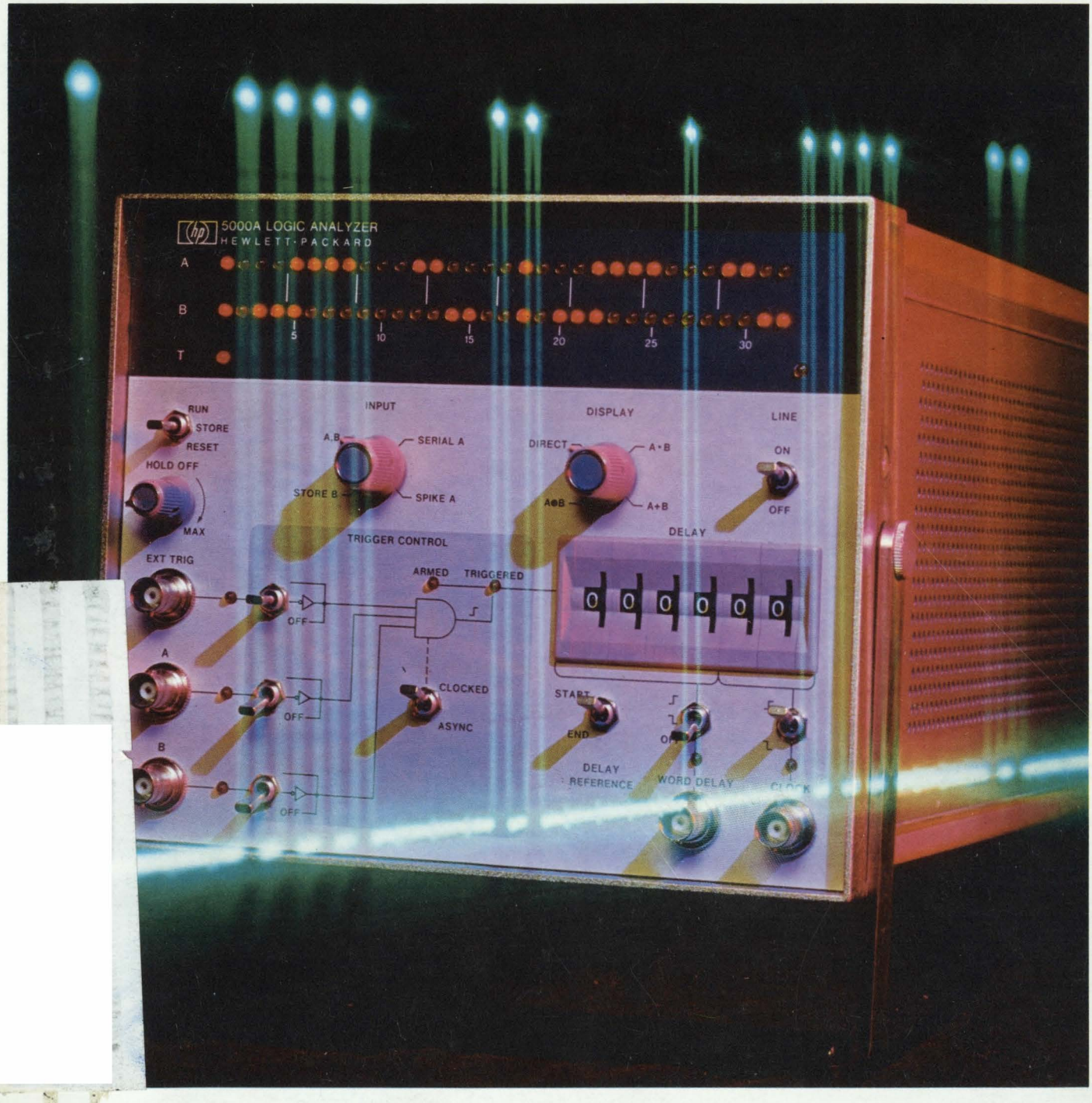
VOL. 21 NO. 7

Electronic Design

FOR ENGINEERS AND ENGINEERING MANAGERS

APRIL 1, 1973

Watch your logic in action. See one pulse, bursts or continuous data to 10 Mb/s, 32 bits at a time, in each of two channels. See what's up or down anyplace in your logic stream. Combine channels logically or cascade them to see 64 bits. Hold the data in one channel and update the other. Learn how on p. 89.



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Dale NS-2 is a vital non-inductive wirewound resistor used in the highly-regarded Micromemory 3000. *Electronic Memories & Magnetics Corporation* selected it for ability to control voltage while permitting the generation of fast rise time currents. But if resistors are your concern, the important thing is that the NS-2 is only one of 108 standard coated, molded and housed non-inductive styles readily available from Dale. Make sure you're taking advantage of all the time and dollar savings available from our broad wirewound line. Here's how:

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INFORMATION RETRIEVAL NUMBER 241

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Type	Freq. (MH_Z)	Output Power (W)	Gain (db)	Supply (Volts)
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TA8807/8/9	3000	1/3/5	5	28
2N6390/1/2	2000	3/5/10	7	28
RCA2003/05/10	2000	3/5/10	7	28
TA8340	1700	0.5	Oscillator	20
TA8695	1300	30	8	28
R44M 10/13/15	390-440	10/13/15	20	12.5

So if you want to design reliability and high performance into your system, design in RCA's RF performance expanders.

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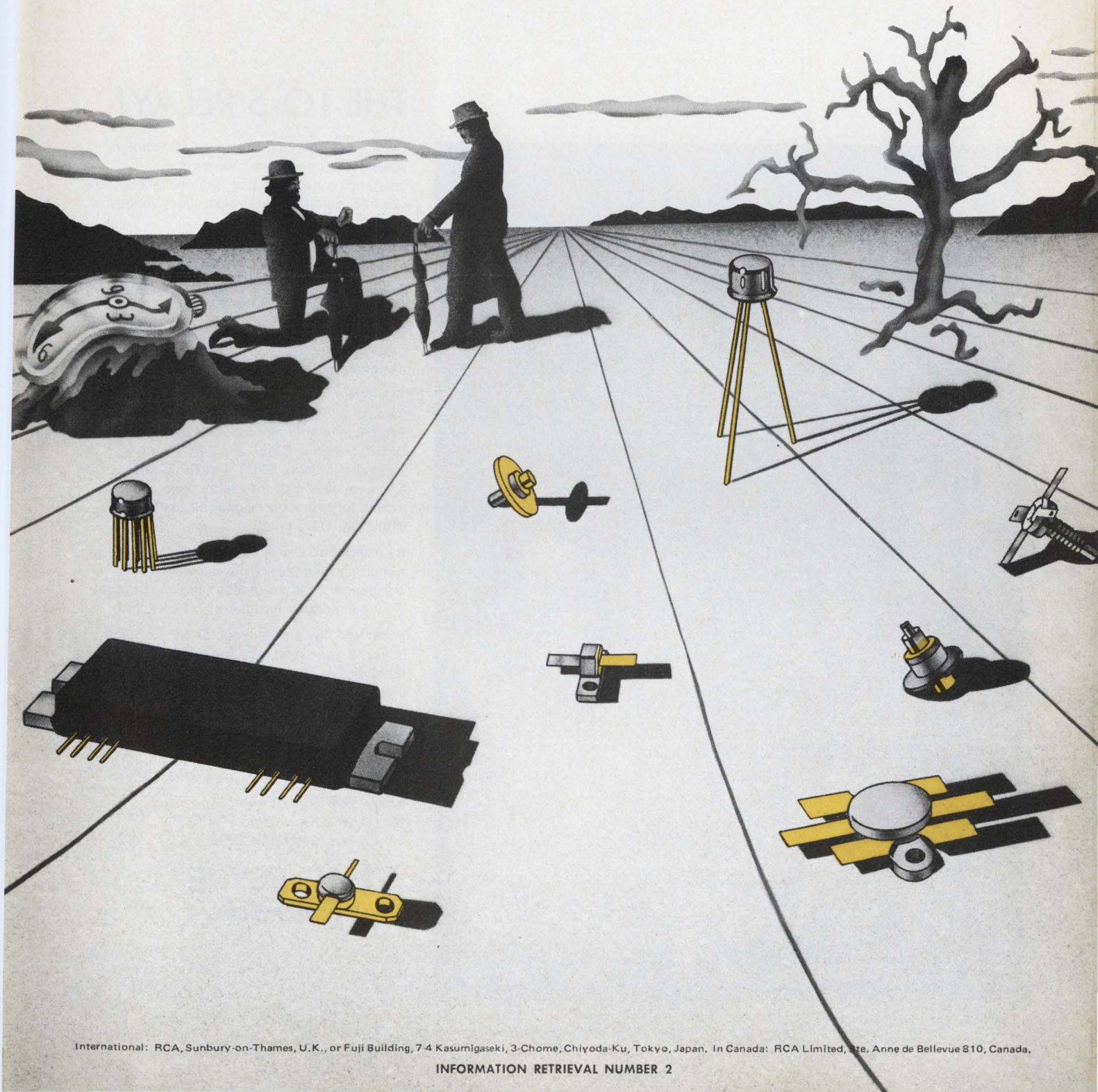
RF performance expanders.



International: RCA, Sunbury-on-Thames, U.K., or Fuji Building, 7-4 Kasumigaseki, 3-Chome, Chiyoda-Ku, Tokyo, Japan. In Canada: RCA Limited, Ste. Anne de Bellevue 810, Canada.

INFORMATION RETRIEVAL NUMBER 2

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Crystal can relays (full size and fractional sizes) have been obsoleted by the outstanding performance, high reliability, low power requirement and cost effectiveness of the TO-5 Relay.

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TELEDYNE RELAYS

INFORMATION RETRIEVAL NUMBER 3

Electronic Design

VOL. 21 NO. 7

FOR ENGINEERS AND ENGINEERING MANAGERS

APRIL 1, 1973

NEWS

TECHNOLOGY

PRODUCTS

Departments

Cover: Photo by Hal Smith Photography, courtesy of Hewlett-Packard, Santa Clara, Calif.

ELECTRONIC DESIGN is published biweekly by Hayden Publishing Company, Inc., 50 Essex St., Rochelle Park, N. J. 07662. James S. Mulholland, Jr., President. Printed at Brown Printing Co., Inc., Waseca, Minn. Controlled circulation postage paid at Waseca, Minn., and New York, N. Y., postage pending Rochelle Park, N. J.

84,392 copies this issue.

THE POSITIVES TO OUR NEW FIXED VOLTAGE REGULATORS.

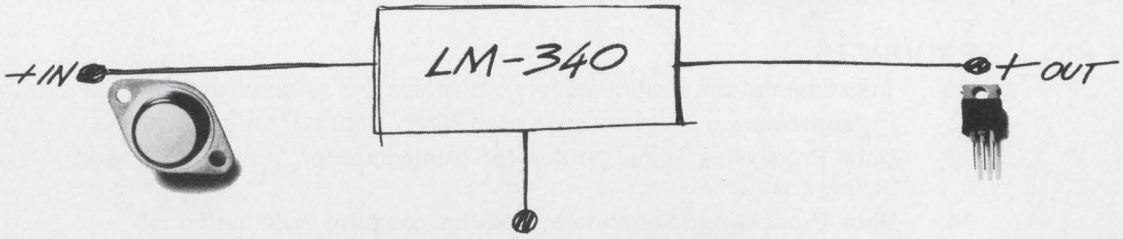
If you're looking for a simple regulator, this may turn you on.

Our new LM340 series TO-220 fixed voltage regulators.

Available in the plastic package and also the TO-3 package, in all temperature ranges, and in 5, 6, 8, 12, 15, 18 and 24 volts (see the page on the right, also).

They're the height of simplicity (no additional circuits to perform the function). Short circuit proof. And virtually indestructible (can't be destroyed by having inadequate heat sink).

Another thing. Our LM340's have a package with a plastic material and mounting material that results in an excellent matching coefficient of expansion and contraction. It'll withstand thousands and thousands of temperature cycles.



A third positive advantage is that we have a big supply on the shelf, ready to go. (A bird in the hand...)

So much for positives.

THE NEGATIVES TO OUR NEW FIXED VOLTAGE REGULATORS.

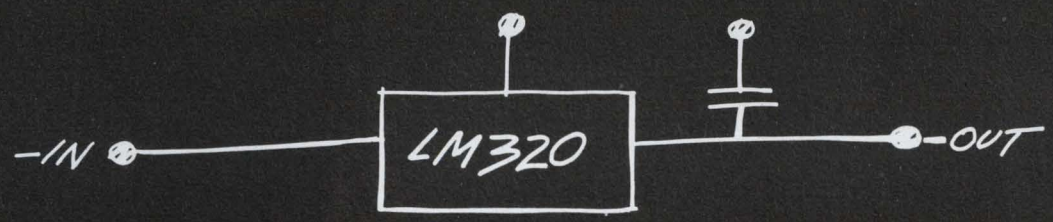
Minus 5 volts and minus 5.2 volts (how 'bout that, ECL users), minus 12 volts, and minus 15 volts. The LM320 series, available in the TO-3 package in all temperature ranges.

And by the way, these are the only negative fixed voltage regulators available today.

Which is another positive.

Want to try 'em out? A Digital Designer's Sample Kit, containing a +5, and −5.2 volt regulator, in the TO-3, and a Linear Designer's Sample Kit, containing a +15 and a −15 volt regulator are available for $6.45 each. That's 1/3 off the standard list price. They're available from distributors.

For further fascinating details write: National Semiconductor Corporation, 2900 Semiconductor Drive, Santa Clara, California 95051.



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across the desk

Future for engineers seen as less than rosy

Congratulations on Richard Turmail's futuristic article, "Engineering Jobs: What, Why, Where?" (ED 1, Jan. 4, 1973, p. 68), in which he has painted an exciting picture of the future of the engineer: More jobs, more money, a major shortage of engineers.

That's right. Beat the drums, blow the bugles, march out with pennants flying. Try your level best to stampede the young into wasting their best learning years studying to become proficient in a trade that will enable them to give their most productive earning years to companies (at a fraction of the salary made by former school-fellows as doctors or lawyers and even as accountants, realty agents, etc.), after which, at a relatively young age, they will be laid off, thrown on the rubbish heap, while their places are taken by fresh columns of younger men newly out of college. The cycle continues, thanks to rosy articles like this one.

On taking a closer look at the "sources" cited—namely, "30 representative companies," the College Placement Council, the director of placement at an engineering school, a "manpower expert" with the Engineers Joint Council and a technical manpower agency—it is clear where the problem lies. Not one of these sources has a vested interest in the economic or social status of the working engineer. In fact, their interests lie in quite the opposite direction.

The companies naturally thrive on a large pool of engineers who are willing to work for lower wages in competition with each other. The universities depend on a large influx of students for their very survival as ivory towers of power, politics and "research." And the job-shoppers need lots of bodies to fit to jobs.

Dr. T. Reginald Garfield
Moore School of Electrical Engineering
University of Pennsylvania
Philadelphia, Pa. 19104.

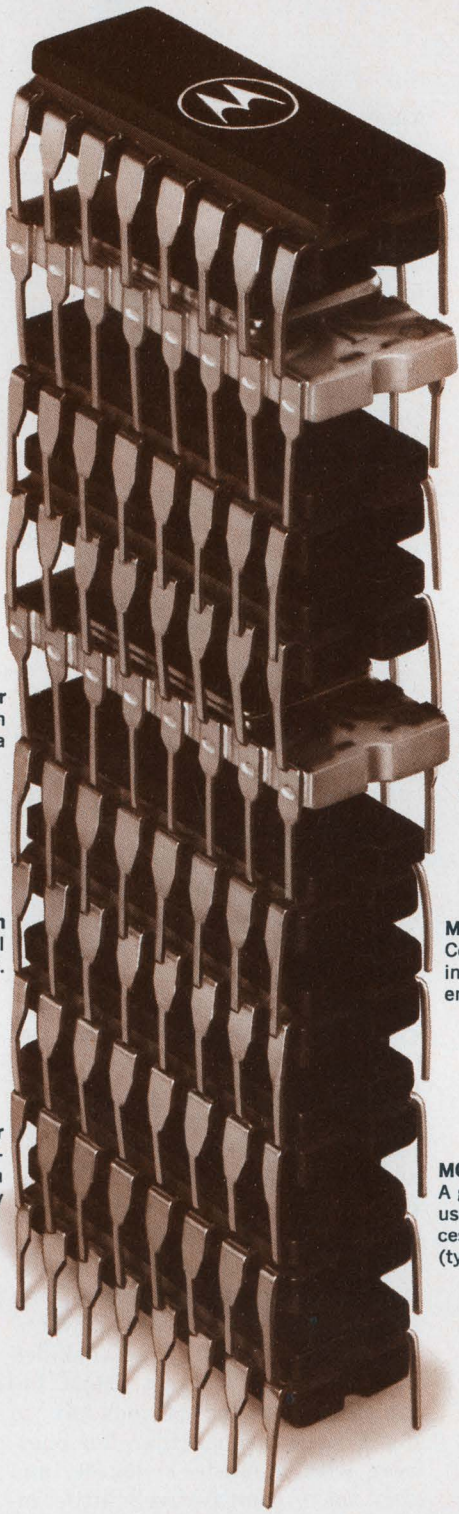
The superficiality of the article on engineering jobs in the Jan. 4 issue is, I believe, potentially very harmful to engineers, present or future, if it is read uncritically. To give you an idea of what I mean, I will comment on just two statements in the article that I find misleading.

The first is a "highlight" that emerged from the ELECTRONIC DESIGN study: "The over-all rate of unemployment among engineering graduates is only about 3%, or about half the national average." Such a statement carries the implication that the ratio of the engineering unemployment rate to that of the general working population is a valid criterion for judging its comparative severity. Among its other defects, that implication ignores the very substantial investment an engineer has made, and often continues to increase, in his education. The national average unemployment rate is almost entirely governed by unemployment of skilled, semi-skilled and nonskilled workers. Most begin their earning periods six to eight years sooner than an engineer with a master's degree, and they make comparatively little in-

(continued on page 11)

Electronic Design welcomes the opinions of its readers on the issues raised in the magazine's editorial columns. Address letters to Managing Editor, Electronic Design, 50 Essex St. Rochelle Park, N. J. 07662. Try to keep letters under 200 words. Letters must be signed. Names will be withheld on request.

Here are 10 new reasons to specify MECL 10,000



MCM10140AL 64-Bit RAM (90 ohm Drive)
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MC10171L Dual 4-Line Decoder
A binary coded 2 line to dual 4 line decoder with selected outputs low. For general purpose data routing at speeds to 4 ns typically.

MC10175L Quint Latch
Provides 5 bits of temporary storage and is useful for accumulator and register file applications. Speed is a fast 2.5 ns through the latch.

MC10129L Quad Bus Receiver
Receives TTL or IBM Bus levels and converts information to MECL 10,000 compatible levels. Latch features in MC10128 and 10129 provide temporary storage.

MC10104L Quad 2-Input AND Gate
Performs the AND gating function in an ECL system thereby saving an additional stage of OR/NOR gating.

MC10114L Triple Line Receiver
Features common mode noise rejection of ± 1 volt at inputs. Added noise immunity facilitates receiving differential signals over long lines.

MCM10148AL 64-Bit RAM (50 ohm Drive)
Similar to MC10140AL except with 50 ohm drive. Both memories offer full binary decoding, two chip enable inputs, and separate data input and data output pins.

MC10173L Quad 2-Input Multiplexer/Latch
Combines two functions on one chip — a real savings in package count. Data delay, with the latch enabled, is typically 2.5 ns.

MC10180L Dual High Speed Adder/Subtractor
A general purpose high speed adder/subtractor for use in arithmetic unit applications of central processors and fast multiplier arrays. Add time 4.5 ns (typ).

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MC10102	Quad 2-Input NOR Gate
MC10104	Quad 2-Input AND Gate
MC10105	Triple 2-3-2 Input OR/NOR Gate
MC10106	Triple 4-3-3 Input NOR Gate
MC10107	Triple Exclusive OR/NOR Gate
MC10109	Dual 4-5 Input OR/NOR Gate
MC10110	Dual 3-Input 3-Output OR Gate
MC10111	Dual 3-Input 3-Output NOR Gate
MC10117	Dual 2-Wide 2-3 Input OR-AND/OR-AND-INVERT Gate
MC10118	Dual 2-Wide 3-Input OR-AND Gate
MC10119	4-Wide 4-3-3-3-Input OR-AND Gate
MC10121	4-Wide OR-AND/OR-AND-INVERT Gate
MC10210	High Speed Dual 3-Input 3-Output OR Gate
MC10211	High Speed Dual 3-Input 3-Output NOR Gate

COUNTERS

MC10136	Universal Binary Counter
MC10137	Universal Decade Counter

MEMORIES

MCM10140	64-Bit RAM (64 x 1) (90 ohm Drive)
MC10145	64-Bit RAM (16 x 4)
MCM10148	64-Bit RAM (64 x 1) (50 ohm Drive)

TRANSLATORS

MC10124	Quad TTL-TO-MECL Translator
MC10125	Quad MECL-TO-TTL Translator

MULTIPLEXERS

MC10132	Dual Multiplexer With Latch (Common Reset)
MC10134	Dual Multiplexer With Latch (Separate Select)
MC10164	8-Line Multiplexer
MC10173	Quad 2-Input Multiplexer/Latch
MC10174	Dual 4 to 1 Multiplexer

DRIVERS AND RECEIVERS

MC10114	Triple Line Receiver
MC10115	Quad Line Receiver
MC10116	Triple Line Receiver
MC10128	Dual Bus Driver
MC10129	Quad Bus Receiver
MC10216	High Speed Triple Line Receiver

FLIP-FLOPS AND LATCHES

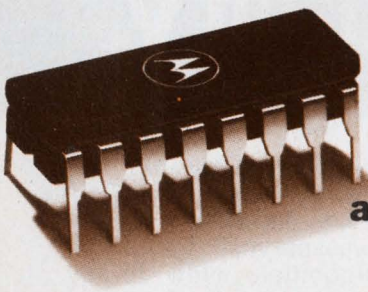
MC10130	Dual D Latch
MC10131	Dual D Flip-Flop
MC10133	Quad Latch
MC10135	Dual J-K Master-Slave Flip-Flop
MC10175	Quint Latch
MC10231	High Speed Dual D Flip-Flop

ARITHMETIC FUNCTIONS

MC10179	Look Ahead Carry Block
MC10180	Dual High Speed Adder/Subtractor
MC10181	4-Bit Arithmetic Logic Unit

OTHER LOGIC FUNCTIONS

MC10141	4-Bit Universal Shift Register
MC10160	12-Bit Parity Generator-Checker
MC10161	Binary to 1-8 Line Decoder (Low)
MC10162	Binary to 1-8 Line Decoder (High)
MC10165	Priority Encoder
MC10171	Dual 4-Line Decoder



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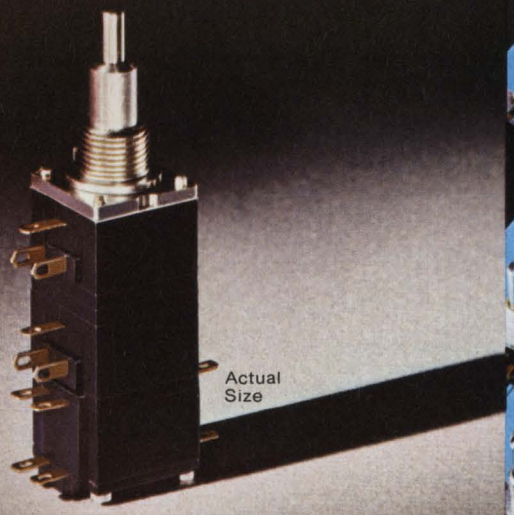
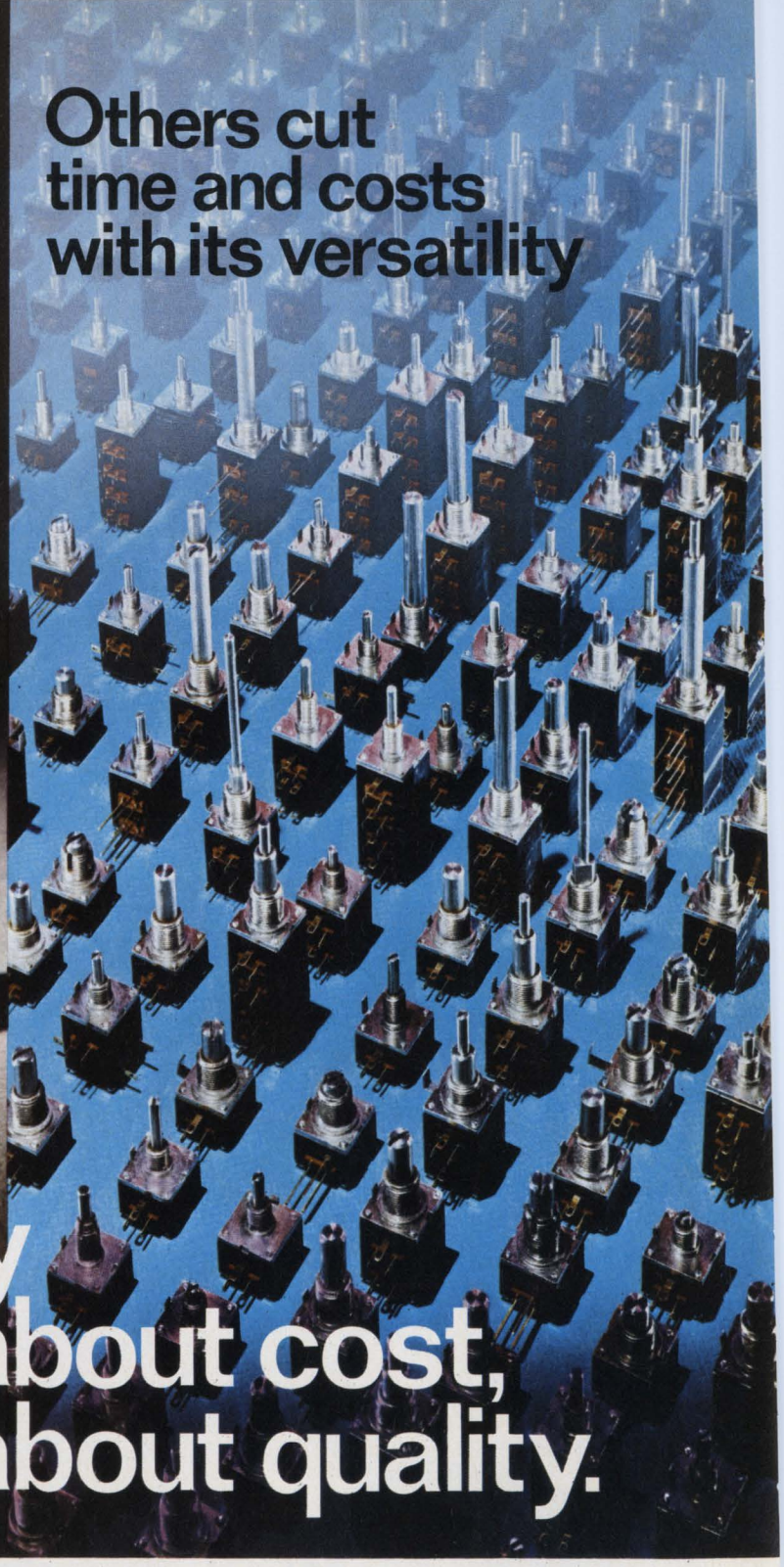


Others cut time and costs with its versatility



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ACROSS THE DESK

(continued from page 7)

vestment in formal training for their jobs. Their skills generally obsolesce at a much slower rate, if at all, and often only under union protection.

Second, the article gives this year's national freshman engineering class as 50,600 students, and it says that "with normal attrition, fewer than 29,000 engineers will be graduated in 1976—a total far short of the 48,000 that the Presidential Manpower Commission has predicted will be the yearly need through the end of the decade." At a time when so little else is normal, why is "normal attrition" assumed?

Mark Smith
MIT Draper Laboratory
37 Cambridge Parkway
Cambridge, Mass. 02142

'Something for nothing' is nothing but folly

I would like to comment on Robert Bruce's reply ("A Cheer for Less Work," ED 2, Jan. 18, p. 7) to your editorial in the Nov. 9, 1972 issue—"Get Enriched (If Not Rich) With Those High Flyers."

I fail to understand the logic of Mr. Bruce's statement that a man's work should be "emotionally rewarding" after Mr. Bruce stated that a man "should not be married" to his work. It appears to a few of us that if a man's work is emotionally rewarding, the man must first be involved emotionally with his work. And how can he be involved emotionally with his work and not be accused of being married to his career?

Some of us would like to believe that the majority of us still have pride in ourselves and our work. Please keep the excellent editorials flowing and do not be discouraged by the few "something for nothing" freaks.

Leven H. Goree
Transmitter Engineering Group Leader
Electronic Communications, Inc.
1501 72nd St. N.
Box 12248
St. Petersburg, Fla. 33733

(continued on page 14)

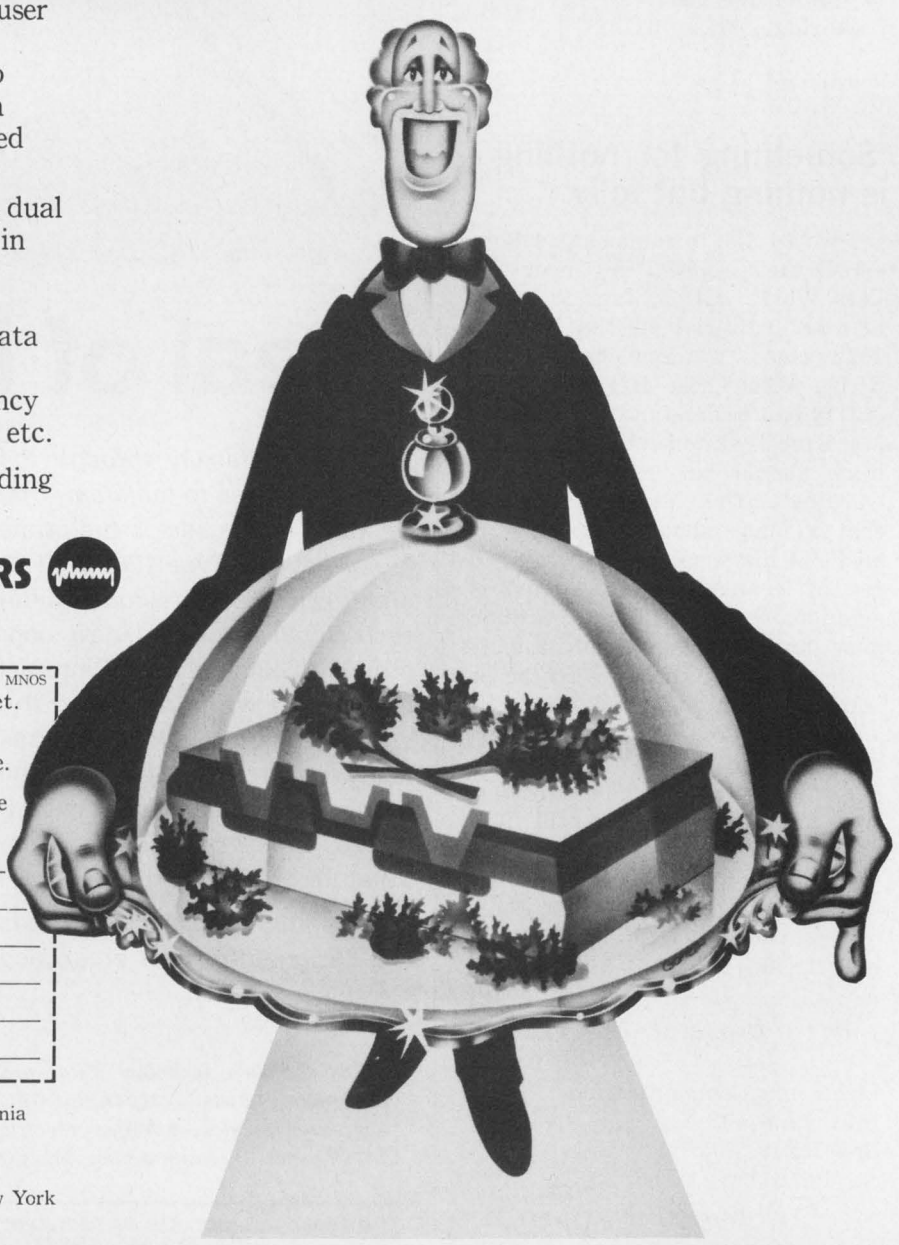
WHAT'S IN PLESSEY'S MNOS SANDWICH? ADVANCED TECHNOLOGY. THE SPECIALTY OF THE HOUSE.

There's only one Metal-Nitride-Oxide-Silicon sandwich commercially available now. And Plessey has it.

The Plessey MNOS transistor is a non-volatile electrically-alterable semiconductor memory. It is specifically designed to meet the most difficult user requirements. Like small memory applications where it is necessary to achieve long-term data retention in power-off conditions. . . for a hundred years.

They come many ways. Single, dual and quad transistors. And together in arrays. They can be used in a wide variety of applications—micro-programming, numerical control, data logging, domestic control systems, automatic repertory dialers, frequency synthesizers, and airborne systems, etc.

As more and more users are finding out, it pays to specify Plessey.



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ACROSS THE DESK

(continued from page 11)

DEAD breakthrough

For a rather unusual device, National Semiconductor has achieved what has hitherto been merely a dream for semiconductor manufacturers—100% yield. At the heart of the device, a Darkness Emitting Arsenide Diode (DEAD) offers complete absence of light emission and zero power dissipation over wide power-supply ranges. Full life-test data are not yet available, but accelerated life tests suggest that the DEAD should have infinite life.

Though it's impossible at this early stage to envision all possible applications of the DEAD, National has already explored its use as a normally-off indicator, a discharged-battery monitor and a readout for write-only memories.

A yield rate of 100% has not yet been achieved for the DEAD, though some manufacturers have approached this level. However, National has succeeded in developing techniques for fabricating DEADs and LEDs simultaneously on the same wafer. For these devices, the total yield is 100%.

Production parts are available on April 1.

Is everybody happy?

After each issue of ELECTRONIC DESIGN, the editors receive about 1000 Information Retrieval Cards with comments from readers. These comments are required reading for everybody on the editorial staff and the editors look to them eagerly for guidance. Sometimes it isn't easy.

As an example, note the comments of two readers of the same recent issue.

From M. S. McNatt of Bendix in Kansas City, Mo.:

"This has got to be the WORST issue of ED I've ever seen. Not ONE article or design idea of interest! Stick with your NORMAL selection!"

From Dan Slater of Piccadilly Ltd. in Fullerton, Calif.:

"One of your best issues. Keep up the good work!"

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Completely broadband and untuned, our highly linear units will amplify inputs of AM, FM, SSB, TV and pulse modulations with minimum distortion. Although all power amplifiers deliver their rated power output to a matched load, only ENI power amplifiers will deliver their rated power to any load regardless of match.

We also designed our amplifiers to be unconditionally stable and failsafe—you need never fear damage or oscillation due to severe load conditions (including open or short circuit loads).

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To find out more about our RF power amplifiers write: ENI, 3000 Winton Road South, Rochester, New York 14623. Call 716-473-6900. TELEX 97-8283 ENI ROC.

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5. You have to start out and stay price competitive.
6. You don't want any surprise problems when Version II is ready.
7. You want the right internal hardware, software, and all the rest.
8. You have to have good technical service back-up when you need it.
9. You're getting into bed with your major suppliers and want to play it as safe as possible.
10. You need all the help you can get from your vendor.
11. You don't want suppliers who end up competing with you.

Big problems. And we have some unique solutions proven by some of the biggest minicomputer buyers in the country. Our customers ran us through some of the toughest competitive bidding you ever saw. Against every name competitor you can mention.

We solved their problems. Partly, because we're not newcomers. Five years and thousands of minicomputers later, we're still solving problems. Successfully. And economically. How about yours?

Call or write me personally. I'll answer by phone or by airplane.

Dave Methvin
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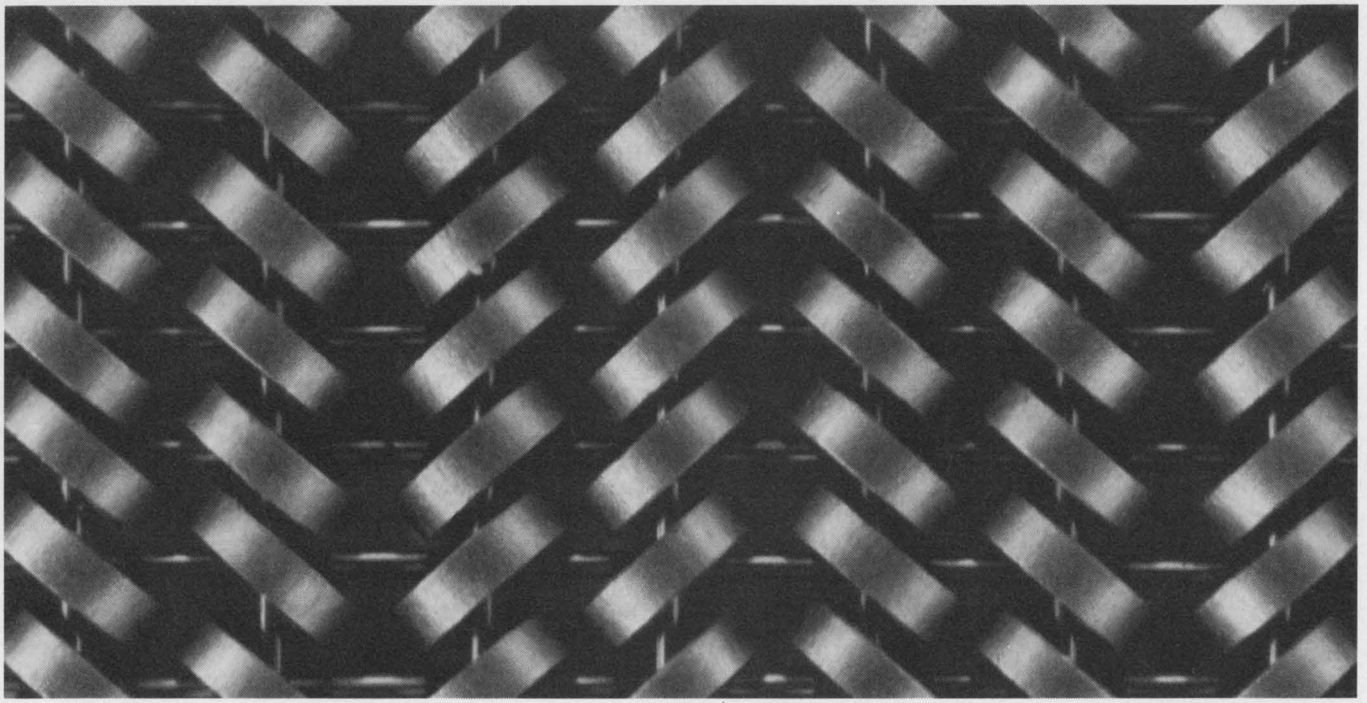

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INFORMATION RETRIEVAL NUMBER 16

news scope

APRIL 1, 1973

Exporting of technology stirs a protest by labor

Most transistor radios sold in the United States come from either Taiwan or Japan. In a few years maybe U.S. space boosters will, too. And what happens to the aerospace industry then?

These thoughts were expressed recently by labor and in Congress when McDonnell Douglas disclosed that it planned to sell the old space workhorse, the Thor-Delta rocket, to Japan.

The AFL-CIO's legislative director, Andrew J. Biemiller, appearing before a Senate subcommittee, described such sales of advanced technology as "devastating" and said that they would "eventually have serious effects on the U.S. labor market." At present some 1200 to 2000 skilled aerospace workers in California are involved in manufacturing the Thor Delta rocket.

Sen. Abraham Ribicoff (D-Conn.) agreed with Biemiller. He asked "why this technology created at great expense to the American taxpayer is being sold to foreign companies for production abroad." Ribicoff also pointed out that there was also a "serious national security implication in the sales." The Senator said that the Senate Finance Committee's Subcommittee on International Trade would dig further into the matter.

Besides the rocket sale to Japan, Biemiller cited other examples of foreign acquisition of American technology that labor opposes: the manufacture of Safeguard missile-system memory components in Hong Kong, the licensing of Mitsubishi in Japan to build the F-4 fighter aircraft and the licensing of Taiwan to build the F-5E fighter.

Also, Biemiller said, Boeing is training 200 Italians to build short-take-off-and-landing aircraft. They will then go home and tool up to sell STOL planes in Europe in competition with the U.S.

In contrast to selling technology abroad, Biemiller pointed out how lucrative it has been for the United States to launch satellites with our own systems for foreign countries, including Canada, France and northern Europe.

Processor for radar made more versatile

A new associative processor called Staran, incorporating what its developer describes as a "breakthrough in the logic design," is said to be more practical, economical and faster than the usual data-processing portions of large ground radars.

The system was developed by Goodyear Aerospace in Akron, Ohio, and its hardware is a general-purpose, stored-program computer that has—instead of a single central-processing unit, which processes targets one at a time or serially—a number of small, economical processing elements that accept targets in parallel.

"We get significantly higher speeds this way," says Wayne Brubaker, manager of Goodyear's digital systems marketing. "And we don't run up against the natural speed limit of a single-processing-unit computer."

One Staran system was shipped to Patrick Air Force Base, Fla., late in February for testing of a collision-avoidance control system. A second was delivered March 15 to the Air Force's Rome (N.Y.) Air Development Center to see how well it serves as a surveillance and control system.

Theoretically there's no limit to the number of processing elements a Staran system can have. "But 8000 seems to be about the practical limit, due to such things as propagation delays," Brubaker says. The system sent to Rome has more than 1000 units.

How did Goodyear do it? "We made a breakthrough in the logic design—the hardware portion—which enables us to come up with software that would do the trick," Brubaker says. The breakthrough is proprietary, he adds, declining to give details.

The Staran system in Florida is working with radar. The one at Rome will operate at first with a Honeywell 645 computer that will simulate a radar output.

New avionics may help counter jet noise

The National Aeronautics and Space Administration is tackling the problem of jet noise through a revised approach that may lead to new avionics for the nation's airliners. The agency has been testing a new, two-segment landing-approach pattern, in which the noise is considerably reduced.

Rather than making a long, three-degree final approach and prolonging the 90-dB noise over 5.5 square miles, jetliner pilots would use a two-segment landing approach. The first portion would be steeper—a six-degree slope—and the second would be the usual three-degree angle at the end. This would limit the noise to two square miles.

The new landing approach would call for some heavy spending.

A new, two-segment instrument landing system would cost approximately $42,000 per aircraft, NASA estimates, and a conventional ground-based, distance-measuring system (DME), which would be required on each runway, would cost about $40,000.

Aircraft now equipped with three-navigation systems would have to be modified for the two-segment landing system, and this would cost about $18,000 per plane. And installation of a completely new, compatible 3-D navigation system would come to close to $200,000.

Collins Radio and United Air Lines have just completed development and evaluation of a two-seg-

ment guidance system in a Boeing 727 and are to start tests this month. The same two companies plan to start work this fall on modifying an existing three-dimensional navigation system in a DC-8 for the two-segment approach.

Optical devices get JEDEC numbers

If receiving a JEDEC registration number is an indication of device maturity, optical isolators have finally come of age. Although they've been available for some time, there was no industry standardization. Designers had to order devices by house numbers.

Now two companies, Texas Instruments and Motorola Semiconductor, have registered a total of seven devices under the JEDEC 4N classification. The new numbers are 4N22, 4N23 and 4N24 for TI and 4N25, 4N26, 4N27 and 4N28 for Motorola.

The 4N classification, established in 1970, means that there are five active terminals on the devices. The seven optical isolators are the first devices to be registered under the classification.

The TI isolators are housed in a hermetically sealed TO-5 six-lead can. The Motorola units came in a six-lead plastic DIP.

While the TI devices were the first to be registered, the Motorola isolators are the first available off the shelf. TI has not yet put its devices on the market.

Comsat planning 2 new satellites

The U. S. maritime fleet and the Navy may soon be sharing communications satellites—one in synchronous orbit over the Atlantic, the other over the Pacific.

The Communications Satellite Corp. Comsat proposes to launch and operate the satellites and says it will ask the Federal Communications Commission for authority to do so soon. The Navy has already signed a contract for close to $28-million for use of portions of the satellites for two years. After this the Navy expects to have its own satellite network in operation.

The Comsat satellites would be designed to last five years. They would use three frequency bands: uhf, 240 to 400 mHZ, for the Navy between Navy-provided terminals and the satellites; L-band, 1533 to 1660 mHZ, for links between commercial maritime ships and the satellites; and C-band, 4 to 6 gHZ, for commercial links between the satellites and Comsat earth stations on each U.S. coast.

Comsat estimates investment costs at approximately $70-million, including two satellites in orbit and one spare on the ground.

New fears plaguing μW-oven industry

Ever since microwave ovens started to become popular, their promoters have waged a big public-relations battle to combat widespread fears of injury by the device. Then, in 1968, the Government wrote standards for the maximum allowable radiation from ovens. Manufacturers met them, fears were allayed and sales soared to an estimated 280,000 units last year. But now trouble has flared up again.

Last month the Consumers Union contended that the Government standards were inadequate, that it would be better for consumers not to use these ovens. Manufacturers have been on the defensive since then.

If the Government standards are unsafe, it's up to the Government to take further action, a Litton spokesman told ELECTRONIC DESIGN. At the same time a spokesman for the Food and Drug Administration's Bureau of Radiological Health said that the bureau's standard for microwave ovens—5 mW per square centimeter at a distance of two inches—was adequate for safe home use.

The safety situation is far from clear. Scientific evidence exists, the bureau spokesman noted, that changes in testicular function can be caused by a 60-minute exposure to 5 mW/cm of microwave energy.

Why does the bureau say that 5 mW/cm is safe? There are two reasons, the spokesman told ELECTRONIC DESIGN. First, the Government assumes that a user will not generally be closer than 14 inches to the oven while it is operating. At that distance the radiation degrades to 0.1 mW/cm. Second, if a person does get as close as two inches to the oven, it will probably be for only a few seconds to look into the oven.

What the bureau does not take into account, critics note, is that there are no data on the cumulative effects of microwave radiation exposure.

The Consumers Union found that even those ovens that met Government requirements were potentially hazardous. According to Allan Eckhaus, a senior project engineer for the union, dirt can build up on the seals of the oven doors, thereby causing leakage beyond the limits specified by the Government. In addition it is possible for such things as paper towels to get caught in the door, which also could cause an increase in leakage.

When questioned about this, Al Redlar, Litton's Long Island district manager for microwave ovens, said that certain maintenance by the user—the cleaning of seals, for example—was required on the ovens. He acknowledged that it was possible for paper toweling to get caught in the door, but he doubted that many consumers would operate the oven like that.

While microwave radiation from ovens can never be totally eliminated, it can be minimized to a level that equals the ambient radiation, notes Don White of Germantown, Md., a consultant in electromagnetic interference, and compatibility. According to him, there is no technological problem—just an economic one.

News Briefs

CRT displays will be the major type used this year by the Defense Dept., NASA and the Federal Aviation Administration, according to a Frost and Sullivan report. Matrix displays, (electroluminescent, LED, plasma and liquid-crystal) are, for the most part, still in the R&D stage, the report says.

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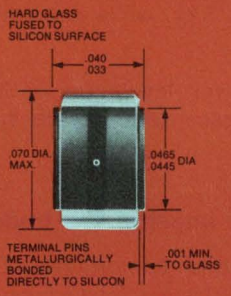

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UM7904A	400		
UM7906A	600		
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news

Active diodes crowding Gunns in noise, power and efficiency

A new generation of active diodes is emerging to challenge Gunn, or transferred-electron, devices (TEDs) in microwave design.

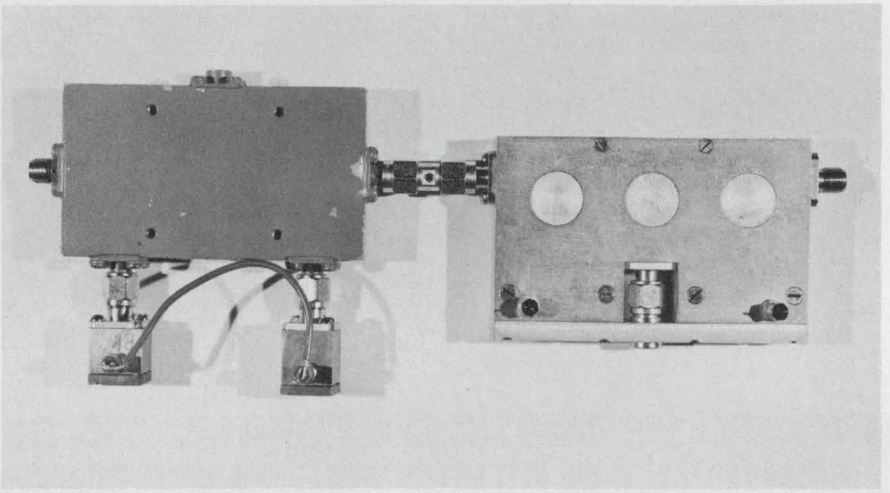
At present TEDs are leading the pack by a wide margin. They are available from a growing number of manufacturers and are finding increasing uses in low-noise, low-operating-voltage commercial applications. Production quantities of TEDs can be obtained with X-band output powers of 300 mW cw, efficiencies of 2-1/2 to 3% and bandwidths of 5 to 6 GHz.

Leading the challenge to TEDs are Impatts (impact avalanche and transit-time diodes). Commercial single-drift, silicon Impatts offer nearly double the power and efficiency of off-the-shelf TEDs at X-band. And laboratory development of double-drift silicon and gallium-arsenide Impatts promise to widen the power and efficiency advantages further.

Down the stretch are Trapatts—trapped-plasma, avalanche-triggered transit diodes, barely out of the laboratory—and Baritts—barrier-injected transit-time diodes still in the laboratory. Trapatts have very high peak powers and efficiencies, while Baritts exhibit very-low-noise operation.

The leading manufacturers of TEDs are Microwave Associates of Burlington, Mass., and Varian Associates of Palo Alto, Calif. Microwave Associates offers, for such uses as local oscillators and voltage-controlled oscillators, a series of diodes for the 4-to-26-GHz frequency range with power ratings of a few milliwatts. Ratings of several hundred milliwatts are available for medium-power applications. Varian's line has about the same power levels for both application areas and extends to about 40 GHz.

Edward A. Torrero
Associate Editor



Starting with transferred-electron preamps for low noise, and finishing with Impatt stages, this four-stage RCA design provides 300 mW at 8 GHz. Efficiency is 3%, while noise figure is a low 14 dB.

TEDs vs Impatts: the tradeoffs

The chief advantages of TEDs over Impatts are lower noise, wider bandwidth and the ability to tolerate open and short-circuit loads safely. But available Impatts, according to Lee MacKenzie, product line engineer at Microwave Associates, have X-band ratings of about 1 W cw (against 300 mW for TEDs) and about 6% efficiency (against 2-1/2 to 3% for TEDs). The spread is wider for laboratory devices. In K_u band, MacKenzie notes, Impatts using GaAs have been developed with output powers of 3 W cw and efficiencies exceeding 20%. For state-of-the-art TEDs, X-band figures are 1 W cw and 12 to 13% efficiencies, he says. The widening power lead accounts for the use of Impatts in high-power amplifiers and transmitters.

The AM and FM noise of both devices depends on bias conditions and circuitry. For most applications, however, silicon Impatts exhibit a fairly flat noise characteristic over frequency. The noise from TEDs rises as the operating frequency approaches the carrier frequency, and it is generally much less than that of Impatts.

The noise advantages of TEDs have established them in low-power applications, including as a source for local oscillators and as the first stage of low-noise amplifiers. Alone among active diodes, TEDs have a clear commercial beachhead in the applications of intrusion alarms and doppler radars.

Both TEDs and Impatts use negative resistance to generate microwave frequencies, as do all active two-terminal devices. But the negative-resistance bandwidth of TEDs exceeds that of Impatts by a wide margin. According to MacKenzie, commercial TEDs have a 3-dB bandwidth of 5 to 6 GHz at X band, while available Impatts have a corresponding bandwidth of about 3 GHz.

Material represents a funda-

mental difference between the two commercial device types. Most Impatts use the well-established techniques of silicon technology, while the manufacture of TEDs depends on the relatively young gallium-arsenide technology. One result: TEDs from different manufacturers normally have only power and frequency in common, and noise levels can vary markedly even from part to part. Reliability, however, is not in question. Measured mean-time-between-failure values for TEDs are reportedly comparable to those for transistors.

While attention on Impatts has centered on cw devices, pulsed units can be expected shortly from Hewlett-Packard. A leading manufacturer of Impatts, the Palo Alto, Calif. company offers devices rated at 1-1/2 W at 5 to 8 GHz, 1-1/4 W at 8 to 10 GHz and 1 W at 10 to 13.5 GHz—the highest powers at these frequencies for commercial Impatts.

According to David Struthers, product marketing engineer at HP, his company will introduce this year a pulsed Impatt capable of 10 to 20 W of peak power at 10 GHz. Intended for low-duty-cycle operation, its pulse length will be about 100 ns. Also expected is a model with longer pulse widths and relatively high duty cycles. Average power should reach 1-1/2 W at 10 GHz.

Struthers sees the future of commercial Impatts emerging from laboratory developments involving double-drift silicon and GaAs diodes.

The double-drift diode consists of two conventional single-drift diodes in series. One uses electron conduction and the other hole conduction. The increased output power results from the increased impedance levels—twice that of a single diode, since two are in series.

For higher efficiencies, and possibly lower noise from Impatts, a complementary Impatt is being investigated by several researchers, including some at the Hughes Electron Dynamics Div. in Torrance, Calif. The complementary diode—so-called because of a complementary reversal of p and n-type regions in the diode—makes use of holes in the drift region, according to Bob Ying, semiconductor section head at Hughes. Since the ionization coefficient of holes is much greater than that of the electrons, a much narrower avalanche region can be obtained for increased efficiencies, he says. Efficiency increases of 50% over standard single-drift diodes are projected.

But the most dramatic Impatt results to date have emerged from Raytheon in Waltham, Mass. Grant St. John, assistant operation manager of the company's Special Microwave Device Operation, reports the development of a GaAs Impatt that delivers 3 W cw at 15 GHz with an efficiency of 20%. At lower power levels, he says, an efficiency of 24% can be obtained.

Raytheon achieved the impressive results by obtaining a modified Read profile—the textbook model for the Impatt and the one for maximum performance values. The profile can also be obtained in silicon, a route being investigated at Hughes because of problems associated with gallium arsenide.

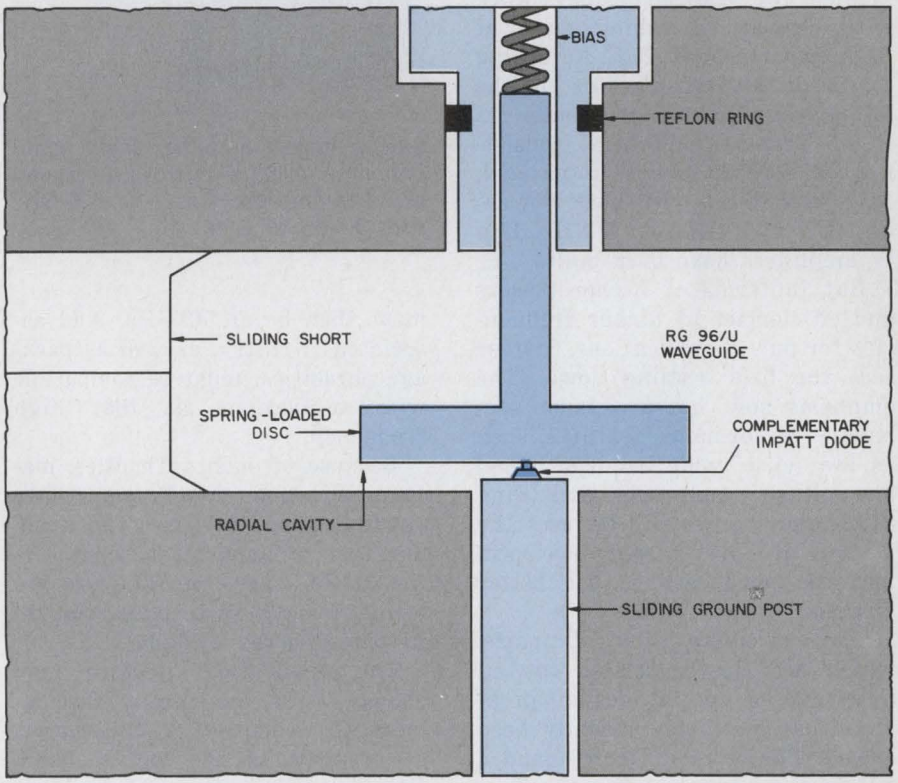
According to Ying at Hughes, reliability data for higher-power gallium-arsenide devices are incomplete. There are no data telling what will happen over long periods when the devices must operate continuously at 200 to 250 C—the temperature range that junctions are subjected to in power devices. However, the GaAs material does have a higher temperature capability than silicon, Ying adds.

For the highest peak powers and for high efficiencies from commercial diodes, the LSA (limited space-charge accumulation) diode can be obtained from Cayuga Associates of Ithaca, N.Y. The LSA diode is actually a special mode of operation of transferred-electron devices.

Cayuga offers LSA devices with peak powers in excess of 100 W and a duty factor of 0.1% (for an average power of 0.1 W) from S through X bands. At C band, an LSA device supplies 250 W of peak power, while at K_u band the peak power drops to 25 W. Efficiency reaches 8 to 10%.

The major problem with these devices is the critical dependence of circuit controls. Bill Camp, senior design engineer at Cayuga, says that load VSWRs must be a maximum of 1-1/4:1 and well-behaved at the fundamental and second harmonic.

Moreover, Camp says, frequency changes with bias and temperature



A complementary mm-wave Impatt oscillator from RCA achieves 700 mW at 30 GHz with an efficiency of 9.2%. The diodes operate cw from 20 to 40 GHz, and a 23% tuning is achieved in K-band.

at a rate of about 5 to 10 MHz/V and 3 to 5 MHz/°C. For constant frequency, the associated circuitry must have, at the least, an automatic frequency control loop to sense frequency changes and make the necessary bias-voltage changes.

Present applications for LSA devices, according to Camp, include beacons and short-range radars. A unique feature of these devices makes them very suitable in range measurers. Only LSA devices, of all high-power, solid-state devices, can turn on and off in a nanosecond, Camp says. Hence range resolutions in inches can be obtained.

Trapatts compete with LSAs

Still another method of obtaining pulsed power and high efficiency is to use a Trapatt. In small quantities, S-band Trapatts may be obtained from General Electric at Owensboro, Ky.

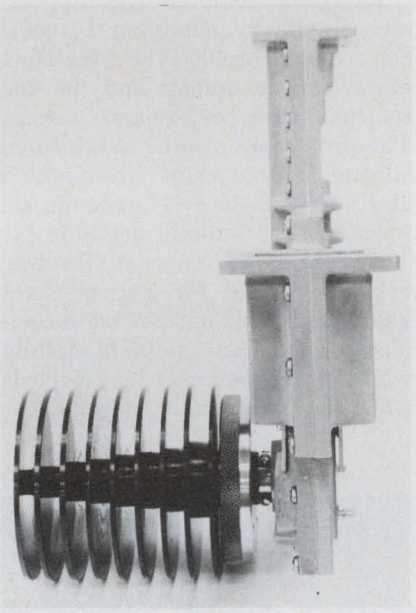
GE, the only supplier of these diodes, has a 2-to-4-GHz Trapatt that can deliver 20 to 40 W of peak power in a pulsed mode. Pulse duration is 1 μs, while pulse rate reaches 10 kHz. Typical pulsed voltage and current are 5 to 75 V and 2 A, and efficiency exceeds 20%.

Much of the laboratory work with Trapatt is taking place at RCA in Princeton, N.J. According to Fred Sterzer, director of the Microwave Technology Center at RCA, Trapatt amplifiers, consisting of several diodes in parallel, have been built with peak powers of 1 kW at 2 GHz. At 3 GHz, 150-W amplifiers have been built.

But in terms of higher powers and efficiencies at higher frequencies for pulsed applications, Sterzer sees the field settling down. The emphasis now, he says, is on secondary performance features, such as low noise, wide bandwidth and low-voltage supply operation. Ying of Hughes agrees. He believes the devices are pretty well developed, and the need now is for better circuits.

The circuitry for Trapatts, which are closely related to Impatts, poses special design problems that have only recently been solved. The chief difficulty—and a major disadvantage when the Trapatt circuitry is compared with that for the other diodes—is the need for both harmonic and subharmonic tuning. In Trapatt devices an avalanche shockfront must be initiated by a small-signal Impatt mode. As a result, circuits must have the proper impedance and line length at both the Impatt and Trapatt frequencies.

Kurt Gsteiger, engineering manager of semiconductor devices at Sperry in Gainesville, Fla., offers the following example: A 10-GHz Trapatt has to support the third or even the fifth subharmonic, since higher-order subharmonics generally yield higher powers. The fundamental, or Impatt, frequency when the fifth subharmonic is used must then be at 50 GHz. And associated circuitry, as well as package parasitics, must be compatible with oscillations at that high frequency.



Silicon Impatt amplifier finds application in AT&T's microwave repeaters. The amp provides 1 W at 6 GHz with 30 dB of gain.

Because of such difficulties, major applications for Trapatts have yet to develop. However, Jim Rush, manager of applications engineering at GE, says that Trapatts are being seriously investigated for use in phased-array systems.

The applications picture may change with the recent development at Sperry of a high-power, cw Trapatt in the low X band. Breaking the pattern of building Trapatt diodes for pulsed applications, Sperry has come up with a Trapatt diode capable of 3 W cw at 7.6 GHz, and with an efficiency of 16%—the highest cw power at the highest efficiency.

Noise measure for the Sperry device was 70 dB at 6.2 GHz—10 kHz away from the carrier in a 100-Hz bandwidth and with a circuit Q of about 50. The noise values are higher than for other diode types. However, Trapatts are generally conceded to be the highest-noise device.

The 3-W Trapatt uses a ring geometry, rather than the more familiar mesa geometry, and a diamond heat sink. Gsteiger says the Sperry breakthrough was obtained by achieving low-threshold power to excite the Trapatt mode and by overcoming the problems associated with efficient heat sinking. Previous attempts had failed, he notes, because of thermal-barrier difficulties at the diamond interface. The new Trapatt can safely dissipate up to about 20 W.

Baritts promise low noise

The noise limitations of active diodes—specifically TEDs—could be overcome practically by Baritts if their efficiency and frequency range could be increased. So thinks Bob Ryder, head of the Microwave Diode Dept. at Bell Telephone Laboratories. He cites typical state-of-the-art results: At 8 GHz, a laboratory Baritt has an output power of 150 mW but an efficiency of only 2 to 3%. And since just "shot" noise is present, noise figures of 10 to 15 dB have been obtained from the experimental samples.

Ryder feels that Baritts could compete with TEDs for use in low-noise receiving oscillators but that higher efficiencies would have to come first. Moreover the full frequency range of these devices would have to be found.

Ryder notes that TEDs operate to about 50 to 60 GHz and Impatts to nearly 100 GHz. But Baritts don't seem to have broken out of X band yet.

On the plus side, Baritts are the simplest diodes—simpler even than transistors, says Ryder. Hence they are potentially the lowest in cost. In addition they are made of silicon rather than GaAs, so the fabrication techniques are fully established. ■■

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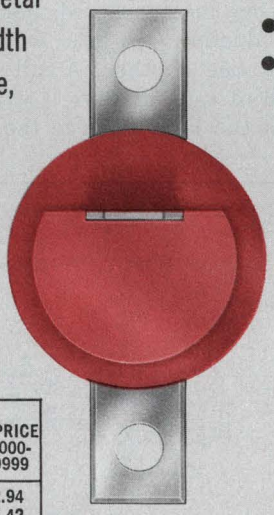

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INFORMATION RETRIEVAL NUMBER 17

Single laser rod yields 4 beams for high-speed holographic work

A laser that produces four separate beams from a single laser rod has been developed at Sandia Laboratories in Albuquerque, N. M. The device will be used to obtain holographic sequences of high-speed phenomena, such as an explosion that may last a few billionths of a second, or erosions of materials placed in hot streams of plasma.

Mercury lamps, which were used initially to make such holograms, were not satisfactory because they did not provide enough illumination. And the two conventional solutions to this problem also have flaws: Firing several lasers in sequence calls for a complex and relatively expensive system. And using optical delay lines to split a single beam into multiple beams produces weak beams.

Sandia's multiple-beam system, invented by the laboratory's Murphy J. Landry, solves these problems and also permits multiple holograms to be made on a single frame or plate. This, Sandia says, eliminates the mechanical movement or beam deflection typically required for multiple-exposure recording.

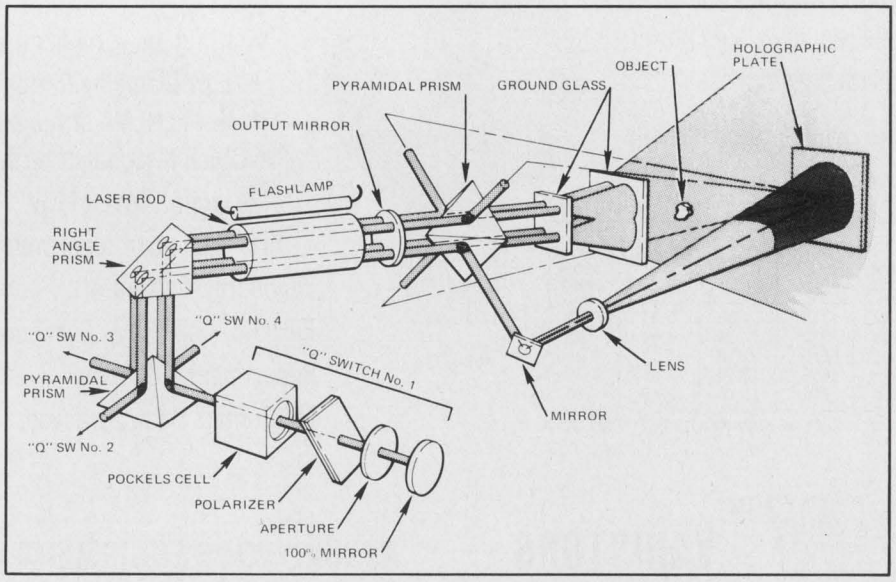
The prototype uses a combination of prisms, apertures, shutters and reflectors to produce four separate beams or pulses in rapid succession from a single ruby rod 1.9 cm in diameter.

The intensity of light from the lasing medium to the end reflector in each assembly is controlled by a Pockels cell, which is actuated by a trigger output from a central oscillator. The oscillator has four independently variable outputs, permitting complete flexibility in opening the Pockels cells and thus varying the separation between pulses.

The key to the device is a Q-switching arrangement that permits separate, parallel volumes of the lasing medium (rod, liquid or semiconductor) to lase independently of one another. A mirror at the end of each of four Q switches reflects the light back to the laser rod many times, until it has built up enough energy to escape through both an output mirror and a pyramidal prism to the holographic plate. (see diagram).

Besides the Q switch, another development that made the system possible is the general improvement in laser rods over the last few years. Rods now produce very little small-angle scattering, which helps to establish lasing cavities that are separated by as little as 0.4 mm of lasing medium.

Thus far the Sandia laser has produced four consecutive pulses, each lasting 25 billionths of a second. The time between pulses can be varied from 25 billionths to one-thousandth of a second. The ability to vary the interval between pulses—resulting from the fact that each cavity is independently controlled—is a major advantage of the multibeam system. It permits exposures to be made from a few picoseconds up to 10 ms apart. A patent on the system has been issued to the AEC. ■■



Light from the laser rod travels (left) to the right-angle prism, splits into four beams via a Q-switching arrangement and on to four mirrors. The mirrors reflect the light back many times to the rod, until the light builds up enough energy to escape through the output mirror (right) and on to the pyramidal prisms and the holographic plate.

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Electronics for cars said to pose bigger challenge than space work

Designing electronic systems for automobiles is tougher than designing for spacecraft, the keynote speaker told attendees to the recent Solid-State Circuits Conference in Philadelphia.

Presenting "A View of Automotive Electronics," Dr. Peter A. Schoeck, director of corporate R&D for Robert Bosch GHbH, Stuttgart, West Germany, cautioned companies that feel their work in sophisticated aerospace projects is sufficient background to enter automotive systems engineering. They fail to realize, he said, that the auto is more complicated than a spacecraft because it does not lend itself to the same degree of theoretical treatment.

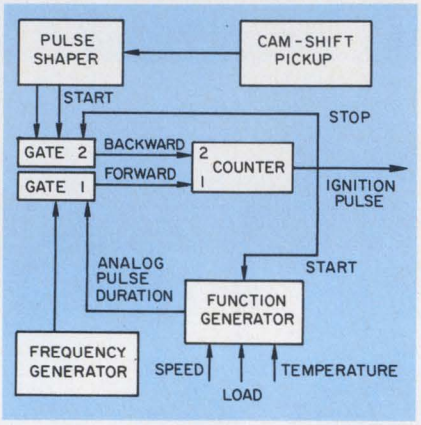
"For instance," Schoeck pointed out, "the parameters of a curved, slippery road are much more difficult to define than a planetary atmosphere. And the thermodynamics of an internal-combustion car engine are more complicated than those of a rocket engine.

"Also, the effects of salt spray, humidity, frequent temperature changes and mechanical stress from 60-G accelerations are possibly harder to predict than the effects of cosmic radiation."

The difficulties in meeting the tough specifications, the keynote speaker said, have slowed the entry of electronics companies into the automotive field. Components for cars must have exceptional reliability, he noted.

"Failure rates that might look extremely good for TV sets are by far not acceptable in cars," he stressed.

But electronics is performing a twofold role—improving the performance of existing devices and realizing entirely new concepts—in auto ignition systems, Schoeck reported. He predicted a new generation of contactless, breakerless systems to optimize power and fuel consumption.



Breakerless electronic ignition timing control system uses an analog function generator to gate digital counts from pickup.

Taking note of ignition parameters like engine speed and manifold pressure, the R&D director said: "The added requirements of emission control [to minimize pollution] will add criteria like catalytic reactor temperature and exhaust gas recirculation. Conventional ignition timers cannot cope with such a variety of parameters. This requires an electronic function generator."

A possible solution, he went on, is a system in which the parameters determining the spark angle are fed into a function generator (see block diagram).

"The duration of the count timed by the function generator determines ignition timing," Schoeck explained. "The generator produces an analog signal with a duration proportional to the spark angle."

The analog signal controls the number of counts that are fed from the frequency generator into the counter through gate 1. The counter also receives a second sequence of counts from a digital pickup on the camshaft. The total count is proportional to the angle through which the camshaft has turned.

The second count reverses the first count, and as soon as the net count reaches zero, the high-voltage generator is triggered and the spark occurs. The ignition pulse restarts the sequence.

"The system represents," Schoeck said, "a hybrid that has a digital sensor on the camshaft and an analog processor or function generator transforming the input parameters into a time period. It is possible to replace the analog process by a digital one. But this will not be practical until inexpensive read-only memories are available.

"The next logical step is to incorporate this processor into a central control unit."

CPUs expected in cars

Will Steffe, manager of design and development of analog products at Fairchild Semiconductor, Mountain View, Calif., and moderator of a panel session on automotive electronics, predicted that central processing units eventually would appear in autos for troubleshooting.

"With a CPU in vehicles," he said, "we can have true diagnostics on board. It can print out what's wrong—and possibly the labor rates and also costs required to fix the trouble. Ideally, the automobile electronics should be self-diagnosing to a throw-away level."

Controlling destructive transients

Solutions to a major problem in automotive electronics—the destruction of semiconductors by high transient voltages—were offered by William F. Davis, project

(continued on page 31)

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INFORMATION RETRIEVAL NUMBER 120

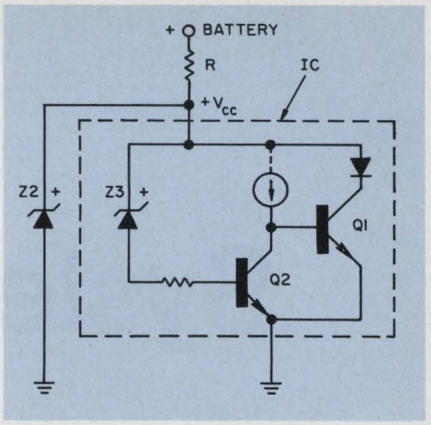
(continued from page 28)

engineer at Motorola Semiconductor Products, Phoenix, Ariz., in a Session XIV paper entitled "Monolithic Bipolar Design Considerations for the Automotive Environment."

Transient voltages caused by "load dump," or a sudden disconnecting of the battery when the alternator is charging, can range from 80 to 120 V, he noted. A zener diode connected between a resistor coming from the main battery supply and the IC chip has been employed to limit these voltage transients to less than the breakdown voltage between the collector and emitter of transistors with the base open (BV_{CEO}). But power dissipation, as well as the cost of the zener, are both high with this arrangement, Davis pointed out.

A new circuit that automatically shorts the base of a transistor to its emitter during transients—and thus increases the breakdown voltage close to the collector-to-base level, which is several times that of the BV_{CEO} value—was described.

It operates (Fig. 2) like this: Transistor Q2 conducts when the supply voltage rises higher than the breakdown voltage of zener Z3. The base of Q1 is thus grounded and is effectively at the emitter level.



High-voltage transient protection is provided by new circuit where zener Z3 and transistor Q2 increase collector-to-emitter breakdown voltage.

Zener Z2, which in the usual configuration draws considerable power, has a substantially higher voltage breakdown rating in the new circuit and thus clamps only the low-energy, higher-voltage transients. This is so when the collector-to-base breakdown is higher than that of the transients.

Less expensive external power transistors can be used with this technique, Davis said, because the maximum current densities and safe operating areas will not be exceeded during transients. ■■

Canada claims a digital-data 'first'

While Bell Telephone and specialized carriers like Datran and MCI are rushing to develop a nationwide digital communications network in the United States, the Trans-Canada Telephone System has announced "the first nationwide digital-data system in the world that operates on a commercial basis."

According to J. C. Carlile, president of Trans-Canada, the new system will dramatically reduce the cost of data communications, in some cases by as much as 90%.

Known as Dataroute, the new service begins this month and will cover all major communities in Canada by the end of the year, according to the utility. The network provides full-duplex, private-line, serial digital-data transmission in a broad range of synchronous and asynchronous speeds, 110 to 50,000 bits per second.

Although primarily a private-line service, Dataroute can accommodate dial access at the remote end of a two-point channel. This is done by terminating the line on an analog modem. The dial-access capability, however, is only one way—Originate. Users can dial the near end of the system and have access to a computer at the remote end, but the remote computer cannot dial out of the near end.

In addition to dial access, several other channel arrangements are available, including point-to-point private lines, multipoint private lines and multidrop private lines.

Another feature of the network is a central control and diagnostic operation that monitors the system automatically and diagnoses problems before they can impair service. ■■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A gas-discharge panel with a 128-by-128 dot matrix has been introduced by Thomson-CSF of France. The panel, called the Pavane, is a 13-mm-deep array of gas cells sandwiched between sheets of dielectric. The cells are separated by 1.27 mm. The brightness of the display is as high as 1000 cd/m^2. The power consumption is 1 mW per dot. The over-all size of the display is 215 by 215 mm. The data can be stored at the panel level, with no need for refreshing. The company is readying a panel of improved resolution that has but 0.635 mm between luminous dots. Also being investigated are a 512-by-512 cell display of higher brightness and contrast, multicolored displays and a manual writing and erasing feature.

CIRCLE NO. 441

Thin-film microwave circuit techniques are being used to fabricate a low-cost doppler radar intruder alarm by Mullard Research Laboratories of Surrey, England. All circuit elements are incorporated in a thin-film circuit on a single 1-cm^2 ferrite substrate. Radiated power is from 5 to 7 mW. With an antenna of 20-dB gain, this gives a range of 20 to 30 meters. The design, still in the experimental stage, may be put on the market eventually.

CIRCLE NO. 442

A V-antenna with lumped capacitive loading has been demonstrated to have very broadband characteristics as well as better directional properties than a straight dipole with the same loading. The advantages of the capacitively loaded V-antenna were shown under a multinational project sponsored by the Serbian National Research Foundation in Yugoslavia. Early experiments designed to eliminate the frequency-dependent properties of the V-antenna with resistive loading resulted in high losses. The capacitive loading is in the form of narrow, transverse gaps between the antenna arms. The gaps are set progressively closer together towards the antenna ends.

CIRCLE NO. 443

A method of fabricating two-phase, charge-coupled structures with electrode separations of 0.1 to 0.3 μm has been developed at the University of Southampton in England. Whereas most scientists have used the double-layer metallization to achieve the very small gaps necessary for charge transfer, the Southampton team has employed a single-layer metallization process. The silicon slice is mounted at an angle, so that wherever steps in the silicon oxide shield a portion of the silicon surface from the metallizing beam of aluminum atoms, discontinuities in the metallization are produced. This simplifies the pattern of the interconnection mask, and the electrical connection between adjacent electrodes is provided automatically.

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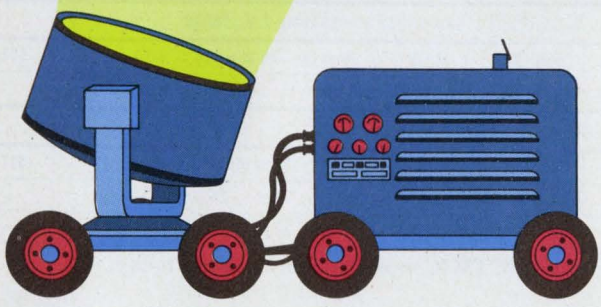

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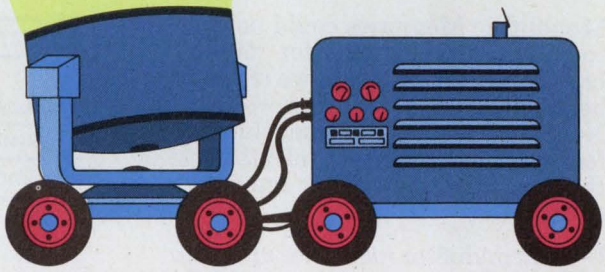

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INFORMATION RETRIEVAL NUMBER 21

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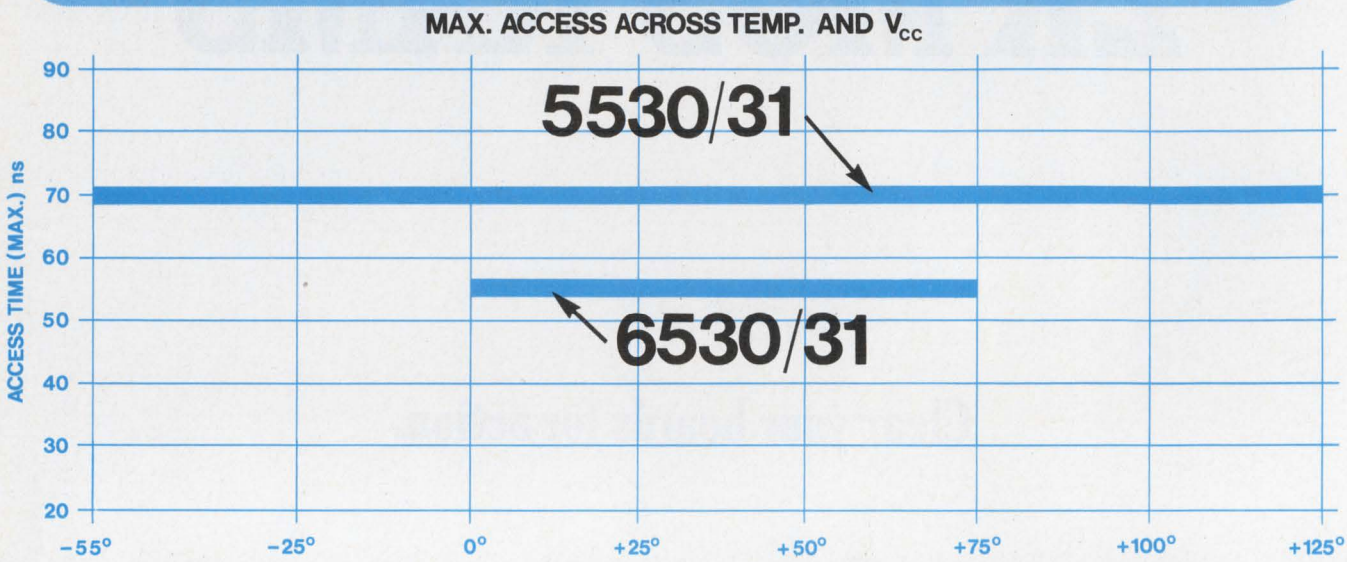

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washington report

Heather M. David
Washington Bureau

F-14 subs start up again

Electronics subcontractors on the Navy's F-14 Tom Cat fighter aircraft program have been notified that contracting beyond the first 134 planes will be renegotiated on an annual basis with price adjustments for inflation and other factors. Prime manufacturer Grumman Aerospace also told the subs to go back to work on F-14 avionics, following the company's compromise agreement with the Navy to finish building the 134 planes—an agreement that will result in a loss to Grumman of between $100-million to $140-million. Principle subcontractors include Litton Industries for the inertial navigation, Fairchild Industries for armament control, Honeywell for automatic flight control, and Hughes Aircraft, which has a direct contract with the Navy for the Phoenix missile system. The General Accounting Office, in a classified report, said technical problems have been uncovered in the central air data computer and airborne weapon control system, but it said the Navy and its contractors are satisfied that progress is being made in resolving them.

Senate considers antitrust data disclosure act

The Senate Judiciary's antitrust subcommittee will probe into the out-of-court agreement between IBM Corp. and Control Data Corp. which resulted in destruction of a computerized file of documents prepared by CDC for its private suit against IBM. The subcommittee will consider several bills which would require public disclosure of documents relevant to all antitrust settlements. It also is expected to look into the problem of private antitrust action settlements which may affect Government cases. The Justice Dept. continues to proceed slowly in preparing its case against IBM, reaping only a small comfort from a Federal Court decision that IBM violated a court order in persuading CDC to destroy the document.

The flak gets thicker for B-1 program

More Congressional trouble looms for several Air Force programs. Sen. William Proxmire (D-Wis.) promises continued investigations into the growing cost of the B-1 bomber, which he charges will pan out at $51.5-million each. The Air Force challenges this arithmetic, saying that the figure should be closer to $46.2-million, but it admits that the aircraft is now 10,000 pounds overweight, which will add to the cost. A group of 10 Congressmen has charged the Air Force with illegal lobbying for the B-1, saying that appropriated funds are being used to take Con-

gressmen on tours of the B-1 plant at Rockwell International.

Trouble in the F-15 Eagle air superiority fighter program cropped up when one test engine acted up. The result: The Defense Dept. allowed the Air Force to release only $40-million of a previously approved $421.6-million production contract for the plane. If the engine problem is ironed out—and the Air Force expects it will be by the end of April—the funds will be released making a total buy for fiscal 1973 of 30 planes.

A program too new to have congressional problems is the AX attack aircraft, which has finally been awarded to Fairchild Industries, despite the continued lobbying by Texas interests who favored buying instead the Dallas-based A-7 attack plane, built by Dallas-based LTV. The lobbying included giving Congressmen free rides in a special two-seat A-7 at Andrews AFB near Washington, D.C.

Air Force to move on airborne command posts

The Air Force will choose a contractor in May to move the communications equipment out of the EC-135 airborne command posts operated by the National Military Command System and the Strategic Air Command and install them in the new Boeing 747 B jet transport, which will take over the command-post role. Earlier plans to develop completely new electronic command-and-control equipment for the 747 have been scrapped. The Air Force recently awarded a $59-million contract to Boeing for two 747 aircraft and an option on a third.

Capital capsules: The Federal Railroad Administration is looking for companies qualified to design, fabricate and install **a computerized wheel and rail dynamic simulator** to test new developments in transportation systems. . . . The Defense Communications Agency will outline its future program plans for industry at **a conference sponsored by the National Security Industries Association,** April 25 and 26, at the National Bureau of Standards in Gaithersburg, Md. . . . NASA will let contracts soon on **technology studies for the design of a highly maneuverable aircraft.** The studies are expected to include new features, such as a fly-by-wire flight control system and computerized and integrated controls. . . . NASA and the Defense Dept. are reportedly wrangling over **the use of a classified high frequency,** which the space agency would like to use to transmit voice, data and TV instructions to the ATS-F satellite. NASA had been given clearance to use the frequency for space-to-space transmission, but the Air Force fears that ground-to-space transmission will interfere with data transmission to earth from its own satellites and high-altitude aircraft. . . . Japan's computer industry is reportedly ready **to end import quotas on integrated circuits and eventually computers,** if the Japanese Government will subsidize the industries to meet competition. The action would not be taken until 1976, however. . . . The discovery that **Saturn's rings are made of solid chunks of material** is causing NASA to revise its earlier idea that spacecraft could fly through them. Jet Propulsion Laboratory scientists made the finding after radar tests in December and January, and, incidently, they chalked up records for the longest interplanetary radar bounces ever attempted. . . . The Air Force has decided to **share worldwide weather information from its heretofore secret weather satellite** with civilian agenices. The Air Force's satellite flies lower and has sensors with higher resolution than those of the National Oceanic and Atmosphere Administration.

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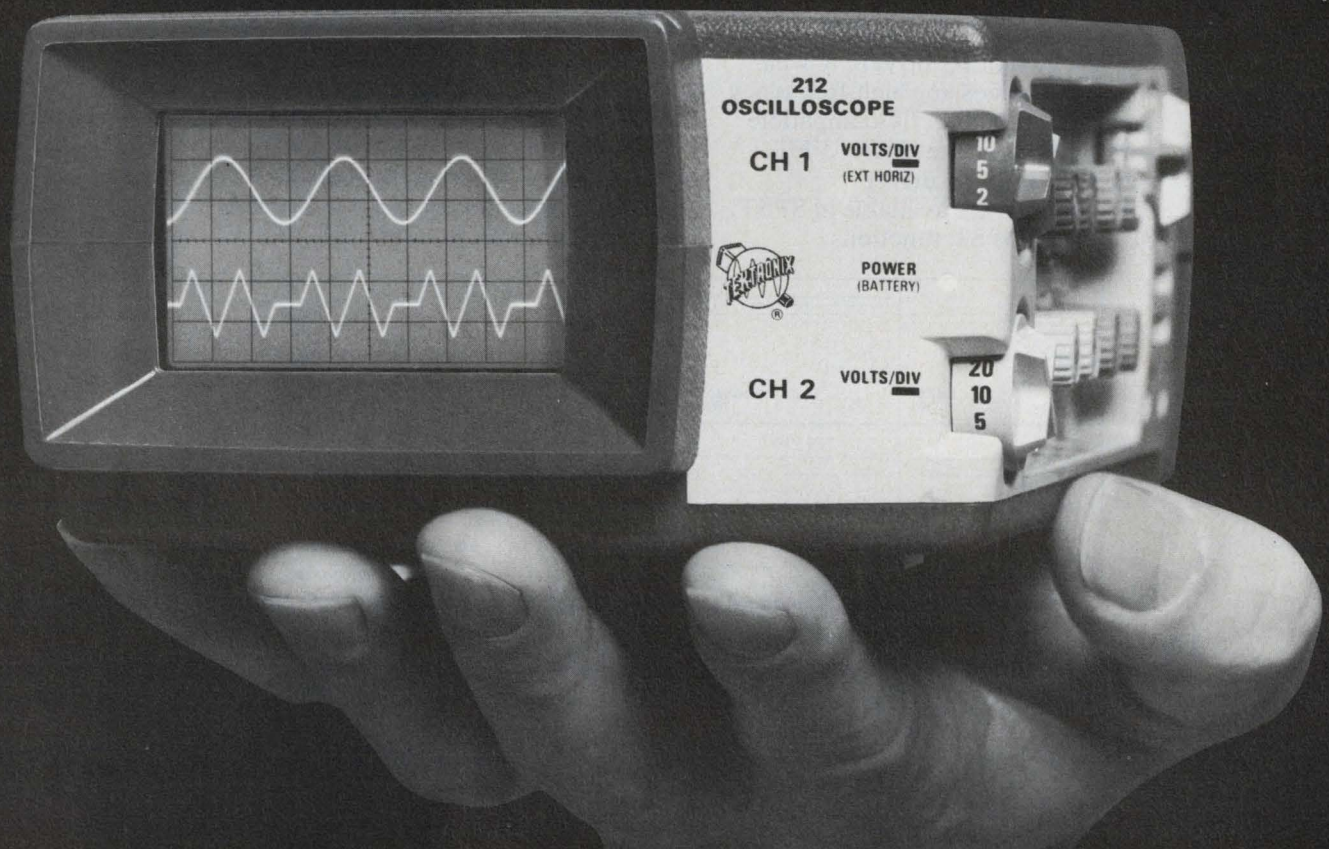

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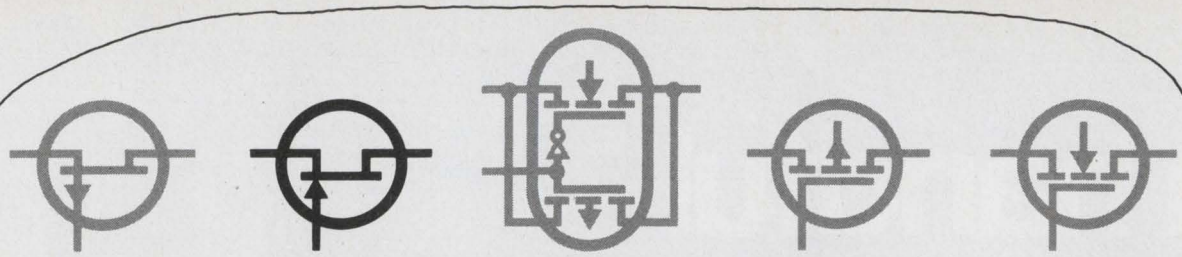

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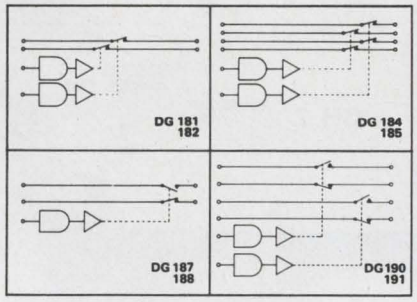
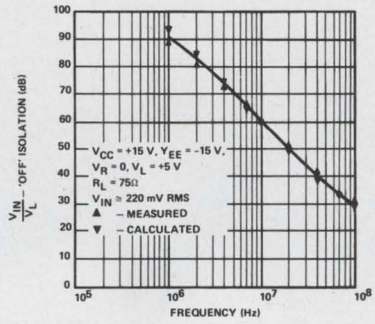
- Constant ON resistance with signals to ± 10 V and 100 MHz
- 60 dB OFF isolation at 10 MHz with 75 Ω load
- t_{on} and t_{off} = 150 ns typical
- 1 nA max (100 pA typical) leakage from signal channel in either ON or OFF state.



DG181-DG191 Functional Diagrams



Switch OFF Isolation vs Frequency — DG181

The key to this exceptional performance is the Siliconix concept of monolithic driver design, with careful attention to critical details such as low driver output impedance. DG181-DG191 driver (switch OFF) resistance to ground is only 200Ω, providing good a-c by-pass on the FET switch gate. Contrast this with other driver circuits with impedances as high as 26 MΩ, which adversely affect isolation characteristics.

The DG181-DG191 series of FET analog switches is an ideal solution to most switching problems. If your case is unique—and whose isn't—our applications people are eager to help. For complete information

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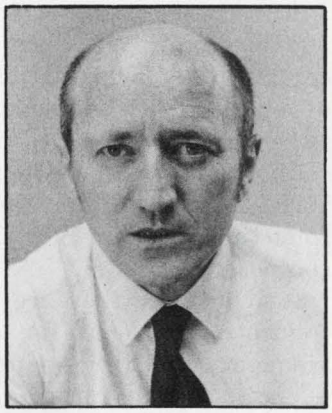
INFORMATION RETRIEVAL NUMBER 24

editorial

Don't show me your camera; Show me your picture



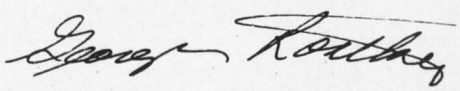
On a recent visit to the Metropolitan Museum of Art, I stood admiring—no, revering—some of Rembrandt's paintings. What that man could do with color and with light and shade has always made a powerful impression on me—and on millions of others. So it's no surprise that museums all over the world treasure their Rembrandt collections and go to great lengths to preserve his paintings. But nobody saves his brushes. And as far as I know, people aren't storming museums asking to see Rembrandt's brushes—or Steichen's cameras.

But in the electronics industry companies often make more noise about their tools than about their engineers. I see many business-solicitation proposals in which companies list all their capital equipment with the minutest detail of make, model and salient features. They list every computer, scope, DVM and counter in the shop. But they forget to say, "Hey, we've got a bunch of awfully bright engineers who know how to use these things."

It's certainly true that you can't do a job if you don't have the right tools. It's not easy to get 0.01% measurements with a 3-digit DVM, and it's tricky to measure 200-MHz waveforms with a 50-MHz scope. But I think that point gets lost when a company's proposal lists every soldering iron.

Where are the engineers? The guys who write proposals often forget them. In itself that's not important because proposals are not the most widely read literary efforts. But they reflect the attitudes of corporate officers who think an equipment list should be more impressive to a customer than a list of engineers and their accomplishments. In thus exposing their attitudes, they expose their failing.

When all other factors are equal, the companies that generate handsome profits and grow are those that respect and depend on their people. Tool worship is no substitute.



GEORGE ROSTKY
Editor-in-Chief

Boost counting speed to 110 MHz with ECL universal counters. These programmable devices are ideal for phase-locked loops and frequency synthesis.

For fast counting of frequencies, the new ECL 10,000 circuits are hard to beat. The range of commercially available circuits includes a series of building blocks for designers of digital systems. The new ICs are universal, programmable counters that can be hooked up to count at 110 MHz. This means that the ECL circuits are about four times faster than TTL counters of similar complexity.

And because they are programmable, the new counters are ideal for phase-locked loops and frequency synthesis—applications in which frequencies usually must be divided or multiplied.

Two types of programmable ECL counters are currently available: a binary unit, in which the divisor (or divide modulus) can be varied from one to 16, and a decade counting unit, whose divisor can be varied from one to 10. In both versions the input, or programmed, number can be either four-wire BCD or hexadecimal. The number preset or loaded into either counter is the initial state from which countdown (decrement) begins. The specific type of counter used depends, of course, on the required range in the divide modulus (M).

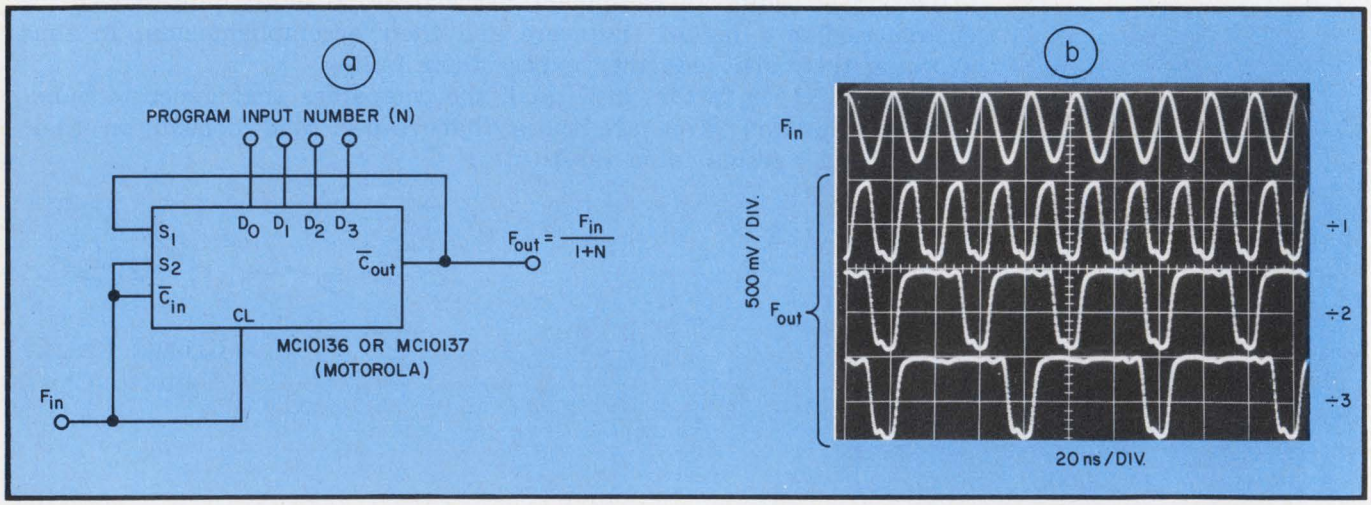
Both versions can be used at input frequencies to over 50 MHz without external gating (Fig. 1). The carry-out ($\overline{C}_o$) signal controls the counter's mode of operation when it is fed back to the S_1 terminal. Count proceeds down from the number, N, preset into the device. On reaching a count of zero, $\overline{C}_o$ goes LOW and permits the next clock (input frequency) pulse to reload N into the counter. In this case the divide modulus, M, is equal to N + 1. The input signal is made common with the carry-in ($\overline{C}_{in}$) and S_2 control lines to prevent a latch-up state when the counter is reloaded.

If a larger divide modulus is required, two or more devices may be cascaded (Fig. 2) but with a sacrifice in maximum operating frequency. Two cascaded binary or decade counters extend the divide modulus to 256 or 100, respectively. But maximum frequency drops to about 35 MHz.

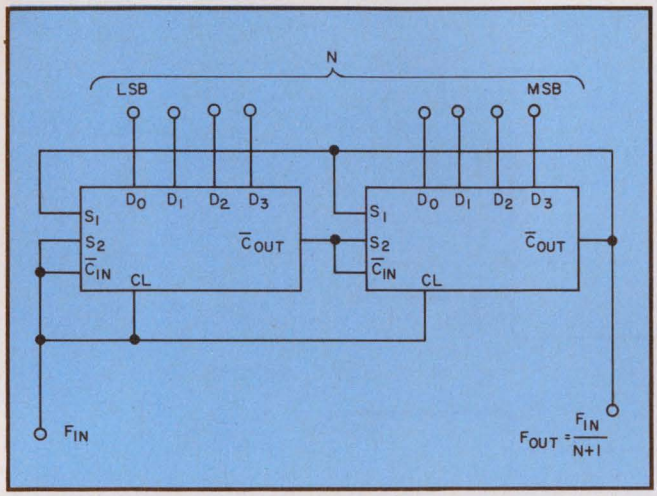
Tom Balph and **Howard Gnauden,** Application Engineers, Motorola Semiconductor Products, Phoenix, Ariz. 85008.

External decoding speeds the count

Other techniques, such as external decoding and "pulse gobbling" produce programmable-counter systems of higher frequency, but at the



1. **Universal, programmable counters on a chip (a)** can be hooked up to countdown (or divide) an input frequency, starting from program input number, N. Scope trace (b) shows input and output frequencies for division by (N + 1) equal to 1, 2 and 3, respectively. Input frequency can range as high as 50 MHz.

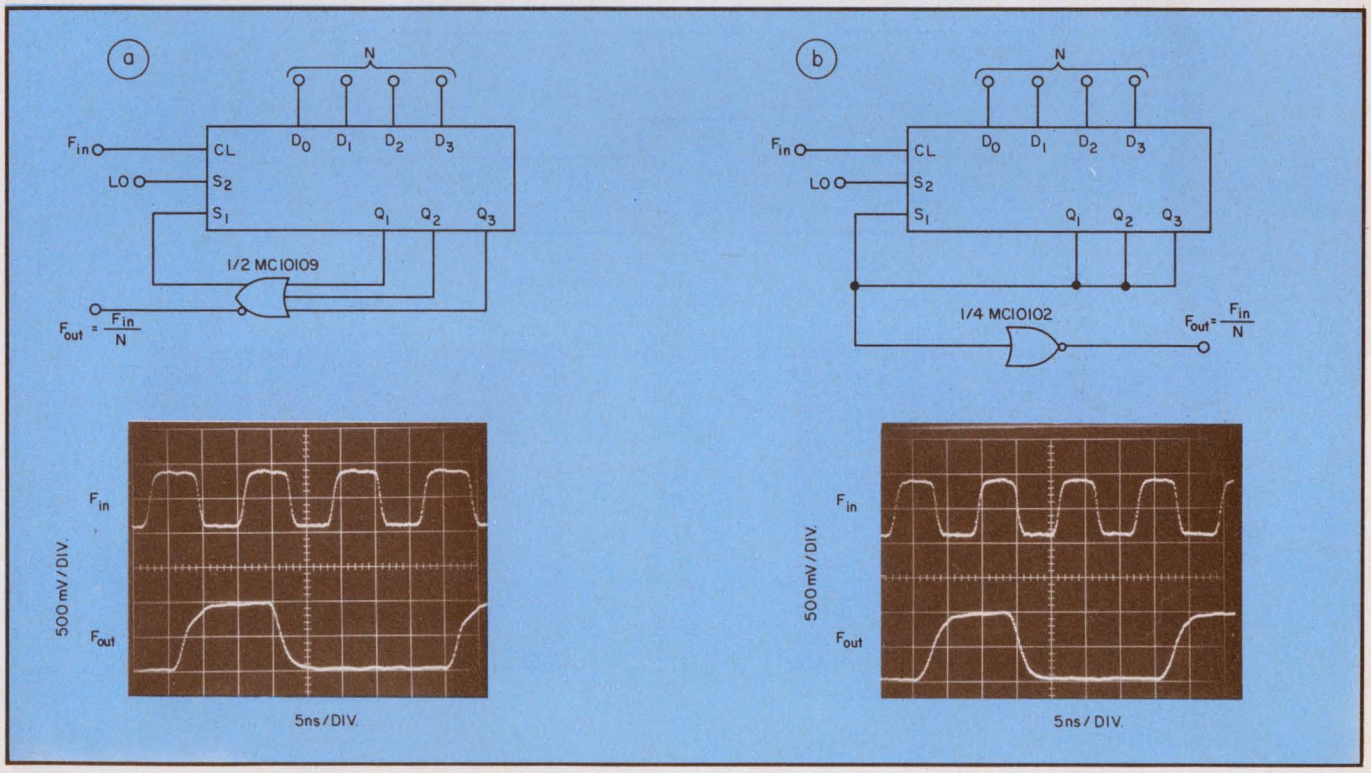


2. **Two counters can be cascaded** to divide by larger numbers (up to 256) than possible with a single counter. But maximum input frequency drops to 35 MHz.

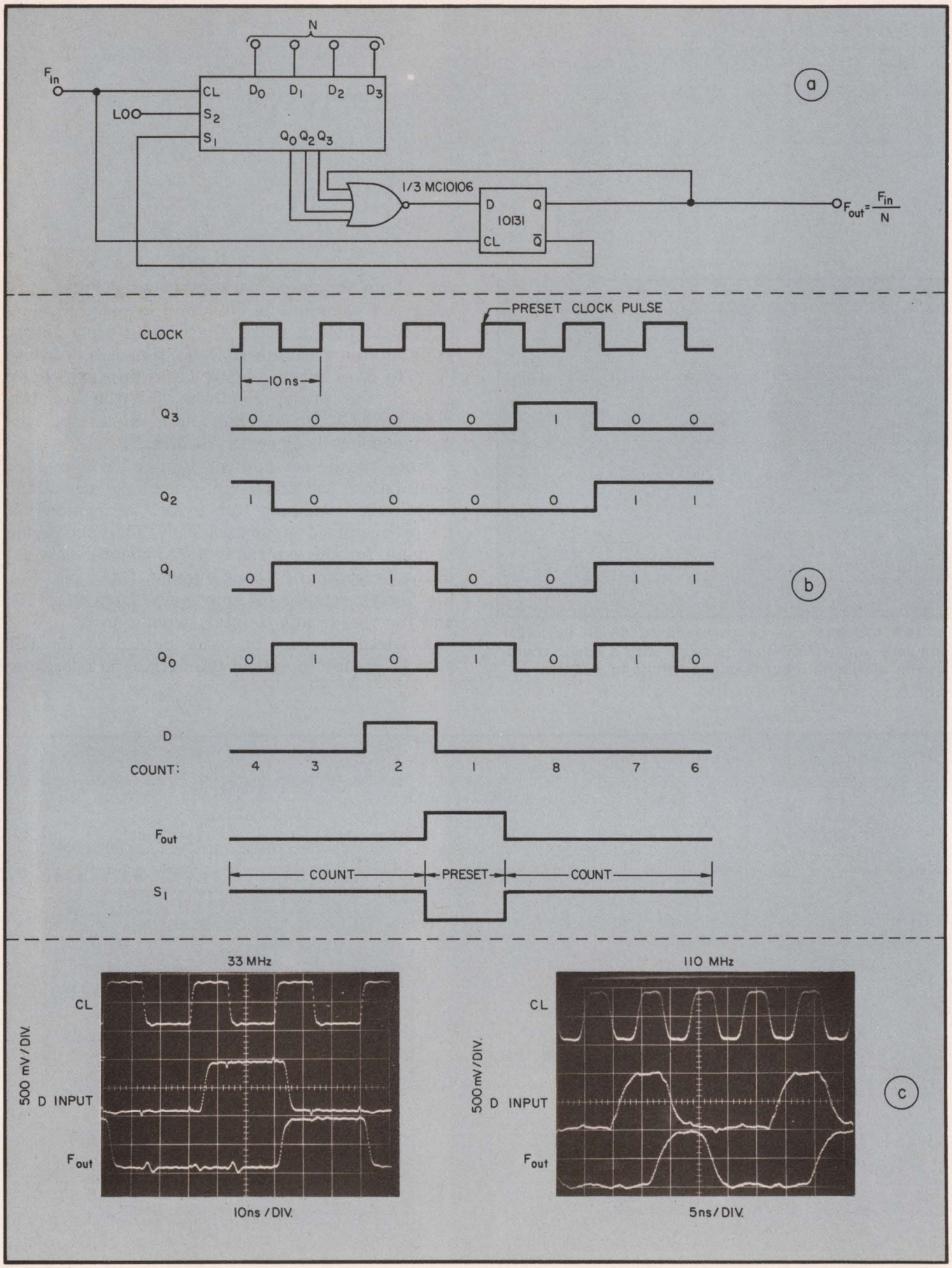
cost of an increased package count. (Pulse gobbling is a technique in which an external flip-flop is used to hold a pulse, the flip-flop thus acting as an auxiliary counter.) Delay time can decrease by 2 to 3 ns when a gate (Fig. 3a) externally decodes the preset condition for the counter. With an ECL 10,000 gate, the maximum operating frequency is typically 75 MHz.

Since the preset number is decoded one clock pulse before the zero-count state is reached, the clock pulse necessary for preset is included in the programmed input number N. Thus the divide modulus for the externally gated counter is equal to the programmed input number ($M = N$). For the binary counter, M may vary from 2 to 15; and for the decade counter, from 2 to 9.

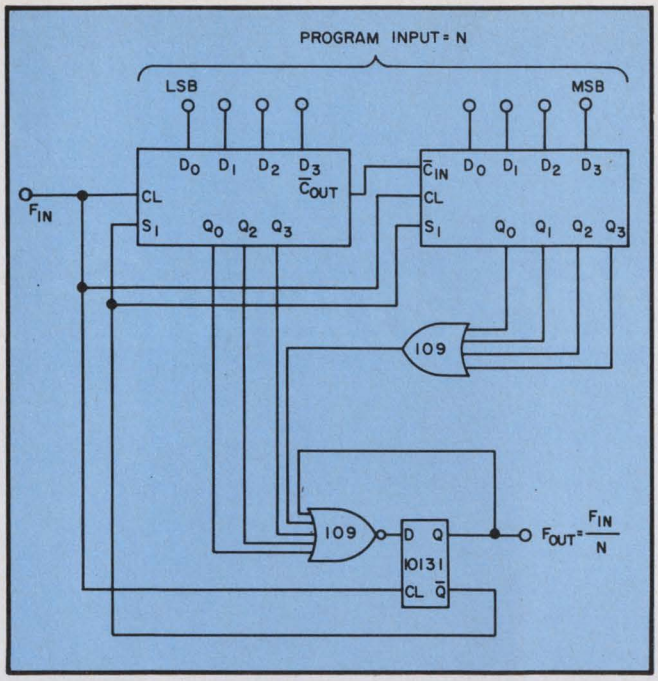
A wired-OR may be used instead of the OR gate (Fig. 3b) to extend the maximum operating



3. **Decoding with an external gate (a) reduces delay** time and, hence, boosts counting frequency. Inputs up to 75 MHz are possible. Waveforms are for N = 3. A wired-OR configuration (b) extends counting frequency even further to 85 MHz. But a gate is still needed for buffering. Waveforms are for N = 3.



4. **Fastest counting frequency** (about 110 MHz) is obtained with an external flip-flop (a). Counting sequence (b) shows that higher frequencies result from separating clock periods within which decode delay and counter preset times occur. Waveforms (c) are for N = 3, and for inputs of 33 and 110 MHz.



5. **Two-stage counter using pulse gobbling** extends divide modulus to 255. Maximum frequency is 80 MHz.

frequency to 85 MHz. A gate is still needed, however, to buffer the output signal (F_{out}). The input and output waveforms (Figs. 3a and 3b) for the gated and wired-OR circuits are for a modulus of three.

Pulse gobbling is even faster

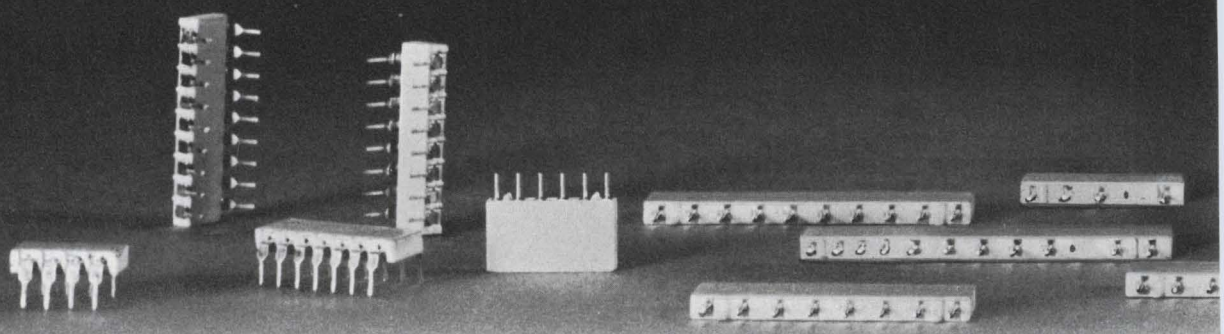
A flip-flop added to the external decoder (Fig. 4a), provides an even shorter preset delay time. This pulse-gobbling technique can boost the maximum counting frequency to above 110 MHz (Fig. 4c). A pulse diagram shows the following sequence of signals for division by eight (Fig. 4b):

The S_1 line is HIGH during the countdown phase. When a count of two is reached, the D input line to the flip-flop is forced HIGH. On the next clock pulse a HIGH state is clocked into the flip-flop, causing both the S_1 line and the D input line to go LOW. The succeeding clock pulse presets the counter, and loads a LOW back into the flip-flop, causing the S_1 line to return to a HIGH state. Thus the counter is again ready to proceed in the decrement count mode.

With pulse gobbling, higher operating frequencies are obtained because the decode delay and setup time (for presetting the counter) occur within separate clock periods rather than the same. As in the preceding example, the divide modulus, M, equals the program input, N.

For larger moduli, two counters can be cascaded with the pulse-gobbling technique (Fig. 5). The divide modulus may be extended to 255 by use of two binary counters. However, the maximum frequency will be limited to about 80 MHz. ■■

CTS *has the answer in*



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Lift afc discriminator performance

by up to 10 dB. Hybrid signal processing offers advantages over conventional resonant and pulse-counter circuits.

In designing automatic-frequency-control systems, the engineer may feel that he has attained as much performance as is theoretically possible when a conventional discriminator, such as the Foster-Seeley, is used. But by using a hybrid digital discriminator, he can squeeze out a further 10-dB improvement in tolerating a lower signal-to-noise ratio.

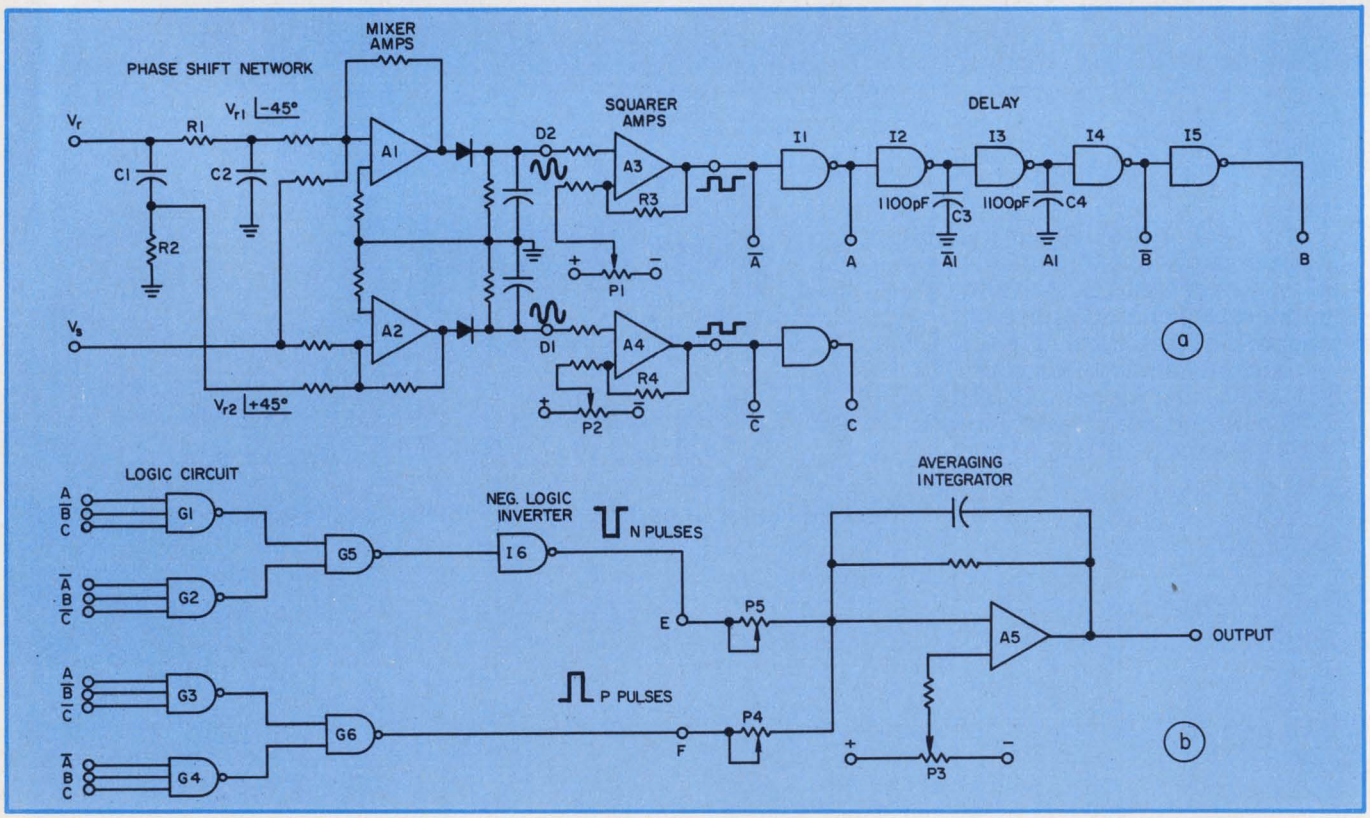
This digital approach has been used by the European Space Research Organization (ESRO), and it is also applicable in the afc design of receivers ranging from civilian TV sets and FM tuners to highly demanding communications systems.

In the ESRO design, improvement was needed in the telemetry receivers. Signals from Highly Eccentric Orbit Satellite (HEOS) were often as weak as −130 dBm, and very tight automatic frequency control was required to avoid tracking the wrong adjacent channel or locking onto a side band only 384 Hz away. The receiver's second i-f channel, nominally at 10 MHz, required that the discriminators be able to detect shifts as low as 300 Hz. Conventional discriminators proved ineffective for these requirements.

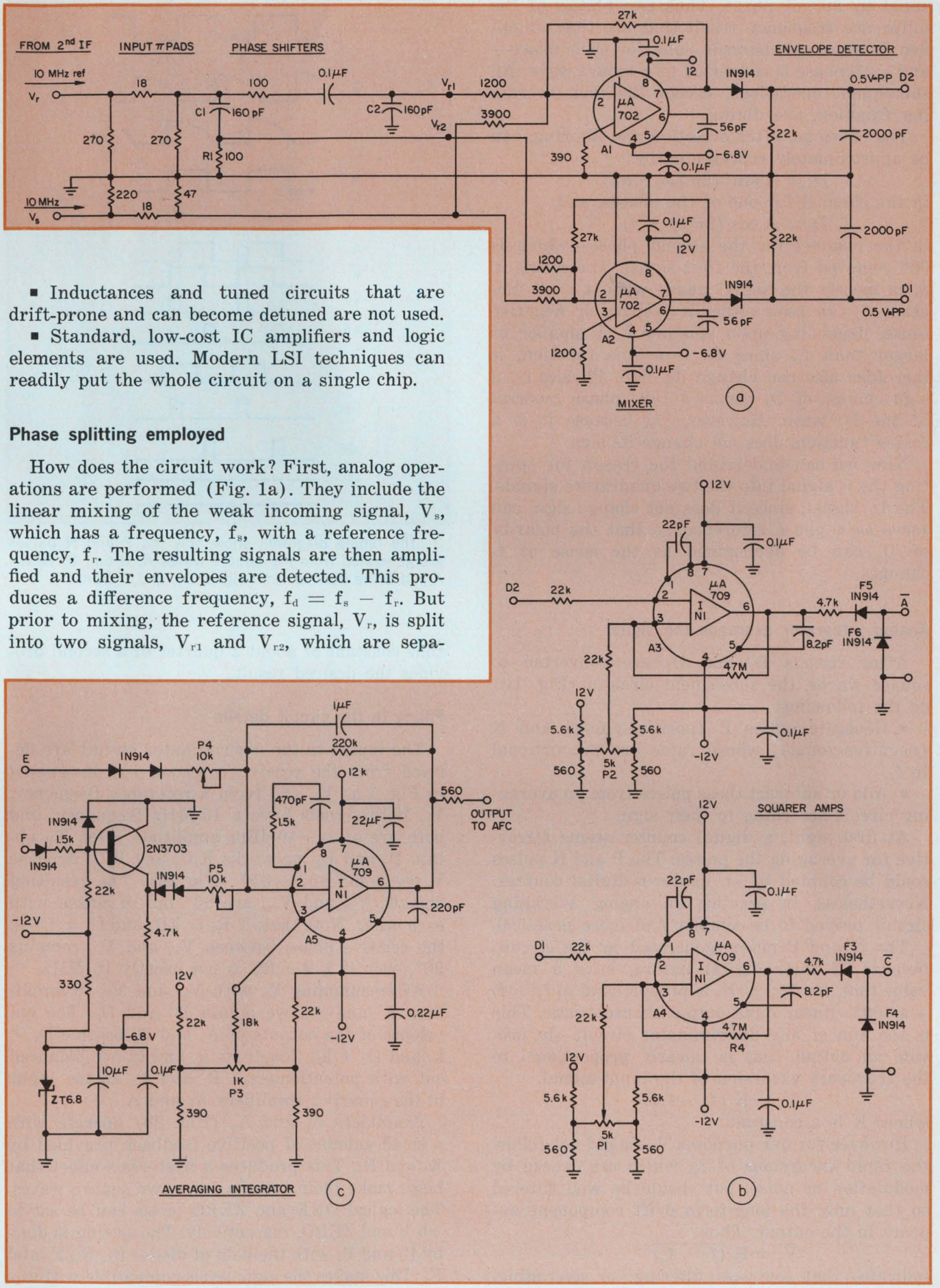
The digital discriminator that was used produced a 10-dB noise threshold improvement, not because it represented any advance in discriminator theory, but because the new digital method offers ways around analog component limitations. The advantages of the hybrid digital discriminator include the following:

- Required analog functions are limited to noncritical operations.

G. Pranzo Zaccaria, Dr. Eng., Via Ugo Bignami 61/6, 00136 Rome, Italy.



1. **This hybrid discriminator** combines analog and digital circuits to allow good performance with 10 dB less signal-to-noise ratio than conventional circuits. No inductances or tuned circuits are used.



- Inductances and tuned circuits that are drift-prone and can become detuned are not used.
- Standard, low-cost IC amplifiers and logic elements are used. Modern LSI techniques can readily put the whole circuit on a single chip.

Phase splitting employed

How does the circuit work? First, analog operations are performed (Fig. 1a). They include the linear mixing of the weak incoming signal, V_s, which has a frequency, f_s, with a reference frequency, f_r. The resulting signals are then amplified and their envelopes are detected. This produces a difference frequency, $f_d = f_s - f_r$. But prior to mixing, the reference signal, V_r, is split into two signals, V_{r1} and V_{r2}, which are sepa-

2. **Mixing, wave-shape squaring and averaging functions** are done with the popular μA 702 and μA 709 op amps.

rated by 90° of phase. Thus two phases of the difference frequency result that are then amplified in separate channels—one for each phase—and each phase is converted to a square wave. All subsequent operations, except the final averaging function, are digital.

The envelope, after detection and filtering, can be approximately represented by

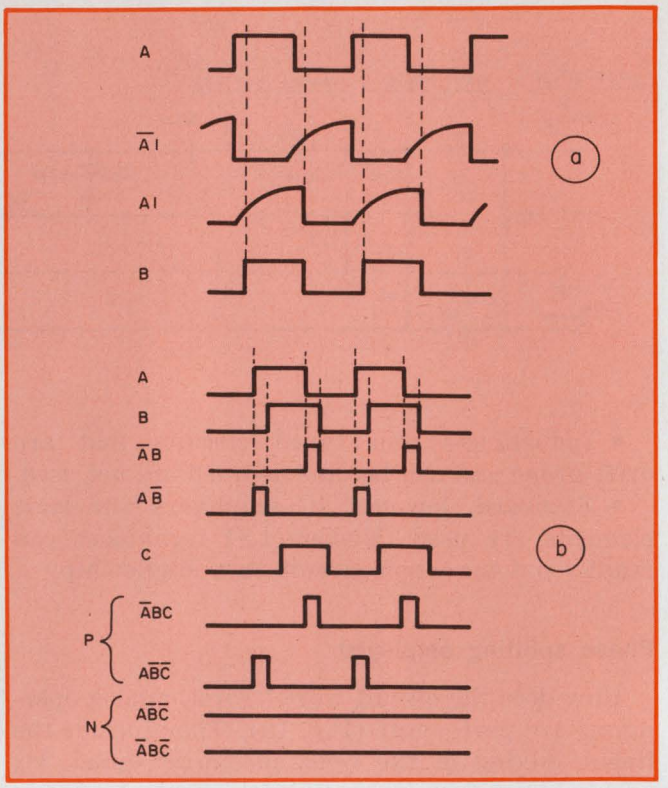
$$D_1 = A \sin (2\pi f_d t + \theta)$$

in the channel for one of the phases, and

$$D_2 = A \cos (2\pi f_d t + \theta)$$

in the channel for the second phase—which is 90° removed from the first signal. The constant, θ, is merely the signal phase when $t = 0$. Because f_d can have either a positive or negative sense, depending upon whether f_s is smaller or larger than f_r, since D_1 is a sine function, it therefore also can change its sign. Physically, a sign change of D_1 means a 180° phase reversal of the D_1 wave. However, D_2, because it is a cosine function, does not change its sign.

Now we can understand the reason for splitting the f_d signal into the two quadrature signals. The D_2 signal, since it does not change sign, can serve as a phase reference, so that the polarity of D_1 can be determined as the sense of f_d changes.



3. **The timing diagrams** show how the P and N pulses are generated from the square waves A, B and C. Waves A and B are derived from signal D_2, and C from D_1.

Analog integrator averages the signal

After signals D_1 and D_2 are converted to square waves, the subsequent circuits (Fig. 1b) do the following:

- Generate pulses P (positive-going) and N (negative-going), whose rates are proportional to f_d.
- Add or subtract these pulses from an averaging circuit according to their sign.

At first sight, a digital counter seems attractive for averaging the pulses. The P and N pulses could be counted by an up-down digital counter. Nevertheless, in practice an analog averaging circuit proved to be simpler and more practical.

The N and P pulses generated by the circuit, because of their digital nature, have a mean value that, for $S >> N$, is proportional to $f_s - f_r$—a 100% linear input-output characteristic. This is the aim of any discriminator circuit—to provide an output that is linearly proportional to the frequency excursion of the input signal.

$$V_o = K (f_s - f_r),$$

where K is a constant.

However for our purposes V_o should not follow the rapid excursions of f_s, which are caused by modulation or noise, but should be well filtered so that only the long-term drift component appears in the output. Thus

$$\overline{V_o} = K \overline{(f_s - f_r)}$$

indicates that low-pass filtering, or averaging, is required. Experience shows that an averaging time constant of about a quarter of a second provides the desired result.

Filling in the circuit details

The inputs to the discriminator circuit are derived from the receiver's second i-f, designated in Fig. 1 as V_s, and from a reference frequency, V_r. Both signals have a 10-MHz frequency, and both are at a −10-dBm amplitude level. To obtain D_1 and D_2, networks R_1C_1 and R_2C_2 dephase V_r by +45° and −45° (Fig 2a). The resulting signals, V_{r1} and V_{r2}, are 90° out of phase with each other. Note that, if $R_1 = kR_2$ and $C_1 = C_2/k$, the relative phase between V_{r1} and V_{r2} remains 90°, even if $1/2\ \pi$ RC is not exactly 10 MHz.

After summing V_s with V_{r1} and V_{r2} in amplifiers A_1 and A_2, we obtain D_1 and D_2. The envelopes of the outputs of A_1 and A_2 become $D_1 + k_1$ and $D_2 + k_2$. Constants k_1 and k_2 are balanced out with potentiometers P_1 and P_2 at the input to the squaring amplifiers A_3 and A_4.

Amplifiers A_3 and A_4 (Fig. 2b) operate with a small amount of positive feedback provided by R_3 and R_4. This produces a hysteresis effect that helps make their outputs form two square waves. The logical ONE and ZERO levels can be set to +5 V and ZERO, respectively. The setting is done by P_1 and P_2 with the help of diodes F_3, F_4, F_5 and F_6. This makes the logic levels compatible with the standard 7400-Series logic. The square-wave sig-

nals, designated as A and C in Fig. 1, are then combined in NOR gates G_1 through G_4.

A delayed square wave, signal B, is then derived from signal A. Capacitors C_3 and C_4 load the output of inverters I_2 and I_3 to produce this delay. The timing diagrams in Fig. 3a show how the delay is created.

With signals A, B, C and their complements, $\overline{A}$, $\overline{B}$, $\overline{C}$, the P and N pulses are now generated as shown on Karnaugh maps:

C \ AB	11	10	00	01
1				1
0		1		

$$P = \overline{A}\,B\,C + A\,\overline{B}\,\overline{C}$$

C \ AB	11	10	00	01
1		1		
0				1

$$N = \overline{A}\,B\,\overline{C} + A\,\overline{B}\,C$$

The logic circuit in Fig. 1b can use 7400-Series TTL/NAND logic to implement these equations.

The timing diagram of Fig. 3b illustrates how the variables A, B and C generate the P and N pulses. Inverter I_6 changes the sense of (inverts) the pulses from G_5 to produce a subtractive input for the averaging integrator circuit.

The method of generation of the P and N pulses and their subsequent treatment are the keys to understanding the operation of the discriminator, and they are also the new features claimed for the discriminator's design. Signals A, $\overline{A}$, B and $\overline{B}$ are derived from D_2 (Fig. 1a) and signals C and $\overline{C}$ are derived from D_1. Therefore from Fig. 3b, it can be seen that in the absence of noise two P or N pulses are generated whenever $D_2 = 0$ (at the zero crossover points of D_2). When $dD_2(t)/dt > 0$ (positive going crossover), then the generated pulses are treated as having the same phase (sign) as D_1 (or C, as in Fig. 3b). When $dD_2(t)/dt < 0$, then the pulses have the opposite phase to D_1—they are considered in phase with $\overline{C}$.

Although the A and C signals are shown 90° apart in phase in Fig. 3b, it is obvious that this phase relationship can vary considerably without affecting the circuit's performance. In fact D_1 and D_2 approach this 90° condition when $|V_{r1}| = |V_{r2}| >> V_s$. This feature is a key factor in the circuit's ability to resist the effects of modulation and noise.

The P and N pulses are summed and averaged by means of integrator-amplifier A_5 (Fig. 2c), which has a time constant of 0.22 seconds. The P and N pulses that result from modulation and noise cancel each other and contribute little to the output after averaging. ■■

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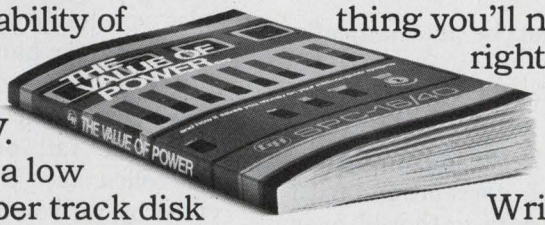


General Automation

INFORMATION RETRIEVAL NUMBER 28

Give it a whack! Calibrated tap-tester, an adaptation of a familiar technique, spots defective parts. Simple and inexpensive, it finds those elusive intermittents.

You are testing a newly designed circuit and suddenly it doesn't work right. What's the first thing you do?

Most likely you will give it a whack. Miraculously, the equipment often starts working again the way it should. Frequently several whacks in various places will help you isolate the problem.

Can this approach be adapted to spot faulty components? It can, and it works. Radiography, thermal shock, thermal cycling, centrifuging or conventional vibration analysis are just a few of the widely used techniques that can spot faulty components, but controlled tap testing is cheaper, faster and often more dependable.

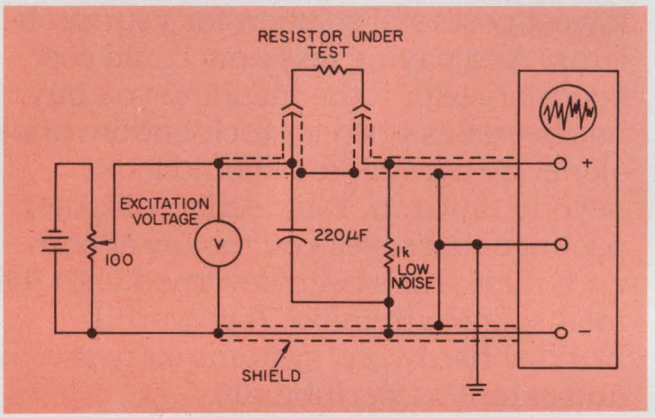
Although resistors are used as the main example to describe the tap-test method, other components and assemblies can also be tested successfully. Only small modifications to the setup, coupled with appropriate acceptance and rejection criteria, are needed.

Resistors are connected into the test circuit (Fig. 1) and lightly tapped in four different positions. An oscilloscope monitors the transient noise spikes. Voltage deflection above a certain critical level corresponds to a high probability that the unit is defective.

The idea is, of course, basically primitive. However, some sophistication in its execution is needed to yield consistent, reliable results. Here are some important points:

- Quiescent pickup noise must be as low and constant as possible.
- All leads must be shielded and made short. All connections must be firm.
- The unit under test must be mechanically damped.
- Shocking in several different directions is recommended.

The rejection/acceptance criteria must be carefully defined from statistical correlation with other methods. For resistors, data gathered over a large number of tests have shown a close correlation between certain voltage deflection levels and faulty components. Deflections of less than 25 μV indicate a good resistor—above 50 μV the probability of a bad resistor increases directly as the deflection level increases.



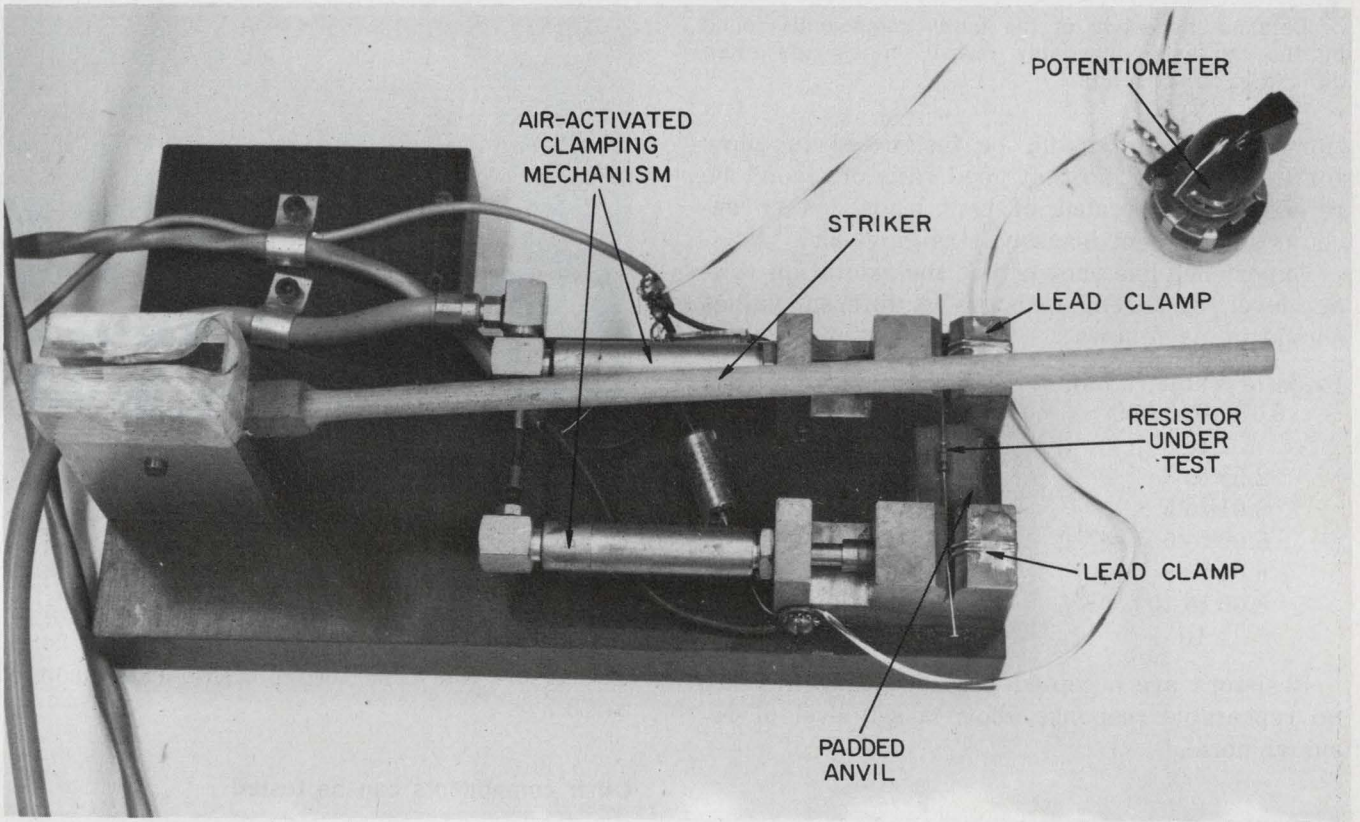
1. **A very simple circuit** fulfills all the needs for systematic tap-testing. Low-noise parts must be used.

Supplying the calibrated tap

The test fixture (Fig. 2) includes a padded anvil in direct contact with the component's body. The pad is of 1/4-inch-thick, 50-durometer rubber, and it is bonded to the massive metal base of the test fixture. The clamps for the component leads are air-actuated. This eliminates possible electrical interference that could occur if electrical solenoids were used. Also, air clamps can supply more force than solenoids of the same size for gripping the leads and ensuring that contact noise does not produce false results. A wooden striker—a 10-inch, 1/4-inch-diameter hardwood dowel—is loosely pivoted at one end. The dowel is manually lifted against a pre-positioned stop and then released. A two-inch free fall onto the component provides a controlled tap that is equivalent to that provided by a two-ounce weight dropped two inches.

For testing resistors (Fig. 3), the fixture's excitation voltage is adjusted to 10 V nominal. No resistor is connected to the fixture at this point. Fresh batteries are the best voltage source to keep noise low. The scope sweep is centered, and the residual noise is noted for several

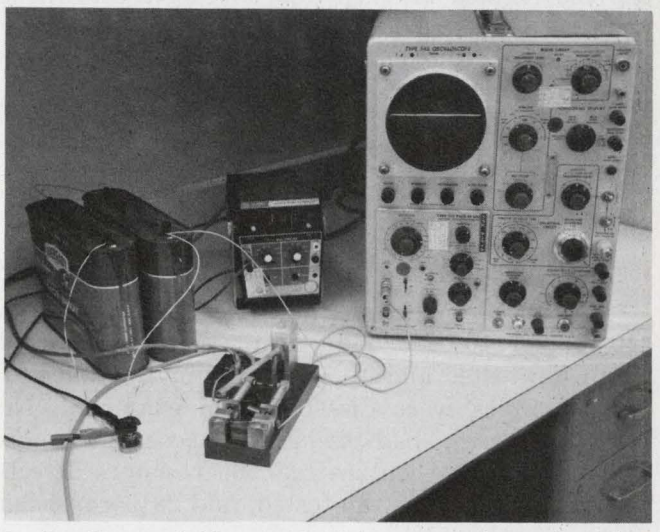
R. D. Sterling, Component Specialist, Martin Marietta Aerospace, Orlando, Fla. 32005.



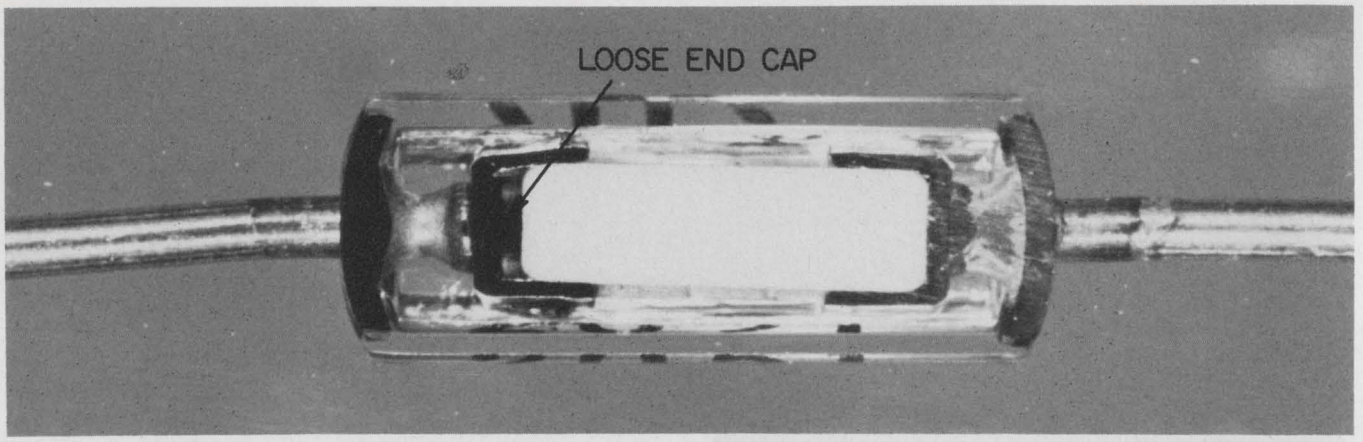
2. **The component holding fixture** for the tap-tester uses an air-activated clamp to ensure firm electrical connections, and a padded anvil provides mechanical support for the component under test.

sweeps. The noise measurement is then repeated for several sweeps, with a calibration resistor of at least 10 kΩ connected to the fixture. The residual noise in both cases should not exceed 30 μV. A sensitivity of 200 μV/cm for the scope, obtained with the help of the proper preamplifier, is adequate.

The resistor under test is centered on the anvil pad and the leads clamped. The pivoted wooden striker is raised to the stop and dropped at least three times. At each tap, the oscilloscope trace is observed for any indication of a discontinuity. The lead clamp is opened, the resistor rotated 90 degrees, and three more taps are administered. This procedure is repeated at 180 and 270 degrees. Bending one of the leads 90 degrees (but not more) 1/4 inch from the end provides a convenient reference for rotation. The produc-



3. **Readily available standard instruments** needing few adjustments provide easily interpreted results.



4. **Detailed inspection of the faulty components** found by the tap-tester invariably reveal serious and often difficult-to-detect faults.

tion department should be instructed to allow for this bending, so that good resistors won't be rejected later because of bent leads. On no account should bent leads be straightened.

Experience has shown that the excitation voltage level for testing resistors of different values should be as follows:

Resistor Value (k ohms)	Excitation Volts (dc)
0.100 to 0.999	3
1 to 2	4
2.05 to 3	5
3.01 to 5	6
5.05 to 6	7
6.04 to 8	8
8.06 to 10	9
10	10

Resistors are accepted provided they indicate no repeatable response above a set level of residual noise.

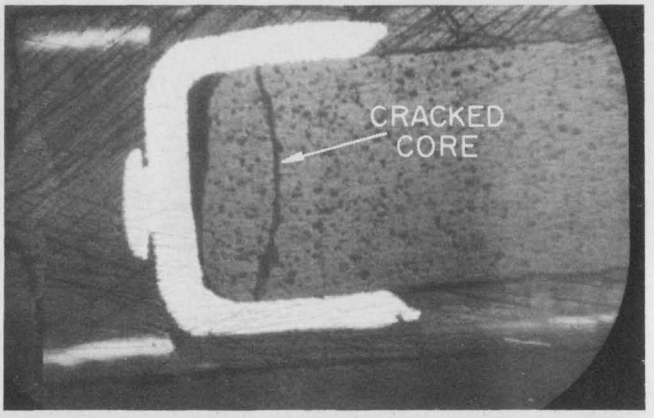
Evaluating the results

The effectiveness of tap testing has been proved. Tested samples were arranged into three categories of deflection levels. The samples were then microsectioned and carefully inspected for defects. These were the results:

Sample Quantity	Deflection Level (μV)	Quantity Defective
37	< 50	0
15	50-99	5
46	100-2000	38

As further proof, samples were selected from 40 lots of 100,000 metal-film resistors that had been tap-tested and approved for production use. The samples were dissected and examined. No cracked cores, bad welds or loose end caps were found. By contrast, 80,000 resistors directly from stock were tap-tested, and 20% rejection rate was found.

Extensive analysis showed that this rejection



rate could be improved if gold was fire-bonded onto the core under the resistive film. The process not only improved contact resistance between the end cap and the film but also provided lubrication that eased the press fit during capping, thereby reducing the frequency of cracked cores. The result was that the rejection rate dropped to 13.7%.

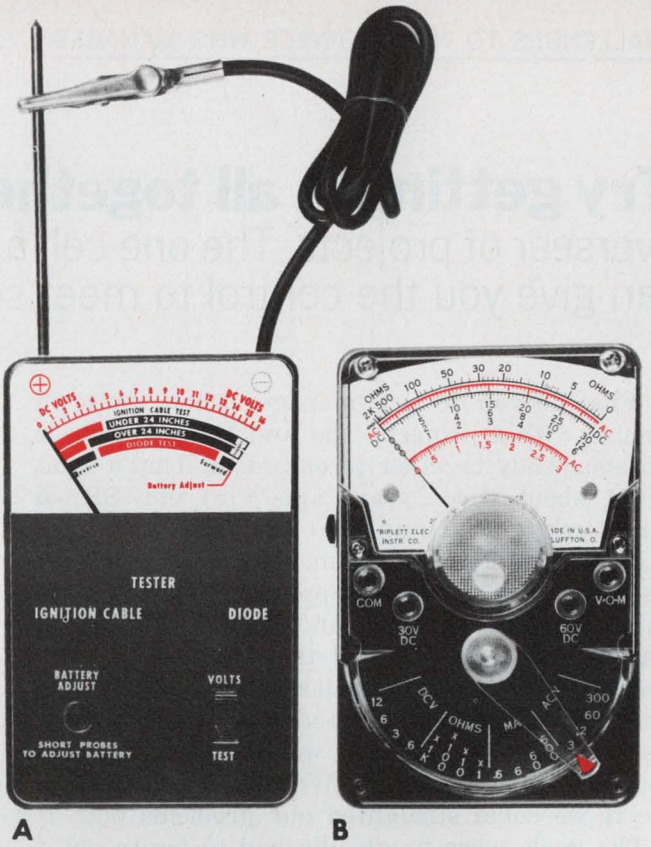
Other components can be tested

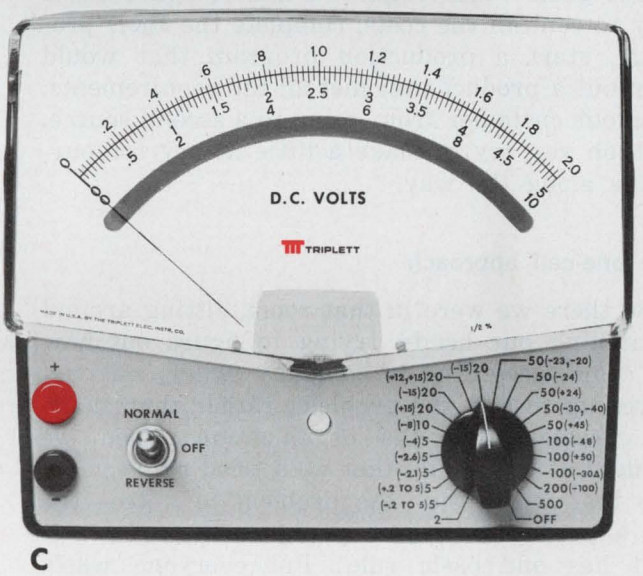
To demonstrate its flexibility, the tap-test setup was modified to test variable resistors, such as the RJ22 series, and CSR13 solid-tantalum capacitors. The variable resistors were needed to set critical voltages in missile-launching test equipment. Under the tap-test procedure, the variable resistor was first driven against its wiper stop, then readjusted to 30% of total resistance and tapped four times. This sequence was then repeated at the 50 and 70% of total resistance settings. The oscilloscope gain was set at 2 mV/cm. A resistor was rejected if a permanent change of more than 4 mV was observed with 2.5 V applied across the resistor.

In tap-testing of the CSR13 solid-tantalum capacitors, a prevalent failure mode—attributed to improper solder bonding to the silver point of the anode—was found. In this case, the dissipation factor was measured instead of voltage. Capacitors that showed an abrupt change were rejected. ■■

If you need a tester with special scales, ranges, accessories or any combination...

Buy a Triplett tester custom-designed for you





Triplett, manufacturer of the World's most complete line of V-O-M's, is ready, willing and able to design and manufacture special testers of virtually any size, style or type to meet your specifications.

Tester A (above) was designed to give auto mechanics a simple, rugged tester for "go/no go" tests that would otherwise be measured in electrical units unfamiliar to them.

Tester B is a modification of a standard Triplett tester incorporating only the specific ranges needed by the field service engineers for whom it was designed.

Tester C has special ranges and special input connectors and cables to permit a single-point connection for trouble-shooting and servicing all the circuits of a complex business machine.

Several other buyers of standard Triplett test equipment request their company name on the dial to personalize their testers.

If you think a custom tester may solve some problems for you, contact your Triplett representative. He'll put you in touch with the Tester Designers and Engineers at Triplett who'll help you analyze the problem and suggest the optimum cost/result solution. Triplett Corporation, Bluffton, Ohio 45817

TRIPLETT
BLUFFTON, OHIO 45817

Manufacturers of the World's most complete line of V-O-M's

INFORMATION RETRIEVAL NUMBER 29

Try getting it all together, suggests this overseer of projects. The one-cell approach to a program can give you the control to meet schedules and cut costs.

What do you do as a manager when you're in trouble with a project? The first thing you do is get everybody together in one room. That's what I did about three years ago with our SRAM (short-range attack missile) program.

It was an R&D program, fixed price, and we were subcontracted to supply the master computer on board the B-52 and FB-111 aircraft. It was behind schedule, and the people who were running it lacked enthusiasm to do what was necessary to make it a good piece of hardware. As a result, our customer was going to take the contract away from us. We asked for time to see if we could straighten our problems out.

The goals were tough. We had to figure out a way to contain the costs, complete the R&D program, start a production program that would turn out a product that met all the requirements, keep our customer from going to a second source, and, oh yes, try to make a little money for ourselves along the way.

The one-cell approach

So there we were in that room, sitting around scratching our heads, trying to figure out how we could, according to company policy, set ourselves up to suit the problem, rather than make the problem suit the organization. Then we thought of something that we'd tried many years ago that would suit the problem to a tee—the cell approach to project management.

It has one basic rule: Put everyone who's working on the project into one area. We're talking about a peak of 350 people working on a project that's worth about $10-million a year in this case.

With a comparatively small contract for a single, though highly complex, computer unit, we established a special SRAM production group totally responsible for the program. We set up as much of the fabrication and assembly effort as was possible in one location. Around the edge of this manufacturing area, we placed the program manager, the purchasing people, engineers, quality and test people—in fact, all of the people necessary to make the SRAM production team virtually a self-sustaining unit.

Everything that was factory-oriented on this program that we could possibly strip out, we took to this area. Now obviously it didn't make sense, for example, to move a multilayer-board facility or to move some of the shop equipment, like the milling machine. But we did get as much equipment as we could into the cell.

Then we built a three-foot wall around the factory part of the cell. We put three or four offices across one wall for the program manager and a few other key people. We told our program manager that he was now in business for himself —just as if he had his own small company.

What did this approach do?

First, it eliminated much of the usual paperwork, because the people involved with the program communicated face-to-face.

Second, it eliminated the costly and time-consuming practice of passing the buck. When there was a problem, the program manager brought his specialists together for a quick solution.

Third, it eliminated most of the time consumed in travel from floor to floor or building to building. Almost everything required was local.

Fourth, supporting personnel could *see* the effect of their activities on production. The purchasing employee, for example, could envision production grinding to a halt if he failed to buy parts on time. Engineers could appreciate how their failure to resolve a technical problem rapidly would interfere with production. They became aware of a personal challenge to meet the needs of the workers rubbing elbows with them daily.

Fifth, the program manager was intimately involved and thus in a perfect position to recognize good work and commend people's efforts.

The result was excellent performance, a major cost underrun and a substantial reduction in the price of follow-on orders.

This type of project management works very well in large companies, because they tend to isolate their departments. Smaller companies, emulating large companies, also tend to put up barriers between their departments. This strings out their communication lines and forces them to write memos about memos when they should be talking about the problems eyeball to eyeball and

Mort D. Margolis, President, Autonetics Div., Rockwell International, Anaheim, Calif. 92803.

Mort D. Margolis

Education: BSME, City College, New York.

Duties: Responsible for all activities of the Autonetics Div. from new-business proposals through design, production and logistic support of operation equipment.

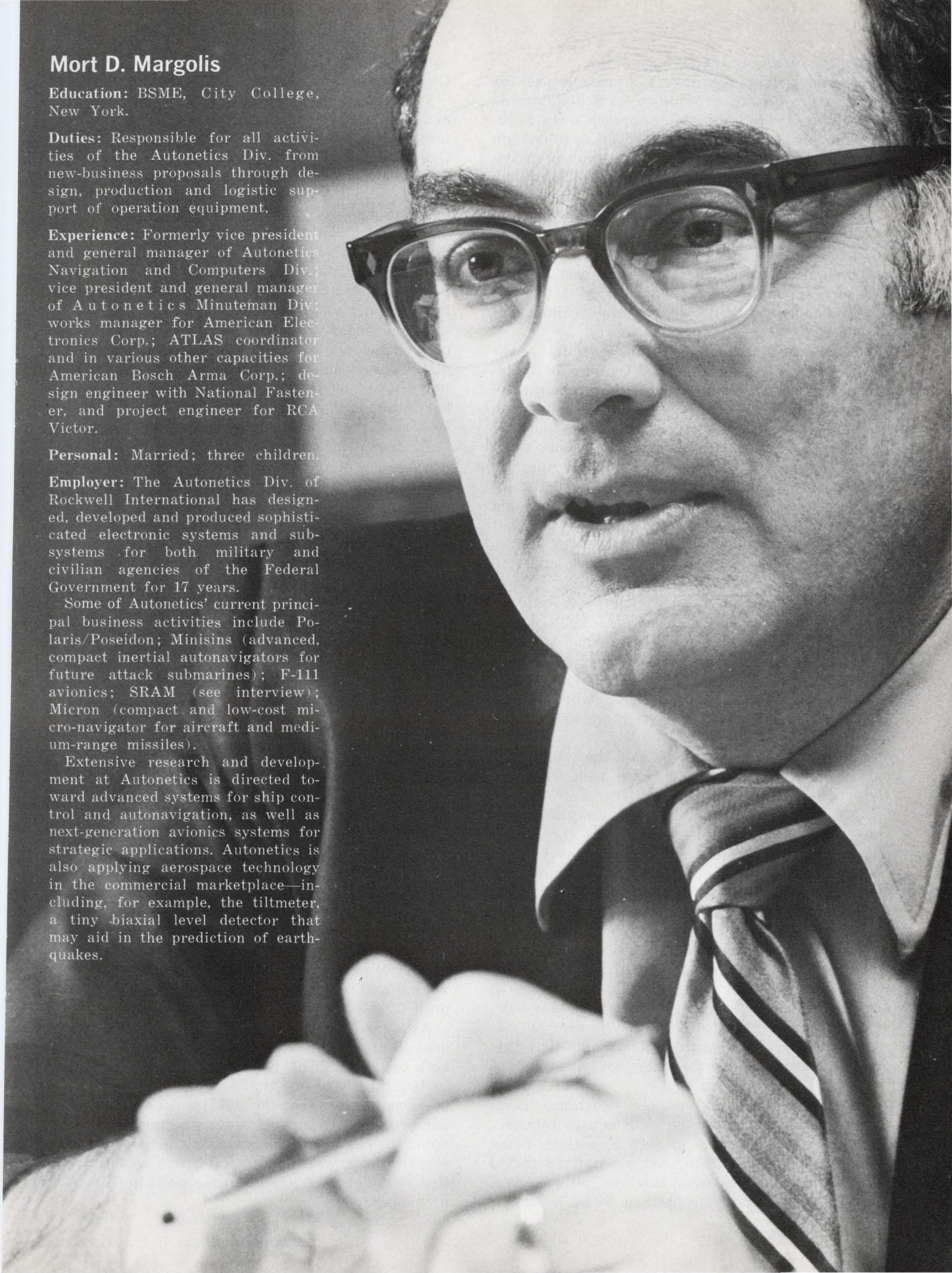
Experience: Formerly vice president and general manager of Autonetics Navigation and Computers Div.; vice president and general manager of Autonetics Minuteman Div; works manager for American Electronics Corp.; ATLAS coordinator and in various other capacities for American Bosch Arma Corp.; design engineer with National Fastener, and project engineer for RCA Victor.

Personal: Married; three children.

Employer: The Autonetics Div. of Rockwell International has designed, developed and produced sophisticated electronic systems and subsystems for both military and civilian agencies of the Federal Government for 17 years.

Some of Autonetics' current principal business activities include Polaris/Poseidon; Minisins (advanced, compact inertial autonavigators for future attack submarines); F-111 avionics; SRAM (see interview); Micron (compact and low-cost micro-navigator for aircraft and medium-range missiles).

Extensive research and development at Autonetics is directed toward advanced systems for ship control and autonavigation, as well as next-generation avionics systems for strategic applications. Autonetics is also applying aerospace technology in the commercial marketplace—including, for example, the tiltmeter, a tiny biaxial level detector that may aid in the prediction of earthquakes.



writing down only the right answers.

The one-cell approach works especially well for certain projects of $15-million to $20-million or less. You couldn't use this approach on a $300-million project; there isn't a room large enough to house it. Maybe you could do it by breaking the project into increments of about $20-million, but I'm not sure.

Controlling the company con artist

Even though the SRAM project was a great success, I don't want to suggest it was trouble-free. People being people, we had nothing but trouble in the beginning.

Recognize that this is a big organization—over 8000 people. It covers a large complex of buildings, and sometimes it becomes difficult to control those people who don't want to be controlled. People who do their work in a business-like way are not the ones I mean. I'm talking about those who always try to work around the rules on which a business is run. We can't afford that.

I'd tell the people what was to be done, and go away and someone would decide that that wasn't the way it should be done, and, "besides he won't check again." I'd come back and find that the engineers were opposed to the idea, everybody in the program was opposed to it, except me and the key people.

To get the cell idea accepted, we had to select key people very carefully, because if they don't go along with the operation, we're done before we've started. We chose people who weren't afraid to experiment, who were company-oriented and who weren't selfish.

So we had to force it. We said that either you do it our way or someone else will. That got everyone's attention.

Engineers think of themselves as professionals, and they are professionals. But they think there are certain material things that help to make them professionals, and that's ridiculous. Among the things they think make them professionals are private offices. That stems from the time when engineers were in short supply and companies used to build offices for them, put a nameplate on the door and give them a 10% to 15% increase. Now engineers don't like to be in the bullpen. They say it's too noisy, or they ask: "Are you demoting me?" Or: "Why are you setting me back 20 years?" Reasoning like this really doesn't make sense; they just have to adapt —we all do.

Another source of engineer resistance stemmed from the fact that our staff is used to working on more than one project at a time. Some engineers assigned to the cell were afraid they'd be out on the street when this one job was over. I told them that if people had to be let go, it wouldn't be the people who did a good job. So they said OK, but they didn't like it.

The planning people didn't like the cell either, and neither did the logistics or the contracts people. But we forced it anyway. I went over there every two weeks, watching and checking up to see that our plans were being carried out.

And we put teeth in this thing. We gave the program manager complete authority. To be sure everybody recognized it, we told him that no one could move off or onto the program unless he countersigned the papers. We had to move some people out and we had to fire a few, but we got it going, and some amazing things happened.

People began to talk to one another instead of writing. They began to understand one another's problems and contributions. Many engineers have a tendency to look down their noses at logistics men. Eye to eye, however, they learned to respect the logistics man's expertise.

We found that the people were even developing a comradeship for one another. They were solicitous when a co-worker was sick. They even coined a name for themselves, "Sraminetics" and displayed the sign. They wore little "Sraminetics" buttons.

We finished up the R&D program without additional losses; we managed to get into production, which everyone had said was impossible, and we delivered the first equipment ahead of schedule. We succeeded because of the closely knit organization that we had developed and because we had eliminated all the hanger-ons, and the communication problems.

Learning to sweat until it works

The quick responses saved time and eliminated aggravation. Picture an engineer in an office in another building saying that he'd be down to talk about the problem. Chances are he'd get down later in the day or a day or two later. Then he'd get back to the office, and he'd rationalize that he had three other jobs to do. The project would fall behind because he'd lag on that job.

If you've got only the one job and you're in the area and a fellow comes up to you and says, "Hey, we've got a problem; this thing doesn't work," you're over there and you're sweating until it does work.

As a result of this experiment, we've used the one-cell approach on two other projects. They've both been successful. We have to be very careful in tailoring what we try though, because today everybody thinks that the cell is a panacea for all our problems. It isn't. However, because the cell approach has helped to reduce the actual cost of some projects, we are bidding on certain contracts that we might not have been so quick to bid on previously. ■■

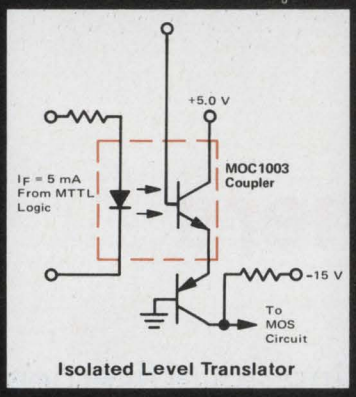
Electronic Design presents the 'top-ten' winners

The following pages display the 10 outstanding advertisements that appeared in our Jan. 4 issue, which featured the "Top-Ten" contest. The contest attracted thousands of readers who attempted to match their ratings of the 10 most memorable advertisements with the "recall-seen" scores from ELECTRONIC DESIGN's regular Reader-Recall survey.

The winning advertisements combine attractive colors, tasteful design and well-written copy. The result: impact. The winners, in order of highest Reader-Recall score, are as follows:

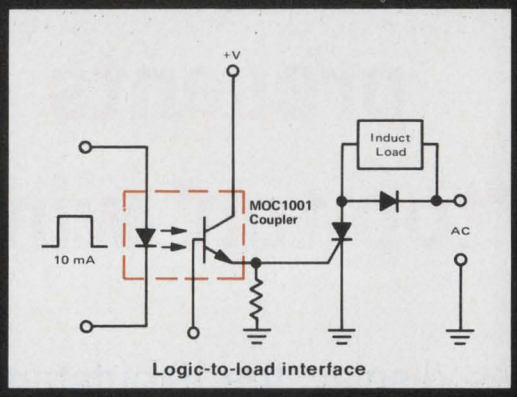
1. Guardian Electric Manufacturing Co.
2. Struthers-Dunn, Inc.
3. John Fluke Mfg. Co., Inc.
4. Motorola Semiconductor Products, Inc.
5. Bourns, Inc.
6. Hewlett-Packard
7. Cherry Electrical Products Corp.
8. Hewlett-Packard
9. Hewlett-Packard
10. Signetics Corporation

If you can't find the lowest-cost optical coupler, relay, switch, translator or interface you want here...



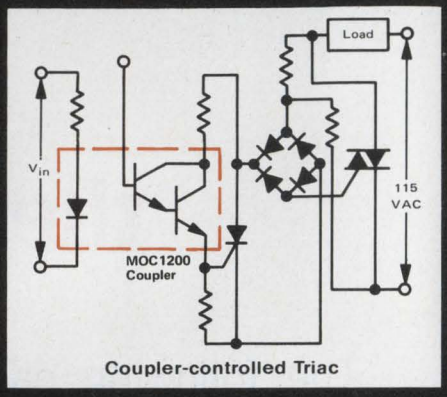
Isolated Level Translator

Type: MOC1003 Coupler
Price: 99¢
Features: 500 V Isolation
30% Transfer Ratio



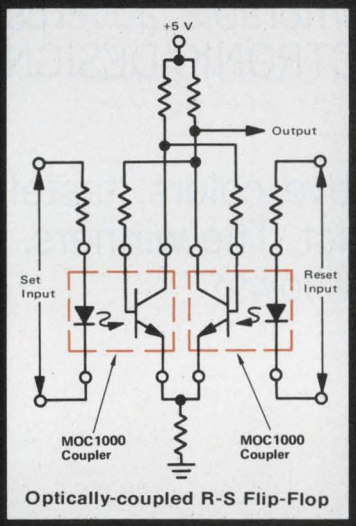
Logic-to-load interface

Type: MOC1001 Coupler
Price: $1.95
Features: 2,500 V Isolation
60% Transfer Ratio



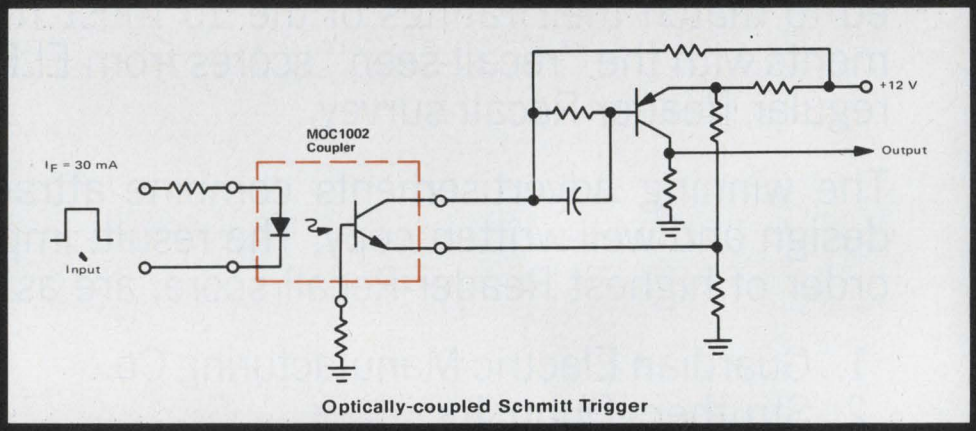
Coupler-controlled Triac

Type: MOC1200 Darlington Coupler
Price: $1.95
Features: 1,500 V Isolation
200% Transfer Ratio



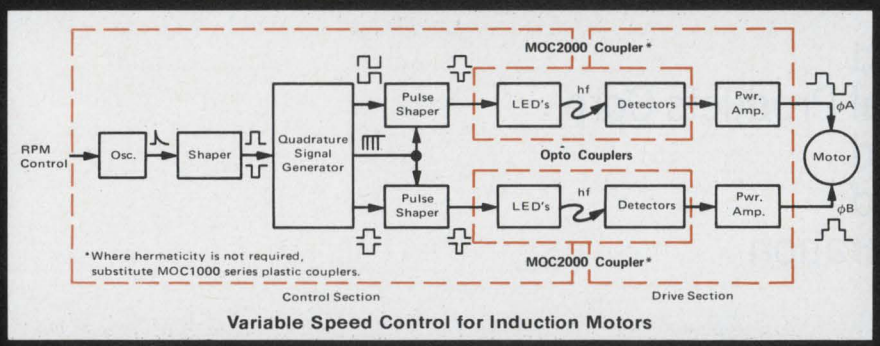
Optically-coupled R-S Flip-Flop

Type: MOC1000 Coupler
Price: $1.75
Features: 1,500 V Isolation
60% Transfer Ratio



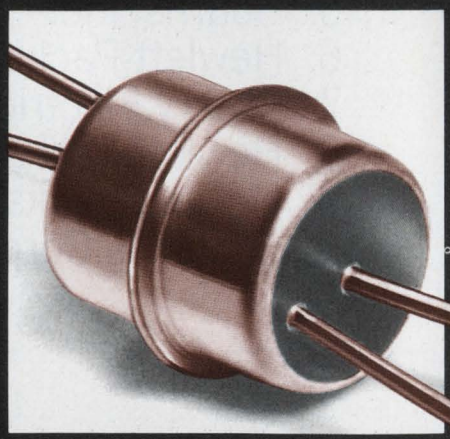
Optically-coupled Schmitt Trigger

Type: MOC1002 Coupler
Price: $1.50
Features: 1,500 V Isolation
30% Transfer Ratio



Variable Speed Control for Induction Motors

Type: MOC2000 Hermetic Coupler
Price: $3.10
Features: 1,500 V Isolation
3.0% Transfer Ratio



better have your isolation examined.

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Call them what you will, they're versatile, quick, simple, reliable. And more economical than ever — Motorola prices now start at just 99¢, 100-up!

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In electro-mechanical relay replacement they offer unbeatable advantages. With no contacts, they're immune to arcing and pitting and provide half the size and 1,000 times the speed of relays. There's no shock or vibration problems and they can be mounted in any position. Their inherently high isolation voltage permits operation in interface systems at different voltage levels and they're compatible with integrated circuits such as MOS, TTL, op amps and regulators.

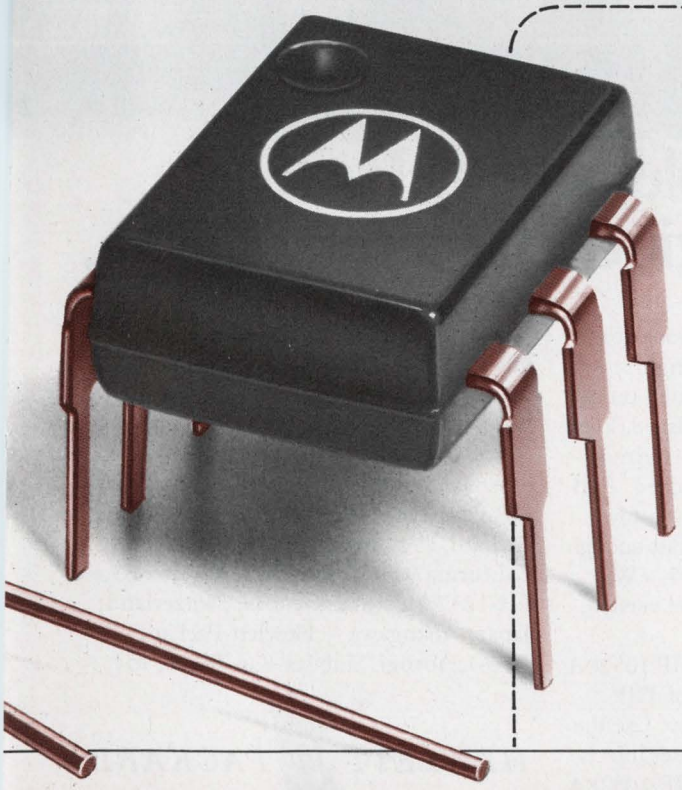
Various responses can be achieved through linear modes of operation with feedback possible for inductive and reactive loads such as make/break timing designs. And with non-degrading solid-state operation, they're truly lifetime circuit performers.

Although of closed construction, they're simplicity itself. Coupler input is connected to a light emitter and the output is a photodetector transistor. The elements are separated by a transparent insulator and housed in a light excluding package. Once assembled, the device is completely electronic in nature, eliminating the designer's need for knowledge of optics.

For information about how they can fit into your system designs, write on your company letterhead to Motorola Semiconductor Products Inc., Box 20912, Phoenix, AZ 85036. We'll send three just-published design aids: OPTOELECTRONICS AT WORK, AN571 — Isolation Techniques Using Optical Couplers and AN575 — Variable Speed Control System For Induction Motors. Circle the reader number for data sheets.

All prices shown are 100-999.

MOTOROLA COUPLERS
—lighten your industrial load



1 *FREE* OPTICAL COUPLER

. . . is yours when you contact the Motorola distributor nearest you. Call him or send the coupon for a free MOC-1003 optical coupler ready for evaluation and prototyping — do it now!

To (distributor) _____

Send me my free Motorola MOC1003 optical coupler immediately!

Name _____

Title _____

Company _____

Div. _____

Address _____

City _____

State _____ Zip _____

INFORMATION RETRIEVAL NUMBER 147

Until you try HP's new IC Troubleshooting Partners, you'll never know how simple logic circuit testing can be.

Just push a button on the Pulser on the left, and let the Probe on the right automatically monitor the response downstream.

How? HP's new 10526T Logic Pulser injects a single 300 nanosecond pulse anywhere in your TTL and DTL circuitry. Low nodes are momentarily forced high, high nodes automatically pulled low. There's no unsoldering or trace cutting. Just press the button and the pulse is there. $95.

And HP's new 10525T Logic Probe checks the result. A single, unambiguous light at your fingertips tells you exactly what's going on. If no pulse is detected, something's wrong.

The Probe may be used to look for much more than just pulses. Highs, lows, bad levels, open circuits and pulse trains to 50 MHz are faithfully displayed. Even single shot events as quick as 10 nanoseconds are captured and stretched. And high impedance won't load even low power TTL, yet the Probe is fast enough to keep up with Schottky. $95. (We also have a high threshold level version, Model 10525H, also $95.)

For other applications, the HP 10528A Logic Clip monitors all pins of DIP TTL/DTL IC's simultaneously. Use the Clip with the Pulser – the Pulser injects clocks, transfers, shifts, etc. HP 10528A Clip, $125.

All three troubleshooters team up as the 5015T Troubleshooters Kit for $285 which gives you a 10% discount and a handy carrying case to boot.

For more information on these and other IC Troubleshooters call your local HP field engineer or write Hewlett-Packard, 1501 Page Mill Road, Palo Alto, California 94304; Europe: P.O. Box 85, CH-1217 Meyrin 2, Geneva, Switzerland; Japan: Yokogawa – Hewlett-Packard, 1-59-1, Yoyogi, Shibuya-Ku, Tokyo, 151.

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INFORMATION RETRIEVAL NUMBER 148

Fluke problem solvers

The new multimeter with advanced L.S.I. for more function power. 26 ranges, 5 functions.

$299... Fluke's new 8000A, Try one for fifteen days, no obligation.

Now you can put the unmatched quality of Fluke instrumentation to work for you at the price of an ordinary multimeter.

Here's the DMM with more function power. Its got 26 ranges, including five ranges of ac and dc volts, five ranges of ac and dc current, and six ranges of resistance. Push button control gives you the simplest most reliable error-free operation possible. The new Fluke 8000A is the only multimeter using an A-to-D converter with inherent self-zeroing to completely eliminate offset uncertainty.

More details are on the next page, but we think you'll want to try this low-priced measurement system now. Fill in the coupon; we'll do the rest.

Circle 240 for more information

Ship me a Fluke 8000A for $299 plus $_____ for additional options checked below. I prefer the following payment option:

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  If using Master Charge, please indicate the 4 digit number appearing above your name ☐☐☐☐
- ☐ Bill against the attached company purchase order for the full amount plus $5 shipping and handling.
- ☐ Cash Order. My check for the full amount is enclosed. Fluke pays shipping and handling.
  (Washington state residents add 5% sales tax.)
  Return within 15 days for full refund if not delighted.

Add the following options:

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- ☐ BCD Data Output — $75*
- ☐ RF Probe — $75
- ☐ AC Probe 20A & 200A — $50
- ☐ HV Probe — $25
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- ☐ Rack Kit-Center — $30
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- ☐ **Send me literature only**

*Choose BCD data output or battery pack; both cannot be ordered in the same instrument.

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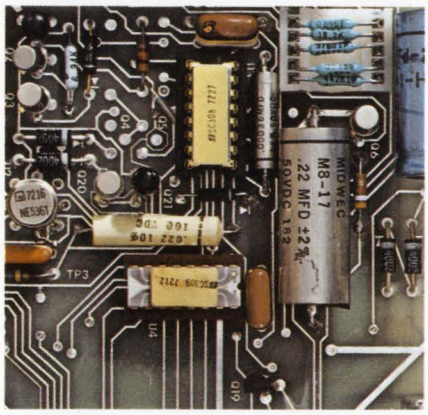
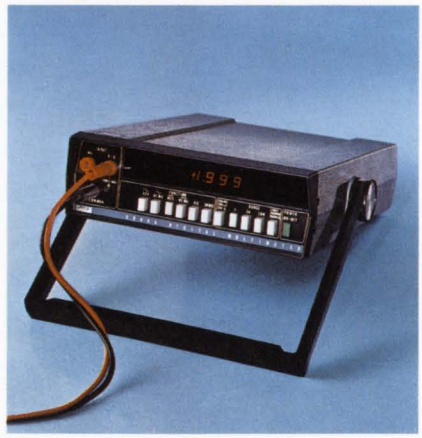


A simple guarantee
You can understand our 12-month guarantee. It's straightforward and honest. And you can believe we live up to it. If anything happens to your 8000A, take it or send it to your nearest factory service center. We'll give you 48-hour turnaround service in the U.S., Canada, Europe and the Far East.

Specs to work by
The new Fluke 8000A has a dc accuracy of 0.1% when you buy it. We guarantee it will still measure within that accuracy without recalibration a year later.
The case is rugged and tough. Drop this multimeter from a bench. Nothing happens to the works inside. We guarantee it.

Wide range of measurements
Measurement flexibility is broad enough to meet all the situations you're likely to encounter. The Fluke 8000A gives you 26 ranges to measure ac and dc voltages from 100 microvolts to 1200 volts, currents from 100 nanoamps to 2 amperes; and resistance from 100 milliohms to 20 megohms.



Wide choice of options
For a few dollars more, you can add a rechargeable battery pack to give you completely portable operation for over eight hours. And when you're back on the line, the batteries will recharge automatically. Other options include digital printer output, deluxe test leads, high voltage probe, rf probe, 200-amp ac probe, carrying case and rack mount kits.

A complete digital multimeter
But with or without options, the Fluke 8000A comes complete with test leads and spare fuses. It all adds up to an instrument you can count on day after day, year after year. Isn't this what you want in a digital multimeter at any price? Fluke thinks so.

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To celebrate our 50th Anniversary—1923-1973

See this beauty at the Struthers-Dunn exhibit during the 1973 Design Engineering Show, Philadelphia, Pa. April 9, 10, 11, 12.

This 1923 Model T FORD as GRAND PRIZE for your most unusual relay application!

Second 50th Anniversary prize: **TEN $50.00 U.S. Savings Bonds.**
Third Prize: **FIVE $50.00 U.S. Savings Bonds.**

ALL entrants will receive a 9″ x 12″ four-color print of this photograph by contest end. Perfect for framing.

Yes! A beautifully restored Model T Ford Station Wagon from the same year the first Struthers-Dunn relays came out! It could be yours for telling us about your most unusual or interesting relay application, as detailed in the rules below. You and the car will be the talk of your town from the day it is delivered. Start writing or thinking about your application today! Note those second and third prizes, too! *Be sure to follow the rules below.*

CONTEST RULES

(1) Entrants must give a clear and complete description of an unusual, but practical and operating, relay application or solution of a relay problem, using electromechanical or reed relays of *any* make or price. *Entries must contain nonconfidential matter only.* No purchase necessary.
(2) Winning entries will be judged on basis of the most unusual applications and/or imaginative thinking of widest interest to relay specifiers.
(3) The three judges, familiar with design and use of relays, will be from the editorial departments of technical trade publications, and their decision will be final.
(4) Brevity, clarity and completeness will count. Be formal or informal. Schematics welcome.
(5) No limit on entries, but keep each entry to one application.
(6) Entries must be postmarked no later than midnight May 15, 1973. Address: *50th Anniversary Contest, Suite 1500, 1201 Chestnut Street, Philadelphia, Pa. 19107.* Do *not* send entries to Struthers-Dunn or its distributors.
(7) For anonymity in judging, entries will be coded and identification removed insofar as possible.
(8) Winning entrants will be notified by July 1, 1973 and publicly announced and identified shortly thereafter.
(9) Grand prize will be delivered to winner's home.
(10) All entries become property of Struthers-Dunn, Inc. and none will be returned. Struthers-Dunn reserves the right to use all entries in its advertising and promotion on an anonymous basis, but entrants will be paid $50.00 for each entry used.
(11) Contest void where prohibited, regulated or limited by law. Winners will be responsible for taxes, if any, on prizes.
(12) Employees of Struthers-Dunn, Inc., its sales affiliates, distributors, advertising agencies, contest judges and members of their families are not eligible.

STRUTHERS-DUNN, INC.

PITMAN, NEW JERSEY 08071
Canada: Struthers-Dunn Relay Div., Renfrew Electric Co., Ltd.

NEW CHERRY KEYBOARD

. . . and so simple any genius could have designed it.

electronic data entry

A NEW KIND OF KEYBOARD

with a uniquely simple design that utilizes scanning technique. Key depression causes a matrix connection between decoder and multiplexer. The LOW output of the decoder appears at the corresponding multiplexer terminal. When the counter reaches the appropriate key code, cross matrix continuity is sensed. The multiplexer then provides a HIGH output to the monostable multivibrator causing a 1 millisecond pulse. This inhibits the clock and stops the counter on the desired code.

A NEW KIND OF KEY

with gold "crosspoint" contacts that eliminate the two main causes of contact failure—(1) formation of insulating chemical film on contact surfaces and (2) mechanical interference of foreign particles on contacts. This proven design concept (Gold prisms at right angles to each other) provides high force per unit of contact area and virtually eliminates contact closure interference from foreign particles.

10

IMPORTANT "MOST WANTED" FEATURES

1 Low cost **2** Long life
3 Low profile **4** Inherent 2 key rollover
5 Wire"OR"able output
6 Low power (1.5 watt max.) **7** Custom designs
8 True typewriter sequencing
9 Only one power level input **10** High reliability

Gold "crosspoint" contacts for unexcelled reliability

Mechanical life in excess of 10 Million operations

FOR TECHNICAL DATA: TWX 910-235-1572 .... or phone (312) 689-7600 ext. 7717. OR write:

CHERRY®

CHERRY ELECTRICAL PRODUCTS CORP.
3600 Sunset Avenue, Waukegan, Illinois 60085

Makers of patented Leverwheel/Thumbwheel Switches, Matrix Selector Switches, Snap-Action Switches and Keyboards.

INFORMATION RETRIEVAL NUMBER 150

SCHOTTKY ON

One-stop TTL shopping for 74S MSI, SSI...

At last. Available now, all in one place. The whole mix in Schottky logic—to match every high speed TTL function in demand today. Signetics broad line of 74S circuits. Plus our compatible 82S series of enhanced MSI devices that help Schottky give you a competitive step-up in speed, in design-ease, in versatility... and of course, in MSI complexity.

And you get it where you want it, when you want it. Fast service directly from distributor stock. Signetics knocks off the waiting list tie-ups, the multi-stop shopping. After all, how can we encourage you to boost system speed by replacing TTL with Schottky equivalents, if you can't get the circuits to work with? All the parts you need—without delays, without runarounds, without making six calls when one should do the job.

Here's where Signetics makes the difference. One call does the job. Completely.

SSI Schottky to cover full function range:

SSI SCHOTTKY 74S TTL	
74S00	Quad 2-Input NAND Gate
74S03	Quad 2-Input NAND Gate (Open Collector)
74S04	Hex-Inverter
74S05	Hex-Inverter (Open Collector)
74S10	Triple 3-Input NAND Gate
74S11	Triple 3-Input Positive AND Gate
74S15	Triple 3-Input Positive AND Gate (Open Collector)
74S20	Dual 4-Input NAND Gate
74S64	4-2-3-2-Input AND/OR/INVERT Gate
74S65	4-2-3-2-Input AND/OR/INVERT Gate
74S74	Dual D-Type Edge-Triggered Flip-Flop
74S112	Dual J-K Edge-Triggered Flip-Flop
74S113	Dual J-K Edge-Triggered Flip-Flop
74S114	Dual J-K Edge-Triggered Flip-Flop
74S40	Dual 4-Input NAND Buffer
74S140	Dual 4-Input NAND Line Driver

You can make the same call encompass MSI too. Signetics 74S MSI circuits offer the same volume availability as SSI, as well as the same total TTL compatibility—pin-for-pin fits with standard TTL and low-power Schottky. Ten MSI devices in stock now, with more to be announced in the next few months.

MSI SCHOTTKY 74S TTL	
74S151	8-Input Data Selector/Multiplexer
74S153	Dual 4-Input-to-1-Line Selector/Multiplexer
74S157	Quad 2-Line-to-1-Line Data Selector/Multiplexer
74S158	Quad 2-Line-to-1-Line Selector/Multiplexer (Inverting)
74S174	Hex D-Type Flip-Flop w/Clear
74S175	Quad D-Type Flip-Flop w/Clear
*74S181	Arithmetic Logic
*74S194	4-Bit Bidirectional Shift Register
*74S195	4-Bit Parallel Access Shift Register
74S251	8-Input Data Selector/Multiplexer w/tri-state
74S253	Dual 4-Input-to-1-Line Selector/Multiplexer w/tri-state
74S257	Quad 2-Line-to-1-Line Data Selector/Multiplexer w/tri-state outputs
74S258	Quad 2-Line-to-1-Line Selector/Multiplexer (Inverting) w/tri-state

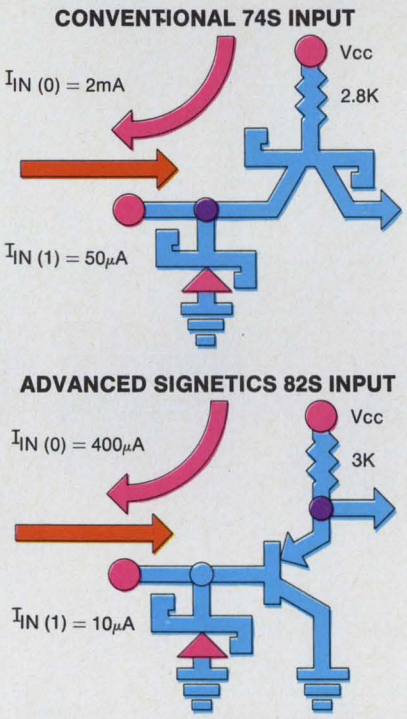
*January-February announcement

Complementing 74S, Signetics 82S series MSI circuits offer significant advantages in sophisticated Schottky systems designs. The conventional TTL input circuit found in all Schottky logic, other than Signetics 82S, suffers from low input impedance.

Signetics advanced PNP structure produces significantly higher input impedance. You can drive far more devices from one output since input current is one-fifth that of standard Schottky inputs. With Signetics 82S MSI you need not worry about noise when driving long lines since, in addition to 10 PNP loads, a termination resistor can be accommodated when needed without fan-out reduction.

THE DOUBLE.

...and now optimized 82S MSI too.



The growing line of 82S includes ultra high speed pin-for-pin replacements for the popular 8200 series MSI. In addition, the 82S90/91 100 MHz counter will replace the 74196/197, and the 82S70/71 70 MHz shift register will replace the 74178/179 in systems requiring improved speed performance.

The BCD arithmetic unit 82S82 replaces at least six MSI packages previously needed for the same function while at the same time operating speed is improved by a factor of 3. For BCD applications that only require addition, the 82S83 adder will replace three MSI circuits, and double operating speed. The 82S62 parity generator/checker is unsurpassed in speed.

Of course the 82S MSI line interfaces with 74S logic directly, operating in the same design environment as all 7400 circuitry but with the added advantage of direct replacement without violating fan-out rules.

MSI SCHOTTKY 82S TTL		
		SPEED
82S30/31/32	8-Input Digital Multiplexer	15 ns
82S33/34	2-Input, 4-Bit Digital Multiplexer	15 ns
82S41/42	Quad Exclusive-OR/Quad Exclusive-NOR	5 ns
82S50/52	Binary-to-Octal/BCD-to-Decimal Decoder	12 ns
82S62	9-Bit Parity Generator/Checker	17 ns
82S66/67	2-Input, 4-Bit Digital Multiplexer	15 ns
82S70/71	4-Bit Shift Register	70 MHz
82S82	BCD Arithmetic Unit	20 ns
82S83	BCD Adder	20 ns
82S90/91	Presettable Decade/Binary Counter	100 MHz

74S/82S Schottky TTL. Just one call to one of our distributors, reps or salesmen. And Signetics puts it on the line. Your line.

Signetics-Schottky
811 East Arques Avenue
Sunnyvale, California 94086

High speed response requested on Schottky TTL data, specs, applications and delivery for 74S SSI, 74S MSI and 82S MSI.

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Title

Company

Address

City State Zip

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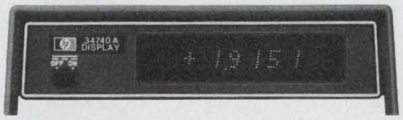
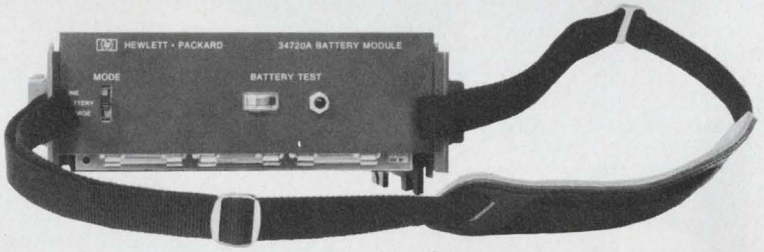
signetics

INFORMATION RETRIEVAL NUMBER 151


34740A
DISPLAY
OFF ON
- 19999
HEWLETT • PACKARD
34702A MULTIMETER
INPUT
V
HI
LO
1000V
MAX
500V
MAX
DCV
ACV
Ω
OHM
V/kΩ
100Ω
1
10
100
1000
10MΩ
INPUT
Ω
350V
MAX
500V
MAX

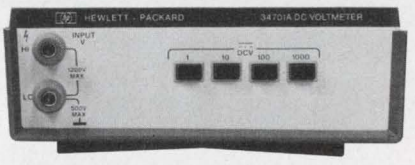
The New Snap-On...

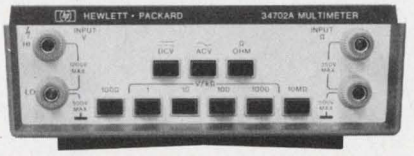




Low-Cost, *4-Digit* Measurement System 3470.

- Bright LED Display section has 100% overranging.
- AC/DC/OHMS snap-on with display. ($600 complete)
- DC snap-on with display. ($475 complete)
- Snap-together expandibility with sandwich centers—battery pack ($200); BCD ($175).
- H-P's exclusive self-test accessory reduces down time ($50).





If you need one of these low-cost DMM's, there's no time like the present. Pick up the phone and call your nearest H-P Representative, now. Or, write to Hewlett-Packard, Palo Alto, California 94304; Europe; P.O. Box 85, CH-1217 Meyrin 2, Geneva, Switzerland. In Japan: YHP, 1-59-1, Yoyogi, Shibuya-Ku, Tokyo, 151.

HEWLETT hp PACKARD

DIGITAL VOLTMETERS

092/41

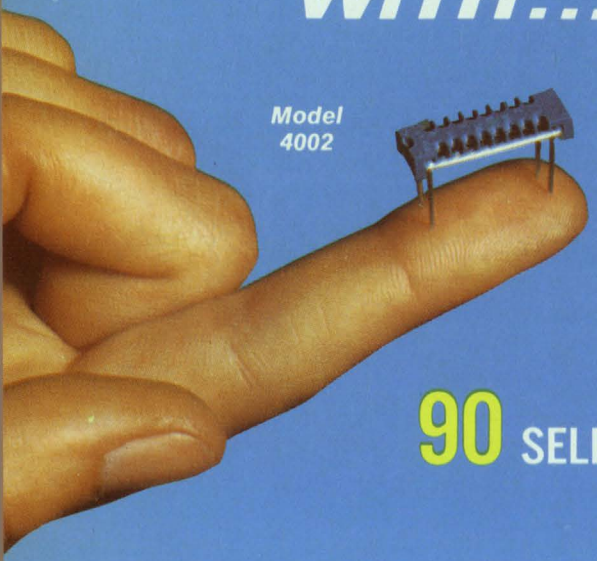
INFORMATION RETRIEVAL NUMBER 152

ELIMINATE RESISTOR STOCKPILES

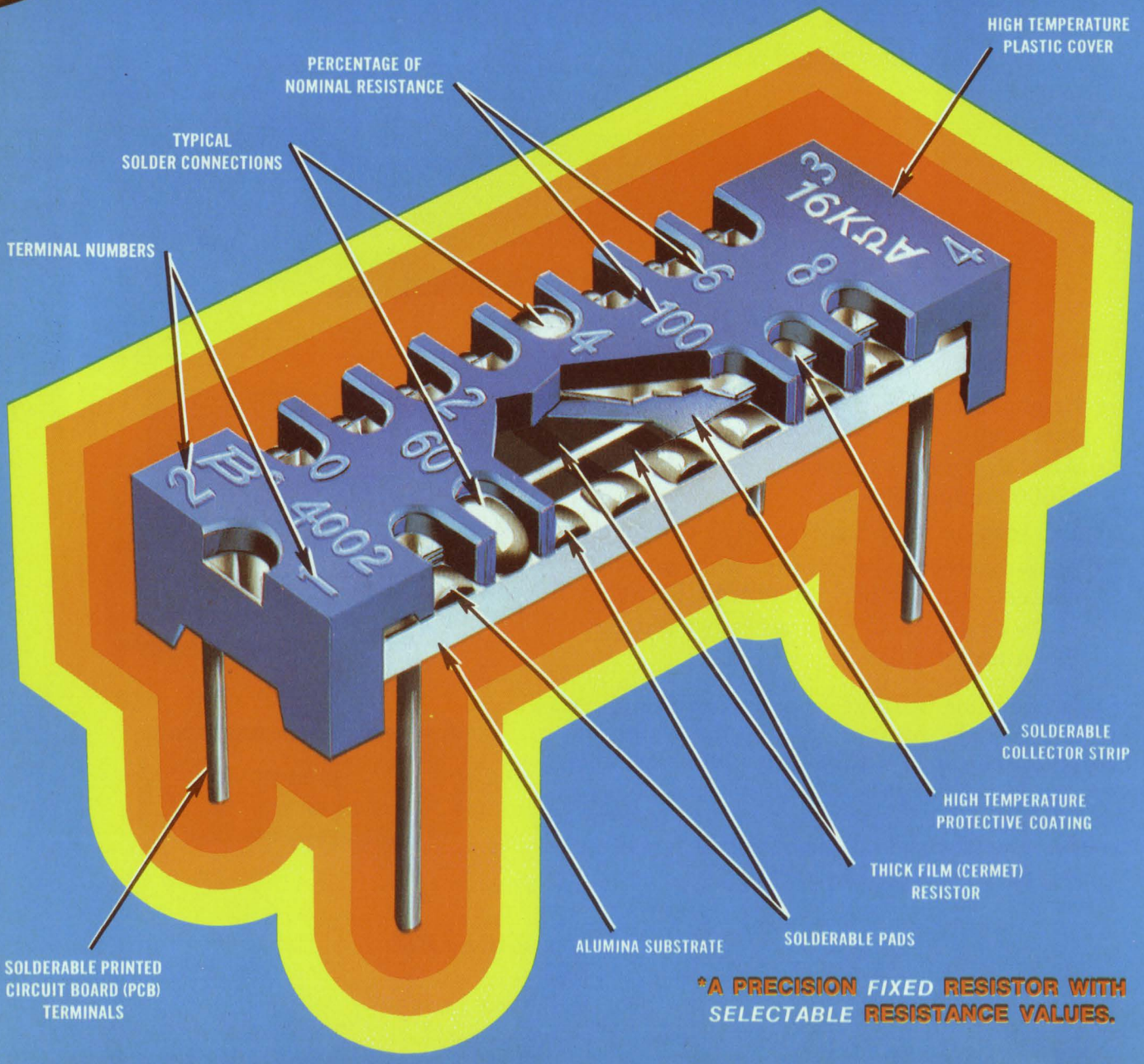
WITH... BOURNS

SFR™

SELECTABLE FIXED RESISTOR*



90 SELECTABLE RESISTANCE VALUES IN 1 TINY UNIT.



*A PRECISION *FIXED* RESISTOR WITH *SELECTABLE* RESISTANCE VALUES.

BOURNS NEW...UNIQUE CONCEPT IN RESISTIVE COMPONENTS ALSO OFFERS

* *33 ohm to 1.25 megohm combined resistance range over 15 units*
* *Selectability within ±1% of required resistance value over the entire range*

BOURNS SFR™
SELECTABLE FIXED RESISTOR

- ... IS A STABLE, THICK-FILM, FIXED RESISTOR *WITH ADJUSTABILITY OF ±1% OR BETTER*
- ... REPLACES STANDARD FIXED RESISTORS IN APPLICATIONS WHERE FINAL RESISTANCE VALUE REQUIRED CAN'T BE PRECISELY DETERMINED AT THE DESIGN STAGE
- ... REPLACES "ONE-TIME ADJUST" VARIABLE RESISTORS IN APPLICATIONS REQUIRING LONG-TERM STABILITY
- ... RESISTANCE VALUE IS SELECTED, THEN *PERMANENTLY*, RELIABLY *SET* BY SOLDERING

LOOK AT THE $$ YOU SAVE ON INVENTORY!!

FOR EXAMPLE: Your application requires selection of individual resistance values from 550 ohms to 1000 ohms, or 40 different resistors at 10¢ each. One Model 4002 provides the same resistance selection within ±1% at 76¢*.

Result: **40 different resistor values: 40 x 10¢ = $4.00**
One Model 4002: 1 x 76¢ = .76

YOU SAVE... $3.24!!

*1,000 piece quantity price U.S. dollars, F.O.B., U.S.A.

it's easy to use

After mounting on PCB; probe the COARSE and FINE adjustment taps (Figures 1 and 2) to determine the precise resistance required. Solder the selected taps (Figure 3) and the SFR RESISTOR is permanently set.

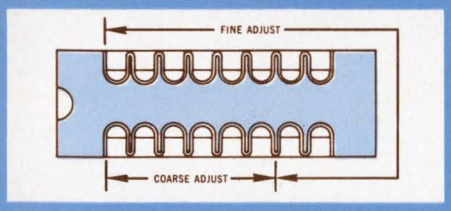


Figure 1

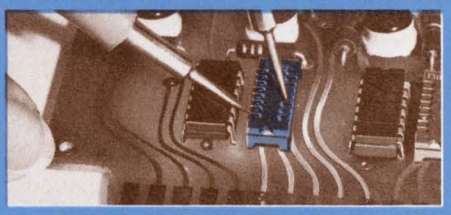


Figure 2

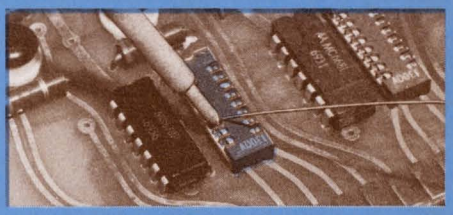


Figure 3

FOR COMPLETE DETAILS AND A BROCHURE:

- CONTACT YOUR LOCAL BOURNS REPRESENTATIVE.

FOR A FREE SAMPLE... write to the factory answering the following on your company letterhead.

(a) My application for the Bourns SFR Resistor is . . .
(b) It will replace (number) of fixed resistors in my inventory
(c) Approximate anticipated annual quantity usage: (number)

BOURNS

"SFR" is a trademark of Bourns, Inc. Patents Pending

BOURNS, INC., TRIMPOT PRODUCTS DIVISION • 1200 COLUMBIA AVE., RIVERSIDE, CALIF. 92507

INFORMATION RETRIEVAL NUMBER 153

Solid State vs.

Your Guardian Angel puts it all together!

Control confusion? Contact Guardian. Perhaps the solution will be a solid state device. Or, an electromechanical relay. Or, a money-saving assembly combining both! Our vast experience in solid state, hybrid and electromechanical devices assures you the most effective possible solution.

Choose the one best solution to your control design problems:

- ☐ Solid State
- ☐ Hybrid
- ☐ Electromechanical
- ☐ All of the above
- ☐ None of the above
- ☑ Ask your Guardian Angel!

Hybrid vs. Electromechanical?

1 CUSTOM CONTROL PACKAGES for sequential switching at precise intervals. In most cases, numerous standard Guardian solid state devices could do the job. But, to lower total cost, Guardian can combine electromechanical and solid state into a single package. The result? Unique solutions to specific control problems demanding adjustable time delay, priority logic, voltage sensing, circuit isolation, or virtually *any* switching problem your system might demand.

2 CUSTOM SOLID STATE CONTROL PACKAGES that put a dozen functions ranging from temperature sensing to time delay and voltage regulation in a single, miniaturized, low-cost module.

3 SOLID STATE RELAYS that perform the function of electromechanical relays with total isolation between control circuit and switching output. Standard designs for most applications—custom designs at near-standard prices!

4 SOLID STATE TIME DELAYS in just about any size, shape, form or delay range your application can demand. Need 30 minute delay? Guardian's got it. A 25 millisecond delay? We've got that, too. And they're yours right-off-the-shelf or in custom designs.

5 HYBRID TIME DELAYS AND RELAYS for low-cost, dependable solutions to perplexing design problems. At Guardian they're yours in standard and custom designs.

6 SOLID STATE VOLTAGE SENSORS that protect other controls and motors from the damaging effects of under-voltage or phase loss during power outages and "brown outs."

7 ELECTRONIC "ZERO CROSSOVER" SWITCHES that form an electrical "cushion" between signal input and load power by switching at 0.0VAC±10V.

COMPLETE APPLICATION DATA IS IN THESE TWO FREE CATALOGS.

GUARDIAN®

GUARDIAN ELECTRIC MANUFACTURING CO. • 1550 W. Carroll Ave. • Chicago, Illinois 60607

INFORMATION RETRIEVAL NUMBER 154

Think Twice:

When is a portable really portable?

HP's 1700 Series Portable Scopes Always Are...

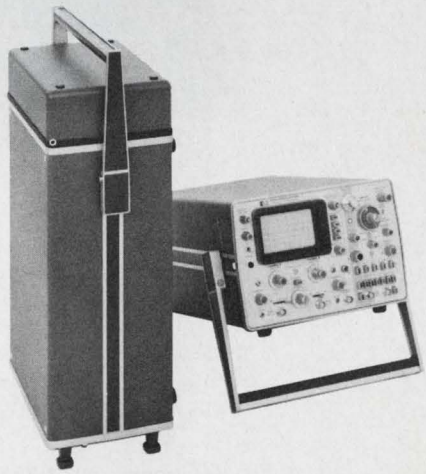
They're tough go-anywhere scopes: weatherproof, dustproof, completely self-contained. Not the kind of "portable" that's gently moved from bench to bench, trailing a power cord. With a 1700 Series scope you don't worry about the rain. Or the rough ride. Or whether, when you get there, you'll find ac or dc power—or no line power.

An HP portable gives you features you'd expect only in a big lab scope. Like a large, bright CRT that lets you see even difficult signals in high ambient lighting, ECL trigger circuits and a trigger hold-off control, and sweep linearity over the full 10 divisions of horizontal display—ideal for maximum resolution in making those critical timing measurements.

But that's just the beginning. Then the 1700 Series allows you to pick the specific features you need for your field service application: conventional or variable-persistence storage CRT; bandwidths of 35, 75, or 150 MHz; sweep speeds as fast as 2 ns/div; delayed or non-delayed sweep; selectable input impedance; bright-scan viewing mode; and a built-in rechargeable battery pack for complete measurement independence.

And we're just as proud of the things you don't get with a 1700 Series portable. No heat sinks. No fans. No ventilation holes to let in dust and moisture. That's because our circuits are designed for very low power consumption—and for long, trouble-free operation. And there's no challenge in servicing our portables. In fact, you can completely recalibrate some models in an hour or less, even if all the internal adjustments are misaligned. It's not very sporting, but this ease of servicing quickly adds up to impressive savings.

So before you choose a scope, check your requirements. Then think twice about costs and benefits. Remember, Hewlett-Packard portables let you make any measurement you need—and they cost from $100 to $250 less than comparable scopes. These 1700 Series portables are priced from $1475 to $2300 for non-storage models and from $2375 to $2725 for models with variable-persistence storage. For help in choosing the HP portable that's best for you, send for a free copy of our "No-Nonsense Guide to Oscilloscope Selection." Or contact your local HP field engineer. Hewlett-Packard, Palo Alto, California 94304. In Japan: Yokogawa—Hewlett-Packard, 1-59-1, Yoyogi, Shibuya-Ku, Tokoyo 151, Japan. In Europe: HPSA, P.O. Box 85, CH-1217 Meyrin 2, Geneva, Switzerland.



Scopes Are Changing; Think Twice.

083/1

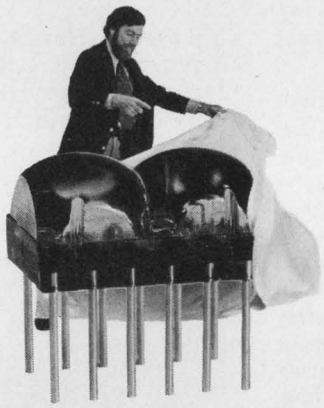
HEWLETT hp PACKARD

OSCILLOSCOPE SYSTEMS

INFORMATION RETRIEVAL NUMBER 155

LITRONIX UNVE

The Beautiful Bugs: This is the year of the DL-4 line of high brightness, low power 0.19 inch digit displays. Its integrated magnifier construction provides a handsome, clear, readable digit. It's bright: 500 ft-L at 10 mA per segment and carries many optional features; electrically isolated decimal point, left or right, pin for pin compatibility with either the MAN-1 or MAN-4. Priced at $3.90 in 100 quantities.



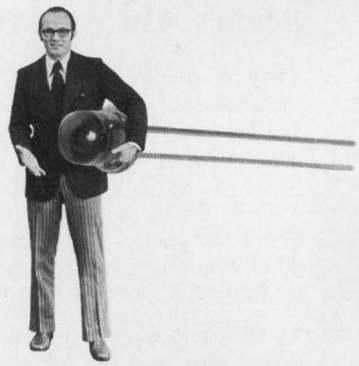
The Two-Seater Coupe: DL-44 is a matching two digit display in a single package. The integrated magnifier construction provides a 0.19 inch economy digit. Designed for multiplexing, the desired digit is displayed by selecting the appropriate cathode. Offers 500 ft-L high brightness at a low power of 10 mA and shipments are categorized for uniform brightness. Priced at $6,80 in 100 to 999 quantities.

The Sporty Model: RL-50 is a small, solid-state lamp with pick-up to 750 ft-L at 20 mA. Its rugged body construction allows superior lead-to-package integrity. The 80 mil package

the bright guys

width permits mounting within .087 mil centers of a common card reader. Operates from 5 volt IC supply and will give you many years of carefree operation. Options: red diffused, red color or white diffused. Priced at $.39 in 1,000 quantities.

Lights Mounted Where You Can See Them: The RL-4403/4440 have a viewing area that extends .140 inch beyond the face of the mounting clip. Its full flood 0.2 inch diameter viewing area allows extra wide, off-angle viewing. And it's bright, .8 mcd (minimum) at 20 mA on only 1.7 volts. It can be easily soldered directly to the PC board, or mounted from the front of a panel with a snap-in clip. Direct replacement for the 5082-4403/4440. Priced at $.49 to $.65 in 1,000 quantities.



The Little Old Lady from Burbank loves her tiny T1 solid-state lamp. It will last forever, requires no gas, it flashes, and is IC compatible. Such a little

Litronix, Inc. • 19000 Homestead Road • Cupertino, California 95014 • (408) 257-7910 TWX: 910-338-0022

Distributors
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Compar, Scottsdale (602) 947-4336
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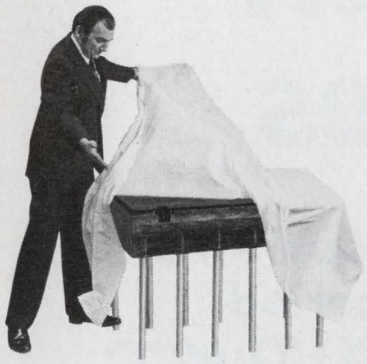
.S 1973 MODELS

thing giving off .5 mcd at 20 mA, imagine! Has standard 1 inch leads. Options: red clear, white diffused, water clear. Priced low at $.33 to $.42 in 1,000 quantities.



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LR-613A-FM	0-40	1.0	0.9	0.75	0.6	305
LR-615A-FM	0-120	0.33	0.29	0.25	0.21	320
LR-616A-FM	0-250	100 mA	90 mA	80 mA	70 mA	340

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LR-615-DM	0-120	0.33	0.29	0.25	0.21	445
LR-616-DM	0-250	100 mA	90 mA	80 mA	70 mA	445

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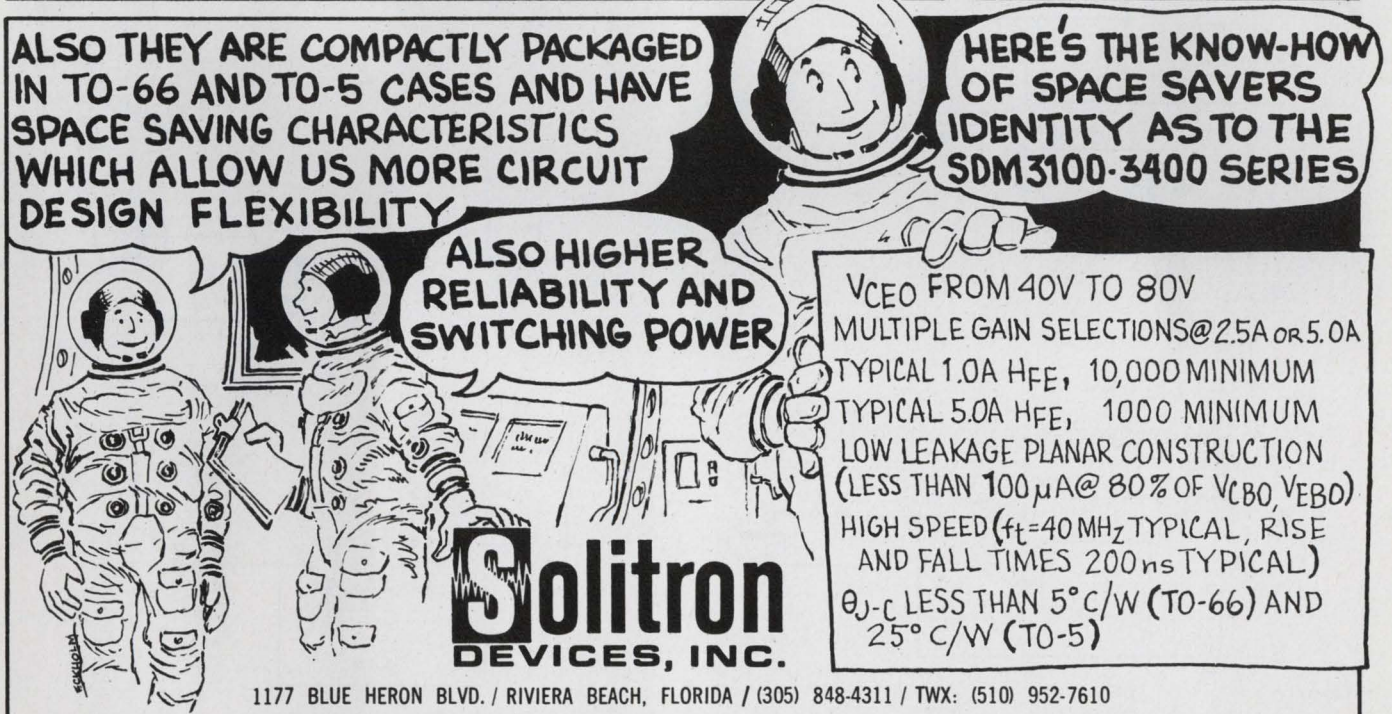

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INFORMATION RETRIEVAL NUMBER 87

ideas for design

Quad op-amp comparators allow continuous monitoring of two inputs

A single IC amplifier chip can be used to monitor the high and low limits of two power-supply lines in a system. And the circuit does not require a dual power supply to perform this function.

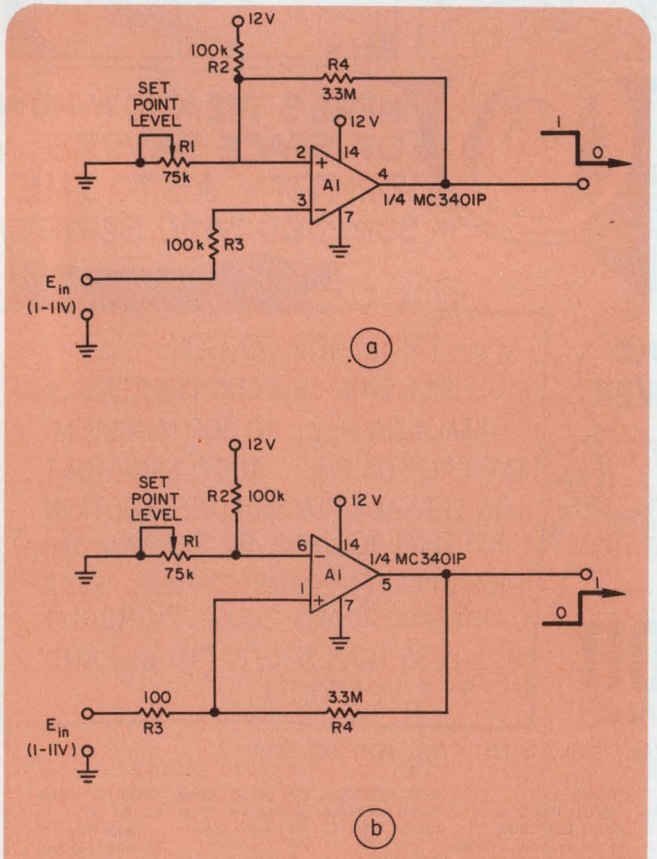
Individual amplifiers can be used as basic comparators (Fig. 1) for operation in one of two ways. The output makes either a high-to-low transition (Fig. 1a) or a low-to-high transition (Fig. 1b) when the input signal exceeds the set-point level. In each case the 3.3-MΩ feedback resistor adds some hysteresis. But its main function is to narrow the band of uncertainty.

A combination of the two basic comparator circuits provides the bracket-type voltage monitor shown in Fig. 2. Amplifier A_1 determines the lower set point and A_2 the upper set point.

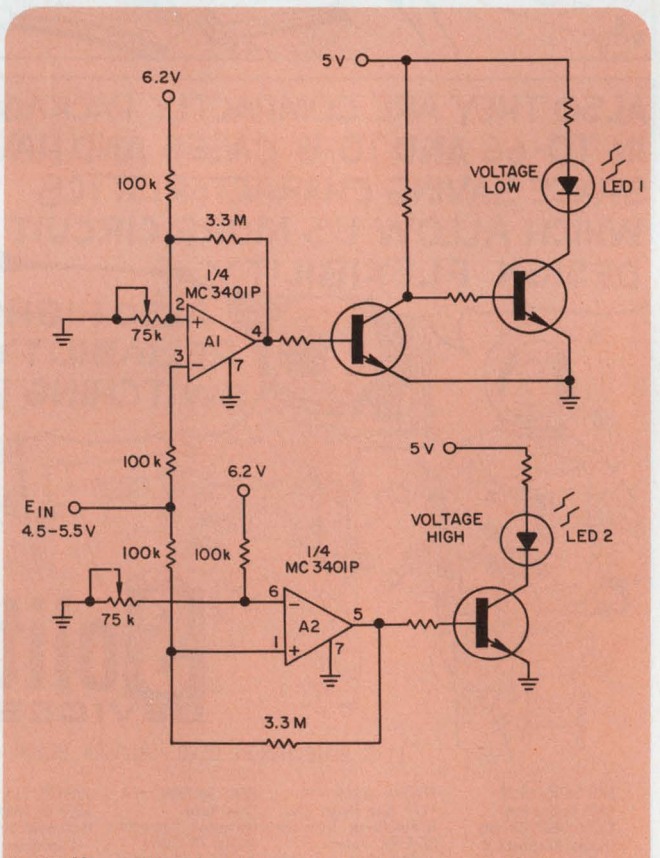
With a reference of 12 V, the set points may be varied from 1 to 11 V. Hysteresis is approximately 10 mV for a set point of 5 V. The individual comparator circuits draw approximately 12 μA from their respective reference and input circuits and about 4 mA from the power-supply line.

Joseph Kish, Diebold, Inc., Canton, Ohio 44709.

CIRCLE NO. 311



1. **Typical comparators** use single-ended IC amplifiers. The outputs remain high (a) or low (b) for input signals below the set point.



2. **Use of the two comparator types** provides over/under voltage monitoring of a single line. One quad IC chip permits monitoring of two input voltages with respect to ground potential.

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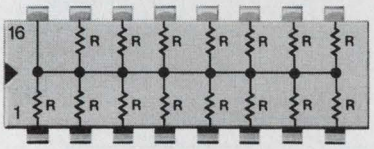
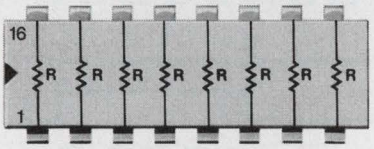


898-1 (15 resistors)
Price (1,000-4,999) $.85

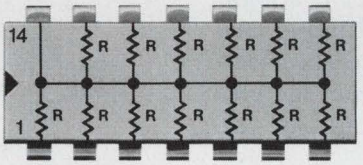


898-3 (8 resistors)
Price (1,000-4,999) $.76

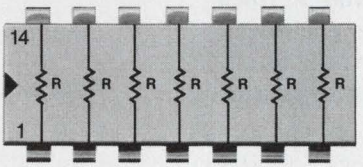
STANDARD RESISTANCE VALUES
(±2% or ±2Ω)

62*	110	330	1.0K	2.2K	6.0K 15.0K
68	150	470	1.5K	3.3K	6.8K 22.0K
100	220	680	2.0K†	4.7K	10.0K

*Standard in 898-3 only.
†Standard in 898-1 only.



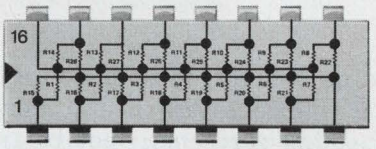
899-1 (13 resistors)
Price (1,000-4,999) $.81



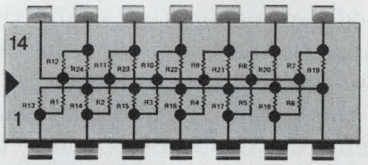
899-3 (7 resistors)
Price (1,000-4,999) $.72

STANDARD RESISTANCE VALUES
(±2% or ±2Ω)

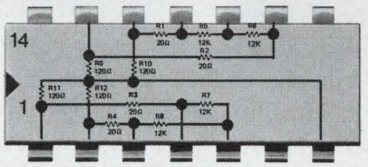
22	62	180	510	1.5K	4.3K	11K
24	68	200	560	1.6K	4.7K	12K
27	75	220	620	1.8K	5.1K	13K
30	82	240	680	2.0K	5.6K	15K
33	91	270	750	2.2K	6.0K	16K
36	100	300	820	2.4K	6.2K	18K
39	110	330	910	2.7K	6.8K	20K
43	120	360	1.0K	3.0K	7.5K	22K
47	130	390	1.1K	3.3K	8.2K	
51	150	430	1.2K	3.6K	9.1K	
56	160	470	1.3K	3.9K	10K	



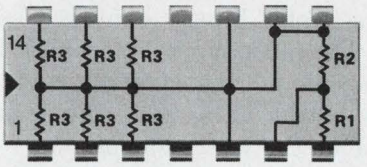
898-5-R220/330
Pulse squaring TTL terminator.
Price (1,000-4,999) $1.45



899-5-R220/330
Pulse squaring TTL terminator.
Price (1,000-4,999) $1.35



899-19
DIP interface network providing resistors for μA711 core sense amplifier configuration.
Price (1,000-4,999) $1.18



899-40
DIP network provides six line terminators and the threshold setting divider for the Intel 3208A sense amplifier.
Price (1,000-4,999) $1.35

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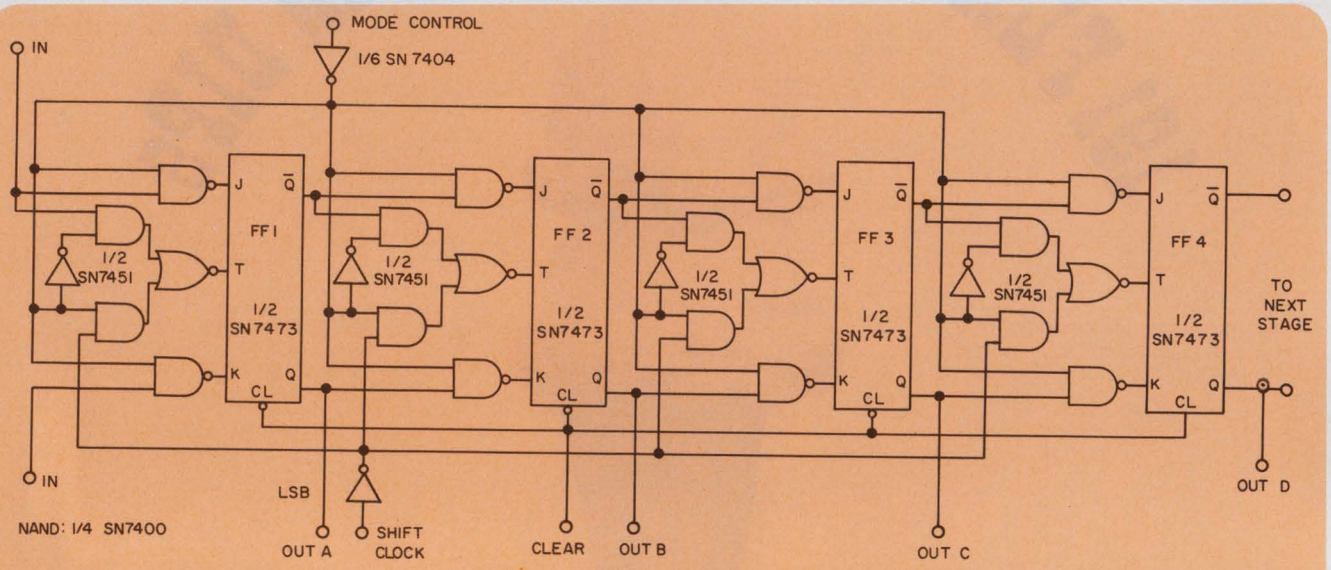
INFORMATION RETRIEVAL NUMBER 23

Shift option improves handling of binary counter data



1. **Mode control** allows this set of J-K flip-flops to count input transitions or right-shift stored data. Larger c-s registers can be obtained by cascading four-bit stages.

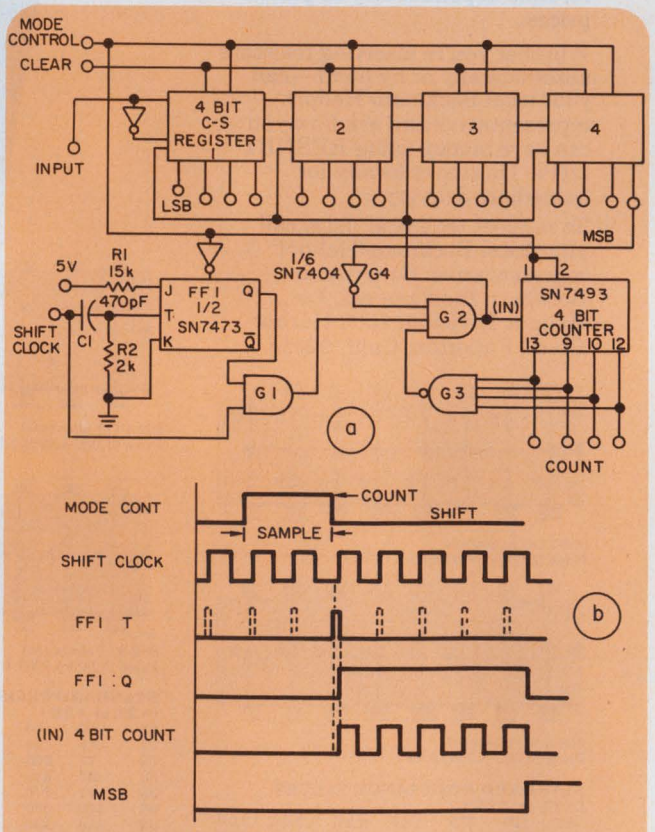
Adding a count/shift mode control to a binary counter improves its usefulness in two ways: (1) Leading zeros need not be transmitted, and (2) Data can be truncated to accommodate any size of parallel channel. Both objectives are achieved by using the count/shift control to right-justify the count data in the register.

When the mode control input (Fig. 1) is a logic ONE, the J and K inputs of each flip-flop are ONE and the $\overline{Q}$ output is connected to the clock terminal of the succeeding flip-flop. Thus the circuit provides a left-justified binary count of the input transitions.

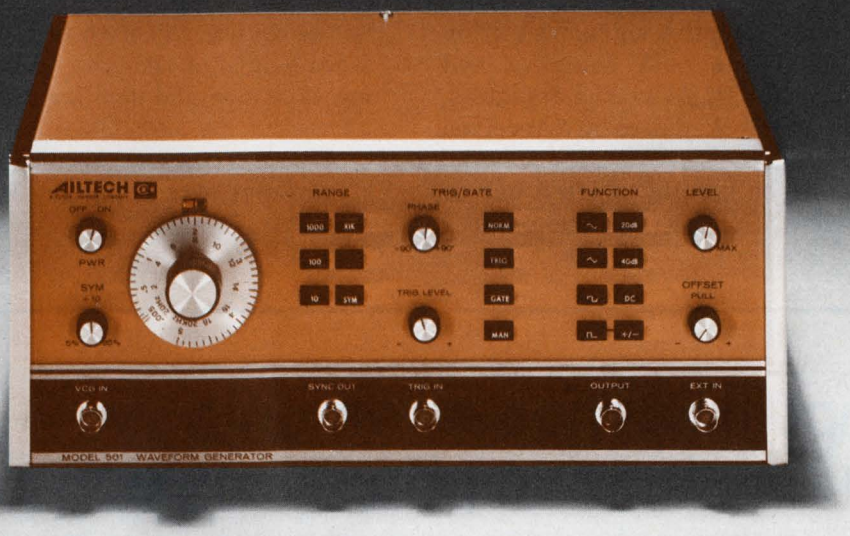
A logic ZERO on the mode control allows right-shifts via the shift-clock line. The J and K lines of each flip-flop are connected to the preceding flip-flop's Q and $\overline{Q}$ outputs, respectively; the shift-clock signal is applied to the clocking inputs of all the flip-flops.

Cascaded four-bit counter-shifter (c-s) circuits form a 16-bit binary counter/register (Fig. 2). When the mode control signal is logic ONE, FF_1 is cleared and the circuit provides left-justified binary count data with the least-significant-bit (LSB) at the leftmost position.

After the sampling period, the mode control signal is made a logic ZERO. The leading edge of the next clock pulse then changes the Q output of FF_1 to a logic ONE. This enables shift-clock pulses to the register and to the four-bit counter. The data are shifted to the right until a most-significant bit (MSB) is detected at the register



2. **Count data are shifted right** (a) until clock pulses are inhibited by the detection of a ONE on the MSB line. FF_1 is in the circuit to insure that only those clock pulses following the sampling period shift the data (b) to the right-justified position.



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terminal that is farthest to the right. Detection of the MSB at G_2 inhibits both counting and shifting. If there are no ONEs in the registers, shifting stops after 15 clock pulses are received by the counter.

The MSBs can now be serially shifted out or wired to other devices. Subtracting the number in the counter from 16 tells the user the required word length of the data to be transmitted in case message size and sending time are important.

Akavia Kaniel, Design Engineer, Digital Equipment Corp., 146 Main St., Maynard, Mass. 01754
CIRCLE No. 312

Two amplitude measurements determine unknown phase angle

An oscilloscope or ac meter with provision for differential inputs can provide phase-angle measurements with accuracies of better than one degree.

If two sinusoidal signals of the same frequency are subtracted, the magnitude of the difference signal will be a minimum when the amplitudes of the two signals are equal. It can be shown that this minimum value, V_{min}, is

$$V_{min} = 2\,E \sin(\Theta/2),$$

where Θ is the unknown phase angle and E is the amplitude of each sine wave. If both V_{min} and E are measured, Θ can be computed from

$$\Theta = 2 \sin^{-1}(V_{min}/2E) \qquad (1)$$

A practical method for instrumenting such measurements is shown in the accompanying schematic. First, the selector is set to the null position and the potentiometer adjusted for a minimum reading (V_N). Next, the selector is set to the "cal" position and the reading, V_E, noted. The value of Θ is found from

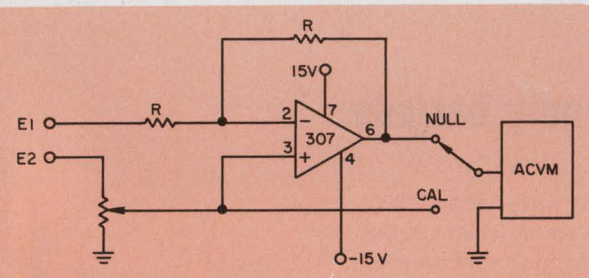
$$\Theta = 2 \sin^{-1}(V_N/4V_E), \qquad (2)$$

which for values of Θ that are less than 15 degrees can be approximated by

$$\Theta \simeq 28.6\ (V_N/V_E). \qquad (3)$$

Where less accuracy is needed, use a differential scope and calculate Θ from Eq. 1.

S. J. Pirkle, Project Engineer, Hewlett-Packard Medical Electronics Div., 175 Wyman St., Waltham, Mass. 02154.
CIRCLE No. 313



The phase angle between E_1 and E_2 may be determined by measuring signal magnitudes in the null and "cal" positions. Before measurements are taken, the potentiometer is adjusted for a minimum signal at the op-amp output.

IFD Winner of November 23, 1972

Jack Mattis, Linear Product Marketing, Signetics, 811 E. Arques Ave., Sunnyvale, Calif. 94086. His idea "Missing-pulse detector reacts to 100-ns pulse widths" has been voted the Most Valuable of Issue Award.

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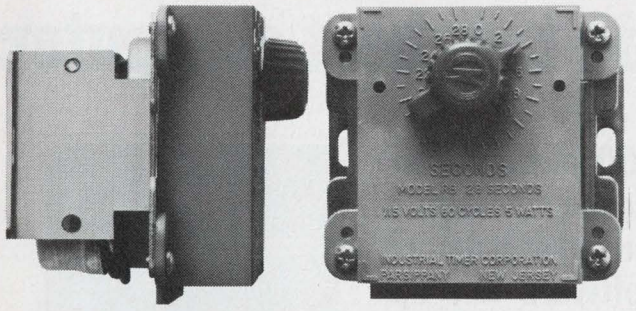

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INFORMATION RETRIEVAL NUMBER 32

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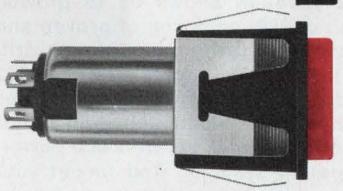

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INFORMATION RETRIEVAL NUMBER 34

Introducing the new, faster Rolm 1602 Ruggednova..the world's toughest computer.

Tough enough to meet Mil Specs E-5400 airborne environment and E-16400 shipboard environment with a more powerful interrupt structure, expanded instruction set, extensive I/O interfaces, proven software and upward compatibility with Data General's Nova Series.

Here is the most complete mil spec computer system you can buy. The heart of the 1602 is a 16-bit, rugged and powerful microprogrammed processor with a 1 microsecond core memory cycle time . . . but the total package is a lot more.

MORE SOFTWARE THAN ANY MIL SPEC COMPUTER

Our licensing agreement with Data General Corporation allows us to provide you with a wide selection of proven and documented software. Any program written on the Nova will operate on the 1602 Ruggednova. Our software set includes assemblers, compilers, debugging aids, utility routines, math libraries and powerful operating systems. And to get your software started immediately, we have a 1602 assembler that runs on the Nova series of machines.

This snow cat carries a Ruggednova interfaced with two radar systems to help map the Canadian glacial fields.

OVER 30 GENERAL-PURPOSE INTERFACES

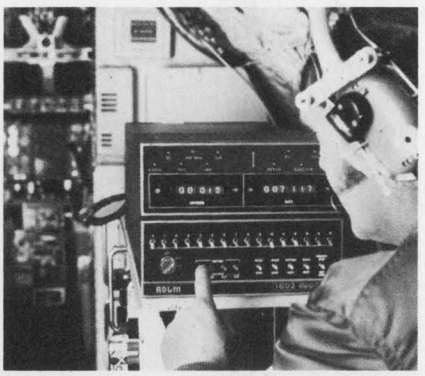
Most military computers are required to interface with more kinds of devices than any other class of computer. That's why Rolm makes available a wide selection of general purpose I/O interfaces for the 1602. These range from serial and parallel digital interfaces to communication interfaces to D/A and A/D converters . . . all the way to NTDS interfaces. They can give you an edge when you go after those contracts. No design costs. No technical risks.

AN EXPANDED INSTRUCTION SET SAVES YOU TIME

Military applications place more rigorous demands on computer execution time and memory requirements than do commercial applications. That's why we expanded the 1602 instruction set beyond the basic Data General set. This gives you increased computational and memory reference capabilities plus reduced program storage and execution time. New instruction types include: stack-oriented instructions, exclusive and inclusive "or," n-bit shift capability, signed and unsigned multiply-divide, double precision arithmetic, a powerful new file search instruction and a special interrupt branching and nesting feature.

A UNIQUE APPROACH TO YOUR SPECIAL INTERFACES

The 1602 is designed so that you can place your special interface inside the chassis. We can provide you with I/O cards with room for 42 integrated circuits and 55 pins to connect your interface to the outside world or other cards in the chassis. You don't have to design a rugged chassis or power supply, plus your interface is qualified to Mil E-5400 and Mil E-16400 by similarity. One of our customers followed this approach in totally packaging an Omega Navigation Set within a Ruggednova chassis.



Ruggednova, shown above, is aboard a Sabreliner jet performing data acquisition and navigation functions for atmospheric research.

MEETS MIL SPECS E-5400 AND E-16400

The 1602 has been designed to meet Mil-E-5400 airborne environments, Class II; Mil-E-16400 shipboard environments, Class I; Mil-Std-461A electromagnetic interference and Mil-S-901 for high impact shock. It has an operating temperature range of −55° to +95°C case temperature, at altitudes from sea level to 80,000 feet. It meets shock specifications of 15 g's with 11 ms duration and vibration tests of 10 g's, 5 to 2000 Hz. Then there are the requirements for humidity, sand and dust, salt spray, salt fog and fungus. The 1602 meets or exceeds them all . . . to become the world's toughest computer.

A FULL LINE OF PERIPHERALS

We can provide you with peripheral devices in every major category . . . fully integrated and documented. These include tape and disc storage units, communication interfaces, line printers, and paper tape equipment . . . plus software that enables you to easily use these devices.

PROVEN IN OVER 300 APPLICATIONS

Ruggednovas have been used in over 300 applications in the past 3 years. The software has been used in over 4,000 systems. These range from helicopter transportable communication systems to shipboard fire control to scientific exploration on a snow cat. If it moves, it should be a Ruggednova.

ATTENTION PROGRAM MANAGERS

The Ruggednova is a complete package of hardware and software. Now, let's talk about the support package you get at no cost. These are items which can reduce your budget and design risk at the same time. We can give you detailed reliability reports, provide two weeks of training, supply a complete documentation package and top it off with a 90-day warranty. We also give you a "how to" software manual, individual software write-ups, and full diagnostic software. And you don't have to worry about qualification tests . . . we are doing them for you. All of this adds up to savings and success for your program.

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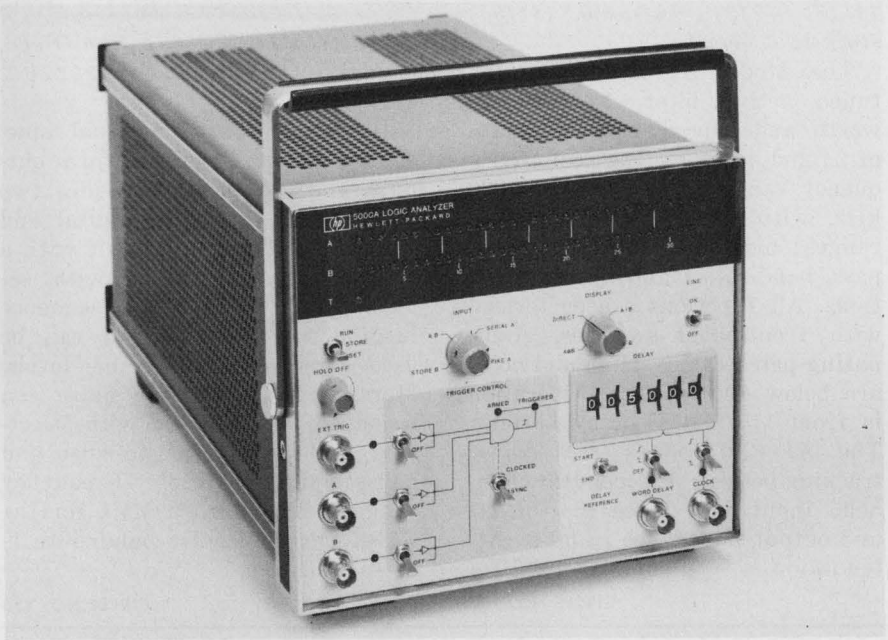
INFORMATION RETRIEVAL NUMBER 36

new products

Logic analyzer displays up or downstream data bits



Hewlett Packard, 1501 Page Mill Rd., Palo Alto, Calif. 94304. (415) 493-1501. P&A: See below.

Here's a new way to troubleshoot or analyze digital logic. Capture the data bits and display them individually with LEDs. An instrument that does that is HP's new logic analyzer. Designated the 5000A, it uses two rows of LEDs to show the HIGH and LOW logic bits for two independent serial inputs, referenced to a system clock.

What can the 5000A do that an ordinary scope or logic probe can't do? It can store data; it can compare data on two independent input channels; it can look at selected bits way downstream—or even upstream—in a data sequence; and it can capture bursts, single-shot or continuous events.

The data input and display sequence go like this: After a trigger is received, the unit simultaneously samples the state of the two input signals on either the positive-going or negative-going transition of each of the next 32 clock pulses. The display advances one LED for each clock cycle until the 32-bit registers are filled.

Digitally controlled triggering lets the user begin the display from a digitally selectable point in the data stream, while clocking in the data synchronizes the analyzer to the circuit under test, thereby ensuring a repeatable display. And since the display shows logic states by clock cycles, it's easy to compare it with truth tables or timing diagrams.

A wide choice of triggering is offered, including an external trigger, either input signal, or logical combinations of all of these. Logic circuitry drawn on the front panel symbolizes the triggering process.

Thus any HIGH-LOW combination of the three signals can be selected as the trigger word. Any input not needed for triggering can be switched to a "don't care" state.

All inputs, including the clock, are monitored by LED annunciators. These act as logic probes to indicate dynamically the input states, including pulse trains.

If the data of interest don't immediately follow the trigger, the 5000A provides a variable digital delay that moves the 32-bit display an exact number of clock pulses—up to 999,999—relative to the trigger. Just dial the appropriate number into the thumbwheel register.

And since the analyzer always has access to the last 64 bits of input data, events occurring up to 64 clock pulses prior to triggering can be displayed. Thus the display window can be moved back in time as well as forward. This is particularly useful for locating data that cause an error.

You can combine the digital delay, digital triggering and single-shot features of the 5000A to capture and display any portion of a long, single-shot data sequence, such as that occurring in calculator circuits. Aslo, a "spike" mode detects and relates occurrence of a spike to the exact clock cycle in which it occurs.

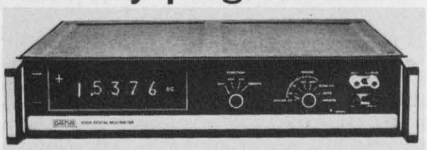
Other modes of the 5000A analyzer include a serial mode, in which the two 32-bit display registers are cascaded to form a single 64-bit register; a store mode, in which B-channel data are locked in while the A register is updated at each trigger; and a comparison mode, in which the analyzer logically compares the two inputs, A and B, and displays the results. The functions $A \cdot B$, $A + B$ and $A \oplus B$ are provided.

Because of its variable threshold (± 1.4 V), the 5000A is compatible with all digital logic families. And the 1-MΩ, 25-pF input impedance can be raised to 10 MΩ, 10 pF, with 10:1 probes. When probes are used, the threshold is extended to ± 14 V.

Other specs include a maximum clock rep rate and minimum clock pulse width of 10 MHz and 15 ns, respectively, and a minimum trigger pulse width of 40 ns. Tentative price of the 5000A is currently $1900. Deliveries are scheduled to begin in mid-April.

CIRCLE NO. 250

$1095 DMM can be remotely programmed



Dana Laboratories, 2401 Campus Dr., Irvine, Calif. 92664. (714) 833-1234. $1095.

Model 4700A DMM is a combination systems and laboratory four-digit measuring device. It provides five dc ranges, four ac ranges, six ohm ranges, isolated BCD output and remote programming, all as standard. Also, the 4700A maintains 0.01% dc accuracy for 90 days. The unit includes full autoranging or manual selection of range in every function. By selecting the desired function, the operator can read dc from 10 μV to 1000 V, ac from 100 μV to 500 V, and resistance from 10 milliohms to 20 MΩ. 100% overrange is available in all functions. CMR is 100 dB.

CIRCLE NO. 251

Digital filter offers cutoff freq to 0.001 Hz

Multimetrics Industries, 120-30 Jamaica Ave., Richmond Hill, N.Y. 11418. (212) 441-4240. $1195; stock to 2 months.

The Model AF-420L, digitally-tuned active filter, has Butterworth and time-domain responses of 24 and 48 dB/octave; cutoff frequency range of 0.001 Hz to 9.99 kHz, with ±2% accuracy on all ranges; high-pass, low-pass, band-pass, band-reject and bypass functions. All functions are performed with front-panel switches, eliminating patch cables. Hum and noise are below 100 μV rms. Operation is from 115/230 V or by battery. The AF-420L offers ±2° phase tracking between independent channels, input impedance = 10 MΩ and output impedance = 50 Ω. Attenuation is 80 dB min to 1 MHz.

CIRCLE NO. 252

Function generator is also noise generator

Wavetek, P.O. Box 651, San Diego, Calif. 92112. (714) 279-2200. $795; 30 days.

In addition to the usual sine, square and triangle waveform outputs, the Model 132 provides two unique noise outputs—digital and analog. By driving the unit with a pseudorandom sequence with selectable clock rates and sequence lengths, the noise output can be used directly at adjustable levels. More significantly, the noise can be added to the signal with selectable calibrated signal-to-noise and noise-to-signal ratios. Frequency range is 0.2 Hz to 2 MHz for the waveforms and noise bandwidth is dc to 100 kHz.

CIRCLE NO. 253

Signal source? DMM? Counter? It's all three

Systron-Donner, Datapulse Div., 10150 W. Jefferson Blvd., Culver City, Calif. 90230. (213) 836-6100. Approx. $1250; June.

One instrument puts it all together. Called the Versatester I, the unit generates sinusoids, square waves and pulses from 20 Hz to 20 MHz; provides ±15 and +5-V power for TTL, linear and MOS circuits; measures and provides a 4-digit display of ac/dc volts and ohms; and, finally, measures and displays frequency or count to 20 MHz.

As a source, the Versatester provides 3-V rms sinusoids with a setting accuracy of at least ±0.1%, and with less than 0.5% distortion to 500 kHz. Distortion to 2 MHz is −40 dB, and to 20 MHz it's −30 dB. Hum and noise are 60 dB down. As for square waves, setting accuracy is also ±0.1%, transition times are approximately 5 ns and amplitude is 5 V pk-pk max. Both upper and lower voltage levels are variable.

Pulses can be delayed from 20 ns to 20 ms and width can be varied from 20 ns to 20 ms. Transition times are also about 5 ns. Amplitude is 5 V.

Measurement capabilities include dc V from ±0.2 to 2000 V with an accuracy of ±0.1% of reading ±1 digit; ac V from 0.2 to 200 V with 3% accuracy to 1 MHz and ±7% above; ohms from 1 Ω to 20 MΩ, with ±0.2% accuracy ±1 digit; and frequency or totalize from 20 Hz to 20 MHz with a sensitivity of 100 mV. Time base stability of the 4-digit counter is ±1 part in 10^6. Input impedance is 1 MΩ on ac V and count, and 10 MΩ on dc V. All specs are tentative.

CIRCLE NO. 254

Line printer for minicomputer offers high speed at low cost

Pertec Corp., 9600 Irondale Ave., Santa Ana, Calif. 92705. (213) 882-0030. $4000-$6000; Mid-April.

Many important minicomputer applications—such as key-to-tape entry, in-house time-sharing and word processing—call for a modestly priced line printer that can operate at high rates. Pertec's Model P-7330 meets this demand with a 300 line/min, 132 column-printout for $1000 less than the closest comparable device, Data Products' Model 2230.

Other manufacturers offer 200 line/min units. In moderate quantities the Tally Model 2200 costs $3000 to $4000, while Nortek's unit costs $6000 to $8000.

The Pertec unit can print an original and five copies with full 132-column width. An ASCII 64-character set is standard, but with an optional 48-character ANSI Fortran subset, the printing speed increases to 385 line/min. Tractor width can be set to accommodate 3.5 to 14-7/8 in. forms.

An electronic top-of-form control is provided, and an operator or the data source can determine pagination. Also, the data source can specify line skips. Perforation skip-over is automatic.

The basic printing mechanism is a high-speed hammer that strikes a thin, circular character band. The character band is a metal strip with etched character and timing marks; it is driven by a closed-loop velocity servo. Each hammer consists of a flat spring of magnetic material, an impacting head and a copper field winding. Hammers have a life expectancy of five years, based on operation at 16 hours a day with a 20% duty cycle.

Data or control-code transfer occurs on a sequential basis with use of seven-bit parallel ASCII coding. A demand line (printer) remains valid except during printing or acceptance of a character. A data strobe (source) indicates to the printer that a character awaits action by the printer. Printing occurs when the 132-character printer buffer is full. All logic levels are TTL-compatible.

Character bands are easy to replace. Optional 48 or 96-character units are available. Other options include a paper-tape, vertical-format control, with 12 channels, stylized characters (Open Gothic, 0.095 inch high by 0.065 inch wide, is standard), and a quiet version of the printer.

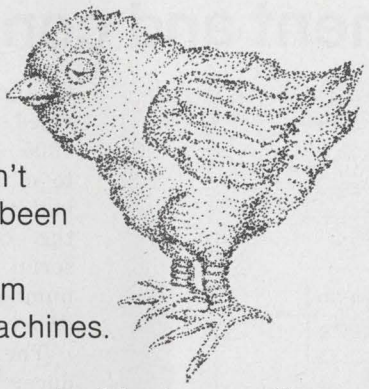
For Pertec **CIRCLE NO. 255**
For Data Products **CIRCLE NO. 256**
For Tally **CIRCLE NO. 257**

CPU operation altered by I/O peripheral

Memory Systems, 3341 W. El Segundo Blvd., Hawthorne, Calif. 90250. (213) 772-4220. from $4298; 60 days.

On-line alteration of microinstructions is possible with this electrically alterable plated-wire ROM designated the OmniROM. The unit consists of plated wire memory and controller designed to attach to both the I/O bus and the ROM bus of an Interdata Model-70 minicomputer. During the load operation, the unit appears as a standard I/O device to the host computer, and data may be read or written to the OmniRom. Once a program-driven switch sets the unit to the "run" status, connection to the I/O bus is inhibited and the connection to the ROM bus is enabled. Host CPU microinstructions are fetched from the OmniROM instead of the host computer ROM. The result—customized firmware which can alter the host computer's command structure in real time. Units are priced from $4298 for 1-k memory and $5500 for 2-k which includes cabinets, controls, cabling, power supply and documentation. **CIRCLE NO. 258**

This switch does everything from mother baby chicks to brew fresh coffee.

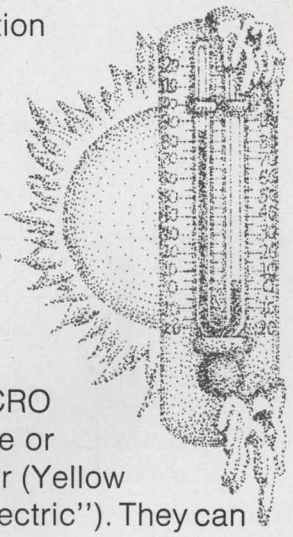


You've probably used our versatile V3 snap-action switch a thousand times and didn't know it. Since 1947, it's been standard equipment on applications ranging from incubators to vending machines.

It offers thousands of variations in circuitry, electrical capacity, actuators and terminals.

For example, various contact designs provide switching capacities that range from milliamps to a ½ hp rating. A choice of integral or auxiliary actuators turns difficult jobs into routine ones. While a selection of terminals, including screw and quick-connect, further uncomplicates your application.

For special jobs, there are special versions. Some can handle temperatures down to —100°F. Others with hi-temp construction can operate at up to +600°F. And still other specials meet UL standards for TV ratings.



The V3 offers this versatility without sacrificing quality or low price.

Contact your MICRO SWITCH Branch Office or Authorized Distributor (Yellow Pages, "Switches, Electric"). They can provide everything from more information to actual products.

Actual Case Size:
1.094" long x 0.625" high x 0.4" deep

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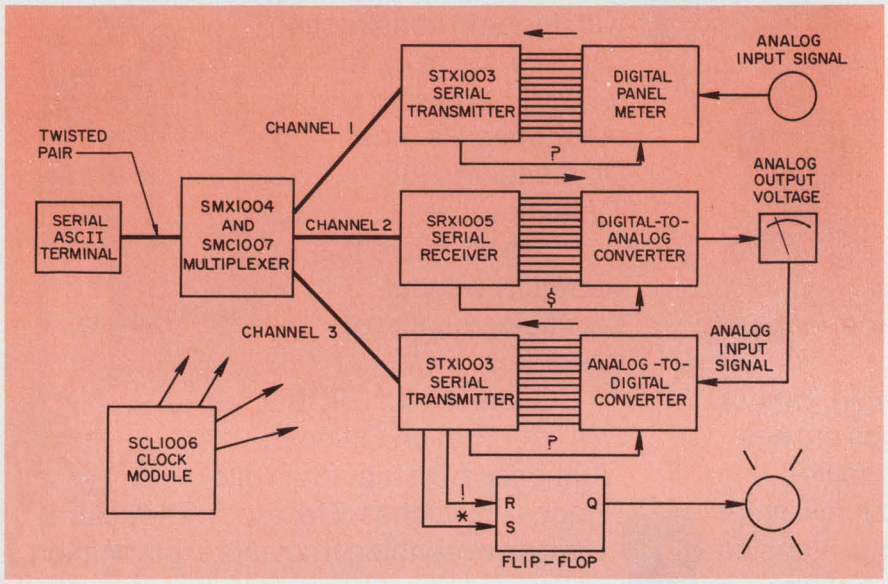
INFORMATION RETRIEVAL NUMBER 40

Serial-data modules simplify automation of process measurement and control



Analog Devices, Inc., Route 1 Industrial Park, P.O. Box 280, Norwood, Mass. 02062. (617) 329-4700. See text; stock.

Automating all or part of a production-process, inventory-control system or a laboratory test setup can be easier than you think. A handful of modules, costing about $1000, and an ASCII input/output device—a teletypewriter, say—might do the whole job. If you want computer control, just connect the system to the computer's teletypewriter I/O port.

Inexpensive a/d and d/a converters (less than $100 apiece), placed at each analog data point, are connected to one of Analog Devices' new series of Serdex (Serial Data Exchange) modules. The modules exchange serial ASCII messages, conveying commands or data between a teletypewriter and the converters.

A single twisted-pair cable can hook up from one to 256 converters over distances up to 10,000 feet. Since standard ASCII characters are used, a computer with control programs written in, say, FOCAL or BASIC can replace the keyboard terminal. No assembly or machine-language programming is necessary.

At present the Serdex modules consist of the STX1003 serial transmitter ($179), SRX1005 serial receiver ($179), SMX1004 and SMC1007 multiplexer subassemblies ($139 and $75, respectively) and the SCL1006 clock module ($65). Prices quoted are for quantities of 1-9.

To demonstrate the versatility of the system, Analog Devices has hooked up a sample configuration (see diagram). In response to a character sequence consisting of the symbol # followed by the required channel number, the multiplexer selects the channel over which data will be sent or collected. For example, the two-character sequence #1 selects Channel 1. A given channel remains enabled until another selection sequence is sent. A single multiplexer handles up to 16 channels. The number of channels can be increased by pyramiding multiplexers.

If Channel 2 is selected, the transmission of an equal sign (=), numeric digits and the dollar symbol ($) will change the DAC output signal. The $ sign signals the DAC to accept the value specified by the digits. Up to eight BCD digits can be processed simultaneously by the SRX-1005. These digits are formatted to a maximum of 32 parallel bits and placed on the input lines of the commanded device. Use of serial transmission minimizes the number of connections between the data source and the terminal.

The user reads a given transducer output by sending a question-mark character (?). Receipt of this character provides a Start-Conversion signal for the ADC. After completing the conversion, the ADC signals the STX1003, and that unit sends the result to the teletypewriter in the form of ASCII numeric characters. Another device should not be addressed until this query-response cycle is completed.

Both the transmitter and the receiver can forward decoded digital commands. Individual lines provide an output pulse on receipt of characters !, *, ? or $. The pulse can activate control or display devices and other circuits, such as the flip-flop shown.

A 20-mA current-loop system links the terminal with the multiplexer (or receiver/transmitter in the case of a single channel). Information is sent by keying the current on and off. This method of communication, in conjunction with opto-electric isolators, ensures reliable operation despite the common-mode noise found in industrial environments. However, the data rate is limited to 50 readings/sec by the photo couplers, though the logic circuits will work at up to 20 k baud.

All modules have 0.025-in. square wire-wrapping pins and require a 5-V dc supply. The largest unit, the multiplexer, measures 4.25 × 3.3 × 0.625 in. Each measuring station requires a clock module (2.1 × 2.1 × 0.6 in.). One clock can serve up to four stations, provided they are near one another.

CIRCLE NO. 259

RCA introduces its one-transistor Darlington.

No we haven't changed the Darlington circuit. We've just turned it into the Darlington transistor. By putting the whole circuit on a single monolithic chip.

In the RCA Darlington transistor design, optimum use of the silicon real estate and single level metallization provide improved performance characteristics. You get greater control over parameters and increased peak current handling capacity . . . up to 15 amps.

It's all spelled out in black and white. $I_{S/B}$ $E_{S/B}$ and Thermal Cycle ratings are all specified . . . even the output diode is characterized.

And they don't come any more rugged. All steel (TO-3) package, controlled solder chip mounting and heavy duty clip connections make the RCA Darlington transistor a dependable workhorse in your system.

So if you're working with discretes, you can now get higher packaging densities, lower your overall system cost and, at the same time, increase system reliability by reducing the number of external connections.

Why not give your system the advantage of all these benefits by switching from the Darlington circuit to the RCA Darlington transistor. It's at your distributor, waiting for you right now in the following configurations:

TO-3 pkg.	T_D@25°C	VERSAWATT plastic pkg.	T_D@25°C	$V_{CEO(sus)}$ $V_{CER(sus)}$
2N6385	100W	2N6388	40W	80V
2N6384	100W	2N6387	40W	60V
2N6383	100W	2N6386	40W	40V

Want more data? Write RCA Solid State, Section 57D1/UTL37, Box 3200, Somerville, N.J. 08876. Phone (201) 722-3200.

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products that make products pay off

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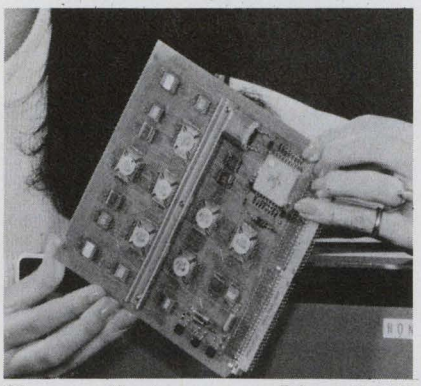
INFORMATION RETRIEVAL NUMBER 41

Mil spec CPU handles tactical assignments



Honeywell Aerospace Div., 13350 U.S. Hwy. 19, St. Petersburg, Fla. 33733. (813) 531-4611. From $2000 (qty 1000).

Model HDC-301 central-processor unit is designed for direct integration into the chassis of missile guidance or aircraft avionics packages. The CPU is housed on a single 6.25 × 6.35 × 0.5 in. PC board, requires 6 W of power and meets MIL 5400, class II reliability spec. Operating characteristics include 10-bit parallel I/O, direct memory access, a single system interrupt and 16-bit instructions. Multiply and divide speeds are 21 and 65 μs respectively. A separate memory unit for data and instructions must be supplied by the user.

CIRCLE NO. 260

Desktop digitizer uses ordinary pen as cursor

Elographics, P.O. Box 388, Oak Ridge, Tenn. 37830. (615) 482-4039. $2990; 30 days.

Touch any coordinate point with a conventional ball-point pen, wait 500 ms and the coordinates will be available in parallel BCD form (TTL compatible). Model E231 displays the coordinates on two DPMs, and in addition furnishes a "print" signal for transferring the above data once digital conversion is completed. Scales for the X and Y coordinates can be set independently of one another. Any arbitrary point can serve as coordinate origin. The work area measures 11 by 15 in. and the system resolution is 0.1 mm.

CIRCLE NO. 261

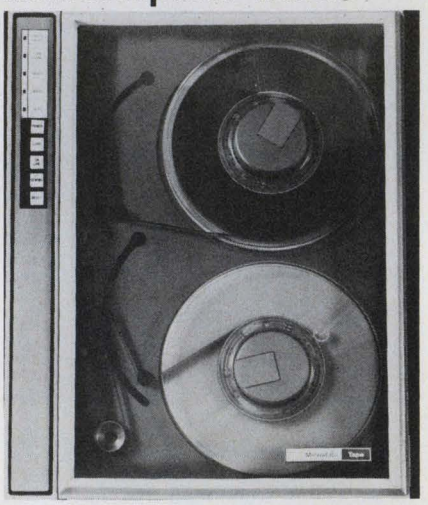
Graphics terminal mixes data, graphics and TV

Computek, Inc., 143 Albany St., Cambridge, Mass. 02139. (617) 864-5140. $3900; 45 days.

The Computek Series 300 terminals allow the combined display of vector graphics, alphanumeric data and television images. These terminals can receive video signal images and display them as background to characters and graphical data like those derived from a computer. Combined visual data can be edited by the user and directed to other terminals or monitors. An unlimited number of vectors and over 1000 characters may be individually edited on a 256 by 256 grid. A complete Fortran-based software package, furnished with each terminal, enables plotting, formatting, editing and interfacing with the user's programs.

CIRCLE NO. 262

Tape transport meets minicomputer needs

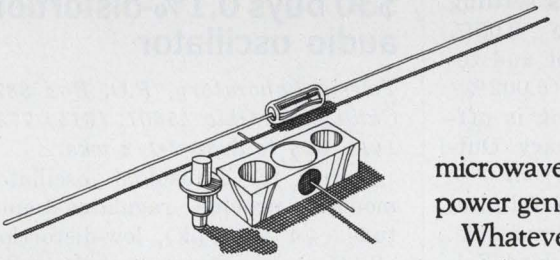


Microdata Corp., 17481 Red Hill Ave., Irvine, Calif. 92705. (714) 540-6730. Under $3000 in quantity.

Model 9000 operates under any set of diagnostics and has features normally found in larger units. File search and rewind speeds are both 200 in/s. The maximum data transfer rate is 72-k char/s (1600 bit/in. at 45 in./s). The unit uses 10.5-in. reels, has direct-drive motors and offers a seven or nine-track recording system. A dual gap read/write head and an erase head are standard with the drive.

CIRCLE NO. 263

Expertise, schmexpertise. It's good old-fashioned know-how.



That's why people buy so many of our PIN diodes.

Because we make them good, we make them fast, and we make them to sell at a price you can afford.

Like less than 50¢ apiece for our glass MA-47110 in quantities of 10,000. The MA-47110 is hermetically-sealed for reliability and is ideally suited for general-purpose switching and attenuating from VHF well into the microwave range. It's the first of a whole series of other economical control devices.

If your application requires it, we can produce PIN diodes to solve your particular power-control problem. Like our silicon-nitride passivated beam leads and hermetically sealed stripline devices. We'll make them in any quantity you want, too. Just a few. Or a whole lot, like the big batch of PIN diodes we successfully delivered for a major phased-array-radar program.

PIN diodes, Schottky barriers, Gunn and Impatt diodes, and lots of other semiconductor devices for microwave frequency conversion, power generation, and control.

Whatever you want, when you want it, at a nice low price.

Plus the proven understanding of microwave circuits and control applications that we've developed over the years.

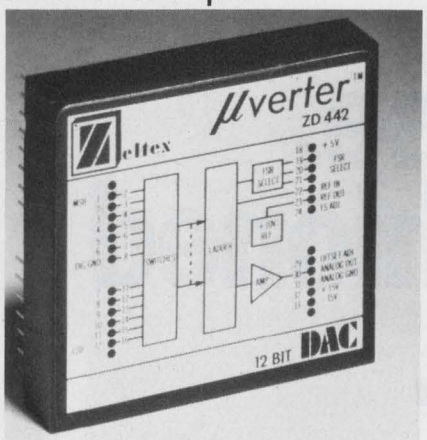
And that's what know-how is all about, isn't it?

MICROWAVE ASSOCIATES
Northwest Industrial Park
Burlington, Mass. 01803
(617) 272-3000

We're Microwave Associates. We know how.

INFORMATION RETRIEVAL NUMBER 43

12-bit d/a converter settles in 5 μs



Zeltex, 1000 Chalomar Rd., Concord, Calif. 94518. (415) 686-6660. $65 (1-24); stock to 2 wks.

Model ZD442 is a 12-bit d/a converter featuring a 5-μs settling time. Other specs are 0.05% (0.002%/°C) scaling error and zero-offset error and 0.01% (0.002%/°C) linearity. Input coding is offset binary or unipolar binary. Output code can be selected from 0 to +10 V, ±10 V or ±5 V. All digital inputs are DTL/TTL compatible. Packaging is in the standard Zeltex microverter case (patent pending). The lead frames are manufactured of beryllium copper with a special tin-plate which meets the salt spray requirement of MIL-T-10727A. The lead dimensions are 0.010 × 0.021 × 0.200-in. Leads are spaced 0.1-in. on center—lead rows are spaced 1.8-in. apart for DIP compatibility.

CIRCLE NO. 264

8-bit d/a converter offers storage in DIP

Micro Networks Corp., 5 Barbara Lane, Worcester, Mass. 01604. (617) 756-4635. $41 (100s); stock to 2 wks.

Micro Networks claims to be the first to offer an eight-bit d/a converter with a storage register in a single DIP package. The MS328B is approximately one-twentieth the size of modular d/a converters containing storage registers. The unit contains an input storage register, monolithic switches, precision ladder network, internal reference and op amps. The unit is housed in a hermetically-sealed 16-pin DIP and requires only ±15 V and +5 V. Input circuitry is TTL compatible, and the output voltage is linear to 1/2 LSB over 0 to 70 C. The MN328B has an output voltage of +5 to −4.961 V.

CIRCLE NO. 265

$30 buys 0.1%-distortion audio oscillator

Telesis Laboratory, P.O. Box 387, Chillicothe, Ohio 45601. (614) 773-1414. $24 to $33; 2-1/2 wks.

Series F sinusoidal oscillator modules provide regulated-amplitude (4.4 V pk-pk), low-distortion (0.1% max) outputs over the audio range of 20 Hz to 20 kHz. They require 10 mA max and operate over a wide range of power supply voltages (±5 to ±18 V). They are available as either fixed-frequency, factory-adjusted packages (prefix F) or as units to which the designer may affix his own external RC frequency-determining network (prefix FE).

CIRCLE NO. 266

Analog integrator is triple-threat device

Optical Electronics, P.O. Box 11140, Tucson, Ariz. 85706. (602) 624-8358. $67; stock.

Model 9018 analog integrator has three basic modes of operation: as a sample and hold amplifier, as a selectable two-input amplifier/summer and as an analog integrator with or without initial condition and charge amplifier. The 9018 is packaged in a 1.125-in. square by 0.5-in.-high module and features ±6 V/μs maximum slewing rate; 1 μs min time constant; complete TTL compatibility; internal ±11-V bound circuit; ±10 FS; and ±0.1% maximum error.

CIRCLE NO. 267

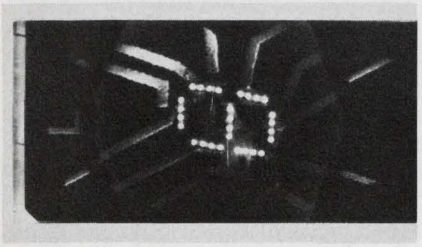
16-bit d/a converter is linear to 0.003%

Burr-Brown Research Corp., International Airport Industrial Park, Tucson, Ariz. 85706. (602) 294-1431. $350 (1-9); 2 wks. ARO.

The DAC45 16-bit d/a converter features maximum drift of only 1 ppm/°C for offset, 1 ppm/°C for linearity and 5 ppm/°C for gain. The current output of this modular unit settles to 0.003% in less than 10 μs, while the voltage output settles in 50 μs. The linearity error of the DAC45 is only 0.003%. Thus the DAC45 can operate over a ±3 C temperature range with less than one part in 65,000 error and over a ±10 C range with less than one part in 16,000 error. The unit is user programmable to obtain output ranges of 0 to +10 V, −10 to +10 V, or −5 to +5 V.

CIRCLE NO. 268

0.19-in LED displays cost $3.90/digit



Litronix, 19000 Homestead Rd., Cupertino, Calif. 95014. (408) 257-7910. $3.90 (100-999); stock.

The Data-Lit are a family of four LED numeric displays that use a "bubble top" integrated lens construction. The devices fall into two basic categories: The Data-Lit 4 and 402 are both 0.19-in. high, common cathode digits offering 300 ft-L brightness at 5 mA per segment. The Data-Lit 4 is pin compatible with the MAN-4; the Data-Lit 402 is a right-hand decimal version of the Data-Lit 4. The Data-Lit 410 and 411 are also 0.19-in. high, but offer a common anode construction pin compatible with the MAN-1/DL-10. The DL-411 differs from the DL-410 in having an electrically-isolated decimal point.

CIRCLE NO. 269

A/d converter gives binary or BCD output

Preston Scientific, Inc., 805 E. Cerritos Ave., Anaheim, Calif. 92805. (714) 776-6400. $1750; 6 weeks ARO.

A new converter provides either binary or BCD-coded outputs. Model GMAD-3 is designed for use in medium and high-speed data conversion systems. Four levels of resolution are available with binary output, from 11 bits plus sign with 7-μs conversion time, up to 14 bits plus sign with 10-μs conversion time. With BCD output, either three digits plus sign resolution in 32 μs, or four digits plus sign resolution in 40 μs can be provided. Over a dozen combinations of output codes and logic levels are available in the Model GMAD-3, including TTL-compatible logic and true bipolar, 1s, 2s, 9s and 10s complement output codes.

CIRCLE NO. 270

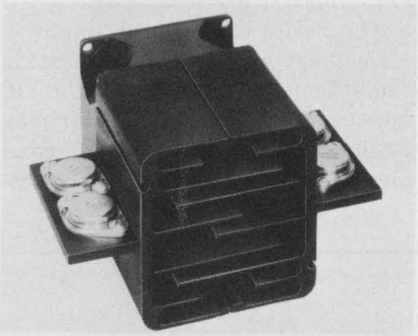
Status indicator displays 12 messages

Industrial Electronic Engineers, Inc., 7220-40 Lemona Ave., Van Nuys, Calif. 91405. (213) 787-0311. $14 (1000s); 5-7 wks. ARO.

The Series 0280 is a backlighted, 12-message display for indicating conditions in a system. The 12 message areas in the indicator may be illuminated individually, in combination, or simultaneously. Numbers, letters, words, symbols—anything that can be put on film—can be displayed, in any color. Over-all size of the Series 0280 is 2.4 × 9 × 2.6-in. Individual message areas measure 0.437-in. square; however, more than one area may be combined to form larger displays. Lamp replacement or message change is simplified by a removable viewing screen.

CIRCLE NO. 271

Cut heat-sink extrusion to desired length



Precision Dipbraze Tor, Inc., 14715 Arminta St., Van Nuys, Calif. 91402. (213) 786-6524.

A 20% to 40% decrease in cost and a 50% reduction in size and weight over comparable units (not specified) are claimed by the manufacturer for its Model 1722 extruded heat sinks. They consist of two identical halves with serrated fins in a tongue-and-groove configuration. The two halves interlock to form a closed, finned channel. A standard 3-1/8-in. fan fastens directly to the unit without any accessories when forced air cooling is required. These extrusions may be ordered in any length, and cut as required. Or a number of individual units, in modular form, can be assembled with threaded rods.

CIRCLE NO. 272

Potting ceramic works to 2800 F, sets in 2 hr.

Aremco Products, Inc., P.O. Box 145, Briarcliff Manor, N.Y. 10510. (914) 762-0685. $33/qt.; stock.

Ceramacast 511, a magnesium-oxide/zircon formulation is suitable to 2800 F. The castable ceramic is a water-mix material, which after mixing can be poured, dipped or sprayed around components to be potted or end-sealed. The material will setup in two hours and after a bakeout at 200 F is ready for use. The dielectric strength is approximately 265 V/mil at 260 C, and its resistivity at up to 600 C is 10^{10} ohms.

CIRCLE NO. 273

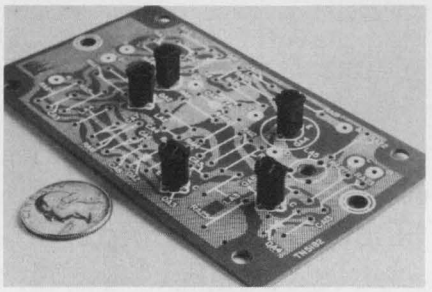
Silver-filled paste cures at room temp

Ablestik Laboratories, 833 W. 182nd St., Gardena, Calif. 90248. (213) 321-6252.

Ablebond 26-2 is a low-cost (price not supplied), electrically-conductive, room-temperature-curing adhesive designed especially for structural bonding where rf attenuation is required. The silver-filled brushable paste has a three-hour work life and produces strong bonds for a variety of materials. Volume resistivity is 0.005 Ω-cm with no change afer 100 hours at 85 C and 85% relative humidity. Ablebond costs about one-third the price of currently available silver-filled adhesives. It is supplied in 1-lb and 4-oz, two-component kits, as well as premixed and frozen in container sizes from 1 cc up.

CIRCLE NO. 274

Transistor sockets have self-aligning lead entry

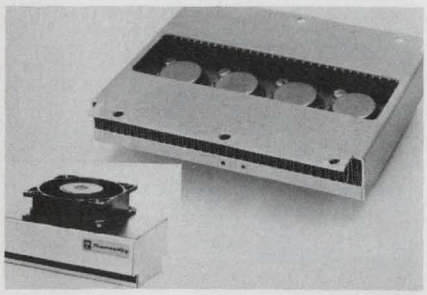


Methode Manufacturing Co., 1700 Hicks Rd., Rolling Meadows, Ill. 60008. (312) 392-3500.

The Six-Pack, a series of transistor sockets for three-lead devices, features a self-aligning lead entry, so there is no need to preform and pre-cut transistor leads. The sockets are assembled in a cluster of six units with a breakaway retaining strip, eliminating the problems inherent in handling individual miniature sockets. This packaging concept also incorporates a stacking feature to protect the terminals. The package can be magazine-loaded for automatic insertion of transistors into sockets. The sockets mount in a 300-mil mounting circle and will accept transistor leads ranging from 14 to 22 mils in diameter.

CIRCLE NO. 275

Modular cooling package works for 7 power semis

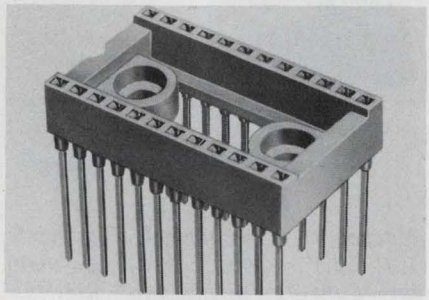


Thermalloy, 2021 W. Valley View Lane, Dallas, Tex. 75234. (214) 243-4321.

A compact package dissipates heat from one to seven case-common power semiconductor devices. Highly effective cooling is provided by air forced through two rows of convoluted fin stock. Coolpax wells may be mounted on other systems where cooling air is already available, or may be provided in integral assemblies including fan. Where electrical isolation between devices is required, separate wells may be provided. Standard mounting hole patterns include TO-3 and TO-66 and stud-mounted cases.

CIRCLE NO. 276

Solderless-wrap sockets accept 24-lead DIPs



Jermyn, 712 Montgomery St., San Francisco, Calif. 94111. (415) 362-7431. $1.20 (250 up); stock.

The A23-2043 solderless-wrap socket accommodates ICs and other devices in 24-lead (0.6-in.) packages. The socket is fitted with gold-plated phosphor-bronze contacts and the socket body is glass-filled nylon. The contacts are readily replaceable during service without removing the socket from the board. The over-all dimensions of less than 1.20 × 0.7 inch allow close packing of sockets on a 0.1-inch matrix.

CIRCLE NO. 277

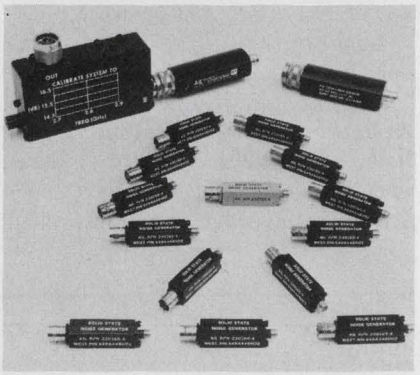
DIP insertion tool averages 4 seconds/IC

Scott Industries, Paramount Bldg., North Chelmsford, Mass. 01863. (617) 251-8595. $2.94; stock.

Dip-Sert/16 facilitates and speeds the manual insertion of 8 to 16-pin dual-in-line packages in sockets and PC board mounting holes. Operators mounting 16-pin packages on PC cards have been found to average less than four seconds per package. This compares with typical hand insertion times of 1-1/2 to 2 minutes or more per package under normal conditions. The Dip-Sert can be used for mounting ICs, relays, resistors and other components housed in the popular dual-in-line packages. Unlike many other hand insertion tools, the Dip-Sert requires no special holders for the components.

CIRCLE NO. 278

Noise sources boost ratios to 42 dB

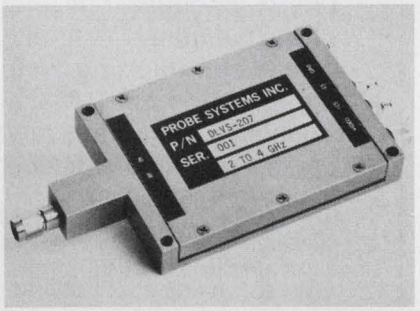


AILTECH, A Cutler-Hammer Co., 815 Broadhollow Rd., Farmingdale, L.I., N.Y. 11735. (516) 595-6471.

High level, solid-state noise sources operate up to 18 GHz with typically a 15% bandwidth. These devices can be provided with excess noise ratios of as much as 42 dB. For the measurement of operating noise temperature or noise figure, the new sources permit the injection of noise into a receiver system through a 20 or 30 dB coupler and still attain a reasonably high, injected noise power in the system.

CIRCLE NO. 300

Detector/log amp has 60-dB linearity range

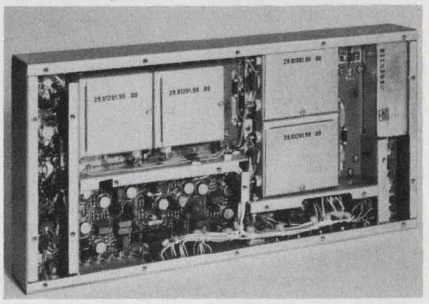


Probe Systems Inc., 655 N. Pastoria Ave., Sunnyvale, Calif. 94086. (408) 732-6550.

A detector/log video amplifier (DLVA) consists of a signal detector matched to a log video amplifier in one small unit measuring 5 × 2.5 × 0.5 inches. Because of the matching, the log characteristic is accurate to ±1 dB over a 60 dB dynamic range. The DLVA series is available in seven different models covering a variety of bandwidths ranging from 50 MHz to 18 GHz.

CIRCLE NO. 301

Uhf power amp/mod with up to 7 k channels

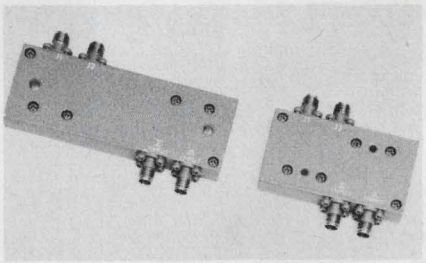


Microwave Power Devices, Inc., Adams Ct., Plainview, L.I., N.Y. 11803. (516) 433-1400. From $6800; 8-12 wks.

The Model PAM2240 AM Power amplifier/AM Modulator operates in the 225-400 MHz band and can handle up to 7000 channels. The company reports that the unit has low distortion transmissions under all conditions of antenna VSWR, power output levelling, output VSWR protection and remote carrier switching capability. The PAM2240 also features a replaceable module construction that simplifies field replacement or repair.

CIRCLE NO. 302

90°/180° hybrids cover multioctave band

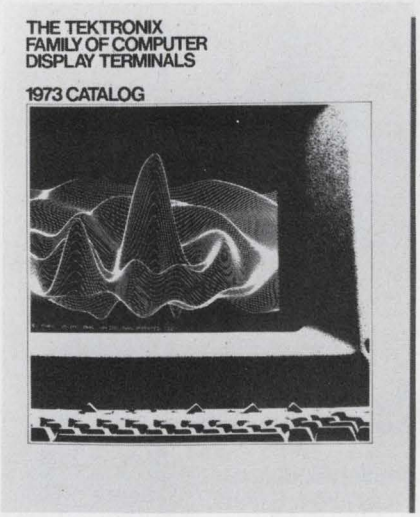


Narda, 75 Commercial, Plainview, L.I., N.Y. 11803. (516) 433-9000. 90° hybrids: $325; 180° hybrids: $375.

Broadband 90° and 180° hybrids, 4330 and 4340, feature high isolation and low VSWR. The 90° hybrids provide a balanced division of power into two transmission lines with 90° separation of phase. The two models available cover the 2-to-12.4 GHz frequency range with a VSWR of 1.3 max, isolation of 17 dB and phase imbalance of ±5°. The 180° hybrids consist of three models covering the 2-to-16-GHz frequency range with a typical VSWR of 1.35 and phase imbalance of ±7°.

CIRCLE NO. 303

new literature



Computer display terminals

Computer display terminals, hard-copy units and peripherals are featured in a 36-page catalog. Included are listings and descriptions of all products in the Plot-10 terminal software line. Purchase and lease terms are described, along with features of the company's after-sale service. Tektronix, Beaverton, Ore.

CIRCLE NO. 320

Electrostatic voltmeters

Data Bulletin SRT-100 covers features, applications and characteristics of electrostatic voltmeters with a range span of from 120 V to 140 kV. Electrical Instrument Service, Mount Vernon, N.Y.

CIRCLE NO. 321

Potentiometers

Over 100 types of wirewound and cermet potentiometers for industrial and military applications are described in the "Potentiometer Buyers Guide." TRW/IRC Potentiometers, St. Petersburg, Fla.

CIRCLE NO. 322

Cylindrical connectors

A 16-page catalog contains electrical and mechanical specifications on cylindrical connectors built to MIL-C-26500 and MIL-C-38300. Cinch Connectors, Minneapolis, Minn.

CIRCLE NO. 323

Mil Spec power supplies

Off-the-shelf Mil Spec dc power supplies are described in a two-color, eight-page catalog. The catalog provides descriptive and specification data, block diagrams, model types, physical data and outline drawings. Also included is environmental test data covering humidity, temperature, shock, acceleration, vibration and RFI testing. ERA Transpac Corp., Moonachie, N.J.

CIRCLE NO. 324

Data-processing equipment

Data sheets and price lists cover the company's data-processing equipment. Qantel, Hayward, Calif.

CIRCLE NO. 325

Synchro/resolver standard

A fully programmable source of three-wire synchro or four-wire resolver signals is described in Data Bulletin SRT-15. The bulletin contains a brief glossary of logic terms used in automatic test systems and full specifications on the instrument. Singer Instrumentation, Los Angeles, Calif.

CIRCLE NO. 326

PM tube shield

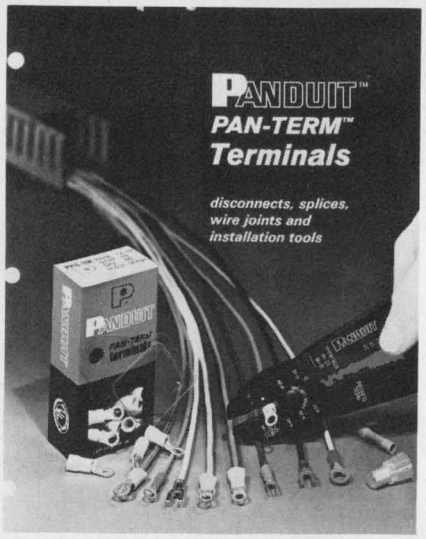
Data Sheet 205 illustrates and describes a five-layer, photomultiplier-tube, magnetic-shielding enclosure. Engineering construction details show how alternate layers of alloys and stainless steel are combined to achieve the required shielding. Ad-Vance Magnetics, Rochester, Ind.

CIRCLE NO. 327

MECL design

The second edition of the MECL System Design Handbook provides two additional chapters: one a discussion of the ac noise immunity properties of MECL 10,000; the other guidelines for the use of MECL 10,000 in severe temperature environments. The 240-page handbook costs $2. Motorola, Inc., P.O. Box 20924, Phoenix, Ariz. 85036.

NEW LITERATURE



Wiring terminations

Terminals, disconnects, splices, wire joints, installation tools and wiring kits are described in a 20-page catalog. Information, specifications and illustrations of all of the terminating devices are in easy-to-read, color-coded chart form. Panduit, Tinley Park, Ill.

CIRCLE NO. 328

Miniature lamps

Low-voltage miniature lamps for electronic and electrical applications are described in a four-page, two-color brochure which includes photos, diagrams and specifications. Mura Corp., Jericho, N.Y.

CIRCLE NO. 329

Pulse, transient recorder

Specifications, a block diagram and a description of the PTR-9200 pulse and transient recorder are highlighted in a six-page foldout. Inter-Computer Electronics, Lansdale, Pa.

CIRCLE NO. 330

Varicap selection guide

A four-page voltage-variable capacitor diode guide presents design parameters for over 350 devices. A nemograph is included to help determine the capacitance ratio between two operating voltages V_1 and V_2 and/or the capacitance at V_2 when the capacitance at V_1 is known. Codi Semiconductor, Fair Lawn, N.J.

CIRCLE NO. 331

Data-acquisition system

A 20-page catalog describes System 256, a minicomputer-compatible data-acquisition system. Electrical and mechanical specifications, performance data and application data are listed. A wide range of options is outlined. Datel Systems, Canton, Mass.

CIRCLE NO. 332

Waveform generator

An eight-page catalog describes F200 series waveform generators. Complete specifications of the units are provided as well as how-to-do-it information for generating a variety of waveforms. Ailtech, City of Industry, Calif.

CIRCLE NO. 333

Reed switches

An illustrated 12-page catalog includes a guide to the selection of the correct reed switch for any type and magnitude of switching application. It covers various forms of actuation, including proximity switching with permanent magnets, bias switching, shielding and electromagnetic actuation. Hamlin, Lake Mills, Wis.

CIRCLE NO. 334

Test system

A nine-page brochure describes the Z337 zener test system. The brochure includes sections on productivity, device protection, test modes and automatic distribution analysis of test results, plus a section on various testing problems peculiar to zener diodes and how these problems are solved. Included are discussions of self-heating, impedance measurements and the company's ΔV test. Teradyne, Boston, Mass.

CIRCLE NO. 335

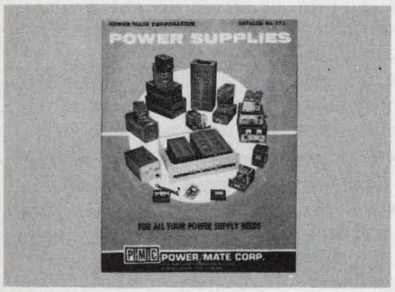
Rf shielded rooms

A line of modular, clamp-together rf shielded rooms is described in an eight-page brochure. The literature also covers a series of rf power and signal line filters and includes specifying information for the rooms. LectroMagnetics, Inc., Los Angeles, Calif.

CIRCLE NO. 336

quick ads

New and current products for the electronic designer presented by their manufacturers.

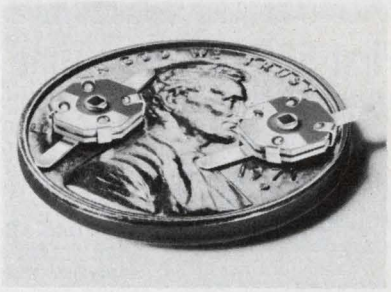


Free catalog of 32,000 power supplies from the worlds largest manufacturer of quality Power Supplies. New '73 catalog covers over 32,000 D.C. Power Supplies for every application. All units are UL approved, and meet most military and commercial specs for industrial and computer uses. Power Mate Corp. (201) 343-6294.

INFORMATION RETRIEVAL NUMBER 181

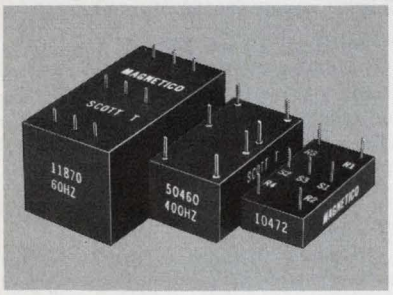
The Lowest Power, Lightest, Smallest 10½" Reel Digital Magnetic Tape Recorder in the World. Operates on 12 volts ±2 volts DC and writes 700,000 tape characters per ampere hour. Small size and low weight permit a wide variety of packaging options. Digi-Data Corp., Bladensburg, Md. (301) 277-9378.

INFORMATION RETRIEVAL NUMBER 182



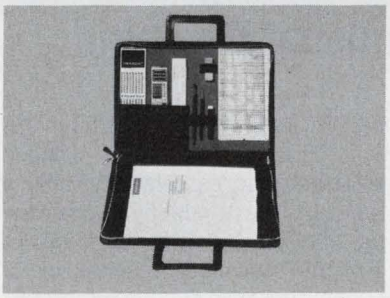
Thin-Trim® variable capacitors are designed to replace fixed tuning techniques. Applications include crystal oscillators, CATV amplfiers, communication and test equipment. Series 9410 has high Q's with five capacitance ranges from 1.0 - 4.5 pf to 10.0 - 50.0 pf. Johanson Manufacturing Corporation, Boonton, N. J. (201) 334-2676

INFORMATION RETRIEVAL NUMBER 183



Scott T Transformer. 11870: 60HZ, 90v, L-L In. 1.1x2.1x1.1. 50460: 400HZ, 90v, L-L In. 7/8x1-5/8 x11/16. 50642: 400HZ, 11.8v, L-L In. 7/8x1-5/8x11/16. 10472: 400-HZ, 11.8v, L-L In. 3/4x1-1/2x3/8. All with 6v RMS sine & cosine output. Magnetico, Inc., E. Northport, N.Y. 11731. 516-261-4502.

INFORMATION RETRIEVAL NUMBER 184



Programmer's tool kit has ten programming tools in a lockable, custom fitted briefcase. Included is a hexadecimal calculator with credit balance and automatic complement features, decimal calculator, slide rule, plus seven other aids. Also available is an octal calculator. Radix Precision Company, Box 13861, Atlanta, Georgia 30324.

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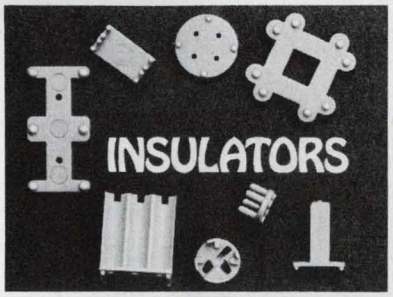

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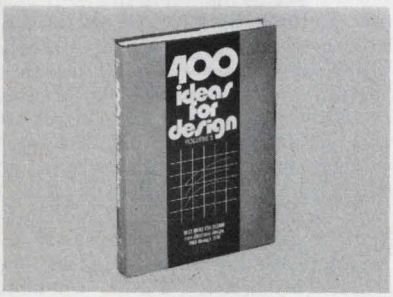

400 Ideas for Design, Vol. 2, Edited by Frank Egan. Ready to borrow, modify, or adapt, the top recent contributions to Electronic Design's popular "Ideas for Design" column range from amplifiers to switching circuits. 288 pp., illus., cloth, $11.95. Circle below for 15-day examination copies. Hayden Book Co., New York, N.Y. 10011.

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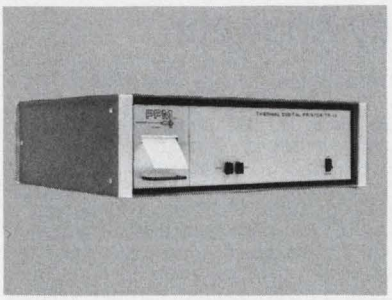

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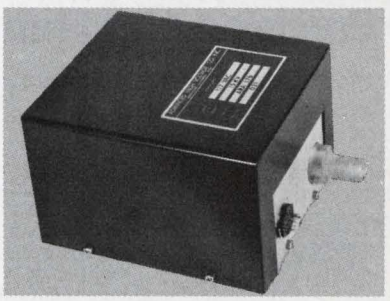

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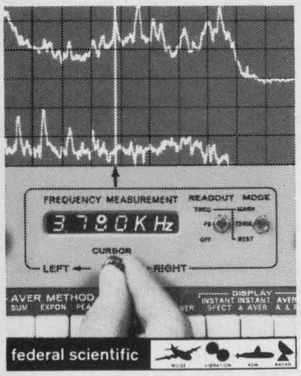

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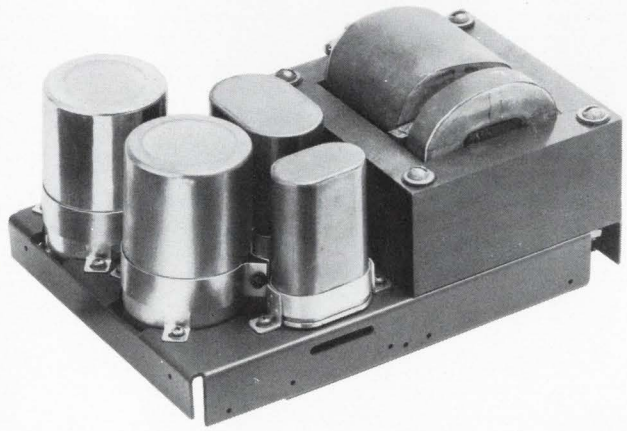

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	***LQD-DA-6312**	±12V†	12A	**135**
	***LQD-DA-6312**	12V	24A	**135**
	****LQD-DA-6312**	18.5V	24A	**135**
	***LQD-DA-6315**	±15V†	10A	**135**
	***LQD-DA-6315**	15V	20A	**135**
	****LQD-DA-6315**	22.5V	20A	**135**

†Same supply is used as single and dual by paralleling output terminals.
*Ratings as measured at output terminals of Lambda LAS 2000 series power hybrid voltage regulator and other microelectronic regulators.
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regulation, load . . . . . .0.2% for 0 to 100% of full load for any line between 105 and 132 VAC.

remote programming resistance . .1000 ohms per volt/nominal only when used with 14-pin power hybrid voltage regulators LAS-2205 – LAS-2228, LAS-2405 – LAS-2415, LAS-2705 – LAS-2728 and LAS-2905 – LAS-2915.

remote programming voltage . . .volt per volt only when used with 14-pin power hybrid voltage regulators LAS-2205 – LAS-2228, LAS-2405 – LAS-2415, LAS-2705 – LAS-2728 and LAS-2905 – LAS-2915.

temperature coefficient . . . . . 0.007%/°C

AC input

line . . . . . 105 to 132 VAC; 59 to 61 Hz

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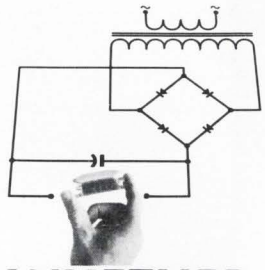

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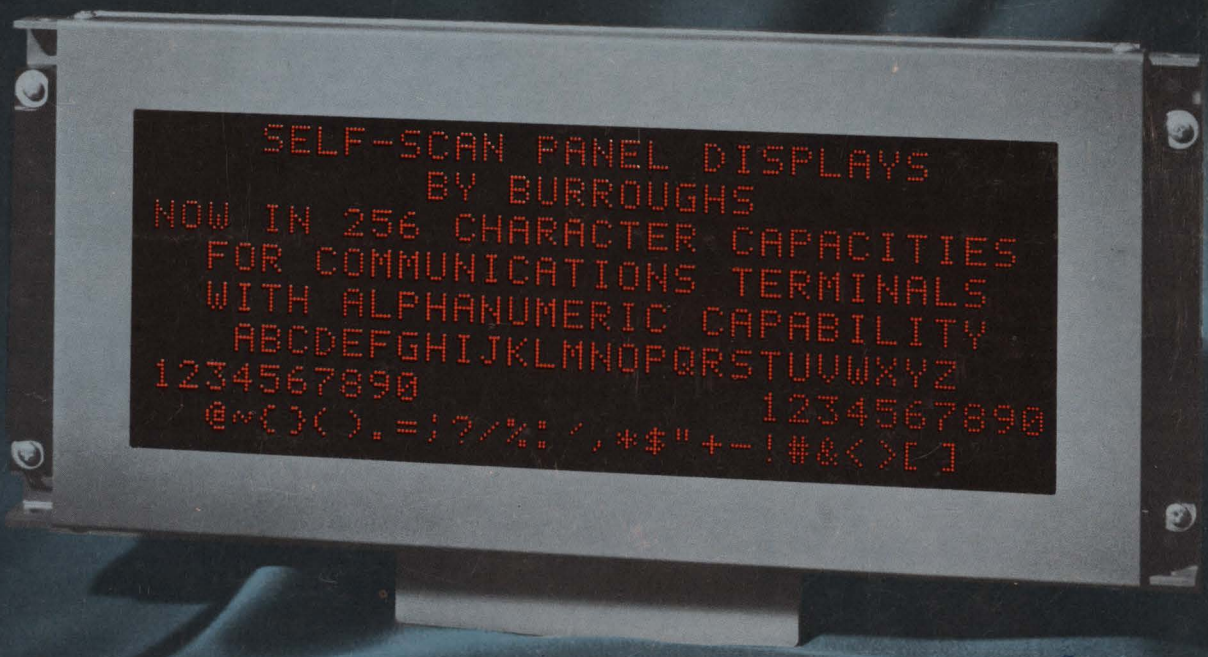

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