions

Self-Test and Error Indicators

UL 1244 Listed

The 50M40 provides 16 independent, normally open relay contacts. The relay contacts can be used as switch closures to supply power to several external points from one source, or scan several sources and supply various inputs to a single measurement device.

The desired relay switch pattern is configured by the user with internal jumpers. When the configuration has been established, the relay scanning sequence, open and close operations, and triggering events are programmed over the IEEE Standard 488 (GPIB) Bus.

Two logic signal lines on the front panel connector are provided for externally controlling the 50M40—one as an output (Ready) to indicate to the user when the relays have settled, and the other as an input (Ext Trig) to tell the MI 5010 Microprocessor that the user is ready for the relay switch configuration to close. Three possible configurations are:

4 groups of 4 individual relays
2 groups of 8 individual relays
1 group of 16 individual relays

CHARACTERISTICS

Type of Relays — Mercury wetted reed.

Possible Configurations (Jumper Selectable) — 1 of 4, 4 each. 1 of 8, 2 each. 1 of 16, 1 of 12 and 1 of 4, 1 each.

Maximum Applied Voltage — 40 V dc plus peak ac.

Maximum Carry Current — 1 A.

Breakdown Voltage — 100 V dc plus peak ac.

Contact Resistance — 0.15 Ω nominal (end of life).

ORDERING INFORMATION

50M40 Relay Scanner Card **$695**
Includes: Interfacing cable (015-0430-00); instruction manual (070-3723-00); reference guide (070-3885-00).

50M41

Programmable Low Level Scanner

10 Differential Contact Pairs Plus Guard

<1 μV Thermal Offset

User Configurable

Handshake Lines to Permit External Control

Isothermal Amplifiers Available for Thermocouple Applications

The 50M41 provides ten pairs of guarded, normally open relay contacts with less than one microvolt of thermal offset in each channel. Each differential pair of contacts is accompanied by a third contact to switch the shield or guard connection. The ten sets of relay contacts can be configured as two groups of five individual relays with two commons, or as one group of ten individual relays with one common. The desired relay switch pattern is configured by internal jumpers. A tree relay can be included in the 1 of 10 configuration to reduce capacitive loading and potential noise problems when using more than one 50M41 in a system. Two handshake lines are provided for externally controlling the 50M41.

A family of high gain, low noise signal conditioning modules—M41A1 through M41A8—is available to condition low level signals for specialized applications with the 50M41.

CHARACTERISTICS

Type of Relays — 10 sealed low thermal EMF relays configurable as one 10-to-1 switch or two 5-to-1 switches.

Thermal Offset — <1 μV differential; <2 μV differential with tree switch.

Maximum Scan Rate — ≥200 cycles/s.

Maximum Applied Voltage (High, Low or Guard of Any Channel to Chassis) — 350 V dc + peak ac.

Maximum Switched Voltage — 150 V dc + peak ac (not to exceed VA rating).

Maximum Carry Current — 250 mA.

Maximum Switched Current — 10 mA.

Maximum Switched VA — 0.15 VA.

ORDERING INFORMATION

50M41 Low Level Scanner Card **$995**
Includes: Interfacing cable (015-0430-00); instruction manual (070-4557-00); reference guide (070-4556-00).

M41A1

Low Level Amplifier for 50M41

10 Differential Inputs plus Guard

Selectable Gains of 1, 10, 100, and 1000

Software Selectable Filter

External Handshake Lines

50M41 Low Level Scanner Required

The M41A1 is a general purpose amplifier with switchable gain in decade steps from 1 to 1000. Provision is made for a guarded input that can be driven by the amplifier's guard driver or by an external signal source. A software selectable low-pass filter with a corner frequency of approximately 4 Hz provides more than 60 dB of normal mode rejection at 60 Hz. The frequency response with the filter turned off is approximately −3 dB at 10 kHz.

CHARACTERISTICS

Gain Ranges

Overall Gain (A)	Input Gain (A)	Buffer AMPL Gain	Output Dynamic Range
1000	1000	1	10 V
100	1000	0.1	1 V
100	100	1	10 V
10	100	0.1	1 V
10	10	1	10 V
1	10	0.1	1 V

Gain Accuracy — ± 0.1% from +18°C to +28°C; ± 0.2% from 0°C to +50°C

Maximum Input Voltage (Respect to System Ground) — 250 V ac RMS (350 V dc + peak ac)

Input Resistance Differential — >10 MΩ paralleled with 0.05 μF capacitor.

RMS Noise (Referred to the Input) — <60 nV/$\sqrt{Hz}$ A=1000. <200 nV/$\sqrt{Hz}$ A=100. <500 nV/$\sqrt{Hz}$ A=10.

FILTER

Bandwidth Filter On — f(−3 dB): ≤6 Hz. f(−60 dB): ≤60 Hz.

Bandwidth Filter Off — >10 kHz.

Settling Time — Filter On: ≤400 ms. Filter Off: ≤150 μs.

ORDERING INFORMATION

M41A1 Low Level Amplifier **$550**
Includes: Instruction manual (070-4605-01).

M41A2 through M41A8

Thermocouple Amplifiers for 50M41

10 Guarded Inputs
Selectable Hardware or Software Temperature Compensation
Software Selectable Filter
External Handshake Lines
50M41 Low Level Scanner Required

Signal conditioning modules M41A2 through M41A8 are thermocouple amplifiers, each designed to operate with a specific thermocouple type (J, K, E, T, S, R, and B, respectively). The thermocouple amplifier provides isothermal connections for up to ten guarded or unguarded thermocouple pairs. Each amplifier provides hardware compensation for its specific thermocouple type; provision for software compensation is made where all thermocouples are not of the same type. Thermocouples are available from your local supplier.

CHARACTERISTICS

Maximum Thermocouple Wire Resistance — 10 kΩ.

Linearity Error — ±0.02% or 1 μV referred to input (whichever is greater).

Common Mode Rejection Ratio — Incremental Dc: ⩾100 dB. 60 Hz: ⩾100 dB.

Input Dynamic Range (Common Mode) — ±10 V.

Incremental Input Resistance (High to LO) — >10 MΩ paralleled by 0.05 μF capacitor.

FILTER

Bandwidth Filter On — f(−3 dB): ⩽6 Hz. f(−60 dB): ⩽60 Hz.

Setting Time — Filter On: ⩽400 ms. Filter Off: ⩽150 μs.

ISOTHERMAL BLOCK

Temperature Gradient — <0.1°C between any two terminals or any terminal and temperature sensor.

Hardware Compensation — ±0.014 (V −V_{ISO}) A (°C) and 0.35°C (0°C to +50°C) or 0.25C (+18°C to +28°C).

Software Compensation — 0.35C (0°C to +50°C) or 0.25C (+18°C to +28°C)

ORDERING INFORMATION

The following thermocouple amplifiers each include instruction manual 070-4605-01.

M41A2 Type J	**$625**
M41A3 Type K	**$625**
M41A4 Type E	**$625**
M41A5 Type T	**$625**
M41A6 Type S	**$625**
M41A7 Type R	**$625**
M41A8 Type B	**$625**

50M50

Programmable Memory Card

16 Kbyte Digital Input/Output
Single 16-Bit or Dual 8-Bit Channels
Independent Dual Channel Operation
200 kHz Acquisition or Generation Rate
TTL Levels
External Handshake Lines

This 16 Kbyte digital input/output device can be configured, under program control, as a single 16-bit input/output port or as two 8-bit input/output ports. These ports can be connected to any of 16 data buffers which can be programmed to different lengths. The total memory of all the buffers cannot exceed 16 Kbytes.

The 50M50 is intended to be used as a digital word generator and/or as a fast, digital data acquisition buffer. As a digital word generator, it can be used with a digital-to-analog converter, such as the Tektronix 50M20, to function as an arbitrary waveform generator. As a high speed data acquisition buffer, it can be used with an analog-to-digital converter, such as the Tektronix 50M10, as an off-line, high speed analog signal measurement system or as a waveform digitizer.

The 50M50 can be programmed to input or output data on two different channels simultaneously, or to input data on one channel while outputing data on the other channel. System commands to the 50M50 control the selection of input/output channels, the control of the data buffers, and the arming functions of the card.

Four handshake lines are provided at the front panel to permit synchronization with the user's external system (one pair for each channel). Other external control lines permit pacing and control of data output and disabling of data input.

CHARACTERISTICS

Data Outputs — 8 or 16 low power Schottky TTL lines. Logical "1": +5 V ±2% (open circuit). Source current is 2.5 mA +2% −7% maximum. Logical "0": ⩽0.7 V. Sink current is 40 mA maximum.

Data Inputs — 8 or 16 low power Schottky TTL lines. Logical "1" (+V Threshold): +1.5 V to +2 V. Source current is −0.16 mA maximum. Logical "0" (−V Threshold): +0.6 V to +1.1 V. Source current is −0.21 mA maximum.

Maximum Data Transfer Rate — 8-Bit Bytes: 200 kHz ±2%. 16-Bit Bytes: 125 kHz ±2%.

ORDERING INFORMATION

50M50 Memory Card **$995**
Includes: Interfacing cable (015-0430-00); instruction manual (070-4550-01); reference guide (070-4554-00).

50M70

Programmable Development Card

32 Data I/O Ports
Interrupt and Trigger Lines
Vector Board Development Region
Mnemonic Instructions
Self-Test and Error Indicator

The 50M70 provides the user with the means of developing his own unique circuit and interfacing it to the GPIB without the need for designing and building the GPIB interface itself. With the 50M70, the user can create a specialized function card to be used in the MI 5010/MX5010 Multifunction Interface System. When completed, the circuit can be programmed in high level language over the GPIB.

The 50M70 contains two 68B21 16-bit interface logic registers (PIAs), address and data buffers, its own firmware, and a 4x4 inch breadboard area for circuit development. The 32 data lines of the PIAs can be individually programmed as inputs or outputs. The PIAs also provide three sets of programmable two-wire handshake lines to permit triggering of the external system by the 50M70 or of the 50M70 by the external system.

Typical 50M70 applications are specialized A/D and D/A converter functions, counter/timer applications, special communication interface functions, keyboard and display functions, digital comparators for triggering and interrupt functions, etc.

CHARACTERISTICS

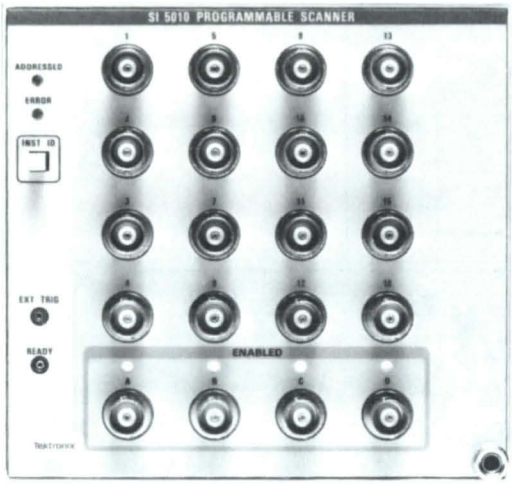
Data Input/Outputs and Handshake Lines — Output High Level: +2.4 V minimum, +5.5 V maximum. Maximum Load Current: −200 μA. Output Low Level: 0 V minimum, +0.4 V maximum. Maximum Sink Current: 3.2 mA. Input Load Current: 1.3 mA nominal, 2.4 mA maximum.

Dc Voltage Sources Available on the Card — +26 V and −26 V ±9%, 100 mA maximum; +8 V ±5%, 600 mA maximum; +5 V ±5%, 1.5 A maximum. Total Combined Power Limit: 7.5 W.

ORDERING INFORMATION

50M70 Development Card **$410**
Includes: Interfacing cable (015-0430-00); instruction manual (070-3725-00); reference guide (070-3886-00).

SI 5010



Programmable Scanner

SI 5010

GPIB IEEE-488 The SI 5010 complies with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats.*

Software Configurable as:
1 Group of 16 Channels
2 Groups of 8 Channels
4 Groups of 4 Channels

$80

350 MHz Bandwidth in 4-Channel Configuration

External Handshake Lines

Built-In Time-of-Day and Pacing Clock

$155

Command Buffer for Controller Free Operation

$10.25

The SI 5010 Programmable Scanner provides the capability of switching and routing up to 16 high frequency input and/or output signals. It always maintains a clean 50 Ω environment through the use of 50 Ω coaxial reed relays. The software-configurable basic four-channel arrangement allows the SI 5010 to be used for point-to-point switching (any connector to any other connector), or to be used in a wide variety of fan-in and/or fan-out configurations.

$245

The SI 5010 has its own intelligence and a built-in command buffer capable of storing up to 300 system commands and executing them in sequence. It is paced by the on-board time-of-day and pacing clock or by signals from the system under test. This requires no interference from the system controller, thus freeing the controller to direct activity elsewhere in the system.

$170

Two handshake lines are provided for externally controlling the SI 5010. An Ext Trig line is provided to allow the SI 5010 switching to be initiated by the external system under test, and a Ready line indicates to the external system when the relays have settled.

$19

CHARACTERISTICS

RF Connectors — 20 BNC connectors, 16 channels and four commons.

Control Input (Ext Trig) — External Trigger: TTL compatible

Control Output Data Accepted (Ready) — TTL compatible. Output goes high when relays have settled.

Channel Configuration (Software Selectable) — 1, 2, 3, or 4 groups of 4 channels. 2 groups of 8 channels. 1 group of 16 channels.

Frequency Response — Any 1 Group of 4: −3 dB at 350 MHz, decreasing to −6 dB at 500 MHz or greater. Any 1 Group of 8: −3 dB at 175 MHz or greater. Any 1 Group of 16: −3 dB at 80 MHz or greater.

Port (Channel) Isolation — 40 dB at 100 MHz.

Characteristic Impedance (Each Channel) — 50 Ω. See VSWR specification.

Rise Time (Each Channel) — <1 ns.

Voltage Standing Wave Ratio (VSWR) — Any 4 Channel Group: 1.25:1 at 100 MHz, increasing to 1.8:1 at 350 MHz. Any Other Combination: 1.5:1 at 100 MHz. 2:1 at 225 MHz.

Insertion Loss — <1 dB at 100 MHz.

Channel Delay Matching — Any Group of 4: 50 ps. Any Group of 8: 110 ps. Any Group of 16: 310 ps.

Type of Relays — 16 Form A, EAC 05Y21A1 40 BAB, or equivalent. 4 Form "C", TO-5, Teledyne 712-6, or equivalent. Pull In Time: 3 ms. Release Time: 3 ms. Breakdown Voltage: 350 V (dc + peak ac). Series Path Resistance (End of Life): 0.5 Ω.

Peak Carry Voltage — Unterminated: 40 V maximum. 50 Ω Terminated: 12.5 V maximum.

Peak Contact Current — 0.25 A maximum.

Peak Switching Voltages — Unterminated: 15 V maximum. 50 Ω Terminated: 3.73 V maximum.

Peak Switching Current — 0.01 A maximum.

ORDERING INFORMATION

SI 5010 Scanner **$2,275**
Includes: Instruction manual (070-3721-00); instrument interface guide (070-4615-00); reference guide (070-3881-00).

Utility Software
For TM 5000/4041 Order 062-6958-01 **$150**
See page 359 for description and ordering information.

RECOMMENDED PROBES

P6056 — 10X Passive. See page 471. **$185**
P6057 — 100X Passive. See page 471. **$190**
P6202A — FET. See page 475. **$680**
P6230 — Bias/offset. See page 474. **$395**

OPTIONAL ACCESSORIES

MULTIFUNCTION INTERFACE SYSTEM

Interfacing Cable — 50-conductor flat ribbon cable with connector to mate with front panel connector of any Multifunction Interface System function card. Other end of the 48-inch cable terminates in bare tinned leads. (This cable is a standard accessory with 50M20, 50M30, 50M40, and 50M70 cards.)
Order 015-0430-00

Single-Width Interfacing Adaptor — Mates with any single Multifunction Interface System function card to permit customized interface wiring between cards or to external system under test. Will accommodate up to five screw terminal blocks (131-3083-00 below).
Order 015-0466-00

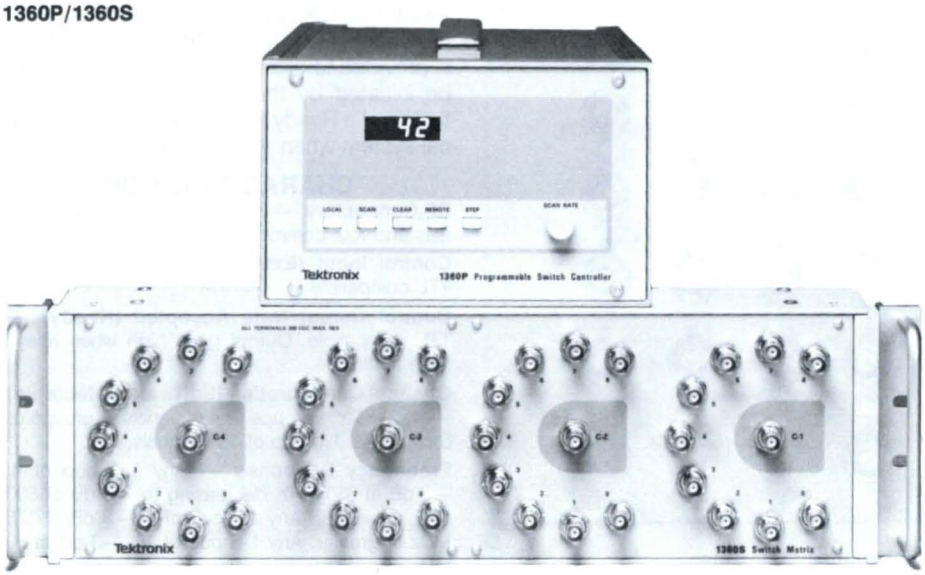
Screw Terminal Block — Mounts in 015-0466-00 Interfacing adaptor above to permit wiring changes without soldering (ten terminals per block). Order 131-3083-00

Triple-Width Interfacing Adaptor — Mates with up to three Multifunction Interface System function cards in an MI 5010 or MX 5010 to permit interface wiring among cards or to external system under test. Contains two 131-3083-00 screw terminal blocks.
Order 015-0473-00

Multifunction Interface System Card Extender — Permits operation of a function card while extended from the front of an MI 5010 or MX 5010. Order 067-1066-00

Function Card Access Shield — Dummy function card of insulating material to protect against possible electrical shock or damage in partially filled MI 5010 or MX 5010.
Order 020-0836-00

1360P/1360S



Programmable Signal Multiplexer

1360P/1360S

GPIB IEEE-488 The 1360P/1360S comply with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats.*

Signal Bandwidth to 300 MHz

50 Ω Environment

Selected Pole Readout

Flexible Switch Configuration

Rackmount or Benchtop

The 1360P/1360S Programmable Signal Multiplexer is a microprocessor-based, GPIB-compatible system instrument which is used to multiplex electrical signals. The 1360P/1360S system includes two separate chassis: the 1360P Programmable Switch Controller and the 1360S Switch Matrix. The 1360P/1360S is not part of the TM 5000 Family and thus does not require a TM 5000 mainframe for operation.

The 1360P Programmable Switch Controller is controlled via the GPIB and provides all the signals required for control of up to four 1360S Switch units. The 1360P is housed in an 8.5-inch wide (half-rackwidth) rackmount chassis, with right or left slider assemblies for rackmounting.

The 1360S Switch Matrix contains four 9-to-1 switches which can be cascaded to provide two 17-to-1 switches; a 25-to-1 switch and a 9-to-1 switch; or a 33-to-1 switch. Up to four 1360S Switch units can be controlled by one 1360P Controller unit to provide up to 129-to-1 multiplexing. In the 9-to-1 configuration, the 1360S has a signal bandwidth of 250 MHz; make/break time in all configurations is <1 ms. The switches in the 1360S can also be ganged together to provide simultaneous and synchronized multiplexing of several groups of signals.

The 1360S is housed in a 5.75-inch high, 19-inch wide rackmount chassis 3 inches deep.

CHARACTERISTICS

Bandwidth (3 dB, Through One Switch Only) — Dc to 300 MHz.

Maximum Input Voltage — 250 V dc + peak ac (not to exceed 10 VA).

Maximum Carry Current — 250 mA (not to exceed 10 VA).

VSWR (Through One Switch Only) — 5.0 at 450 MHz; 3.9 at 400 MHz; 1.9 at 250 Hz; 1.2 at 100 MHz.

Characteristic Impedance — 50 Ω ±1 Ω.

Scan Rate Variability — >10 s to <3 ms.

Make/Break Time — ≤1 ms.

ORDERING INFORMATION

1360P Switch Controller **$2,695**
Includes: Instruction manual (070-3476-00).

1360S Switch Matrix **$1,695**
Includes: Same as above.

To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext. 99

MEASUREMENT PACKAGES

Precise automatic waveform measurements for demanding applications in research, design, manufacturing and quality assurance

Automatically Saves Time

Tektronix measurement packages are specially designed to handle the increasingly complex, expensive, and time consuming task of waveform characterization.

They offer all the power and flexibility of oscilloscope acquisition, which can be coupled with programmable stimulus sources for fully automatic analysis. The packages feature signal processing software with extensive control over instrumentation, waveform manipulations, and graphic display.

Compatibility

Tektronix measurement packages provide system compatibility to allow configuration for many types of test and measurement applications. This flexibility of specialized instrument selection and easy integration allows the application potential of your automated testing unit to increase with your requirement.

System Building Blocks

Whether your application is in scientific research, engineering design or automated manufacturing and quality control, Tektronix provides for each of the functions that comprise virtually every measurement system.

Increase Productivity

Tek measurement packages combine state-of-the-art waveform acquisition capabilities with computer processing and software control. They automatically capture signals, make measurements, then display, store and document the results. Projects can be completed on time and within budget.

Systems That Put You in Charge

From today's research and development tasks to tomorrow's production testing, Tek packages give you all the capabilities needed to characterize your waveforms quickly, efficiently, and accurately.

Device Under Test (DUT)

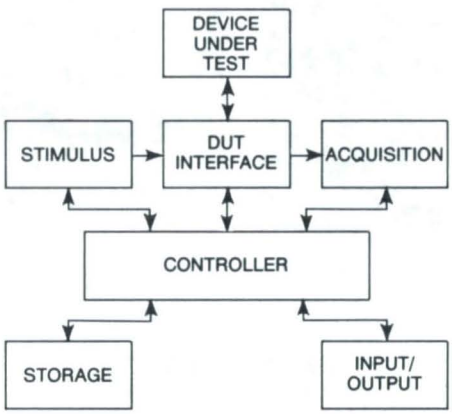
The device that is being tested by the system. The system provides stimulus to the DUT and acquires the results from the test.

Stimulus

Stimulus units, including function generators, signal generators and other sources, provide known control signals to drive the DUT through normal operation patterns or into boundary conditions for performance limits testing.

DUT Interface

The DUT Interface provides a path from the stimulus and acquisition equipment and the DUT. Tektronix provides a number of GPIB compatible products for DUT interfacing.



Acquisition

Tektronix provides a wide range of GPIB compatible test equipment for measuring an acquired signal. The growing family of GPIB compatible waveform digitizers offers the ability to capture signals ranging from seconds to picoseconds, with bandwidths up to 14 GHz. Plus, compatibility with a broad range of plug-ins provides an added dimension of measurement flexibility.

Processing

Tek minicomputer systems built around the DEC Micro/PDP-11 handle larger amounts of data and offer considerable flexibility in peripheral selection, processing power and speed, software modularity and extended memory. Contact your nearest Tek Sales Representative for more information.

Systems built around the Tek 4041 feature benchtop convenience with powerful analytical and instrument control capabilities.

Mass Storage

Mass storage, in the form of disk or magnetic tape, provides permanent storage and easy retrieval of program and raw or processed data.

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Input/Output Devices

Keyboards and keypads on terminals, controllers and some instruments provide convenient access to the system.

Graphics terminals and hard copy units provide alphanumeric and graphic presentation of data and programs as well as permanent documentation. Because the quality of the solution is often dependent on the quality of the display, you gain additional advantage by Tek's leadership in high resolution, reliable graphic and alphanumeric displays.

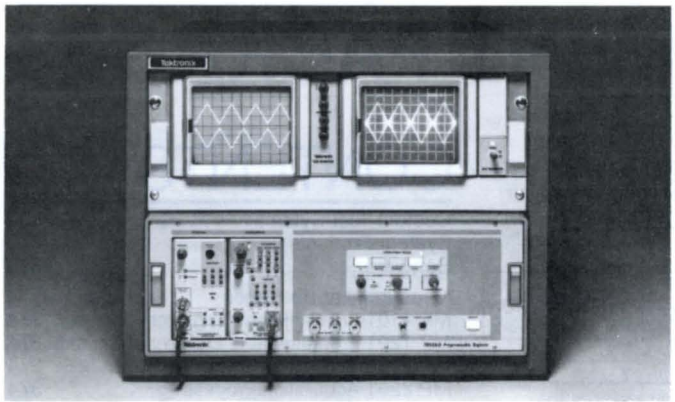
Software

Tektronix minicomputer controllers can be operated with TEK SPS BASIC, a powerful general purpose programming language which offers convenient control of instruments to acquire, process, store and display waveform data with ease. TEK SPS BASIC combines the advantages of being an interactive language with the high performance of a computer operating system. The Tek 4041 comes with its own version of extended BASIC . . . providing both the simplicity desired by the beginner and the flexibility and power required by the experienced programmer.

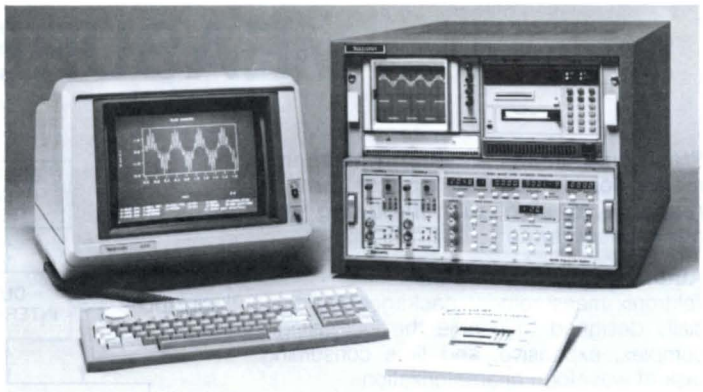
For ordering information on SPS BASIC, contact your nearest Tektronix Sales Representative.

INDIVIDUAL PACKAGE CONFIGURATION

Application	Fastest single-shot transient digitizer, highest bandwidth	Multi-record, dual-channel digitizer for both single & repetitive signals, high bandwidth	Excellent signal acquisition for repetitive signals, high bandwidth	Extensive signal acquisition capabilities with signal analysis	Versatile, compact signal stimulus & acquisition for medium and low speed signals	Makes critical audio measurements consistently, accurately and quickly
Acquisition Instrument	**7912AD**	**7612D**	**7854**	**2430**	**MI 5010/ MX 5010**	**SG 50101/ AA 5001**
Your own controller	**MP 1101** $38,700	**MP1201** $35,970				
Compact controller Tektronix 4041 with enhanced instrument control analysis BASIC software	**MP 2101** $49,170	**MP 2201** $46,600	**MP 2501** $26,800	**MP 2601** $15,650	**MP 2901** $17,950	**MP 2902** $20,775
Expandable controller Micro/PDP-11 w/TEK SPS BASIC control & analysis software	**MS 3101** See page 193	**MS 3201** See page 193				



MP 1101 (shown above) consists of a 7912AD, 7A16P, 7B90P, 620 and 634. The MP 1201 (not shown) consists of a 7612D, two 7A16Ps, and a 620.



The MP 2201 Measurement Package (shown above) consists of 4205, 4041, special software, plus MP 1201 Measurement Package. The MP 2101 Measurement Package (not shown) replaces the MP 1201 with the MP 1101 and adds special software.

MP 1101/MP 1201

GPIB IEEE-488 The MP 1101 and MP 1201 comply with IEEE Standard 488-1975.

MP 1101 Features:

Highest Bandwidth Single-Shot Acquisition (up to 500 MHz at 10 mV/Div, Nonprogrammable)

Fully Programmable up to 200 MHz Bandwidth

Codes and Formats Features

MP 1201 Features:

Dual-Channel Signal Acquisition (up to 200 MS/s Sampling Speed). Signal Bandwidth of 80 MHz

Selectable Record Length From 256 Words to 2048 Words Each Channel

Codes and Formats Features

The MP 1101 is based on the high bandwidth 7912AD Programmable Transient Digitizer. It is excellent for any signal measurement requirement needing single-shot acquisition (either for computer or operator interpretation of extremely fast signals such as laser research and high energy physics phenomena). Without a controller, the MP 1101 can be used as a high bandwidth storage oscilloscope.

In order to achieve 500 MHz bandwidth, a nonprogrammable 7A19 or 7A29 can be substituted for the 7A16P plug-in.

The MP 1201 is based on the 7612D Dual Channel Programmable Waveform Digitizer. It features very flexible record partitioning during acquisition, allowing up to 13 changes in sampling rate per record for optimum signal resolution and best memory utilization.

CHARACTERISTICS

The following characteristics are the same for the MP 1101 and MP 1201 unless otherwise indicated.

ENVIRONMENTAL

Operating Temperature — 0°C to +40°C (+32°F to +104°F).

Thermal Output — Approximately 1550 BTU/hr.

Operating Altitude — 4600 m maximum (15,000 ft).

POWER REQUIREMENTS

Standard Operating Voltage — 115 V (nominal).

Line Frequency — 60 Hz.

Maximum Power Consumption — 450 W (nominal).

PHYSICAL CHARACTERISTICS

See individual component pages for dimensions.

ORDERING INFORMATION

MP 1101 Programmable Digitizer Measurement Package **$38,700**

Includes: 7912AD; 7A16P; 7B90P; 620; 634; mounting hardware; cables; accessories; cabinet (shipped unassembled).

OPTIONS

Option 01 — Delete Plug-ins. **−$5,280**

Option 13 — Change TV scan rate to 625 lines at 50 Hz. **NC**

MP 1201 Programmable Digitizer Measurement Package **$35,970**

Includes: 7612D; two 7A16Ps; 620; mounting hardware; cables; accessories.

Option 01 — Delete plug-ins. **−$4,790**

INTERNATIONAL POWER PLUG OPTIONS

Option A1 — Universal Euro 220 V, 50 Hz.
Option A2 — UK 240 V, 50 Hz.
Option A3 — Australian 240 V, 50 Hz.
Option A4 — North American 240 V, 60 Hz.
Option A5 — Switzerland 220 V, 50 Hz.

MP 2101/MP 2201

GPIB IEEE-488 The MP 2101 and MP 2201 comply with IEEE Standard 488-1975. Both comply with Tektronix *Standard Codes and Formats.*

High Performance Waveform Acquisition

Fully Programmable Over IEEE Standard 488 Bus for System Oriented Operation

Enhanced BASIC Language—Resident 4041 BASIC With Numerous Extensions

MP 2101 Features:

Ultra High Speed Single Shot Digital Storage Capability

Up to 200 MHz Bandwidth at 10 mV/Div and Full Programmability With 7A16P Vertical Plug-In

Up to 500 MHz Bandwidth at 10 mV/Div With 7A19 Vertical Plug-In

Codes and Formats Features

MP 2201 Features:

200 Megasamples per Second Maximum Rate, Each Channel

Two Vertical Channels. Two Independent Time Bases

Eight-Bit Resolution

Codes and Formats Features

The MP 2101 provides the highest bandwidth for single-shot applications (up to 500 MHz in a nonprogrammable configuration by substituting a 7A19 or 7A29 vertical amplifier for the 7A16P), as well as built-in signal averaging. The MP 2201 provides true dual-channel; 200 MS/s digitizing with up to 80 MHz analog bandwidth; and can be tailored for different signal characteristics by using the 7000 Series plug-ins. The optional 4696 Color Ink-Jet Printer extends the usefulness of these packages.

The special MP software included with these packages enables the operator to acquire, analyze (min/max, histogram), process (correlate, convolve, FFT, etc.), display, and store waveforms from the system terminal via easy-to-use menus. The software is also designed to accommodate multiple digitizers of the same type in each system (up to 28 digitizers per system with optional second IEEE-488 bus).

CHARACTERISTICS

ENVIRONMENTAL

Operating Temperature — +10°C to +35°C (+50°F to +95°F).

Thermal Output — Approximately 3750 BTU/hr.

Operating Altitude — 4600 m maximum (15,000 ft).

POWER REQUIREMENTS

Standard Operating Voltage — 115 V (nominal).

Line Frequency — 60 Hz.

Maximum Power Consumption — 1100 W.

PHYSICAL CHARACTERISTICS

See individual component pages for dimensions.

ORDERING INFORMATION

MP 2101 Acquisition/Processing Measurement Package **$49,170**
Includes: MP 1101; 4041, 4205, cabinet, software.

MP 2201 Acquisition/Processing Measurement Package **$46,600**
Includes: MP 1201; 4041, 4205, cabinet, software.

OPTIONS

Option 01 — (MP 2101) Delete plug-ins **−$5,280**

Option 01 — (MP 2201) Delete plug-ins **−$4,790**

Option 10 — Substitute Tektronix 4207 Color Graphics Terminal for 4205. See page 52. **+$1,500**

Option 13 — Change TV scan rate to 625 lines of 50 Hz. **NC**

Option 18 — Add Tektronix 4696 Color Ink-Jet Printer. See page 73. **+$1,795**

Option 22 — Adds Option 01 to 4041 (second GPIB interface and second RS-232C port). This option is not available with Option 23. **+$1,200**

Option 23 — Adds Option 03 to 4041 (disk interface and second RS-232C port). This option is not available with Option 22. **+$1,000**

Option 26 — Adds 4041DDU (10 Mb hard disk and 5¼ in flexible disk). Requires Option 23. **+$1,995**

INTERNATIONAL POWER PLUG OPTIONS

Option A1 — Universal Euro 220 V, 50 Hz.
Option A2 — UK 240 V, 50 Hz.
Option A3 — Australian 240 V, 50 Hz.
Option A4 — North American 240 V, 60 Hz.
Option A5 — Switzerland 220 V, 50 Hz.

For additional information on alternative mounting configurations, contact your local Tektronix Sales Office and ask for a Sales Engineer.

TRAINING

Tektronix Instrument Group Customer Training offers operation and application training to help you get full value out of your instrumentation investment. Information is on pages 191-192. For further information, or to enroll, call us at 1-800-225-7802. For international orders, contact your nearest Sales Office.

The MP 2501 Measurement Package consists of a 4205, 4041, 7854, and software.

MP 2501

GPIB IEEE-488 The MP 2501 complies with IEEE Standard 488-1975.

7854 Waveform Processing Oscilloscope
Dc to 400 MHz Bandwidth at 10 mV/Div
Stores Repetitive Waveforms up to 400 MHz (up to 14 GHz With Sampling Plug-Ins)
Single Shot Events and Pretrigger up to 50 µs/Div With 7B87 Time Base

Enhanced BASIC Language—Resident 4041 BASIC With Numerous Extensions

The MP 2501 Acquisition/Processing Measurement Package is based on the Tektronix 7854 Waveform Processing Oscilloscope, and is designed for signal acquisition, analysis, and processing of repetitive waveforms up to 400 MHz, or up to 14 GHz with optional sampling plug-ins. It provides flexibility for making controller-assisted measurements in fiber optic testing environments using Tektronix sampling plug-in units. The 4696 Color Ink-Jet Printer is a particularly useful option with this package.

The MP software complements the built-in waveform processing and analysis features of the 7854 with menu-driven functions such as CORRELATE, CONVOLVE, FFT, DIFFERENTIATE, INTEGRATE, and TAPER. The MP software also greatly facilitates the storage and retrieval of waveforms and 7854 programs via mass media. The software can control up to 14 7854s (up to 28 with the optional second IEEE-488 bus).

CHARACTERISTICS

ENVIRONMENTAL

Operating Temperature — +10°C to +35°C (+50°F to +95°F).

Thermal Output — Approximately 2750 BTU/hr.

Operating Altitude — 4600 m maximum (15,000 ft).

POWER REQUIREMENTS

Standard Operating Line Voltage — 115 V (nominal).

Line Frequency — 60 Hz.

Maximum Power Consumption — 800 W (nominal).

PHYSICAL CHARACTERISTICS

See individual component pages for dimensions.

ORDERING INFORMATION

MP 2501 Acquisition/Processing Measurement Package (Order appropriate 7000 Series plug-ins, such as 7A16A, and 7B80. See pages 240 and 245.) **$26,800**
Includes: 7854, 4041, 4205, software.

OPTIONS

Option 10 — Substitute Tektronix 4207 Color Graphics Terminal for 4205. See page 52. **+$1,500**

Option 18 — Add Tektronix 4696 Color Ink-Jet Printer. See page 73. **+$1,795**

Option 22 — Adds Option 01 to 4041 (second GPIB interface and second RS-232C port) This option is not available with Option 23. **+$1,200**

Option 23 — Adds Option 03 to 4041 (disk interface and second RS-232C port). This option is not available with Option 22. **+$1,000**

Option 26 — Adds 4041DDU (10 Mb hard disk and 5¼ in flexible disk). Requires Option 23. **+$1,900**

OPTIONAL ACCESSORIES

Recommended Cart — (For 7854 and 4041) K213 Option 10 Lab Cart with keyboard drawer for the 7854 and lower shelf for the 4041. See page 462 for a complete description. **$595**

TRAINING

Tektronix Instrument Group Customer Training offers operation and application training to help you get full value out of your instrumentation investment. Information is on pages 191-192. For further information, or to enroll, call us at 1-800-225-7802. For international orders, contact your nearest Sales Office.

MP 2601

GPIB IEEE-488 The MP 2601 complies with IEEE Standard 488-1978 and with Tektronix *Standard Codes and Formats.*

Two Channels Simultaneous Acquisition

100 MHz Sample Rate for Single-Shot Acquisition

150 MHz Bandwidth for Repetitive Signals

Envelope Mode for 2 ns Glitch Capture at Any Sweep Speed

Signal Averaging to Pull Signals Out of Noise

Extensive Triggering Capabilities

Event Capture on Trigger Events or When Signal Exceeds Predefined Limits

Data Logging Upon Demand, With Each Trigger Event or When Signal Exceeds Predefined Limits

Extensive Time and Amplitude Measurements

Signal Processing and Data Manipulation to Match Measurement Requirements

Ease of Use Via Menu-Driven Control

The MP 2601 Portable Measurement Package provides extensive signal acquisition capabilities with signal analysis and forms a system directed at measurement solutions.

Functions:

- Reference waveform to file transfers 46 files (100 files, Option 29)
- Files to reference waveforms transfer
- Event capture
- 20 parameters on waveforms (top, base, distal, mesial, proximal, min, max, peak to peak, mid, mean, top overshoot, base overshoot, rise, fall, width, duty cycle, period, 1/period, RMS, and area)
- Waveform mathematics (add, subtract, multiply, divide, integrate, 2-point differentiation, 3-point differentation, smoothing, FFT, correlate, add scalar, and multiply by scalar)
- Application programs
- Environmental parameters

ORDERING INFORMATION

MP 2601 Portable Measurement Package **$15,650**

Includes: 4041 (with Option 10); 2430; IEEE-488 cable; S45F601 Software Package.

OPTIONS

Option 05 — Video Trigger. **+$1,050**
Option 11 — Probe Power. **+$165**
Option 18 — Add 4696 Ink-Jet Printer. **+$1,795**
Option 19 — Add 4644 Printer. **+$1,350**
Option 22 — Adds Option 01 to 4041 (second GPIB interface and second RS-232C port). This option is not available with Option 23. **+$1,200**
Option 23 — Adds Option 03 to 4041 (disk interface and second RS-232C port). This option is not available with Option 22. **+$1,000**
Option 26 — Adds 4041DDU (10 Mb hard disk and 5¼ in flexible disk). Requires Option 23. **+$1,995**
Option 29*1 — Add disk-based implementation to provide greater functionality. Incorporates Options 23/26. Includes S45F602 software.
Option 30 — Adds Option 30 to 4041 (program development ROMS & carrier). **+$995**
Option 31 — Adds Option 31 to 4041 (program development keyboard). **+$550**
Option 32 — Add 4205. **+$2,995**
Option 35 — Add 4207. **+$3,995**
Option 36 — Add 4208. **+$8,995**

**1 To order, contact your local Tektronix Sales Office.*

INTERNATIONAL POWER PLUG OPTIONS

Option A1 — Universal Euro 220 V, 50 Hz.
Option A2 — UK 240 V, 50 Hz.
Option A3 — Australian 240 V, 50 Hz.
Option A4 — North American 240 V, 60 Hz.
Option A5 — Switzerland 220 V, 50 Hz.

TRAINING

Tektronix Instrument Group Customer Training offers operation and application training to help you get full value out of your instrumentation investment. Information is on pages 195–196. For further information, or to enroll, call us at 503-642-8013 (collect).

MP 2601 on a K213 Instrument Cart.

MP 2901

GPIB IEEE-488 The MP 2901 complies with IEEE Standard 488-1978 and with Tektronix *Standard Codes and Formats.*

A General Purpose IEEE-488 Development System

Rapid, Error-Free Software Development by Nonprogrammers

Easy Fixturing to the Device-Under-Test

Compatible With IEEE Standard 488 Equipment from Most Suppliers

The MP 2901 overcomes two of the most difficult hurdles in implementing an automated system—writing the test software and interfacing the IEEE-488 system to the unique device-under-test.

The task of software development is dramatically reduced with TEK EZ-TEST software. This software is a high-level, menu-driven program that allows even nonprogrammers to create test software. The generated BASIC code is error-free and structured (to allow easy long-term maintenance). TEK EZ-TEST is powerful and flexible. It supports "learn mode" found in Tektronix instruments for exceptionally easy instrument set-up. Naturally, TEK EZ-TEST has the ability to accept IEEE-488 instruments from other manufacturers as well. The test programs generated are standalone 4041 BASIC programs so TEK EZ-TEST generated programs can be tailored to meet even the most unique test requirements.

The MI 5010/MX 5010 provide A/D, D/A, digital I/O, scanning, switching, and other functions using high level commands. With these functions, the task of stimulating/measuring/switching the device-under-test and the test instruments is made easy because the MI 5010/MX 5010 handle the interface between the device-under-test and the IEEE-488 bus.

CHARACTERISTICS

ENVIRONMENTAL

Operating Temperature — +10°C to +35°C (+50°F to +95°F).

Operating Altitude — 4600 m maximum (15,000 ft).

POWER REQUIREMENTS

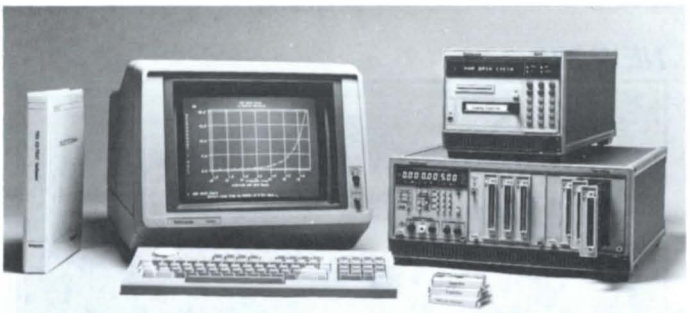
Standard Operating Voltage — 115 V (nominal).

Line Frequency — 60 Hz.

Maximum Power Consumption — 970 W.

PHYSICAL CHARACTERISTICS

See individual component pages for dimensions.



MP 2901 consists of 4041, 4205, TM 5006, MI 5010, MX 5010, PS 5010 and software.

MP 2902 shown with Option 2H (DC 5010 Programmable Universal Counter/Timer).

ORDERING INFORMATION

MP 2901 Incoming Inspection Test Station **$17,950**

Includes: 4041, 4205, TM 5006, MI 5010/MX 5010; extender; PS 5010, TEK EZ-TEST Software.

OPTIONS

Option 03 — Delete MI 5010, MX 5010, PS 5010. **−$6,150**

Option 1A — Add 50M10 A/D Converter Card. **+$895**

Option 1B — Add 50M20 D/A Converter Card. **+$910**

Option 1C — Add 50M30 Digital I/O Card. **+$495**

Option 1D — Add 50M40 Relay Scanner Card. **+$695**

Option 1E — Add 50M41 Low Level Scanner Card. **+$995**

Option 1F — Add M41A1 Low Level Amplifier. **+$550**

Option 1G — Add 50M50 16 k Buffer Memory Card. **+$995**

Option 1H — Add 50M70 Development Card. **+$410**

Option 10 — Substitute 4207 Color Graphics Terminal for 4205. **+$1,500**

Option 18 — Add 4696 Color Ink-Jet Printer. **+$1,795**

Option 19 — Add 4644 printer. **+$1,350**

Option 2A — Add TM 5006 Mainframe with Option 02 and 2 m GPIB Cable. **+$1,275**

Option 2B — Add TM 5006 Mainframe with Option 12 and 2 m GPIB Cable. **+$1,375**

Option 2C — Add DM 5010 4½ Digital Multimeter. **+$2,260**

Option 2D — Add FG 5010 20 MHz Function Generator. **+$3,995**

Option 2E — Add SG 5010 Oscillator. **+$4,195**

Option 2F — Add PS 5010 ±32 V Triple Power Supply. **+$3,050**

Option 2G — Add PS 5004 20 V Precision Power Supply. **+$1,850**

Option 2H — Add DC 5010 350 MHz Digital Counter. **+$4,610**

Option 2J — Add SI 5010 16 Channel, 350 MHz Scanner. **+$2,275**

Option 2K — Add MI 5010 Multifunction Interface. **+$1,760**

Option 2L — Add MX 5010 Interface Extender. **+$740**

Option 2M — Add DC 5009 135 MHz Digital Counter. **+$2,775**

Option 22 — Add Option 01 to 4041 (second GPIB Interface and second RS-232C port). This option is not available with Option 23. **+$1,200**

Option 23 — Add Option 03 to 4041. (Disk Interface and second RS-232C port). This option is not available with Option 22. **+$1,000**

Option 26 — Adds 4041DDU (10 Mb hard disk and 5¼ in flexible disk). Requires Option 23. **+$1,995**

INTERNATIONAL POWER PLUG OPTIONS

Option A1 — Universal Euro 220 V, 50 Hz.
Option A2 — UK 240 V, 50 Hz.
Option A3 — Australian 240 V, 50 Hz.
Option A4 — North American 240 V, 60 Hz.
Option A5 — Switzerland 220 V, 50 Hz.

TRAINING

Tektronix Instrument Group Customer Training offers operation and application training to help you get full value out of your instrumentation investment. Information is on pages 191-192. For further information, or to enroll, call us at 1-800-225-7802. For international orders, contact your nearest Sales Office.

MP 2902

GPIB IEEE-488 The MP 2902 complies with IEEE Standard 488-1978 and with Tektronix *Standard Codes and Formats.*

Eleven Comprehensive Audio Tests

Rapid, Error-Free Test Program Development by Nonprogrammers

State-of-the-Art Measurement Performance

Software Supports All IEEE Standard 488 Instruments and Provides for Unique Test Requirements

The MP 2902 Audio Measurements Package makes critical audio measurements consistently, accurately and quickly. The Tektronix Audio Test Program Generator (Audio TPG) produces automated test procedures quickly and easily. This software development tool dramatically simplifies the process of converting manual tests into software. With the Audio TPG, menus guide nonprogrammers through test development. The result is error-free code written in 4041 BASIC. Tests supported in the Audio TPG include: THD vs Frequency, THD vs Output Level, IMD vs Output Level (SMPTE or CCIF), CCIF IMD vs Frequency, Frequency Response, Signal-to-Noise, Level (Voltage and Power), Linearity, and External Stimulus. Provisions are made for the user to add any unique testing requirements not directly supported in the Audio TPG.

Whether the environment is production or R&D and whether the test requirement is microphone characterization, broadcast station proof-of-performance, or measuring noise and distortion of audiotype machines, the MP 2902 offers accuracy, speed, and consistency.

CHARACTERISTICS

ENVIRONMENTAL

Operating Temperature — +10°C to +35°C (+50°F to +95°F).

Operating Altitude — 4600 m maximum (15,000 ft).

POWER REQUIREMENTS

Standard Operating Line Voltage — 115 V (nominal).

Line Frequency — 60 Hz.

Maximum Power Consumption — 970 W.

PHYSICAL CHARACTERISTICS

See individual component pages for dimensions.

ORDERING INFORMATION

MP 2902 Audio Measurements Package **$20,775**

Includes: 4041; 4205; TM 5006; AA 5001; SG 5010; software.

OPTIONS

Option 1J — Substitute AA 5001. Option 02 (CCIR/DIN) for AA 5001. **+$410**

Option 10 — Substitute 4207 Color Graphics Terminal for the 4205 Color Graphics Terminal. **+$1,500**

Option 18 — Adds 4696 Color Ink-Jet Printer. **+$1,795**

Option 19 — Adds 4644 Dot Matrix Printer. **+$1,350**

Option 2H — Adds DC 5010 Programmable Universal Counter/Timer. **+$4,610**

Option 22 — Adds Option 01 to 4041 (second GPIB Interface and second RS-232C Port). This option is not available with Option 23. **+$1,200**

Option 23 — Adds Option 03 to 4041 (Disk Interface and second RS-232C Port). This option is not available with Option 22. **+$1,000**

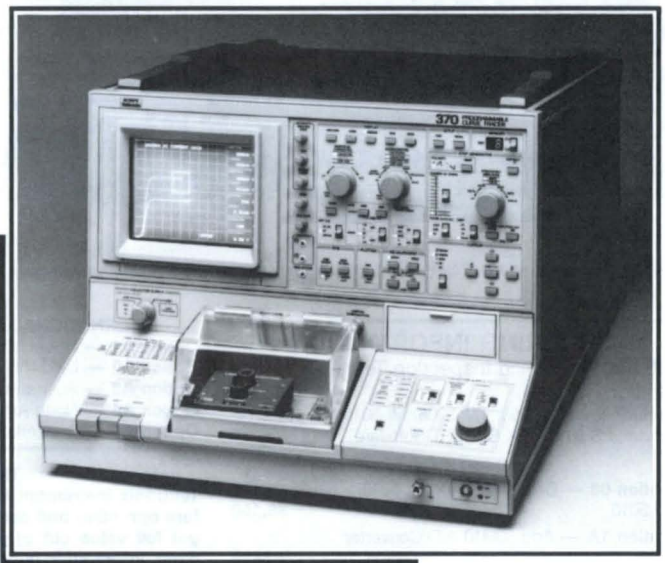
Option 26 — Adds 4041DDU (10 Mb hard disk and 5¼ in flexbile disk). Requires Option 23. **+$1,995**

INTERNATIONAL POWER PLUG OPTIONS

Option A1 — Universal Euro 220 V, 50 Hz.
Option A2 — UK 240 V, 50 Hz.
Option A3 — Australian 240 V, 50 Hz.
Option A4 — North American 240 V, 60 Hz.
Option A5 — Switzerland 220 V, 50 Hz.

CURVE TRACERS

NEW 370



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5CT1N and 7CT1N Curve Tracer Plug-Ins . 389

The 370 Programmable Curve Tracer delivers comprehensive information on a range of semiconductor devices and integrated circuits—from two-, three-, and four-terminal devices such as diodes (signal, rectifier, zener); transistors (bipolar, FET); thyristors (SCR, UJT, Triac) to optoelectronic (optoisolator, photodetector) and ICs.

Like other curve tracers, the 370 reveals more than pinpointed parameters. It shows you what happens between specified points in a quickly graphed curve, thus providing the valuable performance data necessary for accurate design, analysis, and evaluation.

In addition, the 370 offers all the benefits of programmable instrumentation, from curve storage to precise repetition of test parameters and data; from automatic test sequencing to various comparisons of device behavior at different points in time—all with the added capability of computerized control and analysis.

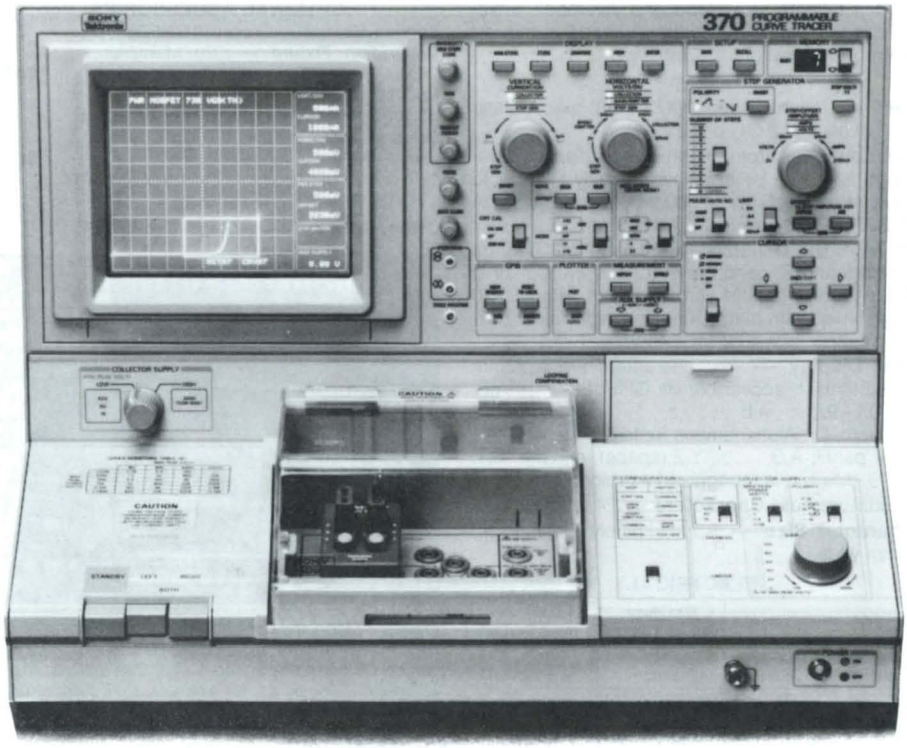
The 576 and 577 Curve Tracers use standard plug-in test fixtures for a variety of low or high current applications. The 172 Programmable Test Fixture and the 176 Pulsed High-Current Fixture are designed for use in the 576. The 178 Linear IC Test Fixture is designed for use in the 577.

The 5CT1N and 7CT1N plug-in units are designed for use in the 5000 Series and 7000 Series oscilloscopes respectively.

The following Curve Tracer System descriptions will help you choose the system that best meets your requirements. Additional information is available. Contact your local Sales Engineer or use the reply card in the back of this catalog.

TEST FIXTURES SELECTION GUIDE

Application/Feature	172	176	177	178	5CT1N	7CT1N
Programmable Test Fixture—Up to 11 different tests	✓					
Pulsed High Current Fixture—1000 W capability		✓				
Standard Test Fixture for 577			✓			
Linear IC Test Fixture				✓		
Curve Tracer Plug-Ins—Test devices up to 0.5 W					✓	✓
Pulsed collector operation to 200 A Peak		✓				
Test single, dual or quad operational or differential amplifiers, comparators, regulators, etc.				✓		
Test Linear IC under low current conditions				✓		
Test small signal transistors under pulsed collector breakdown conditions without overdissipation		✓				
Mainframe Compatibility: 576	✓	✓				
577			✓	✓		
5000 Series oscilloscopes					✓	
7000 Series oscilloscopes						✓
Page	383	384	385	388	389	389
Prices	$5,335	$5,900	$1,425	$3,560	$1,075	$1,785



NEW 370

Programmable Curve Tracer

GPIB IEEE-488 The 370 complies with IEEE Standard 488-1978 and with Tektronix *Standard Codes and Formats.*

Digitized Waveforms

Bubble Memory Storage
Store 16 Test Set-Ups
Store 16 Families of Curves

Plotter Interface

Test Sequencing Without Controller

Waveform Comparisons

Display/Waveform Cursors

Displays 24 Characters of Text

On-Screen Readout of Control Settings/ Cursor Values

Maximum Volts 2000, Vertical Sensitivity 100 pA/Div (1 pA Resolution)

TYPICAL APPLICATIONS

Automate Semiconductor Manufacturing Processes
Incoming Inspection
Production Device Testing
Semiconductor R & D

Program Control

The 370 is programmable via IEEE Standard 488 General Purpose Interface Bus (GPIB). This interface provides remote control and automated acquisition of curve data. You can send characteristic curve data in either direction over the bus (from the 370 to the controller, or vice versa).

When using a controller, you can control the front panel remotely except for controls intended for local use only (such as Intensity). The GPIB complies with Tektronix' Interface Standard for GPIB Codes, Formats, Conventions, and Features.

Digitized Waveforms

Display modes are selected by pushbuttons labeled Nonstore, Store, Compare, View, and Enter. When you select Nonstore, the 370 operates like a conventional curve tracer. When you choose Store, the 370 displays digitized characteristic curves with a bright, flicker-free trace. The Enter button lets you put the digitized display into the 370's bubble memory. The View button recalls displays from memory. With Compare mode, you contrast characteristic curves by displaying Store and View curves simultaneously.

Bubble Memory

The 370 provides nonvolatile memory via a bubble memory cassette plugged into a front panel opening. Each cassette can store 16 families of curves and 16 front panel set-ups. This storage technology is virtually impervious to the dust and grime that impair other storage media performance, making the 370 an ideal measurement instrument for harsh environments like factory floors and incoming inspection areas.

Front Panel Set-Up

The 370 can store 16 sets of front panel control settings and recall them later. Pressing the Save button saves all current front panel settings in bubble memory. Pressing Recall restores the front panel settings that were previously saved.

With stored set-ups, you can easily cycle through a series of tests—either semiautomatically, by pressing front panel controls to begin each test, or automatically, under program control.

Test Sequencing

You can sequence through as many as 16 device tests from the front panel without using a controller.

Performance Conditions

The following electrical and environmental characteristics are valid for instruments operated at ambient temperatures from +10°C to +40°C after an initial warm-up period of 20 minutes, when previously calibrated at a temperature from +15°C to +25°C.

CHARACTERISTICS

COLLECTOR SUPPLY

Polarity/Modes — Select from these seven modes of collector supply operation: Ac at line frequency; + (positive full wave rectified); − (negative full wave rectified); +Dc (positive dc); −Dc (negative dc); +Leakage (positive dc, emitter current); −Leakage (negative dc, emitter current).

Maximum Peak Voltage and Voltage Accuracy — Peak open circuit voltage on all ranges within +10%, −0%, at Max Peak Power of 50 W.

Range	16 V	80 V	400 V	2000 V
Max Peak Current	10 A	2 A	0.4 A	0.05 A
Peak Current Pulsed	20 A	4 A	0.8 A	0.1 A
Min Series*[1] Resistance (Ω)	0.26	6.4	160	20K
Max Series*[1] Resistance (Ω)	800	20K	500K	12.5M

*[1] *Series resistance: available from 0.26 Ω to 12.5 MΩ (±5% or ±0.1 Ω).*

Peak Power — 0.08 W, 0.4 W, 2 W, 10 W, 50 W, 220 W.

Variable Collector Supply — 0 to 100% in 0.1% increments.

Safety Interlocks — A protective cover must be in place over test terminal and lid shut before you can apply collector voltage.

STEP GENERATOR

Current Mode — Amplitude Range: 50 nA to 200 mA in 1-2-5 sequence in 21 steps, selected by Step/Offset Ampl. Max current is 20X step amplitude, except for 2 A when switch is set to 200 mA. Max voltage is at least 10 V. Max opposing offset current is 10X step amplitude. Max opposing volts are less than 7 V. Ripple plus noise is less than 0.5% X step amplitude +1 nA.

Voltage Mode — Amplitude Switch Range: 50 mV to 2 V, in 1-2-5 sequence. Max Voltage: 20X step amplitude. Max Current: At least 2 A at 10 V or less, or 10 mA at 40 V.

Accuracy (Current or Voltage Steps Including Offset) — Incremental 2%. Absolute is less than 2%X total output +3%X amplitude setting.

Offset Control — Variable from −10 to +10X step amplitude, with 0.1% resolution.

Short Circuit Current Limiting — Selected by current limit switch: 20 mA, 100 mA, 500 mA, 2 A (+50%, −20%).

Maximum Opposing Offset Volts — 10X step amplitude.

Maximum Opposing Current — Less than 10 mA.

Step Rates — 2X line frequency (1X line frequency in ac collector supply). Steps occur at 0 collector voltage.

Pulsed Steps — 80 μs or 300 μs wide ±10%.

SONY®/TEKTRONIX® PROGRAMMABLE CURVE TRACER

Steps and Offset Polarity — Same as collector supply polarity when step generator polarity invert is disabled. Opposite to collector supply polarity when step generator polarity invert is selected or configuration switch is set to base grounded. If configuration is set to base grounded, step generator polarity invert is disabled.

Number of Steps — Selectable from 0 to 10.

Auxiliary Supply — Range: −40 to +40 V with 20 mV resolution. Accuracy: Less than 50 mV +2% of total output. Output Current: At least 100 mA ±20 V; at least 10 mA ±40 V.

Nonstore Mode — Collector Current: Range is 1 μA/div to 2 A/div in a 1-2-5 sequence of 20 steps. X10 Mag extends max sensitivity to 100 nA/div (1 nA resolution). Both unmagnified and magnified accuracy are within 3%. Emitter Current: Range is 1 nA/div to 2 mA/div in 1-2-5 sequence of 20 steps. X10 Mag extends max sensitivity to 100 pA/div. Both unmagnified and magnified accuracy are within 3%.

Step Generator Display — Range is 1 or 10 steps/div, or 1 step/10 div. Unmagnified and magnified accuracy are within 3%.

Display Offset — Vertical offset of display centerline value up to 10 div in 21 half-div steps.

Digital Storage Vertical Acquisitions — A/D Converter: Resolution is 10 bits for 10.24 divisions, 100 counts per division. Maximum data points are 1024. Maximum sampling rate is line frequency X1024. Minimum sampling rate is line frequency X2. Collector Current: Range is 1 μA/div to 2 A/div in a 1-2-5 sequence of 20 steps. X10 mag extends max sensitivity to 100 nA/div (1 nA resolution). Unmagnified accuracy is within 1.5% of readout +0.03 div of setting with dot cursor. Magnified accuracy is within 0.5% of readout +0.03 div of setting with dot cursor. Emitter Current: Range is 1 nA/div to 2 mA/div in a 1-2-5 sequence of 20 steps. X10 mag extends max sensitivity to 100 pA/div (1 pA resolution). Unmagnified accuracy is within 1.5% of readout +0.03 div of setting +1 nA with dot cursor. Magnified accuracy is within 0.5% of readout +0.03 div of setting with dot cursor.

Nonstore Horizontal Deflection System — Collector Volts: Range is 50 mV/div to 500 V/div in a 1-2-5 sequence of 21 steps. X10 mag extends max sensitivity to 5 mV/div (50 μV resolution). Unmagnified and magnified accuracy are within 3%. Base/Emitter Volts: Range is 50 mV/div to 2 V/div in a 1-2-5 sequence of 6 steps. X10 mag extends max sensitivity to 5 mV/div (50 μV resolution). Unmagnified and magnified accuracy are within 3%. Step Generator Display: Range is 1 or 10 steps/div, or 1 step/10 div. Unmagnified and magnified accuracy are within 3%. Display Offset: Horizontal offset of display centerline value up to 10 div in 21 half-div steps.

Digital Storage Horizontal Acquisition — A/D Converter Acquisition: Resolution is 10 bits for 10.24 div, 100 counts per div. Sampling rate is 2 to 1024X line frequency. Collector Volts: Range is 50 mV/div to 500 V/div in a 1-2-5 sequence of 21 steps. X10 mag extends max sensitivity to 5 mV/div (50 μV resolution). Unmagnified accuracy is within 1.5% of readout +0.03 div of setting with dot cursor. Magnified accuracy is within 0.5% of readout +0.03 div of setting with dot cursor. Base/Emitter Volts: Range is 50 mV/div to 2 V/div in a 1-2-5 sequence of 6 steps. X10 mag extends max sensitivity to 5 mV/div (50 μV resolution). Unmagnified accuracy is within 1.5% of readout +0.03 div of setting with dot cursor. Magnified accuracy is within 0.5% of readout +0.03 div of setting with dot cursor. Acquisition Modes (Normal, Envelope and Average): Envelope is vertical or horizontal. Average is moving average with weight of 1/4 or 1/32.

CRT

CRT — 7 inch diagonal (173 mm), electrostatic deflection, GH (P31) phosphor.

Readout — Automatic on-screen display. Over range is shown by a flashing display. 100 pA to 2 A/vertical div; 5 mV to 500 V/horizontal div; 5 nA to 200 mA and 5 mV to 2 V per step.

BETA or g_m/Division — 500 nano to 400 mega for Beta and 50 nanoS to 400 S for g_m. Cursor is 4-digit horizontal and vertical values without X10 mag, 5-digit with mag. Offset is 4-digit value. Auxiliary supply is −40 V to +40 V.

Text Display — Text characters are alphanumeric fonts 1, accessible via GPIB; SP,!, . . . A,B, . . . 0,1−,9,/, . . . a,b, . . . y,z, . . . ; u is recognized as micro. Or: Alphanumeric fonts 2, accessible via front panel; A,B, . . . , Y,Z,(space), m,u,n,p,,,0,1, . . . 9,-,/,*,(,); u is recognized as micro.

Maximum Text Characters — 24 letters.

Character Size — Approximately 3 mm high, 2 mm wide.

ELECTRICAL

	Maximum Output Voltage	Maximum Output Current
Base, Base Sense; Emitter, Emitter Sense	±40 V	±20 A
Connectors — (Collector, Collector Sense)		
Adaptor Connectors	±2000 V	±20 A
Step Gen Out Connector	±40 V	±2 A
Aux Supply Connector	±40 V ±20 V	@ ±10 mA @ 100 mA
Ext Base or Emitter Connector	±40 V	±2 A

POWER REQUIREMENTS

Line Voltage Ranges — 115 V ac, 230 V ac. High: 107 V ac to 132 V ac, 214 V ac to 250 V ac. Low: 90 V ac to 110 V ac, 180 V ac to 220 V ac.

Line Frequency Range — 48.0 to 66.0 Hz.

Power Consumption — Maximum: 400 W, 3.5 A at 132 V 60 Hz. Typical: 120 W, 1.3 A at 115 V 50 Hz.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	429	16.9
Height	332	13.1
Depth	637	25.1
Weight≈	**kg**	**lb**
Net, standard	35.0	77.0
Net, with Option 1R, Rackmount	36.0	79.2

ORDERING INFORMATION

370 Programmable Curve Tracer **$15,750**

Includes: Blank adaptor, Kelvin Sense (A1001); In-line transistor adaptor, Kelvin Sense (A1002); Axial lead diode, Kelvin Sense (A1005); 4 and 6 lead dual width transistor/FET (A1007); bubble memory cassette (020-1310-00); protective cover (337-3344-00); spare fuses 125 V/4 amp (159-0259-00); slow blow 250V/2 amp (159-0260-00); power cord (161-0066-00); Operator's manual (070-6064-00); Instrument Interfacing Guide (070-6067-00); Pocket Reference Guide (070-6066-00).

OPTION

Option 1R — Rackmount **+$375**

INTERNATIONAL POWER PLUG OPTIONS

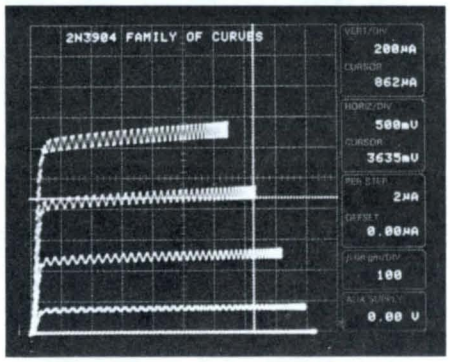
Option A1 — Universal Euro 220 V, 50 Hz.
Option A2 — UK 240 V, 50 Hz.
Option A3 — Australian 240 V, 50 Hz.
Option A4 — North American 240 V, 60 Hz.
Option A5 — Switzerland 220 V, 50 Hz.

OPTIONAL ACCESSORIES

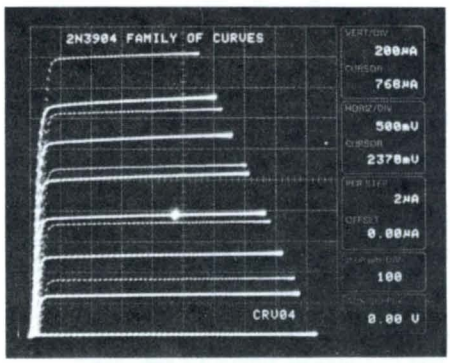
Service Manual — Order 070-6065-00 **$45**
Calibration Fixture — 370 Maintenance. Order 067-1286-00 **$405**
Socket Adaptors — See page 388
HC100 Plotter*1 — Four pen color plotter. See page 445.
Cart — K217. See page 362. **$495**
**1 To order, contact your local Tektronix Sales Office.*

CAMERAS

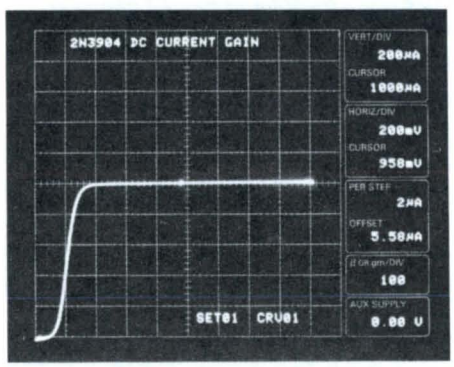
C-59A, C-5C, C-7 — See pages 454, 450, 448



Envelope Mode and Crosshair Cursor—Capture and display maximum and minimum excursions of digitized curves. Detect subtle changes over time that you might otherwise overlook, as, for example, DUT thermal drift. The crosshair cursor in this application shows predrift conditions.



Waveform Comparisons—Simultaneously display real time characteristic curves of a DUT, along with a previously acquired family of curves that are digitally stored in internal memory. Thus, you quickly and conveniently compare the DUT with reference data.



Dot Cursor Mode — Position an intensified dot cursor to any point on the waveform and read out the vertical and horizontal coordinates. The dot cursor is also useful when sending data over the GPIB.

The SONY®/TEKTRONIX® 370 is manufactured and marketed in Japan by Sony/Tektronix Corporation, Tokyo, Japan. Outside of Japan the 370 is available from Tektronix, Inc., its marketing subsidiaries and distributors.

576

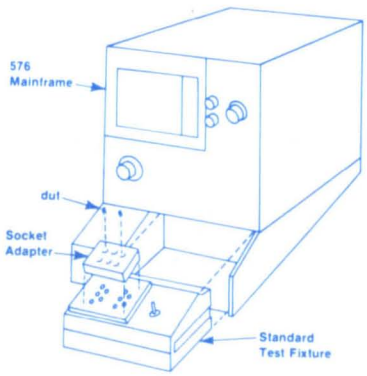
Tests Two- and Three-Terminal Discrete Semiconductors

Power Capability Up to 220 Watts

Convenient Scale Factor Readout

Other Test Fixtures for Semiautomated Testing and Testing Power Devices to 1000 Watts

TYPICAL APPLICATIONS
Semiconductor R & D Production Device Testing Incoming Inspection



The Tektronix 576 Curve Tracer System continues to hold the title "standard of the industry." The 576 accepts three different test fixtures: the Standard Test Fixture, 172 Programmable Test Fixture (see page 383), and the 176 Pulsed High Current Fixture (see page 384). The 576 is an excellent general purpose curve tracer system that performs well in applications where high current testing is required.

With the Standard Test Fixture, the collector supply of the 576 delivers up to 220 watts peak to the device under test. The step generator can deliver up to two amps in both its current and voltage modes of operation. With the 176 High Current Fixture, the 576 is capable of pulsed collector operation up to 200 amps peak.

One of the features that sets the 576 apart from the Tektronix 577 Curve Tracer System is the display area adjacent to the 576's CRT. These alphanumeric indicators provide readout of vertical and horizontal deflection factors, step amplitude, and Beta/div or g_m/div. The Beta or g_m readout saves the operator from the arithmetic usually necessary to arrive at these parameters. These indicators also provide a permanent record of major knob settings in 576 CRT photographs.

Another unique feature of the 576 is the Calibrated Display Offset. Combining a calibrated position control and a display magnifier, the Display Offset increases resolution and allows the operator to make more precise measurements.

Other features of the 576 Curve Tracer include: adjustable current limiting in the step generator; either 300 μs or 80 μs pulse width in pulsed base operation; pushbuttons to check display zero and calibration; and an illuminated graticule.

A safety interlock protects the operator from dangerous voltages. For collector voltages greater than 15 V, a plastic protective safety shield must be in place over the test terminals and its lid closed before collector voltage can be applied.

Standard Test Fixture.

CHARACTERISTICS

COLLECTOR SUPPLY

Modes/Polarity — Norm: Ac (at line frequency); positive or negative full-wave rectified ac. Dc: Positive or negative dc. Leakage: Emitter current rather than collector current measurements. 1000X increase in vertical deflection sensitivity (1 nA/div).

Voltages*1

Range	15 V	75 V	350 V	1500 V
Max Continuous Peak Current	10 A	2 A	0.5 A	0.1 A
Peak Pulse Current	≥20 A	≥4 A	≥1 A	≥0.2 A

**1 Peak open circuit voltages within +35% and −5% of indicated range.*

Series Resistance — From 0.3 Ω to 6.5 MΩ in 12 steps, all within 5% or 0.1 Ω. Peak Power Limit Setting: 0.1 W, 0.5 W, 2.2 W, 10 W, 50 W, 220 W.

Safety Interlock — Protects operator from dangerous voltages.

STEP GENERATOR

Current Mode — Step/Offset Amplitude Range: 5 nA/step (with X0.1 Mult) to 200 mA/step, 1-2-5 sequence. Maximum Current (Steps and Aiding Offset): X20 amplitude setting, except X10 (2 A) at 200 mA/step and X15 (1.5 A) at 100 mA/step. Maximum Voltage (Steps and Aiding Offset): At least 10 V. Maximum Opposing Offset Current: X10 amplitude setting or 10 mA, whichever is less. Maximum opposing voltage is limited at 1 V to 3 V.

Voltage Mode — Step/Offset Amplitude Range: 5 mV/step (with X0.1 Mult) to 2 V/step, 1-2-5 sequence. Maximum Voltage (Steps and Aiding Offset): X20 amplitude switch setting, 40 V maximum. Maximum Current (Steps and Aiding Offset): At least 2 A at 10 V, derating to 10 mA at 40 V. Short Circuit Current Limiting: 20 mA, 100 mA, 500 mA +100%, −0%; 2 A +50%, −0%. Maximum Opposing Offset Voltage: X10 amplitude setting. Maximum Opposing Current: Limited between 5 mA and 20 mA.

Accuracy — Incremental: Within 5%, between steps, within 10% with X1.0 Mult. Absolute: Within 2% of total output including offset, or 1% of amplitude setting, whichever is greater. Offset Multiplier: Continuously variable from 0 to X10 the amplitude setting, either aiding or opposing the step polarity.

Step Rates — Selectable at X1, X2 or X4 line frequency.

Pulsed Steps — ≈80 μs or 300 μs width.

Step/Offset Polarity — Same as Collector Supply polarity and positive in ac position. Polarity can be independently inverted with Step/Offset Polarity control or from the test fixture.

Step Family — Repetitive or single family.

Number of Steps — Selectable from 1 to 10.

Vertical Deflection Factor — Collector Current: 1 μA/div to 2 A/div, 20 steps in 1-2-5 sequence (0.1 μA/div with X10 magnification). Emitter Current: 1 nA/div to 2 mA/div, 20 steps in 1-2-5 sequence. Step Generator: 1 step/div.

Horizontal Deflection Factor — Collector Volts: 50 mV/div to 200 V/div, 12 steps (5 mV/div with X10 magnification). Base Volts: 50 mV/div to 2 V/div, 6 steps (5 mV/div with X10 magnification). Step Generator: 1 step/div.

DEFLECTION CONTROLS

Display Accuracies*1

Display Modes		Offset and Magnified With Centerline Value From:		
Normal and Dc Modes	**Normal (unmagnified)**	**100-40 div**	**35-15 div**	**10-0 div**
Vertical Collector Current	3%	2%	3%	4%
Horizontal Collector Volts	3%	2%	3%	4%
Horizontal Base Volts	3%	2%	3%	4%
Leakage Mode				
Vertical Emitter Current				
10 nA/div to 2 mA/div	3% ± 1 nA	Not Applicable		
1 nA/div to 200 μA/div	—	2% ± 1 nA	3% ± 1 nA	4% ± 1 nA
5 nA/div, 2 nA/div, 1 nA/div	5% ± 1 nA	Not Applicable		
Horizontal Collector Base Volts with Emitter Current of:				
≥1 μA/div	3%	2%	3%	4%
100 nA/div, 10 nA/div, 1 nA/div	3% + 25 mV/ Vert div	Not Applicable		
200 nA/div, 20 nA/div, 2 nA/div	3% + 50 mV/ Vert div	Not Applicable		
500 nA/div, 50 nA/div, 5 nA/div	3% + 125 mV/ Vert div	Not Applicable		
Step Generator Mode				
Vertical	4%	3%	4%	5%
Horizontal	4%	3%	4%	5%

**1 As a percentage of highest on-screen value.*

Displayed Noise*1

Range	15 V	75 V	350 V	1500 V
Vertical Collector	1 μA	1 μA	2 μA	5 μA
Vertical Emitter	1 nA	1 nA	1 nA	5 nA
Horizontal Base	5 mV	5 mV	5 mV	5 mV
Horizontal Collector	5 mV	5 mV	20 mV	200 mV

**1 1% or less, or the values shown.*

Position Controls — Fixed 5 div increments within 0.1 div. Continuous fine control over 5 div or less.

Display Offset — 21 calibrated positioning increments, vertically or horizontally, of 0.5 div or 5 div with X10 Magnifier.

CRT

CRT — 165 mm (6.5 in) rectangular with 10 cm x 10 cm division (12 cm usable horizontal) parallax-free, illuminated graticule, GH (P31) phosphor standard. Accelerating potential is 4.0 kV.

Readout — The readouts, adjacent to CRT, are digital indicators of the following parameters: Per Vert Div from 1 nA/div to 2 A/div; per Horiz Div from 5 mV/div to 200 V/div; Per Step from 5 nA/step to 2 A/step, 5 mV/step to 2 V/step; β (Beta) or g_m, per Div from 1 μ to 500 k calculated from Current/Div, X10 Mag, Step Amplitude, and X0.1 Mult.

POWER REQUIREMENTS

Voltage Ranges — 90 V ac to 136 V ac or 180 V ac to 272 V ac (six positions).

Line Frequency — 48 Hz to 66 Hz.

Maximum Power Consumption (Including DUT Power) — 305 W. Standby Power: ≈60 W.

ENVIRONMENTAL AND SAFETY

Ambient Temperature — Operating: +10°C to +40°C. Nonoperating: −40°C to +65°C.

Altitude — Operating: To 3000 m (10,000 ft). Nonoperating: 15 000 m (50,000 ft).

Vibration — Operating: 15 minutes along each of the three major axes. 0.04 cm (0.015 in) p-p displacement 10 Hz to 50 Hz to 10 Hz in one minute cycles. Held for three minutes at 50 Hz.

Shock — Nonoperating: 30 g's, ½ sine, 11 ms duration in each direction along each major axis. Total of six shocks.

Safety — CSA Certified (CSA 556 B).

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	299	11.8
Height	381	15.0
Depth	591	23.3
Weight≈	**kg**	**lb**
Net	32.0	70.5
Shipping	48.5	107.0

STANDARD TEST FIXTURE (650-0459-01)

A plug-in fixture with two sets of five pin test terminals, the Emitter Grounded or Base Grounded switch, Left-Off-Right switch, Step Gen Output, Ext Base or Emitter input, and the Safety Shield. The test terminals accept either the six pin universal adaptors, three pin adaptors, or the high-power transistor adaptors with Kelvin contacts.

ORDERING INFORMATION

576 Curve Tracer With Standard Test Fixture **$13,870**

Includes: Standard test fixture (650-0459-01); transistor adaptor (013-0098-02); FET adaptor (013-0099-02); TO3 adaptor (013-0100-01); TO66 adaptor (013-0101-00); axial lead diode adaptor (013-0111-00); stud diode adaptor (013-0110-00); Kelvin sensors for large and small plastic transistors (013-0138-01); safety shield (337-1194-01); power cord (161-0066-00); instruction manual (070-0905-01).

OPTION

Option 01 — Deletes the auto scale-factor readout module but maintains provisions for insertion of the module (020-0031-00) at any time. **−$935**

CONVERSION KIT

Auto Scale-Factor Readout Module — Order 020-0031-00 **$1,735**

INTERNATIONAL POWER PLUG OPTIONS

Option A1 — Universal Euro 220 V, 50 Hz.
Option A2 — UK 240 V, 50 Hz.
Option A3 — Australian 240 V, 50 Hz.
Option A4 — North American 240 V, 60 Hz.
Option A5 — Switzerland 220 V, 50 Hz.

OPTIONAL ACCESSORIES

Test Set-Up Chart — Package of 250. Order 070-0970-01 **$10**

Test Fixtures —
(172) See page 383. **$5,335**
(176) See page 384. **$5,900**

Socket Adaptors — See page 388.

Camera — C-59A and adaptor. See page 453. **$1,335**

Cart — K217. See page 462. **$495**

172

Semiautomated Test Fixture

Tests Up to 11 Parameters

Reduces Total Test Time

TYPICAL APPLICATIONS

Production Device Testing
Incoming Inspection

The 172 Programmable Test Fixture, when used with the Tektronix 576 Curve Tracer, permits the operator to quickly perform a sequence of tests on FETs, transistors, and diodes.

The 172 can greatly reduce total test time in applications when more than one measurement is made on a batch of many devices. Without the 172, all devices in the batch must be repeatedly inserted in the test fixture, once for every measurement. However, the 172 Programmable Test Fixture performs as many as eleven different tests on each device.

The 172 sequences through the various tests either automatically or manually. A variable rate control is provided to set the test sequence at a rate which is best for the operator. New operators require more time per test, but with experience they will want to test at a faster rate. A front panel switch or an optional foot switch advances the test in the manual mode.

Tests That Can be Performed on				Programmable Capabilities
Test	**Xstr**	**FETs**	**Diodes**	
1*[1]	H_{FE} $V_{CE}^{(sat)}$	V_P	V_F	Peak Current up to 10 A, Peak Volts up to 350 V.
2	V_{BE}			Horiz range is 100 mV/div to 2 V/div (other conditions same as Test 1).
3	H_{FE}, $V_{CE}^{(sat)}$	I_{DSS}, $R_{DS}^{(on)}$		Base Drive: 100 nA to 110 mA. When testing FETs the base terminal is shorted to the emitter terminal. Collector Sweep: three fixed ranges; 2 V, 5 V, and 20 V peak. Short circuit currents on these ranges are 1.5 A, 2 A, and 150 mA, respectively.
4	Same as #3			
5	I_{CEO} or I_{CES}, I_{CER} with external short or resistor			Voltage Supply: 1 V to 500 V dc. Leakage current measurements to 0.5 A. The most sensitive deflection factor is 1 nA/div.
6	I_{CBO}	I_{GSS}		Same as #5
7	I_{EBO}		I_R	Same as #5
8	$V_{(BR)CEO}$ or $V_{(BR)CER}$ with external resistor		V_F	Current Supply: 100 nA to 11 mA dc for breakdown voltage measurements to 500 V. Up to 110 mA dc for breakdown voltage measurements to 50 V.
9	$V_{(BR)CES}$	BV_{GSS}		Same as #8.
10	$V_{(BR)CBO}$	BV_{GSS}		Same as #8.
11	$V_{(BR)EBO}$		V_R	Same as #8.

*[1] *All of the test conditions for Test 1 are controlled by the 576 front-panel controls. Test 2 has the same conditions as Test 1 except the horizontal amplifier is connected to the emitter-base terminals, and the horizontal deflection factor is controlled by the programming card.*

For the remaining tests, the only 576 controls that are functional are the Polarity and CRT controls such as Intensity, Focus, Display Offset.

CHARACTERISTICS

VERTICAL AND HORIZONTAL AMPLIFIERS

Display Accuracies — The same as the 576 Curve Tracer with its included Standard Test Fixture.

Vertical Deflection Factor — Tests 1 and 2 (Collector or Emitter Current): 1 μA to 2 A/div in 20 steps. Tests 3, 4, and 8, 9, 10, 11 (Collector or Breakdown Current): 1 μA to 0.5 A/div in 18 steps. Tests 5, 6, 7 (Leakage Current): 1 nA to 0.5 A/div in 27 steps. All steps are in a 1-2-5 sequence.

Horizontal Deflection Factor — Test 1: 0.05 V/div to 200 V/div in 12 steps. Test 2 (Base Voltage): 100 mV/div to 2 V/div in 5 steps. Input Z for Test 2: At least 100 MΩ at 100 mV/div and 200 mV/div. 1 MΩ (within 2%) at 0.5 V/div, 1 V/div, and 2 V/div. Tests 3 and 4 (Collector Voltage): 100 mV/div to 2 V/div in 5 steps. Tests 5 through 11 (Breakdown or Leakage Voltage): 100 mV/div to 50 V/div in 9 steps. All steps are in a 1-2-5 sequence.

Collector Sweep Voltage — At least 2 V open circuit, or 1.5 A short circuit, at 100 mV/div and 200 mV/div. At least 5 V open circuit, or 2 A short circuit, at 500 mV/div. At least 20 V open circuit, or 150 mA short circuit, at 1 V/div and 2 V/div.

Current Supply Accuracy — 0.1 μA to 11 mA, accurate within 2% ±30 nA with up to 500 V compliance. 10 mA to 110 mA, accurate within 2% ±30 nA with up to 50 V compliance. Increments of current are: 0.1 μA (from 0.1 μA to 11 μA), 1 μA (from 10 μA to 110 μA), 10 μA (from 100 μA to 1.1 mA), 100 μA (from 1 mA to 11 mA) and 1 mA (from 10 mA to 110 mA).

Voltage Supply Accuracy — 1 V to 500 V, accurate within 3% ±300 mV with at least 0.5 mA compliance.

Test Display Time Range (Automatic) — 400 ms to 1.5 s continuously variable. Manual operation from a front panel switch or optional foot switch.

ENVIRONMENTAL

Ambient Temperature — Operating: +10°C to +40°C. Nonoperating: −40°C to +65°C.

Altitude — Operating: 3000 m (10,000 ft). Nonoperating: 15 000 m (50,000 ft).

Vibration — Operating: 15 minutes along each of the three major axes. 0.04 cm (0.015 in) p-p displacement 10 Hz to 50 Hz to 10 Hz in one minute cycles. Held for three minutes at 50 Hz.

Shock — Nonoperating: 30 g's, ½ sine, 11 ms duration in each direction along each major axis. Total of six shocks.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	200	7.9
Height	165	6.5
Depth	315	12.4
Weight≈	**kg**	**lb**
Net	5.2	11.5
Shipping	8.2	18.0

ORDERING INFORMATION

172 Programmable Test Fixture **$5,335**

Includes: Safety shield (337-1194-01); five programming cards (016-0198-00); 250 programming card pins (214-1633-00); five CRT overlay limit cards (016-0510-00); instruction manual (070-1170-01).

176

Tests High Power Devices

Tests Up to 200 Amps in Pulsed Mode

1000 Watt Capability

The 176 Pulsed High Current Fixture provides the 576 Curve Tracer with pulsed collector operation to 200 amps peak and pulsed base steps to 20 amps peak. When selected, the step offset is also pulsed. The pulsed operating mode allows many tests previously considered impossible. For example, small signal transistors can be tested under pulsed collector breakdown conditions without overdissipation. The 176 Test Fixture fits in place of the 576 Standard Test Fixture. The collector pulse is slaved to the step generator in regard to width and repetition rate.

The pulse width is selected by pressing the 300 μs or 80 μs pushbutton on the 576 mainframe. The repetition rate is automatically set when the 176 is inserted in the mainframe. Repetition rate is also dependent on power line frequency. The five highest Vertical Current/Division settings (0.1 A/div to 2 A/div) of the 576 can be multiplied X10 by actuation of the X10 Vert pushbutton on the 176. This feature enables viewing of up to a 200 amp peak display. The five highest Step Generator Amplitude base current steps of the 576 (10 mA to 200 mA) can be multiplied X10 by actuation of the X10 Step pushbutton on the 176. This feature enables the pulsed base step generator on the 176 to provide up to a 20 amp base step (tenth step). Both X10 Vert and X10 Step pushbuttons provide inputs to the fiberoptic readout in the 576 to display actual values.

CHARACTERISTICS

COLLECTOR SUPPLY (PULSED)

Width — 300 μs or 80 μs determined by 576.

Repetition Rate — Power line frequency.

Polarity — + or − determined by 576 polarity control.

Amplitude — Ranges: 15 V, 75 V, 350 V nominal, controlled by Max Peak Volts switch on 576. Current (minimum available at low line into shorted load): 15 V range, 200 A; 75 V range, 40 A; 350 V range, 8 A.

Maximum Peak Watts — Three illuminated pushbuttons select 10 W, 100 W, 1000 W maximum peak power.

STEP GENERATOR

Current Ranges (X10 Step Selected) — Step/Offset Amplitude Range: 100 mA to 2 A, 5 steps, 1-2-5 sequence. Maximum Current (Steps and Aiding Offset): 200 x 576 Amplitude setting or 20 A, whichever is less. Maximum Voltage (Steps and Aiding Offset): At least 5 V up to 10 A and 2 V up to 20 A.

Accuracy (Current Steps Including Offset) — Incremental: Within 5% between any two steps; within 10% with X0.1 Step Mult. Absolute: Within 3% of total output ±1% of one step or within 3% of one step, whichever is greater.

576 Offset Multiplier — 0 to 100 x 576 Amplitude switch setting.

Step Rate — Power line frequency.

Pulsed Steps — 300 μs or 80 μs wide.

Step/Offset Polarity — Same as Collector Supply polarity. Polarity can be independently inverted with Step/Offset Polarity control.

VERTICAL AMPLIFIER

Deflection Factor (X10 Vert Selected) — 1 A/div to 20 A/div, 5 steps in a 1-2-5 sequence.

ENVIRONMENTAL

Ambient Temperature — Operating: 0°C to +40°C. Nonoperating: −40°C to +65°C.

Altitude — Operating: 5 000 m (15,000 ft). Nonoperating: 15 000 m (50,000 ft).

Vibration — Operating: 15 minutes along each of the three major axes. 0.04 cm (0.015 in) p-p displacement 10 Hz to 50 Hz to 10 Hz in one minute cycles. Held for three minutes at 50 Hz.

Shock — Nonoperating: 30 g's, ½ sine, 11 ms duration in each direction along each major axis. Total of six shocks.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	200	7.9
Height	196	7.7
Depth	290	11.4
Weight≈	**kg**	**lb**
Net	5.8	12.8
Shipping	8.2	18.0

ORDERING INFORMATION

176 Pulsed High Current Fixture **$5,900**

Includes: TO36 adaptor (013-0112-00); stud diode adaptor (013-0110-00); safety shield (337-1194-01); instruction manual (070-1073-00).

577/177

Test Two-Terminal and Three-Terminal Discrete Semiconductors

Storage Capability (Model D1)

Power Capability Up to 100 Watts

TYPICAL APPLICATIONS
Incoming Inspection Semiconductor R & D

177 Standard Test Fixture.

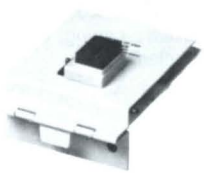
The 577 Curve Tracer System, when used with the 177 Standard Test Fixture, is a smaller and lighter configuration that retains many of the important features and performance of the 576. The 577 also accepts the 178 Linear IC Test Fixture. The major features that separate the 577 from the 576 are a storage CRT (optional) and the emphasis on low current measurements with the 577.

The 577's storage CRT may be used to overlay the characteristic curves of one device on top of the stored characteristics of another. Dot displays (generated during high current pulsed testing or during very low current testing under dc conditions) can be transformed into complete characteristic curves by simply moving them across the CRT while in the storage mode. A good example of a dot display occurs in op amp testing because the open loop, 3 dB bandwidth of many op amps is so low that the curves must be plotted slowly. Linear ICs such as op amps may be tested with the 577 by using the 178 Linear IC Test Fixture (see page 387).

In the 577/177 Curve Tracer System, several features facilitate low current measurements. They include: small current sensing resistors (which result in less capacitive looping), current sensing that always takes place in the collector supply lead (which permits measurements on three-terminal active devices at the lowest current ranges and eliminates the need for a correction to the horizontal deflection factor), and a display filter (which reduces vertical deflection noise).

Although the 577/177 Collector Supply has lower power capability (the 576 can deliver approximately 2.2 times as much power to the device under test), approximately the same test current is available; 10 amps continuous peaks at line frequency. The 577/177 provides its highest currents at a lower voltage than does the 576.

178 Linear IC Test Fixture.



Standard Op Amp Card for 178 Test Fixture.

Three-Terminal Regulator Card for 178 Test Fixture.

Other innovations in the 577/177 Curve Tracer are an emitter-base breakdown position on the lead selector switch, availability of approximately 95 steps from the step generator, an uncalibrated bias supply, independent magnifiers that increase resolution on either or both CRT axes, and a beam finder.

A safety interlock protects the operator from dangerous voltages. For collector voltages greater than 15 V, a plastic protective safety shield must be in place over the test terminals and its lid closed before collector voltage can be applied.

CHARACTERISTICS

All characteristics are for the 577 Curve Tracer Mainframe operating with a 177 Standard Test Fixture.

COLLECTOR SUPPLY

Modes/Polarity — Norm: Ac (at line frequency); positive or negative full-wave rectified ac. Dc: Positive or negative dc.

Voltage*1

Range	6.5 V	25 V	100 V	400 V	1600 V
Max Continuous Peak Current	10 A	2.5 A	0.6 A	0.15 A	0.04 A
Peak Pulse Current	20 A	5 A	1.25 A	0.30 A	0.08 A

1 Peak open circuit voltages within +35% and −5% of indicated range.

Series Resistance — From 0.12 Ω to 8 MΩ in 14 steps, all within 15%, ±0.1 Ω. Peak Power Limit Setting: 100 W, 30 W, 9 W, 2.3 W, 0.6 W, 0.15 W.

Safety Interlock — Protects operator from dangerous voltages.

STEP GENERATOR

Current Mode — Step/Offset Amplitude Range: 5 nA/step (with X0.1 Mult) to 200 mA/step, 1-2-5 sequence. Maximum Current (Steps and Aiding Offset): X20 amplitude setting, except X10 (2A) at 200 mA/step and X15 (1.5 A) at 100 mA/step. Maximum Voltage (Steps and Aiding Offset): At least 7 V. Maximum Opposing Offset Current: X10 amplitude setting or 10 mA, whichever is less. Maximum opposing voltage is limited at 1 V to 5 V.

Voltage Mode — Step/Offset Amplitude Range: 5 mV/step (with X0.1 Mult) to 2 V/step, 1-2-5 sequence. Maximum Voltage (Steps and Aiding Offset): 20 times amplitude switch setting. Maximum Current: At least 100 mA at 0 V. Short Circuit Current Limiting: Not more than 200 mA. Maximum Opposing Offset Voltage: X10 amplitude switch setting. Maximum Opposing Current: Limited between 10 mA and 20 mA (derating to 0 mA at 20 V).

Accuracy — Incremental: Within 2% between steps. Absolute: Within 3% of total output or amplitude setting, whichever is greater. Within 4% with X.01 mult. Offset Multiplier: Continuously variable from 0 to X10 the amplitude setting, either aiding or opposing the step polarity.

Step Rates — Selectable at X1, X2, or X4 line frequency.

Pulsed Steps — ≈300 μs width.

Step/Offset Polarity — Same as Collector Supply polarity and positive in the ac position. Polarity can be independently inverted with Step/Offset Polarity control or from the test fixture.

Step Family — Repetitive or single family.

Number of Steps — Selectable from 1 to 10 full-amplitude steps. Selectable up to ≈95 steps when using Step X0.1 multiplier.

DEFLECTION CONTROLS

Display Accuracies*1

Display Mode	Normal (unmagnified)	Magnified
Norm and Dc Modes		
Vertical Collector Current	3% ±1 nA	4% ±1 nA
Horizontal Collector Volts	3%	4%
Horizontal Base Volts	3%	4%
Step Generator Mode		
Horizontal Mode	4%	5%

1 As a percentage of highest on-screen value.

Vertical Deflection Factor — Collector Current: 2 nA/div to 2 A/div, 28 steps in 1-2-5 sequence (0.2 nA/div to 0.2 A/div with X10 magnification).

Horizontal Deflection Factor — Collector Volts: 50 mV/div to 200 V/div, 12 steps in 1-2-5 sequence (5 mV/div to 20 V div with X10 magnification). Base Volts: −50 mV/div to 2 V/div, 6 steps in 1-2-5 sequence (5 mV/div to 0.2 V/div with X10 magnification). Step Generator: 1 step/div (0.1 step/div with X10 magnification).

Displayed Noise*1

Range	6.5 V	25 V	100 V	400 V	1600 V
Vert Collector	0.5 nA	2.5 nA	8 nA	20 nA	50 nA
Vert Emitter	0.5 nA	2.5 nA	8 nA	20 nA	50 nA
Horiz Base	5 mV	5 mV	5 mV	5 mV	5 mV
Horiz Collector	5 mV	5 mV	—	—	—

Automatic Scale Factor Readout — Change in deflection factor is indicated by lights behind the knob skirt when using X10 Mag.

Automatic Positioning — Trace (or spot) is automatically positioned when Collector Supply polarity is changed when using the 177.

Display Invert — Single control inverts display and repositions trace.

Display Filter — Selectable low-pass filter reduces vertical noise for easier high sensitivity measurements.

CRT

CRT — Rectangular 165 mm (6.5 in) with an 8 x 10 div (1.27 cm/div) parallax-free internal graticule. Two display modules are available for the 577. The D1 display unit has a split-screen storage CRT with phosphor similar to GJ (P1). The D2 display unit has a nonstorage CRT with GH (P31) phosphor standard. Accelerating potential is 3.5 kV.

Beam Finder — Compresses off-screen trace to within graticule area.

POWER REQUIREMENTS

Line Voltage Ranges (±10%) — 100 V ac, 110 V ac, 120 V ac or 200 V ac, 220 V ac, 240 V ac.

Line Frequency — 50 Hz to 60 Hz.

Power — 155 W max at 110 V ac, 60 Hz.

ENVIRONMENTAL AND SAFETY

Ambient Temperature — Operating: +10°C to +40°C. Nonoperating: −40°C to +65°C.

Altitude — Operating: To 3000 m (10,000 ft). Nonoperating: 15 000 m (50,000 ft).

Vibration — Operating: 15 minutes along each of the three major axes. 0.04 cm (0.015 in) p-p displacement 10 Hz to 50 Hz to 10 Hz in one minute cycles. Held for three minutes at 50 Hz.

Shock — Nonoperating: 30 g's, ½ sine, 11 ms duration in each direction along each major axis. Total of six shocks.

Safety — CSA certified (CSA 556 B).

PHYSICAL CHARACTERISTICS

	577		177	
Dimensions	**mm**	**in**	**mm**	**in**
Width	224	8.8	201	7.9
Height	503	19.8	102	4.0
Depth	584	23.0	152	6.0
Weights≈	**kg**	**lb**	**kg**	**lb**
Net	18.1	40.0	1.1	2.5
Shipping	22.7	50.0	2.7	6.0

When the 577 and 177 are ordered together, their combined shipping weight is ≈24 kg or ≈53 lb (domestic).

177 Standard Test Fixture

CHARACTERISTICS

Device Lead Selection — Switch provides six different lead configurations. Three positions for Emitter Grounded measurements provide Step Gen, Open (or Ext), and Short base terminal connections. Two positions for Base Grounded measurements provide Step Gen and Open (or Ext) emitter terminal connections. One position provides for Emitter Base Breakdown or leakage measurements up to 25 Volts.

Left-Right Switch — Selects left or right test connections. Off in center position. Test connection area accepts all Tektronix Curve Tracer adaptors and protective cover. Kelvin connections are provided for emitter and collector terminals.

Looping Compensation — Reduces display loops due to test adaptor capacitance and some device capacitance.

Variable Voltage Supply — Continuously variable bias supply from −12 V to +12 V. Source resistance is 10 kΩ or less.

ORDERING INFORMATION

577/D1 Storage Curve Tracer Mainframe (Without Test Fixture) **$6,915**

577/D2 Nonstorage Curve Tracer Mainframe (Without Test Fixture) **$5,980**

OPTION

Option 10 — 10 cm x 10 cm graticule. **+$95**

TEST FIXTURES

177 Standard **$1,425**

Includes: Transistor adaptor for most bipolar transistors and some MOS FETs (013-0098-02); axial lead diode adaptor with Kelvin sensing terminals (013-0111-00); safety shield for test connection area (337-1194-01); instruction manual (070-1436-00).

178 Linear IC (See next page.) **$3,560**

OPTIONAL ACCESSORIES

Test Set-Up Chart — Package of 250. Order 070-1639-00 **$7.50**

Device Adaptor Sockets — See page 388.

CRT Implosion Shield — Clear. For 577D1. Order 337-1440-00. **$3.70**

Camera — C-5C. See page 445. **$495**

Cart — K213. See page 462. **$595**

178

Tests Single, Dual, or Quad: Operational Amplifiers, Comparators, Differential Amplifiers Regulators and More

Since linear ICs are typically tested under very low current conditions, the 577/178 Curve Tracer System is ideally suited to the task. The 178 Linear IC Test Fixture provides the necessary and accurate low-current measurement capability. Test cards set up the measurement function, and the 577's storage CRT allows the operator to transform the dot display (usually seen under low current dc conditions) into a complete characteristic curve by slowly sweeping the dot across the CRT while in the Storage Mode.

A 577/178 Curve Tracer System is composed of a 577 mainframe, 178 Linear IC Test Fixture, appropriate test cards (choose from three op amp cards and two regulator cards), and the proper socket adaptor that interfaces the system to the device-under-test.

Test cards, which slide into the 178, define the measurement function of the 178 Test Fixture. Two families of test cards are available: op amp cards and regulator cards. Op amp cards are used for testing standard and special op amps, comparators, differential amplifiers, video amplifiers, etc. Regulator cards are used for testing positive and negative three-terminal voltage regulators.

OP AMP CARDS

The Standard Op Amp Card is designed to test devices that require single or dual power supplies, have two (differential) high-impedance inputs, and a single output. Common measurements include: offset voltage, positive and negative input current, CMRR, gain, positive and negative PSRR, positive and negative supply current, and collector supply current.

The Hardwire Card is designed for those applications where there is an advantage in preparing individual cards for specific devices so that they may be quickly switched to accommodate a change in the type of device-under-test. The Hardwire Card also offers a greater degree of freedom to the knowledgeable designer in testing special devices.

The Multiple Op Amp Card allows the operator to test up to four devices in a single package by simply operating a four-position switch. The four-position switch selects the op amp (in a multiple op amp package) or the selection of a linear IC to be tested. The measurements performed are the same as those available with the Standard Op Amp Card.

Socket Adaptors for Op Amp Cards

The device-under-test socket on the Standard and Multiple Op Amp Cards accepts several types of socket adaptors using the Amphenol-Barnes Adaptor System. This system accepts most of the standard package configurations (TO5, DIP, flat pack, etc). Sockets for these cards are shown on the next page.

REGULATOR CARDS

There are two types of Regulator Cards, positive and negative. These cards are used primarily in measuring parameters of three-terminal voltage regulators. Parameters measured include: output voltage, load regulation, line regulation and ripple regulation, and quiescent and common terminal current.

Socket Adaptors for Regulator Cards

Socket adaptors for both positive and negative three-terminal regulators are the same as the Kelvin Sensing Adaptors used on the standard curve tracer. (See next page.)

CHARACTERISTICS

VERTICAL AMPLIFIER

Display Accuracies/Deflection Factor

Vertical*1	Normal	Magnified
Input Voltage or ΔInput Voltage	10 μV/div to 50 mV/div	1 μV/div to 5 mV/div
Accuracy*2	3%	4%
Input Current	50 pA/div to 0.2 mA/div	5 pA/div to 20 μA/div
Accuracy*2	3% ±50 pA	4% ±50 pA
Power Supply Current	0.1 μA/div to 50 mA/div	10 nA/div to 5 mA/div
Accuracy*2	3% ±0.1 μA	4% ±0.1 μA
Collector Supply Current	1 nA/div to 50 mA/div	0.1 nA/div to 5 mA/div
Accuracy*2	3% ±1 nA	4% ±1 nA

*1 1-2-5 sequence.
*2 Percentage of highest on-screen values.

POWER SUPPLIES

Voltage — Positive and negative supplies are adjustable from 0 V to 30 V. Voltage of both supplies can be adjusted from a single calibrated control. Accuracy is within 2% ± 100 mV. Negative supply can be independently adjusted by an uncalibrated control.

Current — At least 150 mA with adjustable current limiting.

SWEEP GENERATOR

Frequency Range — Adjustable from 0.01 Hz to 1 kHz. Sinusoidal signal controls output, common-mode input, or power supply voltages of device-under-test.

Amplitude — Adjustable from 0 V to 30 V peak.

SOURCE RESISTANCE

Resistor Values — Two each, 50 Ω, 10 kΩ, 20 kΩ, 50 kΩ, or external resistors. When vertical deflection factor is in 1 mV through 50 mV/div position, add 550 Ω to all values.

LOAD RESISTANCE

Resistor Values — One each, 100 Ω, 1 kΩ, 2 kΩ, 5 kΩ, 10 kΩ, 20 kΩ, 50 kΩ, or external resistors.

OTHER CHARACTERISTICS

DUT Supplies Disconnect — A single switch disconnects all power to the device-under-test; both plus and minus power supplies, collector supply, and step generator.

Function Switch — Selects vertical and horizontal deflection signals and connection of the test signal to the device-under-test.

Zero — Single pushbutton provides a zero reference to the CRT display and in certain functions, nulls out offset voltage in order to measure Δ input V on the vertical display axis.

COLLECTOR SUPPLY

The 25 V and 100 V ranges of the collector supply (located on 577 mainframe) are available to the 178 Test Fixture. Supply output is located on the 178 front-end panel and on the device card. Automatic positioning with supply polarity is inoperative when using the 178 Test Fixture. (See 577/177 characteristics for collector supply performance.)

STEP GENERATOR

All the capabilities of the step generator (located on 577 mainframe) are available to the 178 Test Fixture. Generator output is located on the 178 front-end panel and on the device card. (See 577/177 characteristics for step generator performance.)

THREE-TERMINAL REGULATOR TEST CARD CHARACTERISTICS

DUT Input Supply — Input Voltage (Two Ranges): 0 V to 30 V is within 2% ±200 mV of dial setting. 0 V to 60 V is within 2.5% ±300 mV of dial setting. Regulation: Within 200 mV. Input Sweep Frequency: Dc to 1 kHz. 300 μs Pulsed Current: 5 mA to 2 A.

Short Duration Dc Current*1

Supply Voltage	Current
0 to 10	700 mA
10 to 20	350 mA
20 to 40	350 mA
40 to 60	120 mA

*1 One minute duration.

DUT Current Load — 5 mA to 2 A within ±3%, ±1.25 mA.

DUT Comparison Output Dc Voltage Accuracy — 0 V to 10 V Range: Within 1% ±20 mV. 0 V to 100 V Range: Within 1% ±150 mV.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	201	7.9
Height	114	4.5
Depth	198	7.8
Weight≈	**kg**	**lb**
Net	1.5	3.3
Shipping	3.6	8.0

ORDERING INFORMATION

178 Linear IC Test Fixture **$3,560**

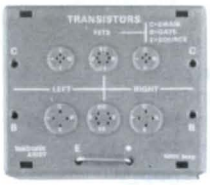
Includes: 16 DIP IC sockets (136-0442-00); standard Op Amp Card with cover and ten patch cords (013-0149-02); interchangeable nomenclature panel for function switch (333-1770-00); instruction manual (070-1977-00).

OPTIONAL ACCESSORIES

2 Inch Patch Cord — Package of 10.
Order 012-0200-00. **$4.75**

Cards —
(Standard Op Amp) One included with 178.
Order 013-0149-02 **$210**
(Hardwire) Order 013-0150-02 **$135**
(Multiple Op Amp) Order 013-0155-01 **$635**
(Positive Regulator) Order 013-0147-00 **$1,275**
(Negative Regulator) Order 013-0148-00 **$1,240**

TEK CURVE TRACER SOCKET ADAPTORS



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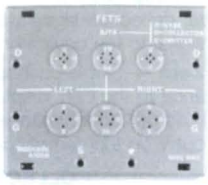

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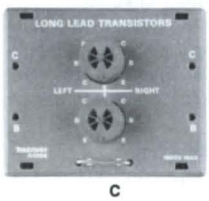

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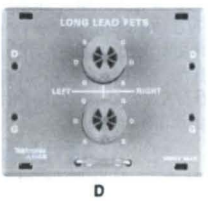

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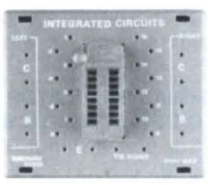

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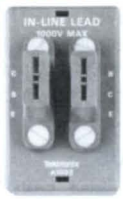

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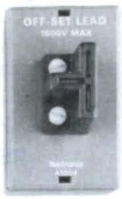

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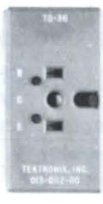

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DUAL WIDTH ADAPTORS

The following accessories fit the side-by-side terminals on test fixtures of the 370, 576, 576/172, and 577/177 Curve Tracers.

A. Transistor Adaptor — Useful for most single and dual bipolar transistors and some MOS FETs. Order A1007 **$225**

B. FET Adaptor — Useful for most single and dual FETs. Order A1009 **$225**

C. Long Lead Transistor Adaptor — Accepts dual or single transistors with untrimmed leads. Order A1006 **$195**

D. Long Lead FET Adaptor — Accepts dual or single FETs with untrimmed leads. Order A1008 **$250**

E. Integrated Circuit Adaptor — Allows connection to multipin device packages. The pins are then connected to the collector, base, or emitter terminals by means of the patch cord. A tie point is also provided so that an external power supply or signal source may conveniently be patched to the IC pins. Includes one each lead for connecting auxiliary supply to tie points (196-3067-00); six each 4 inch test leads (012-0310-00). Order A1010 **$375**

NEW KELVIN SENSING ADAPTORS

The following accessories fit the test fixtures of the 370, 576/172, 576/176, and 577/177 Curve Tracers.

New Base/Gate Terminals — Kelvin sensing adaptors permit Kelvin sensing of base/gate terminal, as shown in F. above. Removing the base/gate terminal allows use on 576/577 test fixtures.

A. In-line Adaptor — Accepts large and small TO-220 transistors with in-line leads. The adaptor will accept devices with approximate spacing between terminals of 0.06 in. up to 0.18 in. It is wired for both B-C-E and C-B-E terminal configurations. Order A1002 **$115**

B. Axial Lead Diode Adaptor — Order A1005 **$110**

C. Offset Lead Adaptor — Used for power transistors. Order A1004 **$120**

D. TO-3/TO-66 Adaptor — Used for power transistors. Order A1003 **$120**

E. Blank Adaptor — For mounting special sockets. Order A1001 **$65**

F. Example showing 6th pin for Base/Gate Kelvin Sensing

NOTE: Adaptors G, H, I are not recommended for use with the 370, as they can remove the gold plating from the test fixture receptacles; however, they will physically fit.

G. Transistor Adaptor — Accepts long or short lead transistors. Can be rewired to accommodate nonstandard configurations. Order 013-0127-01 **$90**

H. Stud Diode Adaptor — Order 013-0110-00 **$105**

I. TO-36 Adaptor — Order 013-0112-00 **$105**

A

B

C

D

MULTILEAD SOCKETS

These sockets are used with the 178 Test Fixture and IC adaptor (013-0124-03).

A. 8 Lead TO Package — Order 136-0444-00 **$47**

B. 10 Lead TO Package — Order 136-0441-00 **$55**

C. 14 Lead Dual In-Line Package — Order 136-0443-00 **$55**

D. 16 Lead Dual In-Line Package — Order 136-0442-00 **$50**

These four sockets are the most commonly required in curve tracer applications. Additional socket configurations, including zero insertion style, are available from Textool Products, Inc., 1410 W. Pioneer Dr., Irving, TX 75061.

3-PIN ADAPTORS

A

B

C

D

The 3-pin adaptors may be used with any of the Tektronix curve tracer products. They do not have Kelvin sensing contacts.

A. TO5 and TO18 — Transistor Adaptor. Order 013-0128-00 **$42**

B. Blank Adaptor — For mounting special sockets. Order 013-0073-00 **$20**

C. TO3 or TO66 — Transistor Adaptor. Order 013-0070-01 **$55**

D. Diode Test Adaptor — Holds axial-lead diodes. Order 013-0072-00 **$92**

5CT1N/7CT1N

Tests Semiconductor Devices to 0.5 Watts

10 nA/Div to 20 mA/Div Vertical Deflection Factors

0.5 V/Div to 20 V/Div Horizontal Deflection Factors

Easy to Operate

The 5CT1N and 7CT1N are oscilloscope plug-ins for displaying the characteristic curves of small-signal semiconductor devices to power levels up to 0.5 watts. The 5CT1N is designed for use in any Tektronix 5000 Series oscilloscope and plugs into one of the vertical compartments (a 5000 Series amplifier or time base must be installed in the horizontal compartment). The 7CT1N is designed for use in any Tektronix 7000 Series oscilloscope and plugs into either a vertical or horizontal compartment (a 7000 Series amplifier or time base must be installed in the corresponding horizontal or vertical compartment).

CHARACTERISTICS

COLLECTOR/DRAIN SUPPLY

	X1		X10	
Horizontal Volts/div	0.5	2	5	20
Voltage Range	0 to 7.5 V	0 to 30 V	0 to 75 V	0 to 300 V
Maximum Current	240 mA	60 mA	24 mA	6 mA

Maximum Open Circuit Voltage — Within 20%. Maximum short circuit current within 30%.

Series Resistance — Automatically selected with horizontal V/div switches. Peak Power: 0.5 W or less depending upon control settings.

High Voltage Warning — When the horizontal V/div switch is in the X10 position, a flashing warning light appears on the front panel indicating that dangerous voltages may exist at the test terminals.

STEP GENERATOR

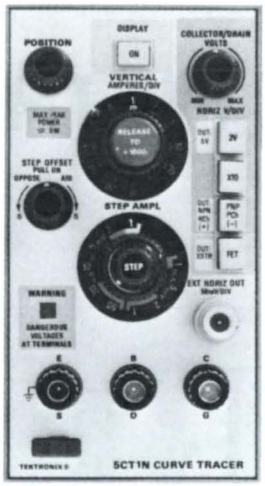
Transistor Mode — Step Amplitude Range: 1 μA/step to 1 mA/step, 1-2-5 sequence. Maximum Current (Steps Plus Aiding Offset): X15 amplitude setting. Maximum Voltage (Steps Plus Aiding Offset): At least 13 V. Maximum Opposing Offset Current: At least X5 amplitude setting.

FET Mode — Step Amplitude Range: 1 mV/step to 1 V/step, 1-2-5 sequence. Voltage Amplitude (Steps Plus Aiding Offset): X15 amplitude setting, 13 V maximum. Source Impedance: 1 kΩ ± 1%.

Accuracy — Incremental: Within 3% between steps. Absolute: Within (3% + X0.3 amplitude setting).

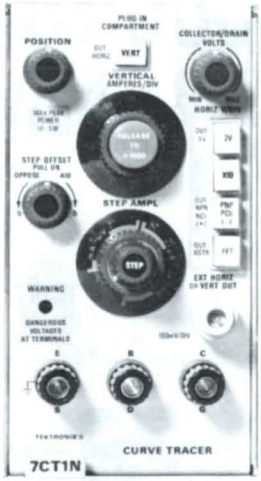
Step Polarity — The step generator polarity is the same as the collector/drain supply in the transistor mode and opposing in the FET mode.

5CT1N



Curve Tracer

7CT1N



Curve Tracer

Number of Steps — Selectable in one-step increments between 0 and 10.

Offset — Selectable from 0 to 5 steps. Polarity aids or opposes the step polarity.

Vertical Deflection Factors — 10 nA/div to 20 μA/div with the ÷1000 control activated. 10 μA/div to 20 mA/div in the X1 mode.

Vertical Display Accuracy — Within 5% in the X1 mode. Within 5% ±0.2 nA per displayed horizontal V when in the ÷1000 mode.

Horizontal Deflection Factors — Selectable, 0.5 V, 2 V, 5 V, or 20 V.

Horizontal Display Accuracy — (5CT1N) Within 5% plus the deflection factor accuracy of the plug-in being driven. The plug-in would be a vertical or horizontal amplifier (such as the Tektronix 5000 Series plug-ins) with a 50 mV/div deflection factor and an input R of at least 50 kΩ and would be used in the horizontal compartment of a 5000 Series oscilloscope mainframe.

Horizontal Display Accuracy — (7CT1N) Within 5% plus the deflection factor accuracy of the plug-in being driven. The plug-in would be a vertical or horizontal amplifier (such as the Tektronix 7000 Series plug-ins) with a 100 mV/div deflection factor and an input R of at least 50 kΩ and would be used in the horizontal compartment of a 7000 Series oscilloscope mainframe.

ENVIRONMENTAL

Shock — Nonoperating: 30 g's, ½ sine, 11 ms duration in each direction along each major axis. Total of six shocks.

Ambient Temperature — Operating: 0°C to +50°C. Nonoperating: −55°C to +75°C.

Altitude — Operating: 5000 m (15,000 ft). Nonoperating: 15 000 m (50,000 ft).

Vibration — Operating: 15 minutes along each of the three major axes. 0.04 cm (0.015 in) p-p displacement 10 Hz to 50 Hz to 10 Hz in one minute cycles. Held for three minutes at 50 Hz.

PHYSICAL CHARACTERISTICS

	5CT1N		7CT1N	
Dimensions	**mm**	**in**	**mm**	**in**
Width	66	2.6	71	2.8
Height	127	5.0	127	5.0
Depth	305	12.0	368	14.5
Weights≈	**kg**	**lb**	**kg**	**lb**
Net	0.8	1.8	1.1	2.5
Shipping	1.8	4.0	2.7	6.0

ORDERING INFORMATION

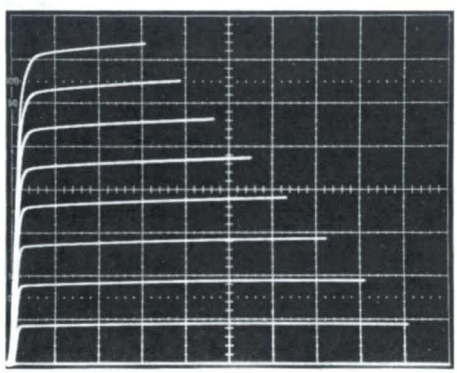
5CT1N Curve Tracer **$1,075**

Includes: Test adaptor with two sets of test terminals, one with TO5 basing and the other with TO18 basing (013-0128-00); instruction manual (070-1246-00).

7CT1N Curve Tracer **$1,785**

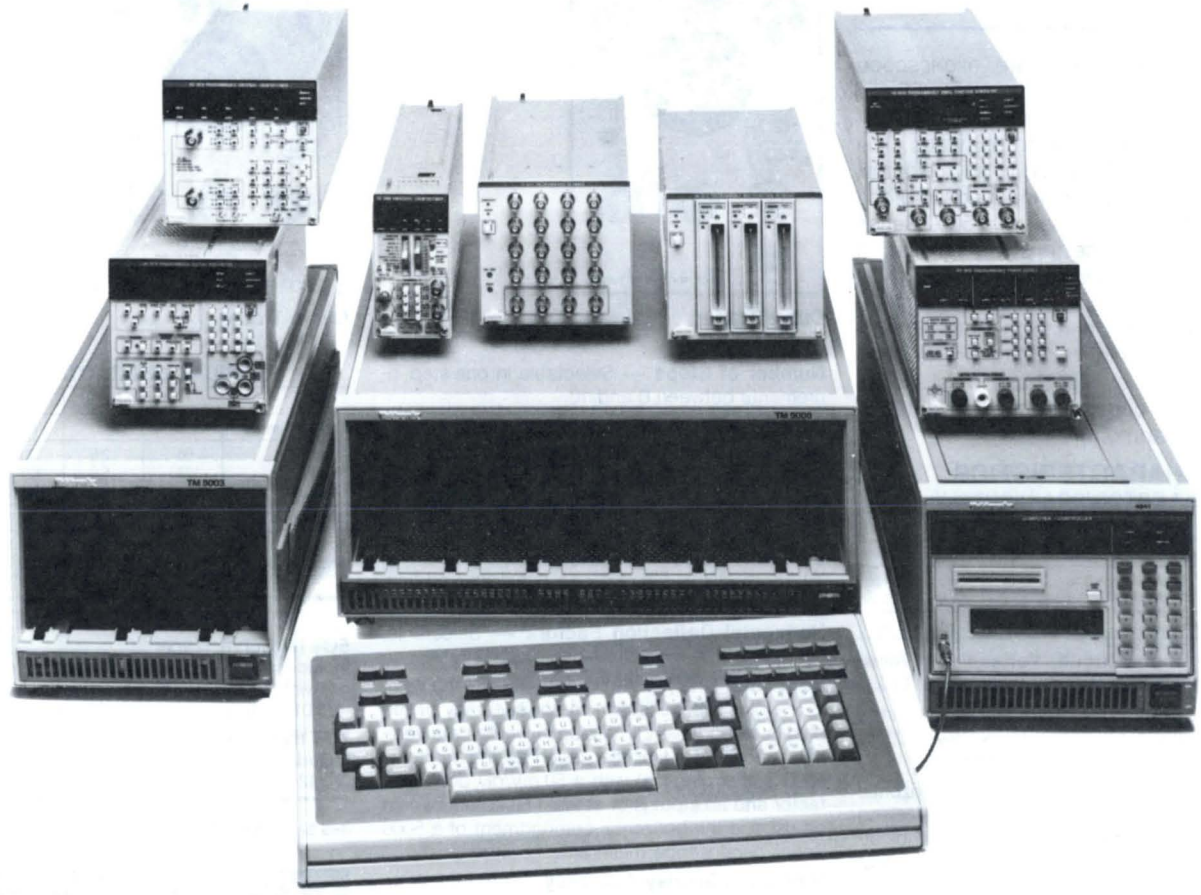
Includes: Same as 5CT1N but with instruction manual 070-1247-00.

See 3-pin adaptors on preceding page.



2N3904 transistor characteristic generated by the 7CT1N. Control Settings are indicated on front panel of 7CT1N.
Vertical: 2 mA/div.
Horizontal: 0.5 V/div.
Base Current: 10 μA/step.

TM 5000 GPIB PROGRAMMABLE INSTRUMENTS



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Designed for Configurability; for Programming Ease; for Productivity.

Test and measurement set-up has never been this friendly, has never been this fast. With Tek's line of TM 5000 programmables, you can continue to build on the concept of configurability. You can link together customized, automated test packages with the same plug-in, pull-out ease as found in our TM 500 manual instrument line. The TM 5000 IEEE Standard 488 compatible, fully programmable instruments are among the friendliest and fastest to integrate you can buy.

The 350 MHz DC 5010 Universal Counter/Timer is the state-of-the-art in high performance universal counter/timers. Its 1 ps time interval averaging resolution is unmatched for the industry.

For lower speeds, the 135 MHz DC 5009 Universal Counter/Timer is the industry's lowest cost, fully programmable counter/timer. It provides all of the functions of the higher performance DC 5010 except rise/fall and null.

The DP 501 Digital Prescaler extends the frequency measurement capability of the DC 5010 and DC 5009 to 1.3 GHz under program control.

The DM 5010 Digital Multimeter measures dc and true RMS ac volts, ohms, and provides a diode test function. Internal math capabilities include averaging, nulling, offset, scaling, dB, and HI/LO/Pass sorting.

The FG 5010 Function Generator features variable symmetry throughout the full 20 MHz bandwidth of the instrument. Other important functions include counted burst, phase lock, and the ability to store and recall ten complete front panel set-ups.

The PS 5010 Power Supply, with its three separately programmable supplies, provides the most widely used voltages, all under complete program control, including current limit, source on/off, and extensive status reporting.

Shown above DM 5010, DC 5009, MI 5010, FG 5010, PS 5010 and 4041 System Controller configured in a benchtop system approximately 15 inches high and 17 inches wide.

The PS 5004 Precision Power Supply provides the high-resolution voltages and currents necessary in the characterization of transistors, ICs, and other semiconductor and hybrid circuits. The actual values of the output voltage, output current, and current limit may be read directly from the 4½ digit front panel display or are available over the GPIB.

The AA 5001 Programmable Distortion Analyzer and SG 5010 Programmable Oscillator are the world's first truly high performance programmable audio test instruments. Together, they provide unequaled capability covering the full range of standard audio testing—THD, IMD, (SMPTE, DIN, CCIF difference tone), gain/loss, and signal-to-noise ratio. The AA 5001 is fully automatic in each of its operating modes—no tuning, no nulling, no level setting, no range changing—even with a remotely located signal source.

A complete range of system control and signal routing capabilities are available with the MI 5010 Multifunction Interface and MX 5010 Multifunction Interface Extender and the SI 5010 350 MHz Programmable Scanner. Function cards currently available for the MI 5010/MX 5010 Multifunction Interface System include: D/A converter, A/D converter, 32-channel digital I/O, 16-channel relay scanner, 10-channel low level scanner (with a choice of signal conditioning modules), 16K memory, and a user-configurable development card.

Each TM 5000 instrument (with the exception of the completely automatic AA 5001) is fully programmable—all front panel functions are programmable over the GPIB. Each instrument (again with the exception of the AA 5001) has a front panel ID button which can be programmed to cause the instrument to generate an SRQ when pushed, to allow operator intervention in an on-going test. Conversely, the SRQ generation capability can be programmed off to prevent inadvertent operator intervention. In addition, the entire front panel of each instrument can be locked out to further prevent operator interference with a test or instrument set-up. When used with the execute-only version of the Tektronix 4041 System Controller, this means that you can place a completely operator-proof test system on the manufacturing floor; the operator can intervene only to the extent permitted by the test programmer.

In addition, Tektronix *Standard Codes and Formats* provides standardized data formats among all TM 5000 instruments, and among all other Tektronix GPIB instruments as well. Standardized instrument data formats open up the lines of bus communication and make your test and measurement system easy to set up and operate. Test and control functions are changed quickly and easily. Common error codes among instruments greatly simplify error-handling routines.

All of the TM 5000 instruments have internal diagnostics capability built right in. Each instrument performs an extensive diagnostic self-test on power-up or on command and, in case of a fault, displays and/or sends over the GPIB an error message indicating the nature of the fault. To further aid in troubleshooting and maintenance of the instruments, each has built-in signature analysis capability; each instruction manual gives a comprehensive list of signatures at nodes throughout the instrument.

The compact, modular TM 5000 instruments operate in the TM 5003 and TM 5006 mainframes to form configurable automated test systems which occupy less than half the rack space of ordinary rackmounted equipment.

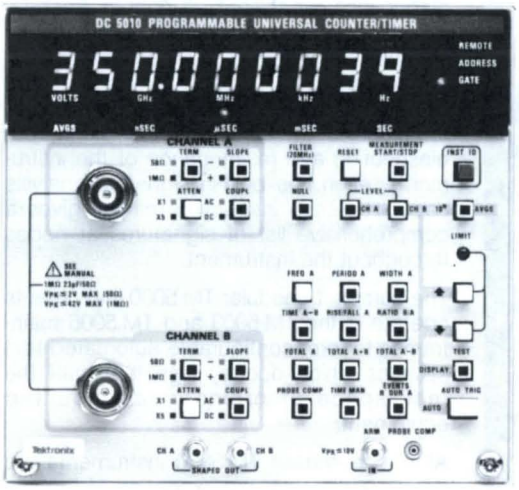
All of the current TM 5000 instruments are double-width, with the exception of the single-width DC 5009 and PS 5004. That is, each (except the DC 5009 and PS 5004) occupy two compartments of the three-compartment TM 5003 or the six-compartment TM 5006 mainframes.

Adherence to standard form and fit means that any TM 5000 product can be replaced in a system without the uncabling, unstacking, restacking, and recabling that is necessary with most instruments. Rebuilding the system for a different task takes seconds, not hours. And, if all instruments in your system need not be programmable, there are almost forty Tek TM 500 manual instruments compatible with TM 5000 mainframes.

All TM 5000 instruments are UL listed.

A TM 5003 or 4041 can conveniently interface with an oscilloscope on a K213 Instrument Cart. Shown with the K213 above is an MP 2601 Measurement Package. MP 2601 consists of a 4041 controller and a 2430 Digital Storage Oscilloscope.

DC 5010



Programmable Universal Counter/Timer

DC 5010

GPIB IEEE-488 The DC 5010 complies with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats.*

350 MHz Both A and B Channels

3.125 ns Single-Shot Resolution

9-Digit Display

1 ps Resolution, With Averaging

Measurement Functions Include:
Reciprocal Frequency Measurement; Period; Width; Time A→B; Events B During A; Totalize A, A+B, A−B; Ratio; Rise/Fall; Time Manual; Arming; Null

Auto or Selected Averaging to 10^9 in All Modes

Duty-Cycle Independent Autotrigger

DVM Mode for Displaying Trigger Level Setting

Shaped A and B Channel Outputs

Hysteresis Compensation

Probe Compensation

See Digital Counter Selection Guide on page 405.

Frequency measurements to 350 MHz (to 1.3 GHz with the Tektronix DP 501 Digital Prescaler), a wide range of time-interval measurement capabilities including rise times and fall times, hysteresis compensation, probe compensation, arming, and high resolution on low frequency signals (up to nine digits in one second or less), all combine to make the DC 5010 a true state-of-the-art universal counter/ timer. Selected averaging of up to 10^9 events provides usable time-interval resolution to 1 ps on repetitive signals. The automatic averaging feature provides a compromise between measurement time and resolution, regardless of input signal frequency. The pseudo-random, phase modulated clock provides increased accuracy by eliminating the possibility of clock-synchronous errors in the time-interval averaging modes. Hysteresis compensation is automatic, further increasing the accuracy of time-interval measurements in the DC 5010. The Null feature permits the nulling of differences in cable lengths in time-interval measurements to provide direct readout of the measurement of interest.

Autotrigger, at the push of a button or upon command over the GPIB, senses the maximum and minimum of the applied signal and sets trigger level to a point midway between the two, regardless of duty cycle. The values of the maximum and the minimum are available over the bus where they can be used by the controller to compute the p-p amplitude of the signal, providing the function of a high-frequency p-p DVM. The value of the trigger level is also available over the bus, and may also be displayed in the nine-digit DC 5010 display. The outputs of both channels' signal shaping circuits are available at the front panel to aid in the proper setting of trigger levels on complex waveforms. The arming input allows measurement of selected events within complex waveforms. The unique Probe Compensation feature permits quick and accurate compensation of attenuator-type probes to provide accurate measurements on signals beyond the amplitude range of the counter itself.

The frequency measurement of the DC 5010 can be extended to 1.3 GHz with the use of the companion DP 501 Digital Prescaler. TM 5000 rear interfacing capability permits the operation of the DP 501 to be controlled over the GPIB through the DC 5010.

A field-installable modification kit is available to upgrade a manual DC 510 Universal Counter/Timer (page 406) to a GPIB programmable DC 5010 Universal Counter/ Timer.

CHARACTERISTICS

Display — Nine-digit LED display, automatic decimal point positioning, LED indicators for units, and measurement gate, and bus conditions. Overflow is indicated by a blinking display.

CHANNEL A AND CHANNEL B INPUT

Frequency Range —
50 Ω Termination: 0 MHz to 350 MHz dc coupled. 100 kHz to 350 MHz ac coupled.
1 MΩ Termination: 0 MHz to 300 MHz dc coupled. 16 Hz to 300 MHz ac coupled.

Sensitivity —
50 Ω Termination Dc: 25 mV RMS sinewave to 350 MHz. 70 mV p-p pulse.
1 MΩ Termination Ac: 25 mV RMS to 200 MHz, 42 mV RMS to 300 MHz.

Attenuation — Selectable 1X, 5X.

Impedance — 1 MΩ paralleled by 23 pF ±2 pF or 50 Ω.

Dynamic Range — 4 V p-p x attenuation.

Trigger Level Range — +2 V to −2 V with 4 mV resolution (X1). +10 V to −10 V with 20 mV resolution (X5).

Trigger Level Accuracy — ±2% of reading for a dc input V, ±40 mV x attenuator.

Autotrigger Frequency Range — 10 Hz to 350 MHz.

Independent Controls — Slope +/−, Attenuation 1X/5X, Couple ac/dc, Impedance 1 MΩ/50 Ω.

Maximum Input Voltage — 1 MΩ input impedance.
1X: ±42 V (dc + peak ac) to 200 kHz; ±2 V (dc + peak ac) to 300 MHz.
5X: ±42 V (dc + peak ac) to 1 MHz; ±10 V (dc + peak ac) to 300 MHz.
In 50 Ω Input Impedance: Signals > ±2 V x attenuator will cause input protection circuitry to switch input to 1 MΩ.

Shaped Out — Shaped replica of signal being measured, aids proper triggering on complex waveforms (≥100 mV typically to 350 MHz into 50 Ω load).

Arming Input — Permits measurements of complex waveforms. A TTL high allows averaging of selected events within a measurement.

FREQUENCY A

Range — 36 μHz to 350 MHz.

Resolution —

$$\pm\text{LSD} \pm 1.4 \times \frac{\text{A Trigger Jitter Error}}{N} \times (\text{Frequency A})^2$$

Accuracy —
Resolution ±(Time Base Error x Frequency A)

PERIOD A

Range — 3.125 ns to 7.6 hrs.

Resolution —

$$\pm\text{LSD} \pm \frac{1.4 \times \text{A Trigger Jitter Error}}{N}$$

Accuracy —
Resolution ±(Time Base Error) x Period A.

RATIO B/A

Range — 10^{-8} to 10^{9} (Frequency Range: 36 μHz to 350 MHz).

Resolution —

$$\pm\text{LSD} \pm \frac{1.4 \times \text{B Trigger Jitter Error} \times \text{Frequency B}}{N}$$

Accuracy — Same as Resolution.

TIME A→B

Range — 2.0 ns to 7.6 hrs.

Minimum Dead Time — 12.5 ns (stop to start).

Resolution —

$$\pm\text{LSD} + \frac{1}{\sqrt{N}} \times (\pm\text{A Trigger Jitter Error} \pm \text{B Trigger Jitter Error})$$

Accuracy — Resolution ±(Time Base Error x Time A→B) + (B Trigger Slew Error) − (A Trigger Slew Error) ±(Channel Delay Mismatch*[1]).

Channel Delay Mismatch — <2 ns between front panel inputs.

Resolution — Best time A→B Avg resolution = ±1 ps.

Repetition Rate — <70 MHz.

[1] Can be removed with "Null".

EVENTS B DURING A

Range — 10^{-8} to 10^{9}.

Maximum B Frequency — 350 MHz.

Maximum A Frequency — 80 MHz.

Minimum A Pulse Width — 4.0 ns.

Minimum Time Between A Pulses — 8.5 ns.

Minimum Dead Time Between Pulses — ≤8.5 ns.

Resolution —

$$\pm\text{LSD} + \frac{\text{Frequency B}}{\sqrt{N}}$$

±(Trigger Jitter Error CH A start edge ±Trigger Jitter Error CH A stop edge).

Accuracy — Resolution + Frequency B (Stop Slew Rate Error − Start Slew Rate Error) + Frequency B x (5 ±2 ns).

WIDTH A

Range — 4 ns to 7.6 hrs.

Minimum Dead Time Between Pulses — 1.6 ns.

Resolution —

$$\pm\text{LSD} + \frac{1}{\sqrt{N}}(\pm\text{Start Trigger Jitter Error} \pm \text{Stop Trigger Jitter Error})$$

Accuracy — Resolution ±(Time Base Error x Width A) + (Stop Slew Rate Error − Start Slew Rate Error) ±2 ns.

Repetition Rate — 50 MHz.

TIME MANUAL

Range — 0 to 3.125 x 10^{4} s (≈8 hrs).

Resolution — ±LSD (100 ms).

Accuracy — ±Resolution ±(Time Base Error x Time).

TOTALIZE A

Range — 0 to 10^{9} counts.

Repetition Rate — 0 to 350 MHz.

TOTALIZE A+B

Range — 0 to 10^{9} counts (A+B ≤10^{9}).

Repetition Rate — 0 to 350 MHz.

TOTALIZE A−B

Range — −1 x 10^{8} to +1 x 10^{9} (either A >10^{12} or B >10^{12} will cause overflow).

Repetition Rate — 0 to 350 MHz.

RISE/FALL A

Range — 4 ns to 10^{4} s (50 Ω) 5 ns to 10^{4} s (1 MΩ).

Repetition Rate — Minimum time between rising (falling) edges is 12.5 ns (80 MHz).

Input Amplitude — (1.4 V to 8 V) x Attenuation (50 Ω), (0.7 V to 4 V) x Attenuation (1 MΩ).

Resolution —

$$\pm\text{LSD} + \frac{1}{\sqrt{N}}(\pm\text{Start Trigger Jitter Error} \pm \text{Stop Trigger Jitter Error})$$

Accuracy — Resolution ±(Time Base Error x Rise time/Fall time) ±2 ns ±4 mV x Slew Rate A Error (near 10%) ±4 mV Slew Rate A Error (near 90%).

PROBE COMPENSATION

Display — 1 or 0 for each channel.

Accuracy — Probe Attenuation x Counter Attenuation x 0.300 (%).

RESOLUTION AND ACCURACY DEFINITIONS

Trigger Jitter Error (Seconds RMS) —

$$\frac{\sqrt{(en1)^2 + (en2)^2}\ \text{(Volts RMS)}}{\text{Input Slew Rate at trigger point (V/s)}}$$

Where: e_{n1} *= 140 μV RMS typical counter input noise for 1 MΩ filter on; 250 μV RMS typical for 1 MΩ, filter off and 340 μV RMS typical for 50 Ω.*

e_{n2} *= RMS Noise Voltage of input signal at trigger point measured with 350 MHz bandwidth.*

Slew Rate Error (Seconds) —

$$\frac{\text{Trigger Level Error (V)}^{*1}}{\text{Input Slew Rate at Trigger Point (V/s)}}$$

[1] Trigger level error =

All functions except Width and Events B During A	Positive Slope	Trigger accuracy times ATTN factor
	Negative Slope	(Trigger accuracy ±10 mV) times ATTN factor
Width A ⎍	Start Edge	Trigger accuracy times ATTN factor
	Stop Edge	(trigger accuracy + hyst) times ATTN factor
⎎	Start Edge	(Trigger accuracy + hyst) times ATTN factor
	Stop Edge	Trigger accuracy times ATTN factor
Events B During A	Same as Width, except each number is multiplied by (Frequency B)	

Note: Input hysteresis is typically 50 mV p-p x attenuation.
N = Number of events averaged.

The minimum number of averages is selected by the Averages button and the ↑ ↓ buttons in decade steps from 1 to 10^{9}. At Channel A repetition rates above ≈250 Hz, the actual number of averages will be:

N = [Frequency A (Hz) x 4 ms] + Averages.
N = Averages setting (below 250 Hz).

This calculation typically leads to better than expected resolution in the displayed answer for small N with only minimal impact on measurement time. It does mean, however, that Arming must be used where only N = 1 is desired for signals ≥250 Hz.

In the Auto mode, the counter measures with a fixed measurement time of about 300 ms (or the time for one event, whichever is greater).

N = Frequency A (Hz) x 0.3 s (N always ≥1).

Time Base Error — The sum of all errors specified for the time base.

TIME BASE

Crystal Frequency — 10 MHz.

Temperature Stability — ±2 x 10^{-7}, 0°C to +50°C.

Warm-Up Time — ±2 x 10^{-7} of final frequency in <10 minutes when cold started at 25°C.

Aging Rate — ≤1 x 10^{-8}/day at time of shipment, 4 x 10^{-8}/week after 30 days of continuous operation, 4 x 10^{-6}/year after 60 days of continuous operation.

Setability — Adjustable to within ±2 x 10^{-8}.

REAR INTERFACE

Inputs — Arming; reset; external time base (1 MHz, 5 MHz, or 10 MHz), prescale.

Outputs — 1 MHz clock.

OTHER CHARACTERISTICS

Power Consumption — 14.5 VA.

GPIB Data Output Rate — ≈10 readings/s maximum.

TM 5000 Power Module Compatibility — The DC 5010 is not compatible with TM 500 Series mainframes.

ORDERING INFORMATION

DC 5010 Programmable Universal Counter/Timer **$4,610**

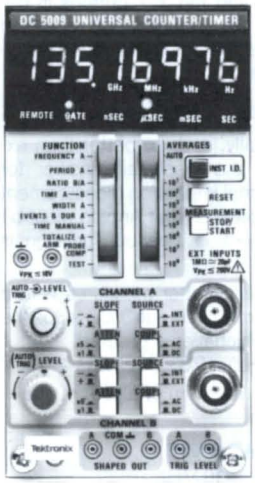
Includes: Shaped output cable (012-0532-00); instruction manual (070-3897-02); instrument interfacing guide (070-4611-00); reference guide (070-3553-00).

Utility Software
For TM 5000/4041. Order 062-6958-01 **$150**
See page 359 for description and ordering information.

RECOMMENDED PROBE

P6125 — 5X Passive Probe. **$70**

DC 5009



Programmable Universal Counter/Timer

DC 5009

GPIB IEEE-488 The DC 5009 complies with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats.*

135 MHz Both A and B Channels

10 ns Single-Shot Resolution

8-Digit Display

5 ps Resolution, With Averaging

Measurement Functions Include: Reciprocal Frequency Measurement; Period; Width; Time A→B Events B During A; Totalize A→B; Ratio; Time Manual; Arming

Auto or Selected Averaging to 10^8 in All Modes

Duty-Cycle Independent Autotrigger

Shaped A and B Channel Outputs

Probe Compensation

The DC 5009 single width Universal Counter/Timer provides all of the measurement functions of the higher performance DC 5010 except rise time/fall time, null, and totalize A ± B.

The powerful reciprocal frequency measurement technique allows up to eight digits of resolution of low frequency signals in one second or less of measurement time. The DC 5009 has the same automatic averaging feature as the DC 5010; selected averaging of up to 10^8 events provides usable time-interval resolution of 5 ps.

Like the DC 5010, the frequency measurement capability of the DC 5009 can be extended to 1.3 GHz with the use of the DP 501 Digital Prescaler. The TM 5000 rear interfacing capability allows the operation of the DP 501 to be controlled over the GPIB through the DC 5009.

A field-installable modification kit is available to upgrade a manual DC 509 Universal Counter/Timer (page 406) to a GPIB programmable DC 5009 Universal Counter/Timer.

See Digital Counter Selection Guide on page 405.

CHARACTERISTICS

Display — Eight-digit LED display, automatic decimal point positioning, LED indicators for units, and measurement gate. Overflow is indicated by a blinking display.

CHANNEL A AND B INPUT

Frequency Range — 0 MHz to 135 MHz dc coupled, 10 Hz to 135 MHz ac coupled.

Sensitivity — 20 mV RMS sinewave to 100 MHz, 40 mV RMS sinewave to 135 MHz, 115 mV p-p at minimum, pulse width of 3 ns.

Attenuation — Selectable 1X, 5X.

Impedance — 1 MΩ paralleled by ≤30 pF.

Trigger Level Range — +3.200 V to −3.175 V with 25 mV resolution (X1). +16 V to −15.875 V with 125 mV resolution (X5).

Trigger Level Accuracy — ±45 mV ±40 μV/°C referenced to 25°C.

Dynamic Range — V p-p ≤3 x attenuation, tr ≤5 ns. V peak ≤3.2 x attenuation.

Autotrigger Frequency Range — 20 Hz to 100 MHz (V_{in} ≥125 mV p-p).

Independent Controls — Slope +/−, attenuation 1X/5X, Couple ac/dc, Source Internal/External.

Maximum Input Voltage
1X: 200 V peak; 400 V p-p from dc to 50 kHz, de-rate to 15 V p-p at 135 MHz. 5X: 200 V peak; 400 V p-p from dc to 5 MHz, de-rate to 25 V p-p at 135 MHz.

Shaped Out — Shaped replica of signal being measured, aids proper triggering on complex waveforms. Amplitude 0 V to ≥+0.3 V from 50 Ω.

Trigger Level Out — A dc level corresponding to the actual trigger level. Accuracy within ±30 mV of internal trigger level.

Arming Input — Permits measurements of complex waveforms. A TTL high allows averaging of selected events within a measurement.

FREQUENCY A

Range — 100 μHz to 135 MHz.

Resolution —

$$\pm\text{LSD} \pm 1.4 \times \frac{\text{Trigger Jitter Error}}{N} \times (\text{Frequency A})^2$$

Accuracy — Resolution ±(Time Base Error x Frequency A)

PERIOD A

Range — 7.40 ns to 3.05 hrs.

Resolution —

$$\pm\text{LSD} \pm 1.4 \times \frac{\text{A Trigger Jitter Error}}{N}$$

Accuracy — Resolution ±(Time Base Error x Period A).

RATIO B/A

Range — 10^{-7} to 10^8 (Frequency Range: CH A to 135 MHz; CH B to 125 MHz.)

Resolution —

$$\pm\text{LSD} \pm 1.4 \times \frac{\text{B Trigger Jitter Error x Frequency B}}{N}$$

Accuracy — Same as Resolution.

TIME A→B

Range — 15 ns to 3.05 hrs.

Minimum Dead Time — 15 ns (stop to start).

Resolution —

$$\pm\text{LSD} + \frac{1}{\sqrt{N}} \times (\pm\text{A Trigger Jitter Error} \pm \text{B Trigger Jitter Error})$$

Accuracy — Resolution ±(Time Base Error x Time A→B) + (B Trigger Slew Error − A Trigger Slew Error) ± (Channel Delay Mismatch).

Channel Delay Mismatch — <2 ns between front panel inputs and <3 ns between rear interface inputs.

Repetition Rate — <35 MHz.

EVENTS B DURING A

Range — 10^{-7} to 10^8.

Maximum B Frequency — 125 MHz.

Minimum A Pulse Width — 15 ns.

Minimum Time Between A Pulses — 15 ns.

Minimum Time Between "A" Start Edge and First "B" Event — 15 ns.

Resolution —

$$\pm\text{LSD} + \frac{\text{Frequency B}}{\sqrt{N}}$$

±Trigger Jitter Error CH A start edge
±Trigger Jitter Error CH A stop edge.)

Accuracy — Resolution + Frequency B (Stop Slew Rate Error − Start Slew Rate Error).

WIDTH A

Range — 15 ns to 3.05 hrs.

Minimum Dead Time Between Pulses — 15 ns.

Resolution —

$$\pm\text{LSD} + \frac{1}{\sqrt{N}}$$

(±Start Trigger Jitter Error
±Stop Trigger Jitter Error)

Accuracy — Resolution ±(Time Base Error x Width A) + (Stop Slew Rate Error — Start Slew Rate Error) ±5 ns.

TIME MANUAL

Range — 0 to 3.05 hrs. May be extended with GPIB.

Resolution — ±LSD (100 ms).

Accuracy — ±Resolution ±(Time Base Error x Time).

TOTALIZE A

Range — 0 to 1.09 x 10^{12} counts. May be extended with GPIB.

Repetition Rate — 0 MHz to 135 MHz.

PROBE COMPENSATION

Display — 1 or 0 for each channel.

Accuracy —

$$\frac{\text{Probe Attenuation x 50 mV x 100 (\%)}}{V_{in} \text{ at Probe}}$$

(2.5% nominal for X5 probe with 10 V p-p at the probe).

RESOLUTION AND ACCURACY DEFINITIONS

Trigger Jitter Error (Seconds RMS) —

$$\frac{\sqrt{(en1)^2 + (en2)^2}\ \text{(Volts RMS)}}{\text{Input Slew Rate at trigger point (V/s)}}$$

Where: $en1$ = 120 μV RMS typical counter input noise
$en2$ = RMS Noise Voltage of input signal at trigger point measured with 150 MHz bandwidth.

Slew Rate Error (Seconds) —

$$\frac{\text{Input Hysteresis/2}}{\text{Input Slew Rate at trigger point (V/s)}}$$

Note: Input hystersis is typically 20 mV p-p.
N = Number of Events Averaged

The minimum number of averages is selected by the averages control in decade steps from 1 to 10^8. At Channel A repetition rates above ≈250 Hz, the number of events averaged will be:

N = [Frequency A (Hz) x 4 ms] + Averages.
N = Averages setting (below 250 Hz).

In the Auto mode, the counter measures with a fixed measurement time of about 300 ms.
N = Frequency A (Hz) x 0.3 s. (N is always ⩾1).

Time Base Error — The sum of all errors specified for the time base used.

TIME BASE

Crystal Frequency — 10 MHz.

Temperature Stability — $\pm 2 \times 10^{-7}$ after warm-up, 0°C to +50°C.

Warm-Up Time — Within 2×10^{-7} of final frequency in <10 minutes when cold-started at 25°C.

Aging Rate — 1×10^{-8}/day at time of shipment, 4×10^{-8}/week after 30 days of continuous operation, 1×10^{-6}/year after 60 days of continuous operation.

Setability — Adjustable to within 2×10^{-8}.

REAR INTERFACE

Inputs — Channel A and Channel B input to 50 MHz (50 Ω impedance, maximum input 3.6 V peak); arming; reset; external time base (1 MHz, 5 MHz, or 10 MHz), prescale.

Outputs — Channel A and Channel B shaped outputs; Channel A and Channel B trigger level outputs; 10 MHz clock; gate out.

OTHER CHARACTERISTICS

Power Consumption — ≈12 VA.

GPIB Data Output Rate — ≈10 readings/s maximum.

TM 5000 Power Module Compatibility — The DC 5009 is not compatible with TM 500 Series mainframes.

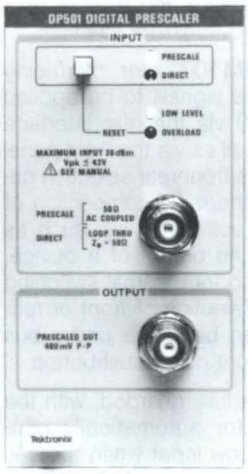
ORDERING INFORMATION

DC 5009 Programmable Universal Counter/Timer **$2,775**
Includes: Tip jack to BNC adaptor cable (175-3765-01); instruction manual (070-3888-00); instrument interfacing guide (070-4612-00); reference guide (070-3560-01).

Utility Software
For TM 5000/4041. Order 062-6958-01 **$150**
See page 359 for description and ordering information.

RECOMMENDED PROBE
P6125 — 5X Passive Probe. **$70**

DP 501



Digital Prescaler

DP 501

Extends Frequency Measurement Capability to 1.3 GHz

Compatible With Most TM 5000 and TM 500 Counters

AGC

Low Level Indicator

The DP 501 Digital Prescaler adds 1.3 GHz frequency counting capability to the Tektronix DC 509/5009, DC 510/5010, and DC 503A Universal Counter/Timers while still allowing full use of all counter/timer functions. There is no need to change input connections as with counters which use the conventional C-Channel input.

The DP 501 is placed in the signal line between the signal source and the counter's input connector such that the signal to be measured passes through the DP 501. Two operating modes are available, Prescale and Direct. In the Prescale mode, the DP 501 divides the input signal frequency by 16 and the associated counter's display to be multiplied by 16 (so that the counter will display the correct frequency). In the Direct mode the signal is simply looped through the DP 501 and applied directly to the counter's input; the counter's display is not affected. This loop-through capability eliminates the need for external switching of the input signal when changing from high frequency measurements to low frequency or time-interval measurements.

The prescaling function can be activated in either of two ways: manually, with a front-panel pushbutton; or, by the "Prescale On" command to the counter when using a GPIB programmable DC 5009 or DC 5010.

Input sensitivity in the Prescale mode is 20 mV RMS to 1 GHz and 30 mV RMS to 1.3 GHz. A Low-Level indicator alerts the user if the input signal amplitude is too low for error-free counting.

An automatic gain control circuit provides optimum immunity to signal noise in the Prescale mode.

The DP 501 and the DC 509/DC 5009 or DC 510/DC 5010 Universal Counter/Timers can be used with the Tektronix 7L14 Spectrum Analyzer (see page 176) and TR 502 Tracking Generator (see page 180) to provide counter accuracy measurements of swept-frequency signals from 100 kHz to 1.3 GHz.

The DP 501 operates in a single compartment of either a TM 500 or TM 5000 mainframe.

CHARACTERISTICS

Prescale Mode

Input — Frequency range is ⩽100 MHz to ⩾1.3 GHz.

Sensitivity — 100 MHz to 1 GHz is ⩽20 mV RMS (−21 dBm). 1 GHz to 1.3 GHz is ⩽30 mV RMS (−17 dBm).

Impedance — 50 Ω ac coupled; vswr ⩽2.2:1.

Output — Amplitude into 50 Ω is ⩾200 mV. Unterminated is 2X terminated value.

Direct Mode

Input — Connected directly to output.

Frequency Range — 0 MHz to >350 MHz.

Impedance — Loop through characteristic impedance is 50 Ω; nonterminated capacitance ≈20 pF (no connection to output).

Output — Connected directly to input. <1 dB insertion loss up to 350 MHz. Powers up in direct mode.

Overload Protection — Prescale: Input disconnects when input signal exceeds +20 dBm ±5 dBm for a period of ≈0.5 s or more.

Damage Level — Prescale: Input may be damaged if signal level exceeds +25 dBm.
Direct: 42 V peak maximum. Maximum current is 250 mA.

Input Attenuation — Automatic: Up to 40 dB range.

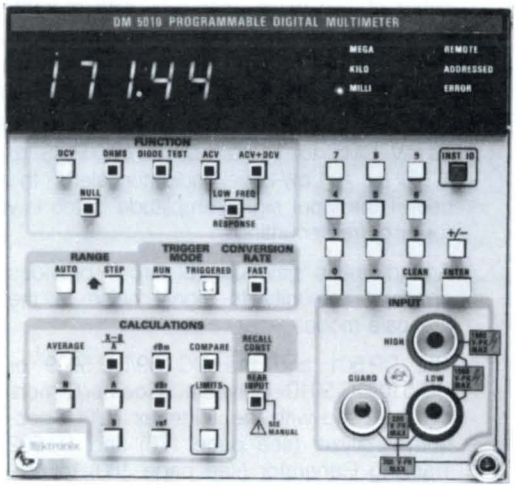
Low Level Indicator — Lights when input signal is below that required for error-free counting.

Tracking Generator Compatibility — Outputs will drive two standard TTL loads. Inputs represent two standard TTL loads. Requires arming input to associated counter.

ORDERING INFORMATION

DP 501 Digital Prescaler **$575**
Includes: Instruction manual (070-4332-00).

DM 5010



Programmable Digital Multimeter

DM 5010

GPIB IEEE-488 The DM 5010 complies with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats.*

4 1/2 Digit, Autoranging

Dc Volts, Ohms, True RMS (ac or ac+dc)

Diode Test

Comprehensive Math Functions: dB Calculations; Averaging; Offset; Scaling; Hi/Lo/Pass

The DM 5010 Programmable Digital Multimeter measures dc voltage, resistance, true RMS ac voltage, and true RMS ac+dc voltage. The internal math capability of the DM 5010 provides most of the calculations normally required for reducing raw measurements to decision-supporting information without controller assistance. These calculations include averaging (up to 19,999 measurements), offset and scaling, conversion to dBm or reference dB, and Hi/Lo/Pass comparisons. User-selectable constants required for calculations can be supplied either through the front panel keypad or via the GPIB.

The internal math capability of the DM 5010 permits such specialized measurements as: ac or dc current measurements through the use of an external shunt resistor and a scaling factor equal to the ohmic value of the resistor; comparison against a percent tolerance (as opposed to an absolute value tolerance) through the combined use of the scaling and Hi/Lo/Pass functions.

The low voltage (0.2 volt) ohms function allows in-circuit resistance measurements without turning on parallel diode and transistor junctions. A Diode Test function is provided for forward and reverse testing of diode and transistor junctions.

The versatile TM 5000 rear interfacing capability allows signals to be applied to the DM 5010 via the rear interface connector as well as via the front panel input jacks. This front-rear selection capability allows the rapid comparison of two signals or voltage levels, such as the input and the output of a device, without the need for external switching of the signal. Selection of front or rear signal input can be made under bus control or by front panel pushbutton.

The DM 5010 is fully guarded, with the Guard connector automatically connected to the Low input when there is no Guard signal lead inserted.

The Null function eliminates much of the requirement for four-wire ohms connections by allowing the operator, or the system, to null out lead resistance in resistance measurements. The Null function also allows the difference between two measurements to be displayed, either directly or as a dB difference.

A special Low Frequency Response function permits stable readouts of low frequency ac voltages.

Range selection is either automatic or manually incremented. Measurements and calculations can be triggered by internal circuitry, a front panel pushbutton, a rear interface signal, or a GPIB command.

Calibration of the DM 5010 is greatly simplified through the use of internal microprocessor-computed nonvolatile calibration constants.

CHARACTERISTICS

DC VOLTS

Ranges — 200 mV, 2 V, 20 V, 200 V, 1000 V.

Accuracy[*1]

+18°C to +28°C		
Voltage Ranges	**Normal Conversion Rate**	**Fast Conversion Rate**
200 mV	±[0.015% of reading +0.01% of full scale (2 counts)]	±[0.05% of reading +0.05% of full scale (1 count)]
2 V through 200 V	±[0.015% of reading +0.005% of full scale (1 count)]	±[0.05% of reading +0.05% of full scale (1 count)]
1000 V	±[0.020% of reading +0.010% of full scale (2 counts)]	±[0.05% of reading +0.1% of full scale (2 counts)]
0°C to 18°C, +28°C to +50°C		
200 mV	±[0.06% of reading +0.035% of full scale (7 counts)]	±[0.1% of reading +0.1% of full scale (2 counts)]
2 V through 200 V	±[0.06% of reading +0.03% of full scale (6 counts)]	±[0.1% of reading +0.1% of full scale (2 counts)]
1000 V	±[0.065% of reading +0.035% of full scale (7 counts)]	±[0.1% of reading +0.15% of full scale (3 counts)]

*[*1] Valid for six months or 1000 operating hours, whichever occurs first, after calibration.*

Common-Mode Rejection Ratio (With 1 kΩ Imbalance) — Unguarded: ⩾130 dB at dc. ⩾80 dB at 50 Hz to 60 Hz.
Guarded: ⩾140 dB at dc. ⩾100 dB at 50 Hz to 60 Hz.

Normal-Mode Rejection Ratio — ⩾40 dB at 50 Hz or 60 Hz ±0.2 Hz.

Maximum Resolution — 10 μV.

Step Response Time (To Rated Accuracy)

Run Mode — Normal conversion rate is ⩽0.53 s. Fast conversion rate is ⩽0.08 s.

Triggered Mode — Normal conversion rate is ⩽0.33 s. Fast conversion rate is ⩽0.06 s.

Input Resistance —
200 mV to 20 V Range: $>10^9$ Ω.
200 V to 1000 V Range: 10 MΩ ±0.25%.

Maximum Input Voltage — 1000 V peak.

TRUE RMS AC VOLTS (ACV AND AC+DC)

Input Signal — Must be between 5% and 100% of full scale.

Ranges — 200 mV, 2 V, 20 V, 200 V, 700 V.

Accuracy[*1]

Ac Volts and Ac Volts + Dc Volts			
+18°C to +28°C	**Normal and Fast Conversion**		
Voltage Ranges	**20 Hz to 100 Hz**	**100 Hz to 20 kHz**	**20 kHz to 100 kHz**
200 mV through 200 V	±(0.8% of rdg +0.2% of full scale)	±(0.2% of rdg +0.2% of full scale)	±(1.0% of rdg +0.5% of full scale)
700 V (15 kHz maximum)	±(0.8% of rdg +0.6% of full scale)	±(0.2% of rdg +0.6% of full scale)	
0°C to +18°C, +28°C to +50°C			
200 mV through 200 V	±(1.25% of rdg +0.35% of full scale)	±(0.65% of rdg +0.3% of full scale)	±(1.45% of rdg +0.65% of full scale)
700 V (15 kHz maximum)	±(1.25% of rdg +0.95% of full scale)	±(0.65% of rdg +0.95% of full scale)	

Ac Volts + Dc Volts Only	
+18°C to +28°C	
Voltage Ranges	Normal and Fast Conversion Rates 10 Hz to 20 Hz
200 mV through 200 V	±(0.8% of rdg +0.3% of full scale)
700 V	±(0.8% of rdg +0.9% of full scale)
0°C to +18°C, +28°C to +50°C	
200 mV through 200 V	±(1.25% of rdg + 0.45% of full scale)
700 V	±(1.25% of rdg + 1.25% of full scale)

*[*1] Valid for six months or 1000 operating hours, whichever occurs first, after calibration.*

Common-Mode Rejection Ratio — Unguarded: Typically ⩾80 dB from dc to 60 Hz. Guarded: Typically ⩾100 dB from dc to 60 Hz.

Maximum Resolution — 10 μV.

Response Time — <1.2 s (except for Low Frequency Response mode).

Input Impedance — 2 MΩ ±0.1% paralleled by <150 pF.

Maximum Input Voltage — 1000 V peak ac, 500 V dc.

Crest Factor — Four (subject to maximum peak input voltage).

See DMM Selection Guide on page 410.

DIODE TEST

Operation — A 1 mA current is generated and the resultant voltage is measured on the 2 V dc range. This produces a voltage sufficient to turn on diode and transistor junctions.

RESISTANCE

Ranges — 200 Ω, 2 kΩ, 20 kΩ, 200 kΩ, 2 MΩ, 20 MΩ.

Accuracy*1

+18°C to +28°C

Resistance Range	Normal Conversion Rate	Fast Conversion Rate
200 Ω	±[0.015% of reading +0.015% of full scale (3 counts)] (using null)*2	±[0.05% of reading +0.05% of full scale (1 count)] (using null)*2
2 kΩ to 200 kΩ	±[0.015% of reading +0.01% of full scale (2 counts)] (using null on 2 kΩ only)*2	±[0.05% of reading +0.05% of full scale (1 count)]
2 MΩ	±[0.10% of reading +0.01% of full scale (2 counts)]	±[0.10% of reading +0.05% of full scale (1 count)]
20 MΩ	±[0.15% of reading +0.005% of full scale (1 count)]	±[1.0% of reading +0.05% of full scale (1 count)]

Accuracy*1

0°C to +18°C, +28°C to +50°C

Resistance Range	Normal Conversion Rate	Fast Conversion Rate
200 Ω	±[0.06% of reading +0.06% of full scale (12 counts)] (using null)*2	±[0.1% of reading +0.1% of full scale (2 counts)] (using null)*2
2 kΩ to 200 kΩ	±[0.06% of reading +0.035% of full scale (7 counts)] (using null on 2 kΩ only)*2	±[0.1% of reading +0.1% of full scale (2 counts)]
2 MΩ	±[0.54% of reading +0.035 of full scale (7 counts)]	±[0.55% of reading +0.1% of full scale (2 counts)]
20 MΩ	±[0.9% of reading +0.01% of full scale (2 counts)]	±[1.6% of reading +0.05% of full scale (1 count)]

*1 *Valid for six months or 1000 operating hours, whichever occurs first, after calibration.*

*2 *When the null function is not used add ±0.2 Ω to all readings.*

Maximum Resolution — 10 mΩ.

Step Response Time (to rated accuracy)

Run Mode — Normal conversion rate is ⩽1.24 s. Fast conversion rate is ⩽0.33 s.

Triggered Mode — Normal conversion rate is ⩽0.73 s. Fast conversion rate is ⩽0.19 s.

Maximum Input Volts — 400 V peak.

Maximum Open Circuit Voltage Developed — <5 V.

OTHER CHARACTERISTICS

Overrange Indication — For Ohms and Diode Test, "OC" is displayed; for ACV, DCV, ACV+DCV, the display blinks.

Measurement Rate — ACV, DCV, ACV+DCV, Diode Test: 3/s at 4.5 digits; 26/s at 3.5 digits. Ohms: 1.6/s at 4.5 digits; 7.1/s at 3.5 digits.

Power Consumption — ≈20 VA.

IEEE Standard 488-1978 Interface Function Subsets Implemented — SH1, AH1, T5, L4, SR1, RL1, PP0, DC1, DT1, C0.

ORDERING INFORMATION

DM 5010 Programmable Digital Multimeter **$2,260**

Includes: One set test leads (003-0120-00); instruction manual (070-2994-01), instrument interfacing guide (070-4603-00); reference guide (070-3542-00).

Utility Software

For TM 5000/4041. Order 062-6958-01 **$150**

See page 359 for description and ordering information.

OPTIONAL ACCESSORIES

Test Leads —

(Black) 4 ft. Order 012-0425-00 **$12.75**

(Red) 4 ft. Order 012-0426-00 **$23**

(Black) 4 ft. Order 012-0426-01 **$23**

Test Lead Set — Includes 012-0425-00, 012-0426-00, and 013-0107-05. Order 012-0427-00 **$29**

Female BNC to Dual Banana Adaptor — Order 103-0090-00 **$9.25**

RECOMMENDED PROBES

High Voltage — To 40 KV. See page 413. Order 010-0277-00 **$180**

P6420 — RF, 2 m Probe. See page 476. **$145**

FG 5010

GPIB IEEE-488

The FG 5010 complies with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats.*

0.002 Hz to 20 MHz

Up to 20 V p-p From 50 Ω

Sine, Square, Triangle, Pulse, and Ramp Waveforms

10 ns Rise/Fall

10% to 90% Variable Symmetry in 1% Steps

Trigger, Gate, Counted Burst

Phase Lock, With Autoscan

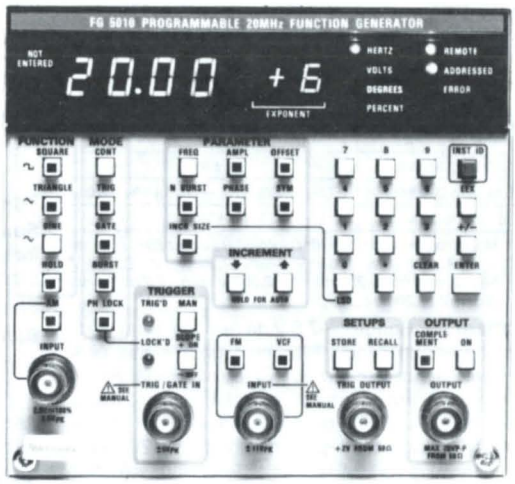
AM, FM, VCF

Waveform Complement

The FG 5010 Programmable 20 MHz Function Generator is a highly versatile GPIB programmable instrument; it is also extremely easy to operate in the manual mode as well. All functions are addressable via the lighted front panel pushbuttons, with nomenclature and functionality clearly designated. The ability to store ten complete front panel setups and recall them with only two keystrokes or by a single command over the GPIB reduces GPIB programming time and enhances standalone bench applications.

The FG 5010 provides the conventional sine, square, triangle, pulse, and ramp waveforms. Variable symmetry, which is usable throughout the entire frequency range, extends pulse and ramp capabilities beyond those of conventional generators. The FG 5010 also provides trigger, gate, counted burst, phase lock, AM, FM, and VCF modes. Variable phase enhances the trigger, gate, burst, and phase lock modes.

FG 5010



Programmable 20 MHz Function Generator

The wide frequency range assures the FG 5010's usefulness in radio and other communication-oriented applications, as well as in low frequency applications such as biological, geophysical, and mechanical simulations.

The FG 5010 maintains frequency accuracy within 0.1% over its full 0.002 Hz to 20 MHz frequency range. Automatic phase lock to an external signal is possible from 20 Hz to 20 MHz. Waveform complement and +/− trigger slope allow interfacing to circuits with the proper waveform phase, especially important in pulse and digital applications. Waveform hold can freeze the output voltage of any 200 Hz or less waveform at its instantaneous value. With the output amplitude set to zero volts, the dc offset can be programmed to provide a dc voltage source of 0 volts to ±7.5 volts in 10 mV steps.

CHARACTERISTICS

Waveform — Sine, Square and Triangle with variable Symmetry providing Pulses and Ramps.

Symmetry — 10% to 90%, 1% steps, ±2% accuracy. Range above 4 MHz is limited by 25 ns minimum triangle transition time (decreases to 50% at 20 MHz).

Frequency — Range: 0.002 Hz to 20 MHz. Accuracy: Continuous mode, ±0.1%. Trigger, Gate, Burst Modes: Frequency ⩽200 Hz, ±0.1%; frequency >200 Hz, ±5.0%. Resolution: Continuous mode, 4 digits, Trigger, Gate, Burst modes. Frequency ⩽200 Hz, 4 digits. Frequency >200 Hz, 3 digits.

Amplitude — Range: 20 mV to 20 V p-p from 50 Ω into open circuit.

Accuracies*1

Frequency	Sine	Square	Triangle
0.002 Hz to 1 kHz	±3%	±2%	±2%
1 kHz to 100 kHz	—	—	±3.5%
1 kHz to 1 MHz	±3.5%	±3.5%	—
100 kHz to 1 MHz	—	—	±4%
1 MHz to 5 MHz	±5%	—	+4%, −5%
1 MHz to 10 MHz	—	±5%	—
5 MHz to 20 MHz	±5%, −10%	—	+4%, −20%
10 MHz to 20 MHz	—	±10%	—

*1 *Measured at +25°C ±10°C into 50 Ω load at 50% symmetry. Resolution: 20 mV from 2.02 V to 20.00 V p-p, 2 mV from 202 mV to 2.000 V p-p, 0.2 mV from 20.0 mV to 200.0 mV p-p.*

Offset — Range: −7.5 V to +7.5 V from 50 Ω into an open circuit. Maximum peak signal plus offset cannot exceed ±15 V open circuit. Accuracy: All waveforms, except squarewave >2 MHz, ⩽ ±(1% of the selected offset + 2% of the signal p-p amplitude +20 mV); squarewave >2 MHz <±(1% of the selected value +5% of the signal p-p amplitude +20 mV). Resolution: 10 mV open circuit, 5 mV into 50 Ω load. 0 V is also provided.

Output Impedance — 50 Ω.

Sinewave Distortion — 20 Hz to 19.99 kHz, ⩽0.5%; 20.0 kHz to 99.99 kHz, ⩽1.0%; 100 kHz to 20.0 MHz, harmonics >30 dB down from 100 kHz to 20 MHz. Valid from +15°C to +35°C into 50 Ω load with 0 V offset, continuous mode, 50% symmetry, and AM, FM, VCF, and Complement off.

Squarewave Response — Rise time and fall time are ⩽10 ns. Aberrations are ⩽5% p-p +20 mV.

Typical Triangle Linearity (10% to 90%) — 0.002 Hz to 200 Hz, ⩽1%; 200 Hz to 100 kHz, ⩽1%; 100 kHz to 2 MHz, ⩽2%; 2 MHz to 20 MHz, ⩽10%.

Trigger Output — 0 V ±100 mV to ⩾+2 V from 50 Ω source impedance into an open circuit.

TRIG, GATE, BURST, AND PH LOCK INPUT

Input Impedance — 1 MΩ or 50 Ω, internally selectable.

Trigger Threshold — 0 V or + 0.5 V, internally selectable.

Amplitude Sensitivity — ⩽250 mV p-p.

Slope — Plus or minus, plus only in Ph Lock.

Minimum Pulse Width — 25 ns.

Maximum Frequency — 20 MHz.

Maximum Input Amplitude — ±5 V peak into 50 Ω, ±20 V peak into 1 MΩ.

Burst Range — 1 cycle to 9999 cycles.

Phase Lock Range — Automatic capture from 20 Hz to 20 MHz.

Phase Lock Time — Typically 8 ms to 88 s, depending on final frequency and start frequency.

AM INPUT

Input Impedance — 10 kΩ (±5% when AM is selected).

Sensitivity — 5 V p-p produces ⩾100% modulation.

Distortion — <2% at 70% modulation and ⩽2 MHz; <4% at 70% modulation and >20 MHz.

Bandwidth — Dc to ⩾100 kHz.

Maximum Input Amplitude — ±20 V pk.

FM INPUT

Input Impedance — 10 kΩ.

Sensitivity — 0 V to ±1 V modulates to ⩾±1% deviation from center frequency.

Distortion — ⩽2%.

Bandwidth — Dc to ⩾100 kHz.

Maximum Input Amplitude — ±20 V peak.

VCF INPUT

Input Impedance — 10 kΩ ±5%.

Sensitivity — 0 V to 10.0 V produces a ⩾1000:1 frequency change, positive going voltage increases frequency.

Slew Rate — ⩾0.063 V/μs.

Bandwidth — Dc to ⩾100 kHz.

Maximum Input Amplitude — ±20 V peak.

OUTPUT HOLD MODE

Range — 0.002 Hz to 200 Hz. (Output holds at instantaneous value.)

PHASE (TRIG, GATE, AND BURST MODES)

Range — ⩽90° to 1 MHz, decreasing to ⩽80° at 20 MHz.

Accuracy —

$\pm 3°$ to 500 kHz; $\pm[7° + (\frac{\text{freq}}{20\text{ MHz}} \times 28\% \times |\Phi|)°]$

for freq >500 kHz. At 25 ±10°C VCF off, output in Normal and symmetry at 50%.

Resolution — 1°.

PHASE (PH LOCK MODE)

Specifications apply for ambient temperature of 25°C ±10°C.

Range — ⩽90°, 20 Hz to ⩽10 MHz; ⩽45° to ⩾10 MHz (Complementing the output extends effective 0 range to ±180°).

Accuracy — ±(2° +5% of selected value).

Resolution — 1°.

OTHER CHARACTERISTICS

Power Consumption — 60 W.

IEEE Standard 488-1978 Interface Function Subsets Implemented — SH1, AH1, T6, L4, SR1, RL1, PPØ, DC1, DT1, CØ.

ORDERING INFORMATION

FG 5010 20 MHz Function Generator **$3,995**
Includes: Instruction manual (070-3467-01), instrument interfacing guide (070-4613-00), reference guide (070-3561-00).

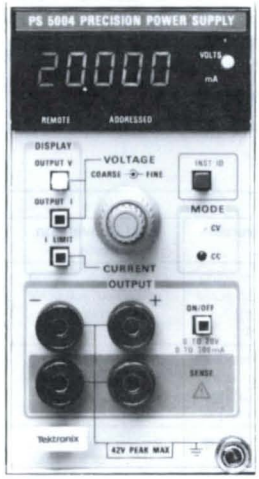
Utility Software
For TM 5000/4041 Order 062-6958-01 **$150**
See page 359 for description and ordering information.

OPTIONAL ACCESSORIES

Rear Interface Signal Cable Kit —
Order 020-0701-00 **$40**

Service Kit — Order 067-1041-00 **$360**

PS 5004



Programmable Precision Power Supply

PS 5004

GPIB IEEE-488 The PS 5004 complies with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats.*

0 V to 20 V Floating Output

0.01% Accuracy

500 μV/0.1 mA Resolution

Constant Voltage or Constant Current With Autocrossover

Voltage and/or Current Monitoring Display

Remote Sensing

The single width PS 5004 Precision Power Supply provides the high resolution voltages and currents necessary in the characterization of transistor, IC, and other semiconductor and hybrid circuits and in the operation of high performance strain gauges and other transducer systems. Its entire 0 V to 20 V output is covered with a coarse and fine adjustment to provide rapid setability and ±500 μV resolution without the necessity of changing ranges. Setability resolution over the GPIB is also ±500 μV. The supply output is available at the rear interface as well as from the front panel terminals. Overall accuracy is ±0.01% ±2 mV.

The PS 5004 operates in either a constant voltage or constant current mode with autocrossover between the two. Front panel annunciators indicate the mode at all times. The operating mode is also reported over the bus and the PS 5004 can be programmed to assert SRQ whenever operating conditions cause it to change from one mode to the other.

To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext. 99

The 4½ digit display shows actual output voltage, selected current limit, or actual output current. The actual output voltage is shown even when the PS 5004 is operating in the current-limited or unregulated mode. Display resolution is 1 mV or 0.1 mA.

The buffered high impedance sense terminals allow proper regulation of the supply with up to 3 Ω of resistance in either of the sense leads.

CHARACTERISTICS

CONSTANT VOLTAGE MODE

Range — 0 V to 20 V in 0.5 mV steps.

Overall Accuracy (Total Effect) — ±0.01% +2 mV from +15°C to +30°C, derating to ±0.035% +3 mV at 0°C and +50°C. Source Effect: 500 μV. Load Effect: 1 mV for a no load to full load change in load current measured at sense terminals.

Step Size Accuracy — 0.5 mV ±0.2 mV.

PARD*1 — ≤2 mV p-p, 10 Hz to 5 MHz.

Load Transient Recovery*1*2 — <200 μs to recover within 5.0 mV of final value for a 100 mA load change.

*1 Characteristics measured at front panel terminals without using remote sense.

*2 Without external energy storage components.

CONSTANT CURRENT MODE

Range — 10 mA to 305 mA in 2.5 mA steps.

Overall Accuracy — ±2% +5 mA.

DIGITAL METER

Configuration — True 4½ digit free running voltmeter. Meter can be selected by front panel controls or via GPIB to monitor output voltage, current or current limit setting. Measurements are displayed on the front panel and are available over the GPIB.

Resolution — 1 mV or 0.1 mA.

Accuracy — Output Voltage: ±0.15% +6 mV. Output Current: ±1.5% +1 mA. Current Limit: ±1.5% +5 mA.

Reading Rate — ≈5/s.

OTHER CHARACTERISTICS

Isolation Voltage (Maximum Allowable Voltage Between Any Output or Sense Terminal and Chassis Ground) — 42 V peak ac + dc.

TM 5000 Power Module Compatibility — The PS 5004 is not compatible with TM 500 mainframes.

Power Consumption — 35 VA maximum.

IEEE Standard 488-1978 Interface Function Subsets Implemented — SH1, AH1, T6, L4, SR1, RL1, PP0, DC1, DT1, C0.

ORDERING INFORMATION

PS 5004 Precision Power Supply **$1,850**

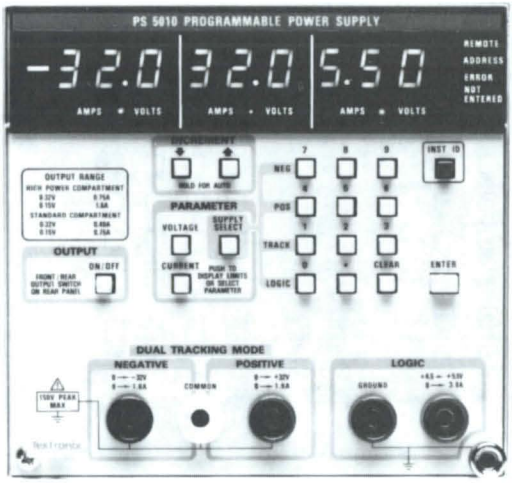
Includes: Instruction manual (070-4442-00); instrument interfacing guide (070-4789-00); reference guide (070-4596-00).

Utility Software

For TM 5000/4041 Order 062-6958-01 **$150**

See page 359 for description and ordering information.

PS 5010



Programmable Triple Power Supply

PS 5010

GPIB IEEE-488 The PS 5010 complies with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats.*

Dual Floating Supplies 0 V to 32 V, to 0.75 A (1.6 A to 15 V)

Logic Supply +4.5 V to 5.5 V, to 3 A

0.5% Accuracy

Programmable Current Limits

Three Independent Digital Displays

Automatic Crossover

The PS 5010 Programmable Power Supply provides a complete and rapid high performance solution for many system power supply applications. Its three supplies provide the most commonly used voltages, and the three digital displays automatically indicate all six voltage and current limit parameters. Automatic crossover from voltage to current limit and a powerful set of GPIB status reporting messages allow the user to be constantly aware of the PS 5010's status.

The PS 5010's dual floating supply provides 0 V to +32 V and 0 V to −32 V, both with respect to a common front panel terminal. Or 0 V to 64 V across the terminals of both supplies together—with currents up to 0.75 A throughout the total voltage range and 1.6 A below 15 V. The logic supply provides +4.5 V to +5.5 V with respect to ground, with currents to 3 A. The user can program the outputs on and off, and can lock out the front panel controls with GPIB commands.

The three supplies can be independently programmed for separate voltage and current limits, and displayed in the LED display.

Whenever a load change causes a supply to change modes from constant voltage to constant current (or vice versa), the corresponding display also changes to show the known current or voltage value. This condition can be reported over the GPIB via an interrupt when the PS 5010 is in the remote state.

CHARACTERISTICS

POSITIVE AND NEGATIVE FLOATING SUPPLIES

Configuration — Dual floating with shared common terminal.

Isolation — 150 V peak front panel, 42 V peak from rear interface, 0.015 μF typical shunt capacitance to ground.

Constant Voltage Mode

Range — Positive: 0 V to +32.0 V. Negative: 0 V to −32.0 V.

Overall Accuracy — Total Effect: ±(0.5% +20 mV). Source Effect: ±(0.01% +2 mV). Load Effect: ±10 mV for 1 A load current change (1 mV when using rear interface output with remote sensing).

PARD (Ripple and Noise) — 10 mV p-p; 20 Hz to 20 MHz.

Resolution — 10 mV ±10 mV (typically ±2 mV) to 10.0 V. 100 mV ±40 mV (typically ±10 mV) >10.0 V.

Load Transient Recovery — 500 μs to recover within 20 mV of nominal value for a 1 A change.

Change Response Time — 1 ms for up or down change with maximum load, 20 ms for down change with no load.

Constant Current Mode

Range — 50 mA to 0.75 A (1.60 A at 15 V and below) in high power compartment; 50 mA to 400 mA (0.750 A at 15 V and below) in two standard power compartments.

Overall Accuracy — ±(5% + 20 mA) Source Effect: ±1 mA line regulation. Load Effect: ±10 mA. Output impedance is typically 5 kΩ shunted by 20 μF.

PARD (Ripple and Noise) — 10 mA p-p, 20 Hz to 20 MHz.

Resolution — 50 mA ±15 mA.

Change Response Time — 20 ms up or down.

LOGIC SUPPLY

Constant Voltage Mode

Range — +4.50 V to +5.50 V, ground referenced.

Overall Accuracy — ±50 mV. Source Effect: ±1 mV. Load Effect: ±10 mV for 1 A load current change (1 mV when using rear interface output with remote sensing).

PARD (Ripple and Noise) — 10 mV p-p, 20 Hz to 20 MHz.

Resolution — 10 mV ±10 mV (typically ±2 mV).

Load Transient Recovery — 500 μs to recover within 20 mV of nominal value.

Constant Current Mode

Range — 100 mA to 3.0 A (Foldback characteristic below 4.5 V, maximum short circuit current is <1.5 A).

Overall Accuracy — ±(5% +20 mA).

Resolution — 100 mA ±30 mA.

Scaled Output — 10 mA = 1 mV ±(2% +2 mV) available at rear interface (not ground referenced).

Overvoltage Protection — SCR crowbar typically trips at 6 V to 7 V.

OTHER CHARACTERISTICS

TM 5000 Power Module Compatibility — The PS 5010 is not compatible with TM 500 mainframes.

Power Consumption — 250 VA maximum in high power compartment, 200 VA in standard compartment.

IEEE Standard 488-1978 Interface Function Subsets Implemented — Same as PS 5004.

ORDERING INFORMATION

PS 5010 Power Supply **$3,050**

Includes: Instruction manual (070-3391-00); instrument interfacing guide (070-4610-00); reference guide (070-3402-00).

Utility Software

For TM 5000/4041 Order 062-6958-01 **$150**

See page 359 for description and ordering information.

SG 5010/AA 5001

GPIB IEEE-488

The SG 5010 and AA 5001 comply with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats*.

Fast, Accurate, Repeatable Measurements

Easy to Use, Minimizes Training Needs

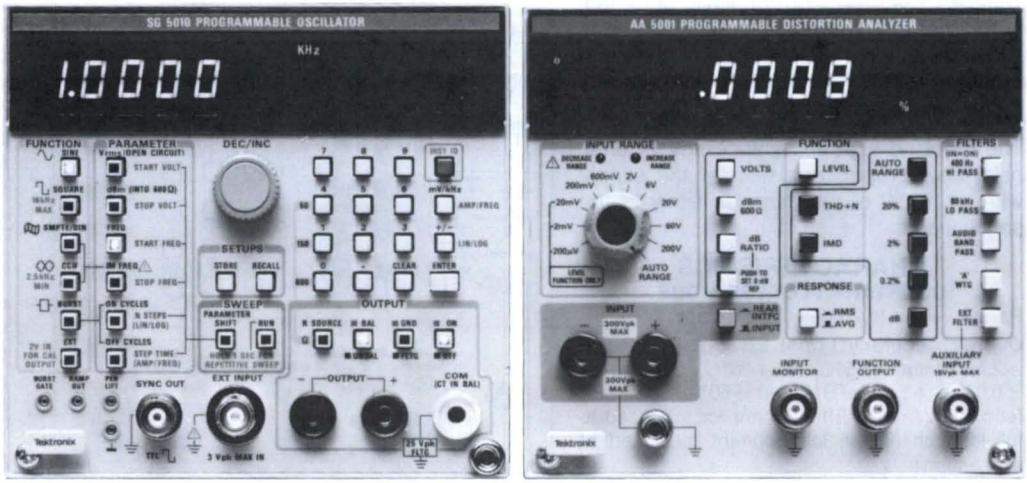
Automatic Low-Cost Documentation of Test Results

Automated Audio Test System Advantages

Tektronix SG 5010 and AA 5001 programmable instruments in a computer-controlled test system will make critical audio measurements consistently, accurately, and in two to four seconds each. Even complex tests can be made by technically unskilled operators since the procedures are controlled by software in the controller. And, permanent graphic or tabular records of test results can be produced at very low cost.

SG 5010

AA 5001



Programmable Audio Test System

An SG 5010/AA 5001 based system will automatically perform such industry-standard tests as harmonic distortion to IHF A202, intermodulation distortion to SMPTE TH 22.51, DIN 45403, IEC 268.3, and IHF A202, frequency response to IHF A202, and noise or signal-to-noise ratio to IHF A202 ("A" weighting filter complies with ANSI specification S1.4 and IEC specification 179 for sound level meters). With the Option 02 capability of the AA 5001, noise measurements can be made to CCIR 468-2 and DIN 45405 standards. The SG 5010 also generates the burst signal necessary for dynamic headroom tests per IHF A202.

A basic automated system consists of the SG 5010 Programmable Oscillator, the AA 5001 Programmable Distortion Analyzer, and an IEEE Standard 488 controller such as the Tektronix 4041 System Controller. Frequency counters, signal switchers, interface devices, disc storage, and hard copy units or plotters can be optionally added to the system.

The MP 2902 is a measurement package offering a total solution to your audio measurement requirements. It includes an automatic test program generator which dramatically reduces software development time and allows program development by nonprogrammers. See page 377.

Other Measurement Capabilities

Features and flexibility of the SG 5010 and AA 5001 permit a variety of other measurements to be easily automated. SMPTE-like IMD measurements can be made at a variety of lower frequencies and any value of upper frequency, and at 1:1 amplitude ratios in addition to the standard 4:1 ratio. A CCIF test with the frequencies selected near the upper band limit of the device under test has been shown to be a very effective and simple-to-implement test for transient or dynamic intermodulation (TIM and DIM). Burst signals of any desired duty cycle can be generated for IHF dynamic headroom measurements and to test compressors and limiters; the between-bursts level can be selected as Off or 20 dB below the burst level. Power measurements are made by a controller computation from a voltage measurement across a known load resistance. SINAD measurements of sensitivity of FM communications receivers are a standard capability of the AA 5001 plus an appropriate RF signal generator. The SG 5010 features an amplifier mode in which an external signal can be converted to the high level, multiple impedance, balanced and floating capability of the SG 5010 output circuitry. Fully program-selectable filters in the AA 5001 allow various choices of bandwidth for distortion measurements and weighting for noise measurements, or rejection of interfering signals. Phase measurements can be added to the system by use of the DC 5009 or DC 5010 Universal Counter Timer.

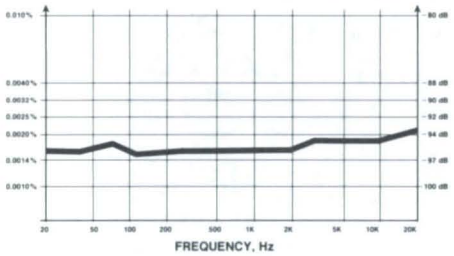
CHARACTERISTICS (SYSTEM)

HARMONIC DISTORTION FUNCTION

Measurement Settling Time — Typically ≤2.5 s above 100 Hz, increasing by 1 s/octave below 100 Hz.

Residual THD + N — V_{in} ≥250 mV, RMS response, all distortion, noise, and nulling resources combined. 20 Hz to 20 kHz ≤0.0032% (−90 dB) with 80 kHz filter. 10 Hz to 100 kHz ≤0.01% (−80 dB) no filters.

TYPICAL SYSTEM RESIDUAL THD + NOISE V_{in} ≥250 mV with 80 kHz filter, RMS response.



INTERMODULATION DISTORTION FUNCTION

Measurement Settling Time — Typically ≤2 s.

Residual IMD — V_{in} ≥250 mV, RMS response.

SMPTE and DIN Tests — ≤0.0032% (−90 dB) for 60 Hz and 7 kHz or 250 Hz and 8 kHz, 4:1 ratio.

CCIF Difference Frequency Test — ≤0.0018% (−95 dB) with 14 kHz and 15 kHz.

LEVEL FUNCTION

Measurement Settling Time — Typically ≤2 s.

Flatness — ±0.1 dB 20 Hz to 20 kHz.

CHARACTERISTICS (SG 5010)

AVAILABLE FUNCTIONS

Sinewave, squarewave, SMPTE/DIN 4:1, SMPTE DIN 1:1, CCIF, Sinewave Burst, IHF Burst (−20 dB or Off between bursts), External Input (Amplifier Mode).

FREQUENCY RANGE AND ACCURACY

Sinewave, Sinewave Burst

SMPTE/DIN: 10 Hz to 163.80 kHz ±0.01%.

CCIF Center Frequency: 2.500 kHz to 163.80 kHz ±0.01%.

Squarewave: 10 Hz to 16.380 kHz ±0.01%.

Resolution in Above Functions

10.00 Hz to 163.80 Hz: 0.01 Hz. 163.9 Hz to 1.6380 kHz: 0.1 Hz. 1.639 kHz to 16.380 kHz: 1.0 Hz. 16.39 kHz to 163.80 kHz: 10.0 Hz.

SMPTE Lower Tone, CCIF Offset From Center Frequency — Selectable From: 40 Hz, 50 Hz, 60 Hz, 80 Hz, 100 Hz, 125 Hz, 250 Hz, 500 Hz, all ±2%.

Sine Distortion (Load ≥600 Ω, THD Including 2nd Through 5th Harmonics) — 20 Hz to 20 kHz: 0.001% (−100 dB). 20 kHz to 50 kHz: 0.0032% (−90 dB). 10 Hz to 20 Hz and 50 kHz to 100 kHz: 0.01% (−80 dB). 100 kHz to 163.8 kHz: 0.032% (−70 dB) any individual harmonic.

SMPTE, DIN or CCIF Distortion — See System Specifications.

Sine Flatness — 20 Hz to 20 kHz: ±0.05 dB. 10 Hz to 163.8 kHz: ±0.2 dB.

Squarewave Rise Time — 1.5 µs ±10%.

Burst Range — 1 cycle to 65535 cycles On. 1 cycle to 65535 cycles Off. Off level either −20 dB or zero. All switching at sinewave zero crossing. Triggered, gated, or free-running burst modes available.

OUTPUT LEVEL RANGE AND ACCURACY

Balanced — Into Open Circuit: 200 µV to 21.2 V RMS. Into 600 Ω: −72.45 dBm to +28.05 dBm.*1

Unbalanced — Into Open Circuit: 200 µV to 21.2 V RMS. Into 600 Ω: −72.45 dBm to +22.05 dBm.*1

Resolution — 0.05 dB in dBm mode, 0.25% or better in volts mode.

Level Accuracy (Sinewave) — 20 Hz to 20 kHz ±2% (0.2 dB). 10 Hz to 163.8 kHz ±3 (0.3 dB).

**1 R_S=50 Ω. For R_S=150 Ω, subtract 1.25 dBm; for R_S=600 Ω, subtract 5.35 dBm.*

OUTPUT IMPEDANCE AND CONFIGURATION

50 Ω ±3%, 150 Ω ±2%, or 600 Ω ±1%, balanced or unbalanced, floating or grounded.

EXTERNAL INPUT

A floating single-ended input is provided for accessing the variable gain stage and high level output amplifier, enabling the use of custom test signals. Input impedance is 20 kΩ; a 2 V RMS input (2.83 V peak maximum) provides a calibrated output.

SYNC OUTPUT

A ground referenced TTL-compatible signal is provided that allows stable oscilloscope display of all functions. In sine and squarewave modes the output is at the signal frequency. In the IM modes the sync output is at the lower or offset frequency. In both burst modes the sync signal follows the burst envelope.

SWEEP MODE

Linear or logarithmic sweep of amplitude or frequency in any function. Sweep is composed of discrete steps. The following sweep functions are programmable via GPIB or from the front panel: swept parameter (frequency or amplitude), linear or log sweep, number of steps up to 99, time per step from 0.1 s to 25 s, start frequency or voltage, and stop frequency or voltage. Start and stop frequencies or voltages can be anywhere within the range of the generator, and sweep direction can be upward or downward. Pen lift and ramp outputs are available for interface to an analog plotter.

STORED SETUPS

Ten different complete front panel setups can be stored in the nonvolatile internal memory and recalled from front panel push buttons or via the GPIB. Additionally, the front panel settings at power down are retained and used at power up.

PROGRAMMABILITY

All functions, parameters, and modes can be controlled over the GPIB using simple English-like commands. All settings can be interrogated, with the resulting response usable as a command to return the instrument to that setting (Learn mode). The GPIB address can be displayed and changed from the front panel.

GPIB Interface Function Subsets Implemented — SH1, AH1, T6, L4, SR1, RL1, PPØ, DC1, DT1, CØ.

CHARACTERISTICS (AA 5001)

HARMONIC DISTORTION FUNCTION

Fundamental Frequency Range — 10 Hz to 100 kHz, automatically tuned to input frequency.

Distortion Ranges — Auto (100%), 20%, 2%, 0.2%, and dB (autoranging).

Accuracy — 20 Hz to 20 kHz is ±1 dB. 10 Hz to 100 kHz is +1, −2 dB. (Accuracy is limited by residual THD + N and filter selection.)

Fundamental Rejection — At least 10 dB below specified residual THD + N or actual signal THD, whichever is greater.

Minimum Input Level — 60 mV (−22 dBm).

LEVEL FUNCTION

Autoranging digital voltmeter displays input signal level in volts, dBm, or dB ratios.

Modes — Volts, dBm (600 Ω), or dB ratio with push-to-set 0 dB reference.

Level Ranges — 200 µV full scale to 200 V full scale in ten steps, manual or autoranging.

Accuracy

Frequency	Volts	dBm or dB Ratio
20 Hz to 20 kHz	±2% ±1 count	±0.3 dB*1 +0.5% of reading
10 Hz to 100 kHz	±4% ±2 counts	±0.5 dB*1 +0.5% of reading

**1 V_{in} ≥100 µV, level ranging indicators extinguished. ±0.2 dB at 1 kHz only. Flatness is ±0.1 dB, 20 Hz to 20 kHz, and ±0.3 dB, 10 Hz to 100 kHz.*

Bandwidth — ≥300 kHz.

Residual Noise —

≤3 µV (−108 dBm) with 80 kHz and 400 Hz filters, RMS response.

≤1.5 µV (−114 dBm) with "A" weighting filter, RMS response (standard instrument only).

≤5 µV (−104 dBm) with CCIR weighting filter, quasi-peak response (Option 02 instrument only).

INTERMODULATION DISTORTION FUNCTION

Fully automatic SMPTE, DIN, and CCIF difference tone measurements. Minimum input level 60 mV (−22 dBm). Accuracy ±1 dB.

SMPTE and DIN Tests — Lower Frequency Range: 50 Hz to 500 Hz. Upper Frequency Range: Usable from 3 kHz to 163.8 kHz. Level Ratio Range: 1:1 to 4:1 (lower:upper). Residual IMD: See System Specifications.

CCIF Difference Frequency Test — Frequency Range: Usable from 4 kHz to 163.8 kHz. Difference Frequency Range: 80 Hz to 1 kHz. Residual IMD: See System Specifications.

ALL FUNCTIONS

Display — 3½ digits resolution at ≈3 readings/s.

Detection — Average or true RMS for waveforms with crest factors ≤3. Option 02 replaces average detector with quasi-peak detector complying with CCIR Recommendation 468-2 and DIN 45405.

Filters —
400 Hz High Pass: −3 dB at 400 Hz ±5%; 18 dB octave slope, at least 40 dB rejection at 60 Hz.
80 kHz Low Pass: −3 dB at 80 kHz ±5%; 18 dB/octave slope.
Audio Bandpass: −3 dB at 22.4 Hz and 22.4 kHz, both ±5%. Complies with CCIR Recommendation 468-2 and DIN 45405.
"A" Weighting: Meets specifications for Type one sound level meters (ANSI S1.4, IEC Recommendation 179). Option 02 replaces "A" weighting filter with CCIR weighting filter complying with CCIR Recommendation 468-2 and DIN 45405.
Ext: Allows connection of external filters.

Input Type — Balanced (full differential).

Input Impedance — 100 kΩ ±2%, each side to ground.

Maximum Input — 300 V peak, 200 V RMS either side to ground or differentially. Fully protected on all ranges.

Common-Mode Rejection — ⩾50 dB at 50 Hz or 60 Hz. Typically ⩾40 dB to 300 kHz.

PROGRAMMABILITY

Function (Level or THD or IMD). Level Mode (Volts or dBm). Input Level and Distortion Ranges (Autorange or default to range selected by front panel switches).
Detector Type (RMS or AVG; or RMS or Q-PK on Option 02).
Filter Selection (400 Hz Hi Pass, 80 kHz Low Pass, 22.4 Hz to 22.4 kHz Band-Pass, "A" Weight (or CCIR WTG on Option 02, Ext Filter).

GPIB Interface Function Subsets Implemented — SH1, AH1, T6, L4, SR1, RL1, PPØ, DC1, DTØ, CØ.

FRONT PANEL SIGNALS

Input Monitor — Provides constant amplitude version of signal applied to input. Output Voltage: 1 V RMS ±10% for input signals >50 mV. Source Impedance: 1 kΩ ±5%.

Function Output — Provides a scaled sample of selected function signal. Output Voltage: 1 V RMS ±3% for 1000 count display. Source Impedance: 1 kΩ ±5%.

Auxiliary Input — Provides input to detector circuit when Ext Filter button is depressed. Sensitivity: 1 V RMS ±3%=1000 count display. Impedance: 100 kΩ ±5%, ac coupled.

REAR INTERFACE SIGNALS

Duplicates of all front panel inputs and outputs are provided to allow external filter connections or oscilloscope monitoring within same mainframe without exposed cables. Detector outputs with specified scale factors also available to drive analog chart recorders, storage oscilloscopes, or similar devices.

ORDERING INFORMATION

SG 5010 Programmable Oscillator **$4,195**
Includes: Instruction manual (070-4331-00); instrument interface guide (070-4790-00); reference guide (070-4330-00).

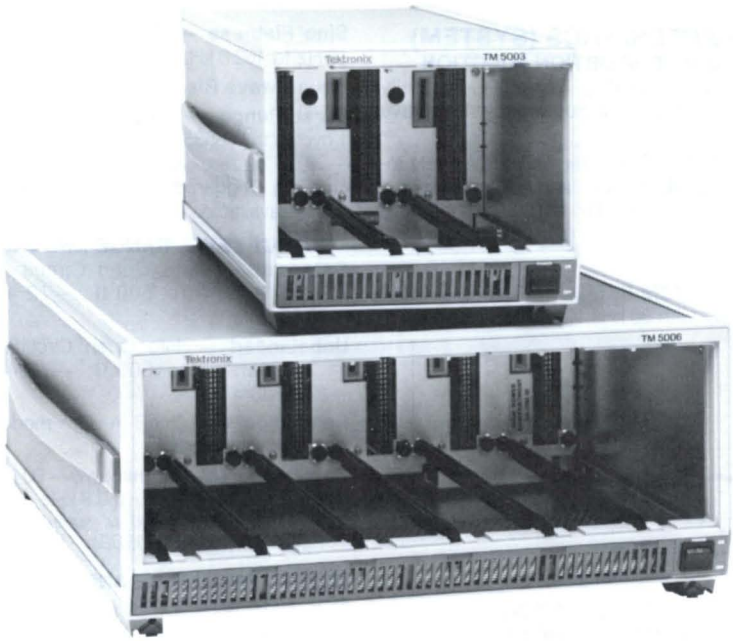
AA 5001 Programmable Distortion Analyzer **$3,450**
Includes: Instruction manual (070-4598-01); instrument interface guide (070-4788-00); reference guide (070-4597-00).

Option 02 — (AA 5001 only) CCIR/DIN. **+$410**

Audio Test Program Generator Software — Order S45F902 **$1,995**

Utility Software
For TM 5000/4041. Order 062-6958-01 **$150**

See page 359 for description and ordering information.



TM 5003 and TM 5006 mainframes shown above.

TM 5003/TM 5006

Power Module Mainframes

GPIB IEEE-488 The TM 5003 and TM 5006 comply with IEEE Standard 488-1978.

The TM 5000 mainframes extend the convenience of the TM 500 concept into the programmable instrument/IEEE Standard 488 area. The TM 5003 accepts up to three instruments at one time; the TM 5006 accepts up to six instruments at one time. These two TM 5000 mainframes were designed specifically for use with the Tektronix TM 5000 line of programmable, IEEE Standard 488 compatible test and measurement instruments, but all of the TM 500 manual plug-in instruments will also operate in these same mainframes allowing manual and programmable instruments to be mounted together in adjacent slots. This capability permits unique compact combinations of test instruments to be assembled for specific test applications.

Any of the mainframes may be operated with less than a full complement of plug-in instruments installed. TM 5000 instruments cannot be operated in TM 500 mainframes.

Benchtop or Portability

The two benchtop mainframes are the TM 5003 and the TM 5006. The TM 5003 is the most compact, accommodating three single-wide plug-ins. The TM 5006 includes a high power compartment at the right-hand end to supply higher current levels to instruments that provide higher performance or higher output levels. Both the TM 5003 and TM 5006 incorporate a quiet fan for optimum cooling; have feet, tilt-bails, handles, and front panel power switches. Both operate from 110 V ac or 220 V ac.

All benchtop models have carry handles for portable applications.

Rackmount

The TM 5006 Option 10 is electrically identical to the standard TM 5006 and features a slide assembly and handles, plus a higher-power fan than the bench version to accommodate the higher ambient temperatures often found in enclosed racks and consoles. Kits are available to rackmount a TM 5003 with a 4041 System Controller.

K213

K213 shown with 436-0132-01 optional shelf.

Mobility

The TM 5003 will fit on the hanging shelf of the K213 cart for use with other instruments. The TM 5006 fits on the top tray of the K217 cart which is useful for applications which require a stable yet mobile platform. The K213 and K217 trays tilt to allow viewing angle adjustment.

Rear Interface Capability

Most TM 5000 plug-in modules contain a duplication of the front-panel input and output connections in the back. Some plug-in modules also have additional signal or control lines that are present only at the back of the instrument. These signals are available at the rear edge-card connector of each plug-in. Any module can be internally connected through the mainframe and also can be externally interfaced out the back panel. Using Option 02 for either mainframe provides the rear interfacing capability.

Economy

TM 5000 mainframes represent a most economical approach in test and measurement instrumentation. Relatively fixed packaging costs for frames, covers, primary power circuits, unregulated secondary power circuits, and other items are a significant portion of the cost of a typical instrument. Since these fixed costs associated with packaging are shared by many functional instruments in the TM 5000 line, the cost-per-function may be lower than comparable, one or two-function monolithic instruments. Because of its modularity, expandability, and versatility, the modular concept represented by TM 5000 may provide the lowest cost-per-test/measurement when you are considering multifunction usage.

Reduced cabling costs made possible by the rear interface capability, the requirement for fewer GPIB cables for an equal number of instruments in the TM 5000 line, and the reduced space requirements for a measurement system all contribute to unprecedented economy for test and measurement requirements.

CHARACTERISTICS

POWER REQUIREMENTS

All of the mainframes have manually selectable taps on the power transformer that permit operation on 100 V, 110 V, 120 V, 200 V, 220 V, or 240 V ± 10%.

Power Line Frequency Range — 48 Hz to 66 Hz.

Maximum Power Consumption — Shown in Mainframes Dimensions and Weights chart.

PHYSICAL CHARACTERISTICS MAINFRAMES (WITHOUT PLUG-INS)

	TM 5003		TM 5006	
Dimensions	**mm**	**in**	**mm**	**in**
Width	230	9.0	445	17.5
Height	194	7.6	194	7.6
Depth	488	19.2	488	19.2
Weights ≈	**kg**	**lb**	**kg**	**lb**
Net	8.6	19.0	14.5	32.0
Shipping	12.0	26.5	20.9	46.0
Maximum Power Consumption*[1]	300 VA		650 VA	

[1] Actual power consumption depends on plug-in selection and operating modes.

ENVIRONMENTAL

Temperature Range — Operating: 0°C to +50°C. Nonoperating: −55°C to +75°C.

Altitude Range — Operating: Sea level to 4600 m (15,000 ft). Nonoperating: Sea Level to 15 000 m (50,000 ft).

ORDERING INFORMATION

TM 5003 Power Module Mainframe **$850**
Includes: Instruction manual (070-2955-00).

TM 5006 Power Module Mainframe **$995**
Includes: Instruction manual (070-2950-00).

OPTIONS

Option 02 — (TM 5003) Rear Interface. **+$100**
(TM 5006) Rear Interface. **+$190**

Option 10 — (TM 5006 only) Rackmount. **+$100**

Option 12 — (TM 5006 only) Option 02 and Option 10 Combined. **+$290**

OPTIONAL ACCESSORY

Rear Interface Data Book —
Order 070-2088-04. **$12**

INTERNATIONAL POWER PLUG OPTIONS

Option A1 — Universal Euro 220 V, 50 Hz.
Option A2 — UK 240 V, 50 Hz.
Option A3 — Australian 240 V, 50 Hz.
Option A4 — North American 240 V, 60 Hz.
Option A5 — Switzerland 220 V, 50 Hz.

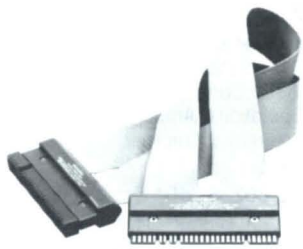
CONVERSION KITS

Cabinet-to-Rackmount — (TM 5006 only) Equipped with slide out assembly, to convert a TM 5006 to rackmount capability.
Order 040-0982-01 **$195**

Rackmount-to-Cabinet — (TM 5006 only) Equipped to convert a TM 5006 with rackmount capability to cabinet style.
Order 040-0983-00 **$90**

Cabinet-to-Rackmount — (TM 5003 only) Equipped with slide-out assembly to rackmount a 4041 Instrument Controller to the left of a TM 5003. Order 040-0984-01 **$215**

FLEXIBLE PLUG-IN EXTENDER CABLE



Designed to couple a TM 500 or TM 5000 Plug-in with the mainframe rear interface board connection extender, cables provide a completely flexible connecting point outside the mainframe for plug-in operation during test or check-out.

GPIB Extender Cable for TM 5000 mainframes. Order 067-0996-00 **$135**

Extender Cable for TM 500 mainframes.
Order 067-0645-02 **$355**

GPIB Interconnecting Cables —
(0.5 m) Order 012-1015-00 **$85**
(2 m) Order 012-0630-01 **$90**
(2 m) Double Shielded. Order 012-0630-03 **$110**

RECOMMENDED CARTS

206 — See page 461. **$235**
K213 — See page 462. **$595**
K217 — See page 462. **$495**

For additional accessories, see pages 436-438.

TM 500 MODULAR TEST AND MEASUREMENT INSTRUMENTS

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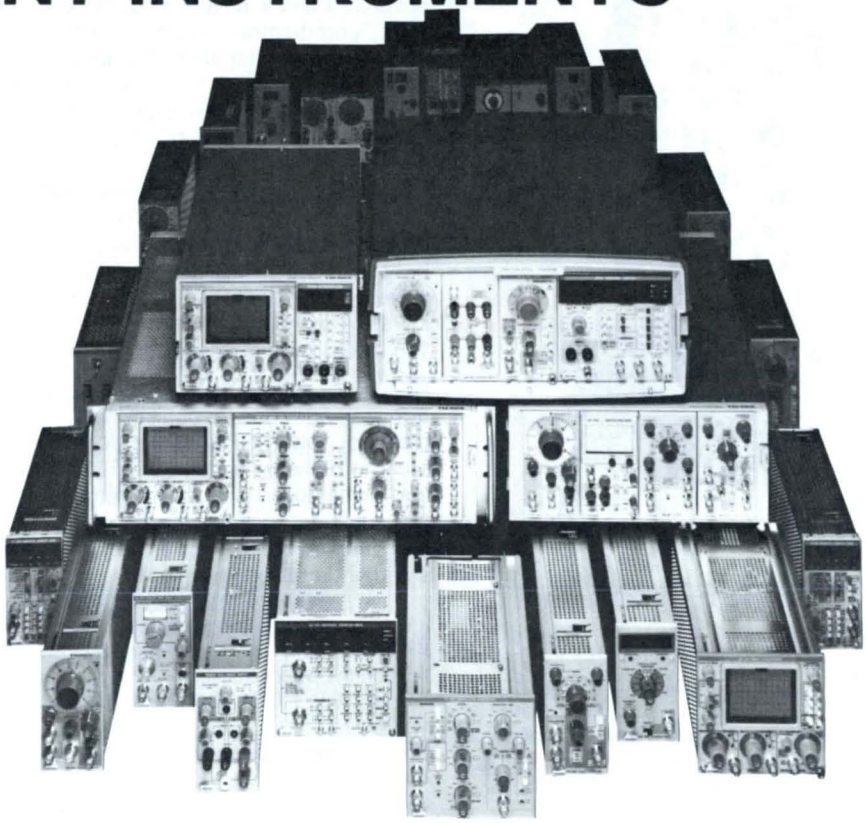


Manual Instruments That Perform in Hundreds of Combinations

Configurability is the watchword for TM 500 instruments and mainframes. For a range of test and measurement needs, choose from almost forty ready-to-go, compact plug-ins to create multifunction packages for a wide diversity of applications, or to solve one unique application problem.

TM 500 Instruments include digital counters, pulse generators, function generators, amplifiers, signal processors, audio oscillators, a distortion analyzer, ramp generators, calibration instruments, power supplies, oscilloscopes, digital delay, and a digital latch. Plus three different blank plug-in kits for customizing special functions.

Combine your instruments with the mainframe that meets your environment. There's a travel mainframe for service work and field testing; a rackmount model for production and test; or standard mainframes, compact and convenient for bench or desk, that accept one to six instruments. Rollabout carts are available for lab configurations with Tek oscilloscopes.

All TM 500 instruments and mainframes are electrically and mechanically compatible. So, you can configure an instrument system more powerful than the sum of its parts: an audio lab with distortion analyzer and storage scope, for example.

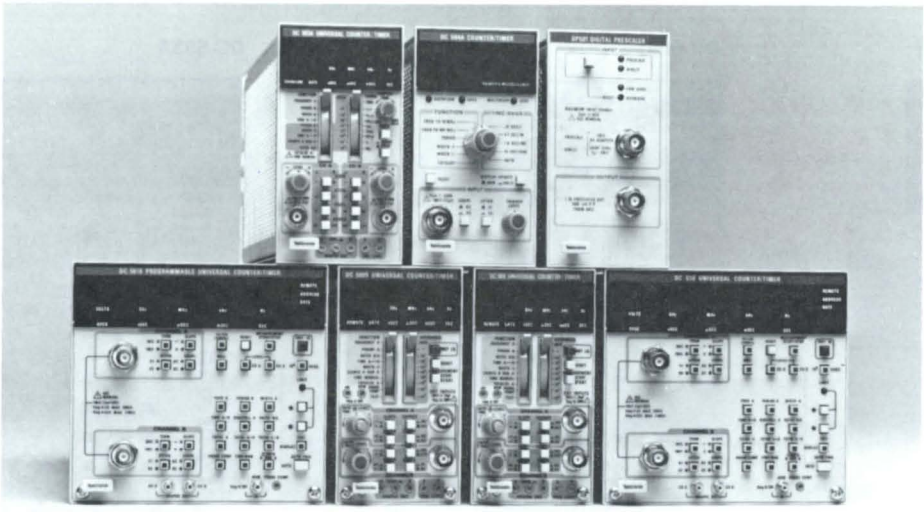
All of the TM 500 manual instruments can be used in TM 5000 mainframes, side-by-side with the TM 5000 GPIB programmable instruments. This yields cost-effective solutions to system application where not all functions or measurements need to be programmed. Cost efficiency is as important a part of the TM 500 concept as solving applications problems. You add on performance capabilities when you need them, using the same mainframe and power supply you started with.

Application and Construction Notes

The TM 500 instrument line is supported by an ongoing program to communicate up-to-date technical information.

Application Notes outline the steps necessary to solve complex problems, or achieve optimal performance and versatility from your TM 500 instruments. Subjects include integration, v-to-f conversion, generating delayed pulses, and transducer measurements.

Construction Notes provide information to build custom circuits using a blank plug-in kit and standard components. These notes are developed from the actual construction of more common special circuits and include parts lists, schematics and other construction details. Some of the available notes include: power supply circuits, thermal true RMS converter, and analog multipliers.



A Counter for Every Purpose

The TM 500 Family of digital counters provides a selection of four counters, each with its own performance and price niche, plus a prescaler that adds 1.3 GHz frequency measurement capability to the line.

The 350 MHz DC 510 and the 135 MHz DC 509 Universal Counter/Timers feature reciprocal frequency measurements and an especially wide range of other measurement functions; plus autotrigger, autoaveraging, arming, probe compensation, and more. And IEEE Standard 488 compatibility can be added as a field modification.

For versatility in counting, the DC 503A 125 MHz Universal Counter/Timer features eight measurement functions, including period, width, and time-interval averaging. Both input channels have the full 0 MHz to 125 MHz frequency range, 20 mV RMS sensitivity, and separate controls for input coupling, attenuation, trigger level, and trigger slope. The 10 MHz clock provides 100 ns resolution of single-shot time-interval measurements, and 10 ps resolution with averaging.

The 100 MHz DC 504A features autorange, period and width averaging, and a 100X resolution multiplier to provide high resolution of low frequency signals.

The DP 501 Digital Prescaler adds 1.3 GHz frequency counting capability to all of the above counters except the DC 504A.

Microprocessor-Based High Performance

Both the DC 510 and DC 509 are microprocessor-based, and contain features available only in high performance, microprocessor-based instruments. Both use a powerful dual-register architecture to obtain high-resolution counting of low frequency signals. The DC 510 provides nine digits of resolution in about a third of a second; the DC 509 provides eight digits of resolution in about a second. The DC 510 provides 3.125 ns single-shot resolution for time-interval measurements. The DC 509 provides 10 ns resolution. With averaging, the DC 510 can provide 1 ps resolution on time-interval measurements; the DC 509, 5 ps resolution.

Other features available in both instruments include autotrigger, autoaveraging, probe compensation, and diagnostic self-test. At the push of a button, the autotrigger feature senses the top and bottom of the applied signal and automatically sets the trigger point midway between the two.

Autoaveraging provides the optimum combination of resolution and measurement time, regardless of the frequency of the signal. Both autotrigger and autoaveraging can be overridden to allow manual (or programmable, in the case of the GPIB versions) control of averaging, measurement time, and triggering levels.

The probe compensation feature on both instruments allows the user to quickly and accurately compensate a high-impedance probe to the instrument input impedance directly. Improperly compensated probes are a common source of timing errors when using counters without this feature.

Both instruments include an arming input and shaped outputs for added versatility when measuring selected parts of complex waveforms.

Both feature a phase-modulated time base to eliminate clock synchronous errors in all time averaging modes.

In addition to all the features of the DC 509, the DC 510 permits direct measurement and display of rise time and fall time.

The addition of the GPIB interface board (a field modification) converts both the DC 510 and DC 509 into their fully programmable, fully GPIB-compatible versions, the DC 5010 and DC 5009, respectively. See pages 392-395 for more information on these and other fully-programmable, GPIB-compatible products in the Tektronix TM 5000 product line.

Accessory Probe

An optional accessory probe, the Tektronix P6125, has been especially designed for use with digital counters. The 5X attenuation provides an optimum match between the counter input characteristics and the voltage levels of all common logic families. Low input capacitance permits acquisition of high-frequency signals with minimum loading of the circuits under test.

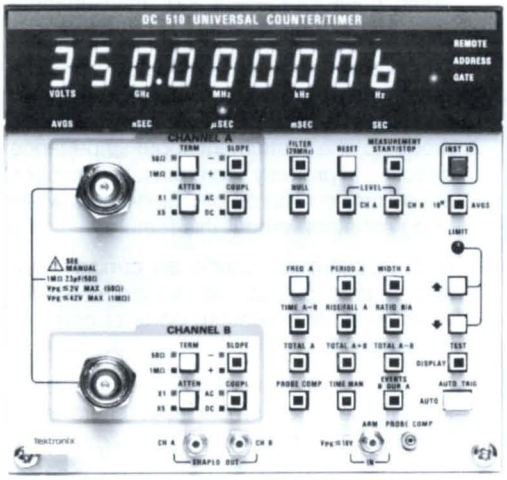
DIGITAL COUNTERS SELECTION GUIDE

Application/Feature	DC 510/DC 5010	DC 509/DC 5009	DC 503A	DC 504A
Frequency Range	350 MHz	135 MHz	125 MHz	100 MHz
Number of Digits	9	8	8	6
Ratio Architecture	✓	✓		
Period Averaging	✓	✓	✓	✓
Width Averaging (Single Input)	✓	✓	✓	✓
Time Interval Averaging	✓	✓	✓	
Autotrigger	✓	✓		
Gated Events Averaging	B during A	B during A	A during B	
Ratio Averaging	✓	✓	✓	
Other	High stability time base, trigger level and shaped outputs, self-test, phase modulated clock, probe compensation, time manual, totalize.	High stability time base, trigger level and shaped outputs, self-test, phase modulated clock, probe compensation, time manual, totalize.	High stability time base trigger level and shaped outputs, time manual, totalize.	Autorange, 100X resolution multiplier
IEEE Standard 488	✓*1	✓*1		
Mainframe Compatibility	DC 510 TM 500/TM 5000 DC 5010 TM 5000 only	DC 509 TM 500/TM 5000 DC 5009 TM 5000 only	TM 500/ TM 5000	TM 500/ TM 5000
Page	406/392	406/394	407	409
Prices Begin At	$4,110/$4,610	$2,275/$2,775	$1,420	$950

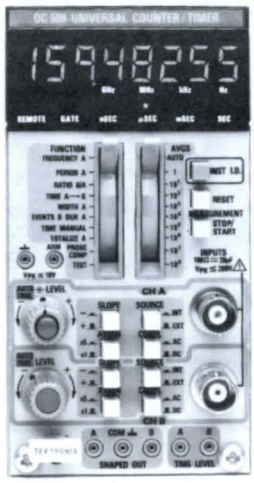
**1 Included with DC 5010/DC 5009. Conversion kit required to add IEEE Standard 488 capability to the DC 510/DC 509.*

For compatible accessories, see page 439.

DC 510



DC 509



DC 503A

Universal Counter/Timers

DC 510/DC 509

350 MHz Both A and B Channels (DC 510)

135 MHz Both A and B Channels (DC 509)

3.125 ns Single-Shot Resolution (DC 510)

10 ns Single-Shot Resolution (DC 509)

9-Digit Display (DC 510)

8-Digit Display (DC 509)

1 ps Resolution, With Averaging (DC 510)

5 ps Resolution, With Averaging (DC 509)

With the exception of programmability and IEEE Standard 488 compatibility, the characteristics and specifications of the DC 510/DC 509 Universal Counter/Timers are identical to those of the DC 5010/DC 5009 Universal Counter/Timers. The detailed specifications of the DC 5010/DC 5009 Universal Counter/Timers are given on pages 392-395.

A conversion kit is available to owners of DC 510s and DC 509s who desire IEEE Standard 488 capabilities. The field modification kit easily converts a DC 510 to a DC 5010 or a DC 509 to a DC 5009.

ORDERING INFORMATION

DC 510 Universal Counter/Timer — **$4,110**
Includes: Instruction manual (070-3552-01).

DC 509 Universal Counter/Timer — **$2,275**
Includes: Instruction manual (070-3464-00).

CONVERSION KITS

IEEE Standard 488 Capability —
(DC 510) Order 040-1023-05 — **$320**
(DC 509) Order 040-0957-04 — **$325**

RECOMMENDED PROBE

P6125 — 5X Passive Probe. — **$70**

DC 503A

125 MHz Both A and B Channels

10 ps Resolution in Time Interval Average With 10^8 Averages

Measurement Functions Include:

Frequency; Period and Period Average; Width and Width Average; Time A→B and Time A→B Average; Events A During B and Events A During B Average; Totalize; Time Manual; Ratio A/B Average

40 MHz Rep Rate in Time Interval Average

Simplified Width Measurement

Trigger Level Outputs for Accurate Trigger Setting

Shaped Outputs for Ease of Triggering

Designed for True Probe Compatibility

The DC 503A offers a broad range of measurement features at an affordable price. The instrument has two input channels, A and B, each with 125 MHz capability. Each channel has separate triggering level, triggering slope, attenuator, and coupling mode controls. Eight measurement functions are available with the DC 503A and an averaging feature allows averaging of 1 to 10^8 occurrences of the signal of interest. Signals to be counted or timed can be applied to channels A and B via front panel BNC connectors, or through rear interface connections. The DC 503A features an easy access front panel and an LSI based design for increased instrument reliability.

The DC 503A is equipped with a temperature controlled 10 MHz crystal oscillator to obtain a highly stable and precise internal time base.

CHARACTERISTICS

Display — Eight digit LED; indicators for units, gate open, and overflow.

Display Time — ≈0.2 s to 5 s and hold.

CHANNEL A AND B INPUT

Frequency Range — 0 MHz to 125 MHz, dc coupled. 10 Hz to 125 MHz, ac coupled.

Sensitivity — 20 mV RMS sinewave to 100 MHz. 60 mV p-p at minimum pulse width (of 5 ns to 100 MHz). 35 mV RMS sinewave to 125 MHz. 100 mV p-p (minimum pulse width of 4 ns to 125 MHz).

Attenuation — Selectable 1X, 5X.

Impedance — 1 MΩ paralleled by ≈27 pF.

Dynamic Range — V p-p ⩽3 V x attenuation. V peak ⩽3.5 x attenuation.

Trigger Level Range — Adjustable ±3.5 V x attenuation.

Trigger Level Accuracy — ±0.5% of reading for a dc input V, ±20 mV x attenuator.

Independent Controls — Slope +/−, Attenuation 1X/5X, Coupled ac/dc, Source Internal/External.

Maximum Input Voltage
1X: 200 V peak; 400 V p-p from dc to 50 kHz, derate to 15 V p-p from 1.33 MHz to 125 MHz.
5X: 200 V peak; 400 V p-p from dc to 5 MHz, derate to 20 V p-p from 100 MHz to 125 MHz.

Shaped Out — Shaped replica of signal being measured, aids proper triggering on complex waveforms. ⩾200 mV p-p from 50 Ω.

FREQUENCY A

Range — 0 MHz to 125 MHz.

Resolution — 0.1 Hz to 10 MHz in decade steps.

Accuracy — ±1 count ±Time Base Error x Frequency A.

To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext. 99

PERIOD B (SINGLE SHOT)

Range — 100 ns to 10^9 s.

Resolution — 100 ns to 10 s in decade steps.

Accuracy — ±1 count ±Time Base Error x Period B ±1.4 x Channel B Trigger Jitter Error.

Frequency Range — 0 MHz to 125 MHz.

PERIOD B (AVERAGE)

Range — 8 ns to 10 s.

Resolution — 1 fs (10^{-15}) to 100 ns in decade steps.

Events Averaged (N) — 1 to 10^8.

Accuracy — $\pm\frac{100\text{ ns}}{N}$ ±Time Base Error x Period B $\pm\frac{1.4 \times \text{Channel B Trigger Jitter Error}}{N}$

Frequency Range — 0 MHz to 125 MHz.

RATIO A/B

Averaged over 1 to 10^8 cycles of Channel B signal.

Frequency Range — 0 to 125 MHz (both Channel A and Channel B).

Accuracy — $\pm\frac{\text{Frequency B}}{\text{Frequency A} \times N}$

$\pm\frac{1.4 \times \text{Channel B Trig Jitter Error} \times \text{Frequency A}}{N}$

$\pm\frac{\text{Frequency A}}{0.3 \times 10^8}$

TIME A→B (SINGLE SHOT)

Range — 100 ns to 10^9 s.

Resolution — 100 ns to 10 s in decade steps.

Accuracy —
±1 count ±Time Base Error x Time A→B
±Channel A Trigger Jitter Error
±Channel B Trigger Jitter Error
±(Channel B stop Trigger Slew Error
−Channel A start Trigger Slew Error) ±4 ns.

TIME A→B (AVERAGE)

Range — 12.5 ns to 10 s.

Minimum Dead Time — 12.5 ns (stop-to-start).

Resolution — $\frac{100\text{ ns}}{\sqrt{N}}$

Events Averaged (N) — 1 to 10^8 in decade steps.

Accuracy —

$\pm\frac{100\text{ ns}}{\sqrt{N}}$ ±Time Base Error x Time A→B

$\pm\frac{\text{Channel A Trigger Jitter Error}}{\sqrt{N}}$

$\pm\frac{\text{Channel B Trigger Jitter Error}}{\sqrt{N}}$

+(Channel B stop Trigger Slew Error
−Channel A start Trigger Slew Error) ±4 ns

EVENTS A DURING B (AVERAGE)

Maximum A Frequency — 125 MHz.

Minimum B Pulse Width — 5 ns.

Events Averaged (N) — 1 to 10^8 in decade steps.

Accuracy —

$\pm\frac{\text{Period A}}{\text{Width B} \times \sqrt{N}}$ x Events A during B

$\pm\frac{\text{Channel B start Trigger Jitter Error}}{\sqrt{N}}$

x Frequency A (in MHz)

$\pm\frac{\text{Channel B stop Trigger Jitter Error}}{\sqrt{N}}$

x Frequency A (in MHz)

+(Channel B stop Trigger Slew Error
−Channel B start Trigger Slew Error)
x Frequency A (in MHz)

WIDTH B (SINGLE SHOT)

Range — 100 ns to 10^9 s.

Resolution — 100 ns to 10 s in decade steps.

Accuracy —
±1 count ±Time Base Error x Width B ±Channel B start Trigger Jitter Error ±Channel B stop Trigger Jitter Error +(Channel B stop Slew Rate Error−Channel B start Slew Rate Error).

WIDTH B (AVERAGE)

Range — 5 ns to 10 s.

Resolution — $\frac{100\text{ ns}}{\sqrt{N}}$

Events Averaged (N) — 1 to 10^8 in decade steps.

Accuracy —

$\pm\frac{100\text{ ns}}{\sqrt{N}}$ ±Time Base Error x width B

$\pm\frac{\text{Channel B start Trigger Jitter Error}}{\sqrt{N}}$

$\pm\frac{\text{Channel B stop Trigger Jitter Error}}{\sqrt{N}}$

+(Channel B stop Slew Rate Error −Channel B start Slew Rate Error)

Frequency Range — 0 MHz to 100 MHz.

TIME MANUAL

Electronic stopwatch, accumulates and displays time between activation of front panel start/stop button or rear interface signal line. Clock rates selectable from 100 ns to 10 s in decade steps. Range 100 ns to 10^9 s.

TOTALIZE A

1 count to 99,999,999 counts at maximum rate of 125 MHz. Start, stop and reset controlled by front panel pushbuttons or rear interface signal lines.

RESOLUTION AND ACCURACY DEFINITIONS

Time Base Error is the sum of all errors specified for the time base.

N is the number of periods averaged in Period B (AVGS) mode, the number of intervals averaged in the Time A→B (AVGS) mode, the number of widths of B averaged in Width B (AVGS) and Events A During B modes, and the number of periods of B in the Ratio A/B mode.

Trigger Jitter Error (in μs)=

$$\frac{\sqrt{(en_1)^2 + (en_2)^2}\ (V)}{\text{Input Slew Rate at Trigger Point (V/μs)}}$$

Where: en_1 = 100 μV RMS typical internal noise.
en_2 = RMS noise of signal input at trigger point for a 125 MHz bandwidth.

Trigger Slew Rate Error (in μs)=

$$\frac{\text{Input hysteresis (V)/2}}{\text{Input Slew Rate at set Trigger Point V/μs}}$$

Where: Input hysteresis = 20 mV peak-to-peak typical.

OTHER CHARACTERISTICS TIME BASE

Crystal Frequency — 10 MHz.

Temperature Stability — < ±2 x 10^{-7} after warm-up, 0°C to +50°C.

Warm-Up Time — Within 2 x 10^{-7} of final frequency in <10 minutes when cold started at 25°C.

Aging Rate — 1 x 10^{-8}/day at time of shipment, 4 x 10^{-8}/week after 30 days of continuous operation, 1 x 10^{-6}/year after 60 days of continuous operation.

Setability — Adjustable to within 2 x 10^{-8}.

REAR INTERFACE

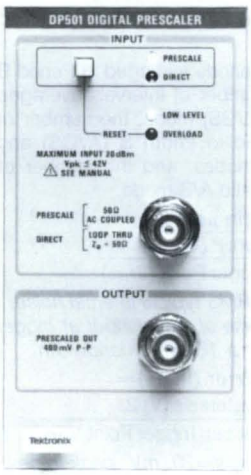
Inputs — Direct count input to 50 MHz, (50 Ω impedance, resistor may be removed for 1 MΩ impedance, remote start/stop, reset; external time base.

Outputs — BCD serial-by-digit, decimal point, overflow, scan clock; trigger level; time base reference.

ORDERING INFORMATION

DC 503A Universal Counter/Timer **$1,420**
Includes: Instruction manual (070-2971-00).

DP 501



Digital Prescaler

DP 501

Extends Frequency Measurement Capability to 1.3 GHz

Compatible With Most TM 500 and TM 5000 Counters

AGC

Low Level Indicator

The DP 501 Digital Prescaler adds 1.3 GHz frequency counting capability to the Tektronix DC 503A, DC 509, DC 5009, DC 510, and DC 5010 Universal Counter/Timers.

The DP 501 is placed in the signal line between the signal source and the counter's input connector such that the signal to be measured passes through the DP 501. Two operating modes are available, Prescale and Direct. In the Prescale mode, the DP 501 divides the input signal by 16 and causes the associated counter's display to be multiplied by 16, so that the counter will display the correct frequency. In the Direct mode, the signal is simply looped through the DP 501 and applied directly to the counter's input; the counter's display is not affected. This loop-through capability eliminates the need for external switching when input signal frequencies occur in both the Prescale and Direct frequency ranges.

The prescaling function can be activated in either of two ways: manually, with a front panel pushbutton; or, when used with the GPIB programmable DC 5009 or DC 5010, by a Prescale command to the counter. Thus, the DP 501 adds programmable frequency measurements to 1.3 GHz to the Tektronix TM 5000 Family of GPIB programmable instruments.

Input sensitivity in the Prescale mode is 20 mV RMS to 1 GHz and 30 mV RMS to 1.3 GHz. A Low-Level indicator alerts the user if the input signal amplitude is too low for error-free counting. An automatic gain control circuit provides optimum immunity to signal noise in the Prescale mode.

The DP 501 and DC 509/DC 5009 or DC 510/DC 5010 can be used with the Tektronix 7L14 Spectrum Analyzer and TR 502 Tracking Generator to provide counter accuracy measurements of swept-frequency signals from 100 kHz to 1.3 GHz.

CHARACTERISTICS

Prescale Mode — Input: Frequency range is ≤100 MHz to ≥1.3 GHz. Sensitivity: 100 MHz to 1 GHz is ≤20 mV RMS (−21 dBm). 1 GHz to 1.3 GHz is ≤30 mV RMS (−17 dBm). Impedance: 50 Ω, ac coupled; vswr ≤2.2:1. Output: Amplitude into 50 Ω is ≥200 mV, p-p. Unterminated is 2X terminated value.

Direct Mode — Input: Connected directly to output. Frequency Range: 0 MHz to >350 MHz. Impedance: Loop through characteristic impedance is 50 Ω; nonterminated capacitance ≈20 pF (no connection to output). Output: Connected directly to input. <1 dB insertion loss up to 350 MHz. Powers up in direct mode.

Overload Protection — Prescale: Input disconnects when input signal exceeds +20 dBm ±5 dBm for a period of ≈0.5 s or more.

Damage Level — Prescale: Input may be damaged if signal level exceeds +25 dBm. Direct: 42 V peak maximum. Maximum current is 250 mA.

Input Attenuation — Automatic: Up to 40 dB range.

Low Level Indicator — Lights when input signal is below that required for error-free counting.

Tracking Generator Compatibility — Outputs will drive two standard TTL loads. Inputs represent two standard TTL loads. Requires arming input to associated counter.

ORDERING INFORMATION

DP 501 Digital Prescaler **$575**
Includes: Instruction manual. (070-4332-00).

P6125 Counter Probe

The P6125 is a low-capacitance, 5X attenuation passive probe specially designed for use with counter/timers. It makes possible more accurate time interval measurements of high speed logic signals. Five-times attenuation provides an optimum match between the counter input characteristics and the voltage levels of all common logic families. The low input capacitance permits acquisition of high frequency signals with minimum loading of the circuits under test.

CHARACTERISTICS

Attenuation — 5X.

Input Resistance — 5 MΩ input.

Capacitance — ≈20 pF.

Bandwidth — Dc to 200 MHz.

Voltage Rating — 250 V (dc + peak ac) derated to 35 V at 100 MHz.

Cable Length — 1.5 meters.

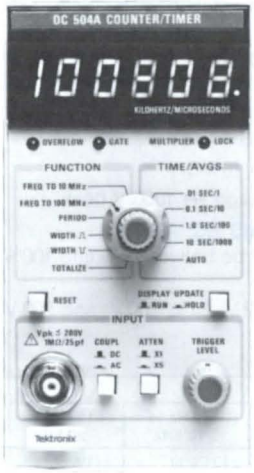
ORDERING INFORMATION

P6125 5X, 1.5 m Counter Probe **$70**
Includes: 8 cm ground lead (175-0263-01); accessory pouch (016-0521-00); two miniature alligator clips (344-0046-00); IC tip tester*1, two 13 cm ground lead probe*2 tips (175-0124-01); retractable hook tip (013-0107-05); probe holder (352-0351-00); insulating sleeve (166-0404-01); instruction sheet (070-3617-00).

*1 *Available in packages of 10 (015-0201-04) or 100 (015-0201-05).*
*2 *Available in packages of 10 only (206-0191-03).*

To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext. 99

DC 504A



Counter/Timer

DC 504A

Dc to 100 MHz

Period and Period Averaging

Width and Width Averaging

Autoranging

100X Resolution Multiplier

The easy-to-use DC 504A Counter/Timer measures frequency from dc to 100 MHz, with an internal prescaler being used for frequencies above 10 MHz. Both direct and prescaled counting are done through the same input connector; no need to change connectors when changing frequency range. Autoranging permits virtual hands-off operation for most measurements. The 100X resolution multiplier automatically provides 0.01 Hz resolution in one second—or 0.001 Hz resolution in ten seconds—on signals from 10 Hz to 25 kHz.

The DC 504A features period and width averaging of up to 1000 events. Selectable dc coupling of the input eliminates the potential errors associated with making width measurements on signals of varying duty cycle with counters that are only ac coupled. Input trigger sensitivity is 30 mV RMS across the entire 100 MHz frequency range. The triggering level range of ±2 volts and the selectable 5X attenuator provides a triggering range of up to ±10 volts.

The totalize mode permits totalizing up to 999,999 events—and beyond, with overflow—with a Display Update-Run/Hold control to hold the display while the internal counter continues to advance.

CHARACTERISTICS

Display — Six-digit LED readout with automatic decimal point positioning and leading zero suppression. LED annunciators indicate gate open, resolution multiplier lock, and display overflow.

INPUT

Frequency Range — Front Panel: Dc Coupled is 1 MHz to 100 MHz. Ac Coupled is 10 Hz to 100 MHz. Rear Interface: Dc Coupled is 0 MHz to 50 MHz. Ac Coupled is 10 Hz to 50 MHz.

Sensitivity — 1X Attenuation: 30 mV RMS sinewave to 100 MHz; 85 mV p-p (at a minimum pulse width of 5 ns). 5X attenuation accuracy is within 2% at dc.

Attenuation — Selectable 1X, 5X.

Impedance — Front Panel, 1X, 5X: 1 MΩ, paralleled by ≈25 pF. Rear Interface, 1X, 5X: 50 Ω ±10% at dc.

Dynamic Range — 1X: ±2.0 V peak, 4 V p-p. 5X: ±10 V peak, 20 V p-p.

Trigger Level Range — ±2.0 V x attenuation minimum.

Maximum Input Voltage — Front Panel: 1X is 200 V peak; 400 V p-p from dc to 50 kHz, derate to 15 V p-p from 1.33 MHz to 100 MHz. 5X is 200 V peak; 400 V p-p from dc to 50 MHz, derate to 20 V p-p at 100 MHz. Rear Interface: ≤4 V peak.

FREQUENCY TO 10 MHz

Range — Dc Coupled: 0 Hz to 10 MHz. Ac Coupled: 10 Hz to 10 MHz.

Resolution — Multiplier Off: 100 Hz to 0.1 Hz, selectable in decade steps or autoranging (100 Hz to 1 Hz only). Multiplier On: 1 Hz to 0.001 Hz, selectable in decade steps or autoranging (1 Hz to 0.01 Hz only). Lock Range: 10 Hz ≤Frequency ≤25 kHz. Multiplication: 100X. Lock Time: ≤5 s. Resolution multiplier automatically increases resolution by 100 when locked; may be defeated by an internal jumper.

Accuracy — ±1 count ±Time Base Error x Frequency. See page 407 for example.

Gate Time — 10 ms to 10 s, selectable in decade steps; or autoranging (10 ms to 1 s only).

FREQUENCY TO 100 MHz

Range — Dc Coupled: 0 Hz to 100 MHz. Ac Coupled: 10 Hz to 100 MHz.

Gate Time (Resolution) — 10 ms to 10 s (1 kHz to 1 Hz), selectable in decade steps; or autoranging (10 ms to 1 s only).

Accuracy — ±1 count ±Time Base Error x Frequency.

Prescale Factor — ÷10.

PERIOD AVE

Range — Dc Coupled: 0 Hz to 2.5 MHz. Ac Coupled: 10 Hz to 2.5 MHz.

Resolution — 100 ns to 100 ps, selectable in decade steps; or autoranging (100 ns to 1 ns only).

Events Averaged (N) — 10^0 to 10^3, selectable in decade steps; or autoranging (10^0 to 10^2 only).

Accuracy —

$$\pm\frac{100\text{ ns}}{N} \pm \text{Time Base Error x Period}$$

$$\pm 1.4\ X\left(\frac{\text{Trigger Jitter Error}}{N}\right)$$

WIDTH AVE

Range — Dc Coupled: 0 Hz to 2.5 MHz. Ac Coupled: 10 Hz to 2.5 MHz.

Resolution — $\pm\frac{100\text{ ns}}{\sqrt{N}}$

Events Averaged (N) — 10^0 to 10^3, selectable in decade steps; or autoranging (10^0 to 10^2 only).

Accuracy —

$$\pm\frac{100\text{ ns}}{\sqrt{N}} \pm \text{Time Base Error x Width.}$$

$$\pm\frac{\text{Start Trigger Jitter Error}}{\sqrt{N}}$$

$$\pm\frac{\text{Stop Trigger Jitter Error}}{\sqrt{N}}$$

+(Stop Slew Rate Error − Start Slew Rate Error) ±10 ns

TOTALIZE

Frequency Range — Dc Coupled: 0 Hz to 10 MHz. Ac Coupled: 10 Hz to 10 MHz. Overflows above 999,999. Display update Run/Hold will hold display while counter continues to advance. Releasing Run/Hold will update display to new value.

TIME BASE

Frequency (at Calibration) — 10 MHz ±1 x 10^{-7}.

Temperature Stability — ±5 x 10^{-6} (±5 ppm), 0°C to +50°C.

Adjustment Resolution — ±5 x 10^{-8}.

Aging Rate — ≤1 x 10^{-6}/year (≤1 ppm/year).

EXTERNAL TIME BASE INPUT

10 MHz. Must drive 1 LSTTL load. V_{IH} = 2.0 V/20 μA V_{IL} = 0.8 V/−400 μA.

RESOLUTION AND ACCURACY DEFINITIONS

Same as DC 503A except DC 504A has 100 MHz bandwidth and input hysteresis = 30 mV p-p typical.

ORDERING INFORMATION

DC 504A Counter/Timer **$950**
Includes: Instruction manual (070-4291-00).

OPTIONAL COUNTER ACCESSORIES

Power Divider — GR, 50 Ω.
Order 017-0082-00 **$780**

Adaptors —
(GR to BNC female) Order 017-0067-00 **$55**
(GR to BNC male) Order 017-0064-00 **$90**

Cable Adaptors —
(BNC to tip jack) DC 503A, DC 509, DC 5009.
Order 175-3765-01 **$32**
(BNC to RF) DC 510, DC 5010.
Order 012-0532-00 **$37**

RECOMMENDED PROBES

P6101A — X1, dc to 34 MHz **$53**
P6106A — X10, dc to 300 MHz **$140**
P6201 — FET, dc to 900 MHz **$1,220**
P6230 — Bias/Offset, dc to 1.5 GHz **$395**
P6056 — 50 Ω, X10, dc to 3.5 GHz **$185**

To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext. 99

PRODUCT SUMMARY

The TM 500 Digital Multimeter line consists of two general purpose instruments, the DM 501A and DM 502A. Both provide exceptional versatility in function and range. In addition to the usual ac and dc voltage, resistance, and ac/dc current functions, both meters offer a dB function and a platinum-resistance temperature-measurement function, which provides digital readout of the surface temperature in degree Centigrade.

The DM 501A and DM 502A each measure dc voltage to 1000 V, ac voltage to 500 V, both ac and dc current to 2 A, true RMS voltages, and resistance to 20 MΩ. The most significant differences are increased resolution provided by the extra digit on the DM 501A, increased temperature measurement range of the DM 501A and autoranging on the DM 502A.

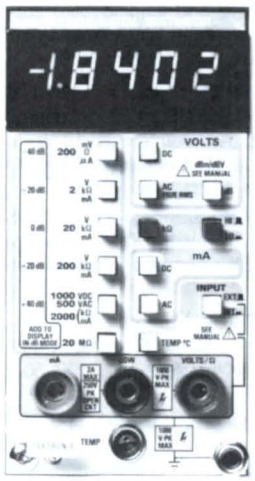
TM 500 digital multimeters offer a compact solution to your measurement needs without compromising wide performance range. The DM 501A and DM 502A provide accuracy and flexibility in laboratory bench, field service, and maintenance applications.

DIGITAL MULTIMETER SELECTION GUIDE

Application/Feature	DM 501A	DM 502A	DM 5010
Number of Digits	4½	3½	3½, 4½*1
Dc Volts Ranges	200 mV to 1000 V	200 mV to 1000 V	200 mV to 1000 V
Dc Volts Accuracy	±0.05%	±0.1%	±0.015%
Dc Volts Best Resolution	10 μV	100 μV	10 μV
Ac Volts Ranges	200 mV to 500 V	200 mV to 500 V	200 mV to 700 V
Ac Volts Accuracy	±0.6%	±0.6%	±0.2%
Ac Volts Best Resolution	10 μV	100 μV	10 μV
Ac or Dc Current Ranges	200 μA to 2 A	200 μA to 2 A	N/A
dB Ranges	+54 dB to −60 dB	+50 dB to −60 dB	Calculated
Resistance (HI-LO) Ranges	200 Ω to 20 MΩ	200 Ω to 20 MΩ	200 Ω*2 to 20 MΩ
Temperature Range	−62°C to +240°C	−55°C to +200°C	N/A
True RMS	✓	✓	✓
Autorange	✓		✓
IEEE Standard 488			✓*3
Mainframe Compatibility	TM 500 TM 5000	TM 500 TM 5000	TM 5000
Page	410	411	396
Prices Begin At	$850	$900	$2,260

*1 *Measurement rate of 26 readings/s at 3.5 digits resolution and 3 readings/s at 4.5 digits.*
*2 *Low Ω plus diode test.*
*3 *Fully programmable, IEEE Standard 488 compatible. See page 396 for complete description.*

DM 501A



Digital Multimeter

DM 501A

0.05% dc Voltage Accuracy

7 Functions Including Temperature and dB

4½ Digits of Readout Resolution

True RMS Capability

The DM 501A Digital Multimeter measures dc and ac voltage, dc and ac current, resistance, dB and temperature. The DM 501A gives 4½ digits of readout resolution. All with 0.05% accuracy and true RMS capability. True RMS allows accurate measurement of distorted waveforms. DB is useful when making critical audio and communication measurements. Fast accurate temperature measurements to 240°C come from the Tektronix P6601 platinum film temperature sensing probe. The P6601 reaches 90% of final reading in 1.5 seconds.

CHARACTERISTICS

DC VOLTS

Ranges — 200 mV, 2 V, 20 V, 200 V, and 1000 V.

Accuracy*1

+18°C to +28°C	
Voltage Ranges	**Normal and Fast Conversion Rate**
200 mV	±[0.05% of reading +0.015% of full scale (3 counts)]
2 V to 200 V	±[0.05% of reading +0.01% of full scale (2 counts)]
1000 V	±[0.05% of reading +0.02% of full scale (2 counts)]
0°C to +18°C, +28°C to +50°C	
200 mV to 200 V	±[0.1% of reading +0.025 of full scale (5 counts)]
1000 V	±[0.1% of reading ±0.05% of full scale (5 counts)]

*1 *Valid for six months or 1000 hours, whichever occurs first.*

Common-Mode Rejection Ratio — ⩾100 dB at dc. ⩾80 dB at 50 Hz and 80 Hz with 1 kΩ imbalance.

Normal-Mode Rejection Ratio — ⩾60 dB at 50 Hz or 60 Hz ±0.2 Hz.

Maximum Resolution — 10 μV.

Step Response Time — <1 s.

Input Resistance — 10 MΩ.

Maximum Input Voltage — 1000 V peak.

TRUE RMS AC VOLTS

Input Signal — Must be between 5% and 100% of full scale.

Ranges — 200 mV, 2 V, 20 V, 200 V, and 500 V (ac coupled).

Accuracy*1

+18°C to +28°C			
Voltage Ranges	**20 Hz to 40 Hz**	**40 Hz to 10 kHz**	**10 kHz to 20 kHz**
200 mV to 200 V	±[1% of reading +0.05% of full scale (10 counts)]	±[0.6% of reading +0.05% of full scale (10 counts)]	±[1% of reading +0.05% of full scale (10 counts)]
500 V	±[1% of reading +0.2% of full scale (10 counts)]	±[0.6% of reading +0.2% of full scale (10 counts)]	±[1% of reading +0.2% of full scale (10 counts)]
0°C to +18°C, +28°C to +50°C			
Voltage Ranges	**20 Hz to 40 Hz**	**40 Hz to 10 kHz**	**10 kHz to 20 kHz**
200 mV to 200 V	±[1.3% of reading +0.075% of full scale (15 counts)]	±[0.8% of reading +0.075% of full scale (15 counts)]	±[1.3% of reading +0.075% of full scale (15 counts)]
500 V	±[1.3% of reading +0.3% of full scale (15 counts)]	±[0.8% of reading +0.3% of full scale (15 counts)]	+[1.3% of reading +0.3% of full scale (15 counts)]

*1 *Valid for six months or 1000 hours, whichever occurs first.*

Common-Mode Rejection Ratio — ⩾60 dB at 50 Hz to 60 Hz with 1 kΩ imbalance.

Maximum Resolution — 10 μV.

Response Time — <2 s.

Input Impedance — 10 MΩ paralleled by 160 pF.

Maximum Input Voltage — 500 V ac RMS, 600 V dc, not to exceed 1000 V peak.

Crest Factor — 4 (at full scale).

dB (TRUE RMS)

Zero dB Reference — 1 mW in 600 Ω (0.775 V) (dBm) Internal jumper change for 0 dB reference of 1.0000 V (dBV).

Accuracy*1

+18°C to +28°C

20 Hz	2 kHz	10 kHz	20 kHz
+50 dB to −50 dB	0	±0.5 dB	
−50 dB to −60 dB	±0.5 dB	±1.5 dB	Typically ±2.5 dB

*1 *From 0°C to +18°C +28°C to +50°C, add 0.6 dB to above accuracy specifications.*

Maximum Resolution — 0.1 dB.

Response Time — <2 s.

Input Impedance — 10 MΩ paralleled by <160 pF.

Maximum Input Voltage — 500 V RMS, not to exceed 1000 V peak. Equivalent to +54 dBV or +56.2 dBm.

Crest Factor — 4 (at full scale).

RESISTANCE

Response Time — <2 s in 200 Ω to 2000 kΩ ranges; <10 s in 20 MΩ range.

Maximum Input Volts — 250 V peak.

Maximum Resolution — 10 mΩ.

HI-LO Ohm Operation — A low voltage is user-selectable for making in-circuit ohms measurements without turning on silicon diode and transistor junctions. A high voltage is also available for testing junctions for forward and reverse resistance.

Maximum Open-Circuit Voltage Developed — <6 V.

Ranges — 200 Ω, 2 kΩ, 20 kΩ, 200 kΩ, 2000 kΩ, and 20 MΩ.

Accuracy*1

+18°C to +28°C

Resistance Ranges	Normal and Fast Conversion Rate	
200 Ω	LO Ω	±[0.15% of reading +0.015% of full scale (3 counts)]
2 kΩ to 2000 kΩ	HI Ω	±[0.15% of reading +0.015% of full scale (3 counts)]
2 kΩ to 200 kΩ	LO Ω	±[0.15% of reading +0.015% of full scale (3 counts)]
2000 kΩ	LO Ω	±[0.3% of reading +0.015% of full scale (3 counts)]
20 MΩ	HI Ω only	±[0.5% of reading +0.015% of full scale (3 counts)]
0°C to +18°C, +28°C to +50°C		
200 Ω	LO Ω	±[0.3% of reading +0.025% of full scale (5 counts)]
2 kΩ to 2000 kΩ	HI Ω	±[0.3% of reading +0.025% of full scale (5 count)]
2 kΩ to 200 kΩ	LO Ω	±[0.3% of reading +0.025% of full scale (5 counts)]
20 MΩ	HI Ω	±[1.2% of reading +0.025% of full scale (5 counts)]
2000 kΩ	LO Ω	±[1.2% of reading +0.025% of full scale (5 counts)]

*1 *Valid for six months or 1000 hours, whichever occurs first.*

DC AND TRUE RMS AC CURRENT

Input Signal — Must be between 5% and 100% of full scale (ac only).

Ranges — 200 μA, 2 mA, 20 mA, 200 mA, and 2000 mA.

Dc Current Accuracy — +18°C to +28°C: ±[0.2% of reading +0.015% of full scale (3 counts)]. 0°C to +18°C and +28°C to +50°C: ±[0.3% of reading + 0.025% of full scale (5 counts)].

Ac Current Accuracy From 20 Hz to 10 kHz — +18°C to +28°C: ±[0.6% of reading +0.05% of full scale (10 counts)]. 0°C to +18°C, +28°C to +50°C: ±[0.7% of reading +0.075% of full scale (15 counts)]. Usable to 20 kHz.

Response Time — <1 s dc current, <2 s ac current.

Input Resistance

Ranges	Approximate Resistance
200 μA	1.0 kΩ
2 mA	100.0 Ω
20 mA	10.2 Ω
200 mA	1.2 Ω
2000 mA	0.4 Ω

Maximum Open-Circuit Input Voltage (mA to LOW) — 250 V peak, fused with 2 A fast blow.

Maximum Floating Voltage — 1000 V peak.

Maximum Resolution — 10 nA.

TEMPERATURE

Range — −62°C to +240°C.

Resolution — 0.1°C.

Accuracy*1

Temperature to be Measured	−62°C to +150°C	+150°C to +240°C
P6601 and DM 501A calibrated as a pair	±2°C	0°C to −6°C
P6601 and instrument not calibrated as a pair	±4°C	+2°C to −8°C

*1 *+18°C to +28°C ambient temperature. For 0°C to +18°C, +28°C to +50°C ambient temperatures, add 1.5°C to above limit in each direction.*

OTHER CHARACTERISTICS

Overrange Indication — Blinking display (except on 1000 V dc and 500 V ac ranges).

Measurement Rate — 3⅓/s.

Power Consumption — ≈9 VA

Inputs — Maximum input voltage is 1000 V. The front panel Volts/Ω, or Low, or mA terminals can be floated to 1000 V peak maximum above ground, the rear input only 200 V peak. For the rear input, ac volts, ohms, and maximum input specfications are derated.

ORDERING INFORMATION

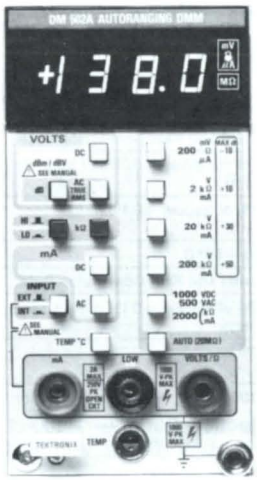
DM 501A Digital Multimeter **$850**

Includes: One pair of test leads (003-0120-00); P6601 Temperature Probe (010-6601-01); instruction manual (070-2749-00).

OPTION

Option 02 — Deletes P6601 Temperature Probe and temperature measurement capability. **−$100**

DM 502A



Digital Multimeter

DM 502A

True RMS

Autoranging

Seven Functions, Including Temperature and dB

0.1% Dc Volts Accuracy

3½ Digit Display

The DM 502A Digital Multimeter measures seven different functions with pushbutton convenience. Autoranging, in all modes except current, eliminates any need for operator selected ranges. The DM 502A measures dc and ac voltage, dc and ac current, dB, resistance and temperature. True RMS provides more accuracy in ac measurements on distorted, noisy, random or other nonsinusoidal ac waveforms. The resistance mode features HI-LO voltage (2 V to 0.2 V). The low voltage is user-selectable for making in-circuit ohms measurements without turning on diode and transistor junctions. The high voltage is available for testing junctions for forward and reverse resistance. The LED indicators provide a bright, readable 3½ digit display.

CHARACTERISTICS

Dc VOLTS

Ranges — 2000 mV, 2 V, 20 V, 200 V, and 1000 V. Automatic or manual ranging.

Accuracy*1

−18°C to +28°C	
Voltage Ranges	**Normal and Fast Conversion Rate**
20 mV to 200 V	±[0.1% of reading +0.05% of full scale (1 count)]
1000 V	±[0.1% of reading +0.1% of full scale (1 count)]
0°C to +18°C, +28°C to +50°C	
Voltage Ranges	**Normal and Fast Conversion Rate**
200 mV to 200 V	±[0.2% of reading +0.1% of full scale (2 counts)]
1000 V	±[0.2% of reading +0.2% of full scale (2 counts)]

*1 *Valid for six months or 1000 hours, whichever occurs first.*

Common-Mode Rejection Ratio — ≥100 dB at dc. ≤80 dB at 50 Hz to 60 Hz with 1 kΩ imbalance.

Normal-Mode Rejection Ratio — ≥50 dB at 50 Hz or 60 Hz ±0.2 Hz.

Maximum Resolution — 100 μV.

Step Response Time — 1 s within a range, +1.5 s for each range change in autoranging mode.

Input Resistance — 10 MΩ.

Maximum Input Voltage — 1000 V peak.

TRUE RMS Ac VOLTS

Ranges — 200 mV, 2 V, 20 V, 200 V, and 500 V. Automatic or manual ranging (ac coupled).

Accuracy*1

0°C to +18°C	Normal and Fast Conversion Rate	
Voltage Ranges	**20 Hz to 40 Hz**	**40 Hz to 20 kHz**
200 mV to 200 V	±[1.5% of reading +0.3% of full scale (6 counts)]	±[0.6% of reading +0.3% of full scale (6 counts)]
500 V	±[1.5% of reading +1.2% of full scale (6 counts)]	±[0.6% of reading +1.2% of full scale (6 counts)]
0°C to +18°C, +28°C to +50°C	**Normal and Fast Conversion Rate**	
Voltage Ranges	**20 Hz to 40 Hz**	**40 Hz to 20 kHz**
200 mV to 200 V	±[1.8% of reading +0.35% of full scale (7 counts)]	±[0.8% of reading +0.35% of full scale (7 counts)]
500 V	±[1.8% of reading +1.4% of full scale (7 counts)]	±[0.8% of reading +1.4% of full scale (7 counts)]

*1 *Valid for six months or 1000 hours, whichever occurs first. Typically usable to 100 kHz.*

Common-Mode Rejection Ratio — ≥60 dB at 50 Hz to 60 Hz with 1 kΩ imbalance.

Maximum Resolution — 100 μV.

Resolution Time — 1 s within a range, +1.5 s for each range change in autoranging mode.

Input Impedance — 10 MΩ paralleled by <100 pF.

Maximum Input Voltage — 500 V ac RMS, 600 V dc, not to exceed 1000 V peak.

Crest Factor — 4 (at full scale all ranges), ≤2 on 500 V range.

dB (TRUE RMS)

Zero dB Reference — 1 mW in 600 Ω (0.775 V) (dBm). Internal jumper change for 0 dB reference of 1,000 V (dBV).

Accuracy*1

+18°C to +28°C	20 Hz	2 kHz	10 kHz	20 kHz
+50 dB to −50 dB	±0.5 dB			
−50 dB to −60 dB	±0.5 dB	±1.5 dB	Typically ±2.5 dB	

*1 *From 0°C to +18°C, +28°C to +50°C, add 0.6 dB to above accuracy specifications. For example, at 0°C the accuracy in the +50 dB to −50 dB range from 20 Hz to 20 kHz would be ±1.1 dB.*

Noise Level — Typically −75 dB.

Maximum Resolution — 0.1 dB.

Response Time — ≤1 s within a range, ≤1.5 s for each range change in autoranging mode.

Input Impedance — 10 MΩ paralleled by <100 pF.

Maximum Input Voltage — 500 V RMS, not to exceed 1000 V peak.

Crest Factor — 4 (at full scale), ≤2 above 40 dB.

RESISTANCE

Ranges — 200 Ω, 2 kΩ, 20 kΩ, 200 kΩ, 2000 kΩ, and 20 MΩ. Automatic or manual ranging.

Accuracy*1

+18°C to +28°C	
Resistance Ranges	
200 Ω to 2000 kΩ	±[0.5% of reading +0.05% of full scale (1 count) + 0.2 Ω]
20 MΩ	±[1% of reading +0.05% of full scale (1 count)]
0°C to +18°C, +28°C to +50°C	
Resistance Ranges	
200 Ω to 2000 kΩ	±[0.8% of reading +0.1% of full scale (2 counts) + 0.2 Ω]
20 MΩ	±[1.3% of reading +0.1% of full scale (2 counts)]

*1 *Valid for six months or 1000 hours, whichever occurs first.*

Response Time — ≤1 s within a range, ≤1.5 s for each range change in autoranging mode.

Maximum Input Voltages — 130 V dc or ac RMS indefinitely. 230 V dc or ac RMS for 30 minutes maximum.

HI-LO Ohm Operation — A low voltage is user-selectable for making in-circuit ohms measurements without turning on silicon diode and transistor junctions. A high voltage is also available for testing junctions for forward and reverse resistance.

Maximum Resolution — 0.1 Ω.

Maximum Open-Circuit Voltage Developed — ≈14 V.

DC AND TRUE RMS AC CURRENT

Ranges — 200 μA, 2 mA, 20 mA, 200 mA, and 2000 mA. Manual ranging only.

Dc Current Accuracy — +18°C to +28°C: ±[0.2% of reading +0.05% of full scale (1 count)]. 0°C to +18°C, +28°C to +50°C: ±[0.3% of reading +0.1% of full scale (2 counts)].

Ac Current Accuracy (From 40 Hz to 10 kHz) — Usable to 20 kHz. +18°C to +28°C: ±[0.6% of reading +0.3% of full scale (6 counts)]. 0°C to +18°C, +28°C to +50°C: ±[0.7% of reading +0.5% of full scale (10 counts)].

Response Time — ≤1 s.

Input Resistance

Ranges	Approximate Resistance
200 μA	1.0 kΩ
2 mA	100.0 Ω
20 mA	10.2 Ω
200 mA	1.2 Ω
2000 mA	0.4 Ω

Maximum Open Circuit Input Voltage (mA to LOW) — 250 V peak, fused with 2 A fast blow.

Maximum Floating Voltage — 1000 V peak.

Maximum Resolution — 0.1 μA.

TEMPERATURE

Range — −55°C to +200°C.

Resolution — 0.1°C.

Accuracy*1

+18°C to +28°C		
Temperature to be Measured	**−55°C to +150°C**	**+150°C to +200°C**
P6601 Probe and DM 502A calibrated as a pair	±2.5°C	±3.5°C
P6601 and instrument not calibrated as a pair	±4.5°C	±5.5°C

*1 *For 0°C to +18°C, +28°C to +50°C ambient temperatures, add ±1.5°C to accuracy specifications.*

OTHER CHARACTERISTICS

Overrange Indication — Blinking display (except 1000 V dc and 500 V ac).

Measurement Rate — Three per second.

Power Consumption — ≈8 VA.

Inputs — Maximum input voltage is 1000 V. The front panel V/Ω, or Low, or mA terminal can be floated 1000 V peak maximum above ground, the rear input 200 V peak. For the rear input, ac volts, ohms and maximum input specifications are derated.

ORDERING INFORMATION

DM 502A Digital Multimeter **$900**

Includes: One pair test leads (003-0120-00); P6601 Temperature Probe (010-6601-01); instruction manual (070-2693-00).

OPTION

Option 02 — Deletes P6601 Temperature Probe and temperature measurement capability. **−$100**

To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext. 99

DIGITAL MULTIMETER PROBES AND OPTIONAL ACCESSORIES

High Voltage Probe

The High Voltage Probe will measure dc voltages from 1 kV to 40 kV with an accuracy of 1% at 25 kV. The division ratio is 1000:1. Common uses include measuring anode voltages on monitors or oscilloscopes. Probe plugs directly into the front end of the multimeter.

CHARACTERISTICS

Voltage Range — 1 kV to 40 kV dc.

Input Resistance — 1000 MΩ.

Division Ratio — 1000:1.

Overall Accuracy — 20 kV to 30 kV 2%.

Upper Limit Accuracy — Changes linear from 2% at 30 kV to 4% at 40 kV.

Lower Limit Accuracy — Changes linear from 2% at 20 kV to 4% at 1 kV.

Input Z at Meter — 10 MΩ required.

ORDERING INFORMATION

High Voltage Probe Order 010-0277-00 **$180**

P6420 RF Probe

The P6420 RF Probe is compatible with DMMs that have an input impedance of 10 MΩ, and comes with a two meter cable.

CHARACTERISTICS

Voltage Range — 5 V to 25 V RMS (70.7 V p-p).

Ac to Dc Transfer Ratio Accuracy — 0.5 V to 5 V RMS ±10% (+15°C to +35°C). 5.0 V to 25 V RMS ±5% (+15°C to +35°C).

Frequency Response — 100 kHz to 300 MHz (±0.5 dB), 50 kHz to 500 MHz (±1.5 dB), 10 kHz to 1 GHz (±3.0 dB).

Input Capacitance — ≈3.7 pF.

Maximum Input Voltage — 42.4 V (peak ac + dc).

Length — Probe only 96 mm. Cable only 2 meters.

ORDERING INFORMATION

P6420 RF Probe, 2 m Cable **$145**

Includes: Retractable probe tip (013-0097-01); BNC female to dual banana adaptor (103-0090-00); alligator clip (344-0046-00); probe holder (352-0351-00); 76.2 mm (3 in) ground lead (175-0849-00); 152.8 mm (6 in) ground lead (175-1017-00); two replaceable probe tips*[1]; electrical insulating sleeve (166-0404-01); data sheet (062-2764-00).

[1] Available in package of ten only. Order 206-0230-03.

Cables — Does not change specifications.

(1 Meter) Order 175-1661-00 **$27**

(3 Meter) Order 175-1661-02 **$27**

P6601 Temperature Probe

The P6601 Probe is a temperature measuring device designed to operate with the DM 502A and DM 501A Digital Multimeters. The temperature sensing element consists of a thin-film platinum resistor on the tip of the probe. Measurements are made by touching the probe tip to the surface whose temperature is in question. The thermal signal is transmitted to the associated digital multimeter through a two-conductor cable.

The thermal time constant on the P6601 Probe is 0.5 seconds ±0.2 seconds. The P6601 is totally immersible except in liquids that are not compatible with Dow Corning 308 molding compound, BeO, silicone rubber, or epoxy adhesives. The sensor and tip are limited to a maximum of +240°C, and cable is limited to a maximum of +140°C.

ORDERING INFORMATION

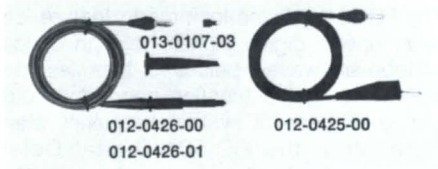
P6601 Temperature Probe

Order 010-6601-01 **$225**

Includes: Instruction manual (070-2620-00).

DMM OPTIONAL ACCESSORIES

The following accessories may be ordered as options for use with any of the three TM 500/TM 5000 Digital Multimeters.



Test Leads —

(Black, 4 ft) Order 012-0425-00 **$12.75**

(Red, 4 ft) Order 012-0426-00 **$23**

(Black, 4 ft) Order 012-0426-01 **$23**

Set (012-0425-00, 012-0426-00, 013-0107-05). Order 012-0427-00 **$29**

Adaptor — Female BNC to Dual Banana. Order 103-0090-00 **$9.25**

Additional accessories begin on page 464.

PRODUCT SUMMARY

When your test and measurement problems require more waveforms for more applications, the high performance TM 500 Function Generators are a versatile solution singly or in combination with one another.

For applications demanding logarithmic or linear sweep the FG 507 offers an accurate and versatile solution. Low distortion, combined with log and linear sweep, is particularly useful in audio and linear communications-oriented applications.

For low frequency function generator applications, set the FG 501A, FG 502, FG 503, or FG 507 to work on biological, geophysical and mechanical simulations or on servo systems.

Applying an external ramp to the VCF input allows any of the TM 500 function generators to double as sweep generators. Applying a suitable modulating signal can produce a frequency-modulated carrier. In addition, the FG 504 and FG 507 can supply internally generated linear or logarithmic sweeps with convenient two-dial control of start and stop frequencies.

Sweeping wide frequency ranges (up to 1000:1) with logarithmic sweep allows you to spread out lower octaves, sweep a full range in less time, and produce easy-to-read Bode plots and graphs.

You can control the starting phase of a waveform in the gated burst or triggered mode with the FG 501A, FG 504, FG 507 and the FG 5010. A gated or triggered waveform efficiently tests tone-controlled systems, loud speaker transient response characteristics, automatic gain control circuits, or other amplitude sensitive systems.

The FG 504's phase lock mode feature lets you convert digital signals to high or low voltage sinewaves, pulses, or triangles; ideal for locking the function generator's output to a house or system frequency standard. With the DD 501 Digital Delay Generator in the "divide by n" mode, the FG 504 can be locked to your frequency reference at a lower frequency.

FUNCTION GENERATORS

Application/Feature	FG 501A	FG 507
Waveforms	Sine, Square, Triangle, Pulse and Ramp with variable symmetry	
Symmetry	≤5% to ≥95% Variable	≤5% to >95% Variable
Frequency Range	0.002 Hz to 2 MHz 200 kHz ±10% with variable symmetry on	0.002 Hz to 2 MHz 200 kHz ±10% with variable symmetry on
Dial Accuracy (% of Full Scale except FG 5010)	Within 3%	Within 3% Within 5% in sweep mode*2
Custom Frequency Range	No	No
Frequency Stability (% of Full Scale)	≤0.05% for 10 min., ≤0.1% for 1 hour, ≤0.5% for 24 hours, constant temperature	
Amplitude: Open Circuit	30 V p-p	30 V p-p
Into 50 Ω	15 V p-p	15 V p-p
Attenuator	0 to −60 dB in 20 dB steps >20 dB additional with AMPL control	
Offset: Open Circuit	±13 V dc, step attenuator decreases offset	
Into 50 Ω	±6.5 V dc, step attenuator decreases offset	
Pk Sig + Offset: Open Circuit	±15 V	±15 V
Into 50 Ω	±7.5 V	±7.5 V
Output Impedance	50 Ω	50 Ω
Amplitude Flatness (10 kHz ref, 50 Ω load) Sinewave	±0.1 dB 20 Hz to 20 kHz ±0.5 dB 20 kHz to 1 MHz ±1 dB 1 MHz to 2 MHz	±0.1 dB 20 Hz to 20 kHz ±0.5 dB 20 kHz to 1 MHz ±1 dB 1 MHz to 2 MHz
Triangle	±0.5 dB 20 Hz to 200 kHz ±2 dB 200 kHz to 2 MHz	±0.5 dB 20 Hz to 200 kHz ±2 dB 200 kHz to 2 MHz
Squarewave	±0.5 dB 20 Hz to 2 MHz	±0.5 dB 20 Hz to 2 MHz
Sinewave Distortion (Maximum Output, 50 Ω load)	≤0.25% 20 Hz to 20 kHz*2 ≤0.5% 20 kHz to 100 kHz Harmonics: ≤−30 dB, 100 kHz to 2 MHz	≤0.25% 20 Hz to 20 kHz*2 ≤0.5% 20 kHz to 100 kHz Harmonics: ≤−30 dB, 100 kHz to 2 MHz
Squarewave Response	≤25 ns rise/fall <3% p-p aberrations	≤25 ns rise/fall <3% p-p aberrations
Triangle Linearity (10% to 90%)	≥99% 20 Hz to 200 kHz ≥97% 200 kHz to 2 MHz	≥99% 20 Hz to 200 kHz ≥97% 200 kHz to 2 MHz
Trigger Output	≥+4 V from 50 Ω	≥+4 V from 50 Ω
External Input	Impedance ≈2 kΩ Trigger threshold level +1 V ±20%	Impedance ≈2 kΩ Trigger threshold level +1 V ±20%
Trigger	±90° variable start phase control	±90° variable start phase control
Gate	±90° variable start phase control	±90° variable start phase control
Phase Lock	No	No
Counted Burst	With DD 501	With DD 501
Internal Sweep	No	Logarithmic or Linear, Separate Start/Stop Dials
Duration		1 ms to 100 s
External Trigger	NA	±1 V ±20% trigger level; ≈2 kΩ input impedance
Ramp Output		≤0.3 V to 10 V from 1 kΩ ±5%
Gate Output		≥+4 V from 50 Ω
Other Modes		Manual Sweep Trig; Manual Sweep; Sweep and Hold
Amplitude Modulation	No	No
Voltage Controlled Frequency (FM)	Up to 1000; 1 Frequency change with 10 V external signal Slew rate ≥0.3 V/μs, 10 kΩ input impedance	
Nominal Hz/Volt Sensitivity	2 x Frequency Multiplier setting	2 x Frequency Multiplier
Output Hold Mode	No	No
Temperature*4	Operating: 0°C +50°C; Nonoperating: −55°C to +75°C	
IEEE Standard 488	No	No
Mainframe Compatibility	TM 500/TM 5000	TM 500/TM 5000
Page	416	417
Price	$925	$2,220

Additional accessories begin on page 489.

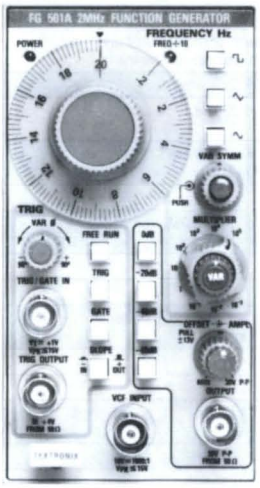
**1 +15°C to +35°C ambient.*
**2 +20°C to +30°C ambient.*
**3 20 Hz to 20 kHz modulation frequency.*
**4 FG 504 requires forced air circulation above +40°C.*
**5 Percent of indicated frequency.*
**6 Absolute voltage accuracy.*
**7 Separate FM function provided (1%/V).*

SELECTION GUIDE

Application/Feature	FG 504	FG 502	FG 503	FG 5010
Waveforms	Sine, Square, Triangle, Pulse and Ramp with variable symmetry	Sine, Square, Triangle Pulse, or Ramp	Sine, Square, Triangle	Sine, Square, Triangle, Pulse and Ramp with variable symmetry
Symmetry	7% to 93% Variable	5%, 50%, 95% Fixed	50% Fixed	10% to 90%, 1% steps
Frequency Range	0.001 Hz to 40 MHz 4 MHz nominal with variable symmetry on	0.1 Hz to 11 MHz Pulse and Ramp, 1.1 MHz	1.0 Hz to 3 MHz Usable 0.01 Hz to 5 MHz	0.002 Hz to 20 MHz
Dial Accuracy (% of Full Scale except FG 5010)	Within 3% to 4 MHz*1 Within 6% to 40 MHz*1	Within 3% to 1 MHz Within 5% to 10 MHz	Withn 5%	Within 0.1% of selected frequency Digital LED Display
Custom Frequency Range	Shipped with capacitor for 20 Hz to 20 kHz	No	With user-installed capacitor	NA
Frequency Stability (% of Full Scale)	≤0.05% for 10 minutes, ≤0.1% for 1 hour, ≤0.5% for 24 hours, constant temperature			≤0.05% for 1 hr, 0.05% for 24 hrs (≤0.1% in trigger, gate, burst mode <200 Hz)*5
Amplitude: Open Circuit	30 V p-p	10 V p-p	20 V p-p	20 V p-p
Into 50 Ω	15 V p-p	5 V p-p	10 V p-p	10 V p-p
Attenuator	0 to −50 dB in 10 dB steps <10 mV p-p with VAR control	Variable control only	Variable control only	Digital Control of fixed and variable 10 mV p-p into 50 Ω
Offset: Open Circuit	±7.5 V dc	±5 V dc	±7.5 V dc	±7.5 V dc
Into 50 Ω	±3.75 V dc	±2.5 V dc	±3.75 V dc	±3.75 V dc
Pk Sig + Offset: Open Circuit	±20 V	±10 V	±15 V	±15 V
Into 50 Ω	±11.25 V	±5 V	±6 V	±7.5 V
Output Impedance	50 Ω	50 Ω	50 Ω	50 Ω
Amplitude Flatness (10 kHz ref, 50 Ω load) Sinewave	±0.5 dB 0.001 Hz to 40 kHz	±0.5 dB 20 Hz to 20 kHz ±1.5 dB 0.1 Hz to 11 MHz	±0.5 dB 20 Hz to 20 kHz ±2 dB 0.1 Hz to 3 MHz	±3% from 0.002 Hz to 1 kHz ±3.5% from 1 kHz to 1 MHz ±5% from 1 MHz to 5 MHz +5%, −10% from 5 MHz to 20 MHz
Triangle	±2 dB 40 kHz to 40 MHz	±3 dB referenced to Sinewave	±1 dB referenced to Sinewave	±2% from 0.002 Hz to 1 kHz ±3.5% from 1 kHz to 100 kHz ±4% from 100 kHz to 1 MHz +4%, −5% from 1 MHz to 5 MHz +4%, −20% from 5 MHz to 20 MHz
Squarewave	±0.5 dB to 20 MHz ±2 dB to 40 MHz			±2% from 0.002 Hz to 1 kHz ±3.5% from 1 kHz to 1 MHz ±5% from 1 MHz to 10 MHz ±10% from 10 MHz to 20 MHz
Sinewave Distortion (Maximum output, 50 Ω load)	≤0.5% 20 Hz to 40 kHz*1 Harmonics: ≤−30 dB 40 kHz to 1 MHz <−20 dB 1 MHz to 40 MHz	≤0.5% 10 Hz to 50 kHz*2 Harmonics: ≤−30 dB at all other frequencies	≤0.5% 1 Hz to 30 kHz ≤1.0% 30 kHz to 300 kHz ≤2.5% 300 kHz to 3 MHz	≤0.5% 20 Hz to 19.99 kHz*1 ≤1.0% 20 kHz to 99.99 kHz Harmonics >30 dB down, 100 kHz to 20 MHz
Squarewave Response	≤6 ns rise/fall fixed 10 ns to 100 ms variable ≤5% p-p +30 mV aberrations	≤20 ns rise/fall ≤3% p-p aberrations	≤60 ns rise/fall ≤3 p-p aberrations	≤10 ns rise/fall ≤5% p-p aberrations
Triangle Linearity (10% to 90%)	≥99% 10 Hz to 400 kHz ≥95% 400 kHz to 40 MHz type ≥98% 0.001 Hz to 10 Hz	≥99% 0.1 Hz to 100 kHz ≥97% 100 kHz to 1 MHz ≥95% 1 MHz to 11 MHz	≥99% 1 Hz to 100 kHz ≥95% 100 kHz to 3 MHz	>98% to 2 MHz >90% to 20 MHz
Trigger Output	≥+2 V from 50 Ω	+2.5 V to 50 Ω load	+2.5 V to 600 Ω load	+2 V from 50 Ω
External Input	Impedance ≥10 kΩ Sensitivity ≤1 V p-p Trigger level −1 V to +10 V	Impedance ≈1 kΩ ≥+2 V Gate Signal required	No	1 MΩ/50 Ω internal setability 0.0 V/0.5 V internal setability
Trigger	20 MHz maximum ±80° start phase control to 10 MHz	No	No	±90° variable start phase control
Gate		Fixed 0° start phase	No	±90° variable start phase control
Phase Lock	100 Hz to 40 MHz ±80° phase range	No	No	20 Hz to 20 MHz (Auto Scan)
Counted Burst	With DD 501	With DD 501	No	1 to 9999
Internal Sweep Duration	Logarithmic or Linear, Separate Start/Stop Dials 0.1 ms to 100 s	No	No	No
External Trigger	+1 V to +10 V trigger level; 1 V p-p sensitivity	NA	NA	NA
Ramp Output	0 to +10 V from 1 kΩ ±5% to 1 ms, ±10% ≤1 ms			
Gate Output	No			
Other Modes	Manual Sweep Trig			
Amplitude Modulation	100% with nominal 5 V p-p input Dc to 100 kHz modulation frequency <5% distortion to 4 MHz at 70%*3 <10% distortion to 40 MHz at 65%*3	No	No	100% with nominal 5 V p-p input Dc to 100 kHz modulation frequency <2% distortion to 2 MHz at 70% <4% distortion to 20 MHz at 70%
Voltage Controlled Frequency (FM)	Up to 1000: 1 Frequency change with 10 V external signal Slew rate ≥0.3 V/ms, 10 kΩ input impedance			Up to 1000: 1 frequency*7 change with 10 V external input
Nominal Hz/Volt Sensitivity	4 x Frequency Multiplier	1.1 x Frequency Multiplier	3 x Frequency Multiplier	10% of selected range
Output Hold Mode	0.001 Hz to 400 Hz	No	No	0.002 Hz to 200 Hz
Temperature*4	Operating: 0°C to +50°C; Nonoperating: −55°C to +75°C			
IEEE Standard 488	No	No	No	Yes
Mainframe Compatibility	TM 500/TM 5000	TM 500/TM 5000	TM 500/TM 5000	TM 5000 only
Page	417	416	416	397
Prices	$3,225	$1,095	$675	$3,995

Additional accessories begin on page 487.

FG 501A



2 MHz Function Generator

FG 501A

0.002 Hz to 2 MHz

30 V Peak-to-Peak, ±13 V Offset

5% to 95% Variable Symmetry

Trigger or Gate, ± Slope

60 dB Step Attenuator

≤0.25% Sinewave Distortion

≤25 ns Rise/Fall

The FG 501A provides low-distortion outputs from 0.002 Hz to 2 MHz. It is capable of generating five basic waveforms—sine, square, triangle, ramp, and pulse—at output levels up to 30 V peak-to-peak with up to ±13 V of offset from a 50 Ω source. Waveform triggering and gating are provided with a variable phase control to permit up to ±90° of phase shift for generating haversines, $\sin^2$ pulses, and haver triangles. A step attenuator provides 60 dB of output signal attenuation in 20 dB steps with an additional 20 dB of variable attenuation. Variable symmetry from 5% to 95% provides ramps and pulses. Pulse rise time is ≤25 ns. Audio sinewave distortion is ≤0.25% and audio amplitude flatness is within 0.1 dB.

Because of its ability to generate low distortion sinewaves, the FG 501A is uniquely appropriate for applications requiring audio signals.

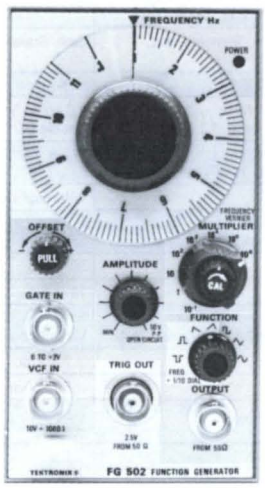
Also useful in audio applications is the 0 dB to 60 dB attenuator designed into the FG 501A.

The wide range variable symmetry of the FG 501A is useful for generation of pulses and ramps.

ORDERING INFORMATION

FG 501A 2 MHz Function Generator **$925**
Includes: Instruction manual (070-2957-00).

FG 502



11 MHz Function Generator

FG 502

0.1 Hz to 11 MHz

Five Waveforms

VCF and Gated Burst

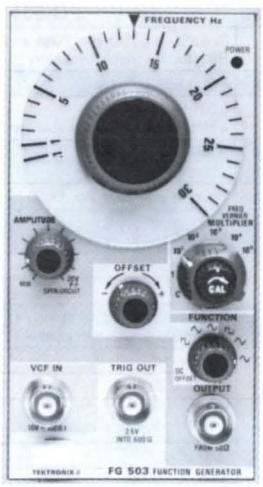
The FG 502 Function Generator provides low-distortion sine, square, and triangle waveforms, and positive or negative ramps and pulses. Output frequency is continuously variable from 0.1 Hz to 11 MHz. The high frequency range from 1 MHz to 11 MHz permits the versatility of the function generator to be extended into the medium radio frequency range. VCF input permits the FG 502 to be used as a sweep generator or as an FM generator.

External gate input permits the FG 502 output in any of its modes to be controlled by an externally supplied pulse to generate bursts of various output waveforms. This feature has application in wireless or radio remote control equipment and in certain phases of the telephone industry.

ORDERING INFORMATION

FG 502 11 MHz Function Generator **$1,095**
Includes: Instruction manual (070-1706-01).

FG 503



3 MHz Function Generator

FG 503

1.0 Hz to 3 MHz

Three Waveforms

VCF

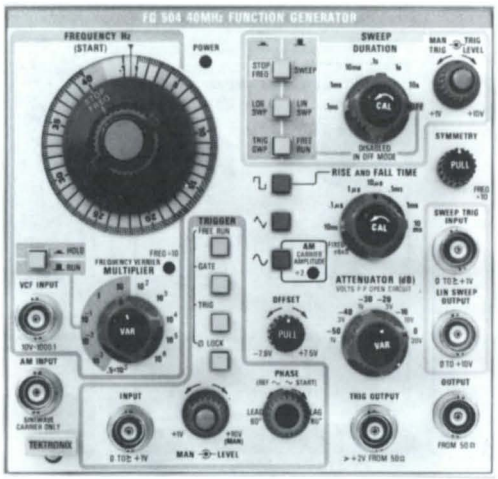
The FG 503 Function Generator provides high-quality low-distortion sine, square, and triangle waveforms. Six decade frequency multiple steps, a custom position for user-determined frequency multiplication, a dial calibrated from 1.0 to 30 (uncalibrated from 0.1 to 1.0), and a frequency vernier control work together to select frequencies in overlapping ranges from 1 Hz to 3 MHz. The output frequency can be swept over a 1000:1 ratio by an external voltage. Output amplitude and offset controls are provided. A trigger output is available for controlling external devices or equipment. Amplitude up to 10 V peak-to-peak can be developed across a 50 Ω load (20 V peak-to-peak open circuit). Selectable offset up to 3.75 V dc across 50 Ω (7.5 V dc open circuit) is also featured.

ORDERING INFORMATION

FG 503 3 MHz Function Generator **$675**
Includes: Instruction manual (070-1727-01).

To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext. 99

FG 504



40 MHz Function Generator

FG 504

0.001 Hz to 40 MHz

Three Basic Waveforms, Plus a Wide Range of Shaping With Variable Rise Times and Fall Times and Symmetry Controls

Logarithmic or Linear Sweep

Up to 30 V P-P Output

Built-In Attenuator

AM and FM

Phase Lock Mode

External and Manual Trigger or Gate

Counted Burst With DD 501

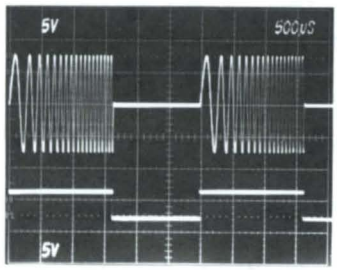
The output of the FG 504 can be phase locked, gated, or triggered by a reference signal. This lets you convert from one waveform to another, such as pulses to sinewaves, as well as adjusting phase relationships. Post attenuator offset enables use of the full ±7.5 V offset range with small signals. And the FG 504 output can be swept, or amplitude or frequency modulated by external signals. In addition, the FG 504 can supply internally generated linear or logarithmic swept frequencies of up to 1000:1 range with convenient control of start and stop frequencies.

The FG 504 also provides trigger output, external voltage control input, and sweep output.

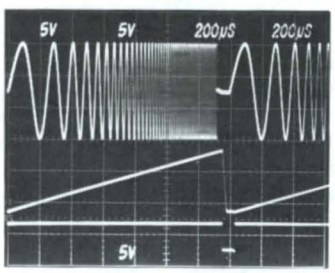
ORDERING INFORMATION

FG 504 40 MHz Function Generator **$3,225**
Includes: Instruction manual (070-2655-00).

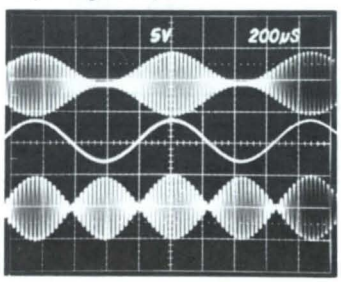
FG 504T 40 MHz Function Generator **$3,640**
Includes: FG 504, TM 503 Mainframe, and 016-0195-03 Blank Panel.



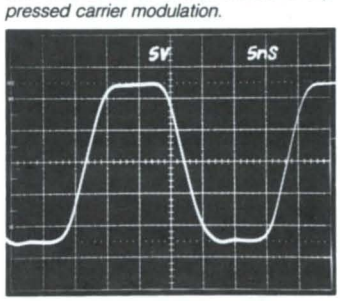
FG 507 triggered sweep mode with output gated on by sweep gate.



FG 507 in logarithmic sweep with sweep ramp and gate outputs.

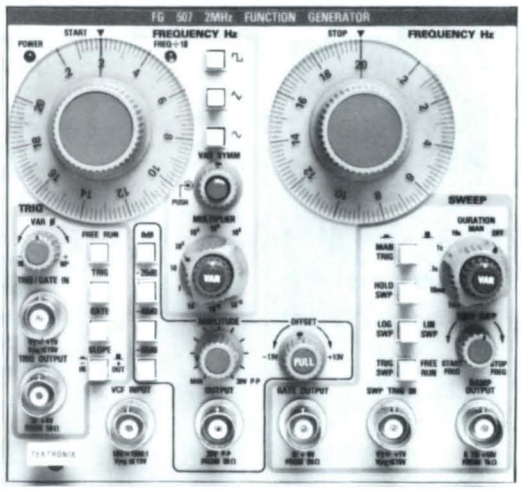


FG 504 True four quadrant multiplier permits normal am or double sideband suppressed carrier modulation.



FG 504 30 volt output with 6 ns rise time and fall time for superior pulse waveforms.

FG 507



2 MHz Sweeping Function Generator

FG 507

0.002 Hz to 2 MHz

Includes All FG 501A Features

Logarithmic or Linear Sweep

Separate Start/Stop Frequency Dials

Sweep Up or Down

Sweep and Hold

Manual Sweep

The FG 507 features the same basic performance as the FG 501A and adds flexible, easy-to-use log and linear sweep capability.

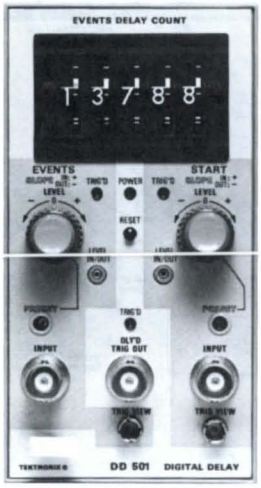
The log sweep of the FG 507 is mathematically correct and allows accurate frequency plots when using log scales, log paper, or a storage oscilloscope like the SC 503. Separate start and stop frequency dials make frequency settings easy to adjust and interpret. The instrument can be internally or externally swept up or down. A third frequency control allows you to manually sweep between the preset start and stop frequencies without disturbing their settings. This is especially convenient for examining frequency and amplitude anomalies of a circuit under test or in setting start and stop points. The sweep generator can be swept and the sweep gate output can be used to gate (burst) the generator on for swept bursts. The sweep hold mode allows the generator to sweep to the stop frequency and remain there until released.

The accurate log/linear sweep capability of the FG 507 plus the low distortion (0.25% over the audio range) make it ideally suited to audio testing.

ORDERING INFORMATION

FG 507 2 MHz Sweeping Function Generator **$2,220**
Includes: Instruction manual (070-2986-00).

DD 501



Digital Delay

DD 501

Digital Events Delay

Delay to 99,999 Events

Divide by N Up to 20 MHz

Pulse Counting to 65 MHz

Time Delay With External Clock

Compatible With Most Attenuator Probes

The DD 501 Digital Delay is an events-counting device which can be used with pulse, function and clock generators in such applications as precise digital delay between two related events, divide-by-N frequency divider, precision gate generator, counted burst output from a gated pulse or frequency generator, etc.

Basically, the DD 501 has two modes of operation. In the gating mode, the DD 501 generates a gate that starts with the application of a start pulse and continues until a selected number of event pulses have occurred. It can be used for generating a counted burst of N pulses when used with a pulse generator capable of being gated. Tektronix generators capable of being gated by the DD 501 are the FG 501A, FG 502, FG 504, FG 507, FG 5010, PG 507, and PG 508.

In the delayed trigger mode, the DD 501 generates a trigger pulse after the selected number of event pulses have occurred. Besides being used strictly for generating precision delays, the delayed trigger mode can also be used as a frequency countdown divider for any frequency up to 65 MHz. In both modes, the desired number of events (from 0 to 99,999) is selected by front-panel thumbwheel switches.

Trigger slope and level controls for both the Start and Events inputs permit use with a wide variety of applied signals. Both inputs are compatible with Tektronix attenuator probes. In special applications, the trigger levels can be remotely set by application of analog voltages through the front-panel Level In/Out jacks.

CHARACTERISTICS

EVENTS DELAY

Count — 10 to 99,999 events.

Maximum Count Rate — 65 MHz.

Insertion Delay — 30 ns or less from final event to trigger output pulse.

Recycle Time — 50 ns or less.

Reset — Manually resets delay counter.

INPUT CHARACTERISTICS

All characteristics apply to both events and start inputs.

Input Impedance — 1 MΩ, 20 pF.

Slope — Either + or −, selectable.

Sensitivity — 85 mV p-p at 30 MHz.

Frequency Response — Up to 65 MHz at 120 mV sensitivity.

Minimum Detectable Pulse Width — 5 ns,

Threshold Level Range — From −1.0 V to +1.0 V (−10 V to +10 V with 10X probe). Can be externally programmed or monitored at front panel jacks.

Trigger View Out — Threshold detector output, at least 0.5 V (200 Ω or less source impedance).

Events Triggered Light — Visual indication that events are being detected.

Start Triggered Light — Visual indication that delay is in progress.

TRIGGER OUTPUT

Pulse Width — Width of events pulse plus 6 ns or less.

Voltage Swing — +0.8 V or less to at least +2.0 V with 3 TTL loads (≈5 mA).

Light — Indicates output trigger.

ORDERING INFORMATION

DD 501 Digital Delay **$1,900**

Includes: Instruction manual (070-1818-01).

284

Pulse Generator

284

70 ps or Less Rise Time Pulse

Sinewave and Squarewave Outputs

CHARACTERISTICS

Pulse Output — 70 ps or less rise time with a pulse width of more than 1 μs and a repetition rate of ≈50 kHz. Aberrations will be determined by the sampling head used. The aberrations following the positive-going transition when using the S-2 sampling head are: < ±5%, or 10% p-p, in first 1.2 ns, ±2% after 2 ns. Pulse amplitude is more than +200 mV into 50 Ω. Source resistance is 50 Ω.

Squarewave Output — Periods of 10 μs, 1 μs, or 100 ns. Amplitude is 10 mV, 100 mV, or 1 V into 50 Ω.

Sinewave Output — Periods of 10 ns or 1 ns. Output amplitude is 100 mV into 50 Ω.

Trigger Output — Squarewave, sinewave, or pretrigger pulse output, depending on the selected main signal output. Amplitude is 200 mV, accurate within 40%. When Pulse Output is selected, the trigger can be switched to arrive 5 ns ±5 ns, or 75 ns ±5 ns ahead of the main pulse. Rise time is 3 ns or less; pulse width is 10 ns or greater.

Output	Period	Timing Accuracy	Amplitude Accuracy		
			1 V	100 mV	10 mV
Pulse	20 μs	±10%			
Square-wave	10 μs 1 μs	±0.5%	±0.5%	±1%	±1.5%
	100 ns	±10%*1	±2%*2	±2.5%*2	±3%*2
Sinewave	10 ns 1 ns	±1%		±20%	

*1 *Crystal controlled.*
*2 *20 ns after transition.*

The 284 is not part of the TM 500 Series, and does not require the use of a separate mainframe.

ORDERING INFORMATION

284 Pulse Generator **$2,400**

Includes: Instruction manual (070-0754-01).

To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext. 99

PRODUCT SUMMARY

The TM 500 Pulse Generator family offers a wide variety of capabilities suitable for most pulse testing applications. Whether testing wide-band systems, simulating data transmission signals, or driving a laser, the versatile TM 500 Pulse Generators have the capabilities to meet your needs.

Particularly important in today's digital world is the capability to generate a variety of pulse signals compatible with the key logic families.

The PG 507 features complementary dual outputs making it ideally suited for digital applications. The dual output feature is particularly useful when working with ECL logic families.

Similar to the PG 507 Pulse Generator is the 50 MHz PG 508 featuring independently variable rise times and fall times. The PG 508's high level performance and versatility cover a broad range of test and measurement applications.

The accurate 50 ohm output impedances of the PG 507 and PG 508 deliver clean signals into logic families, reactive loads, or at the end of an unterminated cable. These 50 MHz multipurpose generators are also designed for high level performance on high impedance circuits (MOS, HTL, and CMOS logic).

In 50 ohm systems, the PG 501 and PG 502 are designed to be compatible with common digital integrated-circuit families (TTL, DTL and ECL), in repetition rates, amplitudes and transition times.

The TM 500 Pulse Generators' wide range of features afford you ease of operation even on the most challenging test and measurement problems.

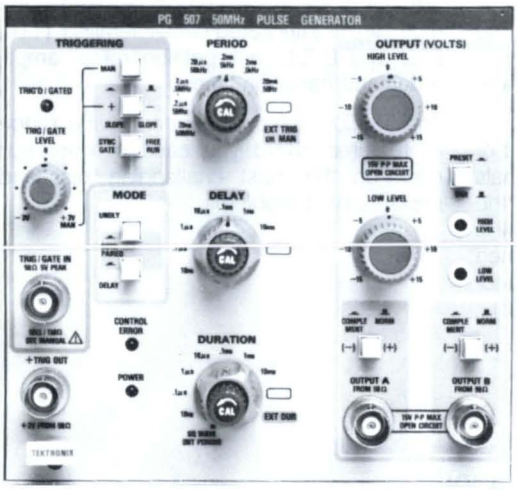
PULSE GENERATORS SELECTION GUIDE

Application/Feature	PG 507	PG 508	PG 501	PG 502
Pulse Period	≤20 ns to ≥200 ms (50 MHz to 5 Hz)		≤20 ns to ≥200 ms (50 MHz to 5 Hz)	≤4 ns to ≥100 ms (250 MHz to 10 Hz)
Pulse Duration Duty Factor	≤10 ns to ≥100 ms		≤10 ns to ≥100 ms	≤2 ns to ≥50 ms
	≥70% to 0.2 μs period, ≥50% at 20 ns period			≥50%
Squarewave Mode	✓	✓		✓
Pulse Delay Duty Factor	≤10 ns to ≥100 ms*1	≤10 ns to ≥100 ms*1		
	≥70% to 0.2 μs period, ≥50% at 20 ns period		Fixed, 20 ns from external trigger	Fixed, 17 ns from external trigger
Double Pulse	✓	✓		
Transition Times	Fixed, ≤3.5 ns, ≤4 ns @ >5 V	≤5.5 ns to ≥50 ms, Independently variable up to 100:1	Fixed, ≤3.5 ns	Fixed, ≤1.0 ns
Aberrations	≤5% p-p +25 mV into 50 Ω load	≤5% p-p +50 mV for pulse within ±5 V into 50 Ω load	Within 3.5% at 5 V into 50 Ω load	Within 5% at 5 V p-p (durations ≥5 ns)
Amplitude: Into 50 Ω	≥7.5 V p-p, ±7.5 V window	≥10 p-p, ±10 V window	≥5 V	5 V, ±5 V window
Open Circuit	≥15 V p-p, ±15 V window	≥20 p-p, ±20 V window	Not specified	5 V, ±5 V window
Source Impedance	50 Ω	50 Ω	Not specified	1 kΩ or 50 Ω
Simultaneous Outputs	✓ complementary		✓ positive and negative	
Pulse Coincidence	≤1 ns at 50% amplitude	NA	≤1 ns at 50% amplitude	NA
Output Controls	Independent pulse top & pulse bottom, normal or PRESET		Independent amplitude controls for + and − outputs, no offset	Independent pulse top and pulse bottom
Normal/Complement	✓ both outputs	✓		✓
Remote Amplitude	Rear interface inputs	Rear interface inputs		
Locked on Mode			✓	
Back Termination	Always back terminated	Always back terminated		✓ switchable
External Input	1 MΩ to 50 Ω input impedance	1 MΩ or 50 Ω input impedance	50 Ω input Z	50 Ω input Z
Trigger Level	−3 V to +3 V, 80 mV p-p sensitivity to 10 MHz 250 mV p-p to 50 MHz TRIG'D/GATED light		+1 V required	+1 V required
Slope	+ or −	+ or −	+ only	+ only
Trigger Mode	✓	✓	✓	✓
Manual Trigger	✓	✓		✓
Duration Mode	✓	✓	✓	✓
Gate Mode	✓	✓		
Counted Burst	✓ with DD 501*2	✓ with DD 501*2		
Trigger Output (50% Squarewave or Follows External Signal)	≥+2 V from 50 Ω approximately 35 ns prior to pulse output (23 ns in squarewave or EXT DUR modes)		≥+2 V from 50 Ω, approximately 8 ns prior to pulse output	≥+2 V from 50 Ω, approximately 10 ns prior to pulse output
Custom Timing Positions	User installed capacitors	User installed capacitors	No	No
Control Error Light	✓	✓		
Mainframe Compatibility	TM 500/TM 5000	TM 500/TM 5000	TM 500/TM 5000	TM 500/TM 5000
Page	420	420	421	421
Prices Begin At	$2,925	$2,325	$850	$3,045

*1 *Add 60 ns for delay from external trigger.*
*2 *Exact count to 20 MHz, usable to 50 MHz.*

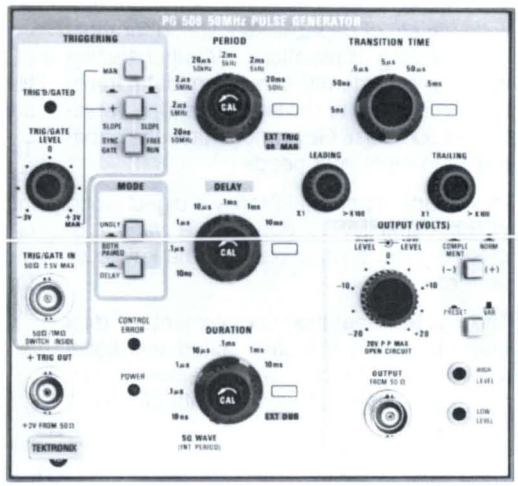
For recommended accessories, see page 487.

PG 507



50 MHz Dual Output Pulse Generator

PG 508



50 MHz Pulse Generator

PG 507

Dual Outputs With Tracking Level Controls

Normal or Complement Pulse Output on Both Channels

15 V Output in a ±15 V Window Into High Impedance, 7.5 V Into 50 Ω

3.5 ns Rise Time/Fall Time

The PG 507 is a high performance, 50 MHz pulse generator designed specifically for logic design applications.

The PG 507 features complementary dual outputs that greatly increase its applicability in logic design areas, especially interfacing within systems or to peripherals. For instance, the complementary outputs allow simulation of line drivers or opposite phase clocks.

The PG 507 also offers versatility to the design engineer in an analog environment. For example, the dual outputs can be used to test differential input amplifiers or multiplexers.

The PG 507 features four output modes: normal complement mode (Channel A output positive going, Channel B output negative going), opposite phase complement mode (Channel A output negative going, Channel B output positive going), simultaneous negative mode (Channel A output negative going, Channel B output negative going), and simultaneous positive mode (Channel A positive going Channel B output positive going).

In addition, the Output High Level and Low Level voltage controls track between channels, making amplitude settings easy.

This unique output flexibility within the normal and complement modes is particularly useful in logic design or control applications requiring simultaneous signals.

ORDERING INFORMATION

PG 507 50 MHz Pulse Generator **$2,925**
Includes: Instruction manual (070-2962-00).

RECOMMENDED PROBES

P6062B — 1X/10X, dc to 100 MHz.
See page 470. **$175**

P6108A — 10X, dc to 100 MHz.
See page 468. **$75**

P6122 — 10X, dc to 100 MHz.
See page 469. **$58**

PG 508

Independently Variable Rise Times and Fall Times to 5 ns

20 V Output in a ±20 V Window to Hi Impedance, 10 V into 50 Ω

Normal or Complement Output

The PG 508 is a highly versatile, general purpose 50 MHz pulse generator. The circuitry of the PG 508 is designed so that rise and fall waveforms closely simulate real world waveforms. This capability is particularly useful in research and development applications demanding versatility in rise times and fall times, such as testing of amplifiers, slew rate testing, comparator simulation and logic circuitry performance tests.

For example, controllable rise times and fall times are extremely desirable when working with CMOS where logic power consumption increases with slower rise times. Also, variable rise times and fall times are used to reduce ringing (transient distortion) problems associated with too fast a pulse.

The PG 508 features a vernier control on the rise times and fall times controllable from 100 to 1. This completely overlaps the next decade range and increases the PG 508's versatility in applications simulating different rise times and fall times, especially the output of nonlinear devices. This overlap feature can also be used to generate a ramp signal or simulate unequal slew rates in an amplifier.

Also adding to the simplicity of using the PG 508 is the capability of changing output amplitude while variable rise times and fall times remain constant.

ORDERING INFORMATION

PG 508 50 MHz Pulse Generator **$2,325**
Includes: Instruction manual (070-2044-01).

PG 508T 50 MHz Pulse Generator **$2,740**
Includes: PG 508, TM 503 Mainframe, and 016-0195-03 Blank Panel.

For counted burst order the
DD 501 Digital Delay (page 418) **$1,900**

Suggested 10 in BNC 50 Ω cable (2 required) for interconnecting PG 508 and DD 501
Order 012-0208-00 **$27**

To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext. 99

Manual (One-Shot) Trigger Generator

The Manual (one-shot) Trigger Generator is used for manually initiating a pulse or complete train of events with instruments that do not have a manual trigger button or where a remote operation capability is desired, such as with some oscilloscopes and the PG 501.

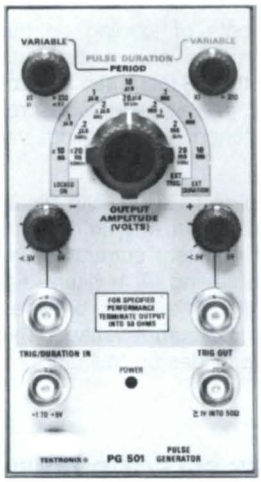
The internal trigger generator circuitry eliminates contact bounce, but will generate pulses as rapidly as the operator can manually cycle the pushbutton.

The output pulse is nominally 2 ms in width and 3 V in amplitude (from 50 Ω) with a rapid rise time and fall time.

ORDERING INFORMATION

Trigger Generator Order 016-0597-00 **$200**

PG 501



50 MHz Pulse Generator

PG 501

5 Hz to 50 MHz

Simultaneous Plus and Minus Outputs

5 V and 3.5 ns Into 50 Ω

Independent Period and Duration Controls

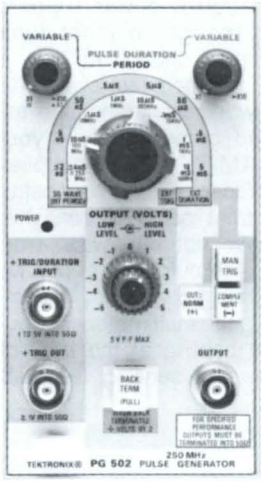
Trigger Out

The PG 501 is a 50 MHz Pulse Generator featuring simultaneous plus and minus outputs, a wide range of pulse-period durations and duty factors, trigger output and external trigger/duration input. Its performance and ease of operation make it well-suited to basic digital and analog applications.

ORDERING INFORMATION

PG 501 50 MHz Pulse Generator **$850**
Includes: Instruction manual (070-1361-01).

PG 502



250 MHz Pulse Generator

PG 502

10 Hz to 250 MHz

1 ns Rise Time

5 V Output ±5 V Window

Independent Pulse Top and Bottom Level Controls

Selectable Internal Reverse Termination

Manual Trigger Button

The PG 502 features fast rise times and fall times, independent top and bottom pulse levels, and adjustable pulse duration. The fast rep rate makes the instrument ideal for design and testing of fast logic and switching circuits.

ORDERING INFORMATION

PG 502 250 MHz Pulse Generator **$3,045**
Includes: Instruction manual (070-1598-01).

50 Ω Precision Coaxial Cable

For use with the PG 502, PG 506, and SG 503. These instruments are internally calibrated for use with this 3 ft 50 Ω coaxial cable into a 50 Ω load.

ORDERING INFORMATION

50 Ω Cable Order 012-0482-00 **$28**

PRODUCT SUMMARY

Design engineers require power supplies that are flexible enough to meet their needs . . . and compact enough to allow a complete, custom-designed test system to fit neatly on a crowded workbench. To assure versatility and convenience in your test system, the TM 500 power supplies can be rear interfaced with other instruments to reduce front panel clutter while providing capabilities not otherwise available. For example, the output level can be monitored via the rear interface by a companion TM 500 digital multimeter without the need for extra cabling at the front of the instrument. Remote sensing terminals available at the rear panel allow sensing of the applied voltage at the load, thereby minimizing the effects of loading on the supply. In addition, the plus and minus floating outputs of the PS 503A can be programmed remotely, by either voltage programming or resistance programming, via the rear interface.

The PS 501-1 supplies 0 to 20 volts (floating) and adjustable current limiting to 400 milliamps, with constant current operation above the limit setting. A multiturn dial with mechanical digital readout provides accurate setting of the output voltage. The fixed 5 volt supply provides up to 1 amp.

The PS 503A provides a floating dual −20 volt to 0 volt and 0 volt to +20 volt variable supply, plus the 5 volt 1 amp supply. The two variable supplies can be set individually and then varied in a tracked mode with a single control. By grounding one of the two outside terminals of the variable supply you can have a 0 volt to 40 volt supply with up to 1 amp of current when the PS 503A is operated in the high-power compartment of a TM 504, TM 506, RTM 506, or TM 5006. Full descriptions of the IEEE Standard 488 compatible PS 5004 and PS 5010 appear on pages 398 and 399.

POWER SUPPLIES SELECTION GUIDE

Application/Feature	PS 501-1		PS 503A		PS 5004	PS 5010	
Power Supplies	**0 to 20 V**	**+5 V**	**+ and −20 V**	**+5 V**	**0 to 20 V**	**+ and −32 V**	**Logic**
Floating	350 V (dc + peak ac)	Ground referenced	350 V (dc + peak ac)	Ground referenced	42 V (dc + peak ac)	150 V peak front panel, 42 V peak rear interface	Ground referenced
Voltage Range	0 to 20 V	5 V	0 to ±20 V	5 V	0 to 20 V	0 to ±32 V	4.5 to 5.5 V
Current Range							
High Power Compartment	40 mA to 400 mA	1 A	100 mA to 1 A	1 A	0 to 300 mA	50 mA to 0.760 A (1.6 A up to 15 V)	100 mA to 3.0 A
Standard Compartment			40 mA to 400 mA			50 mA to 400 mA (0.750 A up to 15 V)	
Voltage Mode							
Overall Accuracy (total effect)					±(0.01% +500 μV)	±(0.5% +20 mA)	±50 mV
Accuracy	0.5%						
Source Effect (line regulation)	5 mV	50 mV	5 mV	5 V ±0.25 V	0.005%	±(0.1% +2 mV)	1 mV
Load Effect (load regulation)	1 mV for a 400 mA change in load current	100 mA for 1 A change in load current	3 mV for 1A change in load current	100 mV for 1 A change in load current	500 μV for 300 mA change in load current	10 mV for 1 A change in load current 1 mV using remote sensing	
Temperature Coefficient	Typically <0.01%/°C		Typically <0.025%/°C		≤(30 ppm +100 μV/°C	Typically <(0.01% +0.1 mV)/°C	Typically <500 μV/°C
Resolution (step size)	1.6 mV		50 mV		500 μV	10 mV up to 10.0 V 100 mV above 10.1 V	10 mV
PARD (ripple and noise) (periodic and random deviations)	0.5 mV p-p 0.1 mV RMS	5 mV p-p	3 mV p-p	5 mV p-p	≤3 mV p-p	10 mV p-p 1 mV RMS	10 mV p-p 2 mV RMS
Current Mode							
Overall Accuracy (total effect)	Current limit		Current limit		Constant current 10 mA to 300 mA	Constant current ±(5% +20 mA)	Current limit with fold back ±(5% +20 mA)
Source Effect (line regulation)						1 mA	
Load Effect (load regulation)						10 mA	
Temperature Coefficient						Typically <(0.1% +1 mA)/°C	
Resolution (step size)					2.5 mA	50 mA	100 mA
PARD (ripple and noise)						10 mA p-p 5 mA RMS	
Display							
Voltage	10 turn potentiometer with a three digit in-line dial and range pushbutton	None	Voltage indicatory lights. Brightness varies with output voltage	None	Five digit LED	Each supply as three digit LED display shared between voltage and current	
Current	LED indicator	None	Current limit indicator lights	None			
Programmability	Voltage programming	None	Voltage and resistance programming	None	IEEE Standard 488-1978 (GPIB) full listen and talk capability with interrupt status reporting		
Tracking		None	Ratio	None	None	Arithmetic	None
Remote Sensing (rear interconnect)	✓		✓		✓	✓	
Output On/Off	✓		✓		✓	✓	
Mainframe Capability	TM 500/TM 5000		TM 500/TM 5000		TM 5000	TM 5000	
Page	423		423		398	399	
Prices Begin At	$710		$750		$1,850	$3,050	

For recommended accessories see page 489.

PS 501-1

Floating Output, 0 V to 20 V

0 mA to 400 mA

Precise Regulation

Low Ripple and Noise

Fixed Output + 5 V at 1 A

3½ Digit Ten-Turn Dial

The PS 501-1 features precise regulation and better than 2 mV resolution (setability) over a 0 V to 20 V range.

CHARACTERISTICS

Output — 0 V to 20 V dc.

Maximum Rated Current — 400 mA to +30°C derating to 300 mA at +50°C.

Accuracy — ±(0.5% + 10 mV).

Current Limit — <40 mA to 400 mA.

Line Regulation — Within 5 mV for a +10% line voltage change.

Load Regulation — Within 1 mV for a 400 mA load change.

Ripple and Noise — 0.5 mV p-p or less; 20 Hz to 5 MHz.

Temperature Coefficient — Typically <(0.01% +0.1 mV)/°C.

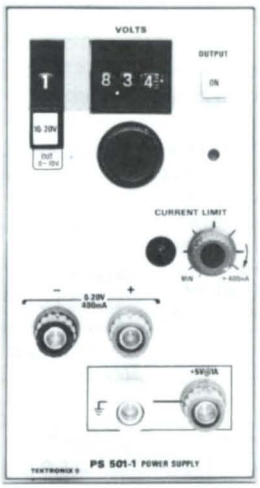
Minimum Resolution — Typically 1.6 mV.

Transient Recovery Time — ≤20 μs to recover within 20 mV of final output voltage after a 400 mA change in output current.

ORDERING INFORMATION

PS 501-1 Power Supply **$710**
Includes: Instruction manual (070-1301-02).

PS 501-1



Power Supply

PS 503A

Independent + and − Controls

Dual Tracking Voltage Control

0 V to ±20 V at 1 A (in High-Power Compartment)

Fixed Output + 5 V at 1 A

Remote Resistance Programming

Over-Voltage Protection Standard

The PS 503A features superior dual tracking performance, over-voltage protection, and remote resistance programming of voltage. When operated in the high-power compartment of a TM 504 or TM 506 mainframe, the PS 503A provides up to 1 A from both 0 V to 20 V supplies.

CHARACTERISTICS

±20 V FLOATING SUPPLIES

Outputs — 0 V to ±20 V dc with respect to the common terminal or 0 V to 40 V dc across the + and − terminals. Outputs can be varied independently or at a constant ratio.

Maximum Rated Current — 400 mA (1 A in high power compartment to +30°C derating to 300 mA (750 mA) at +50°C.

Tracking Mode Offset Error — If the two supplies are set independently to any given voltage ratio and then varied by use of the Volts Dual Tracking control, the two supplies will maintain the same voltage ratio as initially set within ±50 mV.

Current Limit — Adjustable from <100 mA to 1 A (high-power compartment) or <40 mA to 400 mA (standard compartment) on each supply.

Load Regulation — Within 3 mV for 1 A change (high-power compartment) or 1 mV for 400 mA change (standard compartment).

Ripple and Noise — 3 mV p-p or less at 1 A load (high-power compartment). 0.5 mV p-p or less at 400 mA load (standard compartment).

Indicators — Individual voltage indicators and current limiting indicators for both + and − supplies. Standard compartment (400 mA) indicator.

ORDERING INFORMATION

PS 503A Power Supply **$750**
Includes: Instruction manual (070-1834-01).

COMMON CHARACTERISTICS (PS 501-1, PS 503A) 20 V FLOATING SUPPLIES

Primary Power Input — Determined by mainframe (TM 501, TM 503, etc).

Output — Floating, isolated for 350 V dc + peak ac above ground.

Stability — Typically (0.1% +5 mV) or less drift in 8 hrs of constant line, load, and temperature.

Indicator Lights — Voltage variation and current limit.

+5 V GROUND-REFERENCED SUPPLY

Output — 5 V nominal, ±0.25 V at 1 A.

Load Regulation — Within 100 mV with a 1 A load change.

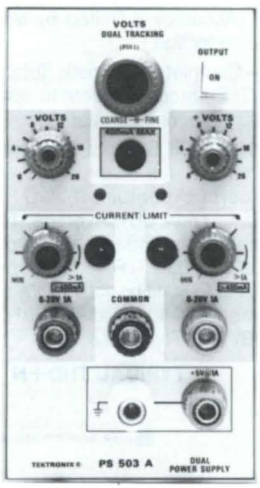
Line Regulation — Within 50 mV for a 10% line voltage change.

Ripple and Noise (1A) — 5 mV p-p or less, 20 Hz to 5 MHz.

Stability — Typically 30 mV or less drift in 8 hrs.

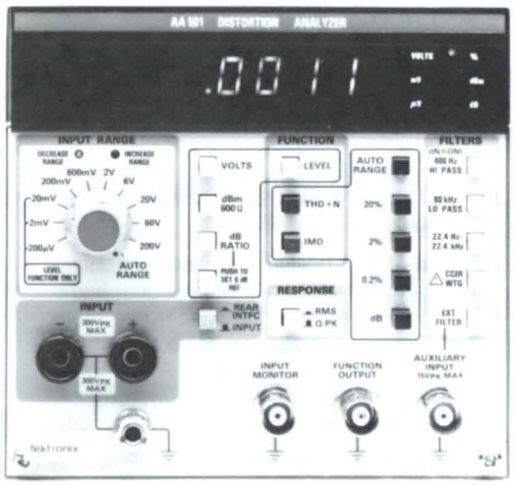
Overload Protection — Automatic current limiting and over-temperature shutdown.

PS 503A



Triple Power Supply

AA 501 Option 02



Distortion Analyzer

AA 501

Fully Automatic: No Level Setting, Tuning or Nulling

Level, Total Harmonic Distortion, and dB Ratio Measurements

Total System Harmonic Distortion Plus Noise (THD+N) <0.0025%

≤3.0 μV Residual Noise

Digital Readout Plus Analog-Like "Bar Graph" for Peaking and Nulling

IMD to SMPTE, DIN, and CCIF (Option 01)

The AA 501 Distortion Analyzer provides completely automatic measurement of level, total harmonic distortion plus noise (THD+N), and (with Option 01) Intermodulation Distortion. Automatic set level, automatic tuning, automatic nulling of the fundamental, and autoranging of the display all combine to permit completely hands-off operation once the mode is selected. Just apply the signal of interest and read the 3½-digit display. A novel analog-like bar graph simulates an analog meter to assist in peaking and nulling of applied signals.

With Option 01, intermodulation distortion measurements can be made to any of the three common standards: SMPTE, DIN, or CCIF. Internal circuitry automatically identifies the signal being used and selects the proper filtering circuits to perform the measurement.

DB ratio measurements can be referenced either to 774.6 millivolts (1 milliwatt in 600 ohms) or to a selected applied signal. The 0 dB reference memory remembers the selected level, and all subsequent measurements are referenced to that level.

To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext. 99

The AA 501 allows readings to be expressed in true RMS or average response, RMS calibrated. Although true RMS is more accurate in most applications, the average response permits comparisons with measurements previously taken with older instrumentation.

The fundamental frequency range is 10 Hz to 100 kHz, with harmonics measured out to 300 kHz.

Any one of four built-in frequency-weighting filters can be switched into the signal paths for preconditioning of the signal to be measured. Provision is also made to permit the use of a user-selected filter. A dc level, which is a function of the display readout, is available at the rear panel of the AA 501.

An Input Monitor connector and a Function Output connector are provided to permit oscilloscope display of the input signal or the result of the filter in the THD+N measurement.

The Option 02 version of the AA 501 is especially designed for use in accordance with CCIR recommendation 468-2 and DIN 45405 (typically used in Europe). In the Option 02 version, the 30 kHz filter and the "A" weighting filter of the standard unit are replaced by a 22.4-Hz-to-22.4-kHz filter and a CCIR-weighting filter, respectively, and the average responding detection circuit is replaced by a quasi-peak detection circuit. The Option 02 also contains the intermod measurement capability of the Option 01.

The AA 501 Distortion Analyzer and the SG 505 Oscillator were designed to be used together as the heart of a state-of-the art audio analysis system. Used together, the two provide total system harmonic distortion of 0.0025% or less.

It should be noted that the automatic frequency tuning of the AA 501 does not depend upon the manual tuning of a companion oscillator. The AA 501 will automatically tune itself to its input signal whether the signal originates from an SG 505 alongside it in a TM 500 mainframe, or from some other signal source miles away.

CHARACTERISTICS

The following characteristics are common to the standard AA 501, Option 01 and Option 02 unless otherwise noted:

HARMONIC DISTORTION FUNCTION

Fundamental Frequency Range — 10 Hz to 100 kHz automatically tuned to input frequency.

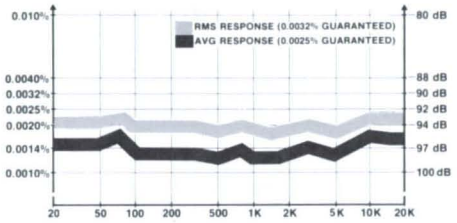
Distortion Ranges — Auto (100%), 20%, 2%, 0.2%, and dB (autoranging).

Accuracy (Readings ⩾4% of Range) — 20 Hz to 20 kHz ±1 dB, 10 Hz to 100 kHz +1, −3 dB. (Accuracy is limited by residual THD+N and filter selection.)

THD — Complete Automatic Total Harmonic Distortion (THD) measurements to specified accuracy in seven seconds or less.

AA 501/SG 505 System Residual THD+N — V_{in} ⩾250 mV, (all distortion, noise, and nulling error sources combined). 20 Hz to 20 kHz: ⩽0.0025% (−92 dB) Average Response with 80 kHz filter (standard and Option 01 only). ⩽0.0032% (−90 dB) RMS Response with 80 kHz filter. 10 Hz to 50 kHz: ⩽0.0071% (−83 dB) RMS Response. 50 kHz to 100 kHz: ⩽0.010% (−80 dB) RMS Response.

TYPICAL THD+N



Typical Fundamental Rejection — At least 10 dB below specified residual THD+N or actual signal THD, whichever is greater.

Minimum Input Level — 60 mV (−22 dBm).

NOISE (OPTION 02)

Noise measurements to CCIR recommendation 468-2 and DIN 45405. True RMS or quasi-peak response. Total system THD + N = 0.0032% (90 dB) RMS response. Balanced input.

LEVEL FUNCTION

Autoranging digital voltmeter displays input signal level in volts, dBm, or dB ratios.

Modes — Volts, dBm (600 Ω), or dB ratio with push to set 0 dB reference.

Level Ranges — 200 μV full scale to 200 V full scale in ten steps, manual or autoranging.

Accuracy*1

Frequency	Volts	dBm or dB Ratio
20 Hz to 20 kHz	±2%	±0.3 dB
10 Hz to 100 kHz*2	±4%	±0.5 dB

*1 V_{in} ⩾100 μV, level ranging indicators extinguished.
*2 On the 200 μV range, accuracy above 50 kHz is +4%, −6% (+0.5 dB, −0.7 dB).

Bandwidth — ⩾300 kHz.

Residual Noise — ⩽3.0 μV (−108 dBm) with 80 kHz and 400 Hz filters. ⩽1.5 μV (−114 dBm) with "A" weighting filter.

INTERMODULATION DISTORTION FUNCTION (OPTION 01/02)

Fully automatic SMPTE, DIN, and CCIF difference frequency test measurements.

SMPTE and DIN Tests — Lower Frequency Range: 50 Hz to 250 Hz. Upper Frequency Range: 3 kHz to 100 kHz. Level Ratio Range: 1:1 to 5:1 (lower:upper). Residual IMD: ⩽0.0025% (−92 dB) for 60 Hz and 7 kHz or 250 Hz and 8 kHz, 4:1 level ratio.

CCIF Difference Frequency — Frequency Range: 4 kHz to 100 kHz. Difference Frequency Range: 50 Hz to 1 kHz. Residual IMD: ⩽0.0018% (−95 dB) with 14 kHz and 15 kHz. Minimum Input Level: 60 mV (−22 dBm).

Accuracy — ±1 dB.

ALL FUNCTIONS

Detection — Average or true RMS for waveforms with crest factors ⩽3.

Filters

400 Hz High Pass: −3 dB at 400 Hz ±5%; at least −40 dB rejection at 60 Hz.
80 kHz Low Pass: −3 dB at 80 kHz ±5%.
30 kHz Low Pass: −3 dB at 30 kHz ±5% (standard and Option 01 only). "A" Weighting: Meets specifications for Type 1 sound level meters (ANSI S 1.4, IEC Recommendation 179) (standard and Option 01 only). Ext: Allows connection of external filters. 22.4 Hz to 22.4 kHz: −3 dB ±5% (Option 02 only). CCIR WTG: CCIR Recommendation 468-2 and DIN 45405, functional only with Q-PK detector (Option 02 only).

Input Impedance — 100 kΩ ±2%, each side to ground, fully differential.

Maximum Input — 300 V peak, 200 V RMS either side to ground or differentially. Fully protected on all ranges.

Common Mode Rejection — ⩾50 dB at 50 Hz or 60 Hz. Typically ⩾40 dB to 300 kHz.

FRONT PANEL SIGNALS

Input Monitor — Provides constant amplitude version of signal applied to input. Output Voltage: 1 V RMS ±10% for input signals >50 mV. Source Impedance: 1 kΩ ±5%.

Function Output — Provides a scaled sample of selected function signal (1000 count display = 1 V RMS ±3%). Source Impedance: 1 kΩ ±5%.

Auxiliary Input — Provides input to detector circuit when Ext Filter button is depressed. Sensitivity: 1 V RMS ±3% = 1000 count display. Impedance: 100 kΩ ±5%, ac coupled.

REAR INTERFACE SIGNALS

Rear INTFC Input — Front panel selected. Same as main Input except, maximum signal input is limited to 42 V peak, 30 V RMS. (Potential crosstalk at rear interface may degrade noise and distortion on performance).

Monitor — Same as front panel Input Monitor.

Function Output — Same as front panel Function Output.

Auxiliary Input — Same as front panel Auxiliary Input.

Converter Output — Dc output of selected response converter. 1 V ±5% for 1000 count display. Source Z: 500 Ω ±5%.

dB Output — Dc output of logarithmic dB converter. 10 mV ±5% per 1 dB of display. Source Z: 1 kΩ ±5%.

ORDERING INFORMATION

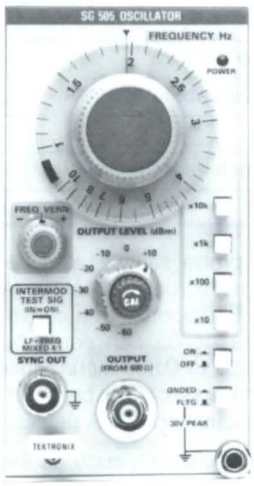
AA 501 Distortion Analyzer **$2,525**
Includes: Instruction manual (070-2958-00).

OPTIONS

Option 01 — Intermodulation Distortion. **+$750**
Option 02 — CCIR/DIN (Includes Option 01). **+$1,150**

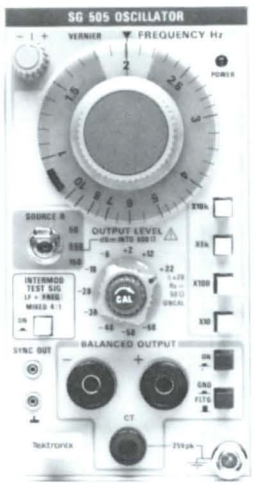
To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext. 99

SG 505 Option 01



Oscillator

SG 505 Option 02



Oscillator

SG 505/Option 01/Option 02

10 Hz to 100 kHz Sinewave Output

Ultra-Low Distortion: <0.0008% THD (Typically 0.0003%)

Floating or Grounded Output

600 Ω Source Impedance

Vernier Frequency Control

Fully Balanced Output (Option 02)

Uncalibrated Output to +28 dBm (Option 02)

Selectable Source Impedance (Option 02)

Intermodulation Test Signal (Option 01 & 02)

The SG 505 Oscillator generates an ultra-low distortion sinewave over the frequency range from 10 Hz to 100 kHz (<0.0008% THD, typically 0.0003% between 20 Hz and 20 kHz). In the standard and Option 01 units the output can be floated or referenced to chassis ground. In the Option 02 unit, the output is fully balanced and floating with a center tap which can be attached to system ground or to either side of the output signal. The oscillator also provides a fixed amplitude ground referenced sinewave at the Sync Out connector, that is identical in frequency to the signal from the Output connector.

Option 01 adds an intermodulation test signal function. This signal consists of a selectable 60 Hz or 250 Hz sinewave mixed with the selected frequency in a 4:1 amplitude ratio.

For communications and broadcast applications, Option 02 provides a fully balanced output of +22 dBm to −68 dBm calibrated, into 600 Ω. A ten-position output level control provides 10 dB/step calibrated attenuation. Uncalibrated outputs can range from +28 dBm (into 600 Ω from a 50 Ω source) to −78 dBm.

Option 02 has a front panel switch that allows the selection of three different source resistances: 50 Ω for low impedance applications (improves measurement accuracies on long cable runs and reduces loading effects), 150 Ω for matching microphone circuits, and 600 Ω for complying with audio/communication industry standard and general purpose applications.

Option 02 also includes the intermodulation test signal capability of the Option 01.

CHARACTERISTICS

MAIN OUTPUT

The following characteristics are common to the standard SG 505 and Option 01.

Frequency Range — 10 Hz to 100 kHz in four overlapping bands. Accurate within 3% of dual setting (with Vernier at center). Vernier Range is at least ±1% of frequency setting.

Calibrated Output — Selectable from +10 dBm to −60 dBm into 600 Ω in eight 10 dB steps. Accurate to within 0.2 dB at +10 dBm and 1 kHz. Step accuracy is ±0.1 dB/10 dB step. An uncalibrated control provides continuous variation from at least +2.2 dB to <−10 dB from calibrated positon.

Amplitude Response — Level flatness ±0.1 dB from 10 Hz to 20 kHz (1 kHz ref); within 0.2 dB from 20 kHz to 100 kHz (excluding >50 kHz on −60 dB output level range).

Harmonic Distortion — <0.0008% (−102 dB) THD from 20 Hz to 20 kHz (typically 0.0003%); 0.0018% (−95 dB) THD from 10 Hz to 20 Hz, and from 20 kHz to 50 kHz; 0.0032% (−90 dB) THD from 50 kHz to 100 kHz (R_L ≥600 Ω).

Output Impedance — 600 Ω ±2%; floating or grounded through ≈30 Ω. Output impedance does not change with Output On/Off selection. Maximum floating voltage ±30 V peak.

Maximum Output Voltage — At least 6 V RMS open circuit; 3.16 V RMS (+10 dBV or +12.2 dBm) into 600 Ω.

SYNC OUTPUT

Signal — 200 mV RMS ±20% sinewave to 20 kHz, at least 120 mV RMS at 100 kHz.

Frequency — Same as main output.

Impedance — Nominally 1 kΩ, ground referenced and isolated from main output.

REAR INTERFACE SIGNALS

Buffered Main Output — Buffered version of actual output signals from front panel connector. ≈300 Ω Output impedance.

Sync Output — Same as front panel Sync Output except output impedance is ≈50 Ω.

Option 01 IM Test Signal

Selecting the IM Test Signal causes a LF sinewave to be mixed with the normal oscillator signal in a 4:1 amplitude ratio.

LF Frequency — Internally selectable 60 Hz (±1 Hz) or 250 Hz (±3 Hz).

Main Output — Composite p-p output within 0.2 dB of normal oscillator mode output.

Residual IMD — Typically <0.0005% from 2.5 kHz to 10 kHz.

Sync Output — LF signal component only, 200 mV RMS ±20%.

Option 02 Oscillator

MAIN OUTPUT

Calibrated Output — Selectable from +22 dBm to −68 dBm into 600 Ω in ten 10 dB steps. Accurate to within 0.2 dB at +22 dBm and 1 kHz. Step accuracy is ±0.1 dB/10 dB step or 20 dB step change. An uncalibrated control provides continuous variation from <−10 dB to +0.3 dB from calibrated position.

Harmonic Distortion — <0.0008% (−102 dB) THD from 20 Hz to 20 kHz (typically 0.0003%); 0.0018% (−95 dB) THD from 10 Hz to 20 Hz, and from 20 kHz to 50 kHz; 0.0056% (−85 dB) THD from 50 kHz to 100 kHz (R_L ≥600 Ω).

Output Impedance — Selectable 600 Ω ±2%, 150 Ω ±2% or 50 Ω ±3% floating or grounded through ≈30 Ω. Output impedance does not change with Output On/Off selection. Impedance to CT is ½ the selected impedance. Maximum floating voltage ±25 V peak.

Maximum Output Voltage — At least 21 V RMS open circuit; 19.45 V RMS (+28 dBm) into 600 Ω from 50 Ω.

Balance — ≤0.5% mismatch of output open-circuit voltages referenced to CT for f ≤20 kHz with output grounded.

ORDERING INFORMATION

SG 505 Oscillator **$875**

Includes: Cable assembly for sync output (175-1178-00); instruction manual (070-2823-00).

OPTIONS

Option 01 — IM Test Signal. **+$220**

Option 02 — Oscillator (Includes Option 01). **+$715**

PRODUCT SUMMARY

The TM 500 Signal Conditioners offer unique capabilities for solving electrical measurement and analysis problems. Compact portability and plug-in flexibility allow complete lab instrumentation set-ups, within stringent space and budget limitations.

These versatile signal alteration devices are applicable to a broad range of measurement needs including: preamplification of low level signals, addition or removal of dc offset, integration, differentiation, or summing of multiple signals; impedance transformation; or amplification (to 80 V peak-to-peak).

The AM 503 is specifically designed to work with the A6302/A6303 Current Probes and incorporates a feature that limits the bandwidth to 5 MHz, to eliminate transients or noise. An illuminated knob skirt indicates calibrated current per division.

The A6302/AM 503 and A6303/AM 503 Current Probe Systems have a wide variety of applications from SCR and power supply measurements to medical applications. These probes use inductive coupling to minimize interference with the circuit under test.

The versatile AM 502 Differential Amplifier lets you control gain, dc offset and low-frequency and high-frequency response for maximum rejection of unwanted signals. Adjustable dc offset allows high amplification even when low-level signals have a dc component of up to 1 V. High performance features of the AM 502 are a dc to 1 MHz bandwidth and 100 dB common-mode rejection ratio.

The AM 501 Operational Amplifier's output power (±40 V and ±50 mA across 800 Ω loads) is more than adequate for most electronic and electro-mechanical applications. This high-output unit has front panel connectors that let you change configurations by selecting feedback components. The AM 501 is easily set up for differentiation, integration, summing and impedance transformation problems.

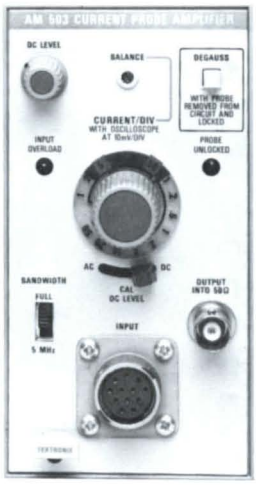
AM 503

Displays Current Signals on an Oscilloscope

Current Range, Maximum Current, and Bandwidth Determined by the Probe Used

The AM 503 Current Probe Amplifier allows display of current on any oscilloscope with 10 mV/div sensitivity, 50 Ω or 1 MΩ input, and (for performance to full bandwidth specifications) at least 75 MHz when using the A6302 or 50 MHz when using the A6303. The amplifier attenuator is calibrated in 12 steps with a 1-2-5 sequence, and the knob-skirt is illuminated to indicate current per division. The current range, maximum current rating, and bandwidth are determined by the particular probe in use. Bandwidth can be set to Full (where it is limited by the probe in use) or to 5 MHz. Coupling can be switch selected to ac or dc. Ac coupling offers a convenient means of measuring low-amplitude ac signals on a high-level dc current. A front-panel indicator warns of input current overload.

AM 503



Current Probe Amplifier

CHARACTERISTICS

The AM 503 characteristics when used with the A6302 or A6303 Current Probes.

Maximum Input Current — 20 A (dc + peak ac) for A6302. 100 A (dc + peak ac) for A6303.

Maximum Voltage for Current Under Test (Bare Conductor) — 500 V (dc + peak ac) for A6302. 700 V (dc + peak ac) for A6303.

Bandwidth (−3 dB) — Dc to at least 50 MHz with A6302. Dc to at least 15 MHz with A6303.

Rise Time (Full Bandwidth) — 7 ns or less with A6302. 23 ns or less with A6303.

Deflection Factor — 1 mA/div to 5 A/div for A6302. 20 mA/div to 50 A/div for A6303. In a 1-2-5 sequence for both probes.

Attenuator Accuracy — Within 3% of indicated Current/Div for both probes.

ORDERING INFORMATION

AM 503 Current Probe Amplifier **$1,125**
Includes: 50 Ω cable with BNC (012-0057-01); 50 Ω terminator (011-0049-01); instruction manual (070-2052-01).

A6303

A6303 Current Probe

Ac and Dc Current Measurements to 100 A

Dc to 15 MHz Bandwidth

Peak Pulse Measurements to 500 A

Ac or Dc Coupling

One Inch by 0.830 Inch Jaw Opening

One-Hand Operation

This clamp-around probe satisfies requirements for current measurements to 100 A from dc to 15 MHz. Equipped with a convenient pistol grip, the A6303 can easily be clamped to cables up to 0.830 inch. Other measurement parameters of the probe include: 100 A continuous and 500 A peak.

By combining an oscilloscope, such as the SC 504, with the A6303/AM 503 Current Probe Amplifier in a TM 500/TM 5000 mainframe you will have a convenient and compact high current amplification/measurement system.

ORDERING INFORMATION

A6303 Current Probe **$1,070**
Includes: Carrying case (016-0622-00); instruction manual (070-3906-01).

A6302 Current Probe

1 mA to 20 A Current Measurement Range

50 A Peak Pulse Measurements

Dc to 50 MHz Bandwidth

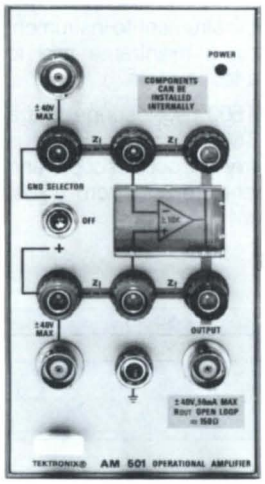
When a A6302 Current Probe is used with the AM 503 Current Probe Amplifier, the current range is from 1 mA to 20 A. Maximum current is 20 A (dc + peak ac). Peak pulse maximum is 50 A, not to exceed a product of 100 A μs. The probe operates through inductive coupling with no electrical contact. A flick of your forefinger operates the sliding jaw in the insulated probe tip. Just put the probe tip around the conductor under test for immediate current readings.

ORDERING INFORMATION

A6302 Current Probe **$565**
Includes: Five inch ground lead (175-0124-01); three inch ground lead (175-0263-01); two alligator clips (344-0046-00); instruction manual (070-3905-01).

To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext. 99

AM 501

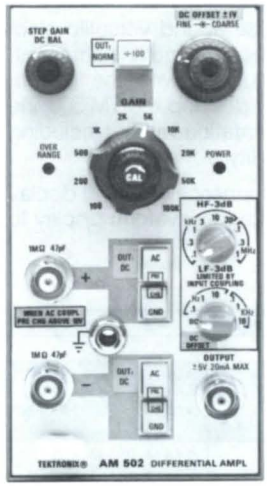


Operational Amplifier

AM 501 Accessory

Auxiliary Circuit Board Kit

AM 502



Differential Amplifier

AM 501

±40 V, 50 mA Output

Open Loop Gain 10,000

50 V/μs Slew Rate

Symmetrical Differential Design

The AM 501 Operational Amplifier features high input impedance (FET), high slew rate, a wide range of input and output voltage, and high output current. Applications include: amplification; impedance transformation; integration; differentiation and summing. It is well-suited as a post-amplifier or offset-generator for signal sources, including the TM 500 modules. Components can be added externally or internally making it ideal for teaching operational amplifier theory.

CHARACTERISTICS

AMPLIFIER

Open Loop Gain — At least 10,000 at 60 Hz into 800 Ω load.

Unity Gain Bandwidth — At least 5 MHz into 800 Ω load.

Common-Mode Rejection Ratio — Typically >20,000 to 1 at 60 Hz for common-mode signals up to ±40 V.

Slew Rate — At least 50 V/μs into an 800 Ω load.

INPUT

Input Bias Current — Typically <500 pA at 25°C, <2 nA at 50°C.

Drift — <100 μV/°C.

Noise — <10 μV RMS.

Maximum Differential Input Voltage — 80 V.

OUTPUT

Voltage Range — At least ±40 V into 2 kΩ.

Current Limit — At least ±50 mA.

Open Loop Output R — ≈150 Ω.

ORDERING INFORMATION

AM 501 Operational Amplifier **$830**

Includes: Instruction manual (070-1616-01).

The Auxiliary Circuit Board Kit attaches to the input and output terminal plugs on the front of the AM 501 Operational Amplifier. The kit is a pc board that has six terminal studs for attachment to the amplifier's banana jacks and is approximately 2.5 inches square. This permits the designer to build a circuit of resistors, capacitors, and other components for use in conjunction with the AM 501's input, output, or feedback circuits. With several boards, the AM 501 Op Amp circuit can be changed instantly in configuration from integrator to differentiator to amplifier, without interfering with the other connectors on the face of the AM 501.

ORDERING INFORMATION

Auxiliary Circuit Board Kit

Order 013-0146-00 **$27**

AM 502

1 to 100,000 Gain

100 dB CMRR

Selectable Upper and Lower −3 dB Points

Dc to 1 MHz Maximum Bandwith

Adjustable Dc Offset

The AM 502 Differential Amplifier features wide bandwidth, high CMRR, and selectable calibrated gain and filtering. Well-suited for general purpose or laboratory work, it can drive oscilloscopes, monitors, chart recorders, displays, or processing devices. In the unity gain mode, it can be used as a signal conditioner. Input dc offsetting to ±1 V is provided.

CHARACTERISTICS

AMPLIFIER

Gain — 100 to 100,000; 1-2-5 sequence; accurate within 2%. 1X gain obtained by 100X attenuation.

HF −3 dB POINT — Selectable in 9 steps (1-3 sequence) from 100 Hz to 1 MHz. Upper −3 dB point reduces to 500 kHz at 50 k gain; 250 kHz at 100 k gain.

LF −3 dB POINT — Selectable in 6 steps from 0.1 Hz to 10 kHz; ac coupling limits −3 dB point to 2 Hz or less.

Variable Dc Offset — At least ±1 V.

Common-Mode Rejection Ratio — Normal Mode: At least 100 dB, dc to 50 kHz. ÷100 Mode: At least 50 dB, dc to 50 kHz.

INPUT

Input Gate Current — ±100 pA for T ≤30°C.

Maximum Voltage Drift — 100 μV/°C referred to input Normal mode.

Maximum Noise — ≤25 μV or less (tangentially measured) referred to input Normal mode.

Maximum Input Voltage — Normal Mode Dc Coupled: 15 V (dc + peak ac). ÷100 Mode Dc Coupled: 350 V (dc + peak ac). Ac Coupled: 350 V (dc + peak ac) with coupling capacitor precharged.

Input R and C — 1 MΩ paralleled by ≈47 pF. Input impedance can be increased to a FET input via a simple internal jumper change.

OUTPUT

Maximum Output — ±5 V, ±20 mA, output resistance is 5 Ω or less.

Minimum Load Impedance — 250 Ω

Over Range — Front-panel lamp indicates most over-range conditions.

ORDERING INFORMATION

AM 502 Differential Amplifier **$1,400**

Includes: Instruction manual (070-1582-01).

Compatible accessories begin on page 464.

PRODUCT SUMMARY

The ubiquitous cathode-ray oscilloscope is the world's most useful and versatile electronics test and measurement instrument. Tektronix, long identified with the oscilloscope, could hardly develop the TM 500 line of modular instrumentation without including CRT display capability.

Four choices of performance level and display size are available to add waveform display to the digital measurement capability of the TM 500 digital multimeters and counters, ranging from the high-performance, dual-trace, 80 MHz SC 504 to the single-trace, single-width, 5 MHz SC 501. The 15 MHz SC 502 adds moderate dual-trace performance to the line, and the 10 MHz, dual-trace SC 503 adds CRT storage capability.

All of the oscilloscopes feature automatic triggering, and the SC 504, SC 503, and SC 502 also provide trigger view and variable trigger holdoff. All of the oscilloscopes have provisions to permit instrument-to-instrument rear interfacing within a mainframe and to external devices of a test system.

With a compact TM 500 oscilloscope and a multicompartment TM 500 mainframe, it is now possible to carry an oscilloscope and companion instruments to and from a test site in one convenient package.

OSCILLOSCOPE SELECTION GUIDE

Application/Feature	SC 504	SC 503	SC 502	SC 501
Number of Channels	2	2	2	1
Vertical Deflection: HF Bandwidth (upper −3dB point)	⩾80 MHz, 0°C to +35°C ⩾70 MHz, +35°C to +50°C	⩾10 MHz, 5 mV/div to 20 V/div ⩾ 7 MHz, 2 mV/div ⩾ 5 MHz, 1 mV/div	⩾15 MHz, 5 mV/div to 20 V/div ⩾10 MHz, 2 mV/div ⩾ 5 MHz, 1 mV/div	⩾5 MHz
Rise Time	⩽4.4 ns, 0°C to +35°C ⩽5.0 ns, +35°C to +50°C	⩽35 ns, 5 mV/div to 20 V/div	⩽23 ns, 5 mV/div to 20 V/div	
Typical Step Response Aberrations (signal limited to 5 major div)	±4%, first ns ±2%, >100 ns	±2%, ⩽3% p-p	±2%, ⩽3% p-p	
Ac Low Frequency Response (lower −3 dB point)	⩽10 Hz, with ac coupling; 1 Hz with 10 Hz probe			⩽2 Hz with ac coupling ⩽2 Hz with ac coupling
Deflection Factors: Calibrated	5 mV/div to 10 V/div in 11 steps in a 1-2-5 sequence	1 mV/div to 20 V/div in 4 steps in a 1-2-5 sequence		10 mV/div, 100 mV/div, 1 V/div
Variable Range	⩾2.5 to 1	⩾2.5 to 1	⩾2.5 to 1	⩾10 to 1
Accuracy (calibrated, +15°C, +35°C)	±2%, 0°C to +15°C, +35°C to +50°C ±3%, 0°C to +50°C	±3%, 5 mV/div to 20 V/div ±5%, 1 mV/div to 2 mV/div; Derate by 1%, 0°C to +15°C and +35°C to +50°C	±2%, 5 mV/div to 20 V/div ±5%, 1 mV/div to 2 mV/div	±3%
Display Modes	CH 1, CH 2, ALT, CHOP, CH 1 minus CH 2, CH 1 plus CH 2, X-Y, Trigger View. Chop Rate: ⩾250 kHz	CH 1, CH 2, ALT, CHOP, CH 1 minus CH 2, CH 1 plus CH 2, X-Y. Chop Rate: ⩾250 kHz	CH 1, CH 2, ALT, CHOP, CH 1 minus CH 2, Trigger View. Chop Rate: 250 kHz	Single Trace, X-Y (internal switch)
Input Coupling	Dc, gnd, ac, internal dc		Dc, gnd, ac	Ac or dc
Input R&C: Input Impedance	1 MΩ ±1% paralleled by ≈20pF	1 MΩ ±1% paralleled by ≈47 pF	1 MΩ ±1% paralleled by ≈47 pF	1 MΩ ±1% paralleled by ≈47 pF
Maximum Input Voltage	250 V (dc + peak ac), 500 V p-p ac at 1 kHz or less	350 V (dc + peak ac), 700 V p-p at 1 kHz or less. Above 1 kHz recommended p-p ac limit is 250 V to 10 kHz derating to 25 V above 100 kHz	350 V (dc + peak ac), 700 V p-p at ac 1 kHz or less	350 V (dc + peak ac)
CMRR (CH 1 minus CH 2)	At least 50:1 at 1 MHz when using same attenuator setting			
Position Range	⩾ ±6 div	⩾ ±6 div	⩾ ±6 div	
Delay Line	Permits viewing leading leading of displayed waveform			
Calibrator	0.6 V ±1%, ≈1 kHz frequency		0.6 V ±1%, ≈twice the power line frequency	
Channel Isolation		2% or less display related crosstalk to 10 MHz	2% or less display related crosstalk to 15 MHz	
Displayed Noise		⩽0.2 mV p-p at 1 mV/div		
Horizontal Deflection Sweep Generator: Calibrated Sweep Rates	0.2 s to 50 ns/div, 21 steps in a 1-2-5 sequence, plus an X10 mag for sweep rates of 5 ns/div	2 s to 0.5 μs/div, 21 steps in a 1-2-5 sequence, plus an X10 mag for sweep rates to 50 ns/div	0.5 s to 0.2 μs/div, 20 steps in a 1-2-5 sequence, plus an X10 mag for sweep rates to 20 ns/div	1 μs/div to 100 ms/div in decade steps
Uncalibrated (Variable) Range	Continuously variable between the calibrated rates, and extends the slowest rate to at least 0.5 s/div	Continuously variable between the calibrated rates, and extends the slowest rate to at least 5 s/div	Continuously variable between the calibrated rates, and extends the slowest rate to at least 1.25 s/div	Continuously variable between the calibrated rates, and extends the slowest rate to at least 1 s/div
Sweep Rate Accuracy (Derate accuracy by an additional 1% from 0°C to +15°C, +35°C to +50°C)	**+15°C to +35°C** / **X1** / **X10**	**+15°C to +35°C** / **X1** / **X10**	**+15°C to +35°C** / **X1** / **X10**	**+15°C to +35°C** / **X1**
	20 ms/div to 0.2 μs/div / ±2% / ±3%	2 s/div to 0.5 s/div / ±4% / ±5%	All sweep rates / ±3% / ±4%	All sweep rates / 5%
	0.2 s/div to 50 ms/div / ±3% / ±4%	0.2 s/div to 5 μs/div / ±3% / ±4%		
	0.1 μs/div to 50 ns/div / ±3% / ±4%	2 μs/div to 0.5 μs/div / ±4% / ±5%		
	Measured over center 8 div, excluding first 50 ns and all after the first 100 div of magnified sweep			
X-Y Mode: Bandwidth	Dc to at least 2 MHz	Dc to at least 500 kHz	Dc to at least 2 MHz	Dc to at least 100 kHz
Deflection Factor	Selected by CH 2 controls and horiz mag X1, X10 with 5% accuracy	Selected by CH 2 controls and horiz mag X1, X10	50 mV/div with 5% accuracy	
Phase Difference	3° at 50 kHz or less	3° at 50 kHz or less	3° at 50 kHz or less	
External Horizontal Amplifier: Input Impedance			1 MΩ with 2% paralleled by 47 pF	⩾100 kΩ paralleled by 25 pF
Maximum Input Voltage			350 V (dc + peak ac); 350 V p-p at 1 kHz or less	±3 V
Trigger: Trigger Modes	Auto, Norm, Sgl Swp	Auto (enhanced), Norm, Sgl Swp		
Enhanced Autotrigger	Automatically adjusts to spread the p-p signal over most of the range of the triggering level control. This provides more convenient triggering, especially on low amplitude signals			
Trigger Sources	CH 1, CH 2, Line, Ext, Int		CH 1, CH 2, Line, Ext	

Compatible accessories begin on page 464.

SC 504

80 MHz Oscilloscope

SC 504

80 MHz Bandwidth

5 mV/Div Maximum Sensitivity

5 ns/Div Maximum Calibrated Sweep Rate

Enhanced Automatic Triggering

True X-Y Capability

Switchable Rear Interface Capability

The SC 504 is a general purpose, dual-trace, nondelayed-sweep oscilloscope. It has a high writing speed with a maximum sensitivity of 5 mV/div and a maximum sweep rate of 5 ns/div (with magnifier). This oscilloscope features Add (CH 1 plus CH 2), differential (CH 1 minus CH 2), and "true" X-Y modes, and also includes rear interfacing capability (switchable CH 1, CH 2 and ext trig inputs). Enhanced autotriggering, trigger view, and variable trigger holdoff make this oscilloscope very versatile and easy to use.

ORDERING INFORMATION

SC 504 80 MHz Oscilloscope **$3,895**

Includes: Instruction manual (070-2296-00).

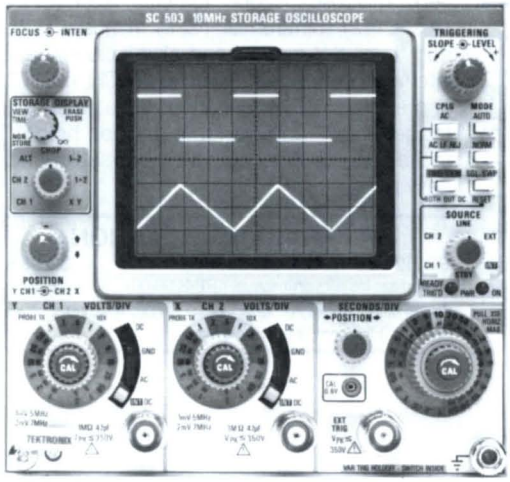
For Floating Measurements, order A6902A Isolator. See page 479 for complete description.

OSCILLOSCOPE SELECTION GUIDE

Application/Feature		SC 504		SC 503		SC 502		SC 501
Trigger Coupling		Dc, ac, ac LF Rej, ac HF Rej		Dc, ac, ac LF Rej				
Trigger Sensitivity (minimum p-p signal required)								
Coupling	**Source**	**Dc to 30 MHz**	**30 MHz to 80 MHz**	**Dc to 5 MHz**	**5 MHz to 10 MHz**	**Dc to 5 MHz**	**5 MHz to 15 MHz**	**Dc to 5 MHz**
Dc	CH 1, CH 2	0.4 div, 60 mV	1.0 div 150 mV	0.4 div	1.0 div	0.4 div	1.0 div	0.4 div
	External Interface	Typically 50 mV	Typically 100 mV to 50 MHz	Typically 35 mV to 60 mV	Typically 80 mV to 150 mV	60 mV	150 mV	5 V
Ac		Requirements increase below ≈50 kHz		Requirements increase below ≈50 Hz				
Ac LF Rej		Requirements increase below ≈10 kHz				Requirements increase below ≈5 kHz		
Ac HF Rej		Requirements increase below ≈50 kHz						
Triggering Level Range		External: ⩾1.4 V		External: ⩾1.2 V; Internal: ⩾−6.0 div		External: ⩾1.2 V; Internal: ⩾±8 div		
External Triggering Input: Input R and C		1 MΩ paralleled by ≈24 pF		1 MΩ paralleled by ≈47 pF				22 kΩ paralleled by ≈150 pF
Maximum Input Voltage		250 V (dc + peak ac); 250 V p-p at 1 kHz or less		350 V (dc + peak ac); 350 V p-p at 1 kHz or less. Above 1 kHz recommended p-p ac limit is 100 V to 10 kHz derating to 10 V above 100 kHz		350 V (dc + peak ac); 350 V p-p ac at 1 kHz or less		
Auto Mode		Sweep free runs without triggering signal. Trigger level range is reduced to ≈ the p-p range of the trigger signal						Sweep free runs without trigger signal or for trigger repetition rates below 10 Hz
Single Sweep		Triggering requirements are as for normal sweep. When triggered, sweep generator produces one sweep only				Triggering requirements are as for normal sweep. When triggered, sweep generator produces one sweep only. Auto push button must be in Out position for operation and for setting triggering controls.		
Trigger Holdoff		At least 20:1 range. The variable control is internally selectable between the Variable Sweep or Variable Holdoff functions.						
CRT: Phosphor		GH (P31)		GX (P44)		GH (P31)		GH (P31)
Deflection						Electrostatic		
Accelerating Potential		≈12 kV				≈12 kV		
Graticule		8x10 (0.25 in/div) internal graticule lines		8x10 (0.25 in/div) internal graticule lines		8x10 (0.25 in/div) internal graticule lines		6x10 div (.203 in/div) internal graticule lines
Rear Interface: CH 1 and CH 2 Vertical Inputs		Selected by CH 1 and CH 2 coupling in Int position. Input Impedance: 50 Ω Custom Modified Input Impedance: 1 MΩ paralleled by ≈60 pF		Selected by CH 1 and CH 2 coupling in Int position. Input Impedance: 50 Ω Custom Modified Input Impedance: 1 MΩ paralleled by ≈100 pF				
Trigger Input		Selected by Trigger Source switch in Int position. Input Impedance: 50 Ω when selected; 25 Ω when not selected. Custom Modified Input Impedance: 1 MΩ paralleled by ≈40 pF		Selected by Trigger Source switch in Int position. Input Impedance: 50 Ω when selected; 25 Ω when not selected. Custom Modified Input Impedance: 1 MΩ paralleled by ≈60 pF				
Z-Axis Input		Input Impedance: ≈1.5 kΩ ±5 V turns beam On from Off condition; −5 V turns beam Off from On condition						
CH 1 Output:		At least 50 mV/div		At least 50 mV/div				
Bandwidth		At least 30 MHz		At least 4 MHz				
Output Impedance		<50 Ω		50 Ω				
Ramp Output		0 V to +10 V ramp. Output Impedance: ≈500 Ω						
Page		429		430		430		430
Recommended Probes		P6101A, 1X; P6102A, 10X; P6062B, 1X/10X. See pages 468 and 470.						
Prices		$3,895		$4,095		$2,795		$1,790

Compatible accessories begin on page 464.

SC 503

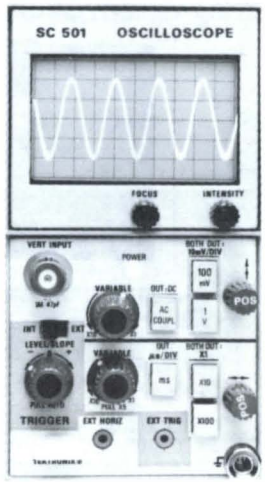


10 MHz Dual Trace Storage Oscilloscope

SC 502

15 MHz Dual Trace Oscilloscope

SC 501



5 MHz Oscilloscope

SC 503

10 MHz Bandwidth, Dual Trace

50 ns/Div Maximum Calibrated Sweep Rate

1 mV/Div Maximum Sensitivity

Bistable Storage Autoerase

Trigger View, Variable Trigger Holdoff

Switchable Front/Rear X and Y Inputs

Rear Z-Axis Input

True X-Y Capability

The SC 503 is a nondelayed sweep, general purpose storage oscilloscope that can be used to store and display waveforms after the input signal is removed.

Other important storage applications of the SC 503 include measurements of signals in computer peripherals, communication terminals and industrial control systems.

The SC 503 also features an autoerase mode that erases the stored signal and automatically retriggers the oscilloscope, and X-Y capability. The X-Y capability allows creation of Lissajous patterns in many cause and effect testing relationships including: acoustic speech testing, nerve potential testing, and optical stimulus response testing.

STORAGE SYSTEM

Stored Writing Speed (Center 6 x 8 Divisions) — At least 80 div/ms (50 cm/ms).

Erase Time — 400 ms to 600 ms.

Autoerase Viewing Time — Continuously variable from ≤0.5 s to ≥5 s.

Maximum Recommended Storage Time — ≈4 hrs.

ORDERING INFORMATION

SC 503 10 MHz Storage Oscilloscope **$4,095**
Includes: Instruction manual (070-3438-00).

SC 502

15 MHz Bandwidth, Dual Trace

20 ns/Div Maximum Calibrated Sweep Rate

1 mV/Div Maximum Sensitivity

Delay Line

Trigger View, Variable Trigger Holdoff

Enhanced Automatic Triggering

The SC 502 is a compact general-purpose 15 MHz dual-trace oscilloscope with high writing speed, a wide range of sweep rates, a wide range of deflection factors, and versatile triggering, including trigger view and enhanced automatic triggering. It is designed to operate in any two adjacent compartments of a TM 500 mainframe.

The SC 502 is intended to be a powerful tool in the field servicing of digital equipment. The CRT of the SC 502 offers a high writing speed as an advantage in the display of digital information, while stable, clean triggering is assured by incorporating well-proven circuits. Thus, the SC 502 offers a unique combination of performance, compactness, and systems capability.

The rear interfacing capability of the SC 502 and all TM 500 instrumentation suggests exceptional applicability to systems of built-in test equipment or rackmounted installations. The TM 515 Traveler mainframe with the SC 502, forms a nucleus for sophisticated, compact field service "packages."

ORDERING INFORMATION

SC 502 15 MHz Oscilloscope **$2,795**
Includes: Instruction manual (070-1878-01).

SC 501

5 MHz Bandwidth

Single Compartment Size

6.4 cm (2.5 in) CRT

Versatile Operating Features

The SC 501 is a single-channel, 5 MHz plug-in unit oscilloscope with a 2.5 inch CRT display that occupies a single TM 500 Series plug-in compartment.

Since the SC 501 fits any TM 500 or TM 5000 mainframe, it can be used on the bench, in a rack, or on the road.

Calibrated sweep rates are selected by push-button logic in decade steps from 1 μs/div to 100 ms/div. A variable control extends the slowest sweep rate to at least 1 s/div and a fixed magnifier extends the fastest sweep rate to 200 ns/div.

A 0 V to 10 V ramp for all sweep rates (excluding the X5 magnification) is provided at a rear interface connector.

The triggering circuits allow stable triggering from either internal or external sources. Autotriggering and manual Level/Slope selection are combined in a single control. It is useful above 10 Hz and provides a bright baseline at all sweep rates.

For X-Y operation an internal switch converts the horizontal deflection system of the SC 501 to an external horizontal amplifier which is internally calibrated for 100 mV/div deflection factor with a bandwidth of 100 kHz.

ORDERING INFORMATION

SC 501 5 MHz Oscilloscope **$1,790**
Includes: Instruction manual (070-1700-01).

Compatible accessories begin on page 464.

To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext. 99

PRODUCT SUMMARY

The CG 5001 is the computerized solution to large-scale scope calibration needs. The CG 5001 can be used as part of a computer-based system to calibrate and verify all major oscilloscope parameters, and is specifically designed for use where many oscilloscopes are maintained. Its programmability, combined with state-of-the-art performance, helps to minimize calibration lab labor while maximizing accuracy of verification checks.

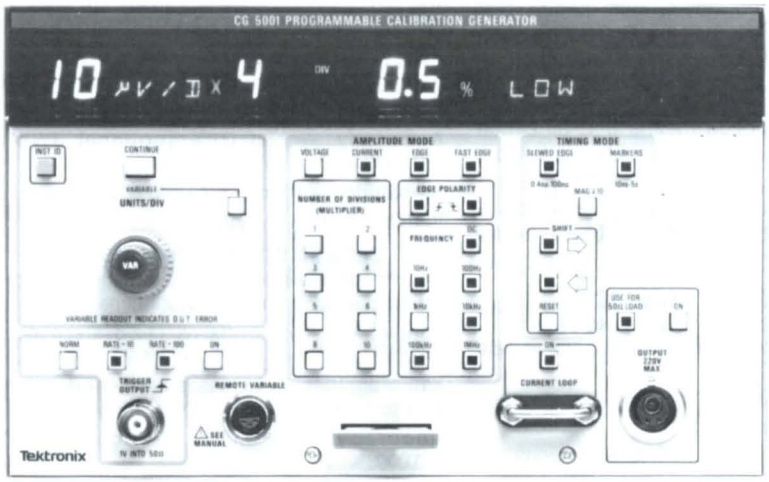
In addition to the CG 5001, TM 500 offers a complete set of calibration instruments that can be configured into a portable test set for in-field oscilloscope service and calibration. These TM 500 oscilloscope calibration instruments offer the widest range of standard amplitude squarewaves, fastest rise times, lowest aberrations, fastest time marks, and widest frequency range of leveled sinewaves available today.

The TG 501 Time Mark Generator provides crystal-controlled time marks from 5 s to 1 ns, plus a variable mode of operation that allows you to read the oscilloscope's timing error directly in percent from the digital display.

The PG 506 Calibration Generator provides clean, fast-rise squarewaves for checking oscilloscope transient response and calibrated-amplitude squarewaves for checking and setting the vertical amplifier gain of the oscilloscope. Like the TG 501, the PG 506 has a variable mode of operation that allows you to read the oscilloscope's calibration error directly in percent from its digital display.

The SG 503 and SG 504 generators provide leveled sinewaves for bandwidth checks (−3 dB points) and triggering performance checks. The SG 503 is a general-purpose leveled sinewave oscillator providing variable output from 250 kHz to 250 MHz. The SG 504 provides a leveled sinewave output that is variable from 245 MHz to 1050 MHz in two bands. The SG 502 Oscillator benefits calibration applications where verification of low frequency rolloff in ac modes and performance measurement of low-frequency-reject triggering modes is required.

CG 5001



Programmable Oscilloscope Calibration Generator

OSCILLOSCOPE CALIBRATION SELECTION GUIDE

Product	Primary Functions	Secondary Functions
CG 5001 Programmable Calibration Generator	Amplitude Calibration 40 µV to 200 V Time Base Calibration 0.4 ns to 5 s	Testing rise time and transient response, attenuator compensation, oscilloscope nonlinearity
PG 506 Calibration Generator	Amplitude Calibration 200 µV to 100 V	Testing rise time and transient response, attenuator compensation
TG 501 Time Mark Generator	Time Base Calibration 1 ns to 5 s	Testing oscilloscope nonlinearity
SG 503 Signal Generator	Bandwidth Calibration 250 kHz to 250 MHz	General leveled RF signal source
SG 504 Signal Generator	Bandwidth Calibration 245 MHz to 1050 MHz	General leveled RF signal source with frequency modulation capability

CG 5001

GPIB IEEE-488 The CG 5001 is designed to support other products which comply with IEEE Standard 488-1978.

The Tektronix CG 5001 Programmable Oscilloscope Calibration Generator is a microprocessor-based generator that can be used as part of a computerized system for the calibration and verification of major oscilloscope parameters, including:

- **Vertical Gain**
- **Horizontal Timing and Gain**
- **Vertical Bandwidth/Pulse Characteristics**
- **Probe Accuracy and Compensation**
- **Current Probe Accuracy**
- **Calibrator Output Accuracy**

The CG 5001's front panel features a wide range of functions, many of which represent a new state-of-the-art in calibration performance. All these functions are programmable by a controller via the GPIB (General Purpose Interface Bus). A "Learn" mode allows any manually-set function or range to be acquired by a controller. Subsequent use of the resulting program requires a minimum of operator skill and makes data logging an automatic operation.

This computer-assisted test and calibration system can provide step-by-step instructions to the operator, thus significantly reducing the skill level required.

Many of the calibration and test steps previously performed by the operator can now be transferred to a computer which executes them in a consistent and error-free manner. To calibrate a particular oscilloscope, the computer's program can send control-setting information to the CG 5001, which then sends the appropriate calibration signals to the oscilloscope. At the same time, a series of operator instructions can be placed on a terminal to automatically coordinate the operator with the calibration signals being sent from the CG 5001. The operator follows these instructions to make the necessary settings of the oscilloscope controls as the calibration or test procedure progresses. The CG 5001 returns error or deviation information to the controller, where it can be compared with preprogrammed reference values for the oscilloscope. A permanent record of the entire maintenance procedure can be stored by the controller and can be printed via peripherals such as a hard copy unit or line printer. Throughout the process, all calibration settings are determined by the computer's program. All front panel settings on the oscilloscope are specified in detail for the operator. Calculations of error percentages are performed automatically.

The CG 5001 is designed to greatly reduce your maintenance costs. Built-in self test routines and hardware check the operation of all major circuits each time the power is turned on.

Modular construction means that all circuit boards unplug (except the Main Interconnect) for easy exchange if service is required. A signature analysis mode is included to facilitate troubleshooting of the digital portion of the instrument.

CHARACTERISTICS

VOLTAGE (AMPLITUDE MODE)

The standard voltage is used to calibrate vertical display accuracy.

Range — 40 μV to 200 V (1-2-5 steps with multiplier).

Multipliers — 1, 2, 3, 4, 5, 6, 8, 10 divisions.

Polarity — Positive from ground.

Accuracy — +0.25% ±1 μV.

Frequency — 40 mV to 80 mV: 10 Hz to 100 kHz. 100 mV to 10 V: dc or 10 Hz to 100 kHz. 12 V to 200 V: dc or 10 Hz to 10 kHz.

Variable Range — ±9.9%.

CURRENT (AMPLITUDE MODE)

The standard current is used to calibrate current probes.

Range — 1 mA to 100 mA (1-2-5 sequence).

Multipliers — 1, 2, 3, 4, 5, 6, 8, 10.

Accuracy — ±0.25% ±2 μA.

Frequency — Dc or 10 Hz to 1 MHz (decade steps).

Droop — ≤1%.

Variable Range — ±9.9%.

LOW EDGE (AMPLITUDE MODE)

The Low Distortion Pulse obtained in this mode is used to test oscilloscope input amplifier and attenuator compensation.

Range — 20 mV to 1 V p-p (50 Ω load only) (1-2-5 steps with multipliers).

Multipliers — 1, 2, 3, 4, 5, 6, 8, 10.

Polarity — Positive or negative transitions to ground.

Rise Time (Fall Time) — ≤1.3 ns.

Abberrations — ±2%.

Long Term Flatness — ±0.5% after first 10 ns.

Frequency — 10 Hz to 1 MHz (decade steps).

Variable Amplitude Range — > ±9.9% from nominal.

HIGH EDGE (AMPLITUDE MODE)

The Low Distortion Pulse obtained in this mode is used to test oscilloscope input amplifier and attenuator compensation.

Range — 1.2 V to 100 V ≥1 MΩ load (1-2-5 steps with multipliers).

Polarity — Positive transition only (negative voltage to ground).

Rise Time — <100 ns.

Aberrations — ±2% of squarewave amplitude.

Long Term Flatness — ±0.5% after first 500 ns.

Frequency — 10 Hz to 100 kHz (decade steps).

Variable Amplitude Range — > ±9.9% from nominal.

MARKERS (TIMING MODE)

The markers obtained in this mode are used to calibrate oscilloscope time bases.

Range — 10 ns to 5 s (1-2-5 steps).

X10 Magnifier — Increase marker rate by a factor of ten (0.1 μs to 5 s range).

Accuracy — ±0.01% (optional TCXO ±0.0003%).

Amplitude — 1 V minimum into 50 Ω.

Variable Range — ±9.9%.

SLEWED EDGE (TIMING MODE)

Slewed Edges are used to calibrate the very fastest ranges found on oscilloscope time bases.

Range — 0.4 ns to 100 ns (1-2-5 steps plus 0.4 ns).

X10 Magnifier — Increases Slewed Edge rate by a factor of ten (5 ns to 100 ns range).

Accuracy — ±0.01% (Optional TCXO ±0.0003%).

Edge Position Uncertainty — ±40 ps.

Amplitude — >1 V into 50 Ω.

Variable Range — ±9.9%.

TRIGGER OUTPUT

The oscilloscope under test is normally triggered externally from this source.

Output Amplitude — 1 V minimum into 50 Ω.

Trigger Rate (Marker Mode) — Normal: Slaved to marker rate from 100 ns to 5 s; remains at 100 ns for faster markers. Divided by 10: Reduces normal trigger rate by a factor of ten. Divided by 100: Reduces normal trigger rate by a factor of one hundred.

Slewed Edge Mode — One trigger per slewed edge.

All Other Modes — Normal: Slaved to output frequency. Divided by 10: One-tenth output frequency. Divided by 100: One-hundredth output frequency.

TIMING REFERENCE OUTPUT
EXTERNAL TIMING REFERENCE

Input Frequency — Any integral multiple of 1 MHz up to 5 MHz.

Required Accuracy — ±0.001%.

Input Amplitude — 1 V to 10 V RMS.

Input Resistance — 10 kΩ (nominal).

ENVIRONMENTAL

Meets or exceeds MIL-T-28800B, Class 5 requirements.

Ambient Temperature — Operating: 0°C to +50°C. Nonoperating: −55°C to +75°C.

Altitude — Operating: 4500 m (15,000 ft). Nonoperating: 15 000 m (50,000 ft).

Vibration — Operating: Displacement (p-p), 0.015 inch. Vibration Frequency: 10 Hz to 55 Hz. Total time: 75 minutes.

Relative Humidity — 90% to 95% at +50°C for 5 days.

Shock — Nonoperating: 30 g's, ½ sine, 11 ms duration, three shocks in each direction along three major axes; total shocks, 18.

Bench Handling — Operating: 45° 4 inches or point of balance, whichever occurs first.

PHYSICAL CHARACTERISTICS*1

Dimensions	mm	in
Width	203	8.0
Height	124	4.9
Depth	305	12.0
Weight≈	**kg**	**lb**
Standard	3.9	8.5
Option 01	4.0	8.7

*1 Maximum Overall Dimensions (triple compartment plug-in).

PULSE HEAD (STANDARD ACCESSORY) FAST EDGE (AMPLITUDE MODE)

The Pulse Head is used to generate fast rise, low distortion pulses for testing higher bandwidth vertical amplifiers.

Polarity — Positive or negative transitions from ground.

Rise Time — ≤200 ps.

Aberrations — ±3% of pulse amplitude; not to exceed 4% p-p for adjacent peaks.

Frequency — 100 Hz to 100 kHz (decade steps).

Amplitude — 1.1 V peak ±5% into 50 Ω.

Variable Range — ±10%.

ORDERING INFORMATION

CG 5001 Programmable Calibration Generator **$14,995**

Includes: Output cable assembly (012-0884-00); pulse head (015-0311-01); instrument interface guide (070-4616-00); program CAL GEN (070-4768-00); instruction manual (070-4767-00).

CG 551AP Programmable Calibration Generator **$14,995**

OPTIONS

Option 01 — Adds High Accuracy Time Base (TCXO) CG 5001/CG 551AP. **+$650**

Option 02 — Deletes Pulse Head CG 5001/CG 551AP. **−$1,100**

Utility Software
For TM 5000/4041. Order 062-6958-01 **$150**
See page 359 for description and ordering information.

CONVERSION KIT

CG 551AP — Field Modification Kit to convert to CG 5001. Order 040-1041-02 **$175**

MAINFRAMES

CG 5001 requires either a TM 5003 or TM 5006. The CG 551AP is a TM 500 version of the CG 5001 and requires a TM 506 Mod JB, TM 515 Mod UB or RTM 506 Mod JB. The CG 5001 is not compatible with TM 500 power module mainframes.

OPTIONAL ACCESSORIES

Comparator Head — Used to calibrate built-in oscilloscope calibrators against the signals available from the CG 5001. Both the oscilloscope calibrator and CG 5001 standard amplitude signals are applied to the Comparator Head and simultaneously displayed on the oscilloscope CRT. The CG 5001 signals are then varied to obtain congruent displays. Errors are then displayed on the CG 5001 readout.
Order 015-0310-01 **$645**

Remote Variable — Permits remote operation of the following front panel controls: Units/Div, Variable-Fixed Button, Continue Pushbutton and the VAR. Order 015-0309-01 **$465**

Pulse Head — (When purchased separately.)
Order 015-0311-01 **$1,400**

Circuit Board Extenders —
(Rigid) Order 067-0975-00 **$110**
(Flexible) Order 067-0974-00 **$145**

To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext. 99

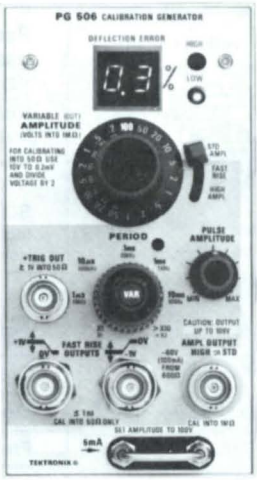
PG 506

Three Squarewave Output Modes

10 Hz to 1 MHz

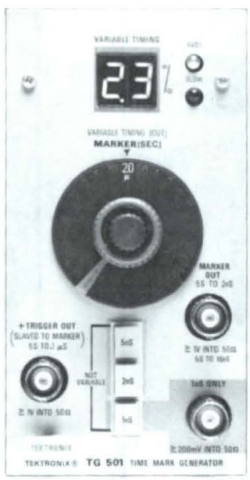
Direct Readout of Oscilloscope Deflection Error

PG 506



Calibration Generator

TG 501



Time Mark Generator

The PG 506 Calibration Generator provides three modes of squarewave output, selectable dc outputs, and a variable-amplitude output with front panel digital indication of oscilloscope deflection error. Simultaneous plus and minus low-level, fast-rise (1.0 ns) squarewaves or high amplitude (60 V), extremely clean squarewaves are available at frequencies from 10 Hz through 1 MHz for checking oscilloscope transient response. A 5 mA calibration current loop is useful for current probe calibration. A 1 kHz squarewave can be generated in the amplitude calibration mode. Its amplitude can be varied around the calibrated level until the squarewave aligns with the oscilloscope vertical graticule divisions. Scope deflection error then can be read directly off the PG 506 digital display in percentage high or low, permitting rapid verification of oscilloscope performance.

CHARACTERISTICS

AMPLITUDE CALIBRATOR MODE

Period — Fixed at ≈1 ms or dc.

Amplitude — From 200 μV p-p to 100 V p-p in 1-2-5 sequence, accurate within ±0.25% into 1 MΩ. 100 μV p-p to 5 V p-p into 50 Ω.

Error Readout — Range: ±7.5%. Resolution: 0.1%.

PULSE MODES

Period — 1 μs to 10 ms (within 5%) in decade steps with the variable control in Cal position. Variable extends period to at least 100 ms.

Symmetry — ≈50% duty cycle.

HIGH AMPLITUDE OUTPUT

Rise Time — Unterminated: 100 ns or less. Terminated into 50 Ω: 10 ns or less.

Amplitude Range — Unterminated: 6 V or less to at least 60 V. Terminated into 50 Ω: 0.5 V or less to at least 5 V.

Leading Edge Aberrations — Within 2% or 50 mV p-p, whichever is greater, when terminated into 50 Ω.

Polarity — Positive going from a negative potential to ground.

Output Resistance Source — 600 Ω within 5%.

FAST-RISE OUTPUTS

Rise Time (Terminated Into 50 Ω) — <1.0 ns.

Amplitude Range (Terminated Into 50 Ω) — 100 mV or less to at least 1.0 V.

Leading Edge Aberrations — Within 2% or 10 mV p-p, whichever is greater, during first 10 ns.

Flatness — Within 0.5% after first 10 ns.

Polarity — Simultaneous positive and negative-going. Positive-going is from a negative rest potential to ground. Negative-going is from a positive rest potential to ground.

Output Resistance Source — 50 Ω within 3% at + and − output connectors.

Trigger Output (Terminated into 50 Ω) — Positive-going signal of at least 1 V.

ORDERING INFORMATION

PG 506 Calibration Generator **$2,995**
Includes: Instruction manual (070-3383-00).

Tunnel Diode Pulser

The Tunnel Diode Pulser provides a clean, fast-rise pulse for adjusting the transient response of high-frequency oscilloscopes and other instruments. It can be driven by the PG 506 at repetition rates exceeding 50 Hz. Output amplitude of the pulse is approximately 250 mV into 50 Ω, while rise time is ≤125 ps; aberrations are <1% in a 1 GHz system.

ORDERING INFORMATION

Tunnel Diode Pulser Order 067-0681-01 **$210**

Precision Voltage Divider

Designed for use with the PG 506 in the Standard Amplitude mode, this 0.4 divider allows your oscilloscope to display a constant four divisions when checking amplitude calibration from 20 μV/div through 1 V/div. It also allows the PG 506 to be more conveniently used with oscilloscopes that cannot display five divisions of amplitude.

CHARACTERISTICS

Input Z — 50 Ω with output load ≥100 kΩ.

Maximum Input — ≤5 V RMS.

Output — 0.4 x PG 506 amplitude.

Voltage Accuracy — ±0.4%.

ORDERING INFORMATION

Precision Voltage Divider
Order 015-0265-00 **$180**

TG 501

Marker Outputs, 1 ns to 5 s

Direct Readout of Oscilloscope Timing Error

External Trigger Output

The TG 501 Time Mark Generator provides marker outputs from one nanosecond to five seconds. A unique feature on the TG 501 is a variable timing output with a front panel two-digit LED display. The display indicates percentage of timing error between the normal time interval and a variable interval that lines up the marker pulse with graticule or division mark on the display. This feature not only provides direct readout in terms of percent error, but also helps eliminate errors associated with visually estimating error from a display.

CHARACTERISTICS

Markers — 1 ns through 5 s in a 1-2-5 sequence.

Marker Amplitude — ≥1 V peak into 50 Ω on 5 s through 10 ns markers. ≥750 mV p-p into 50 Ω on 5 ns and 2 ns markers. ≥200 mV p-p into 50 Ω on 1 ns markers.

Trigger Output Signal — Slaved to marker output from 5 s through 100 ns. Remains at 100 ns for all faster markers.

Internal Time Base

Crystal Frequency	5 MHz
Stability (0°C to 50°C) after ½ hour	within 5 parts in 10^7
Long-Term Drift	1 part or less in 10^7 per month
Setability	adjustable to within 5 parts in 10^9

External Reference Input — Available with internal changes. Acceptable frequencies, 1 MHz, 5 MHz, or 10 MHz. Input amplitude must be TTL compatible.

Timing Error Readout Range — To ±7.5%.

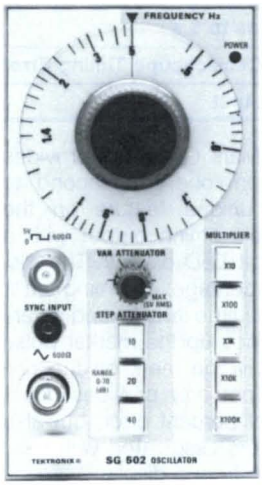
Timing Error Measurement Accuracy — Device under test error is indicated to within one least significant digit (to within one displayed count).

ORDERING INFORMATION

TG 501 Time Mark Generator **$2,620**
Includes: Instruction manual (070-1576-02).

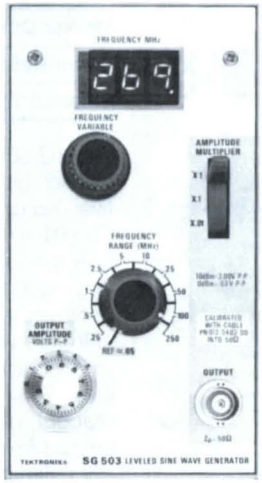
For additional accessories, see page 489.

SG 502



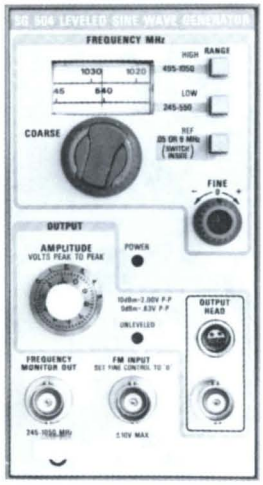
Oscillator

SG 503



Signal Generator

SG 504



Signal Generator

SG 502

5 Hz to 500 kHz Sinewaves and Squarewaves

Low Distortion Sinewave

5 V RMS Open Circuit—600 Ω Source

0 dB to 40 dB Output Variable Plus 0 dB to 70 dB in 10 dB Steps

The SG 502 Oscillator features a wide frequency range of 5 Hz to 500 kHz with low distortion (0.035% between 20 Hz and 50 kHz) and is desirable for general test purposes. Other SG 502 features include 70 dB amplitude control plus a simultaneous fixed amplitude squarewave.

CHARACTERISTICS

SINEWAVE

Frequency Range — 5 Hz to 500 kHz in 5 decade steps. Accurate within 5% of dial setting from 5 Hz to 50 kHz; within 10% of dial setting from 50 kHz to 500 kHz.

Amplitude Response (1 kHz Reference) — Flatness is 0.3 dB over entire range.

Attenuation — Selectable from 0 dB to 70 dB in 10 dB steps with push-buttons. Accurate within 0.2 dB for each step selected, additive. An uncalibrated control provides continuous variation from 0 dB to −40 dB.

Harmonic Distortion — <0.035% (−70 dB) from 20 Hz to 50 kHz. <0.15% from 50 kHz to 500 kHz ($R_L \geq 600\ \Omega$).

Maximum Output Voltage — 5 V RMS open circuit; 2.5 V RMS into 600 Ω.

Output Impedance — 600 Ω, grounded.

SQUAREWAVE

Frequency Range and Accuracy — Same as sinewave. The squarewave switches on the 0° phase of sine out.

Rise Time and Fall Time — 50 ns or less.

Amplitude — +5 V, fixed, open circuit.

Output Impedance — 600 Ω, grounded.

SYNC INPUT

Oscillator can be synchronized to external signal. Sync range, the difference between sync frequency and set frequency, is a linear function of sync voltage.

Input Impedance — 10 kΩ.

ORDERING INFORMATION

SG 502 Oscillator **$1,120**
Includes: Instruction manual (070-1430-01).

SG 503

250 kHz to 250 MHz

Leveled, Variable Output

Digital Readout of Frequency

The SG 503 Signal Generator provides a leveled output that is variable in frequency from 250 kHz to 250 MHz. The selected frequency is indicated by a built-in autoranging frequency counter with a three-digit LED read-out on the front panel. Accurately calibrated output voltage is variable from 5 mV to 5.5 V peak-to-peak into 50 Ω.

CHARACTERISTICS

Frequency Range — 250 kHz to 250 MHz, plus 50 kHz reference frequency.

Frequency Accuracy — Within ±0.7 of one count of the least significant digit of indicated frequency.

Amplitude Range — 5 mV to 5.5 V p-p into 50 Ω termination in three decade ranges.

Amplitude Accuracy (50 kHz Reference) — Within 3% of indicated amplitude on (X1) range, 4% on (X.1) range, and 5% on (X.01) range.

Flatness (P-P) — From 250 kHz to 100 MHz, output amplitude will not vary more than 1% of the value at 50 kHz except that up to +1.5%, −1% variation may occur between 50 MHz and 100 MHz on amplitude multiplier X.1 and X.01 ranges only. From 100 MHz to 250 MHz, amplitude variation is within 3% of the value at 50 kHz.

Harmonic Content — Second Harmonic: At least 35 dB down. Third Harmonic and All Higher Harmonics: At least 40 dB down.

Rear Card Edge Connection — Address the leveling circuit.

ORDERING INFORMATION

SG 503 Signal Generator **$2,400**
Includes: Three foot precision 50 Ω cable (012-0482-00); instruction manual (070-1622-01).

SG 504

245 MHz to 1050 MHz

Leveled, Variable Output

Frequency Modulation Capability

The SG 504 Signal Generator provides a leveled output amplitude that is variable from 245 MHz to 1050 MHz in two bands. Frequency is indicated by a high-resolution tape dial that expands each band over 28 inches. The accurately calibrated output voltage is variable from 0.5 V to at least 4.0 V p-p into 50 Ω.

CHARACTERISTICS

Frequency Range — Low Band: 245 MHz to 550 MHz. High Band: 495 MHz to 1050 MHz, plus 50 kHz or 6 MHz reference frequency (internally selected).

Frequency Accuracy — ±2% of dial indication.

Amplitude Range — 0.5 V to at least 4.0 V p-p.

Amplitude Accuracy (At Reference) — Within 3% of indicated amplitude.

Flatness — ±4% of amplitude at reference frequency.

Harmonic Content — Second Harmonic: At least 25 dB down. Third Harmonic and All Higher Harmonic: At least 40 dB down.

FM Input — Frequency Range: Dc to 100 kHz. Deviation Sensitivity: ±9 V produces from ±0.05% to ±0.5% deviation of carrier, depending on output frequency.

Frequency Monitor Output — ≥0.3 V p-p into a 50 Ω load from 245 MHz to 1050 MHz.

Rear Card Edge Connections — Address FM input, frequency monitor output, and amplitude control.

ORDERING INFORMATION

SG 504 Signal Generator (Includes Leveling Head) **$3,995**
Includes: Instruction manual (070-1632-01).

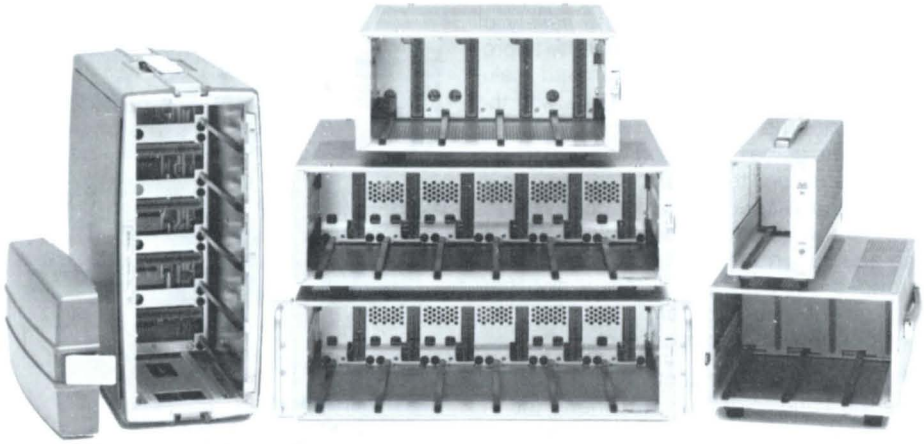
Replacement Leveling Head
Order 015-0282-00 **$515**

TRAINING

Tektronix offers service training classes on the TM 500 Calibration Systems Package. For further training information, contact your local Sales/Service Office or request a copy of the Customer Service Training Catalog on the return card in the back of this catalog.

For additional accessories, see page 487.

To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext. 99



Shown above are TM 515, TM 504, TM 506, RTM 506, TM 501 and TM 503 mainframes.

TM 500 mainframes and plug-ins allow the multifunctionality of a package of instruments. Hundreds of instrumentation packages for specific tasks can be configured.

The TM 500 plug-ins operate in any of six mainframes. One single-width plug-in instrument is accommodated by the TM 501. Up to six instruments can be accommodated in the TM 506 bench-top mainframe and the RTM 506 rackmount mainframe. Three and four-wide mainframes are also available and the five-wide Traveler Mainframe provides for applications that require portability.

Benchtop

Four benchtop mainframes are available. The TM 501 is the most compact. The TM 503 accommodates three single-wide plug-ins. The TM 504 and TM 506 each include a high-power compartment at the right-hand end to supply higher current levels to instruments that provide higher performance or higher output levels. The TM 506 incorporates a quiet fan for optimum cooling. All benchtop models have feet, tilt-bails, handles, front-panel power switches and operate from 110 V ac to 220 V ac.

Portability

All benchtop models have carry handles, sturdy cordwrap rear feet plus optional protective front covers to further enhance portable applications. The TM 515 Traveler Mainframe, designed for superior, multi-instrument portability, is a handsome piece of luggage with molded feet on the bottom and a comfortable, luggage-type handle. It is extremely moisture and dust resistant and designed to withstand the rigors of transport in car trunks and pickup trucks. The rear cover pops off to access the power cord, power switch and allow airflow for the built-in fan.

Rackmount

The RTM 506 rackmount mainframe is electrically identical to the TM 506. It features a slide assembly and handles, plus a higher-power fan to accommodate the higher ambient temperatures often found in enclosed racks and consoles. It is also possible to convert two TM 503's into a rackmount assembly with a kit. This kit has the advantage of requiring four inches less depth than the RTM 506 for space-critical applications, but lacks the fan and the high-power compartments. Other kits are available to rackmount a single TM 503 or a TM 503 with a monitor.

Rear Interface Capability

Most TM 500 plug-in modules contain a duplication of the front-panel input and output connections in the back. Some plug-in modules also have additional signal or control lines that are present only at the back of the instrument. These signals are available at the rear edge-card connector of each plug-in. Any module can be internally connected through the mainframe and also externally interfaced out the back panel.

The TM 515 traveler mainframe is available with the Option 05 interface, which includes everything in the Option 02 except the rear panel multi-pin connector, the mating cable connector, and the BNC connector.

Economy

Reduced cabling costs made possible by the rear-interface capability, and the reduced space requirements for a measurement system all contribute to unprecedented economy for test and measurement requirements.

CHARACTERISTICS

ENVIRONMENTAL

Temperature Range — Operating: 0°C to +50°C. Nonoperating: −55°C to +75°C.

Altitude Range — Operating: Sea level to 4600 m (15,000 ft). Nonoperating: Sea level to 15 000 m (50,000 ft).

POWER REQUIREMENTS

All of the mainframes have manually selectable taps on the power transformer which permit operation on 100 V, 110 V, 120 V, 200 V, 220 V, or 240 V ±10%.

Power Line Frequency Range — TM 501/TM 503: 48 Hz to 440 Hz. TM 504/TM 506/RTM 506/TM 515: 48 Hz to 66 Hz. TM 515 (Purchased with Option 06): Extends upper power line frequency range to 440 Hz.

Maximum Power Consumption — See table below.

ORDERING INFORMATION

TM 501 Power Module Mainframe **Includes:** Instruction manual (070-1304-01).	**$500**
Option 02 — Rear Interface.	**+$60**
TM 503 Power Module Mainframe **Includes:** Instruction manual (070-1305-01).	**$390**
Option 02 — Rear Interface.	**+$90**
TM 504 Power Module Mainframe **Includes:** Instruction manual (070-1716-01).	**$580**
Option 02 — Rear Interface.	**+$120**
TM 506 Power Module Mainframe **Includes:** Instruction manual (070-1786-02).	**$660**
Option 02 — Rear Interface.	**+$180**
RTM 506 Rackmount Power Module Mainframe **Includes:** Instruction manual (070-1786-02).	**$725**
Option 02 — Rear Interface.	**+$190**
TM 515 Power Module Mainframe **Includes:** Instruction manual (070-2020-02).	**$750**
Option 05 — Rear Interface.	**+$90**
Option 06 — 48 Hz to 440 Hz Fan.	**+$170**

OPTIONAL ACCESSORIES

Rear Interface Data Book —
Order 070-2088-04 **$12**

RECOMMENDED CARTS

K213 — Up to TM 504 width; can be used with or without an oscilloscope. See page 462. **$595**

K217 — Use with all TM 500/TM 5000 mainframes. See page 462. **$495**

206 — Table-like utility cart. See page 461. **$235**

PHYSICAL CHARACTERISTICS

	TM 501		TM 503		TM 504		TM 506		RTM 506		TM 515	
Dimensions	**mm**	**in**	**mm**	**in**	**mm**	**in**	**mm**	**in**	**mm**	**in**	**mm**	**in**
Width	99	3.9	221	8.7	305	12.0	442	17.4	483	19.0	381	15.0
Height	152	6.0	152	6.0	152	6.0	152	6.0	133	5.3	173	6.8
Depth	389	15.3	432	17.0	508	20.0	508	20.0	480	18.9	508	20.0
Weight≈*1	**kg**	**lb**	**kg**	**lb**	**kg**	**lb**	**kg**	**lb**	**kg**	**lb**	**kg**	**lb**
Net	2.4	5.4	4.3	9.5	8.4	18.5	13.2	29.0	14.4	32.0	10.2	22.5
Shipping	5.9	13.0	7.7	17.0	11.8	26.0	18.6	41.0	21.0	46.0	13.6	30.0
Max Power Consumption*2	85 VA		250 VA		460 VA		670 VA		670 VA		500 VA	

*1 *Without Plug-ins.*
*2 *Actual power consumption depends on plug-in selection and operating modes.*

MAINFRAME RACKMOUNT-TO-CABINET AND CABINET-TO-RACKMOUNT CONVERSION KITS

Cabinet-to-Rackmount Conversion Kit — Equipped with slide-out assembly, required to rackmount a single TM 503 in a standard rack width. This includes securing hardware and a blank front panel when only one instrument is used. Order 040-0617-02 **$375**

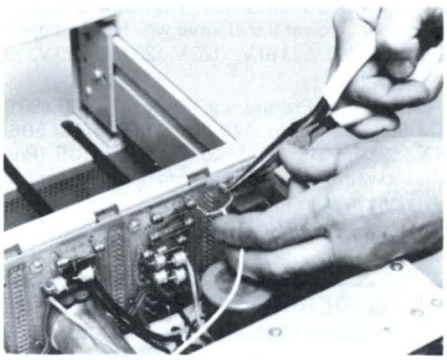
Cabinet-to-Rackmount Conversion Kit — Equipped with slide-out assembly, required to rackmount two TM 503's side-by-side in a standard rack width. Order 040-0616-02 **$205**

Rackmount-to-Cabinet Conversion Kit — Equipped to convert a rackmount TM 503 to a cabinet style. Order 040-0618-01 **$100**

Cabinet-to Rackmount Conversion Kit — Equipped with slide-out assembly, required to convert a TM 506 (cabinet style) to an RTM 506. Order 040-0761-04 **$295**

Rackmount-to-Cabinet Coversion Kit — Equipped to convert an RTM 506 to cabinet style TM 506. Order 040-0762-00. **$130**

Mainframe Rear Interface



TM 5000/TM 500 mainframes offer the unique ability to have separate modular instruments interconnected through the rear interface board of each mainframe. For example, the rear trigger output of a signal source can be interconnected to the rear input of a counter for instant frequency checks at the touch of a front-panel switch. Or, a digital multimeter and power supply can be interconnected to speed precise voltage setups without any need to move test leads. Any module can be internally connected through the mainframe and can also be externally interfaced out the back panel.

TM 5000/TM 500 plug-in modules contain a duplication of the front panel input and output connections in the back. These interface lines are built into the rear-edge circuit card connector of each plug-in. Some modules also have additional signal or control lines that are present only at the back of the instrument. In either case, different modules can be interconnected by the user to reduce front panel clutter or to perform functions not otherwise available.

Mainframes can be interfaced a variety of ways. A user can solder together the appropriate connector pins on a standard mainframe, or can order the mainframe with the Option 02. The Option 02 version of the mainframe comes equipped with square pin connectors on the rear interface circuit board and a special wire kit consisting of standard wires and coaxial cables with mating square pin receptacles. Option 02 also provides a rear-panel male connector, mating cable connectors, and one BNC connector per plug-in compartment.

The square pin connectors eliminate the need to hand-solder connections to the interface circuit board, extending the life of the mainframes. The remaining Option 02 components offer a variety of interfacing alternatives limited only by the user's ingenuity and imagination.

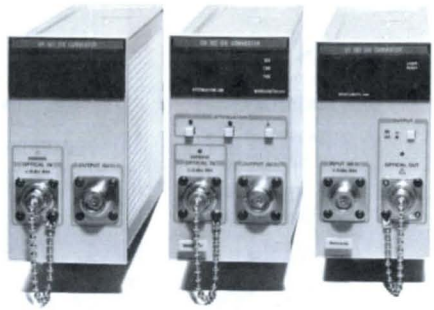
The TM 515 mainframe is available with an Option 05 interface that includes everything in the Option 02 except for the rear panel male connector, mating cable connector and the BNC connectors.

Tektronix has published a Rear Interface Data Book that contains information on the interfacing capability of each instrument "family." This book is available through Tektronix by filling out a card included in each mainframe package.

Tektronix also makes a low-cost "do-it-yourself" Rear Interface Modification Kit. It enables those who don't need the full flexibility of factory installed interface pins at every connector to install a limited rear interface on any TM 5000/TM 500 mainframe except the TM 501. The kit includes fourteen square pins, and three coaxial cables, all with female pin receptacles. Installation instructions also included. For "do-it-yourself" modification kit:

ORDERING INFORMATION

Mainframe Rear Interface
Order 040-0846-01 **$65**



Electrical/Optical
Optical/Electrical Converters

The OT501/502/503 Transmitters and OR501/502 Receivers are designed to transmit and receive signals across fiber. The receivers can be used to convert most instruments to optical instruments (e.g., the optical scope).

Designed as a TM 500 plug-in, they can be used in any TM 500 mainframe.

OT501/502/503 Transmitters

	OT501	OT502	OT503
Wavelength	825 ±15 nm	850 ±10 nm	1300 ±25 nm
FWHM*	<2 nm		<4 nm
Output Power, Dc	+3 dBm		0 dBm
Mod Input	50 Ω		
Mod Input Level Max with 100% Mod	+20 dBm <0 dBm		
Mod Freq Response	.03 to 1700 MHz		.03 to 1500 MHz
Mod Flatness	±1 dB (.05 to 1000 MHz)		
	±2 dB (.03 to 1700 MHz)		±5 dB (.03 to 1500 MHz)

OR501/502 Receivers

	OR501	OR502
Wavelength	700 to 1500 nm	
Photo Element	Ge-APD	
Max Linear Input	−20 dBm	+10 dBm
Frequency Response	.03 to 1500 MHz ±2 dB .05 to 1000 MHz ±1 dB	
Noise Floor	≤−110 dBm/Hz	
Output 50 Ω	−15 dBm typical for −20 dBm optical input	−12 dBm typical −20 dBm optical input
Optical Attenuator	N/A N/A	2.5 dB/step (Nom) 37.5 dB (Max)

** Full wave half maximum.*

ORDERING INFORMATION

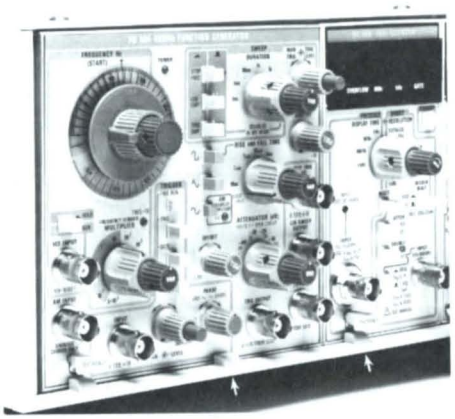
OT501 825 nm E/O Converter **$5,900**
OT502 850 nm E/O Converter **$5,900**
OT503 1300 nm E/O Converter **$9,500**
OR501 O/E Converter **$4,300**
OR502 O/E Converter **$6,500**

OPTIONS

Option 20 — AT&T Biconic Connector. **NC**
Option 21 — Diamond 3.5 Connector. **NC**
Option 22 — FC Connector. **NC**

To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext. 99

Mainframe Retainer Bar



The mainframe retainer bar modification kit comes complete with the retainer bar, all necessary parts and instructions.

You can modify the TM 504 or RTM 506/TM 506 mainframe; each has a separate kit. Initial installation requires replacement of an existing bottom member of the mainframe with a new part supplied in the kit. Then, the retainer bar can be simply added or removed with four screws accessible from the bottom of the mainframe.

ORDERING INFORMATION

TM 504 Mainframe Retainer Bar Kit. Order 020-0548-00 **$55**

TM 506/RTM 506 Mainframe Retainer Bar Kit. Order 020-0549-00 **$60**

Protective Front Cover

A snap-on front cover, molded of high impact plastic, is available for the TM 503 (shown above), TM 504, and TM 506 mainframes. The cover adds 45 mm (1.75 in) to the length of the TM 503, TM 504, and TM 506 mainframes, and clears the longest knob projections on any of the instruments.

ORDERING INFORMATION

TM 503 Front Panel Cover. Order 200-1566-00 **$22**

TM 504 Front Panel Cover. Order 200-1727-00 **$19.75**

TM 506 Front Panel Cover. Order 200-1728-00 **$20**

Accessory Pouch

While the TM 501, TM 503, TM 504, and TM 506 TM 5003/TM 5006 mainframes were designed primarily for bench use, they are frequently carried away for service elsewhere. Taking along the probes, cables, terminators, and other accessories usually required can then be a problem. The soft vinyl accessory pouch neatly solves this problem. Sturdy snap-around straps let the pouch be secured to the carrying handle of any TM 5000/TM 500 mainframe or Tektronix oscilloscope, or the straps can be snapped together to form a carrying handle for the pouch to be used independently. A convenient side zipper lets accessory items be removed or stored without removing the pouch from the mainframe handle. Dimensions ≈9¼ in long x 5¾ in wide x 2 in high.

ORDERING INFORMATION

Accessory Pouch. Order 016-0351-00 **$31**

1105 Battery Power Supply

TM 500 instruments in their mainframes can be operated with the 1105 Battery Power Supply when suitable ac line power is not available. The 1105 is rugged and portable, operating on internal batteries or an external dc source. Operating time is dependent on the number and type of plug-ins being powered, and their operating mode. The following table shows estimated operating time for a full mainframe in a typical situation.

TM 501	5.0 hours
TM 503	1.6 hours
TM 504	1.3 hours
TM 506	0.9 hours
TM 515	1 hour

ORDERING INFORMATION

1105 Battery Pack **$1,690**

Option 01 — 230 V Operation **NC**

TM 500 Carrying Case

These luggage-type carrying cases for TM 500 equipment are molded of high strength glass-epoxy. The TM 503 model weighs 12 pounds empty and measures 23½ inches long by 8½ inches thick by 15 3½ inches high, including rubber feet, lockable latches, and handle. Inside, the resilient polyurethane foam is molded to accept a TM 503 (with or without the protective front cover) plus either a spare TM 500 module or a 200 Series miniscope. A third compartment in the foam accepts miscellaneous cables, accessories, or small tools.

The TM 504 case has a molded foam insert that will accept the TM 504 (with or without the protective front cover) but has no provisions for spare modules or tools. It is 610 mm long x 216 mm thick x 445 mm high, (24 in long by 8.5 in thick by 17.5 in high) and weighs ≈ 14 pounds empty.

ORDERING INFORMATION

TM 503 Carrying Case. Order 016-0565-00 **$465**

TM 504 Carrying Case. Order 016-0608-00 **$515**

TM 515 Carrying Case. Order 016-0643-00 **$580**

Rain Covers

These soft, weather-proof, vinyl-coated Rain Covers come in sizes for TM 503 and TM 504 instrumentation packages and include adequate space for protective front covers. They feature heavy-duty zippers that open from either end, and include their own carrying handles, offset to compensate for the off-center balancing point of TM 500 instrumentation packages. The color is Tek blue.

ORDERING INFORMATION

TM 504 Rain Cover. Order 016-0621-00 **$45**

TM 503 Rain Cover. Order 016-0620-00 **$35**

K213

K213 shown with 436-0132-01 optional shelf.

This Lab Cart is especially designed for a rollabout configuration combining TM 5000/TM 500 Instrumentation with the Tektronix oscilloscope of your choice. It features pistol-grip tilt control and a large accessory drawer in the base. The top tray and shelves accept all TM 5000/TM 500 Series mainframes which are up to four plug-in modules wide, or any Tektronix 7000 Series, 5000 Series, or portable oscilloscope. The K213 comes standard with one lower shelf. Additional shelves are available as optional accessories. The power distribution module on the rear underside of the top tray provides four power outlets and a 15 foot line cord.

See page 462 for additional information.

ORDERING INFORMATION

K213 Lab Instrument Cart **$595**

OPTIONS

Option 05 — Delete Power Strip. **NC**

Option 10 — 7854 keyboard drawer. **+$180**

Option 12 — 5000/7000 Series plug-in storage cabinet. **+$120**

Option 22 — Combines Options 10 and 12. **+$285**

Additional Lower Shelf — Order 436-0132-01 **$55**

Safety Belt to secure oscilloscopes or TM 5000/TM 500 to top tray or lower shelves (not needed for 5000 Series or 7000 Series on top tray). Order 346-0136-01 **$31**

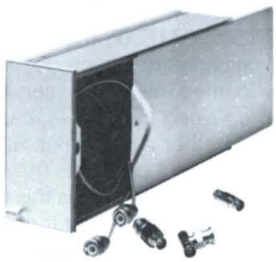
TM 5000/TM 500 Blank Plug-In Panel

When operating TM 5000/TM 500 instruments with less than the full complement of plug-ins, the blank plug-in panel can be used to cover unused compartments.

ORDERING INFORMATION

Blank Plug-In Panel Order 016-0195-03 **$32**

Plug-In Storage Compartment

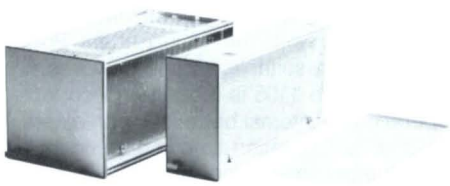


Electronic engineers or technicians away from their bench seldom have enough storage space for probes, cables, "tees," accessories, and small tools. The plug-in storage compartment is a useful adjunct to many rollabout and Travel Lab configurations. If all five compartments in your TM 515 Traveler mainframe are not used for a particular field application, add a plug-in storage compartment for extra convenience. Even a rack-mount TM 500 installation might profit by readily-available terminators or attenuators in a presently unused compartment. Compatible with all TM 500 mainframes and 5000 Series oscilloscope mainframes; inside dimensions 250 mm L x 51 mm W x 106 mm H (9⅞ in L x 2 in W x 4¼ in H).

ORDERING INFORMATION

Plug-In Storage Compartment
Order 016-0362-01 **$155**

TM 500 Custom Plug-In Kits



Single and Double Compartment Sizes
A complete test and measurement set-up for many typical jobs requires at least one non-standard item. Such items commonly include relay circuits or manual switches for routing signals; test oscillators at pre-set frequencies for alignment purposes and markers; digital logic circuits for sequencing, timing, and control; special processors or converters such as log amps, multipliers, and analog-to-digital converters; and a variety of other system elements which are usually not available or economical as complete commercial instruments. The construction and packaging of these special items is always a problem, and the sheet metal work and provision for necessary power supplies often far exceeds the cost of the functional elements. This is why the TM 500 line includes custom plug-in kits. The kits provide perforated main circuit boards that allow rapid construction and wiring of circuits using both discrete components and integrated circuits. Also included are top and bottom rails, side cover, front sub-panel, and a blank dress panel, and the latch mechanism. An instruction sheet details the voltages and currents available in the power module. Standard voltage regulator ICs can be used to provide exact voltages for most individual power supply requirements. The finished special-purpose circuitry or instrument is physically compatible with other TM 500 instrumentation.

Single Compartment With Power Supply
A blank plug-in kit complete with power supply parts and circuit board layout is now available. A single-wide compartment, this plug-in kit saves set up and build time as the power supply circuitry is designed and kitted for you.

Specifically, the supplies parts are:

(1) A ground-referenced positive supply, capable of +7 V to +20 V at up to 400 mA. (Adjustment is centered at 15 V; change of resistor values required for total 7 V to 20 V range).

(2) A ground-referenced negative supply, identical to supply No. 1 except for polarity.

(3) A ground-referenced supply nominally 5 V, not adjustable, with current capability up to 1 ampere.

A series of TM 500 construction notes provide direction for building custom circuits using the TM 500 Blank Plug-in Kits and standard components. Among the construction notes available are: Suggested Power Supply Circuits and Thermal True RMS Converter.

ORDERING INFORMATION

Custom Plug-In Kits —
(Single Compartment with Power Supply) Order 040-0803-02 **$130**
(Single Compartment) Order 040-0652-05 **$115**
(Double Compartment) Order 040-0754-07 **$170**
(Single Compartment Without ECB) Order 040-0821-03 **$70**

To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext. 99

ACCESSORIES

CAMERAS

A camera can be a key part of your measurement system to document and communicate your results with clarity and credibility.

CARTS

Tek carts provide the quality and versatility for many test instruments. They integrate easily into your system and can free up valuable table space or easily transport instruments between sites.

THE ABCs OF PROBES

This comprehensive booklet on signal acquisition probes contains sections on understanding probe specifications and applications and sections on how to select the best probe for your application. Easy to use charts and tables speed the selection process.

For your free copy, ask your Tektronix Sales Engineer for Literature 60-W-6053 or call toll-free in the USA 1-800-426-2200. In Oregon, call collect (503) 627-9000.

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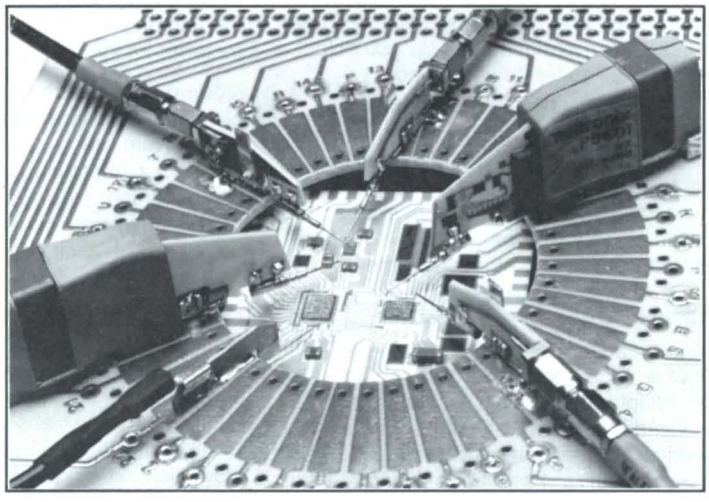

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C-59A 453
HC01, HC02, HC100 454

A camera can be a key part of your measurement system. It allows you to capture single events and document your results, and it helps you communicate your results with clarity and credibility. The following pages give information to help you select a camera well suited to your needs.

MOUNTING ADAPTORS

The table on page 442 indicates the camera adaptors required for most Tektronix instruments and a few by other manufacturers. In some cases, adaptors are available from Hewlett-Packard or others to mount Tektronix cameras to their instruments.

VIEWING

The C-30 Series and the C-50 Series are hinge mounted and can be swung aside to allow a wide-angle view of the CRT. The light-weight C-5C and C-7 can easily be removed to view the CRT or you can use the viewing door in the flash unit. C-5Cs and C-7s without a flash have a large lift-up viewing door in its place. The C-50 Series cameras have an off-axis viewing hood that can accommodate eyeglasses for a comfortable binocular view of the CRT display while excluding ambient light.

GRATICULE LIGHTING

Most scopes have graticule illumination. For those that do not, an image of the graticule may be obtained by using the flash on the C-5C or C-7 Cameras, or a storage scope's background illumination (flood guns).

LENSES

Tektronix camera lenses differ mainly in speed (light gathering ability), field of view and magnification.

Speed

The f-number of a lens inversely signifies its aperture area and light gathering ability. For example: the aperture area of an f/1.4 lens is four times that of an f/2.8 lens of the same magnification and gathers four times the light. The relative light gathering ability of all lenses used in Tektronix cameras is referenced to the f/1.9, 0.85 magnification lens which is arbitrarily rated at 1.0. For recording a stored or stable recurrent CRT display, a lens as slow as the f/16 type used in the C-5C and the C-7 Cameras is adequate. However, to record a fast, dim, single-sweep trace, you may need a lens as fast as the f/1.2 types used in the C-31B and C-51 Cameras.

Field of View

The description for each camera includes a statement of its field of view; this signifies how large a CRT display the camera can fully record. It is determined by the combined effects of the magnification and angular field of view of the lens, any field-limiting apertures in the camera adaptor, camera body, film holder, and the image area of the film. (See "Maximum Magnification" chart on this page.)

Magnification

The rated magnification of a lens signifies its image-to-object ratio. For example, if a lens has a magnification of 0.85 then for every square centimeter on the CRT face the camera would record 0.85 square centimeter of image on the film.

Modern optical technology has made possible wide-aperture, wide-angle, flat-field lenses with short focal length for more compact cameras. To realize their inherent low distortion, high resolution, and uniform focus, these fixed focal length lenses must be used at their design center magnification.

Operating such lenses at a different magnification tends to compromise their important performance characteristics. For this reason, most Tektronix cameras are designed for use at one lens magnification. One exception is the C-30B Camera which has a magnification range of 0.7 to 1.5 (at some increase in distortion at the magnification extremes) to accommodate several portable oscilloscopes that have displays ranging in size from 3.8 cm x 6.3 cm to 8 cm x 10 cm.

For maximum resolution, the lens should produce the largest complete image possible within the image area of the film. The film most widely used for oscilloscope trace recording is Polaroid Type 667 pack film which has an image area of 73 mm x 95 mm. In most cases, the magnification is selected to provide the largest possible complete image of a particular display. An exception is in high writing speed applications where a 0.5 magnification lens is usually used to achieve higher writing speed by concentrating the trace light in a smaller area of the film. See chart below.

SHUTTERS

Of the two available types of shutters, mechanical shutters are simple to operate and are economical. They are actuated by pressure on a release mechanism. Electrical shutters permit remote, automatic, or manual release and offer higher reliability. They may be actuated by an insulated switch closure.

POWER REQUIREMENTS

C-5C

The C-5C uses four AA alkaline batteries.

C-7

There are three choices of power available: battery pack utilizing eight AA alkaline batteries; ac power supply; or external remote power.

C-50 Series

The C-51 and C-53 electric shutters require +15 volts, normally supplied by a 7000 Series oscilloscope. An optional battery pack (016-0270-02) is available for situations where one of these cameras is used on a non-7000 Series instrument. These shutters can be actuated by a switch closure to ground. The C-59A has internal batteries or uses power from the 7000 Series mainframe.

FILMS

Polaroid films are the most convenient to use. They offer the advantages of development in seconds to a finished dry print with wide spectral response, good resolution, and high sensitivity. ASA ratings do not necessarily give a true indication of how a film will respond in CRT recording due to the narrow spectral output range of most phosphors and different spectral sensitivity of various film types. See table on page 441 for listing of Polaroid films. Wet process, roll, or cut films can be used if the proper back is selected. (See the respective camera for optional backs.)

Selected Polaroid films are available through Tek. See page 441. For specs and ordering information, see page 444.

Technical assistance with Polaroid film and back questions or problems is available directly from the Polaroid Corporation. Call 1-800-225-1618 toll free within the U.S.

MAXIMUM MAGNIFICATION NEEDED TO RECORD ENTIRE SCREEN

Screen Size	5 cm x 6.3 cm	7.2 cm x 9 cm	8 cm x 10 cm	9.76 cm x 12.2 cm
Polaroid 3¼ in x 4¼ in pack and roll film	1.0	1.0	0.85*1	0.67*1
4 in x 5 in films	1.0	1.0	1.0	0.85 or less
6 cm x 7 cm format roll film (70 mm, 120 mm, 220 mm, etc.)	1.0	0.67	0.67	Not recommended

*1 *Preferred magnification ratio for the screen size, and to fill most of the usable image area of the film type.*

FILM BACKS

Depending on your application you can choose from a wide variety of cameras and backs. Backs within a series are interchangeable. (See the specific camera for information on a particular back.)

STANDARD AND OPTIONAL FILM BACKS AND HOLDERS AVAILABLE FROM TEK

Tek Modified Polaroid Backs	C-30 Series	C-50 Series	C-4, C-5C, C-7
3¼ in x 4¼ in pack	Std on "P" models	Std on "P" models	Noninterchangeable (C-5C & C-4)
Roll*1	Yes*1	Yes*1	NA
4 in x 3 in AutoFilm	NA	NA	C-7 only
Graflok-Type*2 Interface	Optional*2 Back	Std on*2 "G" Models	NA
Polaroid 3¼ in x 4¼ in pack holder	Yes	Yes	
Polaroid 4 in x 5 in single sheet holder	Yes	Yes	
Polaroid 4 in x 5 in pack holder*3	*3	*3	
120 mm roll	Yes	Yes	
70 mm roll	Yes	Yes	
4 in x 5 in cut film holder*4	*4	*4	

*1 *Polaroid is gradually reducing the number of its roll films. Replacement roll backs are available in limited quantities from Tektronix.*

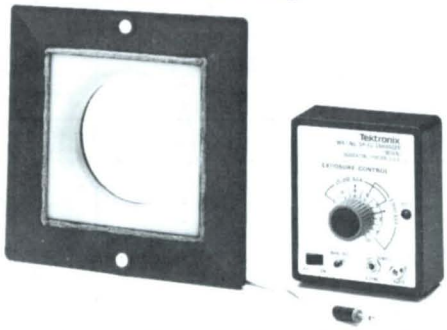
*2 *Requires one of the film holders listed in order to be usable.*

*3 *Will work but available only from Polaroid.*

*4 *Will work but not available from Tek, see your local camera store.*

PHOTOGRAPHIC WRITING SPEED

Photographic writing speed signifies the ability of a particular oscilloscope/camera system to provide a useful photographic record of a fast single-sweep trace. It is stated as an oscilloscope performance characteristic and is expressed in cm/μs or cm/ns. It is designed to answer the question, "What is the speed of the fastest single-sweep trace the system can record?" All statements of writing speed must specify the measurement conditions, including the CRT phosphor and film used, and the definition of a readable trace image.



WSEN (Writing Speed Enhancer) diffuser with control box.

Increasing Writing Speed

Film fogging is a technique for increasing the maximum sensitivity of photographic film by giving it a short exposure to dim, diffuse light. The Tektronix Writing Speed Enhancer (WSEN) is designed to fill this need.

The enhancer installs in minutes, and can be triggered in three ways: by a pushbutton on the control box; remotely, with a switch closure to ground (such as provided by the camera-shutter x-sync switch); or by the oscilloscope-sweep +gate. The WSEN is powered by two 9 V batteries (not included) which are inside the control box.

The film can be fogged before, after, or while the sweep occurs. The techniques are respectively called prefogging, postfogging, and simultaneous fogging. Of these modes, simultaneous fogging provides the greatest gain in writing speed. Automatic, simultaneous fogging is easily achieved by triggering the enhancer with the oscilloscope-sweep +gate.

For more information on photographing high speed signals request Application Note 42-W-5335-1.

Polaroid Film		Relative Film Writing Speed	
ASA Equivalent Speed	Type	Unfogged	Fogged
3,000	667, 107, 084, 47	1 (Reference)	3*2
20,000	612*1	>2	>3.5*2

*1 *Polaroid 612 PACK film, ASA 20,000, is now available with faster writing rate than previous 410 ROLL film.*

*2 *Value depends on film, scope, CRT, camera and the operator.*

The more commonly used Polaroid films for each type of camera back are listed below. Shaded text indicates films available through Tektronix.*5

Film Type	ASA Equivalent Speed	Development Time (Seconds at 75°F)	Format	Resolution (Line Pairs/mm)	Characteristics	CRT Recording Uses: Repetitive	Stored	Single Sweep	Video Display (Gray Medical)	Scintillation Type Displays	Color Displays	Scanning Electron Microscope
3¼ in x 4¼ in Pack Films—Actual image area 7.3 cm x 9.5 cm (2⅞ in x 3¾ in), 8 prints per pack												
611*1	200	45	Positive Print	20	Low Contrast, Wide Gray Scale				✓	✓		•
612*5	20,000	30	Positive Print	20 to 25	High Contrast			✓				
			Negative	160 to 180								
665*4	75	30	Positive Print	14 to 20	Medium Contrast, Wide Gray Scale	•*4	•*4		•*4			✓
107	3000	15	Positive Print	16 to 20	Medium Contrast	•	•	•	•			
084	3000	15	Positive Print	16 to 22	Medium Contrast	•	✓		•	✓		
667*1*5	3000	30	Positive Print	11 to 14	Medium Contrast, coaterless	✓	✓	•	•	✓		✓
669*5	80	60	Color Positive Print	11 to 14	Balanced for Color—Electronic Flash	•			•		✓	
691*5	80	4 min	Color Transparency		Includes Mounts	•			•	•	✓	
AutoFilm (For C-7 only)—Actual image area 10 cm x 7.5 cm (4 in x 3 in), 10 prints per pack												
T-331*1*3*5	400	60	Positive Print	20	Medium Contrast, Extended Gray Scale	•	•		✓	✓		✓
T-336*1*6	100	60	Negative Transparency	40 to 100	Medium Contrast, High Resolution				✓			•
T-339*1*2*5	640	>60	Color Positive Print*2	7 to 9	Medium Contrast, High Speed Color				•*2		✓*2	
Sheet Films—Actual image area 9.0 cm x 11.4 cm (3½ in x 4½ in)												
55			Positive Print	22 to 25								
55 P/N	50	20	Negative	150 to 160	Medium Contrast, Wide Gray Scale	•	•		•			
57	3000	15	Positive Print	16 to 20	Medium Contrast	✓	✓	•	•			
553*5 (8 Pack)	800	30	Positive Print	16 to 22	Medium Contrast	•	•		✓			✓

Polaroid Roll Film Backs are no longer available from Tektronix on new cameras. Polaroid still manufactures some roll films . . . Call their toll free number 1-800-225-1618 for roll film availability.

✓ *Preferred film for application.*

• *Acceptable performance.*

*1 *No coating required.*

*2 *Requires electronic scan reversal to yield a correct reading image.*

*3 *Similar to Type 611.*

*4 *Allow prints to be made from negative; good for documentation or publications.*

*5 *Available from Tektronix. See page 444.*

*6 *Available in 1987.*

CAMERA AND MOUNTING ADAPTOR SELECTION GUIDE

Where two or more cameras are recommended, compare features and specifications to optimize for your application. Tek cameras fit many non-Tek CRT based products. Contact your Tek Sales Representative for more information.

Oscilloscope or Display Device	Recommended Cameras			Mounting Adaptor Part Numbers			
	High Writing Rate	General Purpose	Low Cost	C-4*11	C-5C, C-7	C-51, C-53, C-59A, C-27, C-28	C-30B*13, C-31B*13
11000 Series							
11301	C-51 Opt 11	C-59A Opt 11	C-5C C-7	Not recommended	016-0357-01	016-0249-06	Not recommended
11302	C-51 Opt 12	C-53 Opt 11		Not recommended	Not recommended	016-0249-00	Not recommended
11401 11402			C-4 Opt 10	Not recommended	Not recommended	Not recommended	122-0897-01
5000 Series							
5100 Series Nonstorage*1*3; i.e., 5110, 5112, D10, D12, 577/D1, 5116*6		C-59A	C-4 Opt 02 C-5C; C-7, C-7 Opt 01	122-0895-01	016-0357-01	016-0249-06	Not recommended
5100 Series Storage*1*2; i.e., 5111, 5111A, 5113, 5115, D11, D13, D15, 577/D2		C-59A	C-4 Opt 02 C-5C C-7, C-7 Opt 01	122-0895-01	016-0357-01	016-0249-06	Not recommended
5400 Series Nonstorage*1*2; i.e., 5403/D40, 5440, 5444, D40		C-59A	C-4 Opt 02; C-5C; C-7, C-7 Opt 01	122-0895-01	016-0357-01	016-0249-06	Not recommended
5400 Series Storage*2*4; i.e., 5403/D41, 5441, D41	C-51*2	C-53*2	C-4 Opt 02 C-5C; C-7, C-7 Opt 01	122-0895-01	016-0357-01	016-0249-06	016-0248-01
5223*1		C-59A	C-4 Opt 02 C-5C; C-7, C-7 Opt 01	122-0895-01	016-0357-01	016-0249-06	Not recommended
7000 Series							
8 cm x 10 cm Display; i.e.,7104, 7503, R7103, 7504, 7514, 7613N, 7623, 7633, 7704(A), 7834, 7844, 7854, 7934, R7903, 7904, 7904A, T922R*2	C-51*2 C-31B Opt 01*10*13	C-53*2 C-30B Opt 01*10*13	C-4 Opt 02 C-5C C-5C Opt 01 C-7, C-7 Opt 01	122-0895-01	016-0357-01	016-0249-06	016-0248-01
Large Screen Display*1; i.e., 7403, 7603, 7603N		C-59A	C-4 Opt 02 C-5C; C-5C Opt 01 C-7, C-7 Opt 01	122-0895-01	016-0357-01	016-0249-06	Not recommended
Portables							
Older with 0.8 cm Graticule*5; i.e., 422, 453, 454, 485, 491	C-31B	C-30B	C-4*4	122-0894-01	No adaptor	No adaptor*5	016-0306-01
Newer with 1 cm Graticule*5*7; i.e., 2235, 2245, 2246 Option 01; 2400 Series, 455, 464, 465, 465B, 465M, 466, 468, R468, 475, 475A, 432, 434, 442	C-31B Opt 01	C-30B Opt 01	C-4; C-5C Opt 02; C-5C Opt 04 C-7 Opt 02; C-7 Opt 03	122-0894-01	016-0359-01	No adaptor*5	016-0269-03
1 cm Nonilluminated Graticule*5; 2213(A), 2215(A), 2220, 2225, 2230, 2235, 2236			C-7 Opt 02 C-5C Opt 04		016-0359-01	No adaptor*5	016-0269-03
¼ inch Graticule*4*5*12; i.e., 305, 314, 326, 335, 336, 1501, 1502		C-30B Opt 01*10	C-4 Opt 03*4	122-0896-01	No adaptor	No adaptor*5	016-0327-01
TM 500*5; i.e., SC 502, SC 503, SC 504*4		C-30B Opt 01*10			No adaptor	No adaptor*5	016-0327-01
Nonilluminated Graticule*5*8; 2335, 2336, 2336YA, 2337			C-5C Opt 04*8 C-7 Opt 02*8		016-0359-01	No adaptor*5	No adaptor
Display Monitors							
8 cm x 10 cm*3; i.e., 601, 602, 605, 606, 606B, 607		C-30B Opt 01*10 C-59A	C-4 Opt 02 C-5C; C-7, C-7 Opt 01	122-0895-01	016-0357-01	016-0249-06	016-0248-01
Large Screen 10 x 12 cm*1; i.e., 603, 604, 608, 620, 624, 634		C-59A	C-4 Opt 02 C-5C; C-7, C-7 Opt 01	122-0895-01	016-0357-01	016-0249-06	Not recommended
Older 5 Inch Round*2							
502, 503, 504, 515, 516, 519, 530/540/550/580 Series, 575	C-51*2*10	C-53*2*10	C-59A*10		No adaptor	016-0225-04	016-0243-00
Older 5 Inch Rectangular							
560 Series*2; i.e., 561, 564, 567, 568		C-53*2*10	C-59A*10		No adaptor	016-0224-01	016-0244-00
Television Products							
380, 381		C-30B Opt 01*10	C-4 Opt 03	122-0896-01	No adaptor	No adaptor	016-0327-01
520, 520A, 521, 521A, 522A*1*2		C-59A*10			No adaptor	016-0295-01	No adaptor
1480C		C-53*2*10	C-59A*9*10		No adaptor	016-0342-00*9	No adaptor
528A*2, 1420, 1421, 1422, 1424*1*2		C-59A	C-4 Opt 02 C-5C; C-7, C-7 Opt 01	122-0895-01	016-0357-01	016-0249-06	016-0248-01
529*1		C-53*10				016-0224-01	
1710B, 1711B, 1720/21, 1730/31, 1740, 1741, 1742, 1750		C-30B Opt 01	C-4; C-5C Opt 02; C-5C Opt 04 C-7 Opt 02; C-7 Opt 03	122-0894-01	016-0359-01	No adaptor*5	016-0269-03
Spectrum Analyzers							
2710		C-30B Opt 01	C-5C Opt 04 C-7 Opt 02		016-0359-01	No adaptor	016-0269-03
491*5		C-30B			No adaptor	No adaptor*5	016-0306-01
492A, 492P, 494, 494P, 495, 496, 496P*2, 2754/55/P		C-59A	C-4 Opt 02 C-5C; C-7, C-7 Opt 01	122-0895-01	016-0357-01	016-0249-06	016-0248-01

*1 Only cameras with <0.7 magnification can record the entire screen area of a 10 x 12 cm display.

*2 These scopes do not have camera power. The C-51 and C-53 may be used only if powered with 016-0270-02 battery pack.

*3 These scopes require modification for graticule illumination.

*4 Though these scopes do not have illuminated graticules the graticule may be photographed using storage flood guns on storage models.

*5 Due to physical configuration the C-50 Family cannot be mounted.

*6 The C-7 can only be used for color if the image is electronically reversed.

*7 A corrector lens is required to increase cameras field of view so that the full 8 cm x 10 cm CRT display area can be recorded. The camera should be changed from standard to Option 01. To do this order 016-0301-01 for the standard C-30B or 016-0269-04 for the standard C-31B. These kits include the mounting adaptor and corrector lens.

*8 These scopes have no CRT bezel; therefore, a camera cannot be mounted. A hand held C-5C, C-7, or C-4 can obtain a record.

*9 The C-59A may be used with 016-0224-01, however the image size is reduced.

*10 Adaptor not included with camera. Order adaptor separately.

*11 Use on scopes with graticule illumination or bistable storage.

*12 Scopes do not have graticule illumination.

*13 C-30 Series may cut off the first and last small graticule "tick" marks on some scopes.

*14 Must use f/22 or f/32 to get enough depth of field for good focus.

To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext. 99

CAMERA AND MOUNTING ADAPTOR SELECTION GUIDE

Where two or more cameras are recommended, compare features and specifications to optimize for your application.

Tek cameras fit many non-Tek CRT based products. Contact your Tek Sales Representative for more information.

Oscilloscope or Display Device	Recommended Cameras			Mounting Adaptor Part Numbers			
	High Writing Rate	General Purpose	Low Cost	C-4*11	C-5C, C-7	C-51, C-53, C-59A, C-27, C-28	C-30B*13, C-31B*13
Other Products							
370		C-59A	C-4 Opt 02 C-5C, C-7	122-0895-01	016-0357-01	016-0249-06	Not recommended
576, 5030, 5031		Only C-59(A)*10			No adaptor	016-0288-01 [C-59(A) only]	No adaptor
OF150, OF151, OF152, OF235 TDR			C-4 Opt 02 C-5C; C-7, C-7 Opt 01	122-0895-01	016-0357-01	Not recommended	Not recommended
1240*8*14			C-4 Opt 11	122-0898-01	Not recommended	Not recommended	Not recommended
T900 Series, excluding T922R (see 7000 Series)			C-5C Opt 03 C-7 Opt 04		016-0358-01	No adaptor*5	No adaptor
308			C-4 Opt 03	122-0896-01			

*1 *Only cameras with <0.7 magnification can record the entire screen area of a 10 x 12 cm display.*

*2 *These scopes do not have camera power. The C-51 and C-53 may be used only if powered with 016-0270-02 battery pack.*

*3 *These scopes require modification for graticule illumination.*

*4 *Though these scopes do not have illuminated graticules the graticule may be photographed using storage flood guns on storage models.*

*5 *Due to physical configuration the C-50 Family cannot be mounted.*

*6 *The C-7 can only be used for color if the image is electronically reversed.*

*7 *A corrector lens is required to increase cameras field of view so that the full 8 cm x 10 cm CRT display area can be recorded. The camera should be changed from standard to Option 01. To do this order 016-0301-01 for the standard C-30B or 016-0269-04 for the standard C-31B. These kits include the mounting adaptor and corrector lens.*

*8 *These scopes have no CRT bezel; therefore, a camera cannot be mounted. A hand held C-5C, C-7, or C-4 can obtain a record.*

*9 *The C-59A may be used with 016-0224-01, however the image size is reduced.*

*10 *Adaptor not included with camera. Order adaptor separately.*

*11 *Use on scopes with graticule illumination or bistable storage.*

*12 *Scopes do not have graticule illumination.*

*13 *C-30 Series may cut off the first and last small graticule "tick" marks on some scopes.*

*14 *Must use f/22 or f/32 to get enough depth of field for good focus.*

CAMERA SELECTION GUIDE

Camera	C-51	C-53	C-59A	C-30B	C-31B	C-5C	C-4	C-7
Features	Fastest writing speed Adjustable film and shutter speed Built-in view port Remote shutter actuation Interchangeable film backs Single sweep mode	General purpose for instruments with 8 cm x 10 cm CRTs Adjustable film and shutter speed Built-in view port Remote shutter actuation Interchangeable film backs Single sweep mode	General purpose for CRTs up to 6½ inches; low cost Adjustable film and shutter speed Built-in view port Internal batteries Interchangeable film backs OEM pricing available	Continuously variable magnification Dual swing-away hinge for viewing the CRT Easy operation Interchangeable film backs Compact size OEM pricing available	Max writing speed for portable scopes Dual swing-away hinge for viewing the CRT Easy operation Interchangeable film backs Compact size	Low cost, mounts on most scopes Graticule illuminator Viewing door Easy to use Fixed focus OEM pricing available	Lowest price Tek camera, hand held Easily interchangeable hoods Scope and video hoods Easy to use Fixed focus OEM pricing available	Motorized film back Auto developing prints; uses Polaroid AutoFilms Audible indicators Remote shutter activation Fixed focus OEM pricing available
Lens Apertures	f/1.2 to f/11	f/1.9 to f/16	f/2.8 to f/16	f/1.9 to f/16	f/1.3 to f/16	f/16 fixed	f/4.5 to f/32	f/16 fixed
Magnification	0.5	0.85	0.67	Variable: 0.7 to 1.5 (0.8 with Opt 01)	0.5 (0.43 with Opt 01)	0.67 or 0.85	0.80, 0.70, 0.85 depending on hood used	0.67 or 0.85
Relative light gathering	3.0	1.0	0.65	1.0 (0.9 with Opt 01)	2.7 (2.9 with Opt 01)	0.02	0.14 (0.85 mag) 0.18 (0.70 mag)	0.02
Field of view with Polaroid pack (cm)	8 x 10		10.2 x 12.7	8 x 10 (Opt 01); 7 x 9 (std)		9.8 x 12.2 or 8 x 10	9.1 x 11.87 (std) 10.4 x 13.5 (Opt 02) 8 x 10 (Opt 03)	8.1 x 10.7 (0.85 mag) 10.3 x 13.8 (0.67 mag)
Resolving Power: at center: (lines/mm)	30 or better		10 or better	at 1:1 25 or better	30 or better	6 or better		
at corners: (lines/mm)	15 or better		4 or better	10 or better	15 or better	3 or better		
Shutter Type	Electrical, 1/60 to 4 s (bulb, time, single sweep), remote shutter actuation, x-sync, scope "+ gate" input		Mechanical, 1/125 to 1 s (bulb and time) x-sync			Electrical, 1/10 to 5 s, (Time Mode)	Mechanical, 1/125 s to 1 s (bulb), x-sync	Electronic actuated 1/10 to 5 s, (Time Mode)
Film backs	Polaroid pack standard with "P" models, Graflok back standard with "G" models			Polaroid pack standard with "P" models, Graflok back available (016-0487-00)		Polaroid pack noninterchangeable		Polaroid AutoFilm noninterchangeable (CB-33)
Recommended films (see page 444 for ordering information)	612 667	667 612 691	667 669 691	667 612 669 691	612 667	667 669 691	667 669 691	AutoFilm Only 331 339
Options	Opt 11 corrector lens for 11301 Opt 12 corrector lens for 11302	Opt 11 corrector lens for 11302	Opt 11 corrector lens for 11301/2	01 Provides the correct adaptor (016-0269-03) for Tek portables with 8 cm x 10 cm displays. Also includes a corrector lens for optical correction		See page 445 for specific selections of options	01 (0.85 mag) 02 (0.80 mag) 03 (0.70 mag) 10 (7.2 in diagonal) 11 (8.3 in diagonal) 12 (12.5 in diagonal) See page 447 for specific selections	See page 448 for specific selections
Optional Accessories	Mounting adaptors, battery pack (for C-51, C-53), writing speed enhancer (one for each model), Polaroid pack film back, Graflok 4 in x 5 in back and film holders, x-sync connector, carrying case, foot switch (for C-51 and C-53)			Mounting adaptors, writing speed enhancer, Polaroid pack film back, Graflok 4 in x 5 in back and film holders, and carrying case; x-sync cable, portra lens (for C-30B only)		Mounting hood adaptors, flash unit, viewing door	Scope and video adaptor hoods, color filter kit (122-0909-00)	Film, foot switch, mounting hood adaptors, flash unit, battery pack, 110 V ac power supply
Page	451	451	453	450	450	445	446	448
Prices begin at	$2,360	$1,940	$1,335	$1,480	$1,700	$495	$370	$595

To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext. 99

ORDERING INFORMATION

CAMERA MOUNTING ADAPTOR AND HOOD

016-0217-00	$115	016-0269-04*2	$110
016-0223-01	$85	016-0295-01	$90
016-0224-01	$120	016-0299-00	$100
016-0225-04	$90	016-0301-01*3	$110
016-0226-01	$85	016-0306-01*4	$100
016-0228-01	$120	016-0327-01	$170
016-0243-00	$95	016-0342-00	$235
016-0244-00	$110	016-0357-01*5	$20
016-0248-01	$90	016-0358-01*6	$20
016-0249-06*1	$95	016-0359-01*7	$20
016-0263-00	$95	122-0894-01*8	$45
016-0269-03	$110	122-0896-01*9	$55

*1 Included with C-50 Series Cameras.
*2 Adaptor and lens included with C-31B Option 01 Cameras.
*3 Adaptor and lens kit included with C-30B Option 01 Cameras.
*4 Included with Standard C-30B, C-31B Cameras.
*5 Included with C-5C and C-5C Option 01 Cameras.
*6 Included with C-5C Option 03 Cameras.
*7 Included with C-5C Option 02 and Option 04 Cameras.
*8 Included with C-4 (Standard).
*9 Included with C-4 Opt 02 and Opt 03.

POLAROID REPLACEMENT ROLLER ASSEMBLIES FOR PACK FILM BACKS

(Gray) Order 401-0304-00 $30
(Red and Black) Order 401-0303-00 $26

Note: Because of mechanical differences, both roller assemblies are incompatible with each other's back.

ACCESSORIES FOR OLDER TEKTRONIX CAMERAS

Polaroid Pack Film Back for Older Cameras: C-12, C-19, C-13, C-27
The Pack Film Back accepts the Polaroid pack film. (3¼ inch x 4¼ inch). Order 122-0671-01 $290

Mounting Adaptors for C-12 —
C-12 to 7000 Series and 5000 Series.
Order 016-0299-00 $100

C-12 to 530, 540, 550 Series.
Order 016-0226-01 $85

C-12 to 560 Series rectangular CRTs.
Order 016-0217-00 $115

Writing Speed Enhancer — for C-12, C-27. Provides controlled film fogging to increase writing speed by 3X for 3,000 ASA film and >3.5X with 20,000 ASA film. Installs in minutes. Order 016-0280-02 $380

Carrying Case — for C-12, C-27.
Order 016-0208-01 $800

POLAROID PACK FILMS AVAILABLE FROM TEKTRONIX

Recommended for all cameras with a Polaroid 3¼" x 4¼" Pack Back.

Type 667 — B&W print, no coating required (3,000 ASA).
(3 twin packs) 48 prints. Order 006-6824-00 $42
(25 twin packs) 400 prints. Order 006-6825-00 $350

Type 612 — B&W print, high contrast (20,000 ASA).
(3 single packs) 24 prints. Order 006-6822-00 $35
(50 single packs) 400 prints. Order 006-6823-00 $580

Type 669 — Color print (80 ASA).
(3 twin packs) 48 prints. Order 006-6826-00 $63
(25 twin packs) 400 prints. Order 006-6827-00 $515

Type 691 — Color transparency with mounts, (80 ASA).
(3 single packs) 24 trans. Order 006-6845-01 $39
(50 single packs) 400 trans. Order 006-6845-02 $655

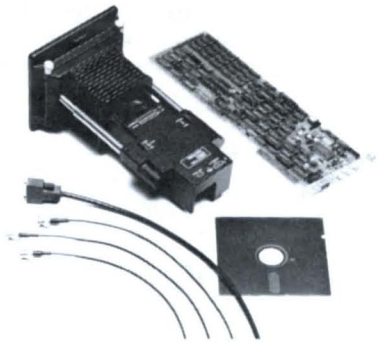
Polaroid AutoFilm (C-7 only)

Type 331 — B&W print, with extended gray scale (400 ASA).
(3 twin packs) 60 prints. Order 006-6815-00 $58
(10 twin packs) 200 prints. Order 006-6816-00 $190

Type 339*1 — Color print (640 ASA).
(3 twin packs) 60 prints. Order 006-6813-00 $71
(10 twin packs) 200 prints. Order 006-6814-00 $220

*1 Not recommended for oscilloscope use. Requires electronic scan reversal of CRT to yield correct reading image on print.

For technical assistance on Polaroid films and backs call Polaroid directly (800) 225-1618 toll free within the U.S. Outside the U.S., Polaroid has Service Centers and Offices, or write: Polaroid Corp., 784 Memorial Drive, Cambridge, MA 02139.



DCS01—The Digital Camera System with C1001 Video Camera with Option 1A frame store board.

NEW DCS01

CHARACTERISTICS

Electrical and camera characteristics are valid only if the camera is operating at an ambient temperature between 0°C and 40°C.

DCS01

Digitizing Technique — Scan converter.

System Writing Speed — MCP Scopes: To bandwidth of the scope (single shot & repetitive). Non MCP Scopes: Single Shot — Dependent on scopes photographic writing speed. Repetitive — To bandwidth of scope.

Nominal Digitizing Resolution — 12 bits (baseline RMS>74 dB, S/N).

Record Length — 512 points.

Number of Channels — 1 (Multiple channel software available in 1987).

Signal Aquisition Rate — 150 to 600 ms with IBM PC AT.

Number of Displayed Waveforms — 6.

Number of Active Waveforms — 26. Number of stored waveforms: (mass storage dependent).

Calibration Output Signal (Into 1 MΩ or 50 Ω)	Form: Square wave. Frequency: 20 kHz within 0.1% Amplitude: 800 mV within 0.2% Steps: Six 100 mV steps (within 0.2%)
Video Output Signal	NTSC standard, RS-170. (Either stored in memory or live from camera)
Oscilloscope Reset Signal	12 V pulse.
Power Requirements (includes camera & board)	Less than 16.5 watts.
Power Requirements	+12 V supply: Less than 300 mA. −5 V supply: Less than 35 mA. +5 V supply: Less than 2.5 A.

C1001 Camera Characteristics

Focal Length	10.746 mm (at 5200 A)
F Number at Infinity	F/1.3
Object-to-Image Distance	163.542 mm at 0.075X 144.723 mm at 0.833X
Spectral Range	400 to 600 nm within 3 dB
Angular Range	23.45°
Distortion	Within 0.3% (at image plane)
Lens Resolution	Center: 100 lines/mm Edge: 20 lines/mm
Imaging Device	Solid State, Inter-line CCD
Pixels	490 Vertical by 384 Horizontal
Resolution	Vertical: 480 Lines Horizontal: 285 Lines
S/N Ratio	Typical: 50 dB. Minimum: 47 dB. Gamma = 1
Sensitivity	2 Lux
Video Output	1 V p-p. Composite Video. 75 Ω

Weight — 48 oz (31.3 g) max with mounting adaptor.

Length — 9.5 in (24.13 cm) no adaptor and bellows collapsed.

Width — 4.75 in (12.07 cm) with no adaptor.

Frame store board — Fits a full slot in an IBM PC ≈13.25 in (33.66 cm).

Scope Compatibility — MCP: 11302, 2467, 7104/R7103. Non MCP: Scopes that have 7 x 9 cm or 8 x 10 cm displays and C-30 Series adaptor. See chart on page 442.

Computer Compatibility

Required IBM PC System Basic System — IBM PC, XT, AT or compatible 384 kbytes memory MS-DOS version 2.1 or higher. One 360 kbyte floppy disk. Numerical co-processor chip: 8087 for PC/XT, 80287 for AT. Color graphics adaptor card.

Recommended System — IBM PC enhanced AT, or compatible with hard disk with 512 kbytes memory, enhanced graphics card and high resolution color monitor. Expanded memory, RAM disk configured, 360 kbyte floppy disk. MS-DOS version 3.1. Communications interface cards: GPIB or RS232C. 80287 numerical co-processor chip.

ORDERING INFORMATION

DCS01 Digitizing Camera System*1 **$5,300**
Includes: Camera, frame store board, software, DCS cable (174-0449-01), 3 BNC to SS cables (174-0430-00), operator manual (070-6157-00).
*1 Requires camera adaptor bezel(s) listed below; one of each option can be ordered.

OPTIONS

Option 1A — Adaptor for 7K, 5K Series scopes. (016-0248-01) +$85

Option 2A — Adaptor for 2400 lines and 8x10 cm scopes. (016-0269-03) +$95

Option 3A — Adaptor for 485 Series and 7x9 cm scopes. (016-0306-01) +$95

Option 1C — GPIB Card for IBM PC with GPIB software.*2

C1001 Video Camera. Requires camera adaptor bezel(s). Same options (1A, 2A, and 3A) as the DCS01. **$2700**
Includes: Camera, cable (174-0449-00); instruction manual.

Option 04 — Power Supply/Interface. Required when used without the frame store card.*2

DX01 DCS Frame Store Board, Cables and Manual*2

Option 01 DXS01 Software *2
Note: A C1001 and DX01 Option 01 equals a DCS01

DX08 DCS01/GPIB Software *2

Option 01 — GPIB Board *2
Note: DX08 with Option equals DCS01 Option 1C
2 Available first quarter 1987

Contact your Tek Sales Engineer for advance software packages.

OPTIONAL ACCESSORIES

2467 — 350 MHz Portable Scope. See page 279.
7104 — 1 GHz Mainframe. See page 222.
11302 — 50 MHz Mainframe. See page 201

Thermal Video Copiers*3
HC01 — 4 x 5 inch for the DCS. **$980**
HC02 — 8 x 10 inch for the DCS. **$1,275**
3 Copiers include 1 roll of thermal paper and an instruction manual.

Thermal Paper —
(For HC01) 1 box (4 rolls) ≈185 pictures per roll. Order 016-0867-01 **$43**
(For HC02) 1 box (4 rolls) ≈90 vertical pictures per roll. Order 016-0868-01 **$77**

Standard C-5C (with flash).

C-5C

Low Cost

Easy to Use

Mounts Onto Many Scopes and CRT-Based Instruments

Covers 8 cm x 10 cm or 9.8 cm x 12.2 cm CRT Displays

Fixed Focus

Lightweight and Compact

Interchangeable Adaptor Hoods

Built-In Flash on Some Models

OEM Pricing Available

Maximum Performance at Minimum Cost

If your application does not require specialized photographic techniques, such as the capability to record single sweeps, this general purpose camera may fill your needs at a low cost. The C-5C is lightweight and modular, with a reliable electronically activated shutter. The three-element f/16 lens offers both 0.67 and 0.85 magnifications, either of which you can easily change by reversing the lens/shutter module and the spacer module positions.

Flash

A variable-intensity xenon flash that evenly lights CRTs with nonilluminated graticules comes on the C-5C and Options 03 and 04. It can be easily retrofitted on C-5Cs that do not have it.

Viewing Door

Flash models have a small built-in door. Nonflash models replace the flash unit with a large lift-up viewing door (016-0630-00).

Adaptor Hoods

Comes standard with camera (see below), and additional hoods can be ordered separately. Easily changed by removing four screws inside hood.

Film

Uses Polaroid pack film; i.e., 667, 665, etc. See page 441 for other films.

The C-5C and C-7 are separate camera systems; therefore, a C-5C cannot be converted into a C-7 and vice versa. However, they do use the same hoods and flash assemblies.

OEM Quantities

The low-cost C-5C Oscilloscope Camera is available in OEM quantities.

Special pricing, terms and conditions are available to qualified OEMs. Contact your local Tektronix Sales Engineer for complete information.

CHARACTERISTICS

Aperture — Fixed at f/16.

Lens — Three glass elements.

Magnification — 0.67 or 0.85.

Relative Light-Gathering Ability — 0.02.

Shutter — Electronic; 1/10 to 5 s; time.

Field of View — 9.8 cm x 12.2 cm (0.67 magnification) or 8.0 cm x 10.0 cm (0.85 magnification).

Power — The C-5C requires (4) AA alkaline batteries (not included). Battery holder inside camera.

PHYSICAL CHARACTERISTICS*[1]

Dimensions	mm	in
Width	168	6.6
Height	140	5.5
Depth	257	10.1
Weights≈	**kg**	**lb**
Net	1.4	3.0
Shipping	1.9	4.1

[1] Standard C-5C.

ORDERING INFORMATION

C-5C Camera **$495**

Includes: Adaptor hood (016-0357-01); flash unit (016-0642-02); instruction manual (070-2824-00).

OPTIONS

Option 01 — 016-0357-01 adaptor hood, no flash. **−$30**

Option 02 — 016-0359-01 adaptor hood, no flash. **−$30**

Option 03 — 016-0358-01 adaptor hood with flash. **NC**

Option 04 — 016-0359-01 adaptor hood with flash. **NC**

OPTIONAL ACCESSORIES

For ordering films see page 444, left hand side.

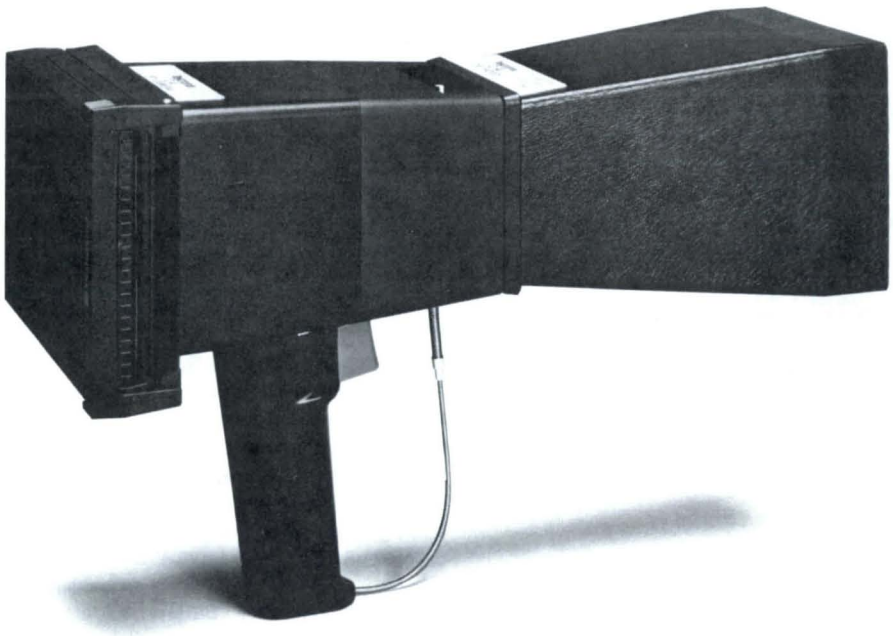
Large Viewing Door — Fits all three mounting adaptor hoods. (Included with C-5C Options 01 and 02.) Order 016-0630-00 **$8.00**

Graticule Flash Unit — Fits all three mounting adaptor hoods. (Included with C-5C and C-5C Options 03 and 04.) Order 016-0642-02 **$150**

Additional Mounting Adaptor Hoods — Requires flash unit or large viewing door.
(C-5C and C-5C Option 01) Order 016-0357-01 **$20**
(C-5C Options 02 and 04) Order 016-0359-01 **$20**
(C-5C Option 03) Order 016-0358-01 **$20**

Features	Standard		Option 01		Option 02		Option 03		Option 04	
Flash Unit	✓						✓		✓	
Large Viewing Door			✓		✓					
Adaptor Hood	016-0357-01		016-0357-01		016-0359-01		016-0358-01		016-0359-01	
Dimensions*[1]	**cm**	**in**	**cm**	**in**	**cm**	**in**	**cm**	**in**	**cm**	**in**
Height										
Inside	13.0	5.13	13.0	5.13	10.5	4.13	9.5	3.74	10.5	4.13
Outside	13.7	5.38	13.7	5.38	11.2	4.40	11.2	4.41	11.2	4.40
Width										
Inside	14.2	5.60	14.2	5.60	12.0	4.74	11.8	4.65	12.0	4.74
Outside	14.9	5.85	14.9	5.85	12.7	4.99	13.1	5.14	12.7	4.99
Compatibility	577, 600 Series with nonilluminated graticule, 1420 Series, 5100 Series		528, 600 Series without graticule or with illuminated graticule, 5400 Series, 7000 Series, T922R, 370		432, 434, 455, 464, 465B, 465M, 466, 468, 475, 475A, 2245, 2246, 2400 Series		T900 Series (except T922R)		2200 Series with nonilluminated graticule 2710	

[1] All dimensions are approximate since each hood has additional plastic notches and grooves for mounting.



Standard C-4 Hand-Held Camera.

C-4

Hand-Held Operation

No Focusing Required

Four Element f/4.5 Glass Lens System

Mechanical Shutter

Adapts to Most Tektronix and Non-Tektronix Scopes and CRT Displays

Five Easily Interchangeable Scope Hoods

Three Large Hoods for Video Screens

OEM Pricing Available

A camera can be a key part of your measurement system. It allows you to capture events, document the results, and it helps to *communicate* the results with clarity and credibility.

The C-4 is a high quality CRT documentation camera at an affordable price. The C-4 is an easy-to-use handheld camera system that uses Polaroid instant pack films which develop in seconds, giving you immediate results. The C-4 is ideal for the lab, classroom, medical facility, TV studio, or design bench. Three video hoods allow instant prints to be made from many common video CRTs.

A Snap to Use

Anyone can take sharp, quality instant pictures after just a few minutes of familiarization with the camera and manual. No photographic skill or training is required!

Portable

The C-4 is hand-held, thus easily moved between test locations without having to remove mounting hardware.

For easy handling, the contoured pistol grip includes a trigger button for the shutter release.

Tektronix and Non-Tektronix Product Compatibility

The five easily interchangeable hoods allow the C-4 camera to fit most Tektronix and non-Tektronix oscilloscopes and CRT displays.

The C-4 is recommended for scopes with either illuminated graticules or bistable storage displays. On nonilluminated graticule scopes the C-4 will only record the waveform.*1

For Tektronix products compatibility see page 443.

For other Tektronix products not listed on page 443, and non-Tektronix oscilloscopes and CRT-based products, refer to mechanical and field of view compatibility below.

**1 The Tektronix C-5C Camera, with flash, is recommended for scopes that do not have an illuminated graticule.*

Hood Selection

The hood is a key part of the C-4 system since it places the camera at the correct distance from the CRT screen, blocks out ambient light, and has a built-in corrector lens to properly focus the image and sets the magnification ratio. Each hood has two snap locks to insure quick interchangeability.

Mechanical Compatibility

It is suggested that the hood's front lip dimensions be used as a guide when determining physical compatibility (see Adaptor Hood Selection Guide on next page). Note: Hoods can fit around the CRT bezel or they can fit against the CRT's face, inside the bezel.

Field of View Compatibility

Check to see that the hood selected provides a large enough field of view (how large a CRT display the camera will fully record). Refer to Scope Hood Selection Guide on the next page.

C-4 VIDEO PRODUCT COMPATIBILITY GUIDE

The following lists compatibility currently tested. Please refer to page 447 for determining compatibility on products not listed.

Display	C-4 Video Hood	
	Opt 11	Opt 12
Option 10 hood fits the new 11401 and 11402 equivalent time scopes		
Tektronix: 4104(A), 4105(A), 4106(A), 4107(A)		✓
Ann Arbor Ambassador *1*4		✓
Apple II Monitor G0905	✓	
Apple MacIntosh Display	✓	
Compaq "Plus"*2	✓	
DEC VR-241*1		✓
DEC MATE II VR-201A*2*3*4		✓
Heathkit H-19*2		✓
IBM PC Jr. Monitor 4863*1		✓
IBM Color PC Monitor 5153		✓
IBM PC Portable	✓	
NEC JB-1201M Monitor		✓
Panasonic TR-930 Monitor	✓	
Quad Chrome Color Monitor		✓
Sony KV1217 Color Monitor		✓
Tandy Color Monitor 16-230	✓	
Zenith ZVM-122*2	✓	
Zenith ZVM-121*2*4		✓
Zenith ZVM-135		✓

**1 Cuts off some of the CRT.*
**2 Tends to have soft focus.*
**3 Possible light leaks since CRT has less curvature than the hood.*
**4 Optical distortion more noticeable.*

Note: Will not work on:
- *Tek: 4025, 4027, or 4050 Series.*
- *Tandy Computers with built-in CRTs.*
- *Apple IIc Monitor A2M2010.*

For additional hoods, see next page.

Special pricing terms and conditions are available to qualified OEMs. Contact your local Tektronix Sales Engineer for complete information.

C-4 Camera Body with hoods: (Left to Right) Option 12, Option 11, Option 10, Option 02, standard and Option 03.

CHARACTERISTICS

Aperture — f/32 to f/4.5 (continuously variable).

Lens — Four glass elements.

Focal Length — 105 mm nominal (without hood).

Magnification — Dependent on hood. See Adaptor Hood Selection Guide at right.

Resolving Power — At Center: At least 6 lines/mm. At Camera: At least 3 lines/mm.

Relative Light Gathering Ability — See Adaptor Hood Selection Guide at right.

Field of View — Dependent on hood. See Adaptor Hood Selection Guide at right.

Shutter — Mechanical; 1/125 s, to 1 s, and bulb.

Synchronization — X-sync switch closure occurs when the shutter reaches its fully open position.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	180	7.4
Height		
With pistol grip	236	9.3
Without pistol grip	119	4.7
Depth		
With standard hood	363	14.3
Without standard hood	185	7.3
Weight≈	**kg**	**lb**
Net		
With standard hood	1.0	2.1
Without standard hood	0.8	1.8

ORDERING INFORMATION

Additional hoods must be purchased separately. See Adaptor Hood Selection Guide at right.

C-4 Camera **$370**

Includes: Body; Pistol Grip (122-0901-00); hood (122-0894-01); operator manual (070-5000-01).

OPTIONS

Option 01 — Delete Hood (Body only). **−$45**

Option 02 — Substitute 122-0895-01 Hood. **NC**

Option 03 — Substitute 122-0896-01 Hood. **NC**

Option 10 — Substitute 122-0897-01 Hood. **+$34**

Option 11 — Substitute 122-0898-01 Hood. **+$34**

Option 12 — Substitute 122-0899-01 Hood. **+$53**

ADAPTOR HOOD SELECTION GUIDE

Extend the C-4's flexibility with additional snap-on hoods

SCOPE HOODS

Scope Hood Part Number	Dimensions*1 Nominal Front Lip Height*3 mm	Height*3 in	Width*3 mm	Width*3 in	Hood Length*2*5 mm	Hood Length*2*5 in	Relative Light Gathering	Field of View*1 (cm)	Magnification	Hood Net Weight kg	Hood Net Weight lb	Hood Price Only
122-0894-01 with Std C-4	108	4.2	122	4.8	178	7.2	0.15	9.1 x 11.87	0.8	0.1	0.3	$45
122-0895-01 with Option 02	132	5.2	143	5.6	206	8.1	0.18	10.4 x 13.5	0.7	0.2	0.4	$55
122-0896-01 with Option 03	80	3.2	100	3.9	171	6.8	0.14	8.0 x 10.0*2	0.85	0.1	0.3	$55

VIDEO HOODS

Video Hood Part Number	Dimensions*1 Nominal Front Lip Height mm	Height in	Width mm	Width in	Diagonal Inside mm	Inside in	Outside mm	Outside in	Hood Length*5 mm	Hood Length*5 in	Magnification	Hood Net Weight kg	Hood Net Weight lb	Hood Price Only
122-0897-01 with Option 10	114*3	4.5*3	159*3	6.3*3	183	7.2	188	7.4	244	9.6	0.55	0.3	0.7	$79
122-0898-01 with Option 11	127*3	5.0*3	168*3	6.6*3	211	8.3	213	8.4	257	10.1	0.55	0.3	0.7	$79
122-0899-01 with Option 12	186*4	7.3*4	262*4	10.3*4	318	12.5	323	12.7	404	15.9	0.35	0.6	1.4	$98

**1 Nominal dimensions.*

**2 Image size is limited by front opening of the hood.*

**3 For outside dimensions add 0.30 cm (0.12 in) to each value. Each wall thickness nominally is 0.15 cm (0.06 in).*

**4 For outside dimensions add 0.14 in to each value. Each wall thickness nominally is 0.07 in.*

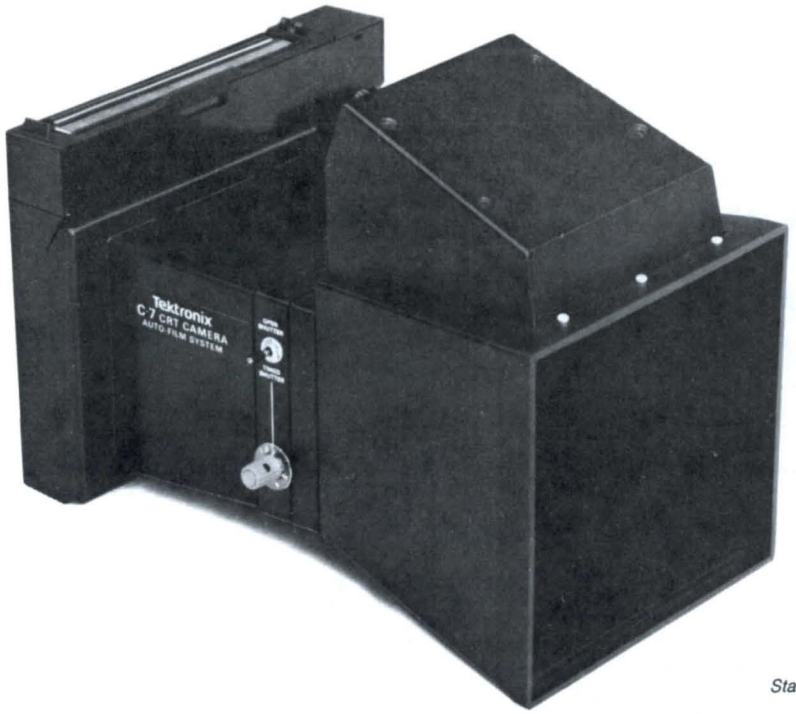
**5 From mounting surface to front lip.*

OPTIONAL ACCESSORIES

Split-Image Focus Plate — Fits into the pack film back (with no film loaded, useful to determine if image is properly in focus and entirely within the camera's field-of-view).
Order 387-0893-02 **$4.50**

Color Filter Kit — Consists of 40.5 mm screw-in 85B filter, corrects the color film balance for most color CRTs. Order 122-0909-00 **$13.50**

For ordering films, see page 444.



Standard C-7.

C-7

Motorized Back

Automatic Print Ejection and Development

Uses Integral AutoFilm From Polaroid

No Focusing Required

Reliable, Electronically Activated Remote or Manual Shutter

Audible Indicators

Protective Circuitry

Battery or Ac Power Supply Operation

Snap-On Print Holder

Graticule Flash on Some Versions

OEM Pricing Available

The Tek C-7 Auto-Eject Camera Delivers Hands-Off Hard Copies in Seconds

This general purpose CRT camera incorporates Polaroid's AutoFilm system that includes a motorized camera back, three integral films and a snap-on holding chamber.

The camera automatically ejects the film after each exposure. Once ejected, the film develops in about 60 seconds to a clean, dry print or transparency. No trimming, peeling or coating is necessary. Prints or transparencies can be collected in the snap-on holder (which is required for the first 30 seconds of transparency film development).

The C-7 was designed so that the user will not have to handle prints until they are completely developed. This is especially important in medical or clean room applications where film handling may cause chemical contamination. Another benefit is that the rollers will not have to be cleaned as often since the chemicals are contained inside the print.

The C-7 and film types 331 and 339 are now certified for use inside class 100 cleanrooms.

The Lens/Shutter System is a Snap to Use

Shutter speed is the only control which requires adjustment on the C-7. The fixed-focus glass f/16 lens system delivers sharp prints. The reliable electronic shutter assures accurate exposures. Some versions of the camera have a flash in the hood to illuminate displays that do not have graticule illumination.

The camera is externally powered by a detachable battery pack (held by two velcro strips), an ac power supply, or your own power source.

An Advanced Feature Set Brings a New Standard of Convenience to Photographic Recording

The C-7 has audible indicators that beep after last exposure, and after each exposure when the input voltage is low.

The camera can be operated by the manual shutter or by an optional foot switch via the remote shutter input jack.

Protective features include: voltage regulation, overcurrent foldback protection and under voltage warning (buzzer).

Magnification can be changed by reversing the lens/shutter module and the spacer modules positions.

Mounting and dismounting is easily accomplished on instruments with Tek-style bezels.

You'll find the built-in CRT viewing door handy when setting up for a picture.

There is even a built-in exposure counter in the camera back!

Polaroid AutoFilm

The Tektronix C-7 Camera System uses Polaroid's AutoFilm exclusively. These integral films were especially developed to work in Polaroid's motorized AutoFilm back which the C-7 uses:

- **Type 331** (ASA 400) is a black-and-white extended gray-scale film for video image recording, providing prints that reproduce the full range of black-and-white densities displayed on video monitors and scope CRTs.

  Presently there is not a high-speed film available, therefore the C-7's applications may be slightly limited. (Faster film(s) may be available from Polaroid in 1987.)

- **Type 336** (ASA 100) is a black-and-white high resolution negative transparency film. (It is scheduled for availability in 1987.)

- **Type 339** (ASA 640) is a high-speed color print film for reproducing color CRT displays. (The color film provides a print with a reversed or mirror image unless the CRT screen image is electronically reversed before making the exposure. This is a function of the film design, not the C-7.)

The AutoFilm's usable image area is 4 in x 3 in, though the actual image size will depend on the magnification and the size of the display. The AutoFilm film packs do not contain internal batteries.

The 10 exposure film packs mean fewer film changes for you. When the C-7 ejects the last print, the camera will automatically produce an audible tone for about 1 second.

Product Compatibility

The C-7 camera can be mounted on most models of Tektronix oscilloscopes and small monitors, using the same hoods as the C-5C. See page 443 for compatibility chart.

Non-Tek displays can be photographed if the product uses a Tek style bezel, or if the camera is held up to the CRT.

Your local Tek Sales Engineer has selected listings of non-Tek products that are compatible with the C-7. The best test is to actually try one on your display.

Technical assistance with AutoFilm is available from Polaroid. In U.S. call 1-800-225-1618. Outside U.S. contact local Polaroid dealer.

Shown above: C-7 and options. Rear left to right: Standard C-7, with Option 01, with Option 02, with Option 03, with Option 04, with Option 05, with Option 20, OEM camera with view ports. Front left to right: Print holding chamber, foot switch, battery pack, service manual, 110 V ac power supply.

CHARACTERISTICS

OPTIONAL/MECHANICAL

Relative Aperture — Fixed at f/16.

Magnification Factor — 0.67 or 0.85.

Lens — Three glass elements.

Relative Light-Gathering Ability — 0.02.

Field of View (Nominal) — 8.1 cm x 10.7 cm (13.4 cm diagonal) at 0.85 mag; or 10.3 cm x 13.8 cm (17.3 cm diagonal) at 0.67 mag.

Shutter — Electronic Actuated: 1/10 to 5 s, open shutter mode.

Remote Shutter Jack — Open collector TTL compatible (for use with foot switch).

Time Between Shots — ≈4 s (plus shutter time).

Audible Indicators (Buzzer) — Out-of-Film Warning: After tenth print is ejected, buzzer will sound for approximately one second. Low or High Voltage Warning: Buzzer will sound during the film-eject cycle when the batteries start to get weak.

Status Outputs — Various status outputs (switch closures and openings) such as "end of film," "dark slide," etc., are available only as a modified product.

POWER REQUIREMENTS

The C-7 requires external power from an ac power supply, battery pack, or a customer supplied source via a Lemo connector.

Voltage — 8 V to 12 V. (Can be configured for 5 V to 12 V, see service manual.)

Current — Idle: ≈1 mA. Maximum: 3 A for 10 s.

Mechanical Interface — Lemo type connector (cable end connector, Tektronix part number 131-0778-00).

POWER SUPPLIES (OPTIONAL)

110 V (119-1847-02) — Output Voltage: 9.5 V nominal. Output Current: 1.5 A nominal, 3 A peak. Line Voltage: 90 V ac to 132 V ac, 50 Hz to 60 Hz nominal.

Battery Pack (016-0799-01) — Number of Cells: Eight. Type of Cells: Alkaline or NiCad AA. (Batteries not included, velcro strips included.)

PHYSICAL CHARACTERISTICS

Std C-7 w/Flash Dimensions≈	mm	in
Width	180	7.1
Height to top of flash	196	7.7
Height with chamber	264	10.4
Depth	251	9.9
Weight≈	**kg**	**lb**
Net	1.3	3.7
Shipping	2.6	5.8

Hoods — Uses C-5C adaptor hoods. Refer to hood's dimensions on page 445.

ORDERING INFORMATION

C-7 requires a power source (does not come as a standard accessory). Order Opt 30*1, Opt 31*1, or use your own power via Lemo connector.

C-7 Camera with Flash **$595**

Includes: Adaptor hood (016-0357-01); print holding chamber (122-1039-00); circuit board covers for 0.67 mag (200-3074-00); for 0.85 mag (200-3031-00); operator manual (070-5127-00).

OPTIONS

Option 01 — 016-0357-01 Hood and no Flash. **−$30**

Option 02 — 016-0359-01 Hood and Flash. **NC**

Option 03 — 016-0359-01 Hood and no Flash. **−$30**

Option 04 — 016-0358-01 Hood and Flash. **NC**

Option 05 — 016-0358-01 Hood and no Flash. **−$30**

Option 20 — Camera Body Only, no Flash or Hood. **−$40**

Option 30*1 — With 016-0799-01 Battery Pack (batteries not included). **+$25**

Option 31*1 — With ac Power Supply (110 V). **+$50**

**1 One of each power source can be ordered.*

OPTIONAL ACCESSORIES

Polaroid AutoFilm —
Type 331 — B&W print, with extended gray scale (400 ASA)
3 twin packs (60 prints). Order 006-6815-00 **$58**
10 twin packs (200 prints). Order 006-6816-00 **$190**
Type 339 — Color print (640 ASA)
3 twin packs (60 prints). Order 006-6813-00 **$71**
10 twin packs (200 prints). Order 006-6814-00 **$220**

Extra Print Holding Chamber —
Order 122-1039-00 **$22**

Foot Switch With 8 ft Cable —
Order 260-1189-02 **$22.50**

Extra Battery Pack With Lemo Connector — Batteries not included. Order 016-0799-01 **$25**

Lemo Connector for Power-In —
Order 131-0778-00 **$16.75**

Ac Power Supply — 8 ft cable with Lemo Connector, 110 V ac Version.
Order 119-1847-02 **$70**

Service Manual — C-7 Camera.
Order 070-5051-00*1

**1 Contact your local Sales Office.*

For additional hoods, graticule flash unit, or large viewing door, see C-5C Optional Accessories Section on page 445.

OEM terms available on this product.

C-30 Option 01
With Corrector Lens Off

C-30 Series

Adaptable to Many Instruments

Standard Models Cover 0.8 cm/div CRTs

Optimized for 8 cm x 10 cm CRTs (Option 01)

Continuously Variable Magnification (C-30B)

Writing Speed Enhancer Available

Fast Light Gathering Ability, With C-31B (0.5 Mag)

Interchangeable Backs

Swings Away for CRT Viewing

OEM Pricing on C-30B

The standard versions of the C-30B and C-31B are primarily for use on the older 400 Series portables that have 0.8 cm/div CRTs. (Mounting adaptor, 016-0306-01, is included.)

The Option 01 models are the same cameras except that a slip-on corrector lens is used for coverage of 8 cm x 10 cm displays, and a different mounting adaptor (016-0269-03 for 2400 Series, 465, etc.) is included.

The C-30B/C-31B cameras can be used on some 7000 and 5000 Series lab scopes (with 8 cm x 10 cm displays); 300 Series; Sony/Tek portables; as well as some 600 Series monitors. See Camera Selection Guide on page 442 for compatibility information.

Dual swing-away hinges allow the camera to be swung out of the way, either to the left or right, for direct viewing of the CRT. The cameras are focused using a split-image focus plate placed inside the Polaroid back. Graflok back cameras use the back's (Graflok) built-in viewing glass.

C-30B

The C-30B is a versatile, general purpose camera for scopes that have 0.8 cm/div CRTs. The C-30B offers a highly reliable mechanical shutter and an f/1.9 lens. It is the only Tektronix oscilloscope camera that features continuously variable magnification (from 0.7 to 1.5) giving you greater photographing flexibility. This version is recommended for the 453, 454, 485 and 491.

C-30B Option 01

The C-30B Option 01 offers an expanded field of view. The f/1.9, 0.8 magnification lens covers an 8 cm x 10 cm CRT screen without vignetting. This camera is recommended for the 2400 Series, 455, 464, 465, 465B, 466, 468, 475, and 475A oscilloscopes.

The C-30B with corrector lens is optimized for use at 0.8 mag only.

CHARACTERISTICS (C-30B)

Specifications are the same for the C-30B and C-30B Option 01 unless otherwise noted.

Aperture — Variable from f/1.9 to f/16.

Lens Speed — f/1.9.

Magnification — Variable from 0.7 to 1.5 (0.8 magnification on Option 01 with C-30B set to 1.0 magnification).

Resolving Power — (at 1:1 magnification). At Center: At least 25 lines/mm. At Corners: At least 10 lines/mm.

Relative Light-Gathering Ability — 1.0 (0.9 on Option 01).

Shutter — Mechanical; 1/125 to 1 s; bulb and time.

Synchronization Output — X-sync contact closure.

Field of View — Standard: 7.0 cm x 9.0 cm. Option 01: 8.0 cm x 10.0 cm.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	191	7.5
Height	130	5.1
Depth	254	10.4
Weight≈	**kg**	**lb**
Net	2.2	4.8
Shipping	4.1	9.0

C-31B

This camera's f/1.3, 0.5 magnification lens offers the fastest writing speed for 2400 and 400 Series oscilloscopes. The 0.5 magnification means that the image size on the print will be approximately one half of the C-30Bs. The C-31B is for 0.8 cm/div CRTs (453, 485, 491, 454).

C-31B Option 01

The C-31B Option 01 offers an expanded field of view. This f/1.2, 0.43 magnification lens system has a relative light-gathering ability of 2.9 covering CRT screens up to 8 cm x 10 cm. It is recommended for the 2400 Series, 455, 464, 465, 465B, 466, 468, 475, and 475A oscilloscopes.

CHARACTERISTICS (C-31B)

Specifications are the same for the C-31B and C-31B Option 01 unless otherwise noted.

Aperture — Variable from f/1.3 to f/16.

Lens Speed — f/1.3

Magnification — Fixed at 0.5 (0.43 on Option 01).

Resolving Power — At Center: At least 30 lines/mm. At Corners: At least 15 lines/mm.

Relative Light-Gathering Ability — 2.7 (2.9 on Option 01).

Shutter — Mechanical; 1/125 to 1 s; bulb and time.

Synchronization — X-sync contact closure.

Field of View — Standard: 7 cm x 9 cm. Option 01: 8 cm x 10 cm.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	231	9.2
Height	140	5.5
Depth	269	10.6
Weight≈	**kg**	**lb**
Net	3.1	6.8
Shipping	5.4	11.0

ORDERING INFORMATION

("P" denotes that the camera has a 3 in x 4 in pack film back. All models include Polaroid pack film back.)

C-30BP Camera **$1,480**
Includes: Polaroid pack film back (122-0752-02); split-image focus plate (387-0893-02); mounting adaptor (016-0306-01); instruction manual (070-2825-00).

Option 01 — Expanded Field of View. **+$44**
Includes: Same as C-30BP except it comes with 016-0269-03 mounting adaptor instead, plus corrector lens (352-0341-01).

C-31BP Camera **$1,700**
Includes: Same as C-30BP, except instruction manual 070-2869-00 instead.

Option 01 — Expanded Field of View. **+$44**
Includes: Same as C-31BP except it comes with 016-0269-03 mounting adaptor instead, plus corrector lens (122-0980-00).

CONVERTING OPTION 01 MODEL TO STANDARD MODEL

The Option 01 versions of the C-30B and C-31B Cameras can be converted to standard models by simply slipping off the corrector lens, removing the mounting adaptor, and adding an 016-0306-01 mounting adaptor. Refer to pages 442-444 for compatibility and price.

CONVERTING STANDARD MODEL TO OPTION 01 MODEL

A standard-model C-30A/B or C-31B can be converted to an Option 01 model by means of a conversion kit which contains a mounting adaptor (016-0269-03) plus the appropriate corrector lens (see Option 01's "Included Accessories").

(Std C-30A/B to Option 01) Order 016-0301-01 **$110**
(Std C-31B to Option 01) Order 016-0269-04 **$110**

See pages 442-443 for prices and compatibility.

To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext. 99

OPTIONAL ACCESSORIES (C-30 SERIES)

Mounting Adaptors — See page 442.

Writing Speed Enhancer — (For C-30A/B and C-31B) Increases effective film speed about 3X for 3,000 speed film. Now supports 20,000 ASA (612) film. Installs in minutes. See page 441. Order 016-0284-02 **$290**

Polaroid Pack Film Back — Accepts Polaroid 3 in x 4 in pack film for C-30A and C-30B. Included with "P" models. (Focus plate included.) Order 122-0752-02 **$185**

Split-Image Focus Plate — Included with "P" models. Order 387-0893-02 **$4.50**

Graflok Type 4 in x 5 in Back — Accepts Polaroid Land 4 in x 5 in film holders, standard cut film holders, filmpack adaptors, roll film holders (except heavy motorized roll film holders). Order 016-0487-00 **$275**
See below for film holders which are required for operation.

Carrying Case — Molded high-impact plastic case with polyurethane foam liners to protect your camera in transit. 18.5 in x 14.5 in x 8 in. Order 016-0587-00 **$130**

X-Sync Cable — Order 012-0364-01 **$28**

Portra Lens — A slip-on auxiliary lens which extends the focus distance of the camera so it can be used for off-scope photography of scenes such as test set-ups. At a maximum distance of 21 in the camera covers 19 in x 21 in. Usable with either the C-30B or C-30B Option 01 (but not with the C-31A or C-31B). Order 016-0246-02 **$38**

OPTIONAL FILM HOLDERS FOR GRAFLOK TYPE BACKS
(C-50 Series "G" Models or C-30 Series with Graflok Back)

Cameras with Graflok type backs must have a film holder in order to be functional.

Here are several holders*[1] that allow the use of roll film, or 4 in x 5 in Polaroid films. Order these holders from Tek, the manufacturer, or from your local camera store.

Polaroid Land #545 4 in x 5 in Film Holder — For Polaroid 4 in x 5 in Single Exposure Film Packets. Order 016-0201-01 **$285**

RH/10 120 Roll-Film Holder — Ten exposures 2¼ in x 2¾ in for 4 in x 5 in Graflok backs. Order 122-0736-01 **$375**

RH/50 70 mm Holder — Fifty exposures, 2¼ in x 2¼ in for 4 in x 5 in Graflok backs only. Order 122-0967-00 **$330**

Roll film holders are also manufactured by several other companies.

*[1] *Other film holders and adaptors (4 cm x 5 cm cut film, pack film, or roll film) are available at local camera store.*

The following film holders are available only through Polaroid (1-800-225-1618 in the U.S.).

Polaroid #550 Film Holder — For Polaroid 4 in x 5 in pack films. Holder fits most 4 x 5 cameras and instruments equipped with Graflok backs, which accept conventional 4 in x 5 in film holders.

Polaroid #405 Film Holder — For Polaroid 3¼ in x 4¼ in pack films. Holder fits most 4 in x 5 in cameras or instruments equipped with Graflok backs, which accept conventional 4 in x 5 in film holders.

C-50 Series

Electronic-Actuated Shutter (C-51, C-53)

High Resolution Images

Photometer Exposure Aid

Range-Finder Focusing

Interchangeable Film Backs

Swings Away From Scope

The Top of the Line

The three C-50 Series cameras are designed for use with all Tektronix 7000 Series oscilloscopes, and can be adapted to fit most 5000 Series oscilloscopes and other Tek instruments. Full selection of film backs, and adjustable film and shutter speeds provide the flexibility to best record your measurements. The photometer exposure aid, similar to light meters used in conventional photography, provides an easy way to approximate the correct exposure for repetitive or stored traces. X-sync connectors allow the camera shutter to trigger the event. And the camera's built-in viewing tunnel lets you see what's on the display when the camera is in place.

The camera shutter (C-51 and C-53) is electrically actuated, open and close, by shutter button, or remotely through a remote input connector located on the side control panel.

When a C-50 Series camera is used with a Tektronix 7000 Series oscilloscopes, a three-pin connector in the scope bezel applies power to the camera and receives from the camera a pulse for resetting the scope sweep when the scope and camera are both in single-sweep modes. Also, when the scope and camera (C-51 and C-53 only) are in the single-sweep mode, the "+ gate" output from the scope can be applied to the "+ gate" input connector on the camera to close the shutter five seconds after the end of the scope sweep.

Special connection lenses are available to adapt the cameras to the new 11301/2 scopes. See page 442 for choosing the correct options.

The C-51 and the C-53 are available in ruggedized versions. Contact your Tektronix Sales Office for further details.

C-51G

C-53P

C-51

Fastest Writing Speed

Reduced Image Size (0.5 Mag) on Print

Remotely Controllable Shutter

Foot Switch Available

Writing Speed Enhancer Available

This camera offers the fastest writing speed of any Tektronix oscilloscope camera. The f/1.2 lens shoots images at 0.5 magnification, clearly capturing fast transients or single sweeps, although at some expense to the image size on the film. The C-51's electric shutter can operate at speeds ranging from 1/60 to 4 seconds, and offers bulb, time, and single sweep modes by manual or remote control.

CHARACTERISTICS

Aperture — Variable from f/1.2 to f/16.

Magnification — 0.5.

Resolving Power — Center: At least 30 lines/mm. Corners: At least 15 lines/mm.

Relative Light-Gathering Ability — 3.0.

Shutter — Electric; 1/60 to 4 s, bulb, time, and single sweep modes, manual or remote control. Scope's "+ gate" is used for shutter actuation.

Synchronization — X-sync switch closure.

Power Requirement — +15 V from 7000 Series oscilloscopes, or an optional battery pack for non-7000 Series instruments (see next page).

Field of View — 8 cm x 10 cm (with pack film).

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	248	9.8
Height	292	11.5
Depth	273	10.8
Weight≈	**kg**	**lb**
Net	4.3	9.5
Shipping	6.8	15.0

C-53

Medium Speed

General Purpose Camera With 0.85 Mag

Remotely Controllable Shutter

Foot Switch Available

Writing Speed Enhancer Available

The C-53, with a 0.85 mag lens, provides the largest practical image of an 8 cm x 10 cm CRT display on Polaroid 3¼ x 4¼ inch pack film. Its f/1.9 lens and 0.85 magnification offer somewhat slower writing speed than the C-51. This camera's electric shutter offers speeds ranging from 1/60 to 4 seconds, and can be operated manually or remotely in bulb, time, or single sweep modes.

CHARACTERISTICS

Aperture — Variable from f/1.9 to f/16.

Magnification — 0.85.

Resolving Power — Center: at least 30 lines/mm. Corners: at least 15 lines/mm.

Relative Light-Gathering Ability — 1.0.

Shutter — Electric; 1/60 to 4 s, bulb, time, and single sweep modes, manual or remote control. Scope's "+ gate" is used for shutter actuation.

Power Requirement — +15 V from 7000 Series oscilloscopes, or an optional battery pack for non-7000 Series instruments (see next page).

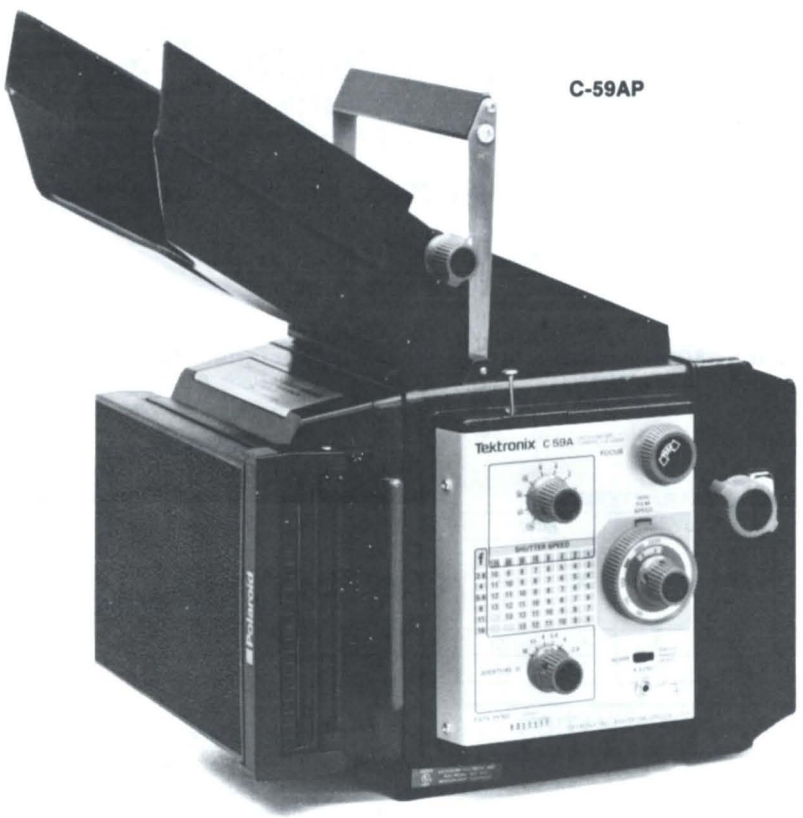
Synchronization Output Jack — X-sync switch closure output.

Field of View — 8 cm x 10 cm (with pack film).

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	191	7.5
Height	292	11.5
Depth	273	10.8
Weight≈	**kg**	**lb**
Net	2.4	7.5
Shipping	5.4	12.0

For Ordering Information, see next page.



C-59AP

C-59A

For Larger CRTs (0.67 Mag)

Mechanical Shutter

Lowest Priced C-50 Series

Photometer Exposure Aid

Range-Finder Focusing

Internal Battery or External Power

OEM Pricing Available

This camera is designed for CRTs up to 6½ inches (10.2 cm x 12.7 cm field of view with Polaroid pack film). With the use of an adaptor frame/corrector lens optional accessory, the camera's field of view can be expanded to fully cover the 6½ inch CRT and adjacent scale readout characters of the Tektronix 576 Curve Tracer and the 5030 Series oscilloscopes. It is the only C-50 Series camera for the 7603. Many of the features of the higher priced C-50 Series cameras are standard on the C-59A: photometer exposure aid, range-finder focusing, bulb and time operating modes, x-sync contacts, and film back interchangeability.

CHARACTERISTICS

Aperture — Variable from f/2.8 fo 1/16.

Magnification — 0.67.

Resolving Power — Center: At least 10 lines/mm. Corners: At least 4 lines/mm.

Relative Light-Gathering Ability — 0.65.

Shutter — Mechanical; 1/125 to 1 s; bulb and time.

Power Requirement — Receives power (+15 V) from a 7000 Series oscilloscope, or from an internal battery pack, 8 AA size alkalines, (12 V) if used on a non-7000 Series oscilloscope.

Synchronization — X-sync switch closure.

Field of View — 10.2 cm x 12.7 cm (wider with optional 016-0288-01 adaptor frame/corrector lens).

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	193	7.7
Height	292	11.5
Depth	273	10.8
Weight≈	**kg**	**lb**
Net	3.2	7.0
Shipping	5.0	11.0

ORDERING INFORMATION

"P" Models accept only Polaroid pack film. "G" Models have a Graflok type back that requires a film holder (see page 454 for film holders). C-59 does not include 8 AA size alkaline batteries.

C-51G Camera **$2,360**
Includes: Mounting adaptor for all 7000, 5000, and small 600 Series (016-0249-06); camera visor (337-0411-02); Graflok film back (122-0931-01) with integral focusing screen; instruction manual (070-1011-03).

C-51P Camera **$2,360**
Includes: Same as C-51G except it has a Polaroid pack film back (122-0926-02) instead of Graflok film back, and a focus plate (387-0893-02).

Option 11*1 Corrector lens for 11301*2

Option 12*2 Corrector lens for 11302*2

C-53P Camera **$1,940**
Includes: Same as C-51P.

Option 11 Corrector lens for 11302*2

C-59AG Camera **$1,335**
Includes: Same as C-51G except instruction manual (070-3632-00).

C-59AP Camera **$1,335**
Includes: Same as C-59AG.

Option 11 Corrector lens for 11301/2*2

C-59A Kit for 576 — Expands the field of view to fully cover the 6½ inch CRT and adjacent scale readout characters of the 576 Curve Tracer and 5030 Series oscilloscopes. The slip-on corrector lens (352-0293-00) reduces the effective magnification of the C-59 from 0.67 to 0.5 so it can record the entire display on Polaroid 3½ in x 4½ in film (for the C-59A camera only). Adapts camera to 576, 5030, and 5031. Order 016-0288-01 **$160**

**1 One or both options can be ordered.*
**2 To order, contact your local Tektronix Sales Office.*

C-50 SERIES OPTIONAL ACCESSORIES

Mounting Adaptors — See page 442.

Battery Pack — Provides auxiliary +15 V power source for using the C-51, C-53 Cameras with oscilloscopes without camera power. A three-position mode switch on the battery pack also allows the camera to be powered from a 7000 Series oscilloscope or an external +15 V source. Includes three pin female connectors for external power in (131-0716-00). Net weight, including batteries, is 1.2 lb. Requires 8 AA size alkaline batteries (not included). Order 016-0270-02 **$290**

Writing Speed Enhancer — Provides controlled film fogging to increase writing speed by 3X for 3,000 ASA film and ⩾3.5X with 20,000 ASA film. Installs in minutes. See page 441 for more information.
(C-51) Order 016-0279-02 **$265**
(C-53) Order 016-0300-02 **$290**
(C-59A) Order 016-0290-02 **$300**

X-Sync Connector Plug — Not shown. Order 134-0079-00 **$1.30**

Foot Switch — For Remote Shutter Actuation of the C-51, C-53, with 8 ft cable. Order 260-1189-02 **$22.50**

Carrying Case — Holds a complete C-50 Series camera with extra film backs and accessories. Order 016-0177-00 **$285**

Polaroid Pack Film Back — Included with "P" models. Order 122-0926-02 **$180**

Focus Plate — Included with "P" models. Order 387-0893-02 **$4.50**

Graflok Type Film Back — Included with "G" models (see page 454 for film holders), accept Polaroid 4 in x 5 in film holders, standard cut-film holders, film-pack adaptors, roll-film holders*1 (except heavy motorized models). Includes integral focusing screen. Order 122-0931-01 **$265**

**1 Other film holders and adaptors (4 cm x 5 cm cut film, back film, or roll film) are available at local camera stores.*

TEK VIDEO COPIERS COLOR PLOTTER

HC01/HC02 Video Copiers

HC100 Plotter

HC01/HC02 Video Copiers

Applications/Compatibility: Personal Computers; Imaging Products with Composite Video Outputs: Digitizing Camera System (DCS01, C1001); Logic Analyzers (except 1241); VCR's; Medical Imaging; TV Camera; Ultrasound Systems; Manual Production

The HC01/HC02 offer copies in seconds (17 and 21 seconds respectively) of the most complex computer screen graphics or TV/CRT display monitor images. The copiers are ideal for a wide range of applications, such as permanent records of teleconferences, medical diagnostics, and measurement and instrumentation data.

CHARACTERISTICS

INPUT SIGNALS

NTSC/PAL/SECAM Composite Video — 1 V p-p, 75Ω terminated, negative sync (video bridged out).

RGB TTL From PC — TTL Level (bridged out), F (H) = 15.75 kHz.

Parallel Data Interface/Teletext/Videotex — TTL Level.

RESOLUTION (DOTS X LINES)

Composite Video Signal

	Frame Mode	Field Mode
NTSC	640 dots x 476 lines	640 dots x 238 lines
PAL/SECAM	640 dots x 512 lines	640 dots x 289 lines

R.G.B. TTL Signal —
Field Mode: 640 x 200 (Noninterlace).
Frame Mode: 640 x 400 (Interlace).

Parallel Data — 640 Dot 80 Column; ASCII 96 Character Built-in; Graphic Mode Application; Printing Speed 160 CH./Sec.

Gray Scale — 16 tones

PRINT SPECIFICATIONS

Paper — Super grade thermal type.

	HC01	HC02	
		V Mode	H Mode
≈ Prints/roll	180	94	75
Width	110 mm (4.3in)	216 mm (8.5in)	
Length	21 m (85ft)	21 m (85ft)	
Print Size	110 x 115 mm (4.3 x 4.1in)	216 x 279 mm (8.5 x 11in)	216 x 220 mm (8.5 x 8.6in)
Image Size	100 mm x 74 mm (3.9 x 2.9in)	200 mm x 148 mm (7.8 x 5.8in)	
Print Speed	≈ 17 Sec	≈ 21 Sec	

POWER REQUIREMENTS

Line Voltage — 120 V ac ± 10%

Line Frequency — 50 Hz/60 Hz

Power Consumption — HC01: 60 W. HC02: 110 W.

PHYSICAL CHARACTERISTICS

	HC01		HC02	
Dimensions	**mm**	**in**	**mm**	**in**
Width	210	8.3	368	14.5
Height	112	4.4	119	4.7
Depth	358	14.1	337	13.3
Weight≈	**kg**	**lb**	**kg**	**lb**
Net	5.5	12.1	7.7	17.0

ORDERING INFORMATION

Each copier includes a roll of thermal paper and a manual.

HC01 4 x 5 inch Video Copier	**$980**
HC02 8 x 10 inch Video Copier	**$1,275**

OPTIONAL ACCESSORIES

Thermal Paper — Four rolls per box.
(HC01) Order 016-0867-01 **$43**
(HC02) Order 016-0868-01 **$77**

Data Cable — 10 foot, male-to-male 9-PIN DB connectors. For connection to RGB TTL PC output. Order 174-0537-01 **$20**

HC100 Color Plotter

Compatibility: 2430, 7854, 7D20, 336 Option 01, 468 Option 02, 370

This low cost four color plotter directly prints the set-up conditions and the acquired waveforms from a number of Tek instruments. The plotter has GPIB and Centronix interfaces.

CHARACTERISTICS

Effective Drawing Size — 267 mm (X-axis) x 192 mm (Y-axis).

Maximum Drawing Speed — 230 mm/sec (along pen axis).

Maximum Resolution — 0.1 mm.

Pen Response Speed — 15 times/sec.

Number of Pens — 4 (changed automatically).

Pen Types — Fiber pens: aqueous ink or oil-based ink. Ball-point pens: aqueous ink.

Paper Sizes — ISO A4: 297 mm x 210 mm. B5: 257 mm x 182 mm. US letter size: 279 mm x 216 mm.

Paper Types — Ordinary paper; OHP film.

Pen Movement Precision — Single Pen: 0.3 mm. Different Pens: 0.5 mm.

Pen Change Precision — Within 0.3 mm.

FUNCTIONS

Drawing Modes — Self Test, Plotter, Printer.

Character Types — ASCII (96 types); International (32 types for 11 countries).

Automatic Pen-Up — 25 during on-line operation.

POWER REQUIREMENTS

Line Voltage — Standard: 117 V ac ± 10%. Option 01: 220/240 V ac ± 10%.

Line Frequency — 49.5 Hz to 60.5 Hz.

Power Consumption — 30 W.

ENVIRONMENTAL

Temperature — Operating: 5°C to +35°C. Nonoperating: +30°C to +70°C.

Humidity — Operating and nonoperating: 85%.

RELIABILITY

Pen Lifetime — Aqueous fiber pen: ≈ 200 m. Oil-based Fiber Pen: ≈ 400 m. Aqueous ball-point pen: 400 m.

PHYSICAL CHARACTERISTICS

Dimensions	**mm**	**in**
Width	415	16.5
Height	81	3.2
Depth	272	10.8
Weight≈	**kg**	**lb**
Net	6	13.2

ORDERING INFORMATION

HC-100 Color Plotter*1

Option 01 — 220/240 V Operation*1

OPTIONAL ACCESSORIES

Centronix Cable*1 — Order 012-0555-00

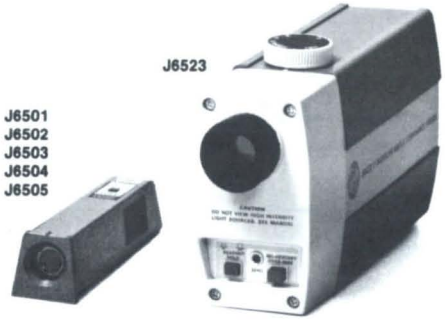
GPIB Cable —
(5 m, single shield) Order 012-1015-00 **$85**
(2 m, dual shield) Order 012-0630-03 **$110**

Extra Pen Cartridge*1 — Order 016-0876-00

Pens — Four colors in each package.
Fiber tip with aqueous ink. 016-0879-00*1
Fiber tip with oil-based ink. 016-0878-00*1
Ball point with aqueous ink. 016-0877-00*1

**1 To order, contact your local Tektronix Sales Office for price and delivery.*

DIGITAL PHOTOMETER/ RADIOMETER



J6523

J6501
J6502
J6503
J6504
J6505

J6511 (shown)
J6512

LIGHT OCCLUDER
016-0305-00

LED ADAPTOR WITH EXTRA LED HOLDER
(included with J6505)
014-0047-00

The Tektronix J16 is a portable digital photometer/radiometer capable of making a wide variety of light measurements—in the laboratory, in the field, or on the production floor. A J16 System consists of a J16 mainframe and one of eight detachable probes. Probes can be either mounted on the J16 or used on the end of an extension cable. All probes have a HOLD switch to allow the reading to be held.

Eight quickly interchangeable probes are available for measuring illuminance, irradiance, luminance, light-emitting diode output, and relative intensity. Recalibration is not necessary when probes are interchanged. Connection of a probe to the J16 automatically selects the correct front panel units indicator. The 3½ digit LED display can be easily read under low ambient conditions.

All probes use silicon photodiodes and multi-element glass filters for maximum stability and accuracy.

The optional BCD/analog output feature allows the user either a BCD output of the displayed reading or an analog signal (level) proportional to the light falling upon the sensor. The J16 can be also used with Tek MI 5010/50M30 system for interface with a GPIB system.

Under normal usage, the internal rechargeable nickel cadmium batteries will operate the J16 for four hours. An ac power supply is recommended for continuous operation.

CONTENTS

J16 Photometer/Radiometer 455
Illuminance Probes 457
Irradiance Probes 457
Luminance Probes 457
Uncorrected Probe 458
LED Test Probe 458

J16 Photometer/Radiometer

Digital LED Readout

Eight Silicon Sensor Probes Quickly Interchange Without Recalibration

Freedom From Saturation Effects Over Entire Range

Accurate Spectral and Cosine Corrections

Metric and US Versions Available

BCD/Analog Output (Option 07)

Ac or Internal Rechargeable Battery Versions

Longer Battery Life—4 Hour Operation

Application Notes Available

Power supplies or battery packs can be changed quickly by removing four screws on the J16's rear panel. The cabinet and probes have an internal threaded socket (¼ inch x 20) for convenient mounting on a tripod or optical bench.

J16-TV Package

The J16-TV package is an excellent transfer mechanism which provides a simple, accurate method for adjustment of monitor screen color temperature. The primary colors are measured and adjusted to produce white color temperature balance.

The J16-TV with optional J6503 or J6523 measures monitor screen brightness on both color and black and white monitors. Other applications include measurement of studio lighting, camera lighting, and illumination of work areas.

The J16-TV package includes: J16 Battery-Operated Photometer, J6502 Irradiance Probe, light occluder, probe extension cable, and battery charger. See Application Note 58A-2926-1 for additional information.

GLOSSARY

Photometry — The measurement of light visible to the human eye.

Radiometry — The measurement of light within the total optical spectrum.

Color Temperature — The temperature of a blackbody whose radiation has the same visible color as that of a given non-blackbody radiator. Usually expressed in °k.

Footcandle — Unit of incident illumination.

Footlambert — A unit of illumination emitted or diffusely reflected by a source.

Two additional units are commonly used—the lux (the metric unit of illuminance) and the nit (the metric unit of luminance).
1 footcandle = 10.76 lux
1 footlambert = 3.426 nits

Illuminance — The amount of luminous flux through a unit of surface area and is usually measured in footcandles (lumens/ft²).

Inverse Square Law — The decrease of light intensity with increasing distance. Twice the distance reduces the illumination to one-quarter.

Irradiance — The amount of radiant flux received by a unit of surface area and is usually measured in watts/cm²*¹.

*¹ *Other units of irradiance such as μW/cm² and W/m² are also used extensively.*

Lambert's Law — Describes the spatial characteristics of a perfectly diffusing surface which may be either emitting or reflecting light. The light emitted or accepted by such a surface decreases with angle (from perpendicular) according to the cosine of the angle.

Luminance — The amount of light emitted or scattered by a surface and is usually measured in footlamberts.

Photopic — Spectral (color) sensitivity of the average human eye, predominantly peaked in the yellow-green region.

Steradian — A unit of area on the surface of a sphere equal to the radius squared. There are 12.6 steradians total area on a sphere.

Spatial — The directional characteristics of light in space.

Spectral — The distribution of light by wavelength within an electromagnetic spectrum.

Note that each radiometric unit has a photometric equivalent differing only in spectral response of the sensor. However, the units are not interchangeable.

PROBE CHARACTERISTICS

Application		Illuminance		Irradiance	Luminance		Uncorrected	Red LED
Probe		J6501	J6511	J6502/J6512	J6503	J6523	J6504	J6505
Range	US*²	0.001 to 1999 footcandles*¹	0.001 to 1999 footcandles	0.001 to 1999 microwatts/cm²	0.1 to 199,900 footlamberts*¹	0.1 to 19,990 footlamberts*¹	Relative response only	0.001 to 1999 footcandles*¹†
	Metric (Opt. 02)*²	0.01 to 19,990 lumens/m² (lux)*¹†	0.01 to 19,990 lumens/m² (lux)	0.01 to 19.990 milliwatts/m²	1 to 1,999,000 candelas/m² (Nits)*¹	1 to 199,900 candelas/m² (Nits)*¹	Relative response only	0.01 to 19,990 lumens/m² (lux)*¹†
Accuracy (Including J16)		Within 5% of NBS standards and ±1 digit in last place. Calibrated with a 3100° k tungsten halogen light source traceable to NBS		Same as J6501, except calibrated with a 762 nm filter	Within 5% of NBS standards and ±1 digit in last place. Calibrated with a 3100° k tungsten halogen light source traceable to NBS		Probe-to-probe accuracy ±5% with tungsten light source	Same as J6501, except calibrated with a 656 nm filter
Spectral Response		Within 2% (integrated) of CIE photopic curve		Flat within ±7% from 450 to 950 nm	Within 2% (integrated) of CIE photopic curve		UV enhanced silicon spectral curve (250 to 1200 nm)	Within 2% (integrated) of CIE photopic curve from 600 to 710 nm
Acceptance Angle		50% sensitivity at 48° off axis	Cosine corrected (180°)	50% sensitivity at 48° off axis	8°	1°	50% sensitivity at 48° off axis	
Stability and Repeatability		Within 2% per year						
Linearity		Within 2% over entire range enabling single point calibration						

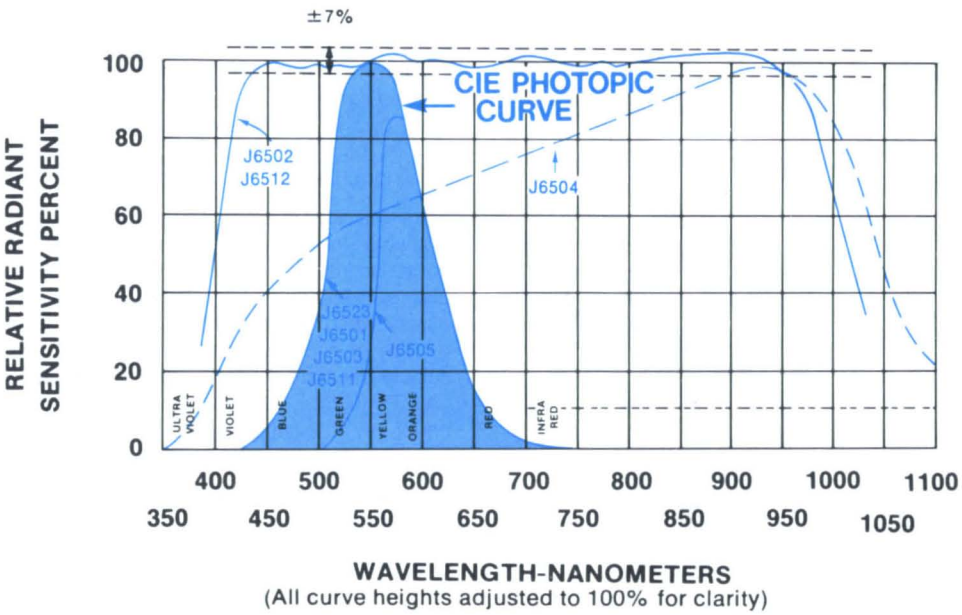
*¹ *An additional decade of sensitivity is included and is usable if the J16 is carefully zeroed and used at a relatively stable temperature.*

† *0.00001 to 199.9 candelas when used with 014-0047-00 LED adaptor or at 3.8 inches source-to-sensor spacing. Luminous intensity readings of higher intensity light sources may be easily made at correspondingly greater distances using the formula: Footcandles x d² = candelas where d is the distance from the source to the sensor in feet. (For metric readings, use lux x d² = candelas where d is distance from the source to the sensor in meters.) Request J16 Application Notes 58A-2635 and 58A-2704-1 for further information.*

*² *US/METRIC CONVERSIONS*

	US to Metric	*Metric to US*
Illuminance	*Fc x 10.764 = Lux*	*Lux x 0.0929 = Fc*
Luminance	*Fl x 3.426 = Nits*	*Nits x 0.2919 = Fl*

TYPICAL PROBE SPECTRAL CHARACTERISTICS

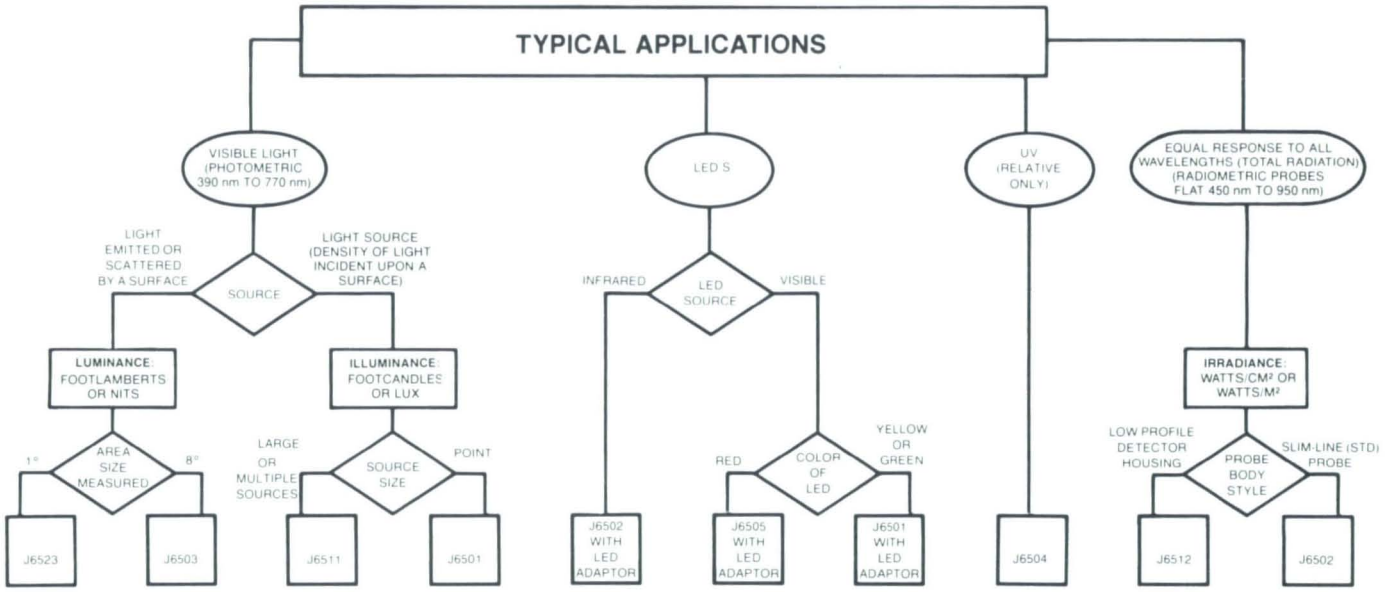


(All curve heights adjusted to 100% for clarity)

NOTE: C.I.E. stands for the International Commission on Illumination.

J16 PROBE SELECTION GUIDE

The following flowchart is an aid in selecting J16 probes. The applications for the probes are too numerous to list, but this should help in your selection.



J6511/J6501 Illuminance Probes

Typical Applications: Measurement of roadway illumination, office lighting, illumination of work surfaces, studio lighting, camera set up, and yellow and green LED testing

See page 459 for available Application Notes.

The J6511 is an illuminance probe with readout in footcandles (lumens/m² (lux) for the J6511 Option 02). A multi-element glass filter and silicon photo-diode ensure a close match to the CIE photopic curve (color corrected). The silicon-sensor recovery time is virtually instantaneous; low light levels can be measured immediately after exposure to bright sunlight.

The angular response is accurately cosine corrected, simulating an ideal 180° field-of-view detector. The low-profile probe has a leveling indicator to ensure accurate measurements where a significant proportion of the illumination comes from sources at low angles to the horizon.

A 25-foot cable between the probe head and J16 allows the user to be out of the field of view while making measurements.

Where cosine correction is not necessary, a standard probe is available (J6501) with the same photopic correction and units as the J6511. The J6501 with the LED adaptor can be used to measure green and yellow LEDs.

J16-TV System with J6502 being used for color monitor set- up.

J6502/J6512 Irradiance Probes

Typical Applications: Laser research experiments, measurements of radiant efficiency, color CRT set-up, and infrared LED testing

See page 459 for available Application Notes.

The J6502/J6512 measure irradiance in microwatts/cm² (milliwatts/m² with Option 02). The spectral response is flat from 450 nanometers to 950 nanometers, ±7%. The response is typically down 50% at 400 nm and 1030 nm.

An optional filter holder is available for the J6502 to mount standard 1 inch diameter customer-supplied filters of up to 3/8 inch thickness. Where high intensity sources are used (over 1990 μwatts/cm²), neutral density filters can be used to extend the range of the J16. (An ND 1 filter has 10% transmission, an ND 2 filter has 1%, etc.). These filters may be held with an optional filter holder.

Where the 1 sq cm sensor is not completely filled by the source for example with a laser beam, the reading obtained represents μwatt instead of μwatts/cm² or milliwatts x 10^{-4} instead of milliwatts/m² (Option 02). Small variations in sensor uniformity may add ±5% uncertainty to this measurement.

The J6512 has a low-profile detector head that is at the end of a six foot cable. Longer cables can be ordered as a special modification.

J6503 8° Luminance Probe

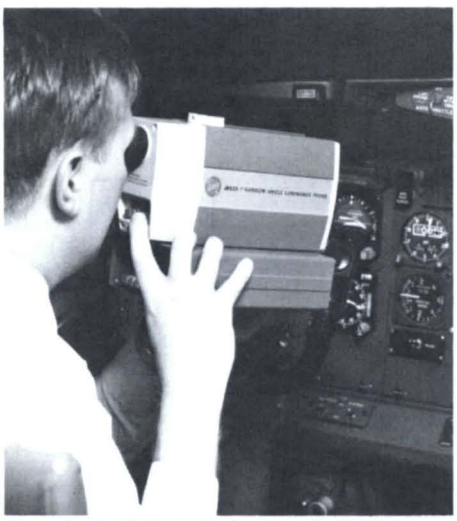
Typical Applications: Measuring brightness of video screens, street signs, light reflected from work surfaces, and movie screens

See page 459 for available Application Notes.

The J6503 measures luminance in footlamberts (candelas/m² (nit) with Option 02) where light scattered or emitted by a surface must be measured. The probe is pointed at the emitting surface.

The probe's response is closely matched to the CIE photopic curve, ensuring accurate results even when measuring spectrally different light sources.

The acceptance angle is approximately 8°, which is determined by internal field stop apertures. Providing that the 8° field is uniformly filled, the probe can be held at any distance from the source. At 21 inches from the front of the probe, the field of view is approximately three inches in diameter. The footlambert or candelas/m² (nit) (Option 02) indicator automatically lights when the J6503 is connected.



Measuring Luminance with the Tektronix J16/J6523.

J6523 1° Luminance Probe

Typical Applications: Measuring highway lighting, video displays, photographic equipment, and lighting equipment.

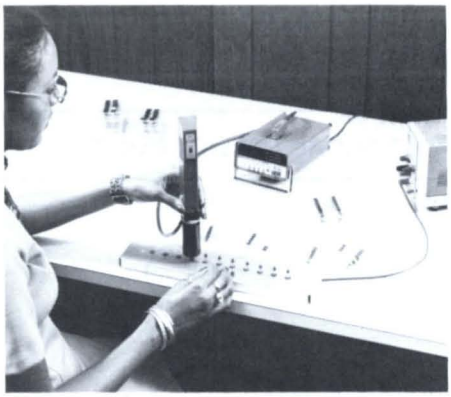
See page 459 for available Application Notes.

The J6523 will measure the luminance in footlamberts (candelas/m² with Option 02) of a spot as small as 0.32 inch in diameter. By using commercially available 55 mm stackable diopters, areas as small as 0.035 inch (+10 diopters) can be measured. These 55 mm diopters are physically similar to threaded 55 mm filters, and are available from most photography stores. (See Application Note 58-AX-3252).

The 1° angle represents 0.21 inch per foot of distance from the probe to the source. Thus at 10 feet, the J6523 measures a 2.1 inch diameter spot.

The probe includes an optical sighting system with a 9° viewing field. The focusing range is 18 inches to infinity, closer with 55 mm close-up diopters. The spectral response is closely matched to the CIE photopic curve (color-corrected) for accurately measuring all commonly used light sources.

The J6523 may be attached to the J16 or used with an optional probe extension cable. A standard ¼ in x 20 threaded socket allows it to be used on a tripod or an optical bench.



J6505 Red LED Test Probe

Typical Applications: Measurement of light-emitting diodes (LED) having spectral outputs in the red region (600 nm to 710 nm).

Note: For yellow or green LEDs use the J6501 probe, for infrared LEDs use the J6502 probe.

See page 459 for available Application Notes.

The J6505 measures illuminance in footcandles (lumens/m² (lux) with Option 02), which can easily be converted into luminous intensity in candelas. (See Application Notes 58-A-2635 and 58-A-2704-1.)

An adaptor supplied with the probe provides a controlled spacing between the sensor and the LED under test. The adaptor excludes ambient light, and has internal baffles to prevent stray reflections during the measurement. Three inserts are supplied with the adaptor to fit common sizes of LEDs (0.080 inch, 0.125 inch, and 0.200 inch in diameter). These inserts are made of soft plastic that can be easily modified by the user.

With the adaptor in place, a reading of 1 footcandle on the J16 represents 100 millicandelas of luminous intensity. With a metric version of the J16/J6505 (Option 02), 1 lumen/m² represents 10 millicandelas. A 10X increase in sensitivity is available on special order.

In the J6505, the silicon photodiode-filter combination provides an excellent match to the photopic curve in the region 600 nm to 710 nm. This close match requires compromising in the 380 nm to 600 nm region making this probe unsuitable for general illuminance measurements. For LED measurements in the yellow or green region, the LED adaptor must be used with the J6501 and the same conversion factor for luminous intensity applies.

J6504 Uncorrected Probe

Typical Applications: Checking light sources used in photoresist or photoprocessing applications, and comparisons of ultraviolet light sources.

See page 459 for available Application Notes.

This probe is designed for applications where only relative measurements need be made. The J6504 has the widest spectral range, and is the most sensitive probe. Use is made of a UV-enhanced silicon sensor and a UV-transmitting window rather than spectral-correction filters.

No units are indicated on the three front panel indicators when using the J6504, since it provides relative readings only.

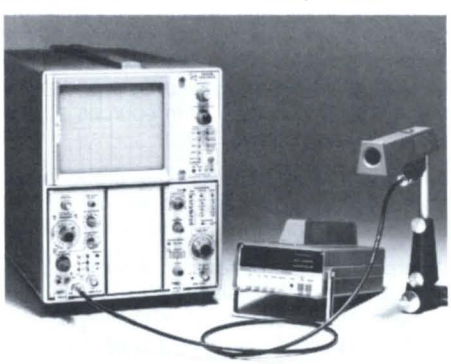
An optional filter holder may be used to mount standard 1-inch diameter filters on standard-configuration probes. Ultraviolet, visible, or near infrared filters can be used to select the wavelength of interest and exclude ambient light.

J16 with analog BCD output (Option 07).

Option 07 BCD/Analog Output

The J16 is equipped with a 25-pin connector on the unit's top. This provides parallel TTL logic anc BCD outputs, a "hold" input line (TTL), and an analog signal output (0 to −2 V or 0 to −6 V), depending on the range, for a full-scale readout. The analog bandwidth is approximately 0.8 Hz.

A cable-end connector and cover have been added to the accessories complement.



J16 probe used to measure pulsed light source.

CHARACTERISTICS

J16 MAINFRAME

(See Probes on previous pages)

Display — 3½ digit LED readout and three LEDs automatically indicating correct units for probe in use. Metric version readout is also available (Option 02).

Stability — Within 2% per year.

Linearity — Within 2% over the entire range, enabling single point calibration.

Integration Time — ≈100 ms.

Calibration — Electrical calibration of the J16 mainframe is performed by use of a calibrated voltage source or DVM traceable to NBS. Calibrated probes can be used with any J16 without additional calibration.

POWER REQUIREMENTS

Standard and Option 01 — Has internal rechargeable NiCad batteries that require 16 hours for a full charge. The J16 will operate nominally four hours continuously on a charge. The J16 cannot be operated from the battery charger for continuous operation since the charging rate is ≈200 mA, while the J16 draws ≈400 mA. For continuous operation an ac power supply is recommended.

Option 03 and Option 04 — Ac only operation, no internal batteries.

J16 AND PROBES ENVIRONMENTAL

Ambient Temperature — Nonoperating: −50°C to +75°C. Operating: −15°C to +40°C.

Altitude — Nonoperating: To 15 000 m (50,000 ft). Operating: To 4600 m (15,000 ft).

Humidity — Operating and Storage: Five cycles (120 hour) to 95% relative humidity at 40°C. Referenced to MIL-E-16400F.

Vibration — Operating: 15 minutes along each of the three major axes at a total displacement of 0.025 in p-p (4 g's) from 10 Hz to 55 Hz to 10 Hz in one minute cycles. Hold for three minutes at 55 Hz. All major resonances must be above 55 Hz.

PHYSICAL CHARACTERISTICS

(With Probe And Battery Pack Installed)

Dimensions	mm	in
Width	123	4.6
Height	60	2.4
Depth	203	8.0
Weight≈	**kg**	**lb**
Net	1.5	3.3
Domestic Shipping	2.3	5.0
Export-packed	4.5	10.0

ORDERING INFORMATION

(PROBES NOT INCLUDED UNLESS NOTED)

J16 Photometer/Radiometer Battery Version, With 115 V ac, 50 Hz to 400 Hz **$1,255**

Includes: Battery charger (119-0375-02); shoulder strap (346-0104-00); battery pack (016-0539-01); nonmetric version instruction manual (070-1879-00); or with Option 02 metric version instruction manual (070-1880-00).

J16-TV Photometer/Radiometer Package for TV Color CRT Set-Up **$1,880**

Includes: Same as J16 plus J6502 irradiance probe, light occluder (016-0305-00), 42 inch probe extension cable (012-0414-02).

OPTIONS (J16/J16-TV)

Option 01 — Battery version with 230 V ac, 50 Hz to 400 Hz charge. **NC**

Includes: Same as J16/J16-TV except battery charger 119-0375-03 is substituted.

Option 02*1 — Metric Readout. **NC**

Option 03 — 115 V ac only operation, 50 Hz to 400 Hz. **NC**

Includes: Ac power pack (119-0404-00); shoulder strap (346-0104-00); nonmetric version instruction manual (070-1879-00); or with Option 02, metric version instruction manual (070-1880-00).

Option 04 — 230 V ac only operation, 50 Hz to 400 Hz. **NC**

Includes: Same as Option 03 except it has ac power supply 119-0404-01 substituted.

Option 07 — BCD/Analog Output. **+$80**

**1 Option 02 must also be ordered for probes.*

PROBES

J6501 Illuminance Probe **$590**

J6502 Irradiance Probe **$590**

J6503 8° Luminance Probe **$590**

J6504 Uncorrected Probe **$550**

J6505 LED Probe, Includes LED Adaptor and 3 LED Holders **$590**

J6511 Illuminance Probe, Cosine Corrected (with 25 ft cable) **$570**

J6512 Irradiance Probe (with 6 ft cable) **$575**

J6523 1° Luminance Probe **$1,670**

OPTIONS (Probe)

Option 02 — Metric probes required for metric readout J16s (Option 02). **NC**

Option 05 — Actual spectral curve of any probe (available on initial order). **+$40**

OPTIONAL ACCESSORIES

42 Inch Probe Extender Cable — Connects J16 to probe. Order 012-0414-02 **$110**

Probe Extender Cables — Up to 30 ft in length are available on special order through your local Tektronix Sales Office.

Light Occluder — For TV color CRT balancing. Order 016-0305-00 **$28**

Filter Holder — Mounts 1 in diameter filters, of up to ⅜ in thickness*1, to probes (except J6511, J6512, J6523). Order 016-0527-00 **$31**

LED Adaptor — With 3 LED Holders (included with J6505). Order 014-0047-00 **$90**

Tripod — Order 016-0253-00 **$135**

**1 Filters available from vendors such as: ORIEL (203) 377-7877 or CORION CORP. (617) 429-5065 and others.*

POWER PACKS

Power packs can be quickly changed by removing four corner screws on the J16's rear panel and sliding the power supply or battery pack out.

Ac Power Supply

Ac Power Supply — Allows J16 to be used without batteries.
115 V ac, 50 Hz to 400 Hz (included with Option 03). Order 119-0404-00 **$240**
230 V ac, 50 Hz to 400 Hz (included with Option 04). Order 119-0404-01 **$250**

Battery Pack

Spare Battery Pack — Order 016-0539-01 **$160**

Battery Chargers— When ordering a battery pack for your ac-powered J16, also order one of the following chargers.

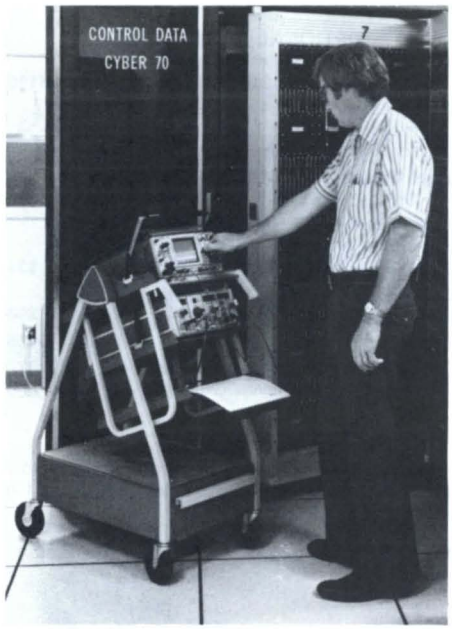
Battery Charger — 115 V ac, 50 Hz to 400 Hz (included with Standard J16). Order 119-0375-02 **$65**

Battery Charger — 230 V ac, 50 Hz to 400 Hz (included with Option 01). Order 119-0375-03 **$60**

Within the basic limitations of the silicon sensors and the J16 design, a number of modifications are possible. Contact your local Tektronix Sales Office or Representative regarding special application requirements.

APPLICATION NOTES

Title	Literature #
Photometry/Radiometry primer, and standardizing CRT measurements	60-W-5750
Luminous intensity and visible LED measurements with the Tektronix J16 Photometer	58-A-2635
Measuring pulsed light sources with the J16 and an oscilloscope	58-A-2702-1
Radiant intensity and infrared emitting diode measurements	58-A-2704-1
Television station applications for the J16 Photometer	58-AX-2764-1
Practical lighting measurements with the Tektronix J16	58-A-2912
TV picture monitor color temperature adjustment using the Tektronix J16	58-A-2926-1
Photographic exposure measurements with the Tektronix J16	58-AX-3060-1
Measuring the luminance of small areas of light with the J16 and J6523	58-AX-3252
Optical communications measurements	58-AX-3602



The Tektronix SCOPE-MOBILE® Cart Family at work.

Tektronix SCOPE-MOBILE® Carts give the quality and versatility needed by many test instrument users.

Tek carts free up your valuable table space and make sharing equipment between work benches easy. They are designed for easy integration into your instrument systems. OEM pricing is available for most models.

Whatever your requirements, Tek has a cart to fit your needs.

DIMENSIONS/LOAD CAPACITY/WEIGHTS

	K212		K213		K217		206	
Dimensions	13 x 17		13.7 x 20 13 x 20 (shelf)		18 x 27		27.6 x 22	
Load Capacity	**kg**	**lb**	**kg**	**lb**	**kg**	**lb**	**kg**	**lb**
Top Tray	36	80	34	75	45	100	45	100
Base	45	100	11	25	45	100	45	100
Hanging Shelf	—	—	18	40	—	—	—	—
Total	82	180	77	170	90	200	90	200
Weights≈								
Net	9	20	26	57	20	43	14	30
Shipping	13	28	34	75	26	57	17	38
Page	461		462		462		461	
Prices	$330		$595		$495		$235	

To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext. 99

INSTRUMENT/CART COMPATIBILITY

✓ — Recommended x — Compatible

	K212	K213	K213 Shelf	K217	206
Terminals/Copiers/Monitors/Plotters					
4000 Series					✓
4611/4612					✓
4631/4632					✓
4634/4635					✓
4644					✓
4660 Series					✓
4695					✓
4900					✓
4926/4970					✓
606B/608/620	x		x		
650 HR Series (Cabinet)				✓	x
670 Series				✓	x
Logic Analyzers					
1240/1241	x	x	x		
308/318/338	x		x		
DAS 9100				✓	x
DAS 9200					✓
Television/Spectrum Analyzers/Cable Testers					
1410R Series				✓	x
1420 Series	✓		x		
1430/1440				✓	x
1450/1470 Series				✓	x
1480 Series Cabinet	✓		x		x
1480 Series Rackmount				✓	x
1500 Series	✓				
1720/1730	✓		x		
1740/1750 Series	✓		x		
1910 (Cabinet)				✓	x
2754/55				✓	x
380	✓		x		
490 Series	✓				
528A	✓		x		
R140 Series				✓	x
R520 Series				✓	x
OF150 Series	✓				
OF235 Series	✓				
Oscilloscopes/Digitizers/Controllers					
11000 Series				✓	x
2200/2300/2400 Series	✓	x	x		
305/314/336	x		x		
390AD				✓	x
400 Series	✓	x	x		
4041	✓		✓		
530/540/550/560 Series (Cabinet)		✓			x
530/540/550/560 Series (Rackmount)				✓	x
7000/5000 Series (Cabinet)		✓			x
7000/5000 Series (Rackmount)				✓	x
7612D/7912AD				✓	x
7D20T	✓		✓		
T900 Series	✓	x			
TM 5000/TM 500 Series					
TM 5003/TM 503/TM 504	x	x	✓		x
TM 5006/TM 506/TM 515				✓	x
Curve Tracers					
370				✓	x
576/577		x		✓	x

K212 Portable Instrument Cart

Typical Applications:

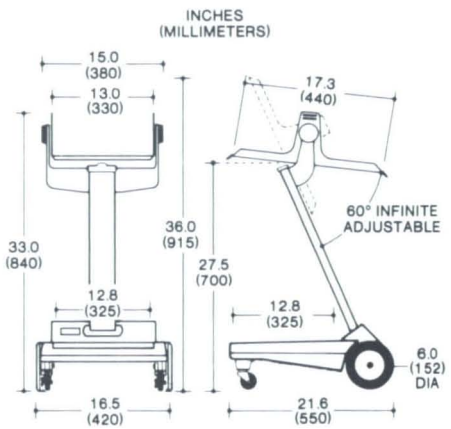
On-site mobility of all portable instruments in medical facilities, labs, computer rooms, manufacturing areas, and other work areas.

The K212 provides a stable yet mobile platform for all Tek portable oscilloscopes and most other portable instruments.

Tilting top tray, large locking front casters, and wide track base are standard features. Two bolt assembly required.

K212 Data Sheet 56-W-5835 is available.

CHARACTERISTICS



Construction — Base of thermoset polyester. Column and top of tray made of high-strength aluminum.

Color — Base and tray are Tek blue. Column and yoke are silver gray.

ORDERING INFORMATION

K212 Portable Instrument Cart **$330**
Includes: Two 1 in x 5 ft securing straps (346-0049-04); retaining bar (650-1881-00); two 3/16" bolts; 3/16" Hex key; instruction sheet (070-5554-00).

Special terms, conditions and discounts are available to qualified OEMs on the K212 and K217 carts. Contact your local Tektronix Sales Office.

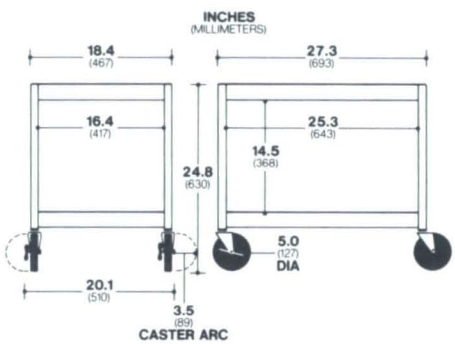
Model 206/206D Utility Cart

Typical Applications:

General purpose use and on-site mobility of general instruments, computer peripherals, laboratory and office use.

Features include a plastic laminate on both surfaces and brakes on front casters.

CHARACTERISTICS

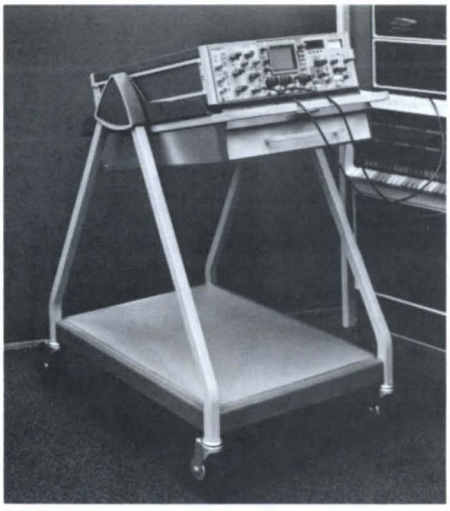


ORDERING INFORMATION

206 Light Gray Finish **$235**
Includes: Instruction sheet (062-1408-02).

206D Brown Finish **$235**
Includes: Instruction sheet (062-6617-00).

To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext. 99



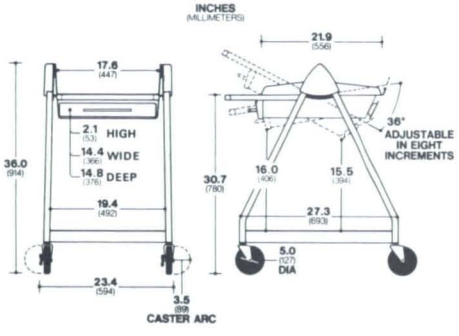
K217 Rack Instrument Cart

Typical Applications:

On-site mobility of most rackmountable or rack-width instruments The ears of the rackmountable instruments extend over the sides of tray.

The K217 directly replaces the 205/205D carts. Standard features include a tilting top tray, storage drawer under the top tray, a four outlet power strip, and front locking casters.

CHARACTERISTICS



Color — Tek blue with silver-gray legs.

ORDERING INFORMATION

K217 Rack Instrument Cart **$495**
Includes: Instruction sheet (070-5653-00).
Option 01 — Brown Finish **NC**

OPTIONAL ACCESSORY

(Fits K217 and 205/205D Carts)

Securing Strap — Nylon webbed, 1 ½ inch x 53 inch to secure instruments to top tray.
Blue for K217. Order 346-0070-01 **$70**
Brown for K217 Option 01. Order 346-0070-03 **$70**

Special terms, conditions and discounts are available to qualified OEMs on the K212 and K217 carts. Contact your local Tek Sales Office.

K213 shown with Option 22.

K213 Lab Instrument Cart

Typical Applications:

On-site mobility of 5000 Series and 7000 Series Oscilloscopes in laboratory and manufacturing environments.

K213 directly replaces Model 3 Lab Cart. Standard features include tilting top tray, brakes on all casters, lockable drawer in the base, four outlet power strip, 7000 Series scope lock-down bar, mounting hardware for TM 500 equipment and older scopes, a hanging shelf and a securing strap.

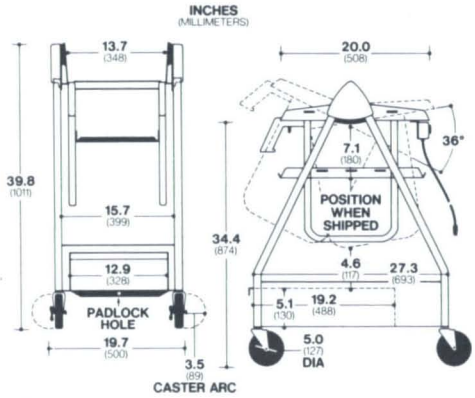
The hanging shelves are supported underneath and tilt with the top tray. These shelves are large enough to carry a TM 504 system or other small-to-medium sized test instruments. Slots in the shelves allow instruments to be secured with straps.

Option 10 provides a sliding drawer for use with the 7854 keyboard. The keyboard drawer mounts underneath the top tray and reduces available hanging shelf space by approximately three inches.

Option 12 gives an enclosure mounted on the standard shelf for storage of unused 5000 or 7000 Series plug-ins. The storage cabinet mounts on or under a shelf, but the option and kit do not include a shelf. Up to two storage cabinets can be installed at one time.

K213 shown with an MP 2601 system.

CHARACTERISTICS



Color — Tek blue with silver-gray legs.

ORDERING INFORMATION

K213 Lab Instrument Cart **$595**
Includes: Securing strap, 1 ½ in x 42 in (346-0136-01); shelf (436-0132-01); miscellaneous mounting adaptors; four outlet, 115 V ac power strip; instruction sheet.

OPTIONS

Option 05 — Delete Power Strip. **NC**
Option 10 — 7854 Keyboard Drawer. **+$180**
Option 12 — 5000/7000 Series Plug-in Storage Cabinet. **+$120**
Option 22 — Combines Options 10 and 12. **+$285**

OPTIONAL ACCESSORIES

(Fits K213 and Model 3 Carts)

Securing Straps — Black nylon webbed, for use on top tray, shelves, or base.
1 ½ in x 42 inch. Order 346-0136-01 **$31**
1 ½ in x 57 inch. Order 346-0156-01 **$26**
Extra Shelf — Mounts below top tray.
Order 436-0132-01 **$55**
7854 Keyboard Drawer Kit — (Option 10 in kit form) Mounts under top tray.
Order 436-0197-00 **$215**
Plug-In Storage Cabinet Kit — (Option 12 in kit form) Mounts on or under hanging shelves. Does not include shelf. Order 436-0196-00 **$145**
Retaining Bar — Used to prevent sliding of portable oscilloscope on top tray or shelf when secured by straps. Mounting hardware included. Order 650-1881-00 **$12**

To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext. 99

THE STRONGEST LINK BETWEEN YOUR TEK INSTRUMENT AND RESULTS

Tek instruments are designed for users who place a premium on equipment quality and on reliability of results. Tek probes are engineered, assembled and tested to provide the most compatible link possible between tests instruments and the circuits under test.

THE ABCs OF PROBES

This comprehensive primer on signal acquisition probes contains sections on understanding probe specifications and applications and how to select the best probe for your application. Easy to use charts and tables speed the selection process.

For your free copy, ask your Tektronix Sales Engineer for Literature 60-W-6053 or call toll-free in the USA 1-800-426-2200. In Oregon, call collect (503) 627-9000.

PROBES: SELECTION CRITERIA

No factor is more critical to optimized system performance than proper probe selection. A probe that's not right for your application can mean a significant loss in measurement results, plus costly delays and errors.

For over 35 years, Tektronix has been designing probes that are matched not only to our scopes, but to your own instrument and application needs. They minimize circuit loading, while extending and enhancing system performance.

By extending our resistive-wire, center-conductor cable technology, Tek 10X Passive probes can transfer a signal frequency that exceeds 300 MHz and presents only an added 3 pF per meter of cable to a circuit.

Tek probe products include active voltage probes, active and passive current probes, high voltage probes, low impedance/high frequency probes, and differential probes.

Bandwidth/rise time, input voltage, input impedance and limiting aberrations are all characteristics to evaluate in terms of your own application.

While electrical considerations are of major importance in your selection, physical parameters, such as probe length and proper tip adaptor, can be equally crucial. Unnecessary cable length, for example, will decrease bandwidth and increase the loading capacitance of the probe.

You'll find a wide variety of adaptors and probe tips available which feature Tek's special alloy coating that minimizes low current conduction problems. All are inherent to the Tek modular probe concept that lets you snap tips and other probe parts together without tools, so maintenance and repair of damaged probes is of minimal expense.

Quick Delivery
The following probes are now ready to ship within 24 hours:

P6101A 1X, 2 m; P6105A 10X, 2 m; P6106A 10X, 2 m; P6122 10X, 1.5 m; P6131 10X, 1.3 m.

See pages 468-469, 472.

To order, call 1-800-426-2200.

Reduced Price
The following probes are available at a reduced price:

P6006 10X; P6028 1X; P6101A 10X; P6105A 10X; P6108A 10X; P6122 10X.

To order, call 1-800-426-2200.

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Differential Probes	482
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A PROBE FOR VIRTUALLY EVERY APPLICATION

Usually there are several probes from which to select. We've indicated in this guide those probes which offer the best performance match, along with other compatible combinations.

	Passive																			Active				Differ-ential	High Voltage		Specialty					Current			
	P6006	P6008*3	P6028	P6048	P6053B	P6056/57	P6060	P6062B	P6063B	P6101A	P6102A	P6105A	P6106A	P6107A	P6108A	P6122	P6130	P6131	P6134	P6149A	P6201	P6202A	P6230	P6231	P6055*4	P6046	P6135	A6902B	P6007	P6009	P6015	P6420	P6601	P6602	P6021*1	P6021*2	P6022*1	P6022*2	A6302*5	A6303*5
11000 Series																																							
11A32	–	–	–	–	–	+	–	–	–	–		–	–		–	–	–		✓		+	+	+			–		–	–	–				–	–	–	–	–	–
11A33	–	–	–	–	+	+	–	–	+	–		–	+		–	–	+				+	+	+			–	✓	–	–	–	–			–	–	–	–	–	–
11A34	–	–	–	–	–	+	–	–	–	–		–	–			–	–	–	✓		+	+	+			–		–	–	–	–			–	–	–	–	–	–
11A52						+															+	+	+	✓		–		–							–		–	–	–
11A71						+															–	–	+	✓		–		–							–		–	–	–
7000 Series																																							
7A13	–	–	–		+		–	+	–	–	✓	+	–	–	–	+			–		+	+	+		✓	–		–	–	+	–			–	–	+	–	–	–
7A15A	–	+	–	+	+		–	+	+	–		+	+	+	+	+				–	+	+	+		–	+		–	–	+	–			–	–	+	–	–	–
7A16A	–	–	–	–	–		–	–	–	–		–	✓	–	–	+				–	+	+	+		–	–		–	–	–	–			–	–	–	–	–	–
7A18A	–	+	–	+	+		–	+	+	–		✓	+	+	+	+				–	+	+	+		–	+		–	–	+	+			–	–	+	–	–	–
7A19						+															+	–	+			–		–							–		–	–	–
7A22	+	+	+				+	+	+	+	+			+						+	+	+		✓	+		+	+	+	+			+	+	+	+	+	+
7A24						+															+	+	+			–	–								–		–	–	–
7A26	–	–	–	–	+		–	–	✓	–		–	✓	–	–	–	+			–	+	+	+		–	–		–	–	–	–			–	–	+	–	–	–
7A29						+															–	–	+			–	–	–							–		–	–	–
7A42	–	–	–		–	+	–	–	–	–		–	–	–	–	–	–	✓			+	+	✓					–	–	–	–				–	–	–	–	–	–
7D12	+	+	–	+	+		+	+	+	+		+	+	+	+	+	+			+	+	+	+		✓	+		–	+	+	+			+	+	+	+	+	–
7D13A																															✓	✓							
7D20	–	+	–	+	+		–	+	+	–		+	+	+	+	+	+			–	+	+	+		–	+			–	+	+				–	–	–	–	–	–
5000 Series																																							
5A13N	+	+	+				+	+		+	+			+						+	+	+	+		+	+		+	+	+				+	+	+	+	+	+
5A14N/5N/8N	+	+	+				+	+		+	✓			+						+	+	+	+		+	+		+	+	+				+	+	+	+	+	+
5A21N	+	+	+				+	+		+	✓			+						+	+	+	+	✓	+		+	+	+	+			✓	+	+	+	+	+
5A22N	+	+	+				+	+		+	+			+						+	+	+	+		+	+		+	+	+				+	+	+	+	+	+
5A26	+	+	+				+	+		+	✓			+						+	+	+	+	✓	+		+	+	+	+				+	+	+	+	+	+
5A38	+	+	–	+	+		+	+	+	–		✓	+	+	+	+	+			+	+	+	+		+	+		–	–	+	+				+	+	+	+	+	–
5A45	–	+	–	+	+		–	+	+	–		+	+	+	+	+	+			–	+	+	+		+	+		–	–	+	+				+	–	+	+	–	–
5A48	–	+	–	+	+		–	+	+	–		✓	+	+	+	+	+			+	+	+	+		+	+		–	–	+	+				+	–	+	+	+	–
5D10	+	+	+				+	+		–				+						+	+	+	+		+	+		+	–	+	+				+	+	+	+	+	+
TM 500 Series																																							
AM 502	+	+	+				+	+		+				+						+	+	+	+		✓	+		+	+	+	+			✓	+	+	+	+	+
AM 503																																						✓	✓
DM 501A																															✓	+							
DM 502A																															✓	+							
DM 505																															✓	+							
SC 501	+	+	+				+	+		+	✓			+						+	+	+	+		+	+		+	+	+	+				+	+	+	+	+	+
SC 502	+	+	+				+	+		+	✓			+						+	+	+	+		+	+		+	+	+	+				+	+	+	+	+	+
SC 503	+	+	+				+	+		+	✓			+						+	+	+	+		+	+		+	+	+	+				+	+	+	+	+	+
SC 504	–	+	–	+	+		–	+	+	–		+		+	+	+	+			–	+	+	+		–	+		–	–	+	–				+	–	+	–	–	–
TM 5000 Series																																							
DC 5009	–	–	–				–	–		–		–		–	–	–	+			–	+	+	+		–	–		–	–	–	–				–	–	+	–	–	–
DC 5010	–	–	–	–	–	+	–	–	–	–		–		–	–	–	–			–	+	+	+		–	–		–	–	–	–				–	–	–	–	–	–
DM 5010																															+								
SI 5010						+															+	+	+			–		–							–		–		–	–

✓ Indicates recommended combinations of probe and instrument.
\+ Indicates usable combinations where probe bandwidth exceeds that of instrument.
– Indicates combinations where probe limits system bandwidth.

*1 With Termination
*2 With 134 Amplifier
*3 Environmental Probe
*4 Matched pair
*5 With AM 503

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	Passive																						Active			Differ-ential	High Volt-age	Spe-cialty	Current					
	P6006	P6008*3	P6028	P6048	P6053B	P6056/57	P6060	P6062B	P6063B	P6101A	P6102A	P6103	P6105A	P6106A	P6107A	P6108A	P6109	P6121	P6122	P6130	P6131	P6133	P6136	P6149A	P6201	P6202A	P6230	P6055*4	P6046	A6902B	P6007	P6009	P6015	P6420	P6602	P6021*1	P6021*2	P6022*1	P6022*2	A6302*5	A6303*5
T900 Series																																								
T912/21	✓	+	+			+	+		+			+		+	+			+	+				+	+	+	+	+	+	+	+	+			+	+	+	+	+	+
T922R	✓	+	+		+		+	+	+			+		+				+					+			+	+	+	+	+	+			+	+	+	+	+	+
T932A/35A	✓	+	−			+	+		−			+		+	✓			+	+				+	+	+	+	+	+	−	−	+	+			+	+	+	+	+	−
300 Series																																								
305/14	+	+	+			+	+		+	+				+									✓	+	+	+	+	+	+	+	+			+	+	+	+	+	+
323	+	+	+			+	+		+			+		+					+				+	+	+	+	+	+	+	+	+			+	+	+	+	+	+
326	+	+	+			+	+		+	+		+		+	+				+				+	+	+	+	+	+	+	+			+	+		+	+	+	+
335	+	+	−	+	+	+	+	+	−			+	+	+	+			+	+				✓	+	+	+	+	+	−	−	+	+			+	+	+	+	+	−
336	+	+	+			+	+		+			+		+	+			+	+				+	+	+	+	+	+	+	+	+			+	+	+	+	+	+
390AD D	+	+	−	+	+		+	+	+	+			+	+				+	+				+	+	+	✓	+	+	−	−	+	+			+	+	+	+	+	−
390AD S	−	+	−	+	+		−	+	+	−			+	+				+	+				−	+	+	+	+	+	−	−	+	+			+	−	+	+	−	−
400 Series																																								
434	+	+	−	+	+		+	+	+	+			✓	+	+	+			+	+				+	+	+	+	+	+	−	+	+	+			+	+	+	+	+	−
455	−	+	−	+	+		−	+	+	+			✓	+	+	+			+	+				+	+	+	+	+	+	−	−	+	+			+	−	+	+	+	−
464	−	+	−	+	+		−	✓	+	−			✓	+	+	+			+	+				−	+	+	+	−	+	−	−	+	−			−	−	+	−	−	−
465/M	−	+	−	+	+		−	+	+	−			+	+	+	+			+	+				−	+	+	+	−	+	−	−	+	−			−	−	+	−	−	−
465B	−	+	−	+	+		−	+	+	−			✓	+	+	+			+	+				−	+	+	+	−	+	−	−	+	−			−	−	+	−	−	−
466	−	+	−	+	+		−	✓	+	−			✓	+	+	+			+	+				−	+	+	+	−	+	−	−	+	−			−	−	+	−	−	−
475	−	−	−	−	+		−	−	+	−			−	✓	−	−			−	+				−	+	+	+	−	−	−	−	−	−			−	−	+	−	−	−
475A	−	−	−	−	−		−	−	−	−			−	✓	−	−			−	+				−	+	+	+	−	−	−	−	−	−			−	−	−	−	−	−
485	−	−	−	−	−	+	−	−	−	−			−	✓	−	−			−	✓				−	+	+	+	−	−	−	−	−	−			−	−	−	−	−	−
2400 Series																																								
2430	−	−	−	−	−	+	−	−	−	−			−	−	−	−			−	−	✓				+	+	+		−	−	−	−	−			−	−	−	−	−	−
2445A	−	−	−	+	+	+	−	−	+	−			−	+	−	−			−	+	✓	✓			+	+	+		−	−	−	−	−	✓	✓	−	−	+	−	−	−
2455A	−	−	−	−	−	+	−	−	−	−			−	−	−	−			−	−	✓		✓		+	+	+		−	−	−	−	−	✓	✓	−	−	−	−	−	−
2445	−	−	−	+	+	+	−	−	+	−			−	+	−	−			−	+	+				+	+	+		−	−	−	−	−	✓	✓	−	−	+	−	−	−
2465	−	−	−	−	−	+	−	−	−	−			−	−	−	−			−	−	✓				+	+	+		−	−	−	−	−	✓	✓	−	−	−	−	−	−
2467	−	−	−	−	−	+	−	−	−	−			−	−	−	−			−	−	−		✓		+	+	+		−	−	−	−	−			−	−	−	−	−	−
2465A	−	−	−	−	−	+	−	−	−	−			−	−	−	−			−	−	✓				+	+	+		−	−	−	−	−	✓	✓	−	−	−	−	−	−
2200 Series																																								
2213A/15A	−	+	−	+	+		−	+	+	−			+	+	+	+			✓	+				−	+	+	+	+	+	−	−	+	+			+	−	+	+	−	−
2225	−	+	−	+	+		−	+	+	−			+	+	+	+			+	+				✓	+	+	+	+	+	−	−	+	+			+	−	+	+	−	−
2235/20	−	+	−	+	+		−	+	+	−			+	+	+	+			✓	+				−	+	+	+	−	+	−	−	+	−			−	−	+	−	−	−
2236/30	−	+	−	+	+		−	+	+	−			+	+	+	+		✓	+	+				−	+	+	+	−	+	−	−	+	−	✓	✓	−	−	+	−	−	−
2245/46	−	−	−	−	+		−	−	+	−			−	+	−	−	✓		−	+				−	+	+	+	−	−	−	−	−	−			−	−	+	−	−	−
2300 Series																																								
2335	−	+	−	+	+		−	+	+	✓			+	+	+	✓			+	+				−	+	+	+	−	+	−	−	+	−			−	−	+	−	−	−
2336	−	+	−	+	+		−	+	+	✓			+	+	+	✓			+	+				−	+	+	+	−	+	−	−	+	−			−	−	+	−	−	−
2337	−	+	−	+	+		−	+	+	✓			+	+	+	✓			+	+				−	+	+	+	−	+	−	−	+	−	✓	✓	−	−	+	−	−	−

✓ Indicates recommended combinations of probe and instrument.
\+ Indicates usable combinations where probe bandwidth exceeds that of instrument.
− Indicates combinations where probe limits system bandwidth.

*1 With Termination
*2 With 134 Amplifier
*3 Environmental Probe
*4 Matched pair
*5 With AM 503

THE ABCs OF PROBES

This comprehensive booklet on signal acquisition probes contains sections on understanding probe specifications and applications and sections on how to select the best probe for your application. Easy to use charts and tables speed the selection process.

For your free copy, ask your Tektronix Sales Engineer for Literature 60-W-6053 or call toll-free in the USA 1-800-426-2200. In Oregon, call collect (503) 627-9000.

See the Difference
The photos at right show signals measured with Tek probes and their commodity counterparts. To get the best performance from your measurement system use Tek probes!

GLOSSARY

Aberrations — Deviation from a theoretically correct response to an input signal. Measured in + and − deviation from the final level (flat top).

A-S Product (Amp Second) — A figure of merit applied to current probes when operated under pulse-type conditions. When the peak current times the pulse width exceeds the A-S rating, the core will tend to saturate and clip portions of the displayed signal.

Bandwidth — Tektronix probe bandwidth specifications assume scope bandwidth "at the probe tip" unless otherwise noted. The specified probe bandwidth must be equal to or greater than the specified scope bandwidth. (All BW figures refer to the −3 dB point.)

Compensation Range — The range of the scope input amplifier input capacitances for which you can compensate your probe.

Circuit Loading — A function of total probe impedance at a specific frequency. Probe tip capacitance becomes the major contributor to circuit loading as frequencies increase or risetimes decrease.

Common-Mode Rejection Ratio (CMRR) — A description of a probe/differential amplifier's ability to reject common-mode signals. At a system CMRR of 10,000:1, a 10 V common-mode input signal will be attenuated to 1 mV at the output, while the differential (desired) signal will be amplified times the system gain.

Derating — Passive voltage probes maximum input voltage is derated after some specific upper frequency. Ac current probes upper and lower frequency derating points are specified for maximum continuous currents.

Dynamic Range — Applies to Active (FET) probes. Specified as the maximum linear as operating range in volts.

Insertion Impedance — Associated with current probes describing the loading effect in ohms (Z) at some specific frequency.

Maximum Input Voltage — Maximum allowable input at the probe tip. Specified as dc + peak ac.

Maximum Ac Current (CW) — Maximum continuous current handling ability of a current probe. Derated with frequency.

Maximum Peak Pulse Current — Maximum peak current handling ability of a current probe. Always greater than the maximum continuous current rating. Controlled by the Amp-Second product.

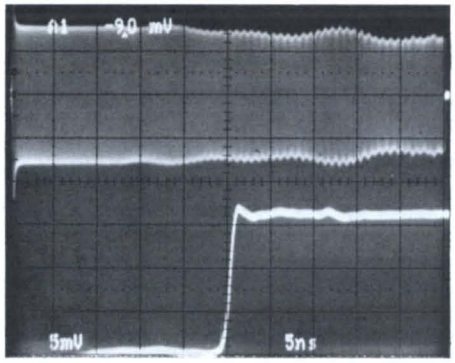
Maximum Peak Pulse Voltage — Maximum peak voltage handling ability of high voltage probes. Specification carries pulse width and duty cycle restrictions.

Rise Time — A probe's 10% to 90% response to a step function.

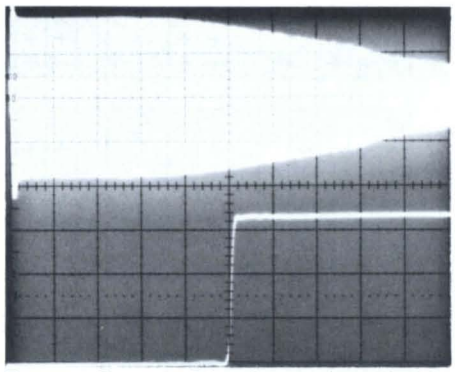
Ringing — Damped oscillation response usually caused by inductive effects of poor probe grounding techniques.

Tangential Noise — A practical method of specifying probe generated noise (active probes). Tangential noise figures are approximately two times RMS noise.

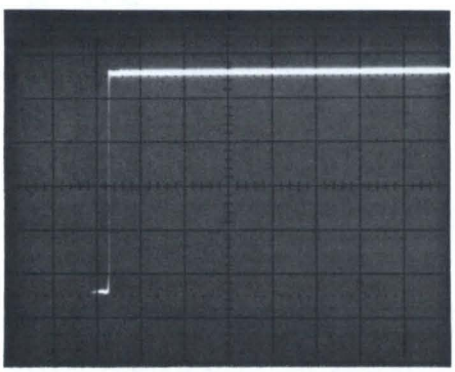
Optimum Performance With Tek



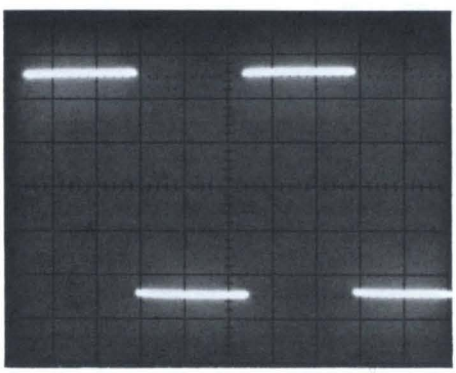
Bandwidth: Tek probe faithfully transmits 300 MHz signal.



Frequency Response: Tek probes evenly matched for clear response.

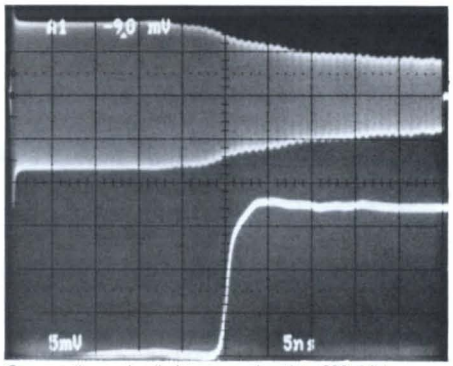


Probe Tip Accessories: By choosing the appropriate ground lead from Tek probe accessories, ringing does not exist.

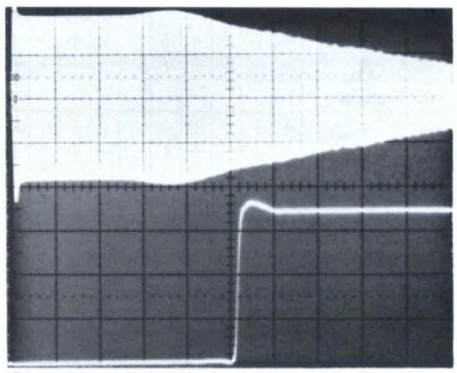


Environmental: Tek offers superior performance. No signal degradation after five days in high humidity.

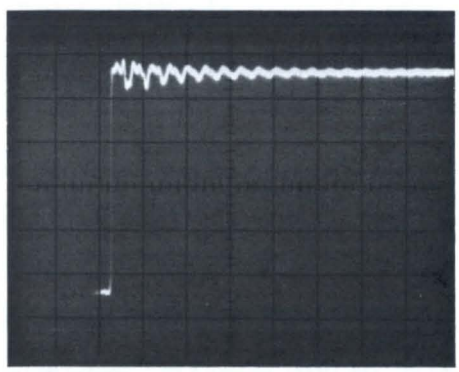
Loss With Commodity Probe



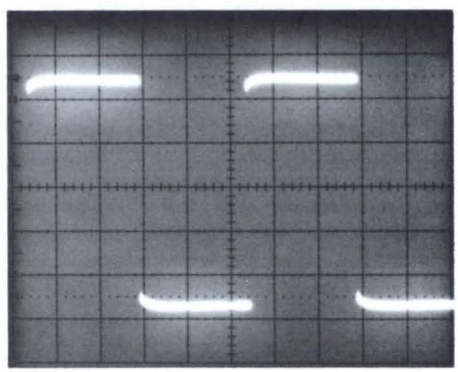
Commodity probe limits same signal to 200 MHz.



Commodity probe peaked resulting in aberrations.



Commodity probes may not have the right selection of accessories to make a faithful measurement.



Commodity probe shows "hook" after same humidity test.

PASSIVE PROBES

For amplitude measurements, the capacitance and resistance of the probe form a voltage divider with the circuit under test. For low frequency (about 5 MHz and below), the resistive component is of primary importance in most probes and should be at least two orders of magnitude greater than the circuit source impedance. For frequencies higher than 30 MHz, the importance of the capacitance increases drastically and will become the prime consideration.

For general-purpose use, these probes offer a wide selection for a variety of applications for 1 MΩ inputs.

Type	Attenuation	Length*1	Old Package Number	New Package Number	Loading		BW MHz*2*4 at −3 dB	DC Maximum	Scope C in pF	Readout	Page
P6006	10X	3.5 ft 6 ft 9 ft 12 ft	010-0127-00 010-0160-00 010-0146-00 010-0148-00	P6006 Opt 01 P6006 P6006 Opt 03 P6006 Opt 04	10 MΩ	7.5 pF*2 8.5 pF 11.0 pF 15.0 pF	35 25 25 12	600 V	15 to 55	No	—
P6007	100X	3.5 ft 6 ft 9 ft 12 ft	010-0150-00 010-0165-00 010-0152-00 010-0154-00	P6007 Opt 01 P6007 P6007 Opt 03 P6007 Opt 04	10 MΩ	2.0 pF*2 2.2 pF 2.4 pF 2.6 pF	25 20 15 13	1.5 kV	15 to 55	No	477
P6008	10X	3.5 ft 6 ft	010-0129-00 010-0129-01	P6008 Opt 01 P6008 (Environmentalized)	10 MΩ	7.5 pF	100 100	600 V	12 to 47	No	471
P6009	100X	9 ft 9 ft	010-0170-00 010-0264-01	P6009 Opt 14 P6009	10 MΩ	2.5 pF 2.5 pF	120 100	1.5 kV	12 to 47	No Yes	477
P6015	1000X	10 ft	010-0172-00	P6015	100 MΩ	3.0 pF	75	20 kV	12 to 47	No	477
P6028	1X	3.5 ft 6 ft 9 ft 12 ft	010-0074-00 010-0075-00 010-0076-00 010-0077-00	P6028 Opt 01 P6028 P6028 Opt 03 P6028 Opt 04	1 MΩ	50.0 pF 67.0 pF 90.0 pF 112.0 pF	17 10 7 4	600 V	Any	Yes	—
P6048	10X	6 ft	010-0215-00	P6048	1 kΩ	1.0 pF	100	20 V	15 to 20	No	471
P6053B	10X	3.5 ft 6 ft 9 ft	010-6053-11 010-6053-13 010-6053-15	P6053B Opt 01 P6053B P6053B Opt 03	10 MΩ	9.5 pF 12.5 pF 13.5 pF	200 200 115	500 V	15 to 24	Yes*5	470
P6055*3	10X	3.5 ft	010-6055-01	P6055 Opt 01	1 MΩ	10.0 pF	60	500 V	20 to 47	Yes	480
P6056	10X	6 ft	010-6056-03	P6056	500 Ω	1.0 pF	3500	500 V	N/A (50 Ω)	Yes	471
P6057	100X	6 ft	010-6057-03	P6057	5 kΩ	1.0 pF	1400	500 V	N/A (50 Ω)	Yes	471
P6062B	10X or 1X 10X or 1X 10X or 1X	3.5 ft 6 ft 9 ft	010-6062-11 010-6062-13 010-6062-15	P6062B Opt 01 P6062B P6062B Opt 03	10 MΩ 1 MΩ 10 MΩ 1 MΩ 10 MΩ 1 MΩ	13.5 pF 100.0 pF 14.0 pF 105.0 pF 17.0 pF 135.0 pF	100 8 100 6 95 4.5	500 V	15 to 47	Yes	470
P6063B	10X or 1X 10X or 1X	3.5 ft 6 ft	010-6063-11 010-6063-13	P6063B Opt 01 P6063B	10 MΩ 1 MΩ 10 MΩ 1 MΩ	11.0 pF 80.0 pF 14.0 pF 105.0 pF	200 12 200 6	500 V	15 to 24	Yes	470
P6101A	1X	1 m 2 m 3 m	010-6101-11 010-6101-13 010-6101-15	P6101A Opt 01 P6101A ★ P6101A Opt 03	1 MΩ	32.0 pF 54.0 pF 78.0 pF	34 15 8	500 V	Any	—	468
P6102A	10X	2 m	P6102A	P6102A	10 MΩ	13.2 pF	60	500 V	36 to 55	Yes	468
P6104A	10X	2 m	010-6104-11	P6104A	10 MΩ	11.2 pF	100	500 V	15 to 35	Yes	
P6105A	10X	1 m 2 m 3 m	010-6105-11 010-6105-13 010-6105-15	P6105A Opt 01 P6105A ★ P6105A Opt 03	10 MΩ	8.7 pF 11.2 pF 13.2 pF	100 100 90	500 V	15 to 35 15 to 35 15 to 30	Yes	468
P6106A	10X	1 m 2 m 3 m	010-6106-11 010-6106-13 010-6106-15	P6106A Opt 01 P6106A ★ P6106A Opt 03	10 MΩ	8.7 pF 11.2 pF 13.2 pF	250 250 150	500 V	15 to 35 15 to 35 15 to 30	Yes	468
P6107A	10X	2 m	010-6107-13	010-6107-13	10 MΩ	13.0 pF	100	500 V	20 to 51	Yes	468
P6108A	10X	1 m 2 m 3 m	010-6108-11 010-6108-13 010-6108-15	P6108A Opt 01 P6108A P6108A Opt 03	10 MΩ	8.7 pF 11.2 pF 13.2 pF	100 100 90	500 V	15 to 35 15 to 35 15 to 30	No	468
P6121	10X	1.5 m	010-6121-01	P6121	10 MΩ	11.0 pF	100	500 V	20 to 26	Yes	469
P6122	10X	1.5 m 2 m 3 m	010-6122-01 010-6122-03 010-6122-05	P6122 ★ P6122 Opt 02 P6122 Opt 03	10 MΩ	11.0 pF 12.0 pF 14.0 pF	100 100 90	500 V	15 to 35	No	469
P6125	5X	1.5 m	010-6125-11	P6125	5 MΩ	20.0 pF	200	250 V	15 to 33	No	469
P6130	10X	1.5 m 2 m 3 m	010-6130-01 010-6130-03 010-6130-05	P6130 Opt 01 P6130 P6130 Opt 03	10 MΩ	12.7 pF 13.2 pF 14.5 pF	250 250 150	500 V	15 to 35 15 to 35 15 to 30	Yes	472
P6131	10X	1.3 m 2 m 3 m	010-6131-01 010-6131-03 010-6131-05	P6131 ★ P6131 Opt 02 P6131 Opt 03	10 MΩ	10.8 pF 13.5 pF 14.5 pF	300 250 150	500 V	14 to 18	Yes	472
P6133	10X	1.3 m 2 m 3 m	P6133 Opt 01 P6133 P6133 Opt 03	P6133 Opt 01 P6133 P6133 Opt 03	10 MΩ	10.8 pF 13.5 pF 14.5 pF	150 150 120	500 V	13 to 30 13 to 30 13 to 25	Yes	472
P6136	10X	1.3 m	—	P6136	10 MΩ	10.8 pF	350	500 V	12 to 18	Yes	472
P6148A	10X	2 m	010-6148-13	010-6148-13	10 MΩ	13.0 pF	50	500 V	20 to 51	No	
P6149A	10X	2 m	010-6149-13	P6149A	10 MΩ	13.0 pF	50	500 V	20 to 51	No	468

*1 *All lengths are nominal and measured electrically for optimum performance.*

*2 *Rating varies with scopes having other than 20 pF inputs.*

*3 *Designed for use with scopes having differential inputs.*

*4 *25 Ω source.*

*5 *Trace identification button.*

Shaded probes indicate additional savings available from decreased prices.
★ These probes available to ship within 24 hours.

To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext. 99

P6101A
Dc to 34 MHz, 1X Modular

P6102A
Dc to 60 MHz, 10X Modular With Readout

P6105A
Dc to 100 MHz, 10X Modular With Readout

P6106A
Dc to 250 MHz, 10X Modular With Readout

P6108A
Dc to 100 MHz, 10X Modular

P6107A
Dc to 100 MHz, 10X Modular With Readout

P6149A
Dc to 50 MHz, 10X Modular

MODULAR PROBES

Tektronix modular probes are designed to save you money in repair and maintenance over the life of the probe. The three modules (probe head, cable, and connector/compensation box) quickly snap or screw together eliminating the need for soldering. Spare modules can be ordered and stocked, reducing down-time and eliminating the need to send a probe in for repairs (see page 488). Modularity, rugged construction and highly reliable hybrid circuitry make these Tektronix probes a cost effective probing solution.

For 1 MΩ Input

Simplified, Faster Maintenance and Repairs

High Fidelity Signal Acquisition at Low Cost

Hybrid Circuitry for Improved Performance

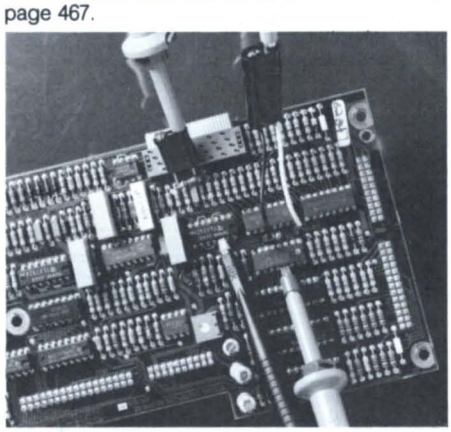
Rugged for Greater Reliability

Tektronix modular passive probes are used to acquire high fidelity signals from low source impedance circuits. The P6102A, P6105A, P6106A and P6107A will automatically scale the readout on oscilloscopes equipped with this feature. All but the P6101A and P6108A provide a ground reference button on the probe head for quick trace identification. The P6107A and P6149A feature a right angle BNC connector.

Tektronix modular probes may be used with all oscilloscopes with 1 Ω input impedance and appropriate input capacitance as indicated in the chart on the preceding page. These probes are compatible with all miniature probe accessories on page 486.

CHARACTERISTICS

For electrical characteristics, see the table on page 467.



For probe accessories, see page 486.
For replaceable modular subassemblies, see page 488.
Instrument compatibility chart is on page 464.

ORDERING INFORMATION

P6101A 1X, 34 MHz, 2 m Modular Probe. *Quick Delivery/Reduced Price* **$53**
Includes: Retractable hook tip (B3, 013-0107-05); probe tip ground cover (B16, 166-0404-01); 5 in ground lead (175-0124-01); 12 in ground lead (G7, 175-0125-01); alligator clip (344-0046-00); two each of black, white and silver cable markers; instruction sheet (070-5299-00).

P6105A 10X, 100 MHz, 2 m Modular Probe. *Quick Delivery/Reduced Price* **$93**
Includes: Same as the P6101A plus adjustment tool (F3, 003-1364-01); instruction sheet (070-5516-00).

P6106A 10X, 250 MHz, 2 m Modular Probe. *Quick Delivery* **$140**
Includes: Same as the P6105A except 3 in ground lead (G7, 175-0263-01) instead of 12 in ground lead; instruction sheet (070-5517-00).

P6108A 10X, 100 MHz, 2 m Modular Probe. *Quick Delivery/Reduced Price* **$75**
Includes: Same as the P6105A; instruction sheet (070-5519-00).

OPTIONS

Option 01 — 1 m cable. **NC**
Option 03 — 3 m cable. **NC**

P6102A 10X, 60 MHz, 2 m Modular Probe **$75**
Includes: Same as the P6105A; instruction sheet (070-5824-00).

P6107A 10X, 100 MHz, 2 m Modular Probe. Order 010-6107-13 **$117**
Includes: Same as the P6105A; instruction sheet (070-5518-00).

P6149A 10X, 50 MHz, 2 m Modular Probe **$110**
Includes: Same as the P6105A; instruction sheet (070-5510-00).

OPTIONAL ACCESSORIES

MANUALS

P6102A Order 070-5847-00	**$1.00**
P6105A Order 070-5231-00	**$3.00**
P6106A Order 070-5232-00	**$3.00**
P6107A Order 070-5297-00	**$3.00**
P6108A Order 070-5233-00	**$3.00**
P6149A Order 070-5247-00	**$3.00**

To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext. 99

NEW

NEW P6103
Dc to 50 MHz, 10X Modular

NEW P6109
Dc to 150 MHz, 10X Modular, With Readout

For 1 MΩ Input

Improved, Rugged Replaceable Tip

Hybrid Circuitry for Improved Performance

New, Two-Piece Modularity

The P6103 and P6109 are modular passive voltage probes. The modular probe head houses all circuitry, including low frequency compensation. The cable assembly comes with an attached BNC connector.

Both probes feature easily replaceable screw-in probe tips. These probe tips have been specifically engineered to provide improved long-term performance and reliability (see pages 486 and 488). Both are compatible with the miniature size probe accessories shown on page 486.

The P6103 is included with the 2225 oscilloscope. The P6109 is included with the 2245 and 2246 GPS oscilloscopes. Oscilloscopes equipped with readout can be activated by the P6109.

ORDERING INFORMATION

P6103 10X, 50 MHz, 2 m Modular Probe **$35**

Includes: Adjustment tool (F3, 003-1364-01); retractable hook tip (B3, 013-0107-05); replaceable probe tip (B27, 131-3723-00); 12 in ground lead (196-3120-00); 2 each of white, yellow, red and green cable markers; instruction sheet (070-6156-00).

OPTIONS

Option 01 — 1 m cable. **NC**

Option 03 — 3 m cable. **NC**

P6109 10X, 150 MHz, 2 m Modular Probe **$58**

Includes: Same as the P6103; instruction sheet (070-6157-00).

OPTIONS

Option 01 — 1.5 m cable. **NC**

Option 03 — 3 m cable. **NC**

P6121 Dc to 100 MHz, 10X
Modular, With Readout

P6122 Dc to 100 MHz, 10X
Modular

P6125 Dc to 250 MHz, 5X
Modular, Counter

For 1 MΩ Input

Small, Precision Tip

Flexible, Low Mass Cable

Hybrid Circuitry for Improved Performance

UL Listed

The P6120 probe family features modular construction, easily replaceable parts and hybrid circuitry. These probes are also fully compatible with the wide selection of miniature probe accessories (see page 486).

The P6122 general purpose probe accommodates oscilloscopes with bandwidths up to 100 MHz (see page 464). The P6121 with readout capability is specifically designed for the Tektronix 2236 oscilloscope to provide close tolerance readings when using the 2236 DMM functions.

The P6125 is a low capacitance, 5X attenuation passive probe specially designed for dc to 250 MHz digital counter/timers. Five-times attenuation provides an optimum match between the counter input characteristics and the voltage levels of all common logic families. It makes more accurate time interval measurements of high speed logic signals possible with minimum loading of the circuits under test.

For probe accessories, see page 486.
For replaceable modular subassemblies, see page 488.
Instrument compatibility chart is on page 464.

CHARACTERISTICS
ELECTRICAL

	P6121	P6122	P6125
Attenuation	10X ±0.2%	10X ±3%	5X ±3%
Loading	11 pF/10 MΩ	11 pF/10 MΩ	20 pF/5 MΩ
Bandwidth	100 MHz	100 MHz	250 MHz
Dc Max	500 V	500 V	250 V
Scope Compatibility	Designed to be used only with the Tek 2236 (1 MΩ input)	May be used with any Tek 100 MHz, 1 MΩ, 15 to 35 pF scope or plug-in*[1]	Use with digital counters/timers and oscilloscopes up to 250 MHz (1 MΩ input)

*[1] *Typical applications include the Tektronix T935A, T922R, T921, 2213, 2215, 2235, 2335, 2336, 2337, 5A38, 5A48, 7A15A, and the 7A18A.*

ORDERING INFORMATION

P6122 10X, 100 MHz, 1.5 m Modular Probe *Quick Delivery/Reduced Price* **$58**

Includes: Adjustment tool (F3, 003-1364-01); retractable hook tip (B3, 013-0107-05); probe tip ground cover (B16, 166-0404-01); 8.8 in alligator ground lead (G10, 195-1870-00); 3.5 in ground lead (G1, 195-6176-01); alligator clip (A16, 344-0046-00); 2 silver cable marker bands; instruction sheet (070-5511-00).

OPTIONS

Option 02 — 2 m cable. **NC**

Option 03 — 3 m cable. **NC**

P6121 10X, 100 MHz, 1.5 m Modular Probe **$100**

Includes: Same as the P6121; instruction sheet (070-5512-00).

P6125 5X, 250 MHz, 1.5 m Modular Probe **$70**

Includes: Same as the P6121; instruction sheet (070-3617-02).

OPTIONAL ACCESSORIES
MANUALS

P6121 Order 070-3739-01 **$1.50**

P6122 Order 070-4431-01 **$3.00**

P6062B
Dc to 100 MHz, 1X/10X With Readout

P6063B
Dc to 200 MHz, 1X/10X With Readout

For 1 MΩ Input

1X to 10X Selectable Attenuation

Attenuation Switch on Probe Body

Scope Readout Changes to Selected Attenuation

The P6062B and P6063B are passive dual attenuation probes designed for oscilloscopes with bandwidths to 100 and 200 MHz. A sliding switch on the probe body selects 1X or 10X attenuation. This 1X-10X switch allows the user to switch in and out a decade of sensitivity without returning to the test instrument. Attenuation may be arbitrarily switched from 1X to 10X to evaluate the effects of loading of the oscilloscope on the circuit under test.

Both probes activate the readout coding for oscilloscopes which have readout capability. Readout changes with the probe attenuation switch so the correct attenuation setting is always displayed on the oscilloscope. A pushbutton for ground reference is standard with both probes. This provides an easy way to identify a trace in a multitrace display.

Both probes are compatible with the miniature accessories shown on page 486.

CHARACTERISTICS

	Nominal Probe Length	P6062B		P6063B	
Attenuation		1X	10X	1X	10X
Accuracy		Same as Scope	3%*1	Same as Scope	3%*1
Input Resistance		Same as Scope	10 MΩ*1	Same as Scope	10 MΩ*1
Input Capacitance	3½ ft 6 ft 9 ft	100 pF 105 pF 135 pF	13.5 pF 14 pF 17 pF	80 pF 105 pF NA	11 pF 14 pF NA
Bandwidth	3½ ft 6 ft 9 ft	8 MHz 6.7 MHz 4.5 MHz	100 MHz 100 MHz 100 MHz	12 MHz 6 MHz NA	200 MHz 200 MHz NA
Maximum Voltage		100 V peak	500 V peak	100 V	500 V
Derated Above		450 kHz	3.5 MHz	450 kHz	4.5 MHz
Derated to Frequency		35 V @ 10 MHz	35 V @ 50 MHz	35 V @ 10 MHz	30 V @ 50 MHz
Aberrations		±3%	<5% p-p	±3%	<5% p-p
Rise Time			3.5 ns		1.7 ns
Compensation Range		15 pF to 47 pF		15 pF to 24 pF	

*1 *In 10X position the input R = 10 MΩ ±0.5% with an oscilloscope input R = 1 MΩ ±2%.*

ORDERING INFORMATION

P6062B 100 MHz, 6 ft Switchable Attenuation Probe **$175**

Includes: Retractable hook tip (B3, 013-0107-05); probe tip ground cover (B16, 166-0404-01); 5 in ground lead (G7, 175-0124-01); 12 in ground lead (G7, 175-0125-01); hook tip (B6, 206-0114-00); two replaceable tips (B25, 206-0191-00); probe holder (352-0351-00); two alligator clips (A16, 344-0046-00); instrument sheet (062-2927-00).

OPTIONS

Option 01 — 3.5 ft cable. **NC**

Option 03 — 9 ft cable. **NC**

P6063B 200 MHz, 6 ft Switchable Attenuation Probe **$215**

Includes: Same as P6062B except 3 in ground lead (G7, 175-0263-01) instead of the 12 in ground lead; instruction sheet (062-2928-01)

Option 01 — 3.5 ft cable. **NC**

For probe accessories, see page 486.
Instrument Compatibility chart is on page 464.

P6053B Dc to 200 MHz, 10X With Trace Identify and Readout

For 1 MΩ Input

Miniature Probe Tip Size

Trace Identify Button for Remote Selection of 7D20 Menus

Fast Rise Time

The P6053B is a miniature fast-rise 10X probe designed for Tektronix instruments having a nominal input capacitance of 15 pF to 24 pF. The probe has a pushbutton for actuating the trace-identify function of the oscilloscope mainframe and readout capability.

The P6053B is compatible with all miniature probe accessories listed on page 486.

CHARACTERISTICS

Attenuation — 10X.

Input Resistance — 10 MΩ.

Input Capacitance — 9.5 pF with 3.5 ft probe. 12.5 pF with 6 ft version, 13.5 pF with 9 ft version.

Bandwidth (with 225 MHz or Greater Oscilloscope) — ≈200 MHz for 3.5 and 6 ft versions, ≈115 MHz for the 9 ft version.

Voltage Rating — 500 V (dc + peak ac). Peak voltage derating is necessary for cw frequencies higher than 5 MHz. At 10 MHz, the maximum allowable peak voltage is 275 V; 23 V at 100 MHz; 18 V at 150 MHz.

ORDERING INFORMATION

P6053B 10X, 6 ft Trace Identify Probe **$170**

Includes: Bayonet tip (B15, 013-0085-01); retractable hook tip (B3, 013-0107-05); two probe tip ground covers (B16, 166-0404-01); 5 in ground lead (G7, 175-0124-01); 3 in ground lead (G7, 175-0263-01); hook tip (B6, 206-0114-00); two alligator clips (A16, 344-0046-00); probe holder (352-0351-00); two each of black, white and silver cable markers; instruction sheet (070-1594-00).

OPTIONS

Option 01 — 3.5 ft cable. **NC**

Option 03 — 9 ft cable. **NC**

P6048 Dc to 100 MHz, 10X

For 1 MΩ Input

Minimum Loading, 1 pF at 1 kΩ

Ac/dc Switch

The P6048 is a miniature low capacitance probe for use with 1 MΩ 20 pF oscilloscopes. The probe input impedance of 1 kΩ paralleled by 1 pF is intended for applications where capacitor loading may distort the circuit waveforms. Ac or dc coupling switch is available to extend the measurement range.

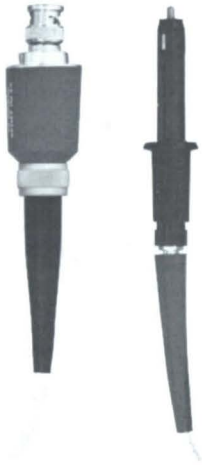
CHARACTERISTICS

Attenuation — 10X.
Input Resistance — 1 kΩ.
Input Capacitance — 1 pF or less.
Maximum Input — Dc 20 V; ac 200 V.
Ac Low Frequency — 7 kHz or less.
Bandwidth —
100 MHz with 150 MHz bandwidth scope;
175 MHz with 250 MHz bandwidth scope.
Typical Probe Rise Time — 1.95 ns.

ORDERING INFORMATION

P6048 10X, 6 ft Minimum Loading Probe **$205**
Includes: Retractable hook tip (E1, 013-0090-00); 2 probe tip ground covers (B16, 166-0404-01); insulating sleeves (D8, 166-0433-00); 5 in ground lead (G7, 175-0124-01); 3 in ground lead (175-0263-01); hook tip (G7, 206-0114-00); 2 miniature alligator clips (A16, 344-0046-00); probe holder (352-0090-00); instruction manual (070-0675-01).

P6008 Environmental
100 MHz, 10X



For 1 MΩ Inputs

−50°C to +150°C Temperature Range

The P6008 Environmental Probe is designed to operate over −50°C to +150°C for the probe body and cable; the compensation box operates from −15°C to +55°C. It is designed for use with dc to 100 MHz oscilloscopes. The probe can be compensated to match plug-ins and oscilloscopes with nominal input capacitance of 12 pF to 47 pF and input resistance at 1 MΩ.

The P6008 is compatable with the screw-tip accessories shown on page 486.

CHARACTERISTICS

Attenuation — 10X.
Input Resistance — 10 MΩ.
Input Capacitance — ≈7.5 pF when used with an instrument having a 20 pF input capacitance.
Bandwidth — Dc to 100 MHz.
Voltage Rating — 600 V dc, ac peak, or dc and ac peak combined. P-p voltage derating is necessary for cw frequencies higher than 20 MHz. At 40 MHz, the maximum allowable p-p voltage is 300 V.
Cable Length — 1.8 m (6 ft).

ORDERING INFORMATION

P6008 10X, 6 ft Environmental Probe **$240**
Includes: Retractable hook tip (A2, 013-0071-01); banana tip (A12, 134-0013-00); 12 in ground lead (G7, 175-0125-01); alligator clip (A15, 344-0045-00); probe holder (352-0090-00); instruction sheet (070-1173-00).
Option 01 — 3.5 ft cable, nonenvironmental **−$10**

P6056
Dc to 3.5 GHz, 10X 500 Ω With Readout

P6057
Dc to 1.4 GHz, 100X 5000 Ω With Readout

For 50 Ω Input

Minimum Loading, 1 pF or Less

<70 ps Probe to Probe Variation

The P6056 and P6057 are miniature low-capacitance probes for use with 50 Ω wideband oscilloscopes. These probes can also be used with 50 Ω sampling systems, with an appropriate BNC adaptor. Both are equipped with a special BNC connector that provides trace identification and CRT readout information when used with plug-in units and mainframes that have these features. A convenient button on the probe activates the trace identification function.

CHARACTERISTICS

	P6056	P6057
Rise Time	<100 ps	<250 ps
Input R @ Dc	500 Ω	5 kΩ
Input R @ 1 GHz	300 Ω	1500 Ω
Maximum Dc + Peak Ac	16 V	50 V
Derated Above	800 MHz	500 MHz
Maximum Peak @ 1 GHz	9 V	21 V
Maximum Peak Pulse	500 V <1 ms	500 V <1 ms

ORDERING INFORMATION

P6056 10X, 6 ft 50 Ω Probe **$185**
Includes: 6 in ground lead (G6, 175-0849-01); 3 in ground lead (G1, 195-6176-01); replaceable tip (B25, 204-0233-00); hook tip (206-0114-00); 2 electrical contacts (B28, 214-0283-00); alligator clip (344-0046-00); instruction sheet (070-1224-00).
P6057 100X, 6 ft 50 Ω Probe **$190**
Includes: Same as P6056.
Option 03 — 9 ft cable. **NC**

For Probe Accessories, see page 486. Instrument Compatability Chart is on Page 464.

TEK SUBMINIATURE MODULAR PASSIVE PROBES

P6130 Dc to 250 MHz, 10X Modular, With Readout

P6131 Dc to 300 MHz, 10X Modular, With Readout

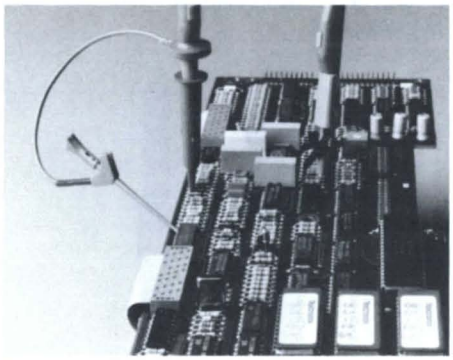
P6133 Dc to 150 MHz, 10X Modular, With Readout

NEW P6136 Dc to 350 MHz, 10X Modular, With Readout

For 1 MΩ Input

- Subminiature Tip for Precise Probing
- Flexible Lightweight Cable
- Modular for Low Cost of Ownership
- Hybrid Circuitry Performance
- UL Listed

The P6130 subminiature probe family features modular construction, hybrid circuitry and a subminiature probe tip which can easily negotiate dense circuitry or tight spaces. Each probe has 10X attenuation and activates the readout-encoding circuit of oscilloscopes with the feature.



Probe Accessories shown in use on a circuit board. A circuit board connector (131-2766-03) is used to connect the probe to the test point for minimal signal distortion and maximum measurement convenience. Other connectors and adaptors are available. See pages 486 and 487.

These probes are compatible with the subminiature probe accessories (see page 487). Full compatibility with the miniature accessories (see page 486) is available when the subminiature-to-miniature probe tip adaptor (013-0202-00) is installed over the probe tip.

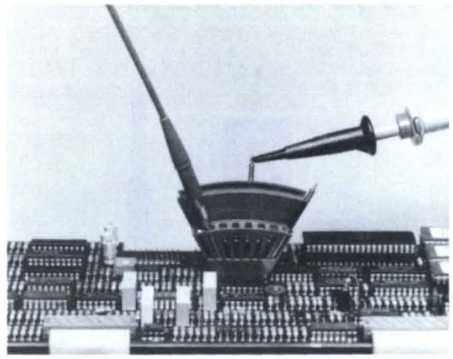
The P6130 general purpose probe can be used with instruments with bandwidths up to 250 MHz (see page 464). The P6131 is specially designed for the Tektronix 7A42 and older 2465 oscilloscope. The P6133 is for use with the 2445A. The P6136 is specially designed for the 2455A, 2465A, and 2467 oscilloscopes.

ENVIRONMENTAL

Temperature Range — Operating: −15°C to +75°C. Nonoperating: −62°C to +85°C.

Humidity — Five cycles (120 hrs) 95% to 97% at +30°C to +60°C. MIL-E-16400F, Class 4.

Altitude — Operating: 4600 m (15,000 ft). Nonoperating: 15 000 m (50,000 ft).



P6130 shown with the KLIPKIT (013-0197-00). All P6130 and P6230 family probes can be used directly in the 16-pin DIP clip. Other probes must use the provided signal/ground pins.

ORDERING INFORMATION

P6130 10X, 250 MHz, 2 m Subminiature Probe **$130**

Includes: Adjustment tool (F3, 003-1364-01); retractable hook tip (C1, 013-0208-01); circuit board connector (C5, 131-2766-03); 8.8 in alligator ground lead (G10, 195-1870-00); 6 in microhook ground lead (G5, 195-4104-00); 2 in ground lead (G9, 195-4240-00); probe holder (352-0687-00); each of white, gray, red and green cable markers; instruction sheet (070-5513-00).

OPTIONS

Option 01 — 1.5 m cable. **NC**

Option 03 — 3 m cable. **NC**

P6131 10X, 300 MHz, 1.5 m Modular Probe **$140**

Includes: Same as the P6130; instruction sheet (070-5514-00).

OPTIONS

Option 02 — 2 m cable. **NC**

Option 03 — 3 m cable. **NC**

P6133 10X, 150 MHz, 2 m Modular Probe **$115**

Includes: Adjustment tool (F3, 003-1364-01); retractable hook tip (C1, 013-0208-01); 8.8 in alligator ground lead (G10, 195-1870-00); 6 in microhook ground lead (G5, 195-4104-00); instruction sheet (070-5795-00).

OPTIONS

Option 01 — 1.3 m cable. **NC**

Option 03 — 3 m cable. **NC**

P6136 10X, 350 MHz, 1.3 m Modular Probe **$150**

Includes: Same as the P6130; instruction sheet (070-6025-00).

CHARACTERISTICS

ELECTRICAL

	Probe Length	P6130	P6131	P6133	P6136
Attenuation		10X ±3%	10X ±1%	10X ±1%	10X ±1%
Loading	1.3 m	—	10.8 pF/10 MΩ	10.8 pF/10 MΩ	10.8 pF/10 MΩ
	1.5 m	12.7 pF/10 MΩ	—	—	—
	2.0 m	13.2 pF/10 MΩ	13.5 pF/10 MΩ	13.5 pF/10 MΩ	—
	3.0 m	14.5 pF/10 MΩ	14.5 pF/10 MΩ	—	—
Bandwidth	1.3 m	—	300 MHz	150 MHz	350 MHz
	1.5 m	250 MHz	—	—	—
	2.0 m	250 MHz	—	150 MHz	—
	3.0 m	150 MHz	150 MHz	120 MHz	—
Dc Max		500 V	500 V	500 V	500 V
Scope Compatibility		May be used with Tektronix 2235, 2236, 464, 465, 466, 475, 485 and any 7000 Series 1 MΩ plug-in such as 7A15, 7A16, 7A18 and 7A26	Designed to be use with the Tektronix 2465A and the 7A42 (1 MΩ input)	Designed for use with the Tektronix 2445A	Designed for use with the Tektronix 2455A, 2465A, and 2467

OPTIONAL ACCESSORIES

MANUALS

P6130 — Order 070-4160-01 **$1.50**

P6131 — Order 070-4210-01 **$3.00**

P6133 — Order 070-5839-00 **$1.00**

P6136 — Order 070-6026-00 **$1.00**

KLIPKIT — Order 013-0197-00 **$40**

Includes: Two clips and four pins.

Extra pins — Packet of four. Order 131-3288-02 **$29**

For probe accessories, see page 486.
For replaceable modular subassemblies, see page 488.
Instrument compatibility chart is on page 464.

To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext. 99

NEW

P6134 Dc to 300 MHz, 10X, Passive Probe, With Identify and Readout

P6135 Dc to 150 MHz, 10X, Passive Differential Probe, With Identify and Readout

For Use With the TekProbe Interface of the New 11000 Series Plug-Ins

New "Intelligent" Probe Interface

Identify Button on Each Probe Allows Remote Sequencing of Oscilloscope Programs

Automatic Input Impedance Selection

Activates Readout on 11000 Series Oscilloscopes

Probe Power Comes Through Connector—No Extra Power Supply or Cables Needed

Uses Subminiature Probe Accessories

The P6134, P6135 and P6231 probes are the first in a new line of "intelligent" probes. Through the new TekProbe interface connector, the probe communicates its type, serial number, attenuation, input impedance, offset scale factor, and other parameters to and from the host instrument. Power for active probes is also supplied through the TekProbe interface, eliminating the need for extra cabling and external power supplies. The new probe connectors allow easy and positive locking to the test instrument.

P6231 Dc to 1.5 GHz, 10X, Bias/Offset Probe, With Identify and Readout

An "ID" button comes standard with each probe which, when pressed, causes any of several programmable actions to be taken by the mainframe (eg., autoset, setup recall, automatic measure, SRQ, etc.).

The P6134 and P6135 are passive probes designed for amplifiers with an input impedance of 1 MΩ. The P6135 comes as a pair of differential probes which can be matched for high CMRR when used with the 11A33 Differential Comparator plug-in.

The P6231 is an active probe designed for amplifiers with an input impedance of 50 Ω, primarily the 11A52 and 11A71 high-frequency amplifiers. Connection of the P6231 into any other 11000 Series amplifier automatically causes the input impedance to be set at 50 Ω. Up to five volts of bias may be applied to the tip of the P6231 to reduce the DC loading on the circuit under test. The offset voltage is selectable from the mainframe touch screen.

Each of these probes is compatible with the subminiature probe accessories shown on page 487. With the addition of the subminiature-to-miniature adaptor (013-0202-00) all miniature size probe accessories on page 486 can be used.

CHARACTERISTICS

	P6134	P6135	P6231
Attenuation	10X ±1%	10X Adjustable ±3%	10X ±3%
Input R	9 MΩ ±0.3%	1 MΩ ±0.32% at dc	450 Ω ±1% at dc
Input C	11.3 pF	10.8 pF	<1.6 pF
Bandwidth	300 MHz	150 MHz	1.5 GHz
Rise Time			<230 ps
Input Voltage	500 V (dc+peak ac)	500 V (dc+peak ac)	10 V dc continuous 30 V (dc+peak ac)
CMRR	NA	20000:1 dc to 1 kHz derating to 100:1 at 20 MHz	NA

ORDERING INFORMATION

P6134 10X, 300 MHz, 1.5 m Passive Probe **$170**

Includes: Adjustment tool (F3, 003-1364-01), retractable hook tip (C1, 013-0208-01), two circuit board connectors (C5, 131-2766-03). 2 in ground lead (G9, 195-4240-00), 6 inch ground lead (196-3113-00), Miniature alligator clip (A16, 344-0046-00), IC grabber (013-0217-00); two each of black, white, silver, gray, blue, orange, red, green and yellow cable markers; instruction manual (070-6029-00).

P6135 Pair of 10X, 150 MHz, 1.5 m Differential Probes*[1]

Includes: Same as the P6134 for each probe; instruction manual (070-6158-00).

P6231 10X, 1.5 GHz, 1.5 m Bias/Offset Probe **$410**

Includes: Same as the P6134; instruction manual (070-6027-00).

For probe accessories, see page 486.

*[1] *To order, contact your local Tektronix Sales Office.*

Active probes have high input resistance and low input capacitance without loss of signal. The dynamic range and measurement capability are substantially increased through the voltage offset control.

Since active probes have a selectable 50 Ω output impedance, the distance from the probe tip to the instrument is only limited by the bandwidth limit of the 50 Ω coaxial cables between the probe and instrument. Active probes are used in measurements where high input resistance and low input capacitance is needed and where frequencies above 250 MHz are encountered.

ACTIVE PROBES SELECTION GUIDE

Type	Attn	Nominal Length	Loading		Rise Time	Input Limits: Maximum Dc + Pk Ac	Input Limits: Linear Dynamic Range	Input Limits: Dc Offset Range	Read-Out	Page	Price
P6046 Diff/Amp	1X 10X	6 ft	1 MΩ 10 MΩ	10 pF 3 pF	3.5 ns	±25 V ±250 V	±5 V ±50 V		No	480	$1,750
P6201 FET	1X 10X 100X	6 ft	100 kΩ 1 MΩ 1 MΩ	3 pF 1.5 pF 1.5 pF	0.4 ns	±100 V ±200 V ±200 V	±0.6 V ±6 V ±60 V	±5.6 V ±56 V ±200 V	Yes	475	$1,220
P6202A FET	10X 100X	2 m	10 MΩ 10 MΩ	2 pF 2 pF	0.7 ns 0.7 ns	±200 V ±200 V	±6 V ±60 V	±55 V ±200 V	Yes No	475	$680
P6230 Bias/Offset	10X	1.6 m	450 Ω	1.3 pF	230 ps	±30 V	±5 V	±5 V	Yes	474	$395
P6231 Bias/Offset	10X	1.5 m	450 Ω	1.6 pF	230 ps	±30 V	±10 V	±5 V	Yes	473	$410

P6230

Dc to 1.5 GHz, 10X Bias/Offset With Readout

For 50 Ω or 1 MΩ Inputs

Bias/Offset From −5 V to +5 V

Internal/External 50 Ω Termination Switch

Low Impedance

Adjustable Tip "Nulling" Voltage

Fully Compatible With Tek Subminiature Probe Accessories

UL Listed

The P6230 is a 1.5 GHz, low-impedance, subminiature, 10X active probe for use with broad-band oscilloscopes. A switch on the compensation box allows selection of internal or external 50 Ω termination so the probe may be used with instruments having either 50 Ω or 1 MΩ input resistances. A coding pin on the BNC connector activates the readout of instruments with this feature.

The P6230 acts as a standard 500 Ω passive voltage probe with the additional capability of having an adjustable tip "nulling voltage". This feature reduces the dc-loading effects of the probe when it is used to measure signals whose mid-voltage value is not at zero volts, or in circuits where the termination impedance is not returned to ground level. The Input Bias/Offset Voltage may be adjusted so that the voltage at the probe input resistor is equal to the test signal potential; thus, no current flows through the input resistor.

For example, if a standard 500 Ω, 10X probe were used to examine an ECL output, the probe's 500 Ω resistance to ground would form a voltage divider with the gate's output-termination resistor. This divider can cause distortion of the output signal levels, shift the dc operation point of the output transistor, and reduce the gate's noise margin.

The dc-load nulling capability of the P6230 helps solve this problem. By adjusting the Input Bias/Offset Voltage to the ECL low level or to the termination voltage, the only effect of the probe resistance will be a small decrease in the ECL output-termination resistance. The effect of the probe on output voltage levels is negligible.

The probe derives its power from the probe power jack on many Tek scopes or an 1101A Power Supply (see next page).

The P6230 is compatible with all subminiature probe accessories listed on page 487. With the subminiature-to-miniature probe tip adaptor (013-0202-00), all miniature probe accessories on page 486 can be used.

CHARACTERISTICS

ELECTRICAL

Attenuation — 10X ±3%.

Loading — 1.3 pF/450 Ω.

Bandwidth — 1.5 GHz.

Dc Offset Range — −5 V to +5 V.

Dc Maximum — 10 V.

ENVIRONMENTAL

Temperature Range — Operating: 0°C to +50°C (+32°F to +122°F). Nonoperating: −55°C to +75°C (−67°F to +167°F).

Humidity — Five cycles (120 hrs) 95% to 97% at 30°C to 60°C. MIL-E-16400F, Class 4.

Altitude — Operating: 4600 m (15,000 ft). Nonoperating: 15 000 m (50,000 ft).

ORDERING INFORMATION

P6230 10X, 1.6 m Bias/Offset Probe **$395**

Includes: Adjustment tool (F3, 003-1364-01), retractable hook tip (C1, 013-0208-00), circuit board connector (C5, 131-2766-03), 8.8 in alligator ground lead (G10, 195-1870-00), 6 in microhook ground lead (G5, 195-4104-00), 2 in ground lead (G9, 195-4240-00), probe holder (352-0687-00); 2 each of white, gray, red and green cable markers; manual (070-4211-00).

OPTIONAL ACCESSORIES

KLIPKIT — 16 pin DIP package accepts the P6230 and P6130 family probes directly. Other probes must use the supplied pins and attach via a retractable hook tip. Included are two DIP clips, and four signal/ground pins.
Order 013-0197-00 **$40**

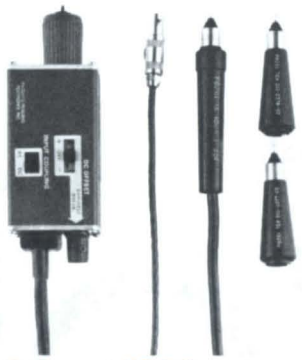
KLIPKIT Signal/Ground Pins — Packets of four pins for use with the KLIPKIT.
Order 131-3288-02 **$29**

For probe accessories, see page 486.
For replaceable modular subassemblies, see page 488.
Instrument Compatibility Chart is on page 464.

To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext. 99

P6201

Dc to 900 MHz, 1X With Readout



For 50 Ω or 1 MΩ Inputs

Unity Gain, Low Input Capacitance

Two Plug-on Attenuator Heads That Maintain Scope Readout Factor

Dc Offset, Ac-Dc Coupling Switch

The P6201 is an active (FET) probe providing unity gain and dc to 900 MHz bandwidth. The P6201 is the best general-purpose probe within its voltage range from the standpoint of electrical performance. Very low input capacitance permits acquisition of high frequency signals with minimum loading of circuits under test while high input resistance minimizes low frequency and dc loading. Plug-on attenuator heads provide higher input resistance and reduced input capacitance.

The probe derives its power from the probe power jack on many Tek scopes, or an 1101A Power Supply.

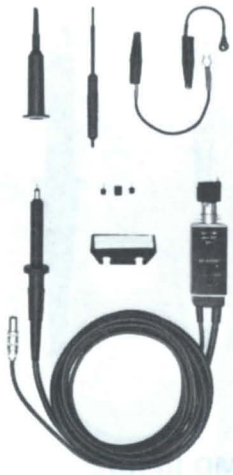
CHARACTERISTICS

	P6201	P6202A
Rise Time	<0.4 ns	<0.7 ns
Bandwidth (verified by rise time)	>900 MHz	>500 MHz
Attenuation	X1	X10
Attenuation Accuracy	±3%	±4%
Input Resistance	100 kΩ	10 MΩ
Input Capacitance	3 pF	2 pF
Input R with Attenuator	1 MΩ	10 MΩ*1
Input C with Attenuator	1.5 pF	2 pF*1
Dynamic Range	±0.6 V	±6.0 V
Dynamic Range with Attenuator	±6 V or ±60 V	±60 V*1
Dc Offset Range	±5.6 V	±55 V
Noise	300 μV	150 μV
Maximum Input Probe Only	±100 V peak	±200 V peak
Derated above	60 MHz	2 MHz
Derated to—at Frequency	5 V at 500 MHz	20 V at 300 MHz
Maximum Input with Attenuator	200 V peak	200 V peak*1
Derated above	50 MHz	150 MHz*1
Derate to—at Frequency	5 V at 500 MHz	70 V at 400 MHz*1
Ac Coupling—3 dB Low Frequency	10 Hz	16 Hz

*1 *Optional accessory.*

P6202A

Dc to 500 MHz, 10X With Readout



For 50 Ω or 1 MΩ Inputs

Dc Offset, Small Probe Size

High Input Impedance Through Freq Range

The low input capacitance of the P6202A permits acquisition of high frequency signals with a minimum loading of circuits under test while the high input resistance minimizes low frequency and dc loading. The dc offset feature offsets any dc component within the range of the control to bring the signal into the dynamic range of the probe.

The P6202A derives its power from the probe power jack on many Tek scopes, or an 1101A Power Supply.

ORDERING INFORMATION

P6201 1X, 6 ft FET Probe **$1,220**

Includes: Retractable probe tip (D1, 013-0135-00); 10X attenuator head (010-0376-00); 100X attenuator head (010-0377-00); 3 probe tips (D9, 206-0200-00); probe tip (D2, 103-0164-00); 30 cm (12 inch) ground lead (G4, 175-0848-02); ground contact (D5, 131-1302-00); alligator clip (A16, 344-0046-00); electrical insulating sleeve (D6, 166-0557-00); ground contact insulator (D7, 342-0180-00); carrying case (016-0156-02); instruction manual (070-1306-00).

P6202A 10X, 2 m FET Probe **$680**

Includes: Retractable probe tip (E2, 013-0097-01); two alligator clips (A16, 344-0046-00); probe holder (352-0351-00); 7.5 cm (3 in) ground (G6, 175-0849-00); probe adjustment tool (F5, 003-0675-01); carrying case (016-0378-00); 13 cm (6 in) ground lead (G8, 175-1017-00); two replaceable probe tips*1; electrical insulating sleeve (B16, 166-0404-01); instruction manual (070-3642-00).

*1 *Available in package of 10 only. Order 206-0230-03 (B26).*

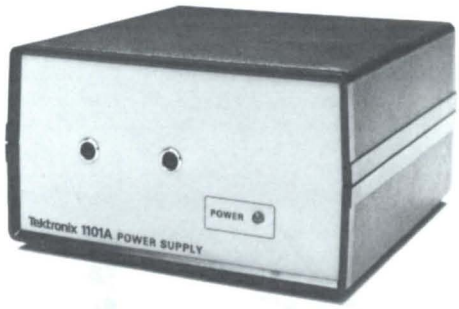
OPTIONAL ACCESSORIES

10X Attenuator — For total 100X attenuation.
Order 010-0384-00 **$75**

Ac Coupling Cap — Order 010-0360-00 **$38**

For probe accessories, see page 487.
Instrument compatibility chart is on page 464.

1101A Power Supply



The 1101A Accessory Power Supply provides power for active probes such as the Tektronix P6201, P6202A and P6230 when they are used with oscilloscopes that do not supply probe power.

The 1101A will provide power for up to two probes. Output power features short-circuit protection.

CHARACTERISTICS

Output Voltages — +15 V dc ±2%; −15 V dc ±2%; +5 V dc ±5%.

Output Currents — 300 mA each supply (short-circuit protected). +15 V, −15 V supplies: ≤1 mV RMS with 300 mA load.

Ripple — +5 V Supply: ≤5 mV RMS with 300 mA load.

Ac Input Voltages — Selectable, 87 V ac to 128 V ac or 174 V ac to 250 V ac.

Line Frequency — 48 Hz to 440 Hz.

Power — 30 W maximum at 115 V ac.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	157	6.2
Height	89	3.5
Depth	165	6.5
Weight≈	**kg**	**lb**
Net	1.7	3.8

ORDERING INFORMATION

1101A Accessory Power Supply **$425**

Includes: Instruction sheet 070-5126-00.

INTERNATIONAL POWER PLUG OPTIONS

Option A1 — Universal Euro 220 V, 50 Hz.
Option A2 — UK 240 V, 50 Hz.
Option A3 — Australian 240 V, 50 Hz.
Option A4 — North American 240 V, 60 Hz.
Option A5 — Switzerland 220 V, 50 Hz.

P6401 Logic Probe

Illuminated Probe Tip Indicates Logic Level

The small, lightweight, hand-held P6401 indicates the state of logic levels in TTL, DTL, or any other system with threshold between 0.7 and 2.15 volts. A strobe input can be used to detect the coincidence of logic signals at two points. An indication of whether a logic pulse has or has not occurred can be obtained in a "store" mode.

Power may be obtained from the unit under test or any five volt supply.

Two bright lights in the probe tip indicate condition of the logic signal.

CHARACTERISTICS

Low State Input Voltage Range — 0 V to +0.7 V ±0.125 V.

High State Input Voltage Range — 2.175 V ±0.125 V to V cc.

Minimum Recognizable Pulse Width — 10 ns.

Impedance — ≈7.5 kΩ paralleled by ≈6 pF.

Minimum Circuit Resistance for Open Circuit Indication — 10 kΩ.

Maximum Safe Input — ±150 V (dc or RMS).

Minimum Recognizable Strobe Pulse Width — 20 ns.

Maximum Safe Strobe Input — ±30 V (dc or RMS).

Strobe Input Impedance — 5.6 kΩ within 20%.

P6401 1.5 m Logic Probe **$170**
Includes: Probe tip hook (B6, 206-0114-00); strobe lead (175-0958-01); strobe lead (175-0958-00); probe tip to 0.025 inch square pin adaptor (A10, 206-0137-01); white plug (348-0023-00); two alligator clips (A16, 344-0046-00); accessory pouch (016-0537-00); data sheet (062-1693-00).

P6420 RF Probe

For 10 MΩ Inputs

10 kHz to 1 GHz Bandwidth

Dc V Output/RMS of Sine Input

The P6420 RF probe measures high frequency ac voltage from 10 kHz to 1 GHz. It provides a dc output voltage proportional to the RMS value of a sinewave input compatible with any DMM with an input resistance of 10 MΩ.

CHARACTERISTICS

Voltage Range — 0.5 V to 25 V RMS (70.7 V p-p).

Ac to Dc Transfer Ratio Accuracy — 0.5 V to 5 V RMS ±10% (+15°C to +35°C). 5.0 V to 25 V RMS ±5% (+15°C to +35°C).

Frequency Response — 100 kHz to 300 MHz (±0.5 dB). 50 kHz to 500 MHz (±1.5 dB), 10 kHz to 1 GHz (±3.0 dB).

Input Capacitance — ≈3.7 pF.

Maximum Input Voltage — 42.4 V (peak ac + dc).

Temperature Range — Nonoperating: −55°C to +75°C. Operating: +15°C to +35°C.

Length — Probe only: 96 mm. Cable Only: 2 m.

ORDERING INFORMATION

P6420 2 m RF Probe **$145**
Includes: Retractable probe tip (E2, 013-0097-01); two alligator clips (A16, 344-0046-00); two replaceable*[1] probe tips; electrical insulating sleeve (B16, 166-0404-01); 75 mm (3 in) ground lead (G6, 175-0849-00); 130 mm (6 in) ground (G8, 175-1017-00); probe holder (352-0351-00); BNC female to dual banana adaptor (103-0090-00); data sheet (062-2764-00).

*[1] *Available in packages of ten (order 206-0230-03) or 100 (order 206-0230-04) (B26).*

OPTIONAL ACCESSORIES

Probe Cables — For P6420 (does not change electrical specifications):

(1 m) Order 174-0076-00	**$15**
(2 m) Order 174-0077-00	**$17**
(3 m) Order 174-0078-00	**$19**

P6602 Temperature Probe

For DMM Input

UL Listed

The P6602 Temperature Probe is a temperature measuring device designed to operate with the 2236 Digital Multimeter. The temperature sensory element consists of a thin-film platinum resistor in the tip of the probe. Measurements are made by touching the probe tip to the surface under test. The resulting resistance is measured by the multimeter through a two-conductor cable. The tip and cable assembly are replaceable.

CHARACTERISTICS

Operating Temperature Range — Probe Head and Cable: −62°C to +230°C (−80°F to +446°F). Banana Jack Style Connector: −15°C to +85°C.

Voltage — 400 V peak.

ORDERING INFORMATION

P6602 1.5 m Temperature Probe **$225**
Includes: Instruction manual (070-4377-00).

To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext. 99

P6007 Dc to 25 MHz, 100X

For 1 MΩ Inputs

1500 V Dc

Low Capacitance Loading

The P6007 is a low input capacitance, high-voltage (1.5 kV) probe. It can be compensated to match all plug-ins and oscilloscopes with nominal input capacitances of 15 pF to 55 pF and input resistance of 1 MΩ.

ORDERING INFORMATION

P6007 100X, 6 ft High Voltage Probe **$120**

Includes: Retractable hook tip (A1, 013-0071-00); banana tip (A12, 134-0013-00); 5 in ground lead (G7, 175-0124-01); 12 in ground lead (G7, 175-0125-01); 0.055 in diameter straight tip (206-0015-00); 0.080 in diameter spring tip (A4, 206-0060-00); hook tip (A6, 206-0105-00); two miniature alligator clips (A16, 344-0046-00); probe holder (352-0090-00); instruction manual (070-0388-01).

OPTIONS

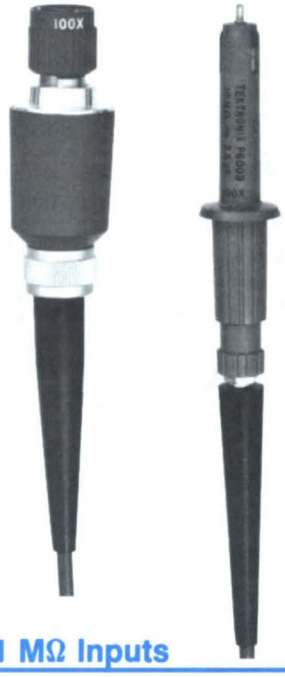
Option 01 — 3.5 ft cable. **NC**

Option 03 — 9 ft cable. **NC**

Option 04 — 12 ft cable. **NC**

P6009

Dc to 120 MHz, 100X With Readout



For 1 MΩ Inputs

1500 V Dc

Dc to 120 MHz

Low Capacitance—2.5 pF

The P6009 is a low input capacitance, high-voltage (1.5 kV) probe designed for use with dc to 150 MHz oscilloscopes. The probe can be compensated to match plug-ins and oscilloscopes with nominal input capacitances of 12 pF to 47 pF and input resistance of 1 MΩ.

The P6009 is equipped with a special BNC connector that provides CRT Readout information when used with plug-in units and mainframes that have these features.

ORDERING INFORMATION

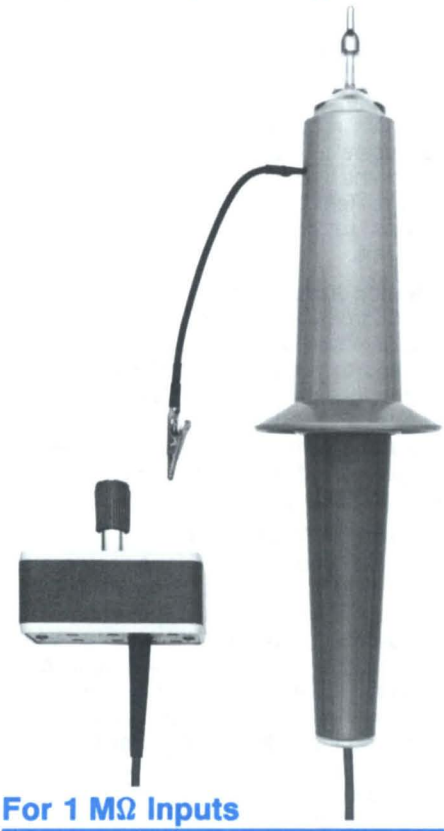
P6009 100X, 9 ft High Voltage Probe With Readout **$195**

Includes: Same as the P6007 plus bayonet ground assembly (A17, 013-0052-00); 3 in ground lead (G7, 175-0263-01); instruction manual (070-0401-01).

OPTION

Option 14 — 9 ft without Readout. **NC**

P6015 40 kV, Peak Pulse, 1000X



For 1 MΩ Inputs

Measure up to 40 kV Peak Pulse

Up to 20 kV Dc + Peak Ac

75 MHz Useful Bandwidth

The P6015 Provides 1000X attenuation for oscilloscope measurements up to 40 kV peak pulse. Voltage or duty cycle derating is necessary for RF voltages at frequencies over 100 kHz, or at temperatures above 25°C.

The probe can be compensated for instruments with nominal input capacitance of 12 pF to 47 pF and input resistance of 1 MΩ.

ORDERING INFORMATION

P6015 1000X, 10 ft High Voltage Probe **$695**

Includes: Carrying case (016-0128-02); high-voltage dielectric fluid (A21, 252-0120-00); alligator clip (A14, 344-0005-00); probe holder (352-0056-00); instruction manual (070-0373-02).

OPTIONS

Option 10 — Without freon. **NC**

Option 25 — 25 ft cable. **$100**

CHARACTERISTICS

	Attenuation	Accuracy	Input Resistance	Input Capacitance			Probe Rise Time	Aberrations	Bandwidth	Nominal Cable Length (ft)	Maximum Dc Voltage	Derated Above	Derated to @ Frequency	Compensation Range (pF)
				3½ ft	6 ft	9 ft								
P6007	100X	3%	10 MΩ	2 pF	2.2 pF	2.4 pF	14.0 ns	±3	25 MHz	3½, 6, 9, 12	1.5 kV	200 kHz	2 kV @ 5 MHz	15 to 55
P6009	100X	3%	10 MΩ			2.5 pF	2.9 ns	±3	120 MHz	9	1.5 kV	200 kHz	300 V @ 20 MHz	15 to 47
P6015	1000X	Adjustable	100 MΩ	3 pF (10 ft only)			4.0 ns	±5	75 MHz	10	20.0 kV	100 kHz	2 kV @ 20 MHz	12 to 47

Above probes compatable with screw-tip accessories shown on page 486. Instrument compatability chart is on page 464.

Floating Measurement Techniques

The industries' need for oscilloscope measurements referenced to voltage levels above/below ground potential has long been recognized. The need to reject signals represents another closely allied measurement requirement. These needs often lead users to employ practices which may distort the waveform measurement or are unsafe. Tektronix offers three safe techniques to solve these measurement problems.

Isolation Amplifiers

The Tektronix A6902B is a voltage isolation amplifier used to connect the circuit under test and the oscilloscope. Signals are coupled across an insulating barrier to the oscilloscope. The isolator provides complete insulation from the signal, no access to dangerous voltages, and complete usability of all oscilloscope functions.

Differential Techniques

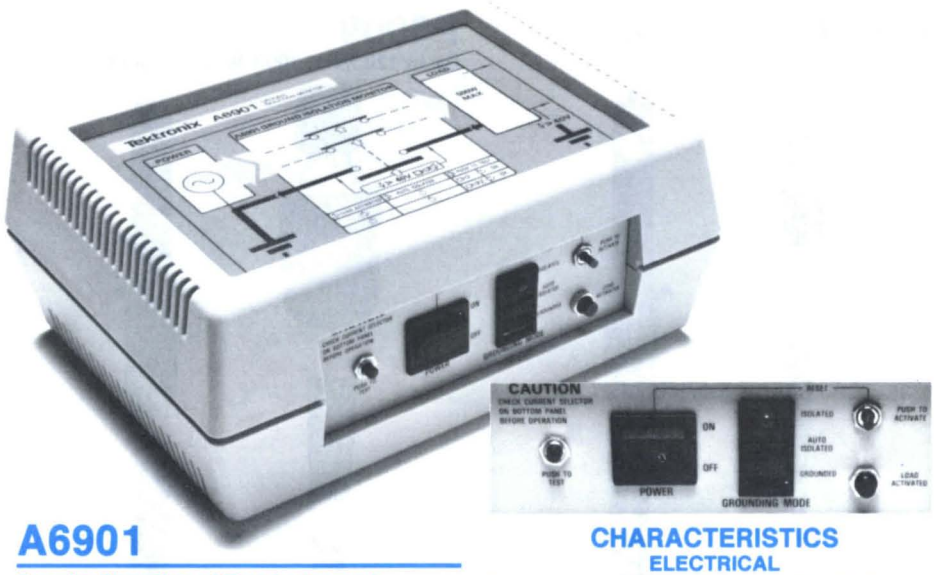
The most popular solution for a floating measurement is the A minus B quasi-differential technique. Most general-purpose dual-trace oscilloscopes have an Add Mode in which two channels can be electrically subtracted, giving a display of the difference signal. This technique limits the common-mode dynamic range and the CMRR to approximately 100:1. Also, examination of low-level signals in the presence of high common-mode voltages can be difficult.

True differential amplifiers like the Tektronix 7A13 are designed specifically to have good rejection of the common-mode signal and display only the difference signal. Common-mode dynamic range is improved but there are bandwidth and floating capability limitations.

Using both A6902B channels as differential input to a 7A13, 7A22 or oscilloscope provides an extra measure of common-mode performance. The isolator probes' common leads are tied together and the signal leads are then used as plus and minus differential inputs to test the circuit. This technique provides the protection of the isolator as well as the combined CMRR capabilities of the isolator and amplifier.

Indirect Grounding

The Tektronix A6901 Ground Isolation Monitor is an indirect grounding device which connects between the power mains and the test instruments, allowing monitored floating measurements. As specified in safety standards, the grounding circuit to the test instrument need not be completed until the available voltage or current exceeds a prescribed amount (40 V peak or 28 V RMS). When this amount is exceeded the power to the instrument is interrupted, a protective ground is re-established, and an audible alarm is sounded. The A6901 also verifies the existance of a functional ground in the power source.



A6901

Permits Elevation of Test Instrument Chassis to 40 V Peak (28 V RMS)

Aids in Circuit Analysis or Circumventing Ground Loop Noise Problems

UL and VDE Safety Certification

The A6901 is placed between a measurement instrument and its power source and acts as an indirect grounding device, allowing floating measurements to be made with operator protection.

The A6901 monitors the voltage on the isolated system. When the voltage exceeds 40 V peak (28 V RMS) the power source to the instrument is interrupted, the isolated grounding system is connected to the power source grounding system, and an audible alarm is sounded. Before power is supplied to the measurement instrument, the A6901 tests the power source for a functional ground*[1]. If a functional ground is not established, the ground isolation monitor will not go into isolated mode.

Applications for the A6901 include elevating a test instrument chassis to logic reference voltages for more accurate logic level measurements, and isolating a test instrument chassis from common-mode voltages present on ground systems to eliminate undesirable noise from signal measurements.

The A6901 also can be used to test power outlets for proper wiring.

*[1] *If the A6901 is used in conjunction with a GFI (Ground Fault Indicator), consult the GFI manual for compatibility information.*

CHARACTERISTICS

ELECTRICAL

Trip Voltage (Dc) — 40 V peak (28 V RMS) or + and −40 V (within 5%).

Trip Current — 0.5 mA, 3.5 mA to 5 mA selectable.

Neutral-to-Ground Continuity — Between 3 V and 10 V RMS (8.5 V and 28.3 V p-p), 50 Hz.

Dc Voltage Trip Delay — <20 ms.

Line Voltage Ranges — 90 V to 128 V RMS, 180 V to 250 V RMS.

Line Frequency Range — 48 Hz to 66 Hz.

Maximum Power Consumption (No External Load) — 12 W at 115 V, 60 Hz.

Load Power — 500 W maximum.

ENVIRONMENTAL

Temperature — Operating: −15°C to +55°C (+5°F to +131°F). Nonoperating: −62°C to +85°C (−80°F to +185°F). Meets MIL-T-28800B, Class 3.

Altitude — Operating: To 4600 m (15,000 ft). Nonoperating: To 15 000 m (50,000 ft). Exceeds MIL-T-28800B, Class 3.

Humidity — Exceeds MIL-T-28800B, Class 3.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Height	87	3.4
Width	206	8.1
Depth	153	6.0
Weights≈	**kg**	**lb**
Net (without accessories)	1.4	3.0
Shipping	2.3	5.0

ORDERING INFORMATION

A6901 Ground Isolation Monitor **$650**

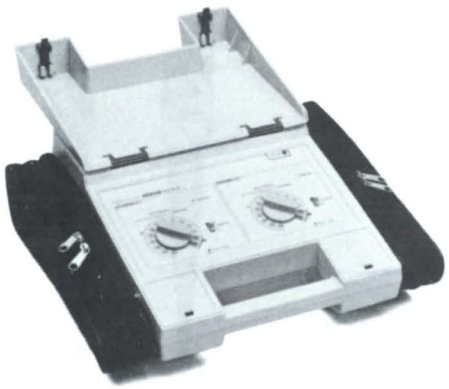
Includes: Operator manual (070-3618-00).

INTERNATIONAL POWER PLUG OPTIONS

Option A1 — Universal Euro 220 V, 50 Hz.
Option A2 — UK 240 V, 50 Hz.
Option A3 — Australian 240 V, 50 Hz.
Option A5 — Switzerland 220 V, 50 Hz.
(North American 240 V not available. Neutral not grounded in 240 V North American Systems.)

To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext. 99

A6902B



For 50 Ω or 1 MΩ Inputs

Two Independently Isolated Channels

High Voltage/High CMRR

UL Certified to 3000 V/Channel (6000 V Maximum Channel Differential)

Dc to 20 MHz Bandwidth

A dual-channel, optical- and transformer-coupled voltage isolator, the A6902B allows safely grounded test instruments to make floating measurements at high sensitivity levels in the presence of large common-mode signals.

The A6902B acts as a buffer between the test instrument and the system under test and extends the range of the test instrument to 3000 V (dc plus peak ac) with the larger industrial probe and to 500 V (dc plus peak ac) with the smaller signal probe. Both probes are quickly interchangeable at the cable connectors. Probes and output cables are stored in removable side pouches for availability and convenience.

Designed for use with any dual-channel oscilloscope, the A6902B permits simultaneous observation of two signals at two different points in the same circuit; or signals in two different circuits without respect to common lead voltages.

The two channels can also be combined to function as an input to a differential amplifier.

Separate, calibrated controls for volts per division on each channel provide for precise floating measurements. The all-plastic case and external controls protect the user during control settings and other operations. Other than probe tip connections, the user is never in close proximity to hazardous voltages.

CHARACTERISTICS

ELECTRICAL

Deflection Factor — Probe Tip Sensitivity: 20 mV/div to 500 V/div in 1-2-5 sequence with oscilloscope set to 10 mV/div. Accuracy: ⩽±5% of indicated V/div switch setting.

Frequency Response — Bandwidth: Dc coupled (to −3 dB point) is ⩾20 MHz. Ac coupled (to lower −3 dB point) is ⩽5 Hz to ⩾20 MHz.

Transient Response — Rise time: 17.5 ns (calculated from bandwidth).

Maximum Working Voltage

Small Probe (500 V) — Probe Center Tip to Earth Ground: 500 V (dc + peak ac). Probe Center Tip to Probe Common: 500 V (dc + peak ac) to 3 MHz. See Figure 2 for voltage derating above 3 MHz. Probe Common to Earth Ground: 500 V (dc + peak ac) to 6 MHz. See Figure 2 for voltage derating above 6 MHz.

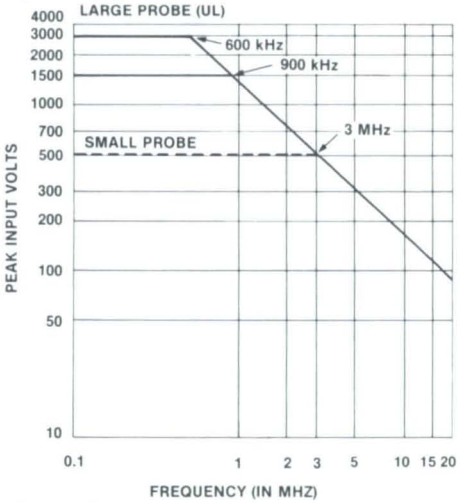


Figure 1. Maximum working voltage between probe input and probe common (all temperatures).

Large Probe — Probe Center Tip to Earth Ground: UL 3000 V. Probe Center Tip to Probe Common: UL 3000 V (dc + peak ac) to 450 kHz. See Figure 1 for voltage derating above 900 kHz. Probe Common to Earth Ground: UL 3000 V (dc + peak ac) to 250 kHz. See Figure 2 for voltage derating above 250 kHz.

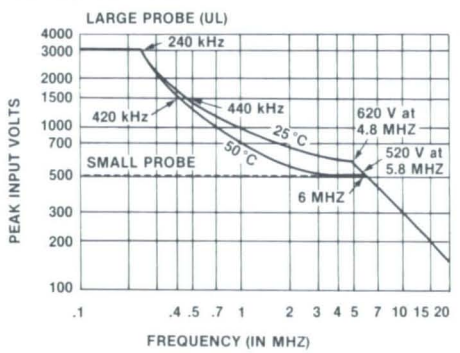


Figure 2. Maximum working voltage between probe common and earth ground.

Maximum Input dV/dt — 100 V/ns.

Input Impedance — Resistance: 10 MΩ ±3%. Capacitance: ≈19 pF with either probe.

Output Impedance — 50 Ω ±5%.

Output Drive — 4 V p-p into 1 MΩ.

Common-Mode Capacitance — 100 pF from probe common to earth ground.

Maximum Common to Ground Slew Rate — 500 V/μs.

Tangential Noise — ⩽20 mV. Dc Drift With Temperature: ⩽10 mV/°C (0.1 div/°C) at output. Range of Output Dc Level: At least +5 div from center screen.

Channel Isolation — Maximum Voltage: Using two 3,000 V UL probes is 6000 V (dc + peak ac) UL. Using two 500 V probes is 1000 V (dc + peak ac).

Delay — 51 ns ±3 ns (large probe), 52 ns ±3 ns (small probe), from probe input to instrument input. CH 1, CH 2 delay difference is ⩽4 ns.

Common Lead Signal Feedthrough — −106 dB from probe input to output BNC to 500 Hz. See Figure 3 for derating above 500 Hz.

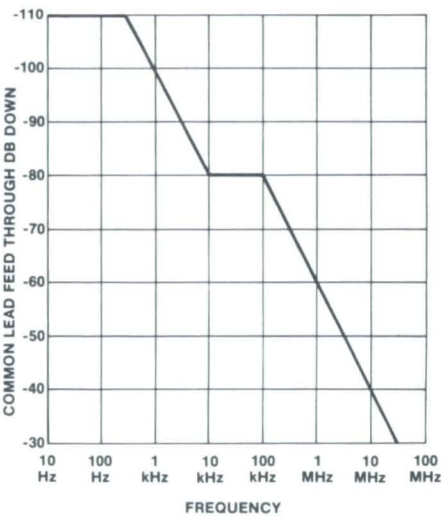


Figure 3. Common lead feedthrough characteristics.

POWER REQUIREMENTS

Line Voltage Ranges — Low: 90 V to 132 V. High: 180 V to 250 V.

Line Frequency Range — 48 Hz to 440 Hz.

Maximum Power Consumption — 24 W at 115 V, 60 Hz.

ENVIRONMENTAL

Temperature — Operating: 0°C to +50°C. Nonoperating: −55°C to +75°C.

Altitude — Operating: To 4500 m (15,000 ft). Nonoperating: To 15 000 m (50,000 ft).

Humidity (Operating and Nonoperating) — Five cycles (120 hr total) with equipment tested nonoperating to MIL-STD-810C Method 507.1, at 90% to 95% relative humidity and 30°C to 60°C.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Height	136	5.4
Width	394	15.5
Depth	344	13.5
Weight≈	**kg**	**lb**
Net with Accessories	6.2	13.7
Shipping	8.0	17.7

ORDERING INFORMATION

A6902B Voltage Isolator **$1,795**

Includes: Two 500 V isolation probes (010-0411-10); right angle power cord (161-0117-00); two 2 m, 50 Ω output cables (012-0204-00); operator manual (070-5614-00).

OPTIONS

Option 02 — Add two large probes. **+$470**

Option 09 — Add two large probes plus two 4 mm banana adaptors. **+$535**

INTERNATIONAL POWER PLUG OPTIONS

Option A1 — Universal Euro 220 V, 50 Hz.
Option A2 — UK 240 V, 50 Hz.
Option A3 — Australian 240 V, 50 Hz.
Option A4 — North American 240 V, 60 Hz.
Option A5 — Switzerland 220 V, 50 Hz.

DIFFERENTIAL PROBES

Tek supports four modes of differential measurements: the differential amplifier probe, the matched pair of probes, the isolation amplifier, and the ground interrupt monitor.

The P6046 is a 100 MHz differential amplifier in probe form. It connnects into one channel of a standard scope amplifier.

A matched pair of P6055 probes can produce CMRR ratios up to 20,000:1 with differential amplifiers. A single 10X probe has accuracy of 1% or less giving a scope-to-probe CMRR of no better than 50:1.

The A6902B provides differential capabilities for signals to 20 MHz, while rejecting up to 3,000 Volts of common mode.

The A6901 allows floating measurements within safe limits. It first checks for a good ground, then breaks the ground connection and continuously monitors the level of voltage elevation, and reconnects the ground if safe limits are exceeded.

P6046

For 50 Ω or 1 MΩ Inputs

1000:1 CMRR at 50 MHz

±250 V Maximum Voltage With 10X Attenuator

Dual Probe Tips for Greater CMRR at High Frequencies

The P6046 Differential Probe and P6046 Amplifier Unit provide unique measurement capabilities with all Tektronix oscilloscopes. The differential-signal processing takes place in the probe itself, resulting in high common-mode signal rejection at higher frequencies. Differential probe-tip signal processing minimizes the measurement errors caused by differences in probes, cable lengths, and input attenuators.

CHARACTERISTICS

CMRR — With deflection factors of 1 mV/div to 20 mV/div: at least 10,000:1 at 50 kHz, 5,000:1 at 1 MHz, and 1,000:1 at 50 MHz.

Common-Mode Linear Dynamic Range — ±5 V, ±50 V with 10X attenuator.

Bandwidth — Dc to 100 MHz (−3 dB).

Rise Time — 3.5 ns or less.

Deflection Factor Range — 1 mV/div to 200 mV/div in 8 calibrated steps, 1-2-5 sequence, accurate within 3% (with an oscilloscope deflection factor of 10 mV/div).

Input RC — 1 MΩ paralleled by 10 pF or less.

Input Coupling — Ac or dc, selected by a switch on the probe. Low frequency response ac-coupled is −3 dB at 20 Hz, 2 Hz with 10X attenuator.

P6046

Dc to 100 MHz, 1X Differential

Displayed Noise — 280 μV or less (tangentially measured).

Maximum Input Voltage — ±25 V (dc + peak ac), ±250 V with 10X attenuation, derated with frequency.

Output Impedance — 50 Ω through a BNC-connector. 50 Ω termination supplied with amplifier for use with 1 MΩ systems.

Probe Cable — 6 ft long, terminated with special nine-pin connector.

ORDERING INFORMATION

P6046 1X, 6 ft FET Differential Probe With Amplifier and Power Supply **$1,750**

Includes: 50 Ω termination (011-0049-01); amp and power supply (015-0106-00); 50 Ω coaxial cable (012-0076-00); hanger assembly (014-0029-00); carrying case (016-0111-01); 10X attenuator (010-0361-00); dual attenuator head (010-0419-00); swivel probe tip; spring ground contact; connector test point jack; instruction manual (070-0756-00).

OPTION

Option 11 — Without Amplifier and Power Supply **−$825**

Power Supply With Amplifier — Order 015-0106-00 **+$1,000**

Probe accessories on page 486.
Instrument compatibility chart on page 464.

P6055

20,000:1 CMRR, 10X With Readout

High CMRR

Compact Size

Low Capacitance

Dc to 60 MHz

The P6055 is a miniature, low capacitance, 10X probe designed for use with Tektronix differential amplifiers with nominal input capacitances from 20 pF to 47 pF. The attenuation ratio is adjustable to compensate for differences in input resistance of the amplifier (the amplifier input resistance must be 1 MΩ ±2%). A special locking type readout connector allows use with instruments with or without readout capability.

When two P6055 Probes are used to drive the two inputs of a differential amplifier, the ability to change the attenuation ratio of one probe versus the other is helpful in maintaining the CMRR of the system. The use of a matched pair of P6055 differential probes provides the best possible system CMRR.

CHARACTERISTICS

CMRR — 20,000:1 from dc to 1 kHz derating to 100:1 at 20 MHz.

Attenuation — Adjustable to 10X.

Input Resistance — 1 MΩ ±0.5%.

Input Capacitance — ≈10 pF when used with instrument that has 20 pF input capacitance; 12.5 pF when used with instrument that has 47 pF input capacitance.

Maximum Useful Bandwidth — 60 MHz.

Typical Probe Rise Time — 5.8 ns.

Maximum Voltage — 500 V (dc + peak ac) from dc to 12 MHz, p-p V derated to 100 V at 70 MHz.

ORDERING INFORMATION

P6055 Matched Pair of 10X, 3.5 ft Differential Probes **$535**

Includes (for each probe): Probe holder (352-0090-00); adjustment tool (F4, 003-0675-00); retractable hook tip (B3, 013-0107-05); two minialligator clips (A16, 344-0046-00); probe tip ground cover (B16, 166-0404-01); 5 in ground lead (G7, 175-0124-01); 12 in ground lead (G7, 175-0125-01); 5 in ground lead (G2, 175-1256-00); hook tip (B6, 206-0114-00); instruction manual (070-1115-00).

OPTION

Option 01 — Single probe with accessories **−$260**

To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext. 99

CURRENT PROBES

Current probes provide a method to measure the current flowing in a circuit from dc to 1000 MHz. For instance, their use can eliminate the calculations that would be required to determine the current from the voltage drop across a current sampling resistor.

Two types of current probes are available, the traditional ac only probe and the "Hall effect" type. Ac only current probes use a transformer to convert current flux into ac signals and have a frequency response from a few hundred hertz to 1000 MHz. Hall effect current probes include semiconductors to provide a frequency response from dc to 50 MHz.

Current probes can be used where low loading of the circuit is necessary. Loading is typically in the mΩ to low Ω range. Current probes can be used for differential measurements; where the probe measures the results of two opposing currents in two conductors in the jaw of the probe.

A current waveform may be very different from a voltage waveform in a current-dependent circuit. Measuring only the voltage will not show this difference. A measurement of the current waveform is necessary to obtain the total picture.

A current probe is used by clipping its jaws around the wire that is carrying the current to be measured. Because it is "noninvasive", a current probe imposes less loading than other probes (typically less than a few nanohenrys in series with the wire at a capacitance of less than 1 pF). Differential current measurements are made by passing the two wires (in correct phase) through the current probe jaws.

The CT-5 increases the high-current measuring capability of most current probes by either 20:1 or 1000:1.

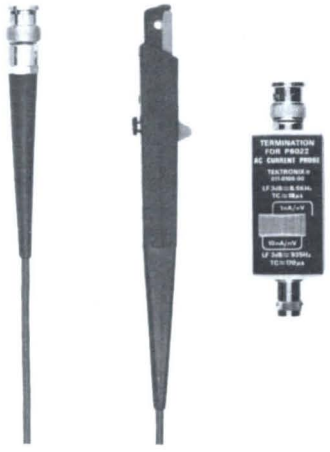
CURRENT PROBE SELECTION GUIDE

Type	Bandwidth Hz to MHz	Displayed Current/Div	Maximum Current					Saturation		Page	Prices
			Peak Pulse	Dc + pk Ac	Ac P-P	Derate Below	Derate Above	Dc	Amp-S Product		
A6302/AM 503	Dc to 50	1 mA to 5 A*1	50 A	20 A	40 A		20 kHz	20 A	100×10^{-6}	483	$1,690
with CT-5	0.5 to 20	20 mA to 5 kA*1	50 kA		40 kA	20 Hz	1.2 kHz		0.1	483	$2,890
A6303/AM 503	Dc to 15	10 mA to 50 A*1	500 A	100 A	200 A		20 kHz	100 A	$10{,}000 \times 10^{-6}$	483	$2,195
P6021 with Passive Termination	120 to 60	20 mA or 100 mA*1	250 A		15 A	300 Hz	5 MHz	0.5 A	500×10^{-6}	482	$430
and CT-5	120 to 20	400 mA or 100 A*1	50 kA		2000 A	300 Hz	1.2 kHz	20 A	0.5	484	$1,630
with 134	12 to 38	1 mA to 1 A*2	250 A		15 A	230 Hz	5 MHz	0.5 A	500×10^{-6}	482	$1,055
and CT-5	12 to 20	20 mA to 1 kA*2	15 kA		2000 A	230 Hz	1.2 kHz	20 A	0.5	484	$2,255
P6022 with Passive Termination	935 to 120	10 mA or 100 mA*1	100 A		6 A	3 kHz	10 MHz	0.2 A	9×10^{-6}	482	$475
with 134	100 to 65	1 mA to 1 A*2	100 A		6 A	1.3 kHz	10 MHz	0.2 A	9×10^{-6}	482	$1,100
CT-1	25 k to 1000	0.5 mA*1 (5 mV/mA)	12 A		1.4 A			0.2 A	1×10^{-6}	484	$175
CT-2	1.2 k to 200	0.1 mA*1 (1 mV/mA)	36 A		7 A			0.2 A	50×10^{-6}	484	$200

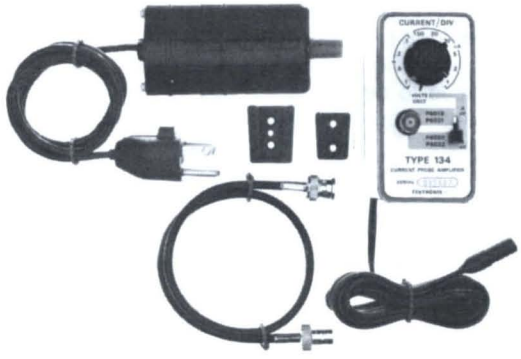
*1 *Scope set at 10 mV/div.*
*2 *Scope set at 50 mV/div.*

P6021 With Termination

P6022 With Termination



134 Current Probe Amplifier



For 1 MΩ Input With Passive Termination

For 50 MΩ/1 MΩ Input With 134

Clip-on Capability

Shielded Probe Heads

The P6021 and P6022 Current Probes and 134 Current Probe Amplifier provide versatility in a user-assembled ac current measurement system. Both probes provide accurate current measurements over a wide range of frequencies and are used with real time oscilloscopes. They can be used with 1 MΩ input instruments with their passive terminations, or with 50 Ω and 1 MΩ input instruments with the 134 Amplifier. Both avoid breaking a circuit by clipping onto a conductor. Just open the spring-loaded slide, place the conductor into the slot and release the slide. No electrical connection is required.

Shielded probe heads are not grounded when the slides are in their open positions, eliminating accidental grounding of the circuit under test.

P6021 Current Probe

For general purpose applications the P6021 provides wide-band performance with excellent low-frequency characteristics. Bandwidth is 120 Hz to 60 MHz. Passive termination is switchable from 2 mA/mV to 10 mA/mV.

P6022 Current Probe

The extra small size of the P6022 makes it ideally suited to measure current in compact semiconductor circuits. Bandwidth is 935 Hz to 120 MHz. Passive termination is switchable from 1 mA/mV to 10 mA/mV.

The 134 is used to extend the measurement capabilities and sensitivity of the P6021 or P6022 Current Probes. A Current/Div switch provides calibrated current steps from 1 mA/div to 1 A/div (with the oscilloscope or plug-in unit adjusted for a deflection factor of 50 mV/div). A passive termination is not required when using a 134 with a P6021 or P6022.

The 134 can also be used as an auxiliary voltage amplifier by placing the Current/Div switch in the Volts position.

PERFORMANCE CHARACTERISTICS

	P6021 with Passive Termination		P6022 with Passive Termination		Probe with 134 Amplifier	
					P6021	P6022
Accuracy 3% Sensitivity	2 mA/mV	10 mA/mV	1 mA/mV	10 mA/mV	1 mA to 1 A/div @ 50 mV/div	
Bandwidth Low −3 dB High −3 dB	450 Hz 60 MHz	120 Hz 60 MHz	8.5 kHz 100 MHz	935 Hz 120 MHz	12 Hz 38 MHz	100 Hz 65 MHz
Rise Time	5.8 ns	5.8 ns	2.7 ns	1.7 ns	9.2 ns	5.4 ns
Droop TC	0.35 ms	1.3 ms	18.7 μs	0.17 ms	13 ms	1.6 ms
Maximum Ac CW From To	15 A peak 1.2 kHz 5 MHz	15 A peak 300 Hz 5 MHz	6 A peak 10 kHz 10 MHz	6 A peak 3 kHz 10 MHz	15 A peak 230 Hz 5 MHz	6 A peak 1.3 kHz 10 MHz
Maximum Peak Current	250 A	250 A	100 A	100 A	250 A	100 A
Amp/Second Product	500×10^{-6}	500×10^{-6}	9×10^{-6}	9×10^{-6}	500×10^{-6}	9×10^{-6}
Maximum Dc	0.5 A	0.5 A	0.5 A	0.5 A	0.5 A	0.5 A
Insertion Z (Ω)	0.03 @ 1 MHz 1.0 @ 60 MHz		0.03 @ 1 MHz 0.2 @ 120 MHz		0.03 @ 1 MHz 1.0 @ 38 MHz	0.03 @ 1 MHz 0.2 @ 65 MHz
Propagation Delay (ns) 5 ft 9 ft	9 15	9 15	9 15	9 15	9 15	9 15
Maximum Voltage Barewire	600 V	600 V	600 V	600 V	600 V	600 V
Net Weight	≈1 lb		≈1 lb		≈5 lb	
Maximum Conductor Size	0.15 in dia		0.1 in dia		0.15 in dia	0.1 in dia
Operating Temperature	0°C to +50°C		0°C to +50°C		0°C to +50°C	

ORDERING INFORMATION

P6021 5 ft Current Probe With Termination **$430**
Includes: 5 in (130 mm) ground lead (G7, 175-0124-01); 3 in (75 mm) ground lead (G7, 175-0263-01); 2 miniature alligator clips (A15, 344-0045-00); instruction manual (070-0947-00).

P6022 5 ft Current Probe With Termination **$475**
Includes: Same as the P6021; instruction manual (070-0948-00).

OPTIONS

Option 03 — 9 ft with termination. **NC**

Option 12 — 5 ft without termination.
(P6021) **−$60**
(P6022) **−$95**

Option 13 — 9 ft without termination.
(P6021) **−$60**
(P6022) **−$95**

134 110 V Current Probe Amplifier **$625**
Includes: Hanger assembly (014-0029-00); cable assembly (012-0104-00); instruction manual (070-0990-01).

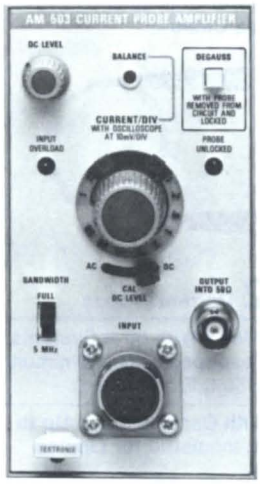
OPTIONAL ACCESSORIES
(P6021, P6022, and 134)

Carrying Case — For P6021 or P6022, and a 134 Amplifier. Order 016-0087-01 **$30**

Passive Termination —
(P6021) Order 011-0105-00 **$120**
(P6022) Order 011-0106-00 **$145**

Power Supply —
(110 V ac) Order 015-0058-01 **$195**

To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext. 99



A6302 Current Probe

20 A Ac and Dc Current Measurements

Dc to 50 MHz Bandwidth

Peak Pulse Measurements to 50 A, 50,000 A With the CT-5 Current Probe

Ac or Dc Coupling

Small Loading—0.1 Ω Insertion Z at 1 MHz, 0.5 Ω at 50 MHz

A6303 Current Probe

100 A Ac and Dc Current Measurements

Peak Pulse Measurement to 500 A

Ac or Dc Coupling

25 x 21 mm (1 x 0.83 in) Jaw Opening

Minimal Loading—0.02 Ω Insertion at 1 MHz, 0.15 Ω at 15 MHz

AM 503 Current Probe Amplifier

For 50 Ω/1 MΩ Inputs

The Tektronix A6302 and A6303 Current Probes are designed to be used with the AM 503 Current Probe Amplifier, any TM 500 Power Module and an oscilloscope. Both probes are used to make SCR, power supply, industrial control and motor start-up current measurements. The A6303 is especially recommended for measuring current in X-ray tubes to ensure compliance with PL 90-602, the Radiation Control for Health and Safety Act of 1968.

The A6302 and A6303 are valuable measurement tools when low loading is important, as when testing high impedance points or with current dependent devices.

Both probes make ac or dc coupled current measurements by the simple act of opening their sliding jaws and placing them around the conductor to be measured. For differential or sum measurements just place properly phased conductors in the probe jaw.

Suggested measurements for the A6302 and A6303 Current Probes include:

- X-ray tube currents
- SCR currents
- Power supply currents
- Motor start-up currents
- Industrial control currents
- Relay currents
- Common-mode rejection of dc and ac currents

CHARACTERISTICS

	A6302 & AM 503	A6303 & AM 503
Sensitivity: Scope @ 10 mV/div Accuracy 3%	1 mA/div to 5 A/div	10 mA/div to 50 A/div
Bandwidth	Dc to 50 MHz	Dc to 15 MHz
Rise Time	7 ns	23 ns
Max Ac Current CW	40 A p-p	200 A p-p
Derated above	20 kHz 2.5 A @ 10 MHz	20 kHz 12 A @ 10 MHz
Maximum Current Peak Not to Exceed A-S product	50 A	500 A
A-S Product	100 x 10^{-6}	10,000 x 10^{-6}
Insertion Z	0.1 Ω @ 5 MHz 0.5 Ω @ 50 MHz	0.02 Ω @ 1 MHz 0.15 Ω @ 15 MHz
Max Hardware Volts	500 V	700 V
Max Conductor Diameter	0.15 inch	0.83 inch
System Prop Delay	≈30 ns	≈40 ns
Cable Length	2 m	2 m
Tangential Noise	0.3 mA	3 mA
Aberrations	±5%	±5%
Magnetic Susceptibility	250 μA/Gauss	25 mA/Gauss
Operating Temp	0°C to +50°C	0°C to +50°C

Note: A6302/AM 503 or A6303/AM 503 calibrated as a set.

ORDERING INFORMATION

A6302 2 m Current Probe **$565**
Includes: 5 in (130 mm) ground lead (G7, 175-0124-01); 3 in (75 mm) ground lead (G7, 175-0263-01); 2 miniature alligator clips (A16, 344-0046-00); instruction manual (070-3905-01).

A6303 2 m Current Probe **$1,070**
Includes: Carrying case (016-0622-00); instruction manual (070-3906-01).

The AM 503 operates in any one of the TM 500 power modules and is connected to either the A6302 or A6303 probes through a multipin connector.

It is calibrated in 12 steps; the knob skirt is illuminated to indicate current per division. Bandwidth can be limited to 5 MHz to eliminate unwanted transients. Both ac and dc coupling are provided. Ac coupling allows the measurement of low amplitude signals on a high level dc current. A front panel light warns of input currents above 100 A dc with the A6303 or 20 A dc with the A6302. A pushbutton allows degaussing of probe when it is removed from the circuit and locked in operating position.

The output of the A6303/AM 503 can be displayed on any oscilloscope that has at least a 50 MHz bandwidth and a 10 mV sensitivity. The A6302/AM 503 can be used on a 75 MHz oscilloscope with 10 mV sensitivity to display the probe's full bandpass. The AM 503 output can be plugged directly into a 50 Ω recording instrument, or a 50 Ω termination which is supplied. See page 426 for a complete description of the AM 503.

ORDERING INFORMATION

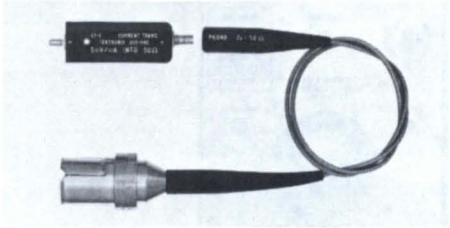
AM 503 Current Probe Amplifier **$1,125**
Includes: 50 Ω BNC cable (012-0057-01); 50 Ω BNC termination (011-0049-01); instruction manual (070-2052-01).

The AM 503 Current Probe Amplifier requires one of the TM 500 Series power modules listed below. The number of plug-ins the module will accept is designated by the last digit in the part number. The optional interface allows connections between plug-ins to be made through the rear panel of the power module.

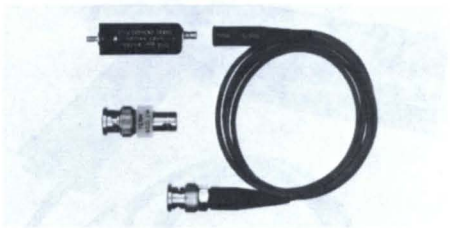
TM 501 Power Module **$500**
Option 02 — Interface. **+$60**

TM 503 Power Module **$390**
Option 02 — Interface. **+$90**

CT-1 With Probe Cable



CT-2 With Probe Cable



CT-1/CT-2 Current Probes

The 1 GHz CT-1 is Used With 50 Ω Systems, or Wide Band Oscilloscopes; Has a Minimum Loading Effect on a 50 Ω Environment

The CT-2 is Used With Oscilloscopes Up to 100 MHz Bandwidth; Insulated for Limited Space Applications

The CT-1 and CT-2 Current Probes are designed for permanent or semipermanent in-circuit installation. Each probe consists of a current transformer, an interconnecting cable and a termination. The current transformers are traversed by a small hole through which a current carrying conductor is passed during circuit assembly.

One probe cable can be used to monitor several current transformers that have been wired into a circuit.

The CT-1 Probe Cable (P6040) provides the connection between the CT-1 current transformer and a GR scope input. This cable can also be used with other test point connectors such as Amphenol Series 27 Sub-Minax or Sealectro Sub-Miniature RF connectors.

The CT-2 Probe Cable (P6041) is used to connect the CT-2 current transformer with a BNC oscilloscope input. A 50 Ω termination is used to terminate the cable at the high impedance input of an oscilloscope.

CHARACTERISTICS

	CT-1	CT-2
Sensitivity	5 mV/mA	1 mV/mA
Accuracy	±3%	±3%
Rise Time	350 ps	500 ps
Frequency Response Low: −3 dB High: −3 dB	 25 kHz 1 GHz	 1.2 kHz 200 MHz
Insertion Impedance at: 10 MHz 100 MHz	 ≈1 Ω 2 Ω	 0.1 Ω 0.5 Ω
Capacitive Loading Barewire	1.5 pF for #14	1.8 pF for #16
Maximum Barewire Voltage	1000 V	1000 V
Dc Saturation Current: Current to Reduce L/R by X2 Pulse Current Rating*1 Not to Exceed: Amp S Product*1 Maximum CW Current*1 Cable Length Prop Delay Cable Connector	 75 mA 12 A 1 x 10^{-6} 450 mA 18 inch 3.25 ns GR874	 175 mA 36 A 50 x 10^{-6} 2.5 A 42 inch 6.1 ns BNC
Operating Temperature	−25°C to +65°C	

1 With 50 Ω termination. Values are reduced by a factor of 2 if unterminated.

ORDERING INFORMATION

CT-1 Current Probe, Current Transformer and Probe Cable, Termination **$175**
Includes: Instruction manual (070-0375-01).

OPTIONS

Option 09 — Current Transformer only. **−$70**
P6040 — Probe Cable only. **$90**

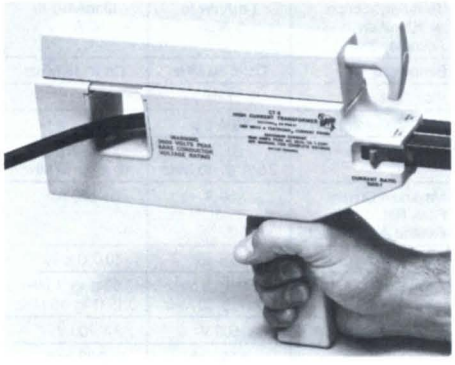
CT-2 Current Probe, Current Transformer, Probe Cable, Termination **$200**
Includes: 50 Ω termination (011-0049-01); instruction manual (070-0406-01).

OPTIONS

Option 09 — Current Transformer only. **−$80**
P6041 — Probe Cable only. **$60**

CT-5

Continuous Currents to 1000 A Peak



1.5 Inch Diameter Conductors

Measurements on Bare Conductors to 3000 V

Nullifies Dc Effects to 300 A With Dc Bucking Coil

Pulsed Currents to 50 kA

The CT-5 is a clip-on high current transformer that extends the measurement capability of the Tektronix P6021 and A6302 clip-on current probes. Maximum low frequency performance is obtained using the A6302/AM 503 Dc Current Probe. Pulse current to 50,000 amps may be measured using the P6021 and passive termination, provided the 0.5 A-s rating is not exceeded. The P6021 and 134 Current Probe Amplifier may also be used for measurements at normal line frequency and above. (The P6022 and CT-5 are not compatible with each other.)

The CT-5 has receptacles for current probes in either 20:1 or 1000:1 step-down ratios. The 1.5 inch square opening makes it possible to clip onto large conductors without breaking the circuit under test. The core and shield assembly are insulated from the windings and the handle. This allows measurements on bare wires to 3000 V, and to 10 kV RMS with a high voltage bushing.

A dc bucking coil assembly allows up to 300 A of dc to be tolerated without appreciably degrading measurements. This is very useful for measuring ac signals on top of a dc voltage level.

CHARACTERISTICS (CT-5)

The following are characteristics of the CT-5 using either the A6302/AM 503 or P6021/134 combinations.

Rise Time — 17.5 ns or less.

Insertion Impedance — ≤20 μΩ at 60 Hz; 20 mΩ at 1 MHz.

Current Range — 20 mA/div to 100 A/div with A6302/AM 503, and 20 mA/div to 20 A/div with P6021/134 (20:1 step down ratio); 1 A/div to 5 kA/div with A6302/AM 503, 1 A/div to 1 kA/div with P6021/134, (1000:1 step down ratio).

Accuracy — ±4%. Maximum Current is 1000 A peak cw.*1

Maximum Voltage of Circuit Test — 3000 V (barewire).

Maximum Dc Bucking Current — 300 mA to buck out 300 A dc (using dc bucking coil).

1 Maximum current 1000 A peak from 20 Hz to 1.2 kHz derating to 100 A peak at 1 MHz.

CURRENT MEASUREMENT COMBINATIONS

Product	Bandwidth	A-s Product	Maximum Current	
			RMS	Peak Pulse
CT-5/A6302/AM 503	0.5 Hz to 20 MHz	0.1	700 A	50 kA
CT-5/P6021/134	12 Hz to 20 MHz	0.5	700 A	15 kA
CT-5/P6021/Term	120 Hz to 20 MHz	0.5	700 A	50 kA

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	57	2.3
Heignt	241	9.5
Depth	266	10.5
Weight≈	**kg**	**lb**
Net	1.8	4.0

ORDERING INFORMATION

CT-5 Current Probe With Dc Bucking Coil **$1,200**
Includes: Carrying case (016-0191-03); 12 in wide, 4 ft long high voltage bushing (015-0194-00); instruction manual (070-1130-00).

OPTION

Option 09 — Without Dc Bucking Coil. **−$100**

OPTIONAL ACCESSORIES

Dc Bucking Coil — Order 015-0190-00 **$330**
High-Voltage Bushing — 12 in wide, 4 ft long. Order 015-0194-01 **$65**

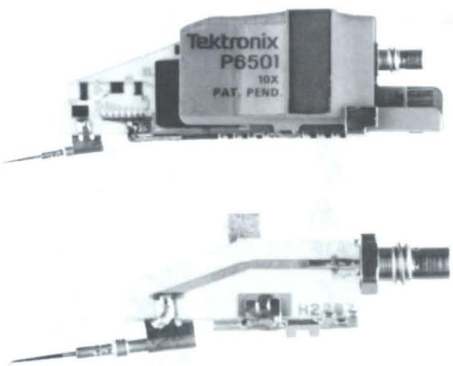
To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext. 99

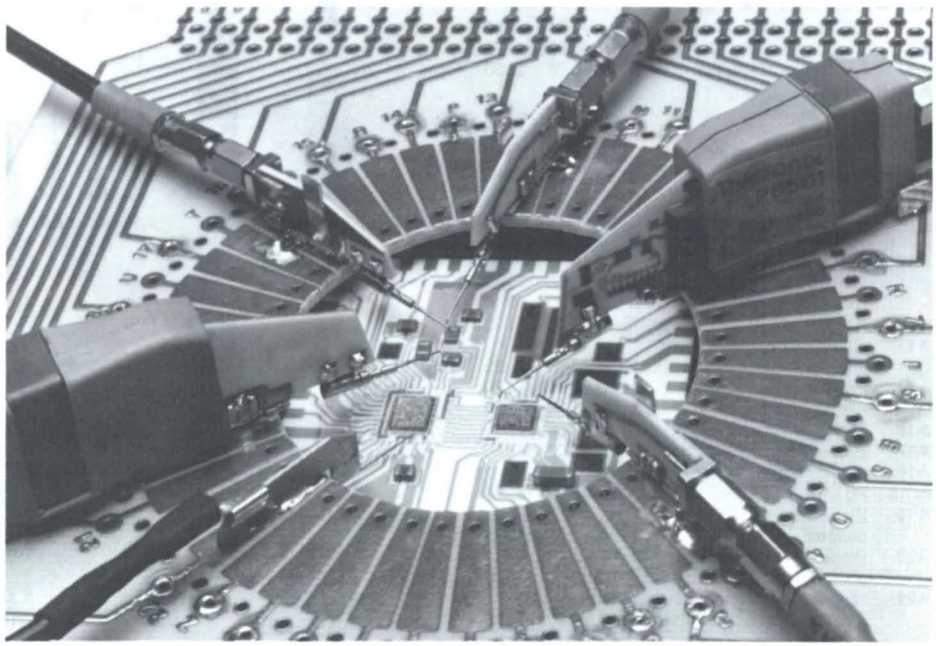
NEW

CARD MOUNTABLE MICROPROBES

NEW P6501
1 MΩ Card Mountable Active Probe

NEW P6507
50 Ω Card Mountable Probe





1.9 pF Capacitive Loading

Probe Card Mountable

Hybrid, IC and SMD Probing

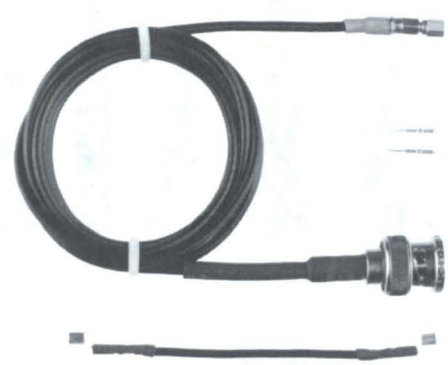
The P6501 Microprobe is a small, 1 MΩ input active probe optimized for probe card mounting and use with probing stations. Its very low profile (about 0.5 in high) avoids interference with the objective lenses of microscopes and lasers. The narrow body of the P6501 (about 0.100 in wide) makes it well suited for high density probing applications.

Power and signal cables to the probe attach through connectors for convenient set up and storage of probe cards between uses. The 50 Ω coaxial signal cable uses a miniature 50 Ω connector at the probe end and a BNC connector on the instrument end. Allowance for a minimum-length ground reference connection is built into the probe.

The P6501 requires a power supply capable of supplying ±15 V at 20 mA and ±5 V at 17 mA. Option 01 includes a power supply which will plug directly into a 115 V, 60 Hz line.

Two types of replaceable tips are offered for extended wear and flexibility: Tungsten for thick film, and Palladium for thin film and IC probing.

The P6507 Microprobe is a 50 Ω input probe and companion to the P6501. The probe can be used as either a 50 Ω input or output probe in card-mounted applications. It consists of a 30 mil thick Alumina hybrid substrate with a 50 Ω stripline. The P6507 uses the same replaceable tips, cables, and connectors as the P6501.



CHARACTERISTICS

	P6501	P6507
Bandwidth	750 MHz	
Rise Time	450 ps	
Attenuation	10X	1X
Input R	1 MΩ	50 Ω
Input C	⩽1.9 pF	N/A
Dynamic Range	±10 V	N/A
Power Supply	±15 V at 20 mA, ±5 V at 17 mA	N/A

ORDERING INFORMATION

P6501 1 MΩ Active Microprobe **$400**
Includes: Two tungsten probe tips (206-0371-01); ground lead (196-3141-00); instruction sheet (070-6300-00).

Option 01 — Add power supply and 1.5 m 50 Ω cable **+$155**

P6507 50 Ω Microprobe **$50**
Includes: One tungsten probe tip (206-0371-01); instruction sheet (070-6301-00).

Option 01 — Add 0.5 m 50 Ω cable. **+$30**

OPTIONAL ACCESSORIES

Power Supply for P6501 —
Order 119-2461-00 **$125**

50 Ω Cable (Miniature to BNC)
(P6507) 0.5 m. Order 174-0668-00 **$30**
(P6501) 1.5 m. Order 174-0538-00 **$30**

Tungsten Probe Tip — (Pkg of 5)
Order 206-0371-02 **$22.50**

Palladium Probe Tip — (Pkg of 5)
Order 206-0370-02 **$27.50**

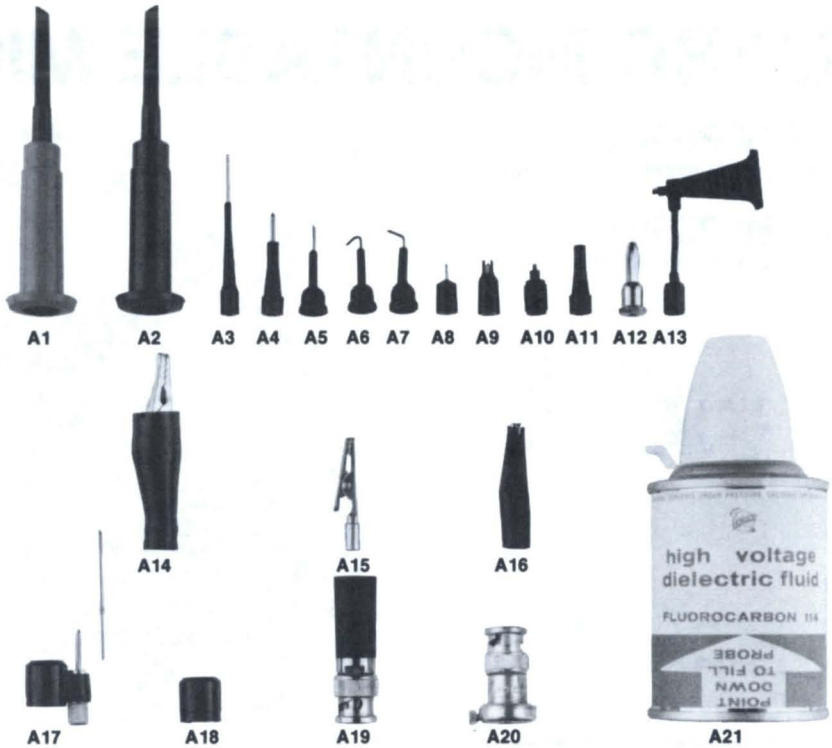
Ground Lead Assembly —
Order 196-3141-00 **$3.50**

Manual for P6501 Microprobe —
Order 070-6188-00 **$4.00**

To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext. 99

P6006, P6007, P6008, P6009, P6015, P6028 and P6060 probes which have #6-32 screw tips.

Code	Description	Part Number	Price
A1	Retractable hook tip	013-0071-00	$4.00
A2	Retractable hook tip for P6008 environmental	013-0071-01	$4.50
A3	Calibration tip (0.063 in dia)	206-0100-00	$11.25
A4	Spring tip (0.08 in dia)	206-0060-00	$2.30
A5	Long straight tip (0.032 in dia)	206-0104-00	$1.30
A6	Hook tip	206-0105-00	$1.30
A7	Right angle hook tip	206-0185-00	$1.50
A8	Straight tip (0.055 in dia)	206-0015-00	$1.05
A9	IC test tip	206-0203-00	$1.15
A10	Ground lead adaptor (0.025 in square pin closing)	206-0137-01	$3.90
A11	Spring tip (accepts 0.065 in dia pin)	206-0061-00	$1.75
	(accepts 0.068 in dia pin)	206-0168-00	$3.40
A12	Banana tip	134-0013-00	$1.25
A13	Pin tip (accepts 0.025 in IBM SLT pin)	206-0134-03	$5.25
A14	Alligator clip for P6015	344-0005-00	$4.90
A15	Alligator clip	344-0045-00	$.80
A16	Miniature alligator clip	344-0046-00	$2.10
A17	Bayonet ground assembly	013-0052-00	$10.50
A18	Insulating ground cover for P6009	166-0428-00	$1.50
A19	Probe screw tip to BNC adaptor	013-0054-00	$15.75
A20	Probe screw tip to BNC adaptor for P6028	013-0056-00	$20.00
A21	High voltage dielectric fluid 3 oz	252-0120-00	$6.25



P6053B, P6055, P6056, P6057, P6062B, P6063B, P610X Family, P612X Family, P6148, P6149A, and P6202A miniature tip probes.

Code	Description	Part Number	Price
B1	Retractable hook tip	013-0105-00	$9.25
B2	Retractable hook tip (for P6202A and P6420)	013-0097-01	$11.00
B3	Retractable hook tip (for all except P6202A and P6420)	013-0107-05	$2.35
B4	IC grabber	013-0191-00	$7.75
B5	Miniature retractable hook (used with adaptors B11 and B12)	206-0222-00	$4.00
B6	Hook tip	206-0114-00	$3.15
B7	Straight tip	206-0114-01	$3.15
B8	Screw tip (#6-32)	103-0051-01	$4.90
B9	Screw tip (#6-32 for P6202A and P6420)	103-0051-00	$4.90
B10	Screw tip with ground connection (#6-32)	103-0131-00	$10.50
B11	Flexible tip (accepts B5 retractable hook)	103-0177-01	$8.00
B12	Dual lead adaptor (accepts B5 retractable hook)	015-0325-00	$19.00
B13	Flexible tip for 0.025 in square pin	206-0193-00	$9.00
B14	Pin tip (accepts 0.025 in IBM SLT pin)	206-0209-00	$4.15
B15	Bayonet ground assembly	013-0085-00	$9.25
B16	Insulating ground cover	166-0404-01	$1.25
B17	IC test ground cover		
	Package of 10	015-0201-04	$7.00
	Package of 100	015-0201-05	$19.00
B18	Miniature probe tip to BNC adaptor	013-0084-01	$9.75
B19	Miniature probe tip to BNC adaptor (for all except P6202A)	013-0084-02	$12.00
B20	Miniature probe tip to BNC female adaptor	103-0096-00	$13.50
B21	Miniature probe tip to GR adaptor	017-0076-00	$65
B22	Miniature probe tip to GR 50 Ω termination adaptor	017-0088-00	$60
B23	Circuit board test point		
	Outer case	131-1436-00	$6.00
	Inner connector (need to order both for one test point)	136-0333-00	$.50
B24	Chassis mount test jack	131-0258-00	$3.15
B25	Replaceable probe tip (for all except P6202A, P6420 and non-"A" P610X probes)		
	Package of 10	206-0191-03	$21.00
B26	Replaceable probe tip (for P6202A and P6420)		
	Package of 10	206-0230-03	$20.00
B27	Replaceable probe tip (for P6103 and P6109)		
	Package of 5	131-3723-01	$6.00
B28	Electrical ground contact	214-0283-00	$1.15

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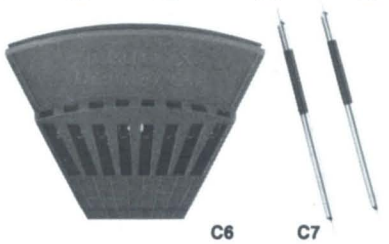
P613X Family and P6230 subminiature tip probes.

Code	Description	Part Number	Price
C1	Retractable hook tip	013-0208-00	$2.00
C2	Subminiature-to-miniature probe tip adaptor (allows use of miniature probe tip accessories)	013-0202-00	$4.75
C3	Subminiature probe tip to BNC adaptor	013-0195-00	$9.50
C4	Subminiature probe tip to GR 50 Ω termination adaptor	017-0520-00	$60.00
C5	Circuit board test points Outer shell (package of 100)	131-2766-01	$47.00
	Inner connector (package of 100)	136-0352-02	$24.00
C6	KLIPKIT (includes two 16-pin DIP clips and four signal/ground pins)	013-0197-00	$40.00
C7	Signal/ground pins for KLIP-KIT (includes four pins)	131-3288-02	$29.00



P6201 Probes

Code	Description	Part Number	Price
D1	Retractable hook tip	013-0135-00	$7.75
D2	Probe tip to miniature probe tip adaptor	103-0164-00	$8.50
D3	Probe tip to BNC adaptor	013-0145-00	$23.00
D4	Probe tip to GR 50 Ω termination adaptor	017-0094-00	$90.00
D5	Ground contact	131-1302-00	$1.15
D6	Insulating ground cover	166-0557-00	$1.25
D7	Ground contact insulator	342-0180-00	$1.25
D8	Ground lead insulator	166-0433-00	$1.00
D9	Replaceable probe tip	206-0200-00	$1.15

Other Probes

Code	Description	Part Number	Price
E1	Retractable hook tip (for P6010 and P6048)	013-0090-00	$7.00
E2	Retractable hook tip (for S-3A, P6202A and P6420)	013-0097-01	$11.00
E3	Retractable hook tip (for 7A11 and P6401)	013-0106-00	$17.50
E4	Retractable hook tip (for 211, 212, 213, 214 and 221 scope probes)	013-0107-02	$3.25
E5	Screw tip (#6-32 for P6045, P6046, P6202A, 7A11 and S-3A)	103-0051-00	$4.90

Probe Tools

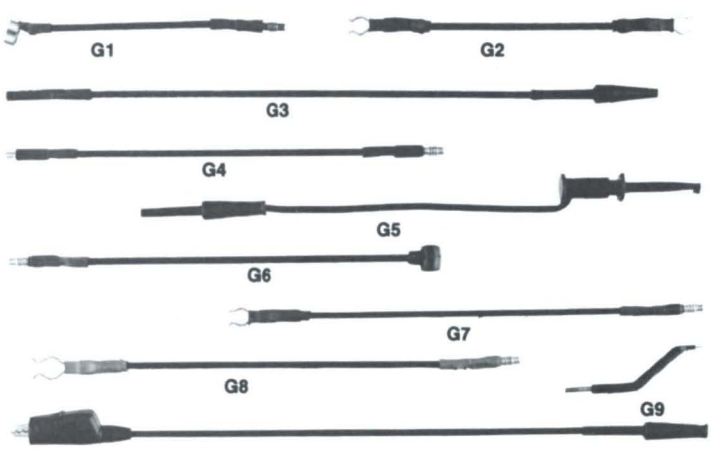
Code	Description	Part Number	Price
F1	Tip extractor for miniature probes (except for P610X "A" version and P612X family probes)	003-0825-00	$1.65
F2	Adjustment tool metal blade (except P6055/P6202A)	003-1364-00	$1.50
F3	Adjustment tool plastic blade (except P6055/P6202A)	003-1364-01	$.60
F4	Adjustment tool for P6055	003-0675-00	$2.10
F5	Adjustment tool for P6202A	003-0675-01	$2.50

Cable Marker Sets (not pictured)

Description	Part Number	Price
FOR 1/8 in dia cable (P6053B, P6062B, P6063B, P6075)	016-0130-00	$7.00
FOR 3/16 in dia cable	016-0127-00	$7.00
FOR All modular cables (P610XA, P612X, P613X, P6230 families)	016-0633-00	$4.25

Ground Leads

Code	Description	Part Number	Price
G1	Probe tip clip-on lead for all miniature size probe tips 3 inches	195-6176-00	$6.25
G2	Clip-on interconnect for P6055 6 inches	175-1256-00	$5.00
G3	Lead for P612X, P613X and P6230 families 12 inches	195-1870-01	$7.00
G4	Screw-in lead for P6054, P6075, P6201, 7A11 probes 3 inches	175-0848-00	$3.00
	5 inches	175-0848-01	$2.10
	12 inches	175-0848-02	$2.30
G5	Microhook for P612X, P613X, P6230 families 6 inches	195-4104-00	$9.50
G6	Probe tip cap lead for all miniature size probe tips 3 inches	175-0849-00	$7.25
	6 inches	175-0849-01	$7.25
G7	Clip-on for P6048, P6053B, P6055,P6062B, P6063B, P600X, P610XA families, P6125, P6148A, P6149 3 inches	175-0263-01	$2.10
	5 inches	175-0124-01	$2.10
	12 inches	175-0125-01	$2.10
G8	Clip-on for P6202A, P6420 and S-3A 6 inches	175-1017-00	$4.15
G9	Low impedance contact for P613X, P6230 families 2 inches	195-4240-00	$2.30
G10	Alligator clip for P612X, P613X, P6230 families 8 inches	195-1870-00	$7.00



MODULAR PROBE REPLACEMENT SUBASSEMBLIES

Probe	Length (m)	Connector/Comp Box		Probe Cable		Probe Head		Probe Tip/Hybrid Tip	
P6101	1	103-0189-00	$18.50	174-0076-00	$15.00	206-0223-02	$22.00	206-0191-03*1	$17.00
	2	103-0189-00	$18.50	174-0077-00	$17.00	206-0223-02	$22.00	206-0191-03*1	$17.00
	3	103-0189-00	$18.50	174-0078-00	$19.00	206-0223-02	$22.00	206-0191-03*1	$17.00
P6101A	1	103-0189-00	$18.50	174-0076-00	$15.00	206-0223-02	$22.00	206-0191-03*1	$17.00
	2	103-0189-00	$18.50	175-0077-00	$17.00	206-0223-02	$22.00	206-0191-03*1	$17.00
	3	103-0189-00	$18.50	174-0078-00	$19.00	206-0223-02	$22.00	206-0191-03*1	$17.00
P6102A	2	206-0352-00	$45.00	174-0077-00	$17.00	206-0302-00	$18.00	206-0338-01*2	$25.00
P6103	1	NA		174-0394-00	$17.00	206-0365-00	$25.00	131-3723-01	$6.00
	2	NA		174-0395-00	$19.00	206-0361-00	$25.00	131-3723-01	$6.00
	3	NA		174-0396-00	$21.00	206-0367-00	$25.00	131-3723-01	$6.00
P6104	1	040-1162-00	$55.00	174-0076-00	$15.00	040-1162-00	$55.00	206-0191-03*1	$21.00
P6104A	1	206-0332-00	$43.00	174-0076-00	$15.00	206-0303-00	$17.00	206-0336-01*2	$25.00
P6105	1	040-1163-00	$55.00	174-0076-00	$15.00	040-1163-00	$55.00	206-0191-03*1	$21.00
	2	040-1164-00	$55.00	174-0077-00	$17.00	040-1164-00	$55.00	206-0191-03*1	$21.00
	3	040-1165-00	$55.00	174-0078-00	$19.00	040-1165-00	$55.00	206-0191-03*1	$21.00
P6105A	1	206-0331-00	$53.00	174-0076-00	$15.00	206-0328-00	$18.00	206-0336-01*2	$25.00
	2	206-0334-00	$53.00	174-0077-00	$17.00	206-0301-00	$18.00	206-0337-01*2	$25.00
	3	206-0320-02	$53.00	174-0078-00	$19.00	206-0302-00	$18.00	206-0338-01*2	$25.00
P6106	1	040-1166-00	$60.00	174-0076-00	$15.00	040-1166-00	$60.00	206-0191-03*1	$21.00
	2	040-1167-00	$60.00	174-0077-00	$17.00	040-1167-00	$60.00	206-0191-03*1	$21.00
	3	040-1168-00	$60.00	174-0078-00	$19.00	040-1168-00	$60.00	206-0191-03*1	$21.00
P6106A	1	206-0313-01	$80.00	174-0076-00	$15.00	206-0328-00	$18.00	206-0336-01*2	$25.00
	2	206-0319-01	$80.00	174-0077-00	$17.00	206-0301-00	$18.00	206-0337-01*2	$25.00
	3	206-0320-01	$80.00	174-0078-00	$19.00	206-0302-00	$18.00	206-0338-01*2	$25.00
P6107	2	040-1173-00	$55.00	174-0077-00	$17.00	040-1173-00	$60.00	206-0191-03*1	$21.00
P6107A	2	206-0247-02	$50.00	174-0077-00	$17.00	206-0217-02	$18.00	206-0339-02*2	$25.00
P6108	1	040-1169-00	$55.00	174-0076-00	$15.00	040-1169-00	$55.00	206-0191-03*1	$21.00
	2	040-1170-00	$55.00	174-0077-00	$17.00	040-1170-00	$55.00	206-0191-03*1	$21.00
	3	040-1171-00	$55.00	174-0078-00	$19.00	040-1171-00	$55.00	206-0191-03*1	$21.00
P6108A	1	206-0332-01	$53.00	174-0076-00	$15.00	206-0303-00	$17.00	206-0336-01*2	$25.00
	2	206-0318-02	$53.00	174-0077-00	$17.00	206-0304-00	$17.00	206-0337-01*2	$25.00
	3	206-0333-00	$53.00	174-0078-00	$19.00	206-0305-00	$17.00	206-0338-01*2	$25.00
P6109	1	NA		174-0392-00	$18.00	206-0362-00	$35.00	131-3723-01	$6.00
	2	NA		174-0391-00	$20.00	206-0360-00	$35.00	131-3723-01	$6.00
	3	NA		174-0393-00	$22.00	206-0366-00	$35.00	131-3723-01	$6.00
P6121	1.5	206-0311-00	$50.00	174-0069-00	$15.00	206-0323-00	$25.00	206-0341-01*2	$25.00
P6122	1.5	206-0312-00	$45.00	174-0069-00	$15.00	206-0324-00	$17.00	206-0342-01*2	$25.00
	2	206-0318-00	$45.00	174-0070-00	$17.00	206-0325-00	$17.00	206-0343-01*2	$25.00
	3	206-0318-01	$45.00	174-0071-00	$19.00	206-0326-00	$17.00	206-0344-01*2	$25.00
P6125	1.5	206-0335-00	$45.00	174-0069-00	$15.00	206-0256-02	$35.00	131-2509-04*1	$50.00
P6130	1.5	206-0313-00	$80.00	174-0072-00	$19.00	206-0270-10	$12.00	206-0270-10*3	$12.00
	2	206-0319-00	$80.00	174-0073-00	$23.00	206-0270-12	$12.00	206-0270-12*3	$12.00
	3	206-0320-00	$80.00	174-0074-00	$27.00	206-0270-11	$12.00	206-0270-11*3	$12.00
P6131	1.3	206-0314-00	$85.00	174-0075-00	$19.00	206-0265-10	$12.00	206-0265-10*3	$12.00
	2	206-0321-00	$85.00	174-0073-00	$23.00	206-0265-12	$12.00	206-0265-12*3	$12.00
	3	206-0322-00	$85.00	174-0074-00	$27.00	206-0265-11	$12.00	206-0265-11*3	$12.00
P6133	1.3	206-0349-00	$65.00	174-0075-00	$19.00	206-0265-10	$12.00	206-0265-10*3	$12.00
	2	206-0350-00	$65.00	174-0073-00	$23.00	206-0265-12	$12.00	206-0265-12*3	$12.00
	3	206-0351-00	$65.00	174-0074-00	$27.00	206-0265-11	$12.00	206-0265-11*3	$12.00
P6134	1.5	206-0363-00	*4	174-0245-00	$19.00	206-0265-13	$12.00	206-0265-13	$12.00
P6136	1.3	206-0359-00	$85.00	174-0261-00	$19.00	206-0265-10	$12.00	206-0265-10	$12.00
P6148	2	040-1172-00	$55.00	174-0077-00	$17.00	040-1172-00	$55.00	206-0191-03*1	$21.00
P6148A	2	206-0288-02	$50.00	174-0077-00	$17.00	206-0217-02	$18.00	206-0339-01*2	$25.00
P6149	2	040-1174-00	$55.00	174-0077-00	$17.00	040-1174-00	$55.00	206-0191-03*1	$21.00
P6149A	2	206-0255-02	$50.00	174-0077-00	$17.00	206-0217-02	$18.00	206-0339-01*2	$25.00

*1 *Probe tips in packages of ten.*

*2 *Probe hybrid tip assemblies in packages of five.*

*3 *Probe hybrid tip assembly in quantities of one.*

*4 *Contact your local Sales Engineer for information.*

To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext. 99

TEST LEADS

Test Lead, Black, 4 ft	012-0425-00	$12.75
Test Lead, Red, 4 ft	012-0426-00	$23.00
Test Lead, Black, 4 ft	012-0426-01	$23.00
Test Lead set includes 012-0425-00, 012-0426-00, and 013-0107-05	012-0427-00	$29.00

LOGIC PROBE TEST LEADS

16 pin low profile DIP clip (can be used with 14 or 16 pin ICs)	015-0330-00	$41.00
10 wide comb set (grabber tips not included)	012-0747-00	$60.00

PERSONALITY MODULE TEST LEADS

40 Pin DIP Clip—10 cm cable (order M/F adaptor below)	015-0339-00	$49.00
40 Pin DIP Clip—30 cm cable Male Adaptor for 40 Pin (order M/F adaptor below)	015-0339-02	$49.00
Male Adaptor for 40 Pin Low Profile DIP Clip	380-0560-05	$16.50
Female Adaptor for 40 Pin Low Profile DIP Clip	380-0647-01	$40.00

KLIPKIT

The P6130, P6131 and P6230 are used directly, other probes must use the supplied pins and attach via a retractable hook tip. Up to 16 pin DIP can be connected. Four supplied pins make signals accessible at the top of the KLIPKIT, or invert the pins for pin signal connection to a common connection strap inside the clip, Two IC clips, 4 signal ground pins and information sheet included.

KLIPKIT	013-0197-00	$40.00

IC CLIP

16 pin DIP, clothes pin style	003-0709-00	$14.50
24 pin DIP, clothes pin style	003-0823-00	$33.00
40 pin DIP, clothes pin style	003-0801-00	$50.00

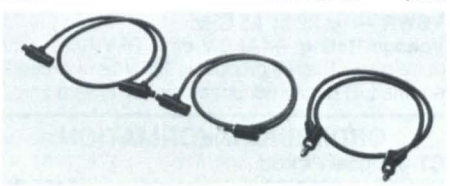
50 Ω AIR LINE

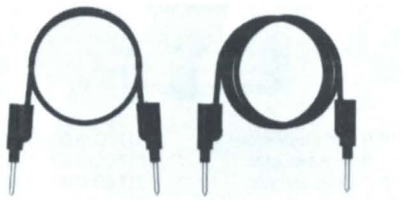
The 20 cm 50 Ω air line is useful as a time-delay device and as an absolute impedance in a time-domain reflectometer system. The characteristic impedance is 50 Ω ±0.4%. Time delay is 0.6698 ns ±0.4%.

50 Ω Air Line	017-0084-00	$205.00

PATCH CORDS

BNC to BNC, 18 in		
Red	012-0087-00	$8.00
Black	012-0086-00	$8.00
BNC to banana plug-jack, 18 in		
Red	012-0091-00	$8.00
Black	012-0090-00	$8.00
Banana plug-jack to banana plug-jack, 18 in		
Red	012-0031-00	$8.00
Black	012-0039-00	$9.00





Pin-jack to pin-jack, 0.08 in dia pin		
Red, 8 in	012-0179-00	$4.25
Red, 18 in	012-0180-00	$4.50
Black, 8 in	012-0181-00	$4.25
Black, 18 in	012-0182-00	$4.50

COAXIAL CABLES BNC

Coaxial, 50 Ω, 42 in	012-0057-01	$18.50
Coaxial, 75 Ω, 42 in	012-0074-00	$19.00
Coaxial, 93 Ω, 42 in	012-0075-00	$32.00
Coaxial, 50 Ω, 18 in	012-0076-00	$17.50
Coaxial, 50 Ω, 18 in, Male to Female	012-0104-00	$26.00
Coaxial, 50 Ω ±1% Precision, 36 in	012-0482-00	$28.00

BSM

BSM Female to BNC Male Coaxial, 10 in, RG58	012-0128-00	$25.00
BSM Female to BNC Male Coaxial, 18 in, RG58	012-0127-00	$30.00

GR 50 Ω

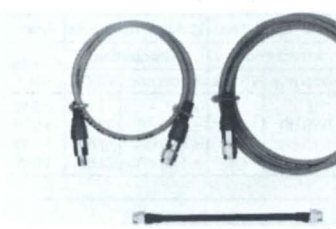
Coaxial, 10 ns, RG58A/U	017-0501-00	$110.00
Coaxial, 5 ns, RG213/U	017-0502-00	$200.00
Coaxial, 1 ns, RG58A/U*[1]	017-0503-00	$95.00
Coaxial, 2 ns, RG58A/U	017-0505-00	$150.00
Coaxial, 5 ns, RG58A/U	017-0512-00	$115.00
Coaxial, 10 in, RG213/U	017-0513-00	$95.00
Coaxial, 20 in, RG213/U	017-0515-00	$105.00

*[1] *Connector on one end only.*

N 50 Ω

Coaxial N Connectors, 6 ft	012-0114-00	$28.00

SMA (3 mm) 50 Ω



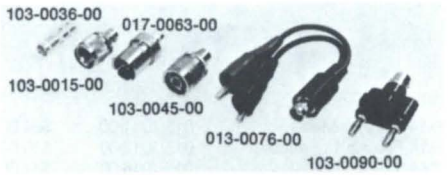
Coaxial, 2 ns, Male to Female	015-1005-00	$110.00
Coaxial, 5 ns, Male to Female	015-1006-00	$175.00
Coaxial semirigid, 500 ps, 4.5 in male only	015-1015-00	$30.00
Coaxial semirigid, 750 ps,	015-1017-00	$43.00
Coaxial, 1 ns	015-1019-00	$140.00

ADAPTORS

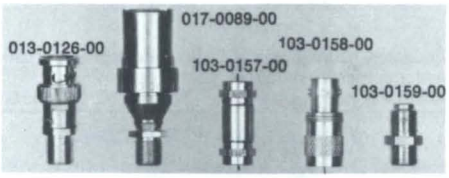
BNC Female to BNC Female	103-0028-00	$6.25
BNC Male to BNC Male	103-0029-00	$6.25
BNC T	103-0030-00	$9.25
BNC Elbow Male to Female	103-0031-00	$8.50

Minimum acceptable order is $25.00.

BNC Male to RG58A	017-0064-00	$90.00
BNC Male to UHF Female	103-0032-00	$6.00
BNC Male to Binding Post	103-0033-00	$5.95
BNC Male to Dual Binding Post	103-0035-00	$14.50
BNC Male to N Female	103-0058-00	$8.50



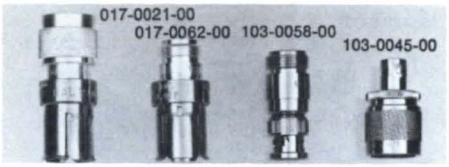
BNC Female to clip leads	013-0076-00	$32.00
BNC Female to RG58A	017-0063-00	$50.00
BNC Female to UHF Male	103-0015-00	$5.25
BNC Female to BSM Male	103-0036-00	$17.75
BNC Female to N Male	103-0045-00	$8.00
BNC Female to Dual Banana	103-0090-00	$9.25
BNC Female to EZ Ball	013-0076-01	$22.00



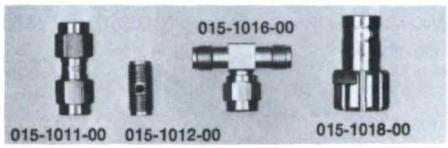
Female to BNC Male	013-0126-00	$18.75
F Female to GR874	017-0089-00	$55.00
F Male to *F* Male	103-0157-00	$7.50
F Male to BNC Female	103-0158-00	$10.50
F Female to *F* Female	103-0159-00	$7.50

RG58A to BNC Female	017-0063-00	$50.00
RG58A to BNC Male	017-0064-00	$90.00
50 Ω termination, thru-line (RG58A to BNC Male)	017-0083-00	$100.00

RG58A Insertion Unit	017-0030-00	$95.00
RG58A T	017-0069-00	$135.00
RG58A Elbow	017-0070-00	$145.00



N Male to RG58A	017-0021-00	$55.00
N Female to RG58A	017-0062-00	$60.00
N Male to BNC Female	103-0045-00	$8.00
N Female to BNC Male	103-0058-00	$8.50



SMA Male to Male	015-1011-00	$24.00
SMA Female to Female	015-1012-00	$10.50
SMA T	015-1016-00	$41.00
SMA Male to BNC Female	015-1018-00	$9.00

ACCESSORY HOUSING

Accessory housing without electrical components is useful for applications requiring special circuitry.

Accessory Housing	011-0081-00	$48.00

ATTENUATORS—TERMINATIONS

BNC

50 Ω ±0.1% precision feedthrough termination (dc −100 kHz, 11 V RMS maximum)	011-0129-00	$120.00
50 Ω feedthrough termination*1	011-0049-01	$31.00
50 Ω 10X (20 dB) attenuator*2	011-0059-02	$43.00
50 Ω 5X (14 dB) attenuator*2	011-0060-02	$43.00
50 Ω (6 dB) attenuator*2	011-0069-02	$43.00
50 Ω 2.5X (8 dB) attenuator*2	011-0076-02	$43.00
50 Ω feedthrough termination (5 W)*3	011-0099-00	$50.00

VSWR

*1 <1.1 dc −250 MHz and <1.2 dc −500 MHz.
*2 <1.1 dc −1.0 GHz and <1.2 dc −2.0 GHz.
*3 1.1 dc −100 MHz.

Characteristics — Dc resistance is 50 Ω ±1 Ω. Attenuation accuracy is ±2% dc, ±5% at 2 GHz. Power rating (except 011-0099-00) is 2 W average.

75 Ω feedthrough termination	011-0055-01	$31.00
93 Ω feedthrough termination	011-0056-01	$31.00
50 Ω to 75 Ω minimum loss attenuator	011-0057-01	$37.00
50 Ω to 93 Ω minimum loss attenuator	011-0058-01	$31.00
75 Ω 10X attenuator	011-0061-00	$35.00
93 Ω 10X attenuator	011-0062-00	$36.00
600 Ω feedthrough termination (1 W, dc to 1 MHz)	011-0092-00	$33.00
75 Ω to 50 Ω minimum loss attenuator (ac coupled)	011-0112-00	$70.00

Characteristics — Accuracy of indicated attenuation ratio is ±2% at dc. Power rating of attenuators is ½ W and terminations 1 W. Voltage standing wave ratio (VSWR) not specified.

GR 50 Ω

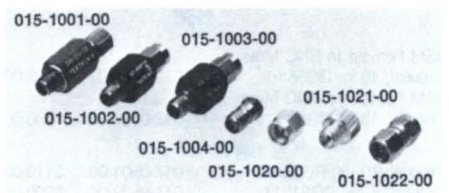
50 Ω 10X attenuator	017-0078-00	$320.00
50 Ω 5X attenuator	017-0079-00	$280.00
50 Ω 2X attenuator	017-0080-00	$220.00
50 Ω termination, end-line	017-0081-00	$285.00

Characteristics — Accuracy of indicated attenuation ratio is ±2% at dc, ±3% at 1 GHz. Voltage standing wave ratio (VSWR) is <1.1 up to 1 GHz. Power rating is 1 W.

N 50 Ω

10 dB attenuator	011-0085-00	$85.00
20 dB attenuator	011-0086-00	$85.00
40 dB attenuator	011-0087-00	$110.00

Characteristics — Frequency range is dc to 12.4 GHz. Power rating is 2 W average, 300 W peak. Impedance is 50 Ω ±1.0 dB.



SMA (3 mm) 50 Ω

50 Ω 2X attenuator	015-1001-00	$145.00
50 Ω 5X attenuator	015-1002-00	$145.00
50 Ω 10X attenuator	015-1003-00	$145.00
50 Ω termination Female	015-1004-00	$70.00
Short-Circuit terminations — (Male)	015-1020-00	$19.00
(Female)	015-1021-00	$30.00
50 Ω termination Male	015-1022-00	$39.00

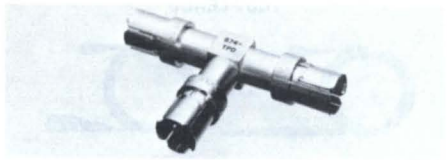
Characteristics

	Dc to 12.40 GHz		12.41 to 18.00 GHz		Power
	Attenuation		Attenuation		
	Accuracy	VSWR	Accuracy	VSWR	Continuous
Termination	±1 Ω	1.15	±1 Ω	1.15	0.5 W
2X (6 dB)	±0.75 dB	1.40	±1.00 dB	2.00	1.0 W
5X (14 dB)	±0.75 dB	1.40	±1.00 dB	1.60	1.0 W
10X (20 dB)	±0.75 dB	1.40	±1.00 dB	1.60	1.0 W

50 Ω POWER DIVIDERS

This coaxial tee is designed for use in broad-band 50 Ω systems where the mismatch introduced by ordinary "Tee" connectors is undesirable. Load isolation is nominally 6 dB while the voltage attenuation ratio is nominally 2X (input to either load arm, other load arm terminated in a standard 50 Ω termination). Maximum VSWR is 1.50 from dc to 12.00 GHz and 1.90 from 12.01 to 18.00 GHz.

Power Divider SMA (3 mm)	015-1014-00	$250.00



This coaxial tee has a 16.67 Ω resistor in each leg, connected so that the tee looks like 50 Ω if two legs are terminated in 50 Ω. It is designed for use in broad-band 50 Ω systems where the mismatch introduced by ordinary "Tee" connectors is undesirable. It is especially useful in a time-domain reflectometer set-up where test line pulser, and oscilloscope must be coupled with a minimum of reflection-producing discontinuities.

Power Divider RG58A	017-0082-00	$780.00

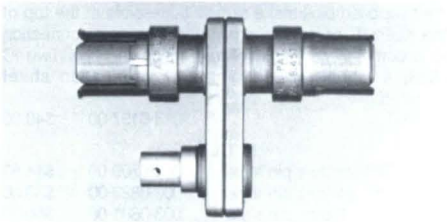
50 Ω COUPLING CAPACITOR

The coupling capacitor is a short length of coaxial line with a disk capacitor (4700 pF ±20%) in series with the inner conductor. Reflection ratio (in 150 ps TDR system), is 0.03 maximum. Voltage rating is 200 V.

Coupling Capacitor SMA (3 mm)	015-1013-00	$230.00

The coupling capacitor is a short length of coaxial line having a disk capacitor (4700 pF) in series with the inner connector. High frequencies are transmitted with small reflection, but dc and low frequencies are blocked. Voltage rating is 500 V.

Coupling Capacitor RG58A	017-0028-00	$115.00



CT-3 Signal Pickoff

Design for use with high-frequency oscilloscopes, the CT-3 Pickoff provides a convenient means of picking off a signal in a 50 Ω system. Used with any of the Tektronix sampling instruments, the CT-3 provides the link for use as a trigger source.

Sensitivity — 10% of the voltage under test, into a 50 Ω load.
Decay Time Constant — 4.5 μs at 0 dc current.
Rise Time — <0.4 ns.
Frequency Response — 50 kHz to 875 MHz at 0 dc current.
Insertion Impedance — With 50 Ω termination is 1 Ω shunted by 4.5 μH, 2 Ω shunted by 4.5 μH without a 50 M termination.
VSWR — <1.2 at 1.5 GHz.
Voltage Rating — At 0 V dc is 25 V RMS. 1 kV pulse peak. The V's product is 100 V μs. If exceeded, the L/R decay will decay rapidly toward zero.

ORDERING INFORMATION

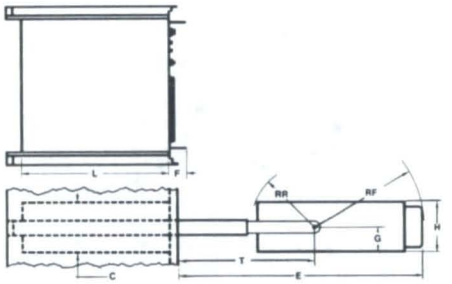
CT-3 Signal Pickoff
Order 017-0061-00 **$195.00**

Minimum acceptable order is $25.00.

MOUNTING DIMENSIONS

	H		L		F		G		E		RF		RR		T		C	
Product	**in**	**cm**	**in**	**cm**	**in**	**cm**	**in**	**cm**	**in**	**cm**	**in**	**cm**	**in**	**cm**	**in**	**cm**	**in**	**cm**
R485*[1]	7.0	17.8	16.2	41.1	1.8	4.6	3.5	8.9	19.3	49.0	10.9	27.7	7.9	20.1	9.3	23.6	6.8	17.3
R5100 R5400*[1]	5.3	13.5	19.0	48.3	1.1	2.8	1.8	4.6	24.6	62.5	—	—	—	—	—	—	5.3	13.5
R5223	7.0	17.8	20.8	52.9	1.3	3.3	—	—	—	—	—	—	—	—	—	—	7.0	17.8
R7103	7.0	17.8	27.7	70.4	1.5	3.8	—	—	29.0	73.7	—	—	—	—	—	—	7.0	17.8
R7704*[1]	7.0	17.8	22.4	56.9	2.3	5.8	1.8	4.6	33.3	84.6	15.3	38.9	10.7	27.2	18.5	47.0	7.0	17.8
R7313*[1] R7603*[1] R7613*[1] R7623*[1]	5.3	13.5	22.3	56.6	2.0	5.1	—	—	25.2	64.0	—	—	—	—	—	—	5.3	13.5
R7844*[1]	7.0	17.8	24.8	63.0	2.3	5.8	1.75	4.4	—	—	—	—	—	—	—	—	7.0	17.8
R7903*[1]	5.3	13.5	22.8	57.9	2.3	5.8	—	—	25.3	64.3	—	—	—	—	—	—	5.3	17.8
R7912*[1]	5.3	13.5	26.9	68.3	1.8	4.6	—	—	26.9	68.3	—	—	—	—	—	—	5.3	13.5
7912AD	7.0	17.8	26.0	66.0	1.95	5.0	—	—	30.7	78.0	—	—	—	—	—	—	6.9	17.5
RTM506	5.25	13.3	18.9	48.0	1.82	4.7	—	—	—	—	—	—	—	—	—	—	5.25	13.3
016-0015-00	5.1	13.0	16.3	41.4	1.8	4.5	—	—	—	—	—	—	—	—	—	—	—	—
016-0115-05	5.3	13.5	16.3	41.4	0.3	0.8	—	—	—	—	—	—	—	—	—	—	5.3	13.5
016-0466-00	5.1	13.0	16.3	41.4	1.8	4.5	—	—	—	—	—	—	—	—	—	—	—	—
016-0468-00	5.2	13.3	14.9	37.8	2.0	5.1	—	—	—	—	—	—	—	—	—	—	—	—
016-0675-00*[1]	8.8	22.4	19.7	50.1	1.5	3.9	3.5	8.9	24.3	61.6	—	—	11.9	30.1	13.3	33.8	8.5	21.6
016-0676-00*[1]	7.0	17.8	19.7	50.1	1.9	4.8	3.5	8.9	24.3	61.6	11.1	28.2	11.2	28.4	13.3	33.8	6.9	17.5
016-0691-01*[1]	7.0	17.8	18.3	46.5	1.5	3.9	3.5	8.9	20.4	51.9	11.8	30.0	—	—	9.5	24.1	6.6	16.7
040-0551-01	14.0	35.6	22.4	56.9	0.6	1.5	—	—	30.9	78.5	—	—	—	—	—	—	—	—
040-0600-00	5.25	13.3	18.3	46.5	0.7	1.8	—	—	—	—	—	—	—	—	—	—	5.25	13.3
040-0601-00	5.25	13.3	18.3	46.5	0.7	1.8	—	—	—	—	—	—	—	—	—	—	5.3	13.5
040-0616-02	5.3	13.5	16.5	41.9	1.1	2.8	1.8	4.6	24.6	62.5	—	—	—	—	—	—	5.25	13.3
040-0617-02	5.3	13.5	16.5	41.9	1.1	2.8	1.8	4.6	24.6	62.5	—	—	—	—	—	—	5.3	13.5
040-0624-01	5.25	13.3	18.3	46.5	0.7	1.8	—	—	—	—	—	—	—	—	—	—	5.3	13.5
437-0031-00	8.8	22.4	9.5	24.1	0.3	0.8	—	—	—	—	—	—	—	—	—	—	5.25	13.3
437-0071-00	7.0	17.8	13.4	34.0	1.4	3.6	—	—	—	—	—	—	—	—	—	—	7.1	18.0
437-0126-03	5.3	13.5	22.3	56.6	2.0	5.1	—	—	25.2	64.0	—	—	—	—	—	—	6.6	16.8

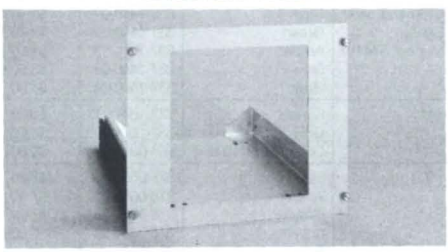
*[1] *These instruments mount with sliding tracks to a standard 19-inch wide rack. Rear support for sliding tracks is required, such as an enclosed rack.*



DIMENSIONS
(Exclusive of Plug-In Units and Probes)

Symbol	Definition
H	Height of front panel
L	Rack front to rearmost permanent fixture excluding cables
F	Back of front panel to foremost protrusion
G	Bottom of front panel to horizontal plane of rotation
E	Maximum forward clearance with instrument out and horizontal
RF	Front radius of rotation
RR	Rear radius of rotation
T	Rack front to pivot point
C	Cabinet height

RACK ADAPTORS



For rackmounting the 7000 Series oscilloscopes in a standard 19 in wide rack. Rack adaptor includes slide-out assemblies. 7000 Series mask finish is light gray.

7704A, 7104, 7834 and 7854 — Rack height is 15.75 in, rack depth is 21.38 in, shipping weight is ≈41 lb. Order 040-0611-01 $525

455 and 465M — Includes cradle mount, rack height 7 in, rack depth 18.75 in. Order 040-0825-01 $565

2445A and 2465A — Order 016-0691-01 $350

2335 — Order 016-0468-00 $310

2213A, 2215A and 2235 — Order 016-0466-00 $115

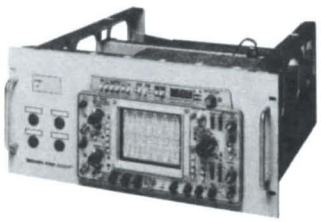
2236 — Order 016-0015-00 $255

464 and 466 — Order 016-0676-00 $445

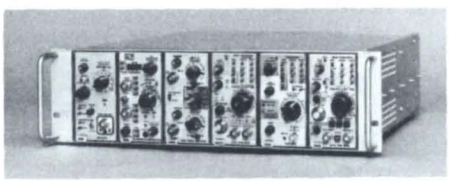
485 — Order 016-0558-00 $490

434 — Order 016-0272-00 $300

468 — Order 016-0675-00 $540

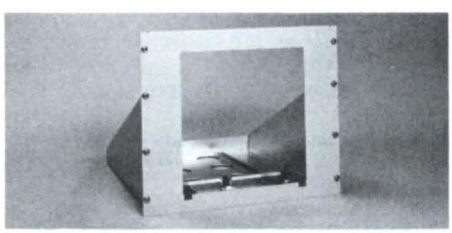


STORAGE CABINETS



7000 Series Plug-In Units — Holds 6 plug-in units, for mounting in a 19 in rack, 5.25 in high. Order 437-0126-03 $1,045

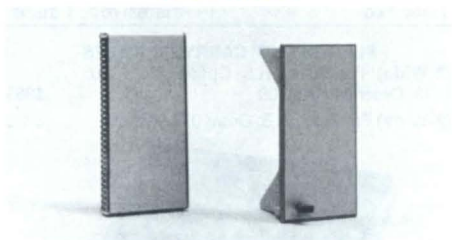
CRADLE MOUNTS



For rackmounting 7000 Series cabinet-type oscilloscopes in a standard 19 in wide rack. Cradle mount consists of a cradle (or "shelf") without slide-out assemblies and a mask to fit over the regular instrument panel. 7000 Series mask finish is light gray.

7704A — Rack height is 22 in, shipping weight is ≈16 lb. Order 040-0560-00 $490

BLANK PANEL



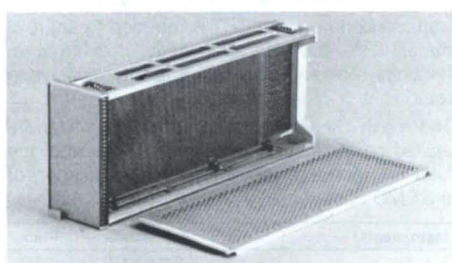
Blank Panel — When operating the 5000/7000 Series mainframes or the TM 500 or TM 5000 Series mainframes with less than a full complement of plug-ins, the blank panel may be used to cover an unused compartment. The panel for the 7000 Series is also good for EMC Shielding.

7000 Series — Order 016-0155-00 $60

5000 Series — Order 016-0452-00 $23

TM 500/TM 5000 Series — Order 016-0195-03 $32

BLANK PLUG-IN CHASSIS



Blank Plug-In Chassis — Available for all Tektronix mainframes. The 7000 Series provides a printed circuit board, plug-in frame, and securing hardware. The 560 Series, 1-Series, and Letter Series plug-in chassis have an interconnecting plug, securing hardware and plug-in frame.

7000 Series — Order 040-0553-03 $165

5000 Series — Order 040-0818-03 $130

TM 500 Series — Order 040-0652-05 $115

560 Series — Order 040-0245-00 $165

Minimum acceptable order is $25.00.

OSCILLOSCOPE PROTECTIVE COVERS

The cover provides protection for the oscilloscope during transport or storage. Made of waterproof blue vinyl, the covers are available for both laboratory and portable instruments. The covers for 500, 5000, and 7000 Series laboratory oscilloscopes have clear vinyl frontal areas.

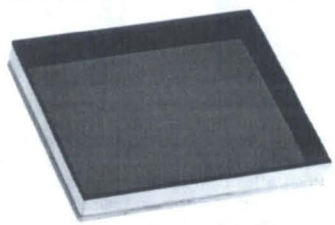
PROTECTIVE COVERS

Instrument	Part Number	Price
200 Series	016-0512-00	$17.25
323, 324, 1401A, 1401A-1, 1501	016-0112-00	$8.75
314, 335	016-0612-00	$70.00
326	016-0532-00	$49.00
453A, 454A, 491	016-0074-01	$18.00
434, 464, 466	016-0365-00	$26.00
465, 465B, 475, 485	016-0554-00	$19.25
5000 Series	016-0544-00	$18.00
7300, 7400, 7600 Series	016-0192-01	$20.00
7704A, 7900	016-0531-00	$15.00

PLUG-IN UNIT CARRYING CASES

(3-Wide) For 7L14, 7L5 Option 25, 7D20, 7L18. Order 016-0626-00 $365

(2-Wide) For 7L12, 7L5. Order 016-0625-00 $330



CRT MESH FILTERS

The mesh filter improves display contrast for oscilloscope viewing under high ambient light conditions.

A fine metal screen with a matte black surface is utilized to reduce light reflections. Although light transmission from the CRT is reduced to approximately 28%, the high attenuation of external reflections allows viewing low intensity displays in room light or other bright surroundings.

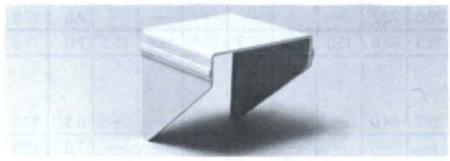
The mesh filter also serves as an EMC filter. Installed on the instrument, the metal frame of the filter is grounded, providing effective filtering of the EMC spectrum.

Instrument*[1]	Part Number	Price
314, 326, 335	378-0063-00	$23.00
432, 434	378-0682-00	$55.00
422, 491, 453A, 454A, 485	378-0648-00	$55.00
465, 465B, 475, 464, 466, 434	378-0726-01	$80.00
7400, 7603	378-0696-00	$65.00
7100, 7500, 7700, 7800, 7900 Series and 7613, 7623, 7633	378-0603-00	$65.00

[1] For both cabinet and rackmount instruments.

VIEWING ACCESSORIES

The viewing accessories listed normally mount on the oscilloscope graticule cover. In many cases, they will also fit camera-mounting bezels. If you intend using a camera on your oscilloscope, check with your Tektronix Sales Engineer for bezel-viewer compatibility before ordering.



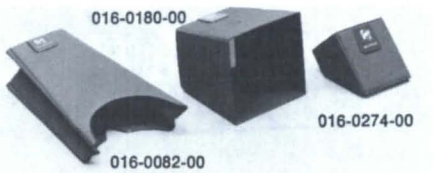
Folding Viewing Hoods —
(576) Order 016-0259-00 $25.00
(577, 5000, and 7000 Series) Order 016-0260-00 $26.00
(326, 314, 335, SC 502, SC 503, SC 504) Not pictured. Order 016-0297-00 $2.10

Polarized Viewers — For Tektronix older 5 inch oscilloscopes. The viewers reduce troublesome reflections and glare under high ambient light conditions.

Rectangular Viewer. Order 016-0039-00 $90

Plastic Round Viewer. Order 016-0053-00 $42

Viewing Hood — For Tektronix older 5 inch round oscilloscopes. Includes molded rubber eyepiece and separate tubular light shield. Order 016-0001-01 $175



Collapsible Viewing Hoods — For oscilloscopes with rectangular CRTs. Blue vinyl material, folds flat for convenient storage.

(422, 453A, 454A, 485, 491) Order 016-0082-00 $19

(422, 453A, 454A, 485, 491) Order 016-0274-00 $19

(464, 466, 455, 465, 465B, 475, 2200 Series, 2445A, 2465A) Order 016-0592-00 $14

Folding Binocular Viewing Hoods — (434, 455, 464, 466, 465B, 475, 475A, and 2200 Series) Order 016-0566-00 $18.75

Polarized Collapsible Viewing Hoods — To reduce reflections and glare under high ambient light conditions.

(432, 434, 455, 465, 465B, 475, 464, 466, 2445A, 2455A, 2465A) Order 016-0180-00 $50

Viewing Hoods — Molded gray polystyrene with polyurethane eyepiece.
(576) Order 016-0153-00 $50
(5000 and 7000 Series, 601, 602, 603, 604, 528 and 577) Order 016-0154-00 $42

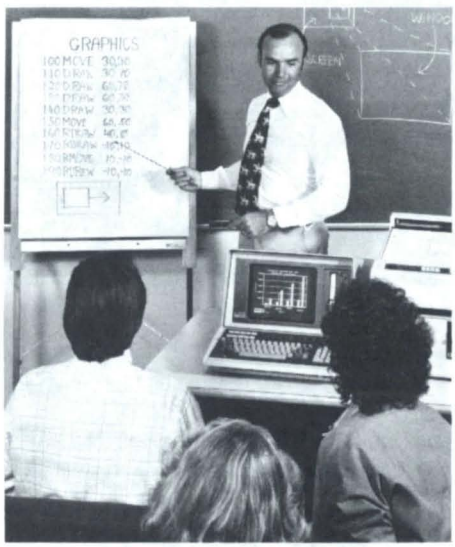
CATHODE RAY TUBE LIGHT FILTERS

Instrument*[1]	Color	Part Number	Price
200 Series	Blue	378-0691-00	$1.50
314, 335	Blue	378-2016-01	$1.70
434	Blue	378-0678-01	$2.30
455, 465M	Blue	337-2122-00	$5.75
465, 465B, 475, 464, 466	Blue	337-1674-00	$6.25
	Clear	337-1674-01	$6.25
	Smoke-gray filter	337-1674-07	$6.25
540, 550 Series 565, 575	Smoke-gray*[2]	378-0567-00	$14.25
	Green	378-0568-00	$11.50
	Blue	378-0569-00	$11.50
	Amber	378-0570-00	$14.25
576	Blue*[2]	378-0616-00	$5.75
603, 604	Clear (603*[2])	337-1440-00	$3.70
	Green	337-1440-01	$3.70
	Amber	337-1440-02	$3.50
	Blue	337-1440-03	$3.50
	Gray	337-1440-04	$4.50
	Graticule (8x10 div)	331-0303-00	$15.00
605, 606, 607	Blue	337-1674-00	$6.25
	Graticule	337-1674-10	$10.00
	Clear Shield	337-1674-13	$11.50
	Gray*[2]	337-1674-06	$5.00
	Graticule (8x10 div)	331-0391-00	$9.00
608	Amber	378-0704-00	$10.00
	Graticule*[2]	337-2126-02	$10.00
2200 Series	Blue*[2]	337-2775-00	$3.75
	Clear TV Graticule	337-2775-01	$1.95
2300 Series	Blue Implosion Shield*[2]	337-2760-00	$1.65
	Clear Implosion Shield*[2]	337-2781-00	$4.40
2400 Series	Blue*[2]	378-0199-03	$2.10
	Clear Implosion Shield*[2]	378-0208-00	$1.50
5100 and 5400 Series (except 5441)	Clear	337-1440-00	$3.70
	Green	337-1440-01	$3.70
	Amber	337-1440-02	$3.50
	Blue	337-1440-03	$3.50
	Gray	337-1440-04	$4.50
5441	Clear*[2]	337-1674-01	$6.25
	Gray	337-1674-06	$5.00
	Graticule (8x10 div)	331-0391-00	$9.00
7603	Blue	378-0684-00	$7.00
	Amber	378-0684-01	$7.00
	Gray	378-0684-02	$7.00
	Green	378-0684-03	$10.00
	Spectrum Analyzer Graticule	337-1439-01	$8.50
	Blue Implosion Shield*[2]	337-1700-01	$5.75
	Clear Implosion Shield	337-1700-04	$5.50
7613, 7623 7623A, 7633	Spectrum Analyzer Graticule	378-0625-07	$14.50
	Green (UV)	378-0625-08	$5.00
7844, 7313 7700 Series 7613, 7623 7100 Series 7900 Series	Blue*[2]	378-0625-00	$6.25
	Amber	378-0625-01	$9.50
	Gray	378-0625-02	$6.25
	Green	378-0625-03	$5.00
	Gray TV Graticule NTSC Clear Shield	378-0625-06	$12.00
	Spectrum Analyzer Graticule	337-1159-02	$8.50

[1] For both cabinet and rackmount instruments unless rackmount version is listed.
[2] Standard filter supplied with instrument.

CUSTOMER SERVICES AND INFORMATION

Tektronix Means . . . Fast, Flexible Worldwide Support



The people behind the product are friendly and ready to help you.

Get sales information and assistance to evaluate and order the products you want.
Ask for a Customer Service Representative the first time you contact Tektronix. The CSR can give you information on products and the names of the Sales Engineers assigned to serve your product interest. Tektronix Sales Engineers will respond to your technical and business inquiries.

Sales Engineers can give you information on dozens of products, so that you can select the one model best suited to your present and future applications, and will be happy to arrange a demonstration of that product.

Your Customer Service Representative or Sales Engineer can provide you with information on prices, terms, delivery dates, shipping estimates and best means of shipping.

Customer-site installations are thorough.
Tektronix provides on-site installation for most computer graphics products and most Tek-configured systems for computer graphics, semiconductor test, microprocessor development, and acquisition/processing. The Tektronix service specialist will make sure your equipment is set up properly with all functions operating to specifications, and will walk you through the basics of its performance.

Training and assistance gets users up to speed, fast.
Your Tektronix product is most useful to you when you're thoroughly familiar with it. Ask your Sales Engineer for a demonstration.

Tektronix also offers formal classes and self-study aides. Ask your Sales Engineer for details about Customer Training.

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Sales and Service Office	Inside Back Cover

Test and Measurement Seminars
Tektronix instruments and programmable instrument systems represent the upper limits of productivity potential. Tektronix has designed seminars to help enhance your understanding of the capabilities of your equipment.

Customer Training Seminars naturally complement the Tektronix commitment to help you achieve optimum utilization of your equipment—A commitment that begins with engineering excellence and continues through training—helping you to develop new and more productive applications, fast!

These fast-paced courses, conducted at key locations throughout the U.S., combine classroom lectures with supervised, hands-on laboratory sessions. Participants receive manuals and workbooks containing detailed course notes and lab exercises.

If you are interested in registering for one of these seminars or would like more information on a particular seminar, call instrument group customer training at (503) 642-8013 or write:

Tektronix, Inc.
Customer Training
P.O.Box 500 M/S 54-074
Beaverton, Oregon 97077

For your convenience, Tektronix also offers private seminars conducted at your company. Call us for more information.

The following products have customer training available.

7854	2230
2465	2220
2445	MS3101
2430	MS3201

QUALITY CARE FOR

FAST, PROFESSIONAL SERVICE

Local support, worldwide. Every Tektronix product is backed by our worldwide service organization providing fast, on-site response and quick turnaround from 60 service points in the U.S.A, plus service offices in over 60 other countries.

Professionals at your service. Just call. Over 1,400 knowledgeable service personnel, including Customer Service Representatives, Specialists, Service Managers and others are dedicated to maximizing your uptime.

"Product Alert" escalation. Tektronix Specialists are not only provided state-of-the-art diagnostic tools, updated documentation, and the world's best service instruments, but also a program of back-up support. "Product Alert" escalates your level of service when necessary from Local, to Regional, to Factory Support. We stay on top of a problem until it's resolved.

And, no one can match our large, local inventories of latest version Tek modules, assemblies and other parts.

A LIFETIME OF SUPPORT

A Comprehensive Warranty, as specified on page 500, accompanies every new, serialized product.

***Warranty-Plus* Options** provide low-cost extended coverage for selected products. See pages 496, 497.

Annual Support Agreements, described here and on the next page, ensure maximum uptime.

Other Service Offerings include "Per-Incident", FIRM PRICE, "Per-Call", Self-maintenance support, Installation, and Time-and-Material services.

Our Long-Term Support Program ensures service availability for discontinued products years out of production. And, we will use our best efforts to service obsolete products if the necessary parts are available.

CALL YOUR LOCAL TEKTRONIX OFFICE

Custom services available at selected offices are not included in this catalog. Likewise, not all U.S.A. programs described here are offered in every country. For details in your area, call the Tektronix Sales, Service or Distributor Office nearest you.

CUSTOMER-SITE SUPPORT

For most Computer Graphics and Microcomputer/CASE Products, Intelligent Graphics Workstations, Artificial Intelligence Systems, DAS 9200 Series Logic Analyzers, and 11000 Series Oscilloscopes

Fast, on-site service is available through Support Agreements or "Per-Call".

Annual Customer-Site Support Agreements. Our fastest response is reserved for agreement holders. All travel, parts and labor are covered.

To maximize uptime, preventive maintenance is included to inspect, clean, and adjust your equipment to peak performance. Mandatory engineering upgrades are installed at no extra charge to enhance safety and reliability.

Our eight work-hour response target means "one-day service" for virtually all customer sites in the contiguous U.S.A. during normal business days. For even faster response, multi-shift or weekend coverage,

ask about our Customer-Site Agreement Options. Contact your local Tek office or call 1-800-835-6100 for prices and details.

"Per-Call" Service. Dependable on-site service is also available at time-and-material rates plus travel expense. Repairs are warranted for 90 days.

Installation/Relocation Services. Tek offers expert moving and system set-up services at fixed-fee "Per-Call" rates.

Software Update Agreements provide current releases of Tektronix licensed software documentation. Call 1-800-835-6100 to order agreements on IGW, PLOT 10, AIM, and LoPro software. Call your Tek Sales Engineer for agreements on CASE software.

Technical Assistance Services may be obtained by calling your local Tektronix applications engineer for help in implementing Tek software, training users, or solving applications problems. The scope of assistance can be defined before costs are incurred.

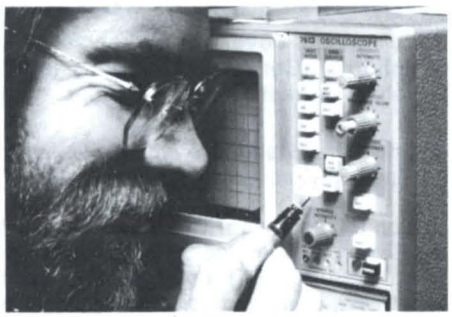
TEK PRODUCTS

SERVICE CENTER SUPPORT

For most Instrumentation, Television and Communications Products

Tek Service Centers are staffed, equipped, and supplied to provide quick, effective service.

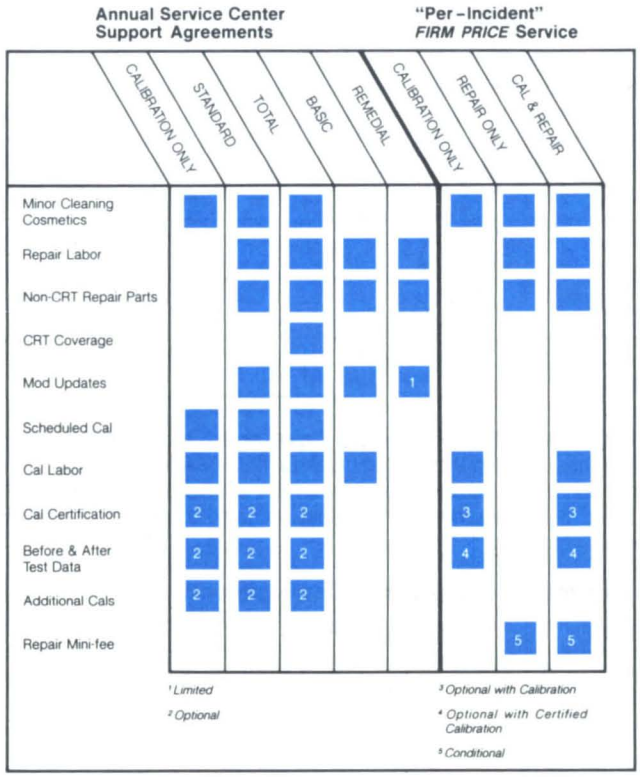
Annual Service Center Support Agreements offer five levels of support, all with top priority turnaround. In most cases, 12 months of coverage costs less than a single repair and calibration. Discounts are available and Tek pays one-way shipping.



The various support alternatives are summarized in the chart below. There are some eligibility requirements and exclusions. Call your local Tek office for complete information.

The FIRM PRICE Program gives you, in advance, the exact cost to repair and/or calibrate your instruments on a "Per-Incident" basis. Over 550 products are included. Mini-fees may apply when the repair requires less than an hour's labor. Contact your local Tek office for complete FIRM PRICE information.

Time and Material Service restores performance to current products excluded from the FIRM PRICE Program and to most damaged or discontinued products. Obsolete products may require a written quote which you approve to initiate repair.



SELF-MAINTENANCE SUPPORT

For customers who choose to perform their own maintenance

Parts and Supplies are Available. To order, call the Parts Order Desk at your nearest Tektronix office with the part name, product model and serial number.

Module Repair and Return Services for specified modules of selected products are obtained through our Module Repair Center, Factory Service, Beaverton, Oregon. For complete details, request a copy of our Module Services Selection Guide, 81-A-6247.

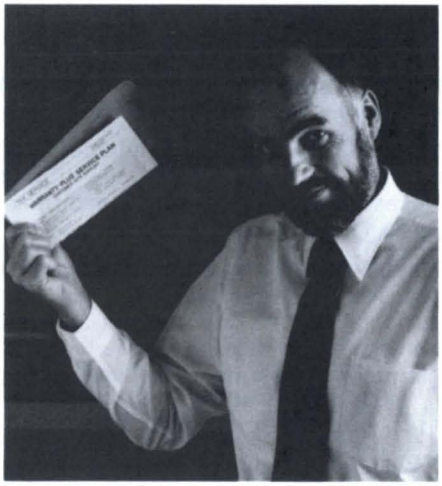
Provisioning (Service Sparing) can be arranged by your Tek Sales Engineer. Tek will recommend the appropriate spares for your product inventory and provide parts to your specifications.

Test Fixtures and Calibration Aids can be purchased through your local Tek office. Product-specific test fixtures and aids that are available are identified under most product listings in this catalog and in the current Logistics Data Book.

Service Training includes classes and self-study aids in a variety of electronic, service-related subjects. Formal classes are offered at various Tek locations across the country. For a class schedule and listing of audio, video, and printed study aids and training packages, request a copy of the Customer Service Training Catalog from your local Tek office or by completing the reply card in this catalog.

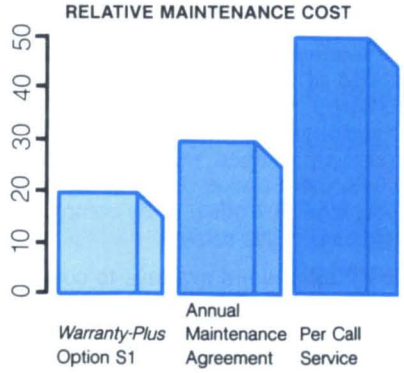
Service Publications available to customers include Service Manuals (circuit schematics, parts lists, operating maintenance, troubleshooting information), TEKNOTES Newsletter, and Microfiche Service Manuals with updates. Order printed manuals as you would any part. Request a subscription to TEKNOTES through your Tektronix Representative. Microfiche manuals (all ANSI standard 105 mm x 148 mm) and yearly subscriptions to new or revised service information on microfiche may be ordered by product, entire group or product line series, or as a full set of all Tektronix products. Contact your local Tek office for a Microfiche Products Files Catalog, 81-W-5678.

WARRANTY-PLUS SERVICE



Complete coverage for less. If you want high priority service at the very lowest cost, order *Warranty-Plus*.

Warranty-Plus Service Plans are available with most Tektronix products as purchase or leasing options. A year's coverage costs less than one typical on-site service call or one FIRM PRICE repair and calibration. Product quantity discounts apply for added savings.



Coverage is continuous, beginning when your Product Warranty expires. Maintenance costs are fixed for at least one full year and, with some products, up to five years.

***Warranty-Plus* means maximum uptime.** You receive our highest priority service. Approvals or paperwork delays are eliminated.

In addition to parts and labor, travel or one-way shipping, *Warranty-Plus* includes preventive maintenance and scheduled calibrations as appropriate to each product.

See the product listing for available option types and prices. Complete descriptions of *Warranty-Plus* options are available from your Tektronix Sales Engineer.

WARRANTY-PLUS CUSTOMER-SITE SERVICE

Fast, on-site coverage for selected computer-based products, systems, and peripherals (Computer Graphics and Microcomputer/CASE Products, Intelligent Graphics Workstations, and Artificial Intelligence Systems)

Option S0: Installation and Set-up. With Option S0 (S "zero"), Tektronix will install, set up, and verify product performance, including travel to your site up to 75 miles each way.

Option S1: First Year Coverage. For products ordered with Option S1, service coverage is extended beyond the 90-day Warranty period to a full year. Travel, labor, modules and parts (including CRT) are covered. Scheduled preventive maintenance is provided to inspect, test, clean and adjust equipment such as mechanically-based copier, plotters and disk drives, Tek-configured systems, and CRTs to optimum performance. Mandatory safety and reliability upgrades are installed at no extra cost. For those selected products with a one-year warranty period, this option is not available.

Option S1 is only available with standard end-user sales and only at the time of product purchase. Specify Option S1 when ordering.

Month of Ownership	1	2	3	4	5	6	7	8	9	10	11	12
Warranty Only	Warranty Coverage											
Warranty-Plus Option S1	Warranty Coverage			*Warranty-Plus* Coverage								

Option S2: Two-Year Coverage. For products ordered with Option S2, service coverage (including the warranty period) is extended to two full years. Option S2 is only available at the time of product purchase.

Year of Ownership	1	2
Warranty Only	Warranty Coverage	
Warranty-Plus Option S2	Warranty Coverage	*Warranty-Plus* Coverage
Warranty-Plus Coverage for Products with 1 Year Warranty		*Warranty-Plus* Coverage

Option S3: Three-Year Coverage. For products ordered with Option S3, service coverage is extended (including the warranty period) for the first three years of product ownership. Option S3 is for those customers that want to take advantage of a one-time purchase and significant savings. Your Sales Engineer has details.

Year of Ownership	1	2	3
Warranty Only	Warranty Coverage		
Warranty-Plus Option S3	Warranty Coverage	*Warranty-Plus* Coverage	
Warranty-Plus Coverage for Products with 1 Year Warranty		*Warranty-Plus* Coverage	

Option S9: First Year Software Update Coverage. Option S9 maintains Tek-licensed software at its highest revision level during your first year of ownership at no charge. It provides (1) appropriate media and documentation, (2) access to Tek's software development process, and (3) price protection against damage to original media. Specify Option S9 prior to product shipment.

***NEW* On-Site Service for 11000 Series Oscilloscopes**

Month of Ownership	1	2	3	4	5	6	7	8	9	10	11	12
Warranty Only	Depot Level Warranty											
Warranty-Plus Option S1	On-Site *Warranty-Plus* Coverage											

FOR NEW PURCHASES

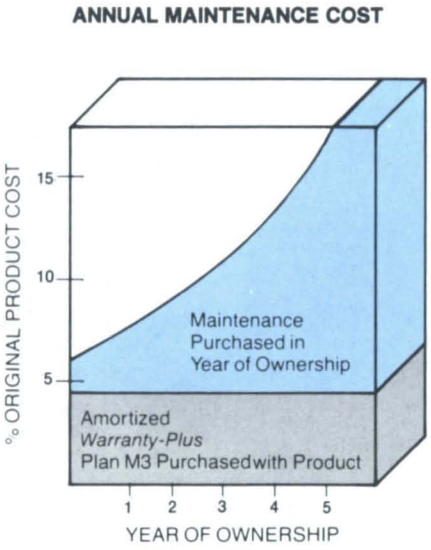
WARRANTY-PLUS SERVICE CENTER SUPPORT

Five levels of long-term coverage for selected instrumentation and communications products

Options M1–M5: Long-Term Service Center Support. Tektronix now offers five *Warranty-Plus* options which extend service coverage up to five years for products with one-year and three-year warranties. Choose calibration only, repair only, or both.

One Up-Front Fee Ensures Years of Low-Cost Performance. *Warranty-Plus* offers substantial savings over FIRM PRICE repair and calibrations or comparable support agreements you may purchase later.

Its long-term coverage fixes your costs now, protecting your budget from service price increases for the duration of the plan you choose.



More Uptime, too. Proper care and factory approved repairs improve overall reliability and performance. And since service is prepaid, there is no waiting to process P.O.s or obtain approvals for unplanned expense. None are needed. Just call.

M Options are only available at the time of product purchase. Specify Option M1, M2, M3, M4, or M5 when ordering.

For 2000 Series Portable Oscilloscopes, Specific Spectrum Analyzers, and instrumentation products

Year of Ownership		1	2	3	4	5
Warranty		Warranty Coverage	Warranty Coverage	Warranty Coverage	—	—
Optional *Warranty-Plus* Service	Option M1	—	1 Calibration	1 Calibration	—	—
	Option M2	—	—	—	Remedial Coverage	Remedial Coverage
	Option M3	—	1 Calibration	1 Calibration	1 Calibration + Remedial Coverage	1 Calibration + Remedial Coverage
	Option M4	1 Calibration with Certification	2 Calibrations with Certification	2 Calibrations with Certification	—	—
	Option M5	1 Calibration with Certification	2 Calibrations with Certification	2 Calibrations with Certification	2 Calibrations with Certification + Remedial Coverage	2 Calibrations with Certification + Remedial Coverage

WARRANTY-PLUS CONDITIONS

International *Warranty-Plus* Options. *Warranty-Plus* is available in most countries, but service is only provided in the country where the product and plan are purchased.

Response and turnaround times may be different than those provided in the United States. Please consult the Tektronix subsidiary or approved distributor in your country.

Response and Turnaround Times. In the United States, *Warranty-Plus* S Option Customer-site service is performed during normal business hours at the customer's site with no travel charges and within eight work-hours of notification, if the site is within 75 miles of a Tektronix Service Center. If not, response may be longer.

Warranty-Plus M Option Service Center Support is priority service performed at designated Tektronix Service Centers with turnaround completed within five days of receipt of product.

Customer Responsibilities. With Customer-site S Options, an end-user contact name, phone, and location must be designated at the time of purchase.

With Service Center M Options, it is the customer's responsibility to deliver the product for servicing to the service center designated by Tektronix, with shipping charges prepaid. Return shipping is paid by Tektronix.

Coverage Exclusions. *Warranty-Plus* Service purchased in the United States is only valid within the United States.

As you may expect, service under a *Warranty-Plus* Agreement does not apply if the failure is caused by misuse or inadequate care or maintenance, such as:

(a) Damage from repair attempts by non-Tektronix personnel

(b) Improper use or connection to incompatible equipment

(c) Modification or integration that increases time or difficulty in servicing your product

Complete descriptions of coverage, terms, conditions, and prices for all *Warranty-Plus* Plans are available from your Tektronix representative.

A WEEK OF TRAINING AT TEK IS WORTH YEARS OF EXPERIENCE AT THE BENCH

"Practical knowledge is the shortest route to higher productivity"
Tektronix Service Training brings experienced technicians up to date on new products, and new technicians up to speed on practical maintenance. Fast.

Our product specialists and professional instructors have carefully prepared and tested each course of study. The very same courses and materials are used to train Tektronix Service Technicians and Specialists.

Training manuals and study guides, audio and video tapes are structured with exercises to quickly develop skills in logical diagnosis and practical repair techniques.

Formal Classroom Training is Extensive and Intensive
It includes both lecture and daily hands-on lab periods for one, two or three weeks.

Under the guidance of Tek Service instructors, participants sharpen their skills in troubleshooting, isolating faults, and repairing Tek products.

Most importantly, learning the step-by-step preventive maintenance routines, as approved by Tek Factory Service, will ensure long product life and maximum uptime to your users.

A poster schedule is available giving dates, time and places for classes in the coming months.

Self-Study Aids Let You Learn at Your Own Pace
At home or on the job. According to your schedule.

Our storehouse of service training aids is full of stimulating self-study tapes and study manuals, and because each package is interactive, it's almost like having your own personal instructor. Most packages include evaluation modules.

You can reduce your training cost per technician by building your own library of training tapes and materials, the ones most relevant to your Tek products and technician skills. Then reuse them to train new technicians.

You'll find tapes that introduce basic concepts right on up to multimedia packages for the advanced service engineer or specialist.

MULTIMEDIA TRAINING PACKAGES

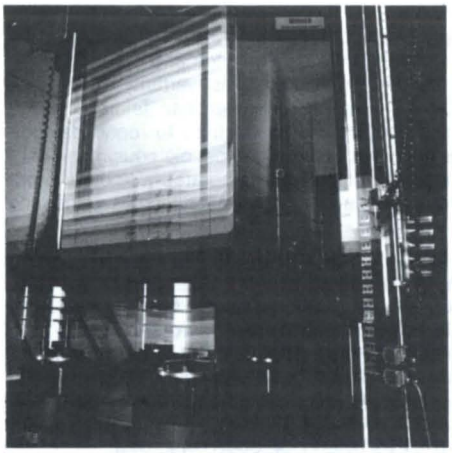
Title	Part Number	Price
Basic Data Communications, Parts I and II	062-3743-00	$450
Basic Data Communications, Parts I thru IV	062-3257-00	925
Basic Digital Concepts	062-3378-00	575
Digital Counter and Meter Concepts	062-5432-00	400
GMA 301/302/303 Display Monitors Maintenance	062-8422-00	350
401X Series Graphic Terminal Maintenance	062-6181-00	225
463X Series Hard Copy Unit Maintenance	062-8950-00	100
Logic Analyzer Concepts	062-5430-00	400
Oscilloscope Maintenance Concepts	062-3258-00	325
Sampling Concepts	062-5261-00	325
577/178 Linear IC Test Fixture Operation	062-3626-00	275

Call for information:
(800) 835-6100 or (503) 642-8842. Classes are typically full one or two months in advance. Please call us now to register for class or to request your own copy of the Tektronix Service Training Catalog which has complete descriptions and course prerequisites for all classes and tapes. Or write:

Tektronix Service Training
P.O. Box 500, D.S. 54-077
Beaverton, OR 97077

In Europe, call:
Tektronix Europe B.V.
Site: Planetenweg 99
2130 HL Hoofddorp
Telephone 31-(2503) 15644

Check the Specifications. You'll Find Long Product Life Designed-In.



Reliability Standards Second to None

Tek products are engineered for high reliability from the initial stages of design. Components and assembled products of every prototype and preproduction model are subjected to "accelerated-life" reliability tests in our Labs. If any fall short of Tek Standards, changes are made.

Manufactured products are thoroughly tested before they're fitted in custom-designed, lab-tested shipping cartons.

Product Specifications to Meet Your Environment

In Tek's Environmental Labs, field conditions are taken to extremes. Shock, vibration, high humidity, electromagnetic radiation, electrostatic discharge, power line surge, high/low temperature and altitude tests are conducted.

The environmental characteristics listed among the product specifications in this catalog may include some or all of the above types. The specification limits for humidity, vibration, shock and transportation are intended to be beyond what is expected in use. Operation at these extremes may cause minor physical deterioration but should not cause electrical performance to deteriorate outside specifications. Continual use at the specified limits of temperature and altitude should not cause significant short-term deterioration. Higher temperature will reduce long-term reliability. The EMC test is completely nondestructive.

GENERAL TERMS OF SALE

Credit and Payment Terms

Tektronix, Inc. offers many different terms of sale in order to meet varied purchasing objectives and to assist in financial planning.

Credit accommodations must be arranged with Tektronix's Credit Department. Orders and request for credit accommodations should be placed with your local Tektronix Sales Office, listed on the inside back cover.

If, in the judgement of Tektronix, the financial condition or payment record of the Buyer at any time does not justify shipment of order on the payment terms requested, Tektronix may refuse to ship unless it receives payment in advance, or at its option, payment upon delivery of equipment. Businesses established for six months or less may not meet minimum requirements for extended and/or installment terms of sale.

The following terms may be arranged with a Tektronix Sales Office:

Net 30 Days Standard Terms

Standard terms of sale are Net 30 days following the date of invoice. There are no discounts for early payment.

60, 90 and 120 Days Extended Terms of Sale

Extended terms of 60 to 120 days are available on the same single payment basis as standard terms. Since the cost of extended terms is not included in catalog prices, a service charge is added to the invoice. The amount of the service charge depends upon the number of days the terms are extended. Request for extended terms must be made at the time of order placement.

Installment Purchases—Security and Lease Agreements

This program provides monthly installment payment terms while Tektronix Products are in use. Accessories and parts are not available unless they are associated with the products being purchased. New and used products may be purchased with a deduction for applicable quantity discounts.

Security and Lease terms are not invoiced. Reminders of each installment are sent to the customer 10 days prior to the due date. The due date of each monthly payment on an installment term will be approximately 30 days from the date of shipment and every 30 days thereafter until completion of the contracted term. Failure to receive any reminder notice from Tektronix shall not affect customer's obligation to pay charges when due.

Except for standard warranty, maintenance is not provided under either a Security Agreement or a Lease Agreement. Additional maintenance is not provided under either a Security Agreement or a Lease Agreement. Additional maintenance coverage may be purchased where offered as an option to the instrument or may be purchased as a separate transaction. Maintenance ordered as an option may be financed along with the product.

The customer is required to pay applicable property taxes, licenses, etc. and furnish adequate insurance to Tektronix for loss and damages for both Leases and Security Agreements.

Security Agreement

An advance payment equal to approximately 10% of the purchase price of the equipment desired is required for a Security Agreement. Installment terms covering the balance of the contract price are available for 6, 12, 18, 24, 30, or 36 months.

Minimum balance amounts may be financed, ranging from $1000 for six months to $2000 for thirty-six months. Longer terms of 48 months to 60 months are available by quotation for financed balances of more than $25,000. There are no maximum finance balances. Upon completion of the term of the Security Agreement and prescribed payments, the customer owns the equipment.

Lease Agreement (Minimum is $1,000)

A standard lease term of 6, 12, 18, 24, 30, and 36 months is offered. Longer terms are negotiable. Under a Lease Agreement the customer pays for the use of the product for the term of agreement. It is not a month-to-month rental . . . it is a non-cancellable, fixed-term lease requiring no advance payment. At the expiration of the lease there is the opportunity to update the instruments, to renew the existing lease, or to return the equipment at the expense of Tektronix, Inc. The customer may exercise an option to purchase the equipment at any time during the term of the lease, provided he gives thirty days written notice. A portion of the installments will be credited toward the purchase price. Not available for Information Display Products.

Information Display Products

Information Display Computer Graphics Products are available under 3 expanded Leasing programs. Terms vary from 90 days to 4 years.

Comprehensive Lease — This full service lease provides 7 features ensuring customer flexibility. Key features include maintenance, product upgrade, and purchase credits. *Basic Lease* — Customers can use this program to acquire Information Display Products at our lowest monthly rates. *Ownership Lease* — This even payment plan ensures title transfer at the lease end. No down payment or ending balloon payment is required.

In addition to these standard programs, specialized leasing programs answer customer needs in the areas of new product evaluation, short term rental, supplying interim products for delayed items, credit acceptance, and others. Custom Leases can also be structured, providing a tailored solution for individual customer requirements.

Minimum Order

The minimum acceptable order is $25.00.

Shipment

All prices, quotations, and shipments are FOB Beaverton, Oregon, unless otherwise specified.

Unless otherwise specified, shipment will be made via most economical method and air shipments will be insured at full valuation unless your order instructs otherwise.

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HARDWARE WARRANTY SUMMARY

Tektronix warrants to its Customers that the products that it manufactures and sells will be free from defects in materials and workmanship for the periods set forth in the table below. If any such product proves defective during the applicable warranty period, Tektronix, at its option, either will repair the defective product without charge for parts and labor or will provide a replacement in exchange for the defective product.

In order to obtain service under this warranty, Customer must notify Tektronix of the defect before the expiration of the warranty period and make suitable arrangements for the performance of service. Tektronix will provide such service at Customer's site for certain categories of products, as indicated in the table below, if Customer's site is within the normal on-site service area. Tektronix will provide on-site service outside the normal on-site service area only upon prior agreement and subject to payment of all travel expenses by Customer. In all other cases, Customer shall be responsible for packaging and shipping the defective product to the service center designated by Tektronix, with shipping charges prepaid. Tektronix shall pay for the return of the product to Customer if the shipment is to a location within the country in which the service center is located. Customer shall be responsible for paying all shipping charges, duties and taxes, if the product is returned to any other location. The locations at which the services will be provided for different categories of products or product groups are set forth below.

This warranty shall not apply to any defect, failure or damage caused by improper use or improper or inadequate maintenance and care. Tektronix shall not be obligated to furnish service under this warranty a) to repair damage resulting from attempts by personnel other than Tektronix representatives to install, repair or service the product; b) to repair damage resulting from improper use or connection to incompatible equipment; or c) to service a product that has been modified or integrated with other products when the effect of such modification or integration increases the time or difficulty of servicing the product.

THIS WARRANTY IS GIVEN BY TEKTRONIX WITH RESPECT TO THE LISTED PRODUCTS IN LIEU OF ANY OTHER WARRANTIES, EXPRESSED OR IMPLIED. TEKTRONIX DISCLAIMS ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. TEKTRONIX' RESPONSIBILITY TO REPAIR OR REPLACE A DEFECTIVE PRODUCT IS THE SOLE AND EXCLUSIVE REMEDY PROVIDED TO THE CUSTOMER FOR BREACH OF THIS WARRANTY. TEKTRONIX WILL NOT BE LIABLE FOR ANY INDIRECT, SPECIAL, INCIDENTAL OR CONSEQUENTIAL DAMAGES IRRESPECTIVE OF WHETHER TEKTRONIX HAS ADVANCE NOTICE OF THE POSSIBILITY OF SUCH DAMAGES.

PRODUCT CATEGORIES	WARRANTY PERIOD	SERVICE LOCATION
Oscilloscopes (except 2200, 2300, 2400 Series) and Plug-Ins; TM 500/TM 5000 Series; Communications Network Analyzers (except 834 Series, 835 & 836); Logic Analyzers (except 9200 Series); Spectrum Analyzers (except 494 and 494P); Television Products (except 1980 and 650 and 690 Series); Waveform Digitizers; Curve Tracers; Photometers/Radiometers; Cameras; Carts; Probes; CRTs; Isolators; Computer Graphics Products: 4100H Series, 4900H01; Test System Interface Family	1 year from date of shipment	Service Center designated by Tektronix
Oscilloscopes: 2200, 2300, 2400 Series; Spectrum Analyzers: 494 and 494P; Monitors: 650 and 690 Series; Communications Network Analyzers: 834 Series, 835, 836 and 067-0986-00	3 years from date of shipment	Service Center designated by Tektronix
Monitors: 606B, 608, 620, 634	3 months, except 1 year from date of shipment for CRT	Service Center designated by Tektronix
Computer Graphics Products (except 4100H Series, 4900H01 and those listed below); Intelligent Graphics Workstations; Monitors: GMA 201; 1980; 4041 Controller; Computer Aided Software Engineering Products (except V-Systems, MV Systems); Artificial Intelligence Systems	3 months, except 1 year from date of shipment for CRT	Customer's site if within normal on-site service area
Computer Graphics Products: 4104A, 4105A, 4106A, 4107A, 4109A, 4205, 4207, 4208	1 year from date of shipment	Customer's site if within normal on-site service area
Custom Test Systems; Semiconductor Test Systems; Computer Aided Software Engineering Products: V-Systems, MV Systems; Logic Analyzers: 9200 Series; Delta Series	3 months, except 1 year for CRT, beginning on the date of installation by Tektronix, or one month from date of shipment, whichever is earlier	Customer's site if within normal on-site service area
Parts, Assemblies, Supplies and Test Fixtures: All 9-digit part numbered items except Probes, CRTs, and 067-0986-00	3 months from date of shipment	Service Center designated by Tektronix
Service	3 months from date of shipment or date of completion if performed on-site	Location where original service was performed

SOFTWARE WARRANTY SUMMARY

Tektronix warrants that any software product for which Tektronix publishes a corresponding "Software Product Description" will conform to the specifications set forth in the Software Product Description, when used properly in the specified operating environment, for a period of three (3) months. The warranty period begins on the date of shipment, except that if the program is installed by Tektronix, the warranty period begins on the date of installation or one month after the date of shipment, whichever is earlier. If any such software product does not conform as warranted, Tektronix will provide the remedial services specified in the applicable Software Product Descriptions. Tektronix does not warrant that the functions contained in the software product will meet Customer's requirements or that operation of the programs will be uninterrupted or error-free or that all errors will be corrected. Software products for which Tektronix does not publish a Software Product Description, or for which Tektronix does not set forth specifications in the Software Product Description, are provided "as is" without warranty of any kind, either express or implied; except that, Tektronix warrants that the media on which such software products are provided will be free from defects in materials and workmanship for a period of three (3) months from the date of shipment. If any such medium proves defective during this warranty period, Tektronix will provide a replacement in exchange for the defective medium.

In order to obtain service under this warranty, Customer must notify Tektronix of the defect before the expiration of the warranty period and make suitable arrangements for such service in accordance with the instructions received from Tektronix. If Tektronix is unable, within a reasonable time after receipt of such notice, to provide the remedial services specified in the applicable Software Product Description, when such services are indicated, or provide a replacement that is free from defects in materials and workmanship, Customer may terminate the license for the software product and return the software product and any associated materials to Tektronix for credit or refund.

This warranty shall not apply to any software product that has been modified or altered by Customer. Tektronix shall not be obligated to furnish service under this warranty with respect to any software product a) that is used in an operating environment other than that specified or in a manner inconsistent with the User's Manual and documentation or b) when the software product has been integrated with other software if the result of such integration increases the time or difficulty of analyzing or servicing the software product or the problems ascribed to the software product.

THIS WARRANTY IS GIVEN BY TEKTRONIX WITH RESPECT TO THE LISTED PRODUCTS IN LIEU OF ANY OTHER WARRANTIES, EXPRESSED OR IMPLIED. TEKTRONIX DISCLAIMS ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. TEKTRONIX' RESPONSIBILITY TO PROVIDE REMEDIAL SERVICE WHEN SPECIFIED, REPLACE DEFECTIVE MEDIA, OR REFUND CUSTOMER'S PAYMENT IS THE SOLE AND EXCLUSIVE REMEDY PROVIDED TO CUSTOMER FOR BREACH OF THIS WARRANTY. TEKTRONIX WILL NOT BE LIABLE FOR ANY INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES IRRESPECTIVE OF WHETHER TEKTRONIX HAS ADVANCE NOTICE OF THE POSSIBILITY OF SUCH DAMAGES.

For further details regarding OEM or specific hardware or software warranties, please consult your local Sales Office.

OEM COMPONENTS

Special Information for OEM
At Tektronix we offer many products with terms, conditions, and pricing for OEMs. Computer graphics components, small screen displays, certain cameras, tv signal test and measurement instrumentation—we offer these and other products on a special basis to the original equipment manufacturer.

But terms and conditions tell only part of the Tektronix OEM story. Our products have the quality, reliability, and top performance per dollar that the OEM needs to stay competitive.

Choose the Performance Level to Match Your System
In many product areas our wide range of OEM components allows you to select just the optimal performance you need for the system you are building. When your systems demand highest performance, Tektronix will provide the quality products to meet your standards.

In price-sensitive situations, the wide Tektronix selection usually lets you select exactly the performance level you need—no more, no less.

Special OEM Terms and Pricing Help Keep You Competitive
Ask your local Tektronix representative about the special OEM terms and pricing available to you.

Service and Support— When and Where You Need It
Tektronix has service centers throughout the U.S. and in many countries around the world. We offer long term parts support to protect your investment.

If you need applications assistance, we're ready to help. Our OEM specialists are trained to help solve interface problems. That's solid support when you need it.

You and Tektronix: A Quality Partnership
Explore the advantages of working with Tektronix: excellence in products, support, and service.

Your local Tektronix representative can help you obtain full details on how you can profit from a quality partnership with Tektronix.

See how our OEM expertise can add value to your system.

POWER SOURCE CONSIDERATIONS

Most Tektronix instruments provide wide-range regulated supplies, or quick change line-voltage selectors for convenient selection of line-voltage operating ranges. Transformer taps in other instruments can be changed to accommodate specific line-voltage operating ranges or can be factory wired for a specific range if specified on the purchase order.

Many Tektronix instruments are designed to operate from a power source that will not apply more than 250 Volts RMS between the supply conductors or between either supply conductor and ground.

Many Tektronix instruments can be fitted with one of the power cord/plug options listed below and wired for the voltage as indicated, if specified on the purchase order.

North American	120 V	Standard
Universal Euro	220 V	Option A1
United Kingdom	240 V	Option A2
Australian	240 V	Option A3
North American	240 V	Option A4
Switzerland	220 V	Option A5

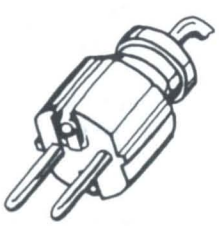
The power cord/plug options may become available on instruments not specified in this catalog. Refer to the individual product ordering information for those products offering these options as of publication date.

Except for some double-insulated instruments, most Tektronix instruments are equipped with either a three-conductor attached power cord or a three-terminal power-cord receptacle. The third wire or terminal is connected directly to the instrument chassis to protect operating personnel.

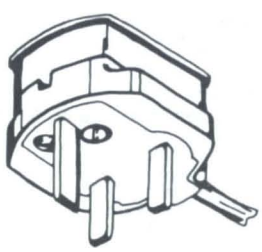
Power-cord coding follows one of the two following schemes:

	Scheme 1	Scheme 2
Line	Black	Brown
Neutral	White	Light blue
Ground (safety earth)	Green-yellow	Green-yellow

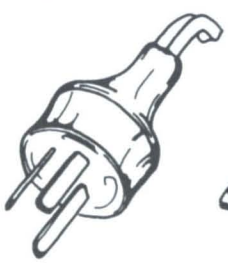
Standard North American 120 V Plug



Option A1 Universal Euro 220 V Plug

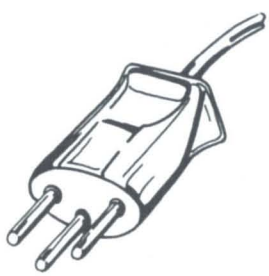


Option A2 UK 240 V Plug



Option A3 Australian 240 V Plug

Option A4 North American 240 V Plug



Option A5 Switzerland 220 V Plug

For customers outside listed countries, contact your nearest area office:

Asia, Pacific Rim, Central & South America

Tektronix, Inc., Americas Pacific U.S. Export Sales
P.O. Box 500, MS 73-323
Beaverton, Oregon 97077
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(800) 547-1165
Telex: 4742110 TEKEXP

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Unite de Maintenance et Calibration
des Equipements Electroniques
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Adelaide, South Australia 5000
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Canberra Office
CNR, Cohen & Jolly Sts.
Belconnen
Canberra 2617
Austr. Capital Terr. 2606
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Melbourne Office
CNR, Russell and Council Sts.,
Hawthorn East,
Melbourne,Victoria 3123
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East Perth, West Australia 6000
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Telex: (950) 642418 DCCI BJ

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Northern Ontario Customers
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Telex: 04354602 TEKTRONIX VCR

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Cable: SELECTRONICA

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(T&M Products)
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Calle 26 #305
Phone: 506 () 21-59-54
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Telex: 605 2395

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Telex: (855) 35239 TEKAS DK
Fax: 45 (2) 68-00-70

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(T&M and IDG Products)

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y Orellana
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Telex: (393) 22865 PROTEC ED

Guayaquil Office
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Guayaquil,
Site: Calderon #103 y Malecon
Phone: 593 (4) 526093

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Fax: 202 3499253

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Fax: 202 3499253

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Telex: (857) 123435 TEKOY SF
Fax: 358 (0) 7520033

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Telex: (842) 691012 TEKSAV

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CORPORATE OFFICE

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PRINCIPAL PLANT

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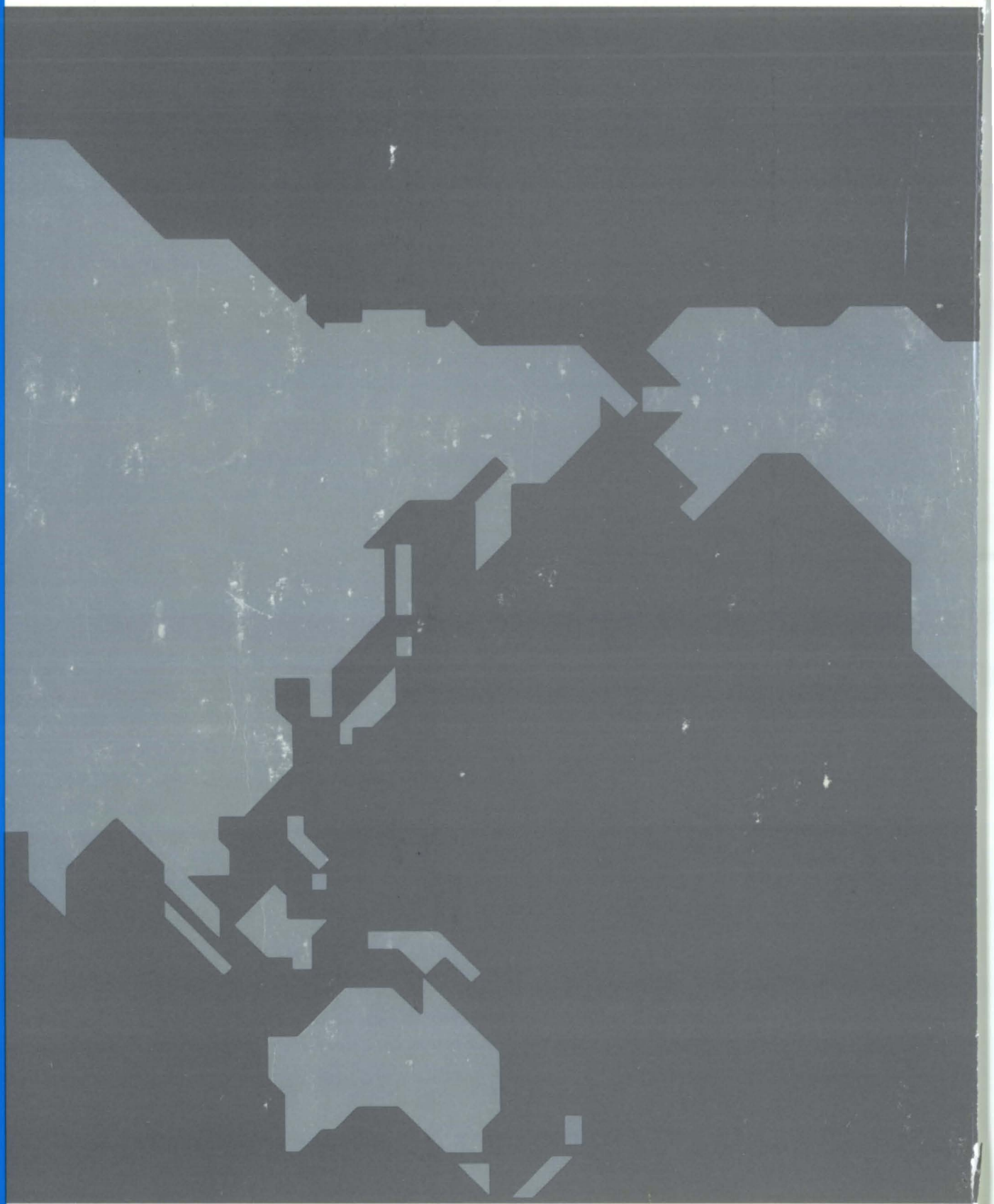
DIRECT ORDER:

For Continental United States, Alaska, Hawaii, Virgin Islands and Puerto Rico. Contact our National Marketing Center.
Phone: (800) 426-2200
For State of Oregon,
call collect (503) 627-9000.



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