VOL. 23 NO. 8

Electronic Design®

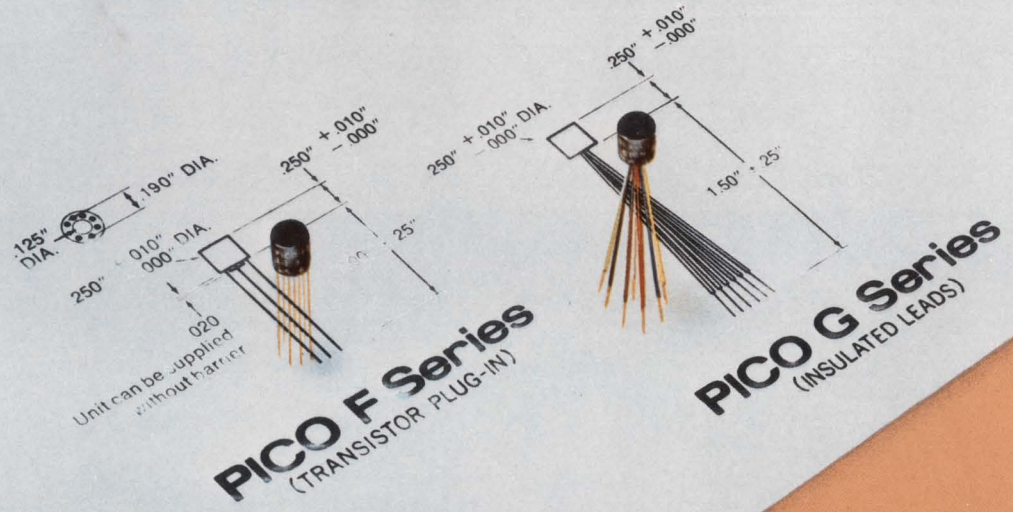
FOR ENGINEERS AND ENGINEERING MANAGERS

APRIL 12, 1975

Scopes and cameras abound, making selection a difficult task. Modular scopes can be tailored for special jobs, but costs can soar. And some portable scopes offer the performance of larger units. Cameras are available for most scopes, but some storage scopes may lessen the need for them. Get the details on p. 48.

ultra-miniature transformers

¼" x ¼"



SPECIFICATIONS

- **MIL-T-27D:** All Units Are Designed to MIL-T-27D and Are Hermetically Sealed in a Metal Case. PICO is a QPL source.
- **Frequency Response:** ±3 db, 400 Hz-250 KHz at 1.0 milliwatt.
- **Maximum Distortion:** 5% With Rated Power Level at 1 KHz.
- **Dielectric Strength:** All Units Tested at 200 V RMS.
- **Insulation Resistance:** Greater than 10,000 Megohms at 300 V DC.
- **Weight:** 1.1 GRAMS.
- **Operating Temperature:** –55°C to 105°C (All Units Can Be Supplied to Class S Requirements 130°C maximum).
- **Terminals:** .012 Diameter Gold Plated Dumet Wire In Accordance With MIL-STD-1276 Type D. Leads May Be Welded or Soldered.
- **Thermal Shock:** 25 Cycles, Method 107C, MIL-STD-202D, Test Condition A-1

PICO PART NUMBER F Series	PICO PART NUMBER G Series	PRIMARY IMPEDANCE OHMS	SECONDARY IMPEDANCE OHMS	POWER MILLIWATTS at 1 KHz	PRIMARY UNBALANCED DC CURRENT ma	PRIMARY DC RESISTANCE OHMS	SECONDARY DC RESISTANCE OHMS	MILITARY DESIGNATION
F5705	G6005	50	50	100	5.0	7.5	9.0	TF5RX17ZZ
F5710	G6010	100	100	100	5.0	15	18	TF5RX17ZZ
F5715	G6015	120 ct	3.2	100	4.5	15	0.75	TF5RX17ZZ
F5720	G6020	150 ct	12 split	100	4.0	20	2.4	TF5RX17ZZ
F5725	G6025	300 ct	600 split	100	3.0	40	90	TF5RX17ZZ
F5730	G6030	400 ct	400 split	100	2.5	54	58	TF5RX17ZZ
F5735	G6035	500 ct	50 split	100	2.0	62	10	TF5RX17ZZ
F5740	G6040	500	600	100	2.0	62	90	TF5RX17ZZ
F5745	G6045	600 ct	600 split	100	2.0	70	90	TF5RX17ZZ
F5750	G6050	900 ct	600	100	1.5	130	90	TF5RX17ZZ
F5755	G6055	1K ct	1K split	100	1.5	110	140	TF5RX17ZZ
F5760	G6060	1.5K ct	600 split	100	1.2	175	69	TF5RX12ZZ
F5765	G6065	2K ct	8K split	80	1.0	200	1000	TF5RX12ZZ
F5770	G6070	10K ct	500 split	80	0.5	1000	60	TF5RX12ZZ
F5775	G6075	10K	500	80	0.5	1000	60	TF5RX12ZZ
F5780	G6080	10K ct	1 2K split	80	0.5	1100	160	TF5RX12ZZ
F5785	G6085	10K	1.2K	80	0.5	1100	130	TF5RX12ZZ
F5790	G6090	10K ct	2K split	80	0.5	1100	250	TF5RX12ZZ
F5795	G6095	10K ct	10K ct	80	0.5	1100	1100	TF5RX12ZZ
F5800	G6100	10K	10K	80	0.5	1100	1100	TF5RX12ZZ
F5805	G6105	10K ct	10K split	80	0.5	1100	1100	TF5RX12ZZ
F5810	G6110	25K ct	1K split	50	0.3	2100	130	TF5RX12ZZ
F5815	G6115	25K	1K	50	0.3	2100	130	TF5RX12ZZ
F5820	G6120	30K ct	1.2K	50	0.3	2300	180	TF5RX12ZZ

Send today for PICO's Designers Kit!

PICO now offers a Designer's Kit containing ten (10) representational ¼" x ¼" transformers. The kit contains PICO's F5710 and G6025; F5730 and G6045; F5755 and G6065; F5770 and G6090; F5795 and G6110.

PICO's Designers Kit No. FG-100 . . . **$50.00** each

In addition to the ¼" Series PICO offers over 600 other standard transformers to choose from.

Delivery—stock to one week . . . specials take a little longer—9 days.

Send for free 36 page catalog.

INDUCTORS

PICO PART NUMBER F Series	PICO PART NUMBER G Series	INDUCTANCE HENRIES		DC CURRENT ma	DC RESISTANCE OHMS	MILITARY DESIGNATION
F5825	G6125	SERIES	10.0	0	2250	TF5RX20ZZ
			2.75	2		
		PARALLEL	2.5	0	560	
			.65	4		
F5830	G6130	SERIES	5.5	0	1000	TF5RX20ZZ
			1.5	2		
		PARALLEL	1.3	0	250	
			.40	4		
F5835	G6135	SERIES	.85	1	240	TF5RX20ZZ
			.25	6		
		PARALLEL	.21	2	60	
			.06	12		
F5840	G6140	SERIES	.6	0	144	TF5RX20ZZ
			.15	5		
		PARALLEL	.15	0	36	
			.04	10		

PICO Electronics, Inc.

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For immediate pricing and engineering information— ***call collect***

Starting now, the function generator market does a 180.

The new 180 Series from Wavetek.

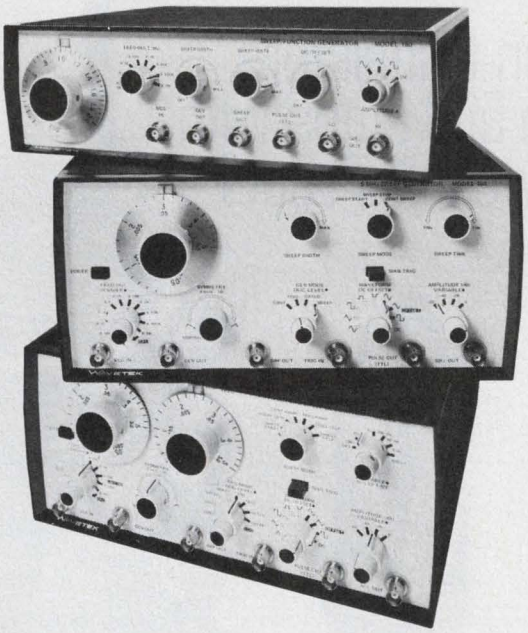
This is where Wavetek turns it around again. With three new high-performance, low-cost generators.

The Model 180 Sweep/ Function Generator $275

Believe it or not, this is a full sweeper—from 0.01 Hz to 2 MHz—with internal 1000 to 1 sweep. The 180 has sine, square and triangle wave outputs (20v output p-p), plus dc voltage, dc offset, and a separate TTL output. It also has a full attenuator which means you get super-clean signals down to −50dB. If you measure price vs. performance, no other instrument even comes close.

The Model 184 Sweep Generator $495

The 184 has all of the above, plus some other features that you wouldn't expect for the price. First of all, the 184 goes all the way up to 5 MHz, and provides continuous, triggered and gated operation. For precise adjustment of continuous sweep, there's a control to individually set start and stop points. There's also a variable symmetry control and another for amplitude—down to −60 dB. Like the rest of the instruments in this series, the 184 comes in a tough, lightweight package.



The Model 185 Lin/Log Sweep Generator $595

As you can see, the 185 has two frequency dials, which give you the ultimate in precise sweep start/stop settability. Now you can sweep up or down the frequency range, which goes from 100 μHz to 5 MHz with continuous and triggered ramps or discrete steps. Like the 184, this model has continuous, triggered and gated operation. Of course, there are both linear and logarithmic modes, and log sweep width is an incredible 100,000 to 1.

We haven't told you everything.

There's a lot more to the 180 series than the three instruments described here. But that's another story.

When we let that out, the market may just do a 360.

For more information, contact Wavetek, P.O. Box 651, San Diego, California 92112. Phone (714) 279-2200. TWX 910-335-2007.

WAVETEK®

INFORMATION RETRIEVAL NUMBER 2

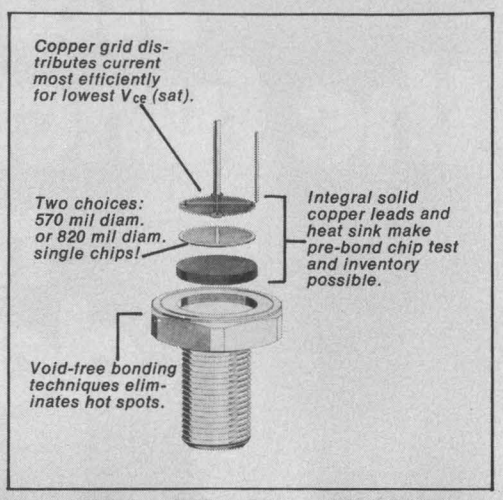
Save Space. Save Weight. Increase Reliability.

Paralleling transistors doesn't pay —not when an inherently rugged single device can do the job far more reliably, using much less space, weight, and at lower total system cost. That's why PowerTech's unique single-chip NPN silicon high-power transistor is the *one* way to go.

Used alone, our space-saving single-chip device eliminates multiple failure sources while reducing the environmental testing costs inherent in parallel arrays. Because of their simplicity they're available off-the-shelf–pre-rated, pre-tested and inventoried to meet virtually any hi-rel JAN and JAN-TX hi-current requirements without custom prices and long custom waits. For information, application assistance, and free design guide call Sales Engineering, PowerTech, Inc., 9 Baker Court, Clifton, N.J. 07011; (201) 478-6205.

Type #	(pk.) I_c	V_{ceo}	(h_{fe} = 10) V_{ce} (sat) @ I_c
JAN-TX 2N5926	90A	120V	0.6V @ 50A
PT-7511	90A	200V	0.6V @ 50A
JAN-TX 2N5927	120A	120V	0.6V @ 70A
PT-6502	200A	80V	0.7V @ 100A
PT-9502*	500A	80V	0.5V @ 300A

350 Watt Power Rating
*625 Watt Power Rating
Guaranteed SOAR



TO *UN*PARALLEL IS TO SAVE:

Silicon transistors to 500 amps with lowest V_{CE} (sat)

PowerTech, Inc.
"BIG IDEAS IN BIG POWER"

INFORMATION RETRIEVAL NUMBER 3

Electronic Design 8

VOL. 23 NO.

FOR ENGINEERS AND ENGINEERING MANAGERS

APRIL 12, 1975

NEWS

TECHNOLOGY

PRODUCTS

DEPARTMENTS

Cover: Designed by Art Director Bill Kelly. Photos courtesy of Dynascan, Heath, Hewlett-Packard, Philips, Tektronix and Vu-Data.

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OEM Referral Program
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Enrollment Form

"If you're an OEM, I'd like you to join in an exciting new sales building program."

William Long
VP OEM Group
Digital Equipment Corporation

It's our brand-new catalog of OEM systems.

A book Digital salesmen will be using regularly to point out Digital OEMs to potential users of OEM systems.

A book which should mean bigger sales for everyone who's in it — and one of them can be you.

The OEM catalog is the key to a massive new program. Its whole intent is to help our OEMs sell computerized systems to end users. It's the OEM Referral Program. Here's how it works.

We're compiling a catalog of information supplied by our OEM customers on their systems.

With the total support of our worldwide sales force, backed by an advertising campaign in industrial magazines, we're offering help to anyone contemplating the purchase of major equipment.

That help takes the form of detailed suggestions on how to buy computerized equipment. Suggestions on where to buy the type of equipment they need, and who they can buy it from.

The systems we suggest, of course, are sytems sold by Digital OEMs.

What the catalog does is to categorize these systems (which span virtually the entire spectrum of OEM systems on the market today) so our salesmen can match prospects' needs with appropriate OEM systems.

The catalog, like the whole program, is serious business. It has only one purpose: to help your sales effort. After all, every system you sell to your customers is one more computer we sell to you.

But while the OEM Referral Program will be an increasingly important part of our own marketing strategy, it's not the whole story by any means.

We will continue to come out with new breakthroughs in the areas of price and performance.

And we will continue to work with our OEMs in every way we can to help keep us both profitable in these profit-squeezed times.

In short, we will continue the policies that have kept us the leader in the OEM computer field ever since it started. Because in all that experience, we've learned something about the OEM marketplace:

We're a success only if you are.

For more information, write Digital Equipment Corporation, Maynard, Massachusetts 01754. (617) 897-5111. European headquarters: 81 route de l'Aire, 1211 Geneva 26. Tel: 42 79 50. Digital Equipment of Canada Ltd., P.O. Box 11500, Ottawa, Ontario K2H 8K8. (613) 592-5111.

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Vice President, Publisher
Peter Coley

Editors
Editorial Offices
50 Essex St.
Rochelle Park, NJ 07662
(201) 843-0550
TWX: 710-990 5071
Cable: Haydenpubs Rochellepark

Editor-in-Chief George Rostky
Managing Editors:
Ralph Dobriner
Michael Elphick

Associate Editors:
Dave Bursky
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Contributing Editors:
Peter N. Budzilovich
Alberto Socolovsky
Nathan Sussman

Editorial Field Offices
East
Jim McDermott, Eastern Editor
P.O. Box 272
Easthampton, MA 01027
(413) 527-3632

West
David N. Kaye, Senior Western Editor
8939 S. Sepulveda Blvd.,
Suite 510
Los Angeles, CA 90045
(213) 641-6544
TWX: 1-910-328-7240

Editorial Production
Marjorie A. Duffy

Art
Art Director, William Kelly
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across the desk

A reader bugged by 'obiter dicta'

Alan J. Rider's article on the techniques of interviewing engineers is amazing, to say the least ("'Meet' the Applicant Before Talking to Him," ED No. 25, Dec. 6, 1974, pp. 86-88). A close analysis reveals that the author has done nothing more than package his own prejudices into a collection of obiter dicta.

His example of the worthless Ph.D. is atypical, trite and certainly does not attest to his expertise regarding hiring practices. He seems to exhibit a contempt for educated engineers, noticeable in the absence of any degree notations in his background description.

The article explains in great detail how to exploit the engineer, but it mentions nothing about what the company should give the engineer in return, save the unrealistic salary of 12 k to 13 k a year and all the unpaid overtime one can work.

The sort of philosophy created by this sort of mentality is the reason I have left the logic/circuit design field for areas of technology that are state-of-the-art but not exploitive in nature.

Charles Zabilski
Video Tape Engineer
Consolidated Film Industries
959 North Seward St.
Hollywood, CA 90038

The author replies

I found Mr. Zabilski's letter somewhat difficult to comprehend, though I am pleased that he found our article "amazing."

It is unfortunate that he failed to grasp the implicit message; therefore I shall state it explicitly. The process of hiring engineers and other personnel is treated too casually and too inexpertly in our industry. The result is that the compatibility of candidates and positions is left to chance more often than is necessary. Predictability of a good match between the two can be significantly improved.

One of my first experiences as a manager was in hiring a Ph.D in theoretical physics to design circuits, only to have him turn out to be ineffective. Mr. Zabilski will be pleased to know that I also supervised another Ph.D who was truly a superb circuit designer.

I consider my educational background irrelevant to the value of the ideas contained in the article. However, if it will put Mr. Zabilski's mind at ease, I hold a BSEE from George Washington University, plus about 20 credits.

I don't understand how he could interpret the article as explaining how to "exploit" the engineer. The fact is it suggests how to lessen the chance the engineer will be exploited in the hiring process. A cruel hoax practiced too frequently in our industry is the hiring of people on a trial basis without informing them of the fact—the "let's see how he works out" technique.

Mr. Zabilski did turn up a glaring error in the article. The 12-k and 13-k figures refer to starting salaries.

Alan J. Rider
Reston Consulting Group
12206 Quorn Lane
Reston, VA 22091

That perfect gift

Editor-in-Chief George Rostky normally gets lots of phone calls and letters in response to his edi-

(continued on page 14)

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.

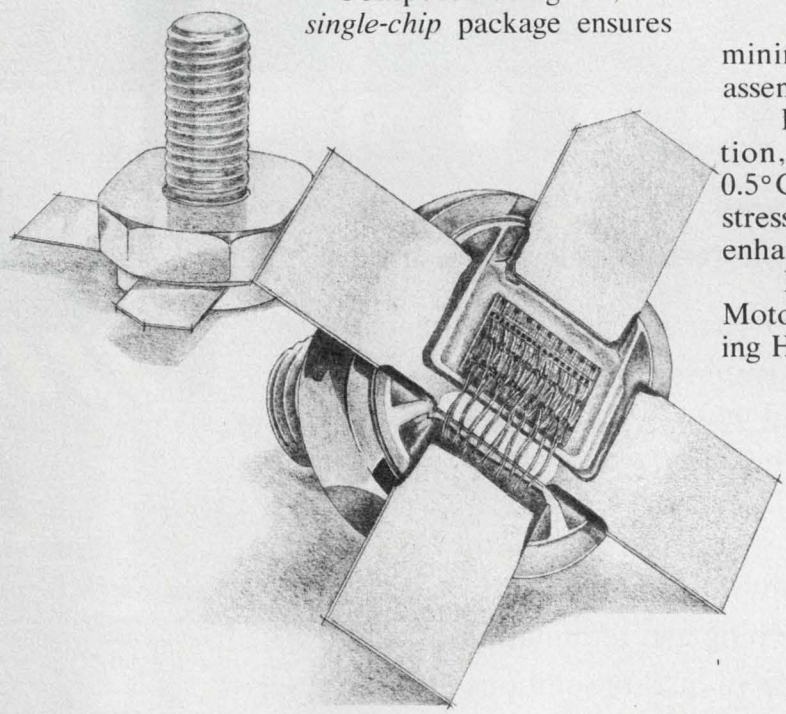
Another technical knockout

the first rugged, 50V, SSB device

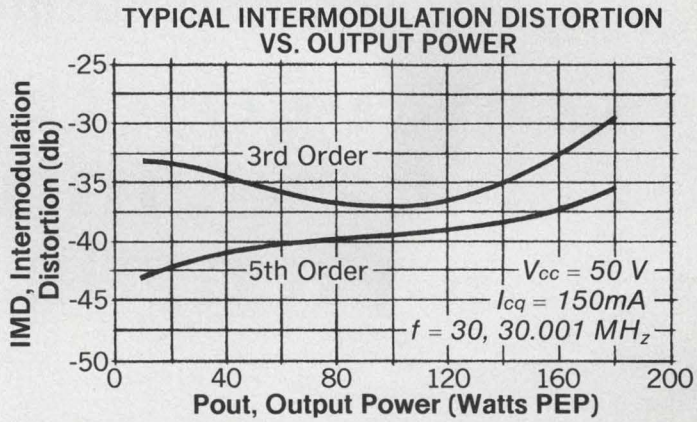
The biggest RF power chip — 150 W PEP — in production today now makes base station/marine linear amplifiers small enough to fit into one single desk top cabinet.

The MRF428 is state-of-the-art 50 volt V_{CC}... supply, drive and output stages for 1 KW SSB linear amps can now be single-unit designs. No more separate, outsized high-current power supplies.

The '428 offers unprecedented ruggedness: 30:1 VSWR at all phase angles and load-pull tests to 50 volts.



Computer-designed, the *single-chip* package ensures minimized die and wire bonding, controllable assembly techniques, ruggedness and consistency.



Performance runs out to 320 W power dissipation, 13 dB minimum gain at 150 W PEP and 0.5°C/W Θ_{JC} for excellent heat dissipation under stress. And cooler chips mean improved linearity, enhanced IMD.

Big is small now with the MRF428. See your Motorola rep for OEM applications help in building HV SSB radio. Be first with the first...

heavyweight

from Motorola, the RF producer.

INFORMATION RETRIEVAL NUMBER 8

Breakthrough in mass termination.

Lower-cost coaxial ribbon cable assemblies. In any length.

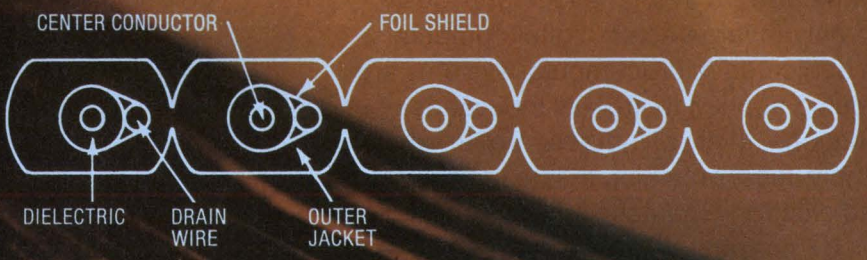
New AMP coaxial ribbon cable is just that—true coax in ribbon form. With no compromises.
No degradation in system performance.
Solves the long-existing coaxial cable termination problem.

We can provide complete assemblies for your specific requirements. In any length, with 6 to 26 positions. The assemblies come in 50-, 75- or 93-ohm ratings, on .100-inch grid spacing. And 95-ohm rating on .125-inch spacing. Connectors mate with .025² posts—either 90° board-mount pin headers or I-O posts.

Revolutionary patented concept with drain wire parallel to center conductor, permits low-cost gang stripping and terminating, and still further demonstrates AMP's leadership in quality solutions to termination problems.

For information on AMP coaxial ribbon cable that gives you true coaxial performance, and reasonable price, call (717) 564-0100, circle the Reader Service Number, or write AMP Incorporated, Harrisburg, PA 17105.

The ribbon is made up of individual coaxial cables, each with a solid center conductor and a foil-wrapped drain wire shield. The drain wire is not spirally wound around the dielectric, but runs parallel with the center conductor. This feature allows the cable to be cut anywhere and yet be consistently and reliably terminated.

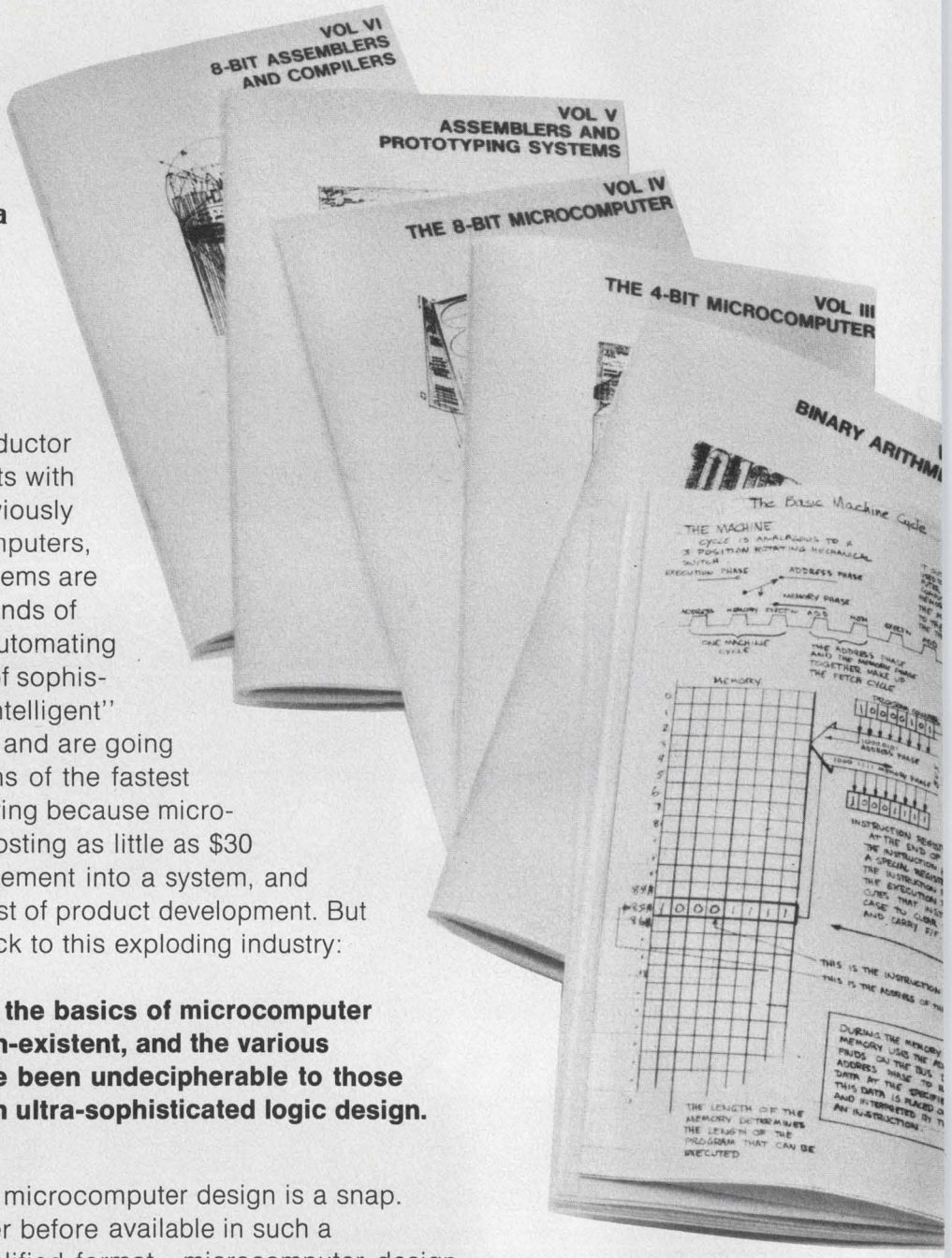


AMP
INCORPORATED

INFORMATION RETRIEVAL NUMBER 9

Microcomputer

A new six-volume programmed learning course from Iasis tells you EVERYTHING about what microcomputers are and how you can design and implement a microprocessor-based system.



Since the transistor was invented, no single electronics innovation has made such an impact as the microcomputer. Powered by tiny semiconductor chips containing computing elements with the same powers and functions previously found only in large scale digital computers, these dedicated microcomputer systems are now being applied to literally thousands of applications. Microcomputers are automating assembly lines, providing the heart of sophisticated electronic games, making "intelligent" computer peripherals even smarter, and are going so far as streamlining the operations of the fastest food chains. This revolution is occuring because microcomputers are very inexpensive—costing as little as $30 in production volume—easy to implement into a system, and significantly reduce the time and cost of product development. But there has been one serious drawback to this exploding industry:

Training materials and courses in the basics of microcomputer technology have been virtually non-existent, and the various published manuals and texts have been undecipherable to those not already intimately familiar with ultra-sophisticated logic design.

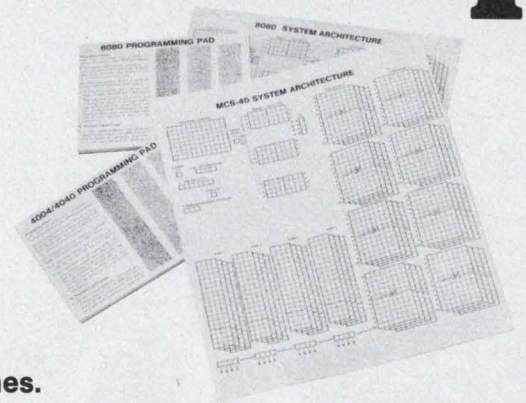
Once a designer has the hang of it, microcomputer design is a snap. But without the fundamentals—never before available in such a readable, understandable and simplified format—microcomputer design has been unbelievably difficult. The comprehensive, step-by-step six-volume Programmed Learning Course on Microcomputers from Iasis makes the unbelievably difficult almost ridiculously simple. The authors of these texts have been involved on a professional level in the microcomputer industry since it became an industry. Their direct, first-hand experience in the whys, hows, wherefores and potentials of microcomputers

Iasis Texts:

1. Binary Arithmetic
2. Microcomputer Architecture
3. The 4–Bit Microcomputer
4. The 8–Bit Microcomputer
5. Assemblers and Prototyping Systems
6. 8–Bit Assemblers and Compilers

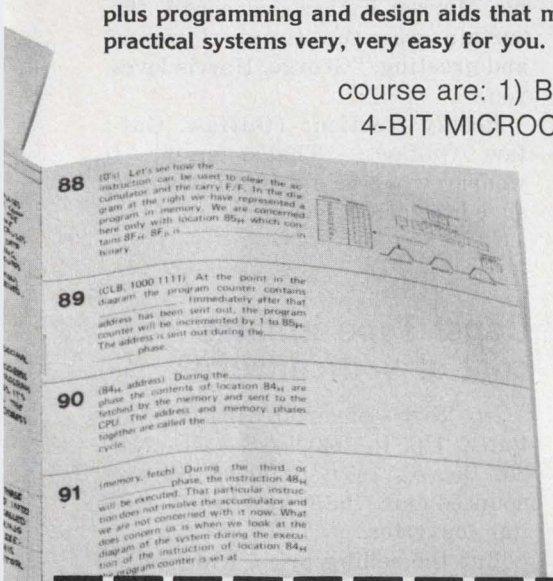
Finally, you can get a comprehensive training course on microcomputers that puts all the hard-to-get information at your fingertips in an easy-to-read, easy-to-understand and even easier-to-implement manner. You can get it here...now.

design is a snap.



have made this six-volume collection the most valuable and meaningful series ever published on microcomputer design. The books combine the most effective methods of programmed instruction with the entire gamut of essential information vital to the designer of a micro-based system. You begin with the ABC's of microcomputers and go through a virtual post-doctoral course... **and the unique, self-testing programmed learning Iasis course enables you to understand and absorb every bit of the information every step of the way through the six volumes.**

The Iasis course gives you more than 700 pages of detailed, illustrated microcomputer information—including more than 1,700 self-tests you use to evaluate your progress—plus programming and design aids that make the design of practical systems very, very easy for you.



Specific details are provided on four of the industry's most versatile microcomputers—the 4004, 4040, 8008 and 8080 from Intel Corporation—but the basic design information will apply to any and all microprocessors. The six volumes you receive with the course are: 1) BINARY ARITHMETIC; 2) MICROCOMPUTER ARCHITECTURE; 3) THE 4-BIT MICROCOMPUTER; 4) THE 8-BIT MICROCOMPUTER; 5) ASSEMBLERS AND PROTOTYPING SYSTEMS; and 6) 8-BIT ASSEMBLERS AND COMPILERS. Plus, this detailed course provides you with two programming pads and two simplified design aids so you may quickly and easily develop both 4-bit and 8-bit microcomputer systems. Use the coupon below to order your course from Iasis, Inc., 770 Welch Road, Suite 154, Palo Alto, California 94304.

Special introductory price on this remarkable new course is just $99.50... and if it isn't everything we say it is or even more, return it within 15 days for a full refund!

iasis inc.

Order before May 31, and you'll save a full $25 on the Programmed Learning Course on Microcomputers! In addition, all introductory orders will include a bonus seventh volume, the Microcomputer Applications Handbook!

(After May 31, 1975, price for the complete Iasis course will be $124.50, plus $2.50 for postage and handling.)

Here's my check or money order *(no cash, please). RUSH* my 6-volume Programmed Learning Course on Microcomputers, including the bonus Applications Handbook and programming aids, to the address below. HURRY!

☐ Send one complete course for $99.50 in U. S. funds. My payment is attached. (California residents, please add $5.97 State sales tax.)

☐ Send me information by return mail on quantity discounts.

ALLOW 15 DAYS FOR DELIVERY IN THE U. S. AND 6 WEEKS FOR DELIVERY OUTSIDE THE UNITED STATES.

iasis inc.

Mail today to: Iasis,
770 Welch Road, Suite 154,
Palo Alto, California 94304.

You can use your BankAmericard or Master Charge, too!

☐ CHARGE MY ORDER TO THE CREDIT CARD NO. BELOW:

BankAmericard No. _____

Master Charge No. _____

For Master Charge, add 4-digit number immediately above your name on the card. It is _____

HERE'S MY SIGNATURE _____
(Sign here if credit card charge)

NAME _____

ADDRESS _____

ORGANIZATION _____ MAIL STOP _____

CITY/STATE/ZIP _____

(continued from page 7)

torials. But he doesn't often get a parcel. He did, though, in response to his editorial "Service With a Smile" (ED No. 2, Jan. 18, 1975, p. 47), in which he commented unfavorably on the shower head and shower curtain in his room at a London hotel.

On reading the editorial, Jack Kompan, marketing communications manager at Harris Semiconductor, rained good wishes and a gift—a white shower curtain—on Rostky.

Rostky didn't know about it until he found the curtain mounted across the entrance to his office, placed there by his secretary, Evelyn Morris. Embazoned across the curtain was the Harris logotype and greeting. "George, Harris loves you."

Rostky reaction: (Guffaw. Guffaw. Guffaw.) "That's terrific. I wonder what he'd send if I wrote an editorial on love?"

Oops! Typo inflates cost of s/d converter

In "S/d Converter Operates at Rates Up to 3600°/s" (ED No. 25, Dec. 6, 1974, p. 111) you announced our 168B synchro-to-digital converter.

But the selling price, which was stated as $5500, should have read $550. We cannot now expect much response for a product that was developed to be price competitive and is announced at a price nine to 10 times the competition!

Harold C. Ericsson
Control Sciences, Inc.
10315 Woodley Ave.
Granada Hills, CA 91344

ED Note: We apologize to Mr. Ericsson for our not catching the printer's typographical error.

Correction

In "Focus on Graphic Recorders," ED No. 3, Feb. 1, 1975, p. 65, the address for Houston Instruments is incorrect. The correct address is One Houston Square, Austin, TX 78753.

(continued on page 16)

Multiple choice

1,700 answers to electrical enclosure needs by Hoffman.

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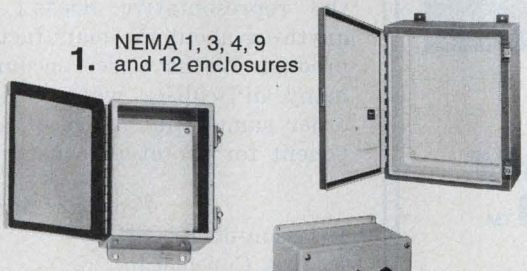

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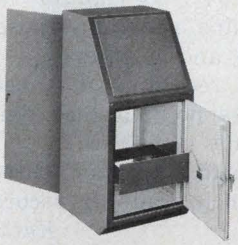

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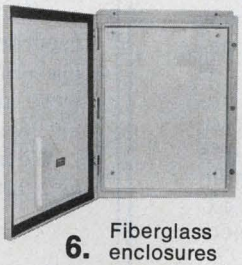

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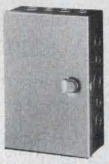

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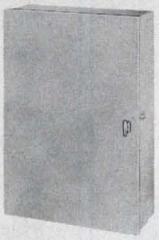

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INFORMATION RETRIEVAL NUMBER 12

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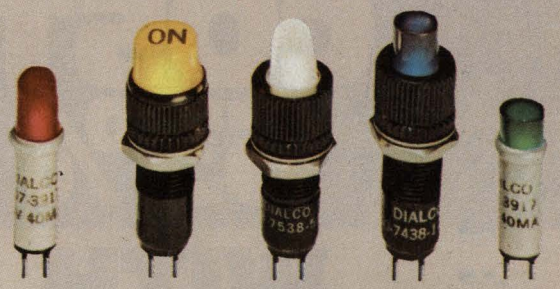

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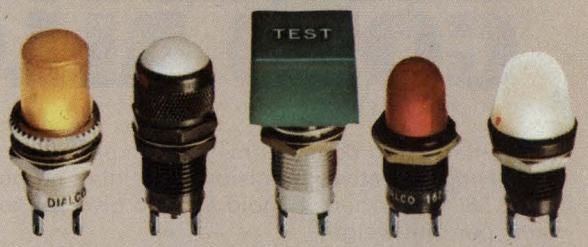

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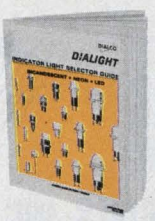

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INFORMATION RETRIEVAL NUMBER 13

ACROSS THE DESK

(continued from page 14)

A rap at foreign reps by a would-be buyer

Your editorial "Making It Tough for European Engineers" gave a very exact picture of the poor performance of local representatives in our South American market (ED No. 26, Dec. 20, 1974, p. 49). American suppliers should be more strict when selecting these agents.

Lots of orders are lost because the representative doesn't know anything about the manufacturer's product. We have also encountered many difficulties when trying to order sample quantities of a component for prototype construction.

A. M. Ferrari
Technical Manager
Ericsson do Brasil
Rua da Consolacao
Sao Paulo, Brazil 01416

. . . And a further word on graphic recorders

Your article on graphic recorders was terrific ("Focus on Graphic Recorders," ED No. 3, Feb. 1, 1975, p. 54). As manufacturers of a very fine general-purpose chart recorder, and as specialists in analog data recording in general, we were disappointed that our product wasn't mentioned.

We make a two-pen, three-channel, 10-inch scanning recorder.

Kathy Zika
Office Manager
Tetrahedron Associates, Inc.
7605 Convoy Court
San Diego, CA 92111

A thorough study of the recorder market would have revealed that Soltec Corp.'s Rikadenki and San-Ei recorders as the most desirable. Both of these companies are the largest in their field in the Orient. Rikadenki is in the servo graphic recorder market, including recorders from single-pen to 10-pen, with all 10 pens overlapping and writing the full 10-in. (250-mm) chart width. San-Ei is in the oscillographic market.

Marvin R. Solomon
President
Soltec Corp.
10747 Chandler Blvd.
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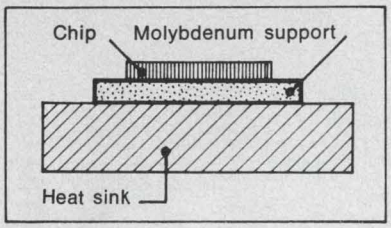

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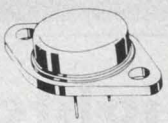
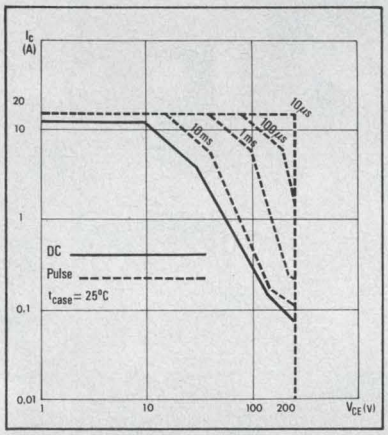
(10 000 cycles)
"on" : 2 minutes
"off" : 1 minute
t case : 125 °C max.
Δt case : 110 °C max.

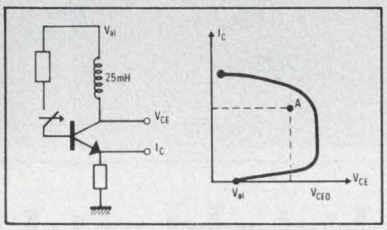
T03 case



FORWARD OPERATION : SAFE OPERATING AREA



REVERSE OPERATION : TESTING CIRCUIT



High performances :
BUX 10→15 (150 W)
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Economical :
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Fast switching :
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DATA DISPLAY PRODUCTS

INFORMATION RETRIEVAL NUMBER 16

2 security systems screen body responses of people

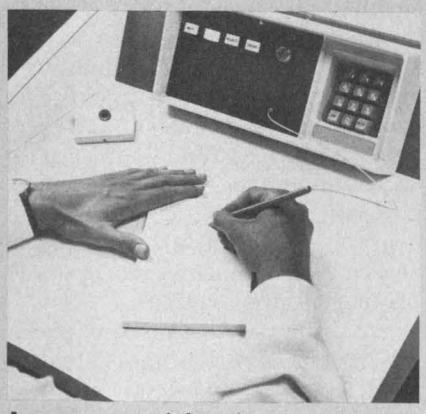
Two sophisticated methods of identifying people automatically have been developed for high-security applications.

In one, identification is made through analysis of the pressure pattern produced when a person writes his name. In the other, the transfer function of the human body for acoustic signals is determined.

In the signature approach, the person writes his name with a special pen. Analysis of the written signature was deemed too easy for forgers to overcome. Instead, the new system checks the signature dynamics—a measure, with respect to time, of the pressure applied to the pen.

Known as Signac—for signature access control—the system was developed by Veripen Inc. of New York City and is being considered for use by the Electronic Systems Div. of the Air Force at Hanscom Air Force Base in Massachusetts.

According to Capt. Gregory A. Cieciwa, project engineer at the division's Base and Installation Security Systems Program Office, statistical evaluation has proved that each person's pressure pattern is unique to the individual and reasonably constant from one signature to the next.



Access control by signature is done with the Signac identification system from Veripen, Inc.

Since the pressure applied is only indirectly related to signature appearance, he goes on, the pressure pattern of a forgery will appear different from the genuine signature. An individual's pressure pattern is virtually impossible to duplicate, Captain Cieciwa says.

Using the special pen, a person first records between three and six samples of his signature. His writing pressure is converted into an electrical signal by a transducer in the pen. This signal is then digitized and processed by a National Semiconductor IMP-16C/300 microprocessor, which forms a signature standard for each person.

To gain access to a protected area, each person must first punch in an identifying number that allows the system to retrieve his standard from memory and compares it with the sample. If the samples match, entrance is permitted.

Accuracy of the system is reported to be high. It is said to reject qualified users incorrectly 1% of the time and to accept unqualified users 2% of the time.

The basic system, which can handle 1000 names and up to four remote entry stations, costs $32,000. For applications requiring control of as many as 10,000 people, the microprocessor is replaced by a mini. In such a system as many input stations as needed can be accommodated.

In the body-measurement approach, Novar Electronics Corp. of Barberton, OH, makes use of the fact that the human body acts as a filter for acoustic energy and that each body has its own unique transfer function. The company's identification system measures an individual's frequency response.

According to James H. Ott, president of Novar, acoustical energy is transferred to the body by a transducer placed in a door mat, door handle or other convenient area. The induced energy is then modified by the bones of the body, and the signal, which is retrieved by another transducer, has a different amplitude, phase shift and frequency content than the original. By comparison of the input and output, it is possible to get the transfer function of the body.

In a working system, Ott notes, a person stands on a door mat that contains the transmitting transducer. When the door knob is touched, the signal picked up from the body by the receiving transducer is analyzed to see how it has changed. The results of these measurements are then passed through an analog-to-digital converter. The resulting digital data can then be stored in a computer memory and used as a template for screening people.

Ott indicates that, like fingerprints, the human transfer function is unique to each person. This is because no two human skeletons are the same. Even in twins, he notes, there are differences caused by modifications in bone growth, which depends on living and working patterns.

Although the identification system is still in the prototype stage, Ott says that commercially available equipment should be ready by the first quarter of 1976.

New OTH-B radar to be cw bistatic

The Air Force will build a cw bistatic over-the-horizon backscatter (OTH-B) radar system in Maine. A developmental prototype, the system is part of the Defense Dept.'s on-going program, begun in the 1950s, to create a network of sensors to detect approaching enemy bombers far from U.S. coasts (see "Backscatter Radar on 2 Coasts to Detect Planes Over Horizon," ED 14, July 6, 1972, p. 30).

OTH radar, which bounces its signals from the ionosphere to earth and back several times, can detect bombers even at low altitudes. A good OTH radar, the Air Force says, should give the U.S. as much

as two hours' warning. Conventional line-of-sight radars, on the other hand, see only about 200 miles, which boils down to a warning of several minutes.

The new system, to be built by General Electric, will be a high-power, high-frequency (5 to 30 MHz) cw bistatic system. The last three OTH-B experimental systems the Air Force built and tested (in Maine, Virginia and the polar region of Canada) were hf, pulse-doppler, monostatic systems.

A cw system was chosen to avoid the extremely high bursts of power that pulse radar systems require. With cw, off-the-shelf transmitters can be used, and there should be less interference with heart pacemakers and other electronic equipment.

If the prototype cw system performs well, two operational systems are to be built, one in Maine and the other in the state of Washington.

The transmitter for the new system will be built in a relatively uninhabited area near Moscow, ME. The receiver—105 miles away, to avoid ground-wave interference from the transmitter—will be near Township, ME.

PLZT may challenge established displays

Numeric displays made from PLZT ceramic, a transparent electro-optic material developed at Sandia Laboratories in 1970, are nearing the point where they may do battle with the more established liquid-crystal and light-emitting-diode displays.

According to Cecil E. Land, principal investigator in the project at Albuquerque, NM, the PLZT display is now potentially competitive in a number of applications "where voltage levels are available to drive it." One example Land gives is the hand-held calculator.

PLZT ceramic material 3 mils thick requires an initial turn-on voltage of 90—or, for a 1-mil-thick sample, 30 V. Liquid crystals require from 5 to 20 V, and LEDs from 2 to 3 V. Offsetting PLZT's high turn-on voltage requirement, however, is its ability to stay illuminated without sustaining power. Due to its electrostatic memory, the material will maintain a light for several days.

PLZT also has these other advantages, Land says:

- High contrast ratios—nearly 100 to 1 with 90 V applied for 50 μs. Nominally liquid crystals have a ratio of from 10 to 1 or 20 to 1.
- Fast switching speeds—10 to 50 μs at 16 kV/cm. Liquid crystals require 10 ms.
- Long life. The material has been cycled up to 100 billion times without degradation.

The solid-state, seven-segment PLZT displays use a transverse quadratic electro-optic effect (Kerr effect), or fringe-field effect, that is created in a thin plate of the ceramic. This effect, produced by application of a voltage between electrodes on opposite surfaces of the plate, allows use of the PLZT devices in both the transmission and reflective modes.

The transmission-mode devices, for use where backlighting—such as a luminescent panel—is possible, consist of a polarizer, solid transparent electrode, PLZT plate, seven-segment numeric mesh electrode and a second polarizer (analyzer) crossed at 90° to the first polarizer. The analyzer serves as the viewing face of the thin sandwich.

The reflective-mode devices, which use ambient light, consist of a polarizer, 1/4-wave retarder, mesh electrode, PLZT plate and a solid metal reflective electrode. Ambient light passes through the sandwich and is reflected back to the surface by the metal electrode, obviating the need for backlighting.

The protoype devices built thus far have 5-mil-wide mesh electrodes separated by 5-mil gaps. The electrodes are sputter-deposited metal or indium-tin oxide. The transparent electrode in the transmission-mode device is indium-tin oxide, while the metal electrode in the reflective-mode device is an aluminum film.

Opto-electronic switch handles 100 V in 10 ps

By using laser light beams to start and stop an electrical signal, a researcher at Bell Telephone Laboratories, Murray Hill, NJ, has produced a switch that operates at 10 ps and can switch as much as 100 V.

Until now, the fastest switching device available has been the Josephson junction device. But it is capable of switching only a few volts and must be operated at cryogenic temperatures. In addition it needs fast electronic control pulses. These are difficult to get, but the optical pulses for the laser switch are easily generated with off-the-shelf equipment.

According to David H. Auston, developer of the new switching technique, "the device should work at speeds as fast as 1 ps." The switching speed is limited only by the duration of the optical pulses.

In describing how the new switch works, Auston explains that beams of laser light are focused on a piece of light-sensitive semiconductor. The semiconductor exhibits both surface and bulk photoconductivity.

The semiconductor chip contains a microstrip transmission line that has a gap of high resistance, which prevents the signal from being propagated. The other side of the chip contains a ground plane.

Two optical pulses of different wavelengths are used to turn the switch on and off. The pulses are generated when a single pulse is extracted from a neodymium glass laser and then doubled in a KDP crystal to get a second pulse at half the wavelength.

The two pulses are then separated by a beam splitter, delayed and focused onto the gap in the silicon microstrip structure. The shorter, 0.53-μm pulse brings the surface photoconductivity mechanism into play and causes a thin layer of high conductivity near the surface of the silicon, turning the switch on. The longer, 1.06-μm pulse is delayed and then used to turn the switch off. The longer absorption depth of this pulse penetrates to the ground plane, shorting the transmission line and preventing propagation.

According to Auston, peak transmission through the gate is better than 95% when it is on and less than 5% when it is off. Signal levels as high as 100 V have been switched, he reports.

gain (this can be approximated by a Darlington transistor), and the output current becomes $I_s \pm I_{in}$.

Since $I_s = V_{R3}/R_3$ and $I_{in} = -(V_E/R_{in}) \pm (V_{in}/R_{in})$, I_{out} can be found:

$$I_{out} = (V_{R3}/R_3) - [\pm (V_{in}/R_{in}) + (V_R - V_{R3})/R_{in}]$$

For Q_1 to remain in conduction, I_S must always be larger than the terms in the square brackets of the last equation. Standby current of 2 mA can maintain conduction in Q_1 at all times. Thus for $V_{in} = \pm 10$ V, $I_{in} = \pm 16$ mA; $R_{in} = 625\ \Omega$.

Since the output current is referred to ±0.7 V, set $V_E = +4$ V to bias Q_1. The maximum current that will flow out of the V_e node towards the V_{in} terminal occurs when $V_{in} = -10$ V. The current reaches a maximum of 22.4 mA.

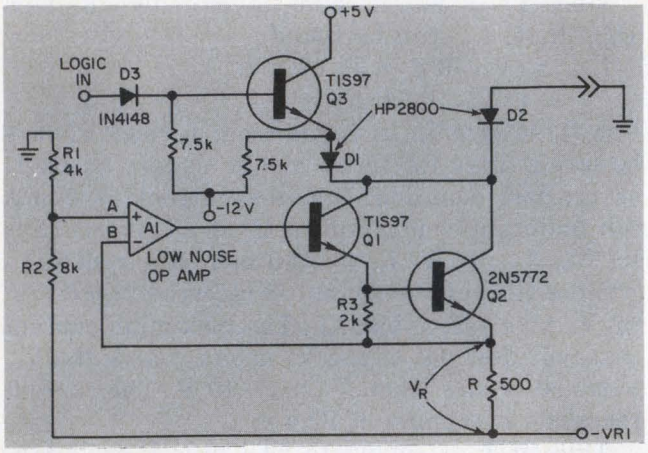
Thus, if I_s is set up to 24.4 mA, $I_o = 2$ mA. This current is negated by $-V_R$ and R_4 so the net current into the comparator and d/a converter is 0 to 32 mA for an input of −10 to +10 V. Again, the high accuracy of the circuit is due to precision resistors in R_1, R_2, R_3 and R_{in} and some additional trimming.

High stability in the voltage-to-current converter can be achieved by use of high β transistors in the transconductance amplifier and by adjustment of the amplifier's offset for a zero temperature coefficient. Linearity is ensured as long as you make sure the transistor operates in the active region at any value of V_{in}. If you do this, V_E doesn't vary by more than 100 mV, and V_E is further reduced to almost zero by the open loop gain of the amplifier. For example, if $A = 1000$, V_E changes by 0.1 mV when V_{in} changes from −10 to +10 V. The resulting error is 0.1 mV, which is 1 part in 100,000.

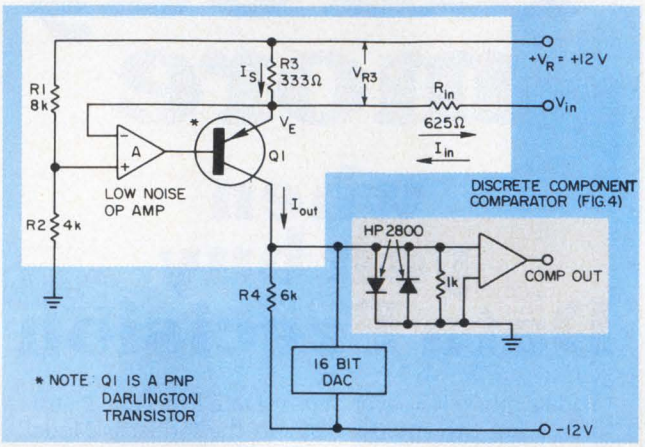
Since V_{R3} remains constant, and the power change across Q_1 doesn't change the output current, the only power change in the circuit is in R_{in}. To combat any thermal transients caused by the power change, use a very low tempco resistor (1 ppm/°C or less).

Fast settling speed—300 ns to 0.0015%—is fairly easy to get this time. Since no more than 100 mV of transient signal appears at V_E, the amplifier doesn't have to move by more than this amount to null the error signal to zero. The amplifier should have low output impedance—and, of course, high speed—so any voltage swing at the collector of Q_1 is absorbed by the output of amplifier A.

There are no critical component matching procedures for the converter. Just use low-tempco 0.01% film resistors—typically 1 ppm/°C—for the four-MSB circuits and voltage-to-current converter; 5 ppm/°C, 0.01% resistors in the 12-bit d/a portion and ±12-V regulators. IC dual transistors with betas of 200 or more and drifts of 20 μV/°C or less should also be used. ■■



6. **Each of the four MSB current switches** must be analyzed to find the error sources that can degrade a/d converter performance.



7. **A simple voltage-to-current converter** uses an op amp and a high beta transistor to transform an analog input voltage into a proportional current.

can even monitor the wideband noise, which in this example is about 30 μV pk-pk.

The circuit of Fig. 5 reduces the thermal-transient effects further. The first stage has a gain of 10, so the output can easily be handled by any IC comparator. The settling time from overdrive down to 0.25 mV is less than 250 ns.

Aside from input-circuit thermal problems, you'll find many other headaches—for instance, the MSB current switches in the d/a or the voltage-to-current converter circuit. These switches have several important constraints: settling in 500 ns or less, accuracy adjustable to within 50 nA, stability with less than 10 nA/°C drift and noise of less than 80 nA pk-pk at the operating bandwidth of the a/d.

A typical diode switch consists of a current source and diode steering logic (Fig. 6). The current source has an op amp, two transistors and three very stable resistors. The op amp, A_1, operates in the noninverting mode.

A logic input to the anode of D_3 steers I_0 through either D_1 (thus cutting off D_2) or through D_2 (cutting off D_1). This bucks the current source against the input current.

With this arrangement, thermal transients are minimized, since there is no power change across the current source, except in the transconductance elements Q_1 and Q_2. Also, because these two transistors are in a closed-loop feedback system with A_1, any power changes caused by voltage variations at the collectors are immediately compensated by the open loop gain of A_1.

Hot-carrier diodes help provide the high speed needed for fast settling. The worst-case settling occurs when the MSB current flows through D_2 to the summing point. At this time the combined capacitance of D_1, Q_1 and Q_2 add to about 8 pF and a settling time about 300 ns, or 0.0015%.

In addition to temperature drift accuracy, stability and noise are three major problems that have to be solved to ensure proper a/d converter operation. As a start, use 0.01% precision resistors for R_1, R_2, R and other critical trim resistors. For good stability, you can temperature-compensate the MSB switching circuit. This is done by adjusting the offset voltage of A_1 to counteract any drift causd by Q_1, Q_2 or the current-determining resistors.

To minimize the noise, use a discrete component design for A_1. This will reduce the noise to about 0.1 LSB.

The last major section of the a/d—the voltage-to-current converter—also has some critical specs (Fig. 7). Accuracy must be tighter than 1 part in 130,000 and linearity the same; stability should be 2 ppm/°C or tighter; and the wideband noise should be less than 50 nA when referred to a full-scale current of 32 mA.

Changes in power dissipation have to be minimized to eliminate any thermal transients that could add or subtract from the input. Speed or settling capability should be fast—no more than 0.5 μs to reach 1 part in 130,000. Reflections back into the signal source pose another problem that is often neglected. When this happens, any output from the converter cannot be trusted.

The voltage-current converter uses a transconductance circuit that transforms the voltage input into a proportional current (Fig. 7). Amplifier A_1 feeds transistor Q_1, which operates as a common-base amplifier. If you assume the amplifier has an infinite open-loop gain and zero bias current, the voltage across R_3 becomes

$$V_{R3} = V_R R_1/(R_1 + R_2).$$

In addition assume that Q_1 has infinite current

If you follow the thermal path in the front end of a comparator circuit, you will see the trouble spots (Fig. 3). At time, t_o, D_1 is on and D_2 is cut off. The negative input through R_{in} turns on D_3 and reverse-biases Q_1 at -0.7 V. Transistors Q_1 and Q_2 form a differential input circuit that is similar to comparator front ends.

Since the base of Q_2 is grounded, Q_1 is off and Q_2 is on. The power dissipation for Q_1 is zero, while that for Q_2 rises to $(V_{CC} - IR_L + V_{be})I$. After time t_1 elapses, the logic input rises to +1 V. This turns off D_1 and turns on D_2, and current through R_1 is bucked by the input current. The base of Q_1 now sits at 0 V and if the offsets of the transistors are equal to zero, the current, I, splits equally between the two transistors. Each transistor now has power dissipation equal to $(V_{CC} - IR_L/2 + V_{be})I/2$.

The differences in power dissipation for the transistors are:

For Q_1, $P = (V_{CC} - IR_L/2 + V_{be})\ I/2$;

For Q_2, $P = (V_{CC} - 3IR_L/2 + V_{be})\ I/2$.

Thus when Q_1 turns on, it warms up and changes the thermal gradient of the circuit as well as its own emitter-base voltage. At the same time Q_2 starts to cool, since it loses half of the current it carried. You can approximate the heating effect as follows: For every 5-mW change in transistor power dissipation, the base emitter temperature varies by 1 C and V_{be} changes by 2.2 mV. Thus you can calculate the error caused by thermal changes and referred back to the input.

The thermal changes are transient

The thermal change lasts anywhere from 20 μs to milliseconds, depending upon the physical mass of the transistors. With this knowledge, you can now estimate the thermal change across the base-emitter junctions of Q_1 and Q_2:

$V_{be} = [(V_{CC} - IR_L/2 + V_{be}) + (V_{CC} - 3IR_L/2 + V_{be})]\ (1/2)\ (2.2\ mV/5\ mW)$

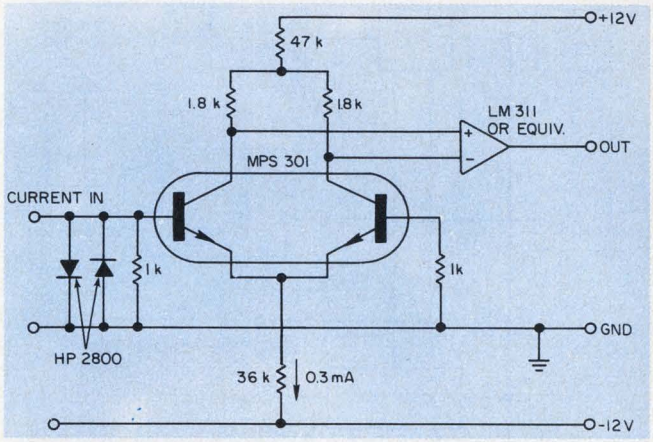
$= V_{th}$ (thermal change referred back to the input).

This equation can be simplified to

$$V_{be} = (2.2\ mV/5\ mW)\ (V_{CC}\, I - R_L I^2 + V_{be}\, I) = V_{th}. \quad (1)$$

If, in the circuit of Fig. 3, you assign the values $I = 2$ mA, $R_L = 1$ kΩ and $V_{CC} = 15$ V, you would get a thermal change of 12.1 mV in V_{be}.

To get a signal-to-thermal-transient ratio of 2 to 1, the signal resolution should be not less than 24 mV. As you can see, thermal considerations in the comparator are critical, and any change in power dissipation of the input transistors should be minimized.



5. **A practical comparator amplifier** makes use of both IC and discrete components to get the most gain and the fastest response to input signals.

Design your own comparator

Eq. 1 can be rearranged to solve for the current flowing in the common-emitter resistor:

$$I = (V'_{CC}/2R_L)\ (1 - \sqrt{1 + 4KV_{th}R_L/V'^2_{CC}}),$$

where $K = 5$ mW/2.2 mV and $V'_{CC} = V_{CC} - V_{be}$.

This can be reduced to

$$I = KV_{th}/V'_{CC}.$$

Thus if you want to resolve 0.5 mV and you have $V_{th} = 2$ mV, by referring to Fig. 4, you can set the collector voltage equal to a minimum of +1 V and calculate from Eq. 2 that the emitter resistor current is 300 μA. Each transistor then draws only 150 μA when balanced.

You can also calculate the differential voltage gain of this stage as

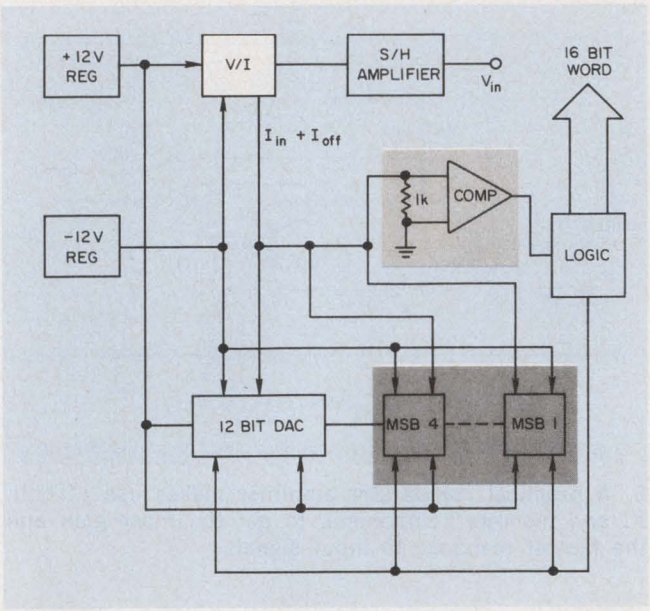
$$A_V = R_L/r_e + (r_b + R_s)/(1 + \beta).$$

For large values of β, this can reduce to $A_V = R_L/r_e$. For an emitter current of 0.3 mA and a load resistor of 1 kΩ, the voltage gain is only 6. The time-constant associated with the differential stage can be approximated by

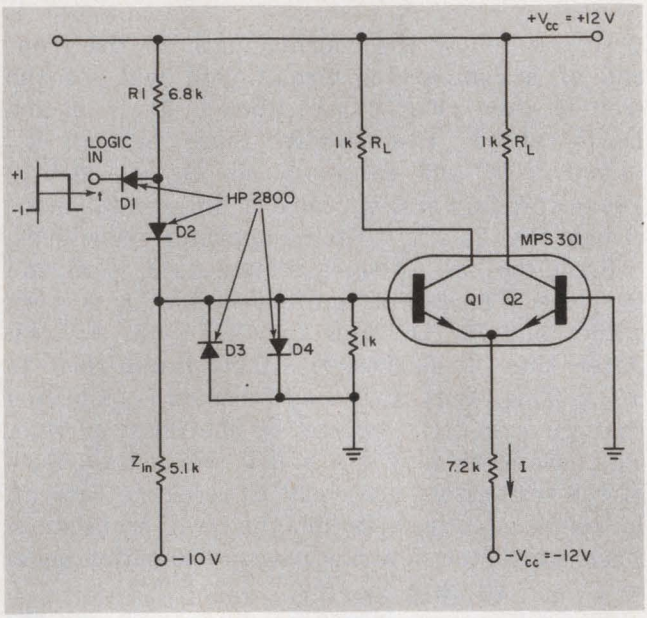
$$t_s + R_s\,[C_{be} + C_{ob}(R_L + r_e)r_e].$$

For maximum speed, use hot carrier diodes for D_1 and D_2. These clamp the input at ± 0.4 V, with input currents of ± 2 mA and keep the input capacitance to less than 2.4 pF.

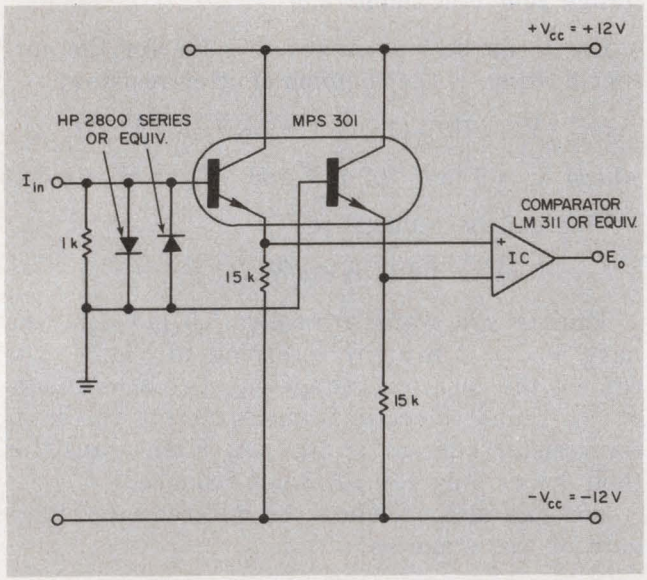
Three stages with gains of 6 will provide total gain of 216, amplify the 0.5-mV signal input to 108 mV and allow for settling-time measurements down to 0.01% in less than 250 ns. You



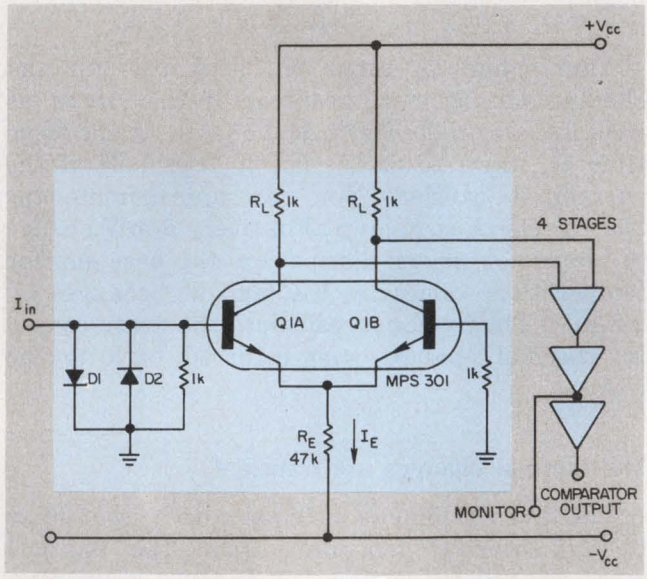
1. **Break down the 16-bit a/d converter** into functional blocks. This helps simplify the analysis.



3. **Input signal voltages to D_1** control the current flow, and thus the on or off state of Q_1.



2. **Use of a monolithic dual-transistor** in the a/d comparator circuit helps to reduce the bias current needed from the source and to lower the offset current.



4. **The front-end design of the comparator circuit** is the most critical step. Additional gain stages following the first stage amplify the signal to TTL levels.

Comparison of common a/d conversion methods

Method	Complexity	Achievable accuracy	Typical size (in.)	Typical cost ($)	Typical "high" speeds
Serial	Simple	16	2 × 4 × 0.4	$ 250	20 ms
Successive	Medium	16	1.75 × 5.5 × 4.5	1300	8 μs
*Cyclic	Complicated	10	3 × 5 × 0.4	1000	200 ns
Serial Parallel	Complicated	16	4 × 5.5 × 4.5	4000	3 μs

*Cyclic converters are not usually available with accuracies greater than 10 bits due to absolute amplifier design limitations.

Design a precision a/d converter. You can build a 16-bit successive-approximation unit that's accurate to 0.005% with controlled thermal transients and noise.

You face a string of problems when you design a precision, 16-bit analog-to-digital converter. Noise, accuracy, speed, stability, temperature drift and cost are all important. Of the common conversion schemes, the successive-approximation method offers the best combination of design parameters for many applications (See table).

A 16-bit a/d must resolve to 1 part in 65,000. Thus for an input signal that might typically fall anywhere in a −10 to +10 V range, 1 bit is only 320 μV. And if a total conversion time of 8 μs is allowed, each bit must be determined within 0.5 μs.

In successive-approximation converters the worst-case condition for settling time will occur when the input signal reaches half scale. In the circuit of Fig. 1 the input is first converted from a bipolar voltage to a unipolar current of, say, 0 to 32 mA. At half scale the input current is exactly 16 mA, and it gets balanced against the MSB current, which is also 16 mA. And, as we've seen, this balancing must take place in less than 0.5 μs, including the settling time for MSB turn on. This permits settling of the comparator, the MSB current and any logic delays.

For accurate conversion, the sum of the wide-band noise in the amplifier, voltage-to-current converter, digital-to-analog converter and comparator must not exceed 0.5 LSB or 160 μV pk-pk.

The current to be resolved will fall between 0 and 32 mA, and the answer must be given in 500 ns. The comparator detects any deviation from exact balance. Not only must the comparator make a decision to drive logic, it must also monitor the voltage at the junction of the d/a and voltage-to-current converters.

Start the design with packaging

To achieve precision and ease construction, use a modular approach. The circuit can be divided into 11 basic modules (Fig. 1). Due to the inherently low input impedance of this type a/d converter (600 to 1000 Ω), you must include a sample-and-hold amplifier in the input circuit. The s/h should provide an input impedance of around 1000 MΩ, and acquire a signal to within 0.002% in 1 μs to prevent slowing down the conversion.

Other sections of the modularized circuit might include the voltage-to-current converter, +12-V and −12-V reference regulators, a 12-bit d/a (used for the lower 12 bits), four matched MSB current switches, a high-speed comparator and a logic block with all the control circuitry and storage functions.

Over-all thermal stability must be better than 7.5 ppm (0.5 LSB) for the a/d to be useful over 0 to 60 C. So all modules must be temperature-compensated between 0 to 60 C, so temperature gradients do not affect accuracy.

In a 16-bit converter one of the most important sections is the comparator. This module must determine to within half a bit or less, when the input current balances the current output of the d/a inside the a/d. For example, if the input current is 16 mA, the comparator must establish within 0.35 μs of the convert signal whether the current output of the first MSB current switch nulls the input. Since the maximum input current is 32 mA, the LSB equals 0.5 μA.

The comparator determines the polarity of the difference current and also drives the d/a control logic. Both currents are summed by the comparator in a 1-kΩ resistor. The resulting input to the comparator can be as small as 0.25 μA (0.25 mV), and it must be amplified to a TTL logic swing.

Thus the comparator has some pretty tough specs: A_V of 12,000, settling in less than 0.35 μs to within 0.25 mV, input bias current of 100 nA or less and offset voltage drift of 20 μV/°C or less.

A typical IC comparator (Fig. 2) with an extra dual transistor input circuit can meet all these conditions. But it fails in one important area—thermal transients.

Gilbert Marosi, Senior Project Engineer, Intech, 1220 Coleman Ave., Santa Clara, CA 95050.

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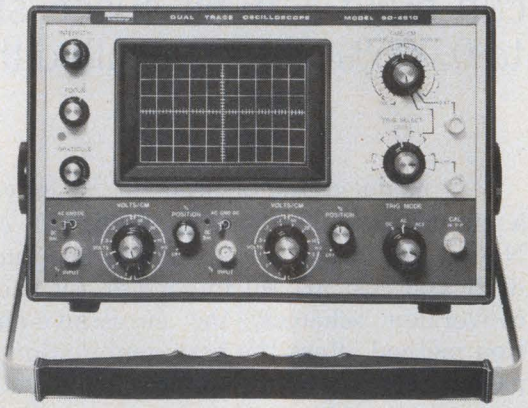

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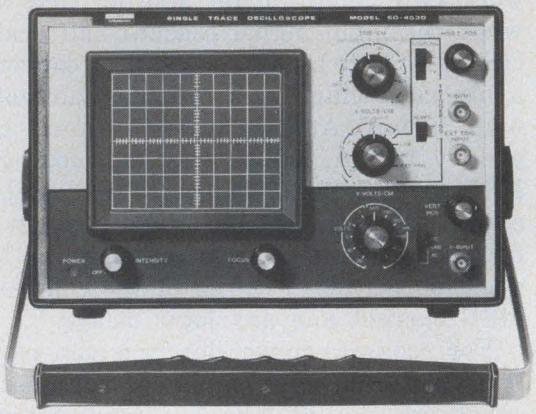

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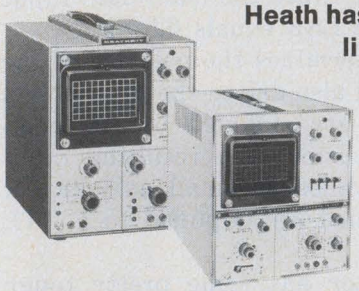

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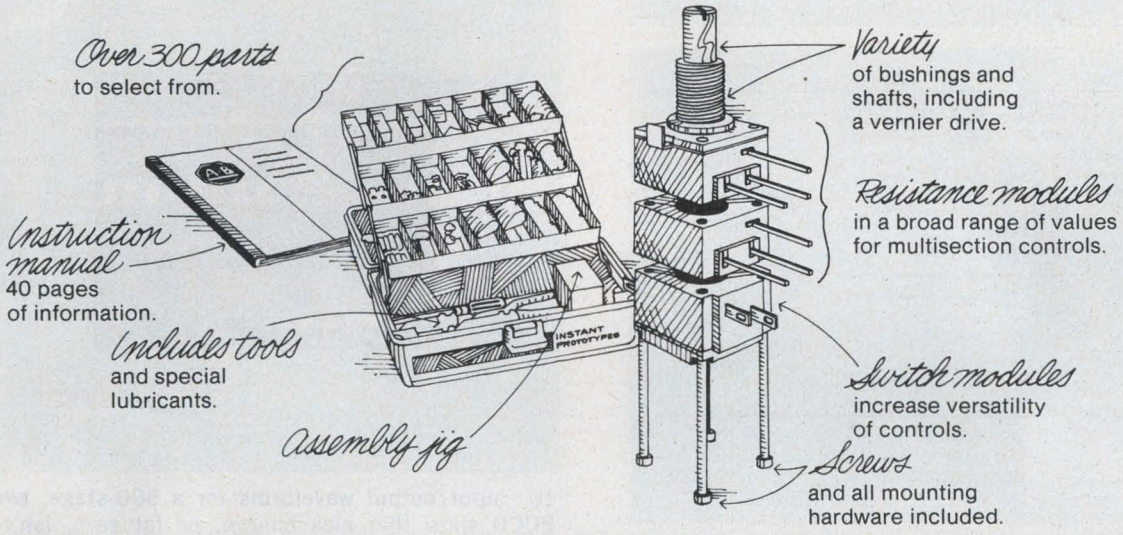

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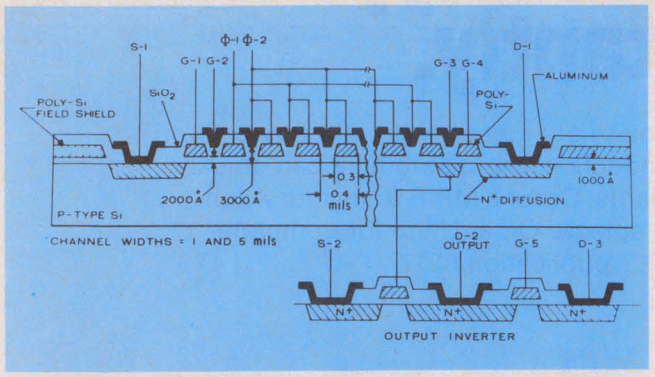
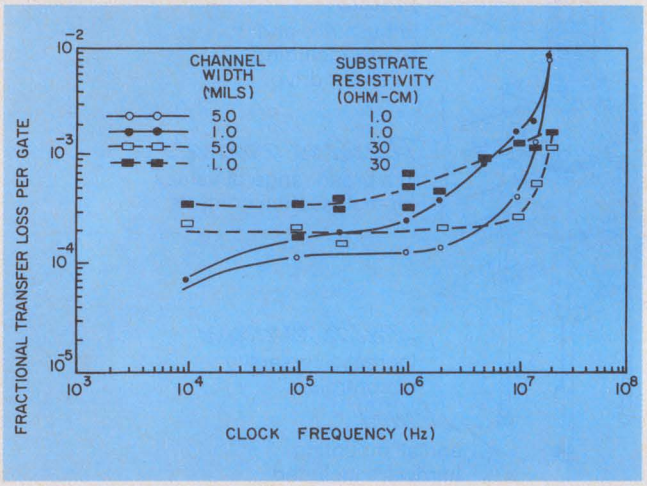
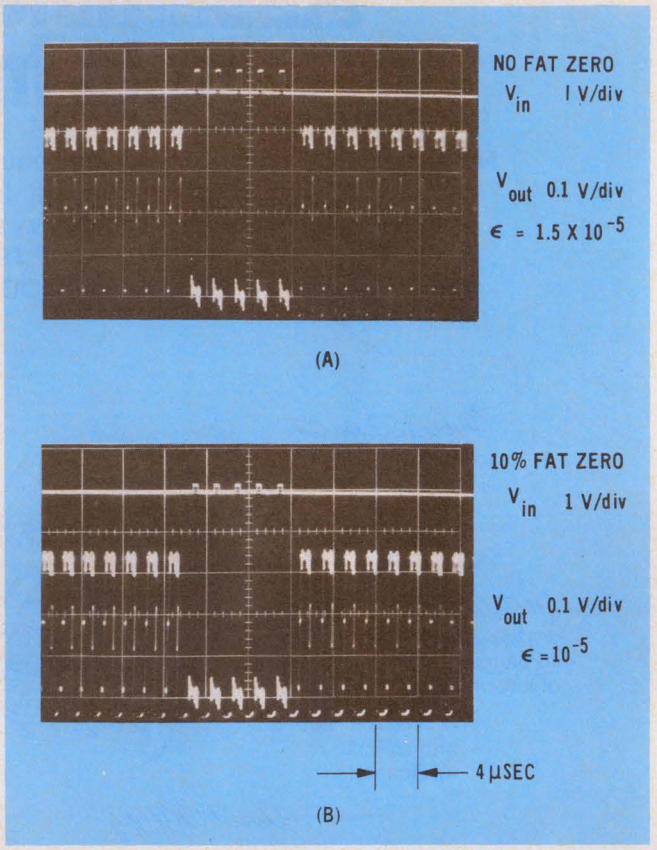




9. **The fractional transfer loss of 500-stage, two-phase SCCDs** with 30% bias charge is obtained for different channel widths and substrate resistivities.



10. **Input/output waveforms for a 500-stage, two-phase BCCD** show that bias charge, or fat zero, isn't necessary (a). But it can reduce transfer losses (b).

in surface-channel CCDs. A signal-to-noise ratio of 60 to 80 dB should still be possible with SCCDs.

- Several low-noise input techniques are available. They have thermal-noise fluctuations that are comparable to those associated with charging of the capacitance of the input potential well.
- Noise associated with the resetting of the output floating diffusion can be considerably reduced by a technique of synchronous double sampling.
- Output circuits in the form of a floating-gate amplifier (FGA) or a distributed FGA are expected to lead to still smaller noise levels in the output circuit.
- Analytical and experimental studies indicate that noise inherent in the charge-transfer action of CCDs won't impose any limitation on the size of memory elements in the foreseeable future.

What about CCD performance?

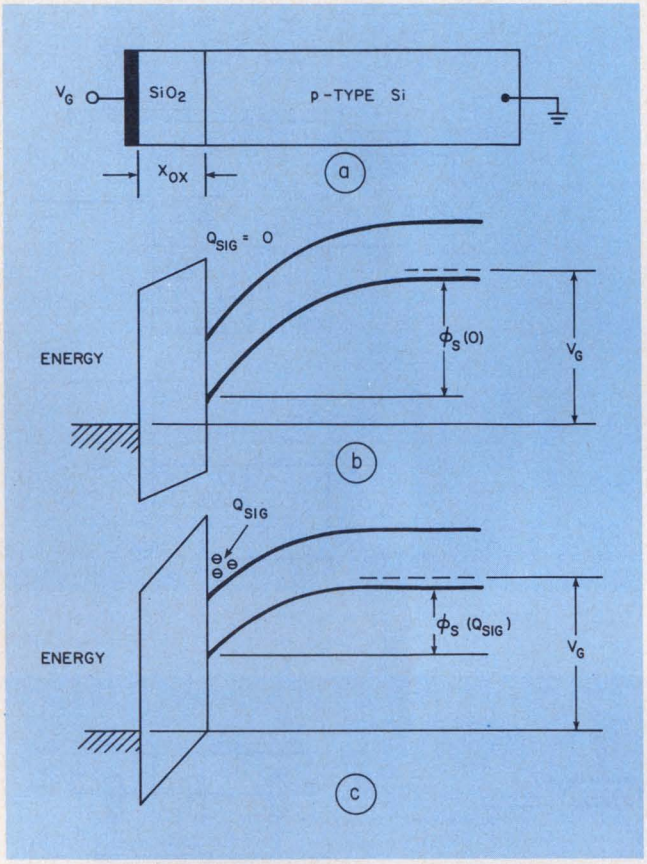
The two most important performance characteristics of CCDs are dark current and transfer inefficiency, or transfer losses, as a function of clock frequency. Charge-transfer efficiency, which was 0.99 for a three-phase SCCD in 1970, has reached 0.99999 for two and three-phase SCCDs in 1974.

The dark-current characteristics of a CCD include the average thermally generated background charge as well as localized dark-current spikes that are very sensitive to the applied gate voltage. Dark current background levels as low as 5 to 10 nA/cm^2 have been reported. However, the control of dark current and its spikes remains one of the critical aspects of CCD manufacturing.

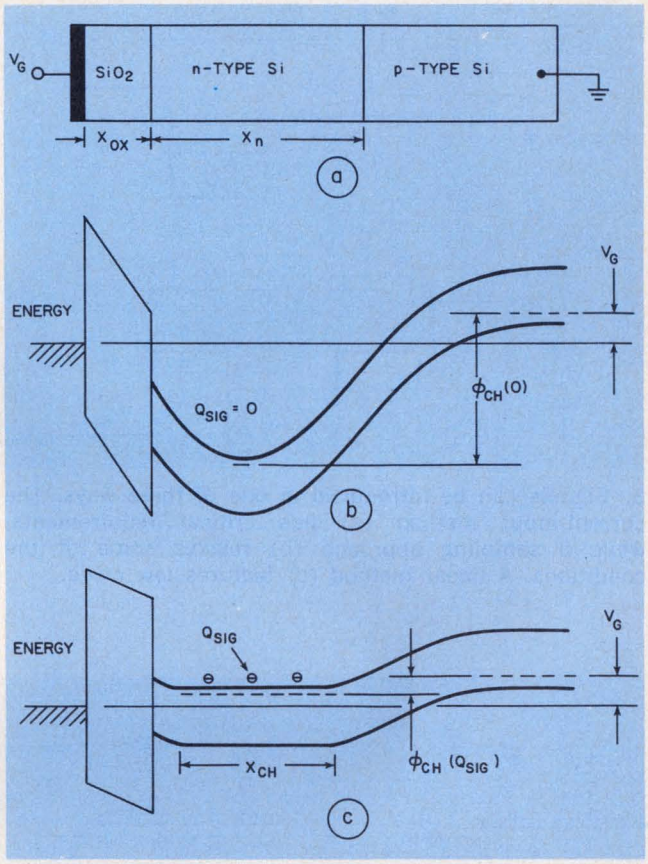
The typical performance of an SCCD is shown in Fig. 9. Transfer efficiency varies inversely with the density of fast-interface states. The lowest fractional transfer loss for an SCCD has been reported by Bell Laboratories: A 1600-stage 40 μm-wide triple-polysilicon-gate line imager had a loss of 1×10^{-5} at a clock frequency of 0.3 MHz.

For BCCDs, fractional transfer losses in the range of 10^{-4} to 10^{-5} have been reported by several companies. A fractional loss of 5×10^{-5} at a clock frequency of 135 MHz was reported by Philips.

The output waveform for a 500-stage, two-phase BCCD with and without fat zero are shown in Fig. 10. These waveforms illustrate the capability of BCCDs for high charge-transfer efficiency. ■■



7. **A surface-channel CCD** (a) forms potential wells at the surface of the silicon substrate rather than below as in a bulk CCD. Energy bands for an empty potential well (b) are altered by charge signal (c).



8. **A buried, or bulk, channel CCD** (a) forms wells below the surface. Energy bands for an empty well (b), change markedly when charge signal is present (c). A BCCD doesn't require bias charge.

the signal can be sensed nondestructively, so that only transfer noise is introduced into the charge signal. The floating gates are connected to an on-chip MOS amplifier.

Surface vs buried channel

The charge-coupled device can be constructed as a surface-channel device (SCCD) or as a buried-channel device (BCCD), as shown in Figs. 7 and 8, respectively.

The potential wells of an SCCD are formed at the Si-SiO_2 interface. In contrast, the BCCD forms wells below the silicon surface to avoid charge trapping by surface states. The silicon substrate has an additional thin layer whose conductivity type is the opposite of that of the substrate. During the operation of a BCCD and with no signal charge—$Q_{SIG} = 0$—the top layer is depleted of mobile charge. Hence the potential minimum forms below the surface of silicon.

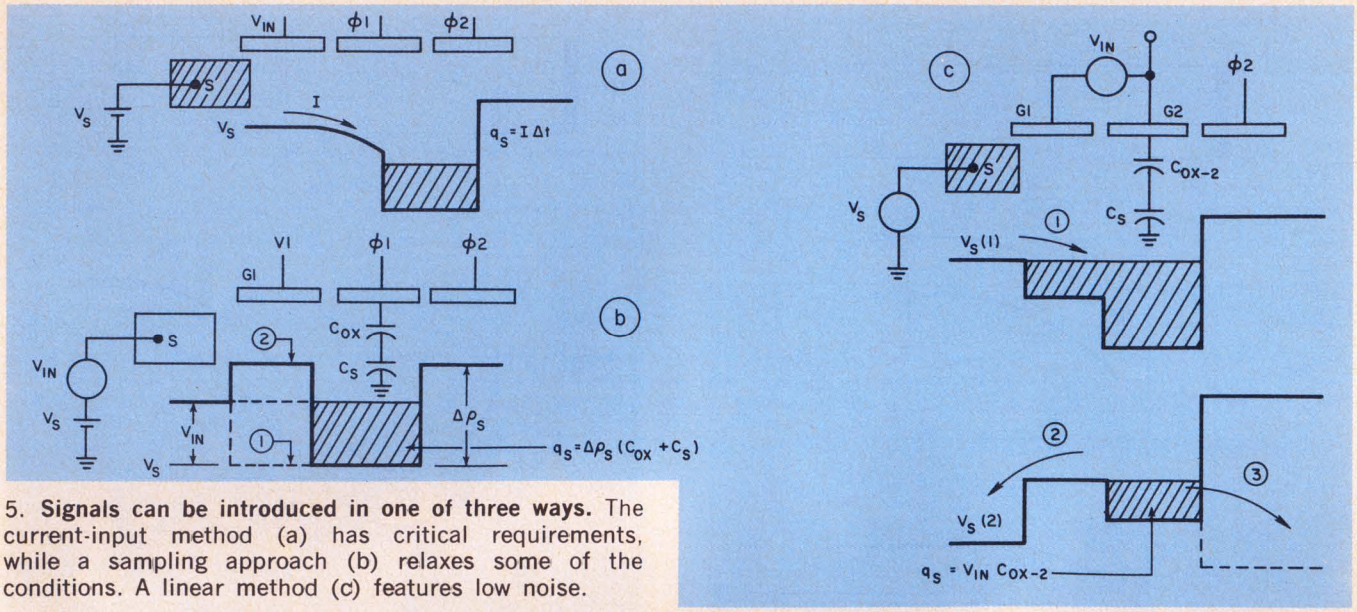
Although the analysis and the design of BCCDs are somewhat more involved than that of SCCDs, the external operation of the two may differ only by the dc level of the clock voltage pulses. However, a BCCD doesn't require a fat zero—bias charge—for high efficiency, or $\eta > 0.9999$. Also, it doesn't exhibit noise caused by the trapping of charge by the fast interface states, and it has a higher frequency response than an SCCD with the same dimensions.

In fact, a BCCD with a thick epitaxial top layer can achieve $\eta > 0.9999$ with clock frequencies in excess of 100 MHz. However, the maximum charge signal in a BCCD is up to three times smaller than that of SCCD. Also, the BCCD can have a higher dark current—a type of leakage—than the SCCD.

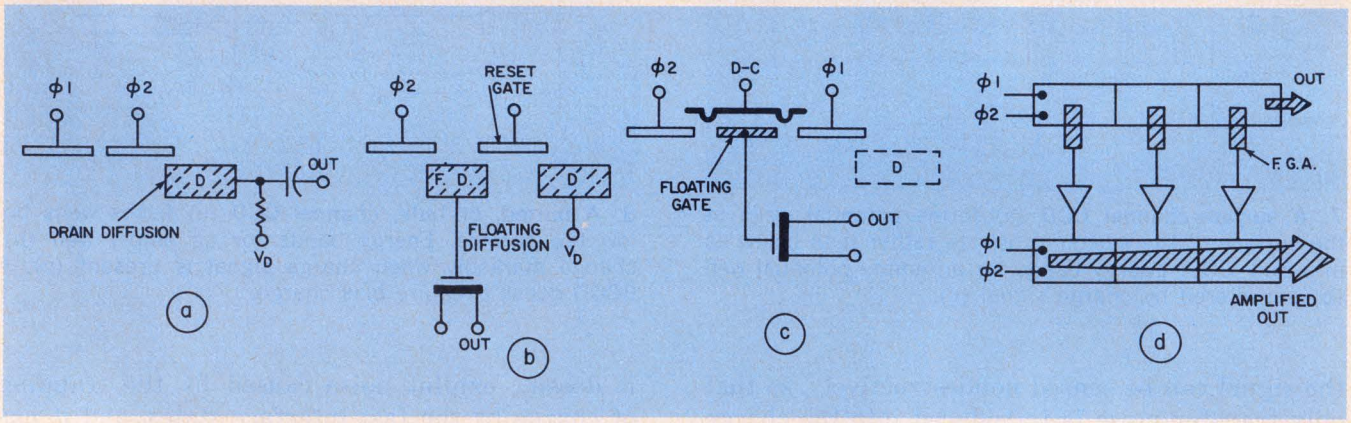
As with most other ICs, noise represents an important consideration in the evaluation of CCDs. Such applications as signal processing and imagers can require either very low signals or large dynamic range. Also, the theoretical minimum size of a CCD memory element depends on noise characteristics, since a memory's error rate is a function of the signal-to-noise ratio.

The general conclusions on noise in CCDs are as follows:

- Transfer noise due to free-charge transfer is quite low. Usually it involves only the small amount of charge left behind.
- Noise associated with trapping of charge by fast interface states and that caused by a fat-zero signal represent the major noise fluctuations



5. **Signals can be introduced in one of three ways.** The current-input method (a) has critical requirements, while a sampling approach (b) relaxes some of the conditions. A linear method (c) features low noise.



6. **Signals can be detected in one of several ways.** Current sensing (a) employs the drain diffusion of the output stage. Voltage or charge-sensing is obtained with an internal floating-diffusion amplifier (b). And nondestructive sensing can be obtained with an internal floating-gate amplifier, in either single (c) or distributed form (d). With a floating-gate amplifier, only transfer noise is introduced into the signal.

A charge-presetting input method is linear, has the advantage of low noise, and it doesn't depend on threshold (Fig. 5c). The basic concept is to form a potential well at gates G1 and G2, with input gate G1 acting as a barrier between the source diffusion and the input well under G2. The input is applied as the relative voltage between gates G1 and G2.

The input well is first overfilled by raising the source potential above the G1 barrier. The excess input charge returns to the source diffusion when its potential is lowered. If the same channel oxide is used for both gates G1 and G2, the input charge signal, q_s, is

$$q_s = V_{in}\,C_{ox-2} \qquad (2)$$

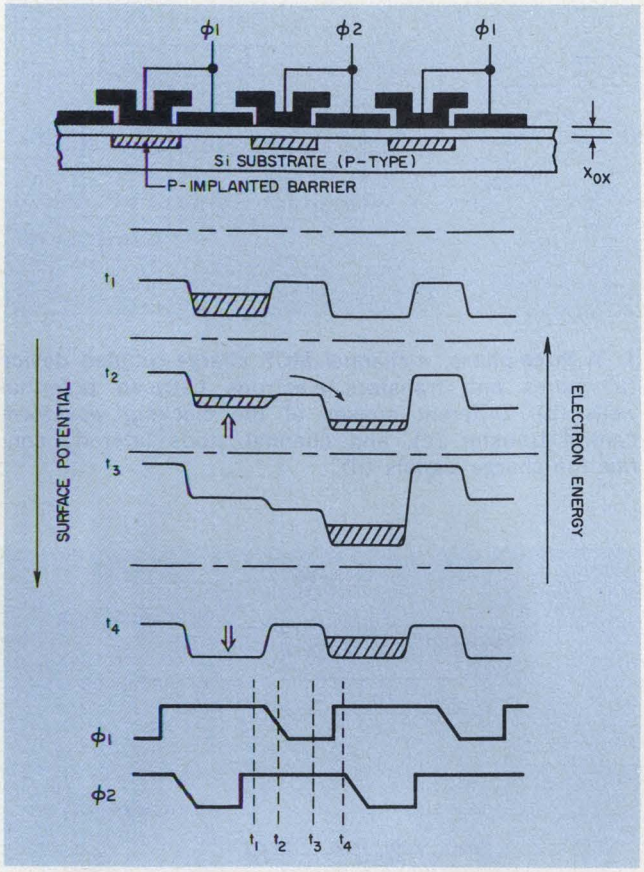
where C_{ox-2} is the oxide capacitance of gate G2.

Three methods are also available for the detection of charge signals at the output (Fig. 6). Current sensing measures current flow in the drain of a CCD (Fig. 6a). The current results from charge signals coupled to the drain diffusion by the last gate electrode. And the output signal takes the form of a current spike at a relatively high capacitance terminal. In theory, the method provides a highly linear detection scheme.

Amplifier comes on the chip

The floating diffusion amplifier (Fig. 6b) is the most popular detection approach when an on-chip amplifier is used. The output circuit periodically resets the floating diffusion to a reference potential. The floating diffusion, in turn, is connected to the gate of an on-chip inverter or source-follower amplifier. The detected signal varies proportionally with the floating-diffusion voltage as a function of the charge signal. Hence the technique is referred to as a voltage, or charge-sensing, method.

With a floating-gate amplifier (Fig. 6c or 6d),



4. **Two-phase push-clock operation** employs overlapping clock pulses. Charge is "pushed" across the barrier.

charge by the interface states can be avoided by buried-channel construction. In this type of CCD, however, small trapping losses may be observed. They are attributed to charge trapping by stationary bulk states.

Up to 3 gate levels used

The most common CCD structures employ sealed-channel construction involving one, two or three levels of polysilicon (Fig. 2). The selectively doped single-layer structure (Fig. 2a) passivates the interlectrode spaces with high-resistivity polysilicon. A second-layer metallization (aluminum) forms interconnections.

Polysilicon-aluminum, or two levels of polysilicon gates (Fig. 2b), represents a self-aligning, overlapping gate structure. Gate separation is formed by thermally grown SiO_2 that has a thickness comparable to that of the channel oxide. This gate structure can be used for construction of two-phase as well as four-phase CCDs.

The triple-polysilicon structure (Fig. 2c) represents another alternative. It has the unique feature of a separate polysilicon level for each phase.

The number of clock phases can be reduced to two, or even one, if the potential wells are made directional with an asymmetrical CCD-gate structure. This can be accomplished by connection of separate storage and barrier gates to a common clock voltage. In turn, the storage and barrier regions can be formed with two different thicknesses of channel oxide or by modification of the substrate doping level through ion implantation.

Push clocks vs drop clocks

Unlike three or four-phase CCDs, two-phase devices can operate with nonoverlapping positive clock-voltage pulses. Overlapping clock pulses are referred to as push clocks, while nonoverlapping clock pulses are called drop clocks.

In two-phase drop-clock operation (Fig. 3), the transfer barriers are formed by ion-implanted p-type regions under transfer gates. The shift of charge from the potential well under the ϕ_1 storage electrode to a well under ϕ_2 occurs during the positive ϕ_2 pulse. A similar process moves charge from ϕ_2 to ϕ_1 during the positive ϕ_1 pulse to complete the cycle.

In two-phase push-clock operation (Fig. 4), charge is "pushed" across the potential barrier during the fall time of the clock waveform.

The two-phase structure also may be operated from a single clock line by application of a dc bias to one of the phases. Then half of the transfers involve drop-clock operation, and the other half are push-clock.

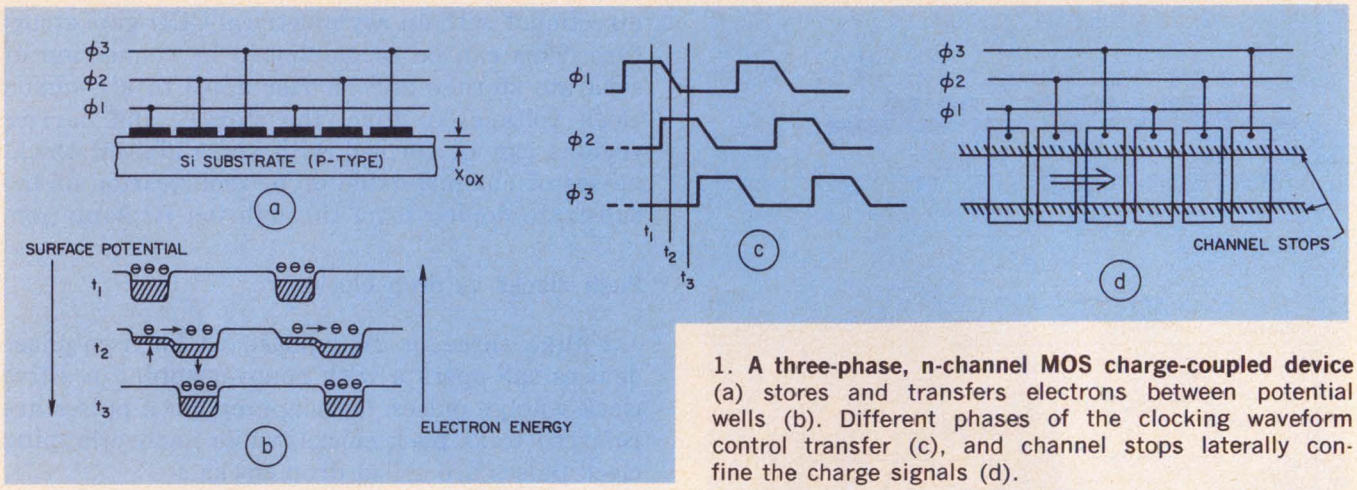
Input stages accept electrical signals

Of course, for applications, means must be provided to introduce charge into the CCD register and then to detect signals at the output. An electrical input is usually introduced by one of the three ways shown in Fig. 5.

In the current-input method (Fig. 5a), the source diffusion, S, is dc-biased, and an input voltage pulse, V_{G1}, is applied to the first gate, G1. The combination forms an MOS current source that fills the first potential well under ϕ_1 for the duration, Δt, of the input pulse. This method is relatively critical, since the amount of charge introduced depends on the MOS threshold voltage as well as the amplitude and duration of the input pulse, V_{G1}.

A more controlled method samples the input signal voltage, and the first potential well then fills to the voltage of the source diffusion (Fig. 5b). The input is applied as the source-diffusion voltage, while input gate G1 isolates the first potential well from the source.

This method works best with a relatively slow fall time for the input-gate clock pulse. And though input charge isn't determined by the sample-pulse amplitude or duration, it does depend on the MOS threshold of gate ϕ_1.



1. **A three-phase, n-channel MOS charge-coupled device** (a) stores and transfers electrons between potential wells (b). Different phases of the clocking waveform control transfer (c), and channel stops laterally confine the charge signals (d).

fer efficiency, η. The fraction left behind is the transfer loss, or transfer inefficiency, and it is denoted by ϵ, so that $\eta + \epsilon = 1$. Because η determines how many transfers can be made before the signal seriously distorts and becomes delayed, it is the most important performance parameter.

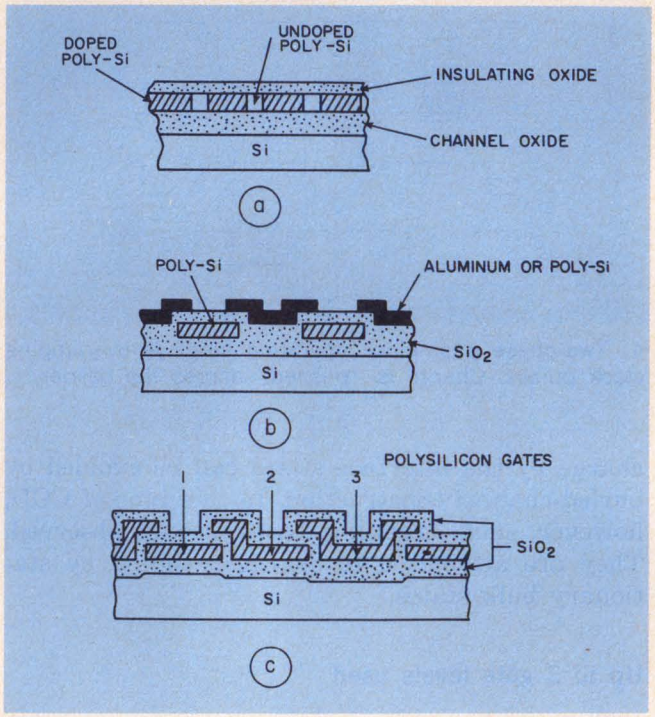
Boosting transfer efficiency

If a single charge pulse with an initial amplitude P_0 transfers down a CCD register, after n transfers the amplitude, P_n, will be

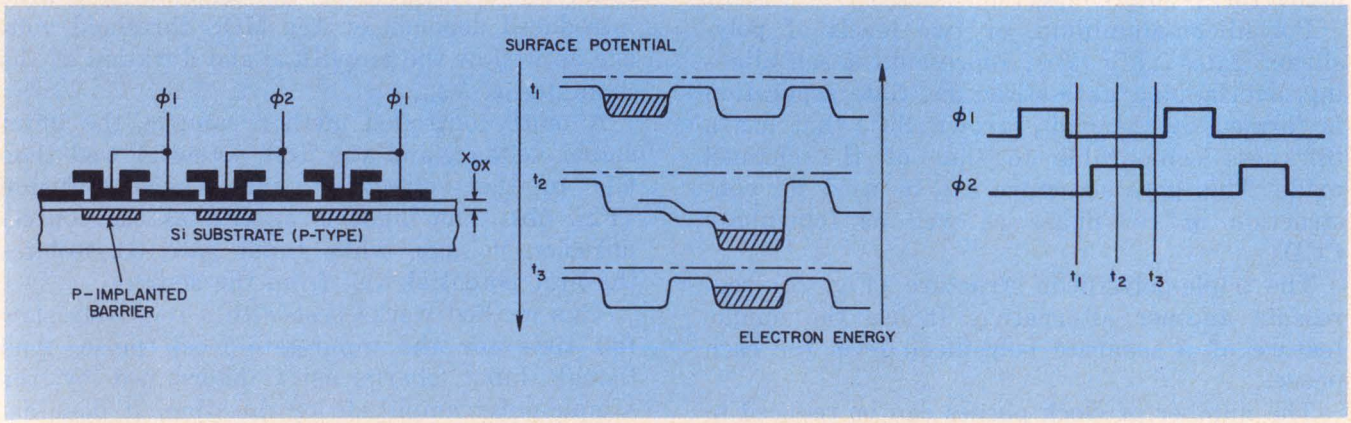
$$P_n = P_0 \eta^n \simeq P_0(1 - n\epsilon) \text{ (for small } \epsilon). \quad (1)$$

Clearly ϵ must be very small if many transfers are required. If you allow an $n\epsilon$ product of 0.1 and an over-all loss of 10%, a three-phase, 330-stage shift register requires $\epsilon < 10^{-4}$, or a transfer efficiency of 99.99%.

The maximum achievable value for η depends on two factors: how fast the free charge can transfer between adjacent gates and how much of the charge gets trapped at each gate location by stationary states. In surface-channel devices, charge trapping usually results from the fast states at the Si-SiO_2 interface. The trapping of



2. **CCD structures generally employ sealed-channel construction.** This can involve a single level of doped polysilicon gates (a), polysilicon-aluminum or two polysilicon levels (b), or three levels of polysilicon (c).



3. **Two-phase drop-clock operation** uses nonoverlapping clock pulses.

The ABCs of CCDs. They're basically MOS analog registers that can be employed in either analog or digital applications. Here are pointers in evaluating them.

If you haven't designed with CCDs yet, it's probably only a question of time before you do. Charge-coupled devices are turning up in photosensor arrays, large-storage memories and such signal-processing components as variable delay lines, transversal filters and signal correlators.

In most applications you probably won't be involved in specifying the construction of a CCD. However, a basic knowledge of CCD operation will help you evaluate the devices from different manufacturers. And system design can be optimized around a specific device.

Actually a CCD is a simple device. In essence, it is a shift register formed by a string of closely spaced MOS capacitors. A CCD can store and transfer analog-charge signals—either electrons or holes—that may be introduced electrically or optically.

Charges stored and shifted

The storing and transferring of charge occurs between potential wells at or near a silicon-silicon dioxide interface. The MOS capacitors, pulsed by a multiphase clock voltage, form these wells. For a three-phase, n-channel CCD (Fig. 1), the charges transferred between potential wells are electrons.

The application of a positive step voltage to a gate electrode (like ϕ_1 at time t_1) forms a depletion region in the p-type silicon beneath a gate. The particular gate is the one that causes a minimum of electron energy—a potential well—to exist at the $Si\text{-}SiO_2$ interface (Fig. 1b). However, the potential well doesn't last indefinitely, and thermally generated electrons eventually fill the well completely. Thus the CCD is basically a dynamic device in which charge can be stored for much shorter times than the thermal relaxation time of the CCD's capacitors. Depending on device processing, this time may vary from one second to several minutes at room temperature.

The introduction of minority-carrier signals reduces the depth of the well, much like the way a fluid fills up a container. Charges transfer from wells under the ϕ_1 electrodes to wells under ϕ_2 because of the surface potential changes due to clocking (Fig. 1c). A similar transfer moves charges from ϕ_2 to ϕ_3 and then from ϕ_3 to ϕ_1. After one complete clock cycle, the charge pattern has moved one stage (three gates) to the right. No significant amount of thermal charge accumulates in a particular well because the charges are continually being swept out.

Note that the three-phase structure is symmetrical and the direction of charge flow is determined by the clock-phase sequence. For example, by an interchange of the ϕ_1 and ϕ_3 clock lines, the charge could be made to transfer to the left. Operation with less than three-phase clocks requires an asymmetry in the CCD structure to determine the direction of signal flow.

The charge signals are laterally confined into a channel by means of channel stops (Fig. 1d). These can be heavily doped diffusions, thick-field oxides or another gate level (field shield) under the phase electrodes to which a dc bias is applied.

Charges transfer in 3 ways

Free charge moves from one well to another by three separate mechanisms: self-induced drift, thermal diffusion and fringing field drift. Self-induced drift, a charge-repulsion effect, is only important at relatively large signal-charge densities. It is the dominant mechanism in the transfer of the first 99% or so of charge signal.

Thermal diffusion results in an exponential decay of the remaining charge under the transferring electrode. The decay has a time constant that increases as the square of the center-to-center electrode spacing. Fringing field drift can help speed the charge-transfer process considerably. The fringing field is the electric field in the direction of charge flow, and it depends on process parameters and device geometry.

The fraction of charge transferred from one well to the next is referred to as the charge-trans-

Walter F. Kosonocky and **Donald J. Sauer**, Members of the Technical Staff, RCA Laboratories, Princeton, NJ 08540.

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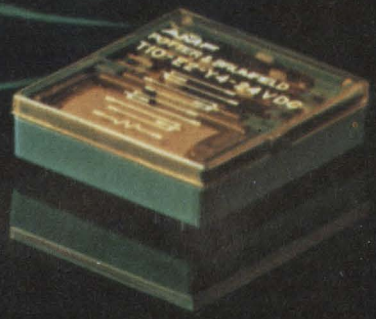

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however, is probably Polaroid's 107 film pack, which has an ASA rating of 3000.

Polaroid film does have disadvantages, though. It is difficult to write on the prints, they do not reproduce well on office copiers, cannot be obtained in rolls or packs of more than eight, and the film is expensive.

In the last five years a new type of scope camera has appeared: the inexpensive hand-held camera. It does not offer the sophisticated photographic capabilities of the "bolt on" cameras, but it is useful for many applications. While the bolt-on cameras sell for about $700 each, the hand-held cameras can be purchased for less than $200.

But whether you use a hand-held or bolt-on camera, if you use it with the newer internal-graticule scope tubes, you're bound to run into trouble. These tubes do not have illuminated graticules. To record them on the film, it is necessary to illuminate the background by front-lighting the phosphor with a source inside the camera or by rastering the CRT at a low intensity before or after the trace is recorded. This results in a photo that has three shades of gray.

Although cameras with Polaroid backs are used most widely, still and movie cameras that do not use Polaroid film are also employed.

Non-Polaroid film is still favored when many pictures must be taken and when the display intensity can be set and there is no need to view the results immediately. The film cost can be as low as a penny a frame.

Movie cameras are rarely used with scopes. On any given run, the time base for the display, which is provided by the moving film, lasts only as long as the film holds out. Practical limits on the amount of film that can be stored and pulled past a given point, and the decay time of the phosphor—which must be short to prevent spot smearing—limit the movie film approach to about 25 kHz. And the film costs for this recording technique can be quite high. ■■

Need more information?

We wish to thank the companies that provided information for this report. The products cited in the report have been selected for their illustrative, or in some cases, unique qualities. However, manufacturers not mentioned in the report may offer similar products. Readers may wish to consult manufacturers listed here and Electronic Design's GOLD BOOK for further details.

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A portable scope camera that has a viewing hood to permit monitoring of the waveform on the CRT is the Model SC02 from Vu-Data.

The HP 197A scope camera has a built-in UV light which can be used to record the black lines of internal-graticule scopes. The electronically controlled shutter of this Hewlett-Packard camera provides exposure times from 1/30 to 4 seconds.

Multimode scopes have been made that combine both storage modes and add other improvements to provide an additional mode: fast transfer bistable.

When specifying storage scopes, don't forget that one of the most important parameters is storage writing speed. This tells how fast the electron beam can draw a usable picture across the CRT in the storage mode. It is specified in units of length—generally centimeters—per unit of time.

Writing speed can be measured by single sweeping at increasingly faster horizontal rates until a single shot is barely visible in the stored mode. But this is a subjective measurement; two people performing the same test on the same scope could come up with different answers.

To determine the maximum frequency at which a storage scope can capture a single-shot event, divide the writing speed by 10 to determine the approximate frequency in megahertz. For example, if the writing speed is 100 cm/μs, a 10-MHz single-shot signal can be captured and displayed.

If your measurement requirement exceeds this guideline, ask for a demonstration of the scope, since most instruments can be tweaked to capture, faster signals. (For more information on storage scopes, see "Choose the Right Storage Oscilloscope," ED No. 24, Nov. 22, 1974, p. 150.)

For permanent records use a camera

New storage scopes that can capture and store very-high-speed data for long periods have reduced the need for oscilloscope cameras. But for a hard-copy record of a scope trace, cameras are still a must. Also, if you want to record an event that occurs too fast for the storage scope to capture, you can use a camera and a nonstorage scope.

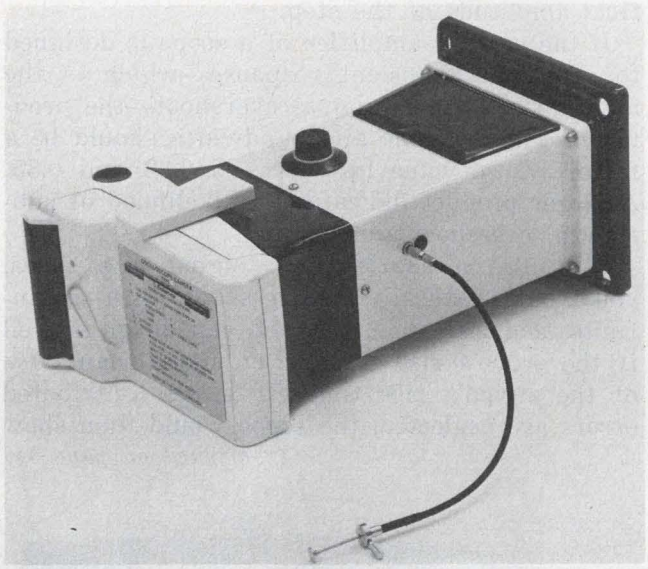
When choosing a camera, consider first what type of waveform will be recorded. Will it be a stored, repetitive or single-shot event? Stored and repetitive traces require the least capability in writing speed, while the single-shot requires the highest.

Within the camera, writing speed is determined by two things: maximum lens opening and the reduction ratio of the lens system. As the image size is reduced, the same amount of light is concentrated on a smaller area of the film. The best compromise between writing rate and image size comes at a magnification ratio of approximately 0.5:1. Prefogging, or partially exposing the film before it is used, can increase the effective speed of any system twofold to fourfold.

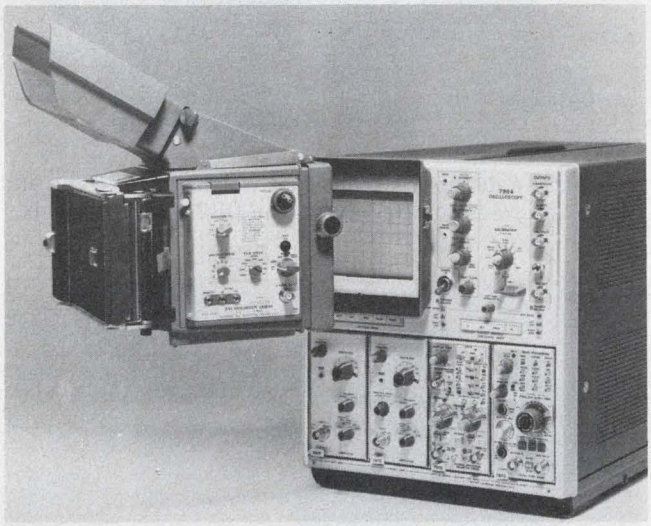
The shutter requirements of the scope camera must also be considered. For remote operation, an electric shutter is desirable, while a more economical mechanical shutter may be preferable for the occasional user of scope cameras.

Because of the range of CRT display sizes, it is important to consider the field of view of the camera. Just because a camera will fit on a scope does not mean that the system will have an adequate field of view.

For maximum photographic flexibility, cameras with interchangeable film backs should be used. While these are more expensive, they give the user a choice of roll, pack or sheet film. Polaroid Type 410 roll film has a film speed, or ASA, of 10,000 and is the obvious choice for high-speed work. The most commonly used film,



A low cost bolt-on camera that fits all standard scopes with a 6 × 10 cm screen is available from Ballantine. Known as the 7000A the camera features a pre-focused lens and a preset aperture.



Bolt-on cameras like the C-51 from Tektronix, are designed to work with specific scopes. The C-51 has an electronically controlled shutter, fast writing rate and an automatic single sweep control.

an error of about 2%.

Vertical deflection systems that have a rise time that is equal to the fastest rising signal applied are often considered adequate.

Errors in measuring very fast rise times directly may come from several sources: linearity limitations of the vertical amplifier and of the sweep circuit, and visual errors caused by display of the waveform on only a small part of the full screen.

Triggered sweep eliminates 'dancing'

Did you ever have a problem with your television set at home where the vertical oscillator was getting old and you had to readjust it each time the line voltage changed? A similar problem can occur in an oscilloscope. If the sweep generator is not properly triggered, you'll get a dancing waveform.

In early scopes the sweep generator free-ran continuously at a frequency just below that of the input signal or one of its submultiples. When the input signal was applied to the free-running sweep generator, it increased its output frequency. While this was an easy way of synchronizing the sweep generator to the input waveform, it required careful adjustment of controls to lock in the signal.

This early form of triggering had several problems. Included were loss of sync as a result of drift and difficulty in synchronizing to a signal that varied in amplitude or frequency.

These problems have been overcome, however, with the development of triggered sweep scopes. In these units the input signal determines the start of each sweep by triggering the sweep generator. Not only does this triggered sweep give a steady, drift-free display, but it also permits accurate control of the starting point on a given waveform.

There are two key parameters in triggering: sensitivity and frequency range. Trigger sensitivity indicates how small the signal can be on the CRT and yet remain stable, while trigger bandwidth is an indication of the range of signal frequency that can be displayed in a triggered mode.

When you evaluate a scope, look at the trigger levels used and see how easy it is to get a stable trace on the scope. First, get a source for a 1-kHz sine wave. Display two or three cycles across the full screen. Now vary the trigger level control so the trace starts at different points on the waveform. Now change the amplitude to see if this has any effect on triggering.

If you're going to be working with slow signals, be sure the scope has a dc-coupled trigger. The lower-priced scopes—generally those below $800—don't have this capability.

Storage scopes capture high-speed data

Storage scopes can retain and display the image of an electrical waveform on their tube face, even after the waveform ceases to exist. This image retention may be for only a few minutes or it may be for days. This makes storage scopes ideal for capturing high-speed signals.

Storage scopes operate in one of two modes: variable-persistence and bistable. The variable-persistence mode allows selection of the time during which a stored image can be viewed.

Bistable operation allows waveforms to be stored and displayed until they are erased. A special phosphor having two stable states is used.

ing. As a matter of fact, some scopes have no shielding at all, while others use cold-rolled steel. The best shielding is of mu metal. Check to see what shielding it has before you buy it. If you're going to use a scope in a laboratory where there aren't too many stray magnetic fields and you want to save money, you can always opt for the cheaper scope without shielding.

To make scopes less susceptible to noise, some manufacturers have taken a leaf from the voltmeter and counter manufacturer's notebook and have included a bandwidth-reduction switch. This cuts frequency-related noise.

When noise does appear in scopes, it shows up as fuzziness or extra traces on the screen and as false trigger signals.

Noise specifications are available for many high-frequency scopes expressed as voltage, equivalent-resistance or scale divisions. Beware of rms noise specs. These can be as much as six times lower than the actual peak values and thus downplay the real problem. Be especially careful if the application involves short, precise or hard-to-capture signals.

Sensitivity is increasing

The input sensitivity of a scope is an indication of how much voltage is necessary to deflect a CRT beam a given distance. Sensitivities are increasing, but be careful when you compare the input sensitivities of two scopes. The specs are not always given in the same units. The sensitivity of most scopes is given in millivolts per centimeter. However, some give it in millivolts per division.

Even if you determine the correct units for sensitivity, you still may not know much about it. Chances are the figure listed for sensitivity on the data sheet is not the figure at the scope's rated bandwidth, but at some lower frequency.

It's particularly important that you be wary of sensitivity specs on dual-channel scopes. On some it is possible to cascade the two input amplifiers to get greater sensitivity. Make sure you're not comparing the sensitivity of a single amplifier on one scope with cascaded amplifiers on another.

Another important thing to remember is that when you talk about sensitivity, you're talking about a voltage that appears at the scope's input terminal and not at the probe tip.

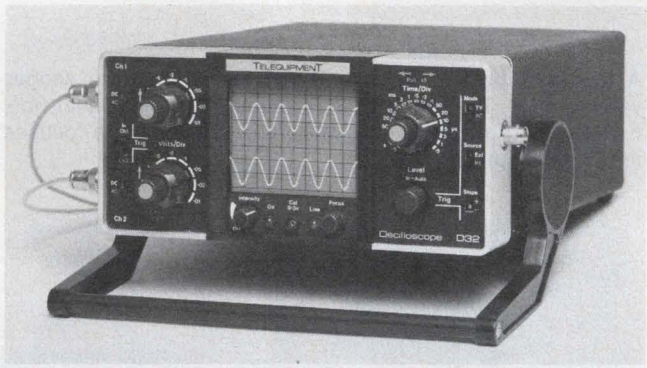
Rise time explained

With today's heavy emphasis on digital circuits, one of the most important specs to consider in oscilloscope selection is rise time. This is defined as the amount of time it takes for a step function to go from 10% to 90% of the final amplitude of the step.

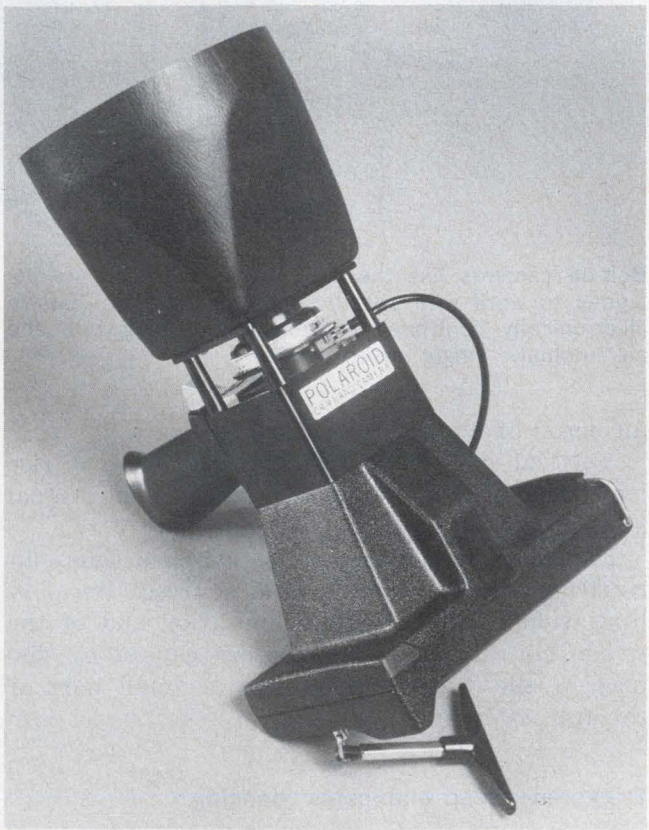
If the vertical amplifier of a scope is designed for optimum transient response—which is the fastest rise with minimum overshoot—the product of the rise time and bandwidth should be a factor whose value lies between 0.33 and 0.35. A larger product indicates the likelihood of substantial overshoot and ringing.

If you're measuring fast signal rise times, you would naturally like a scope with an infinitesimal rise time, but you can do quite well if the scope's rise time is no more than 20% of the signal's rise time. If sweep-contributed errors are neglected, the scope would then show

(continued on page 54)



A miniature dual-trace scope that weighs only 10 lbs and has a bandwidth of 10 MHz is the D32 from Tektronix.



Hand-held scope cameras, such as the CR-9 from Polaroid, can be used with most oscilloscopes by simply changing the hood.

high-frequency units—are designed for 50-Ω loads. For tests on such equipment, the 50-Ω input offers not only its usual advantages, but also maintains the impedance match of the system, minimizing distortion and insertion loss.

While scopes generally have either 1-MΩ or 50-Ω inputs, some units have a switchable input that can give both.

Probes: They're precision instruments, too

Too many engineers forget that oscilloscope probes are also precision instruments. Although most probes are relatively hardy, if dropped, squashed or fried with high voltage, both passive and active probes can be damaged.

Passive probes are harmed most often by physical abuse. Engineers have been known to use them as substitute pliers, component holders or oxide scrapers. Fortunately their tips are often replaceable. And while their cases are fairly strong, they can be cracked by heavy loads —such as feet, a misplaced heavy instrument or a fall. Cables, too, can be overstressed or twisted.

Overvoltages can damage passive probes. Both the voltage and power ratings of probes are there for a reason. Exceeding them may cause temporary inaccuracies or permanent damage due to heating or dielectric breakdown. In fact, some high-voltage probes require special insulation fluids, and an underfilled condition can also be damaging.

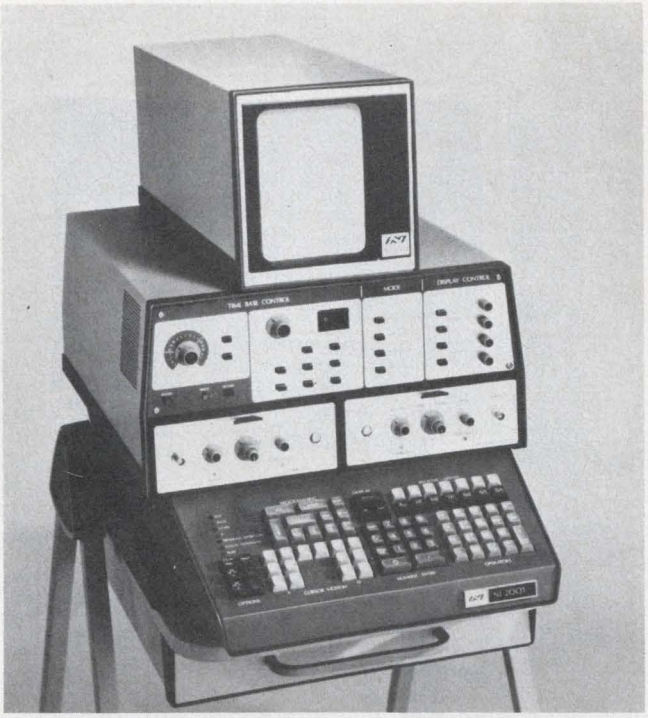
One thing to watch out for when you're using a probe is compensation. Probes require compensation at all times. For passive probes, this is simply a matter of bringing the capacitance-resistance ratio of the probe in line with that of the scope. When either is changed or stressed, the compensation must be checked. In most cases the only adjustment needed is to a variable capacitor built into the probe.

Active probes—which use active devices such as FETs, to achieve high input impedance and low input capacitance—are more vulnerable. The overvoltage tolerance is smaller, and permanent destruction of a component may result. At $100 to $200 a probe, that can get to be expensive.

Active probes may need more adjustments than passive ones. The adjustments may include dc offset, balance, range and capacitance.

But active probes have two major advantages: (1) The isolation is high between the measurement point and the probe cable and scope, allowing for high input resistance and low capacitance, and (2) Full bandwidth is obtained without input signal attenuation.

Most active probes are compatible with either 1-MΩ or 50-Ω scope inputs without use of adapters. When working in the 50-Ω mode, use 50-Ω cable to extend the probe length without increasing capacitive loading. The longer cables, however, will slow the rise time.



A programmable calculating oscilloscope uses the Intel 8080 microprocessor to perform time and voltage measurements as well as other calculations. The scope is the NI 2001 from Norland.

One very important point to remember when you're using active probes: They require external power. While some oscilloscopes have a separate probe power supply, most do not.

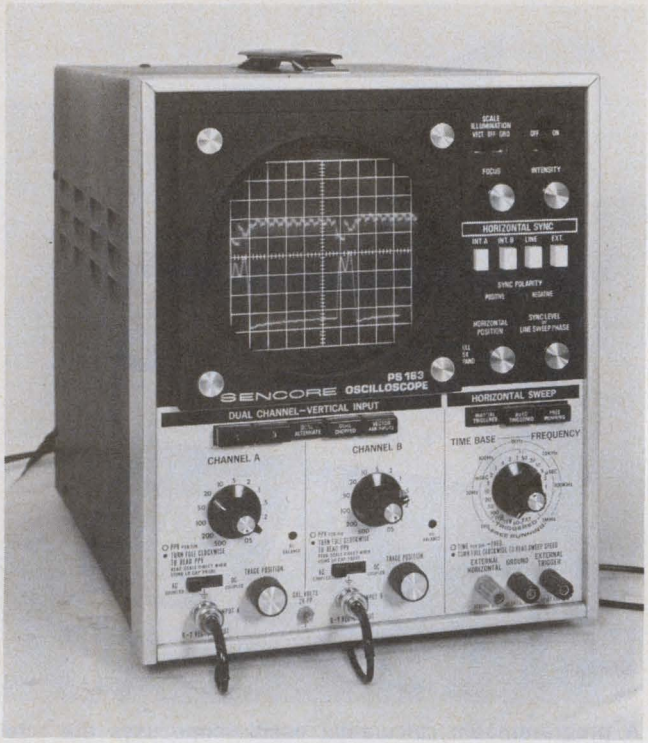
Also, as you move up in frequency, the probes become more expensive. At 100 MHz the cost of an active probe is about 25% of the price of the scope.

As frequency goes up, so does noise

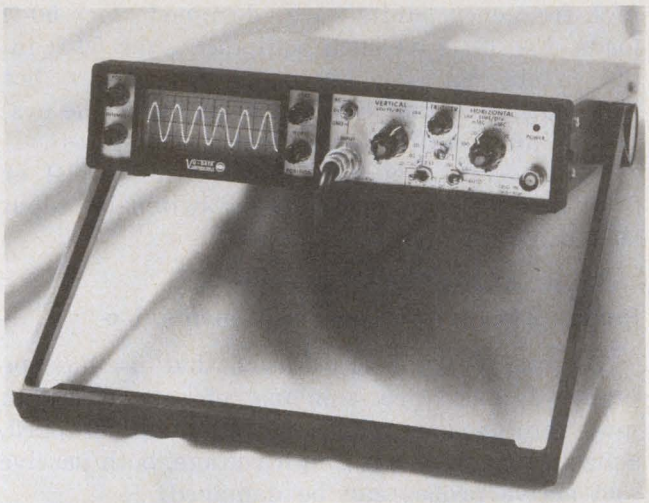
Some noise is inevitable in any scope, but as bandwidths and sensitivities increase, noise becomes a more significant factor. Several types can affect a scope. There is power-supply noise, component noise, thermal noise and pickup of man-made noise, such as ignition interference. There is also 1/f noise, which becomes greater as the frequency decreases, and there is white noise.

White noise has constant energy and therefore is reproduced much more strongly as bandwidth increases. But it is not the big problem; 1/f noise, power-supply noise and interference from stray magnetic fields are. Above 10 kHz, 1/f noise ceases to be a major problem. Elimination of the other noise problems requires the use of special input circuits, short connecting cables and good shielding.

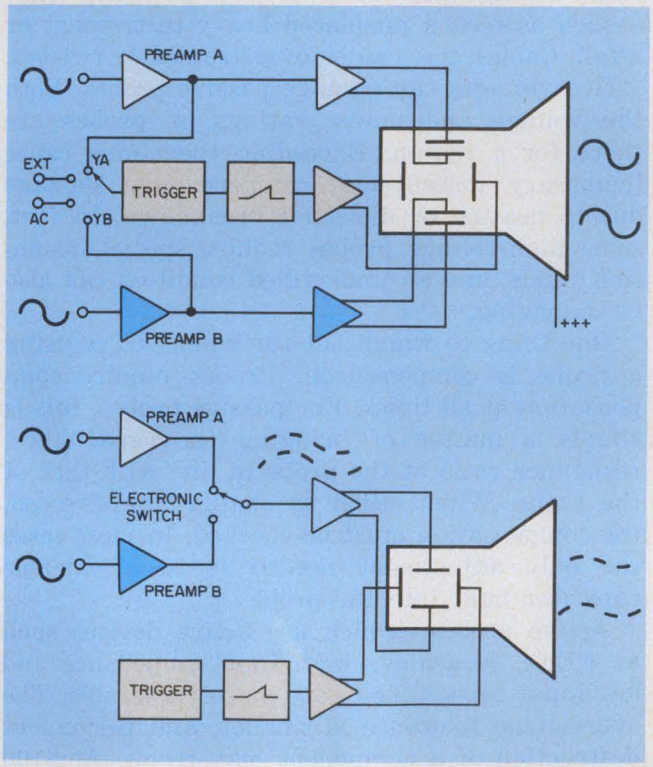
Unfortunately not all scopes have good shield-



Medium price and performance are available with the PS163 dual-trace scope from Sencore. It features 5-mV sensitivity and less than 2 degrees of phase shift between channels.



A mini-portable scope that weighs only 5-1/2 lbs and has a bandwidth of 20 MHz is the PS910B from Vu-Data. It operates from standard C cells, nickel-cadmium batteries or the ac line and consumes only 8 W.



Two electron beams can be generated with only one gun in split-cathode CRTs (top). A dual-channel scope that uses this technique has two vertical deflection circuits and one horizontal. Dual trace circuits (bottom) that time share one electron beam to provide two channels are more commonly used.

vides a low degree of circuit loading, a measure of protection for the scope and a good degree of accuracy. When frequencies increase, however, the combination of input capacitance and high resistance results in a long time constant. This seriously affects both time measurements, such as pulse rise time, and amplitude measurements of short pulses.

The high input impedance is only high for frequencies below about 1 MHz. Above that point, the shunt capacitance takes over. For example, a 1-MΩ input with 10 pF of input capacitance across it has an effective impedance of only 50 Ω at 320 MHz.

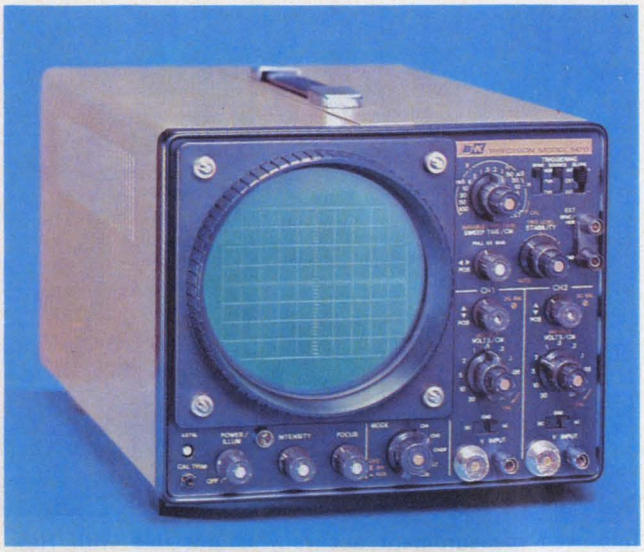
Low-impedance 50-Ω inputs were developed for such high-frequency applications. Instead of having an extremely variable impedance over a range of frequencies, 50-Ω inputs provide stable loads over a wide frequency range and virtually eliminate the effects of capacitive loading.

Of course, with its low impedance, the 50-Ω input draws more power from the circuit. This means that amplitude measurements may be significantly affected. Time measurements are better because of the lower RC time constant.

Since 50-Ω inputs do not limit the power dissipation inside the scope as much as do 1-MΩ inputs, manufacturers generally supply some additional protection, such as fuses or relays.

But if you're going to use a 50-Ω input to measure high-speed logic circuits, you're in for trouble. Most IC logic families are high-impedance and limited in power-sourcing capabilities. This means that high-impedance circuits are needed. When speed prevents use of the 1-MΩ input, 50-Ω inputs can be used with multiplier probes. This trades lower loading for a decrease in scope sensitivity.

Many types of equipment, however—especially



An inexpensive dual-trace scope that has a bandwidth of 10 MHz is the Model 1470 from Dynascan.

For example, if the chopping rate is 100 kHz and the sweep duration 1 ms, there will be 100 segments in each trace. How well these separate segments depict all the detail in the two waveforms establishes the usefulness of the chopped mode compared with the alternate mode or dual-beam scope.

When using dual-channel scopes it is important to remember that two simultaneous, nonrecurrent signals of short duration may be displayed on a dual beam scope, but can't be displayed on a dual trace scope. When looking at recurrent signals that can be displayed on dual-trace units remember that phase errors can arise.

This problem can be overcome by use of the chopped mode, but a limitation is imposed by the finite chop frequency that may well interfere with the signals to be measured. Of course, these errors can be completely avoided with a dual-beam scope that has two electron guns. Such a scope would have two time-base generators that sweep the two signals at different rates.

Most dual-beam scopes available today, however, use a single gun with a split cathode. These scopes have tubes that contain one set of horizontal deflection plates and two sets of vertical plates. The split-beam approach requires that each of the two inputs have separate amplifier chains. This technique, like the dual-gun approach, eliminates the need for chopped and alternate display modes, and it allows twice the usual light-energy levels to be employed.

Modular scopes cost more

Although for many applications a modular scope offers great versatility, having both standard and special measurement capabilities, it is more expensive than a stand-alone unit. Plug-in scopes generally have a large power supply to accommodate the modules used. This adds to the cost. So does the special mechanical design of the scope mainframe.

The main problem with modular scopes is that often many expensive, surplus modules are sitting on the shelf, doing nothing simply because there aren't enough mainframes in the place. Often owners of plug-in scopes use the modules 10 minutes a year, and then only to calibrate them. Manufacturers push modular scopes for two reasons. A mainframe owner becomes a captive customer for modules, and a standardized mainframe can be made in quantity —leading to mass-production economies.

Another disadvantage of modular scopes is that they're expensive to maintain. Individual modules are usually very densely packed and have to be pulled apart to service them. Of course, the entire module can be replaced by a spare, but that adds to system cost. In contrast, most stand-alone scopes are easily serviced.

On the positive side, plug-in scopes do offer a wide range of measurements that might otherwise be unavailable or very costly to obtain in a stand-alone scope. These specialty requirements include sampling to 18 GHz, logic-state analysis and spectrum analysis, to name a few.

A handle doesn't make it portable

What is a portable oscilloscope? Not any scope that has a handle on it. A scope is portable, most manufacturers say, if it weighs less than 25 lb. The design should include an impact-resistant case and lightweight power supplies.

In general, portable scopes do not represent any compromise in performance; often the contrary is true. Because of their system design, many portable scopes have better performance than their modular counterparts.

But a portable scope is not always a good buy, especially if it is going to be used a lot in the laboratory. One drawback is its small screen size. While this is not an inherent feature of portables—some have screens as big as those of lab models—most have smaller screens that limit resolution.

Front-panel layout is another problem with portable scopes. Since there is less room than there is on the front panels of lab scopes, it's important to check that the controls are not so close together that you practically need a pair of tweezers to operate them.

Recently there has been much controversy over the merits and demerits of 50-Ω and 1-MΩ input impedance. The key issue when making a comparison is input impedance vs frequency.

For most applications, the 1-MΩ input pro-

trace scopes can be used for all but a handful of applications, and they don't cost much more than the single-trace instruments. The cost for the additional circuitry ranges from 10 to 15% of the total instrument price, and it is well spent. With the dual-trace scope, one waveform can be compared with another—something that has become increasingly important with the growing use of digital logic.

Dual trace vs dual beam

Don't confuse dual-trace scopes with dual-beam scopes. In the former you have one electron beam that is time-shared between two input signals; in the latter, two electron beams are produced either by use of two electron guns or one gun with a split cathode. Whether the time-shared beam or the dual-beam approach is used, each has advantages and disadvantages.

The most common approach to two-channel scopes is the one that uses a single beam and one set of vertical deflection plates that are time-shared between two vertical deflection channels. One advantage of this method is that there are no convergence problems, since only one vertical deflection system is used. Dual-trace scopes cost less than dual-beam, and they offer better comparison capabilities.

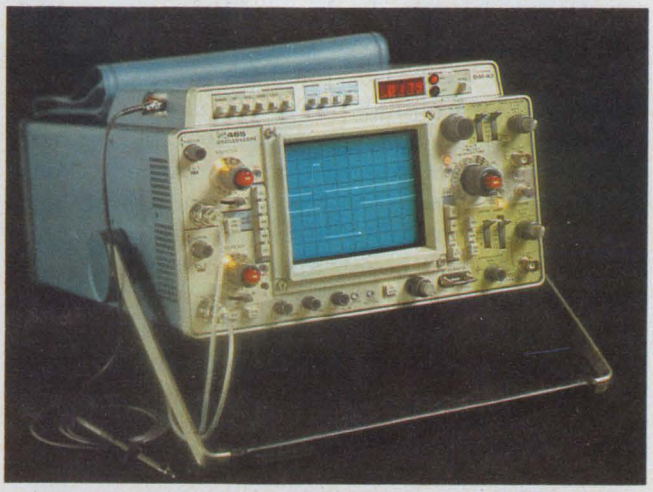
The electronic switching circuitry in a dual-trace scope should be capable of operating in two modes: rapidly during sweeps or synchronously during sweep-retrace intervals. The first mode is called "chopped," the second "alternate." The alternate mode is used more frequently and is preferred for displays that have fast sweeps. The chopped mode is usually reserved for comparing low-frequency recurrent signals or nonrecurrent signals of long duration.

When two very bright traces are displayed in the chopped mode, faint lines connecting the two traces may show up. These are chopping waveform transients. You can eliminate them either by turning down the intensity or using a scope that blanks the CRT beam during these transition intervals. The chopping rate should be as high as possible, so long as the resulting traces are not broadened significantly by distortion of the chopped signal. The chopping frequency can vary from as low as 80 kHz to as high as 1 MHz, depending on which scope you use.

The disadvantages of the dual-trace, time-shared approach include the availability of only half of the light output of the CRT, because of the time-sharing process. Also, when the chopped mode is used with relatively fast nonrecurrent sweeps, the traces are not continuous but are made up of separate segments. The number of segments depends on the chopping rate and the sweep duration.

Improved measurement accuracy is possible with Hewlett-Packard's 1722A microprocessor scope. This 275-MHz scope gives direct readout of time interval, frequency, dc and instantaneous voltage and percent.

Delayed sweep and mixed sweep operation are two of the key features of Ballantine's 1040A. It is a portable 40-MHz dual-channel scope.



Increased measuring capability results when the DM 43 digital multimeter module from Tektronix is added to any of the 464, 465, 466 or 475 portable scopes. The module makes it possible to measure temperature, time resistance and voltage.

FOCUS on Scopes and scope cameras

Oscilloscopes are among the least misused, least misunderstood and least misspecified pieces of test equipment around. But this doesn't mean there are no problems for the buyer. If you're choosing a scope, you still have to weigh these tradeoffs:

- Single trace vs dual trace vs dual beam.
- Modular vs stand-alone.
- Portable vs nonportable.
- Low input impedance vs high impedance.
- Storage vs nonstorage.

And the problem is compounded if you're thinking of using a camera with the scope. This requires dealing with alien parameters, such as lens and film speed, and depth of field.

Other problems that crop up when you consider a camera for use with your scope include deciding what kind of film to use, what the picture format should be and whether the camera should be purchased from the scope manufacturer.

It's like buying a car

Choosing an oscilloscope is like buying a car. Very often brand name and horsepower (or bandwidth, in the case of a scope) influence the choice. Many engineers have a tendency to overspecify when it comes to oscilloscopes. This results in the purchase of unnecessarily expensive equipment that is often more difficult to operate. A good analysis of what you really want the scope to do will save you money.

Many factors should enter into the selection of scopes. These may range from frequency response to layout of the front panel. Among the parameters most often considered are configuration, bandwidth, sensitivity and triggering, and time-base capability.

Configuration relates to the physical characteristics of the instrument—whether it will have one or two channels, be modular or stand-alone and laboratory or portable.

In most cases you're better off buying a dual-trace scope rather than a single-trace unit. Dual-

Dual-trace oscilloscope from Philips has a bandwidth of 120 MHz. Using a special power supply, the PM 3260 can operate from almost any line voltage and frequency. It consumes only 45 W and needs no fan for cooling.

Jules H. Gilder
Associate Editor

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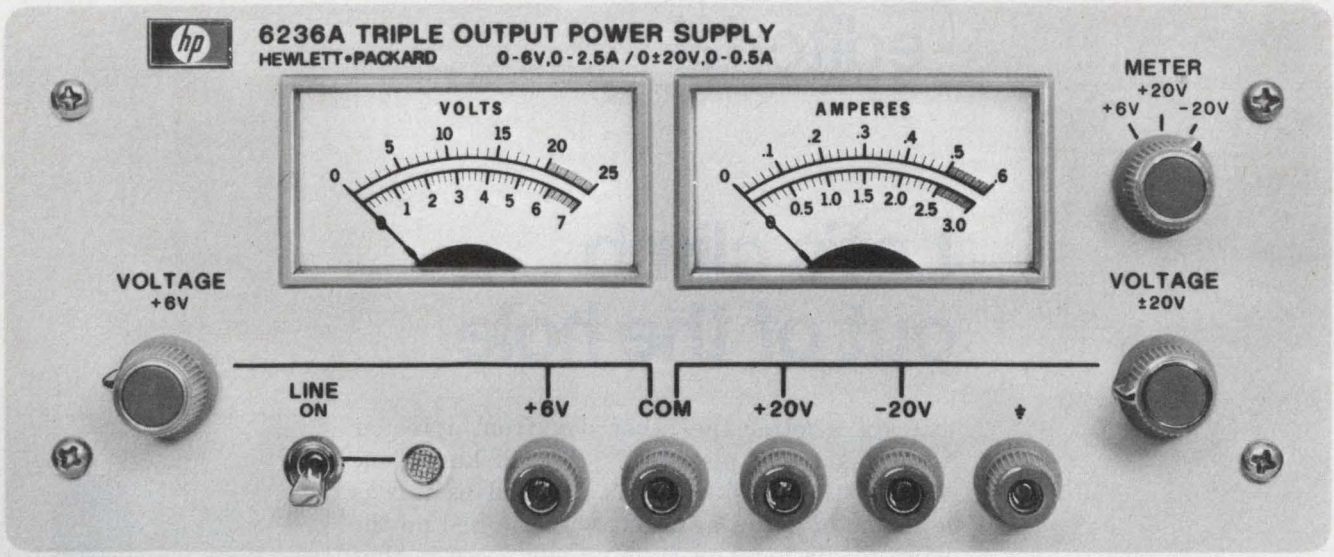

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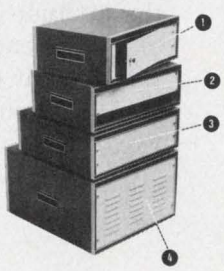

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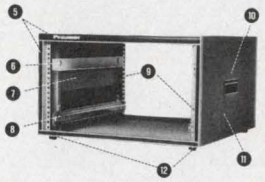
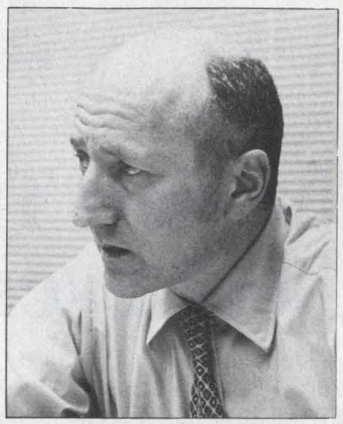


INFORMATION RETRIEVAL NUMBER 34

editorial

Let's climb out of the hole



I got a letter the other day from a reader who was really pissed off. "We all know," he wrote, "that business isn't as good as it was a couple of years ago. But why the hell do the news media keep on rubbing our noses in that fact? Are they making things any better? Are they telling us something we don't know?"

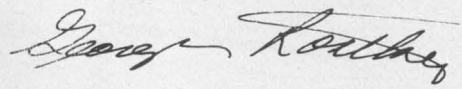
This reader, Larry Collins, went on that "as usual" the news media are behind the times, and, in fact, business in some areas has begun to pick up. The improvement isn't sensational yet and we're far from a seller's market, but there are certainly signs of recovery. Yet the media in the electronics industry as well as other industries seem to act on the premise that bad news is good news. They assume that bad news sells papers.

Well, I agree with Mr. Collins. I think there's been entirely too much yakking about how bad things are and too much neglect of signs of improvement. Electronic Design, I hope you've noticed, has been absent from the chorus of doomsayers. It's not that we didn't know the situation was bad but that we figured you knew it already. We didn't feel obligated to tell you what you already knew and we didn't feel there was anything to be gained by yelling about how bad things were unless we had a solution—which we didn't.

But we have some thoughts now. We warned in the past that it's possible to talk ourselves into a deeper recession. Now I'd like to urge that it's possible also to talk ourselves more quickly out of one. I don't want to seem like a Pollyanna and I don't believe that if we think only nice thoughts then only nice things will happen. Yet I am convinced that we can actively help ourselves pull out of the recession faster.

We can talk up the good news and we can act as if, in fact, there is going to be a tomorrow. We can, for example, release that purchase order we've been sitting on in the expectation of lower prices. If we get rid of the attitude of despair that some of us have developed, we may be able to inspire enough confidence in our customers so that we'll be able to move some of our own products which, in turn, will force us to buy more products from our vendors.

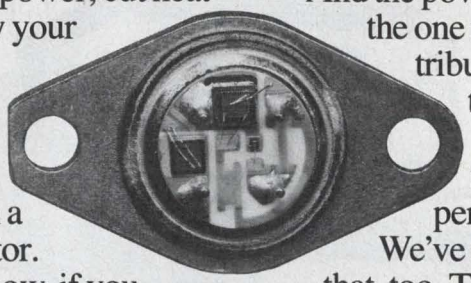
I think we can all help if we can kick the bad-news habit.



GEORGE ROSTKY
Editor-in-Chief

Build a switching regulator in half the time.

You know that a switching regulator can quadruple the efficiency of your power supply. It'll save power, cut heat loss, simplify your design, save board space, weigh less, and maybe cost less than a linear regulator.



But until now, if you wanted a switching regulator, you had to start from scratch. It took a lot of time and a lot of effort.

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The power circuit is the trickiest part of the switching regulator to design, since it involves choosing the commutating diode and switching transistors, then fiddling with the circuit to get the best drive and bias conditions.

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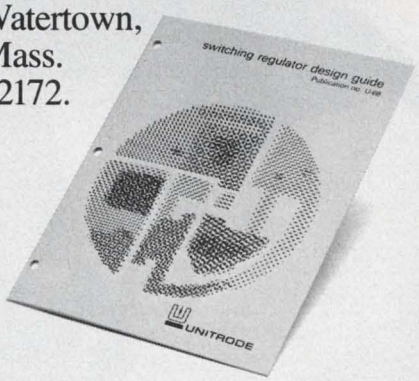

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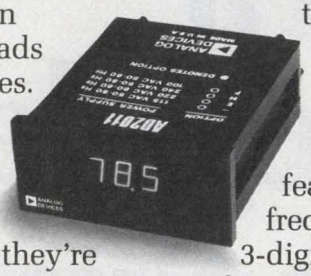
IS YOUR AC METER TELLING YOU LIES?

If you're measuring anything other than undistorted sine waves, you need an instrument that reads out true RMS values.



Most people think any old AC DPM or DMM does this. Fact is, they don't. Unless they're an expensive true RMS DMM, they read the rectified average value of the input, calibrated to the RMS value of a sine wave. Which usually results in gross errors.

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ANALOG DEVICES

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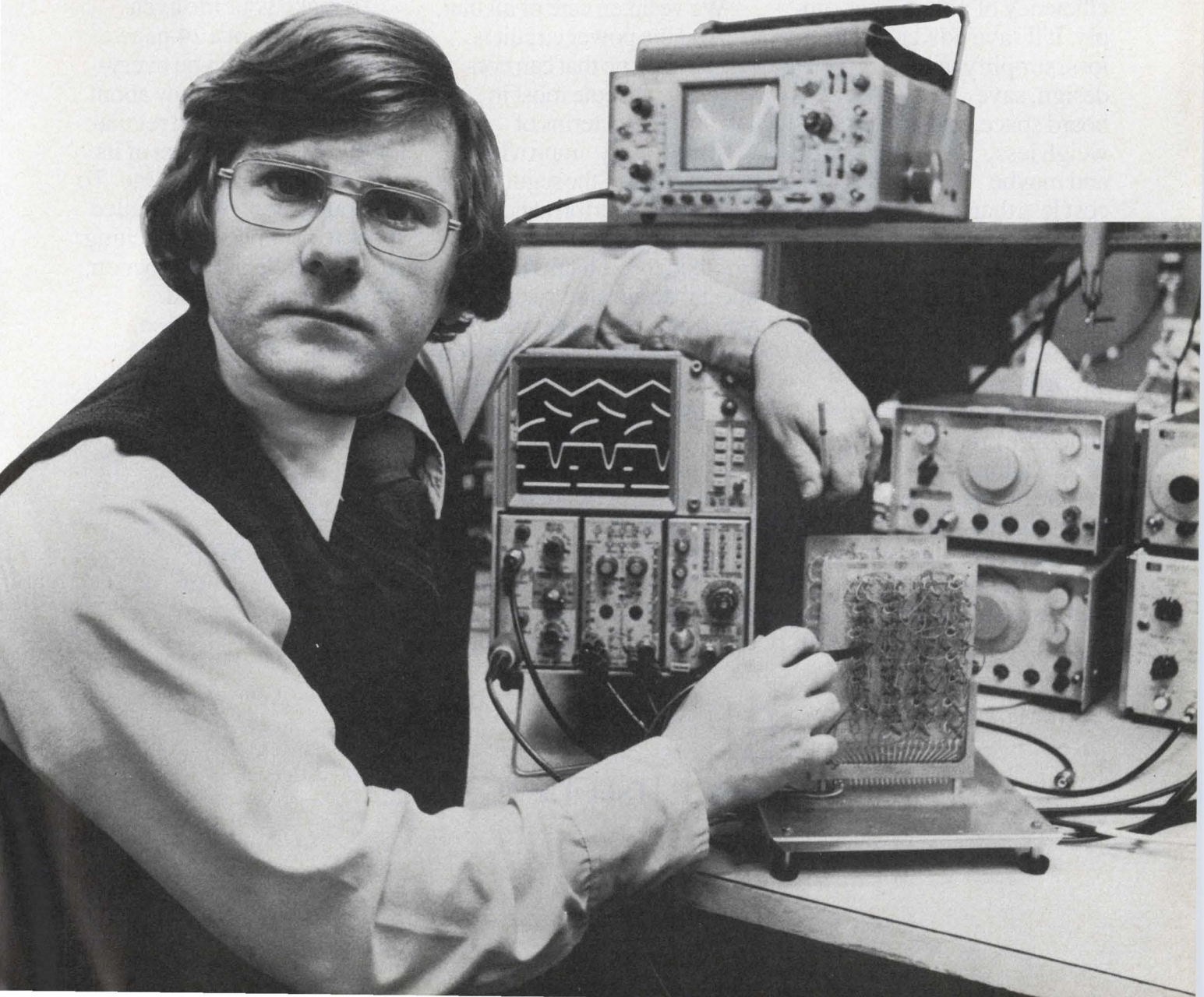


an offer for sale and was prohibited if the unit had not been certified —even if it was a dummy.

The commission plainly doesn't intend to permit a manufacturer or vendor to create a market for a product that may not comply with its requirements.

Importation for test and evaluation, according to the FCC, means only for compliance with FCC requirements and "does not mean for evaluation for sale purposes."

Marketing strictures of this kind have had a significant impact on manufacturers of rf devices covered by commission rules.

To reduce "spectrum pollution" and "electromagnetic smog" to tolerable levels, the agency says it "will be taking an increased role in the regulation of rf devices with an interference potential for which the commission does not presently prescribe technical standards."

A new U.S. Dept. of Research proposed

Research and technology will be upgraded in Government operations if legislation proposed by the House Committee on Science and Technology makes it through Congress. Titled "The National Science Policy and Organization Act of 1975," the bill would create, among other things, a Dept. of Research and Technology Operations.

Presenting strong arguments for the proposal, Rep. Olin E. Teague (D-TX), chairman of the committee, said: "Science and technology are an element of our contemporary culture as pervasive and important as economics or education or labor or environment. . . . Science and technology should be fabricated concretely and statutorily into the managerial structure of our National Government."

Included in the new department would be the National Aeronautics and Space Administration, the Energy Research and Development Administration, National Science Foundation and such sections of other departments as the National Bureau of Standards, Weather Service and National Oceanic and Atmospheric Administration. In addition the legislation would create a Government corporation to ensure maximum use of scientific and technological information generated at public expense.

The bill would also enunciate a national science policy as well as establish a council of Advisers on Science and Technology in the Office of the President.

Capital Capsules:

Sen. William Proxmire (D-WI), chairman of the Senate's appropriation subcommittee on Housing and Urban Development and Space and Science, **believes the $16-billion space-shuttle program may be on the verge of a financial breakdown.** The Senator bases his most recent "overrun" scare on General Accounting Office studies that say NASA's repeated use of the $10.5-million-per-launch estimate is misleading, since it doesn't include any research funding or the costs of payloads placed in orbit by the shuttle. . . . The Energy Research and Development Administration is investing $2.6-million with Hughes Research Laboratories **to develop a new type of mercury valve that would be used to convert between alternating and direct current** at the terminals of high-voltage dc transmission lines. A spinoff from the spacecraft ion engine that Hughes developed for NASA, the new device promises to be smaller and more reliable than the old mercury-arc devices. . . . A NASA scientist has found that **black chrome, once used for plating cameras and decorating other objects, is some 20 per cent more efficient than current coatings for solar collectors.** Black chrome is as solar-selective and much cheaper than the other prime candidate, black nickel.

washington report

ELF submarine network to get home base

Sanguine, the homeless Navy communication system (Wisconsin and other states have said "thanks, but no thanks") is changing physically, technically and by name. As Seafarer, the controversial shore-to-submarine communications system will be installed either at Nellis Air Force Base in Nevada or at the Ft. Bliss (TX)-White Sands (NM) military complex.

The Dept. of Defense has given the Navy approval to go ahead with additional design validation work on the new version of the Extremely Low Frequency (ELF) system, which will be a surface variation of the Sanguine. Research and development effort will continue on an underground hardened and dispersed system and on an even harder deep underground complex. All three use the same ELF frequency band and receiver equipment.

Environmental studies to date by the Defense Dept. have indicated no adverse environmental impact from the strong electromagnetic radiation, but steady static from ecologists have made the Navy system an unwelcome neighbor wherever it tried to settle.

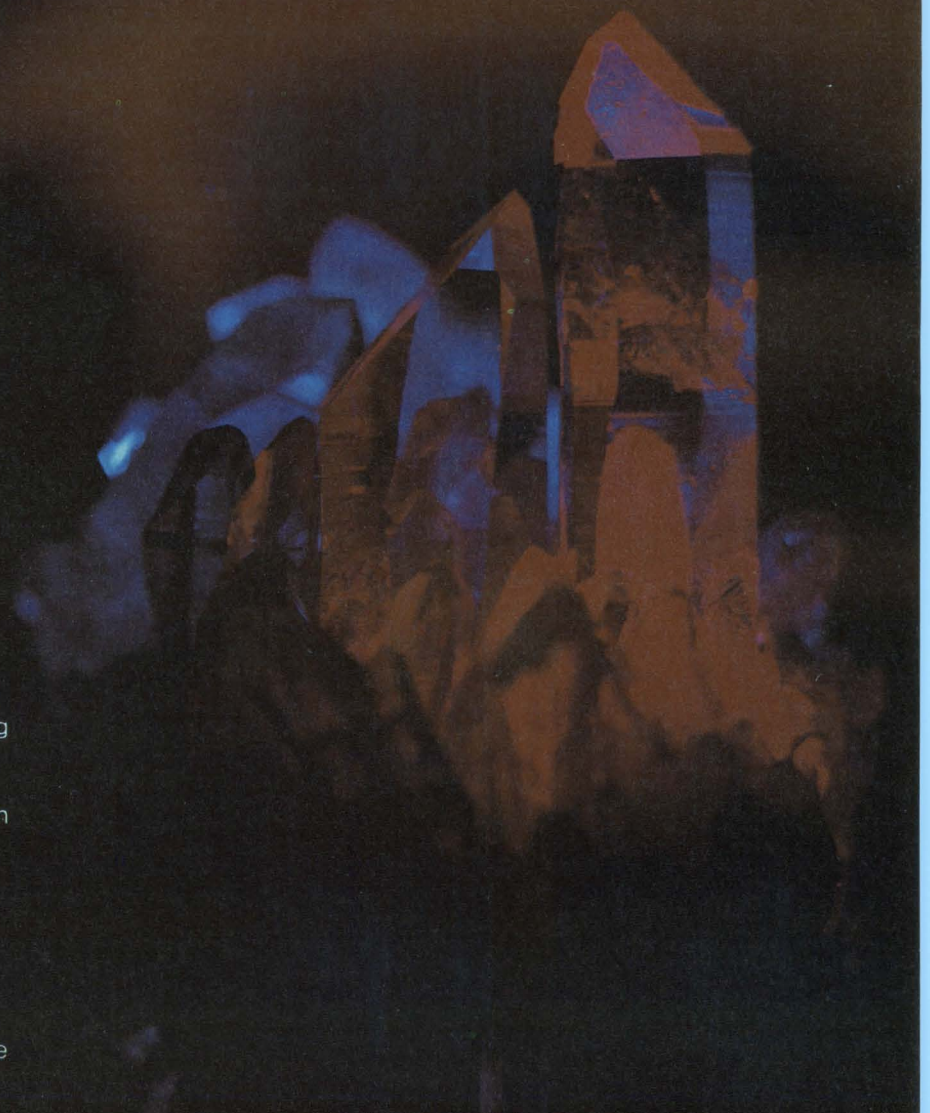
Breaking the ice via microwaves

Side-looking radar may be the ice breaker that will allow 12-month shipping operations on the Great Lakes. Shippers now, more or less, forget the whole thing for three and a half months. "Icewarn," a microwave information system developed by the National Aeronautics and Space Administration, uses airborne side-looking radar to find ice weak enough for a ship to break through. In tests last winter, such data were transmitted via a ground station or satellite to the National Oceanic and Atmospheric Administration at Wallops Island, VA, and from there to the Coast Guard Ice Navigation Center in Cleveland. In current tests the Cleveland station is beaming facsimile maps to the ships by radiotelephone. The system could be operational in the Great Lakes by next December, ready for the annual ice season.

FCC maintains strict stance on rf equipment

The Federal Communications Commission continues to refine its marketing rules and is leaving little doubt about its strict attitude on rf devices. In response recently to the Electronic Industries Association, the agency said that the display of a receiver at a trade show constituted

in the beginning there was quartz . . .



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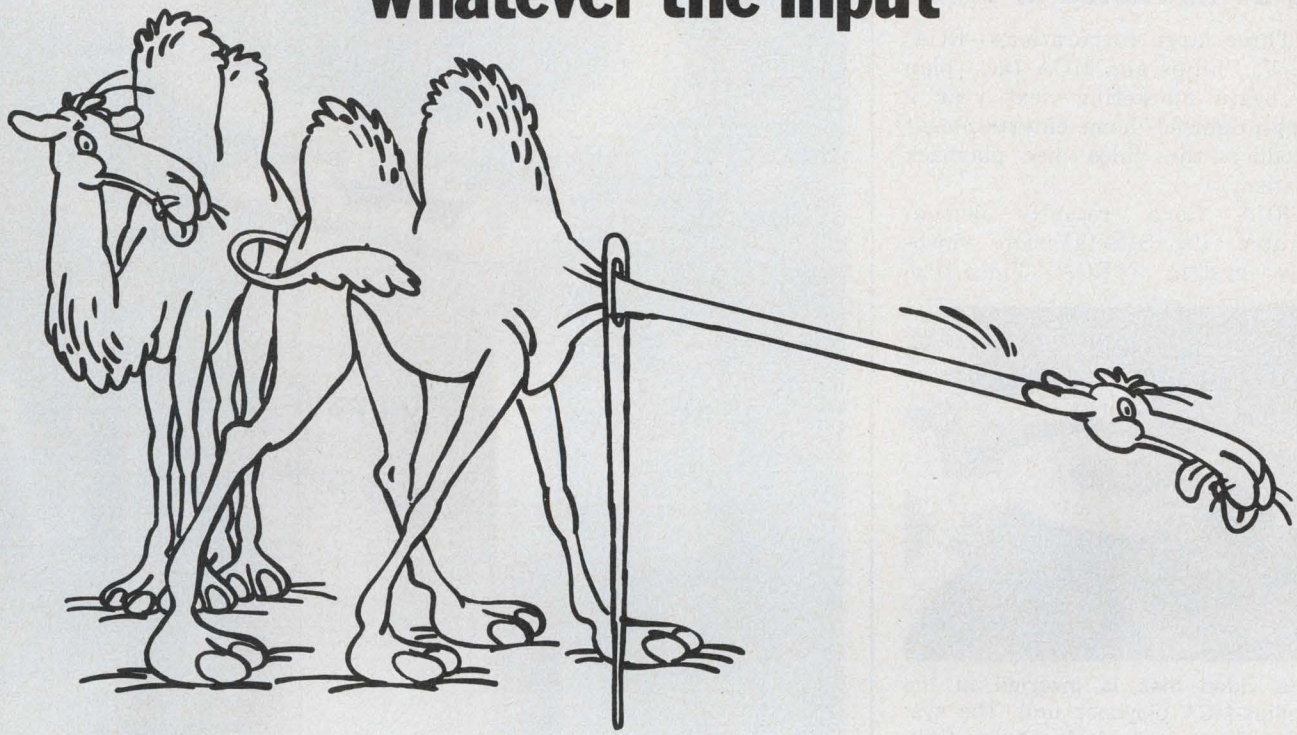

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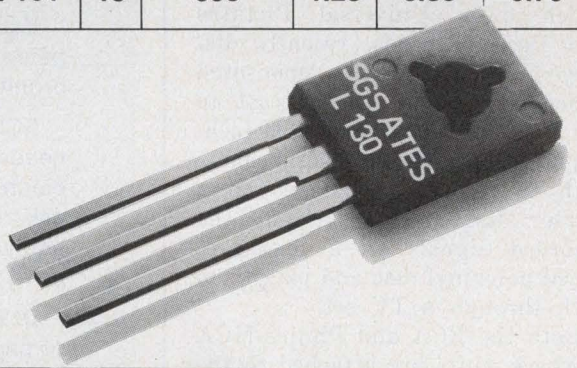

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INFORMATION RETRIEVAL NUMBER 45

INFORMATION RETRIEVAL NUMBER 40 ►

Two video disc systems to be marketed in 1976

Three large corporations—RCA, N. V. Philips and MCA Inc.—plan to begin marketing next year a long-promised home-entertainment product—the video disc playback system.

RCA Corp. recently demonstrated its SelectaVision videodisc system ("RCA Video-Disc Entry Gives Hour of Inexpensive Viewing," ED No. 6, March 15, 1975, p. 19). It uses a pickup stylus that detects variations in capacitance between its tip and a grooved metallic dielectrically coated vinyl disc.

The video disc is inserted in the Philips-MCA playback unit. The system offers such features as slow-down, freeze frame and reverse.

N. V. Philips of the Netherlands and California-based MCA Inc., which owns Universal Pictures and Decca Records, recently displayed their jointly sponsored Videodisc system. In contrast to the RCA unit, it uses optical techniques—a low-power laser beam—both to record the images on a master disc and to pick up the recorded signals on a mass-produced polyvinyl disc and play them back through a TV set.

Both the RCA and Philips-MCA playback units are attached to the input antenna terminals of any home TV receiver. They display both color or black-and-white pictures and sound from video discs.

Both discs are 12 in. diam and can hold 30 minutes of programming on each side.

Philips-MCA and RCA plan to sell their Videodisc players for about $500, with pre-recorded albums priced at $2 to $10. ■■

on the control panel signal if the preset parameters are violated.

Outputs permit the print scanner to control the number of labels printed and to indicate visually when the press run is 95 per cent completed. Print-out terminals for periodic digital readout of press quality and production control information are available as an option.

The laser, a helium-neon device that emits a bright red light (6328 Å), is exactly like the one supermarkets will use to scan a customer's packages. The laser is focused on a prism mounted on a constant speed motor. The motor repetitively moves the beam across the moving paper. The scanned beam appears on the paper as a solid red line.

As the beam moves from light to dark areas, the photodetector emits a voltage that goes from high to low. The signal processor and digitizer separate the signal from background and other interfering light and digitize the signal into a series of "1's" and "0's," which correspond to the light and dark areas of the printed material.

The "1's" and "0's" are constantly being monitored while the computer looks for the UPC pattern. When the light and dark patches begin to match the pattern, the computer interprets the digits into decimal numbers. By knowing how fast the line is scanning, the computer can measure line width by clocking the length of time it takes to scan the middle bar of the UPC symbol.

The keyboard, similar to that on a calculator or telephone, is used by the operator to store numbers in the memory of the computer. The computer constantly compares the information it receives from the head with the corresponding information in its memory. Memory data are constantly updated. When the computer senses that something is wrong in the printing, such as line width, print contrast or the number of rejects, the appropriate alarm is made.

Reading an entire UPC symbol takes less than 0.001 second. The computer analyzes the "1's" and "0's" in much less than 1 millionth of a second.

A 12-digit array displays information selected by the panel switches in bright 0.3-inch-high numbers which may be read at 20 feet.

The unit is expected to sell for $5874. ■■

The Universal Product Code is printed in ink on the outside of each package in a grocery. The width of each line represents a code number that can be translated to information, such as the item's manufacturer, product classification, tax category, brand name and weight.

For the day's price, a central computer is queried. Besides speeding the checkout process and avoiding errors, the system gives the grocer continually updated inventory data.

Display panel of the Monitor 101 provides a keyboard (right) for entering numbers into the computer's memory and selector buttons (lower left) for displaying desired data.

There are a few other 12-bit D/A converters around that sell for $39 in 100's, but it's a real hassle to make them work. For openers, you usually have to add your own reference and output amplifiers and all the associated components. These 15 to 19 extra parts could cost you from $15 to over $60, not to mention your assembly and test time. And, you have to use a lot of PC board real estate for each converter you use in your system.

Take heart! Our new DAC80 Series IC 12-bit D/A converter is designed to solve your problems. It has its own built in reference and output amplifiers, and it takes only three passive components to decouple the power supply. If you want to trim the offset and gain, you'll need only five more. At most, these parts will cost you about $4, and your assembly and test time will be minimal. Not only does our $39 price in 100's match the lowest around, but DAC80's are more complete, easier to use, and take up less total space.

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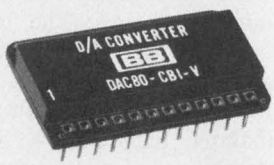

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INFORMATION RETRIEVAL NUMBER 26

Laser-computer system rejects defective POS codes at the press

Those little black lines on your packages at the grocery store are telling the laser at the cash register what you've bought, and a point-of-sale computer is filling in the price. But if those lines are not printed right—too far apart, too wide, or too narrow—the checkout operation grinds to a halt. And the POS system is supposed to speed it up.

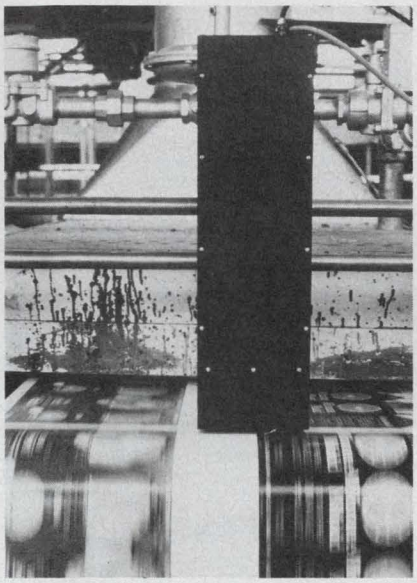
A solution is at hand. A laser-based computer system called Monitor 101 has been developed that can analyze Universal Product Code (UPC) symbols at tremendous speeds before they get to the store. It will do it as soon as the imprinted boxes or labels leave the press. The system was developed and built by Metrologic Instruments, Inc., Bellmawr, NJ, in cooperation with Surescan, Inc., Westville, NJ, which will market it.

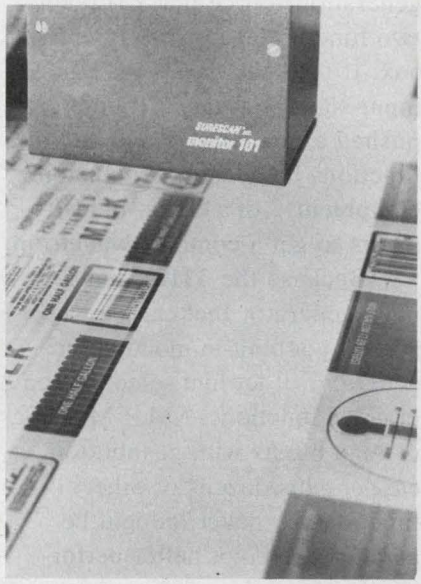
"The system simply represents advanced laser-scanner technology applied to UPC symbol printing," says Metrologic's president, C. Harry Knowles.

The design consists of three parts: laser scanner head, detector head and computer. Each part is modular, flexible and programmable, which, Knowles says, makes them adaptable to a variety of totally different tasks—"such as case control in warehouses, parts positioning and carton identification."

The Monitor 101 has been designed not only to identify a good or bad UPC symbol on each printed item, but also to record the total number of packages being printed for purposes of inventory control.

The scanner also verifies line resolution and compares the measured line width with automatically computed UPC line-width tolerances. The unit measures ink density and background "whiteness" and computes the print-contrast ratio.





Focused laser beam sweeps across freshly printed Universal Product Codes before they've left the production line, to see if they are correct and will be legible to the point-of-sale system that will process them in supermarkets.

Even while the press is operating, Monitor 101 is computing the number of good labels. It then displays the percentage of good labels based upon the last 1000 packages run.

The labels are compared with a reference standard issued to individual manufacturers by the Uniform Product Code Council. In addition the scanner checks each label for UPC parity coding.

What the hardware is like

The print scanner consists of two electromechanical components: an aluminum-encased scanner, which can be mounted on any printing press, and its computer counterpart, which is installed alongside the press or in a remote-control room.

As the printed item leaves the final-impression cylinder and heads for the drying section of the press, a laser beam scans across each newly printed UPC symbol several times at 50,000 feet per minute. In combination with the scanning laser light, the UPC symbol generates a pattern of reflected light, which strikes a photomultiplier tube and is converted into a digital output.

At the same time the scanner's head measures line-width directly in thousandths of an inch. Press operators can monitor this function to adjust their press for cylinder impression and ink quantity. Pushbutton switches on the Monitor 101's control panel allow the setting of upper and lower limits of UPC line-width acceptability.

Encoded lines can be measured directly or as a percentage of the standard number. Indicator lights

John F. Mason
Associate Editor

He just completed half a day's testing before his morning coffee break.

The secret? His new 3312A Function Generator—the new-generation source that's actually two function generators in one box. It took the hassle out of his input-signal set-ups. He simply pushed a few buttons and had the functions he needed. No custom equipment...or a kludge of instruments to get a complex waveform.

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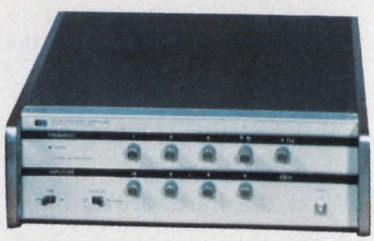

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INFORMATION RETRIEVAL NUMBER 25

Need an 'invisible' vhf antenna in a vehicle? Open the door a bit

How can the police or the military conduct secret vhf communications from a vehicle without advertising the fact by using a whip antenna?

The answer, according to Dr. Kurty Ikrath, an Army research physicist and specialist in antennas that don't look like antennas, is to leave the rear door of the vehicle slightly ajar, thus forming a slot antenna.

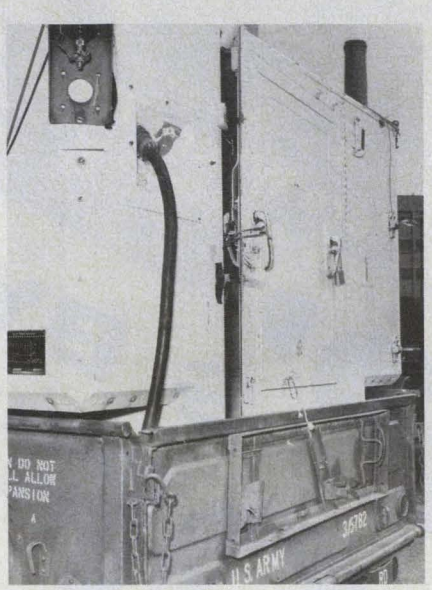
The biggest problem, Ikrath points out, is in coupling energy so the vehicle is an efficient radiator of vhf energy. The use of hybrid electromagnetic antenna couplers (HEMACs) is promising, he says (see "It's a Tree . . . a Pole . . . a Man; No! a Short-Range Antenna," ED No. 26, Dec. 20, 1973, p. 52), but this approach also has problems.

Tests of HEMACs have been made on vehicles equipped with the Army's PRC-25 and VC-12 vhf transceivers. The couplers proved to have matching problems.

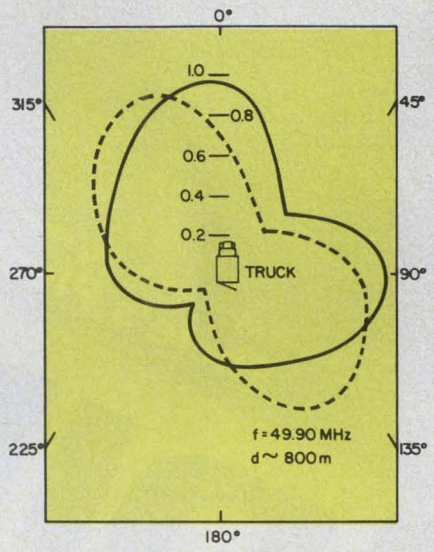
The door-slot antenna, besides having simplicity of design, has relatively good tuning characteristics, Ikrath says. Powered by a VC-12 transmitter, the antenna has been tested and found effective within a seven-mile range. And the installation of this antenna on metal trucks appears to be relatively simple.

At medium and high-frequency bands, a vehicle or a helicopter can be used as a large radio antenna rather than as a counterpoise for a conventional whip antenna, Ikrath says. This is done by coupling with HEMACs to produce suitable rf surface current distribution.

These couplers worked well at medium and high frequencies because the dimensions of the vehicle were small compared with a wavelength. However, at vhf frequencies between 30 and 80 MHz the problem is complicated, because the vehicle dimensions are close enough to the wavelength to make placement of nonconventional antennas critical.



An invisible vhf antenna is formed by the partly-open door of this shelter on a 3/4 ton Army truck.



The directivity of vehicle door-slot antennas varies with surroundings. Patterns are from two locations.

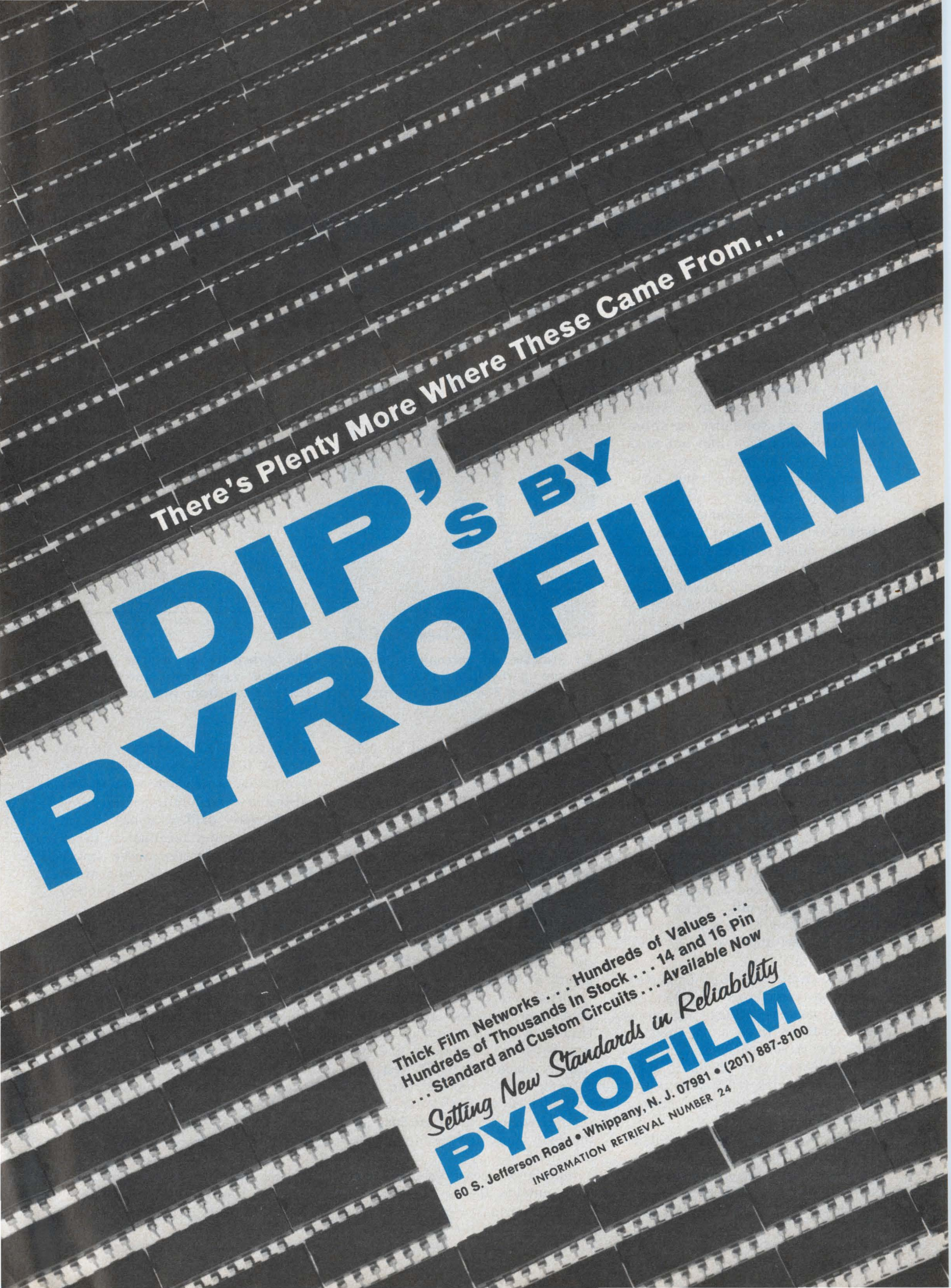
Because of HEMAC coupling problems in the vhf region, the door-slot approach was tried, Ikrath explains. The dimensions of three sides of a metal body on the rear of a 3/4-ton truck were on the order of one-half the wavelength at 60 MHz, he says.

Initial efforts involved the use of a 2-to-5-cm slot in the door frame, in the form of a tapered gap between the frame and the slightly opened door. To test this concept, Ikrath reports, two holes were drilled at the center of the vertical edge of the open door and the door jamb, and terminals were implanted.

Impedance measurements made from outside the truck with the tailgate down revealed a resonance at 44 MHz with an impedance of 400 Ω. Because of the relatively high impedance—50 Ω was desirable—two additional terminal holes were drilled some 37 cm above the center terminal. A tuned circuit laced across these upper terminals aided in optimum matching, while the signal was fed into the two center terminals. A third set of terminals, 37 cm below the center, were tuned to provide best performance.

The experiments with this setup resulted in discovery that the signal strength improved appreciably when the tailgate of the truck was raised. In a voice communications test the door-slot antenna of the truck was fed with the output of a VRC-12 transmitter, with low power of 2 to 3 W and high power of 25 to 30 W at 49.9 MHz.

Communication with a local receiving station that had a vhf antenna on the roof was effective for seven miles, Ikrath notes. ■ ■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INFORMATION RETRIEVAL NUMBER 24

Small $10 magnetometer reported a rival of bulky kilo-buck units

An alkali-vapor magnetometer, pocket-sized and costing about $10, is reported to be as sensitive as bulky vapor units costing thousands of dollars in locating oil fields, mineral deposits and archeological treasures.

Developed by researchers at the Columbia University Radiation Laboratory, the new magnetometer operates on a variation of the principle used in costly alkali-vapor magnetometers that respond to a magnetic field by measuring the rotation of atomic particles. Whereas previous designs have used low-density metal vapors to provide a readily measurable indication, the Columbia model uses vapor under high pressure—a feat heretofore thought impossible.

Prof. William Happer, inventor of the device, explains that the magnetically induced rotation of atoms in vapor magnetometers is measured when light is passed from a laser or vapor lamp through a cell containing that same vapor under low pressure. The vapor cell is excited with rf on the order of 122 kHz per gauss.

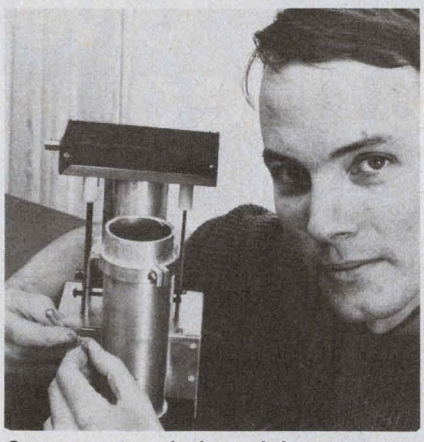
Absorption of light takes place in the cell at a frequency that is dependent on both the strength of the magnetic field and the frequency of the applied rf field. This decrease in light output is measured by photomultiplier tubes in conventional equipment and by a silicon photosensor in Professor Happer's design.

Fields measured to .01 gamma

Present costly vapor magnetometers, used for aerial surveys, measure fields down to 0.01 gamma. (The earth's field ranges from 25 to 70,000 gamma.) Happer predicts that his magnetometer will be as sensitive.

In previous experiments with low-pressure vapor cells, an increase in the pressure of an order of magnitude or so has increased random electron collisions and created system noise that masked the measurement.

But Happer discovered that by increasing cell pressure from about 10^{-6} Torr to 10 Torr—an increase of 10^{11}—the atomic collisions tend to average out, and a sharp resonance point proportional to the external magnetic field reappears.

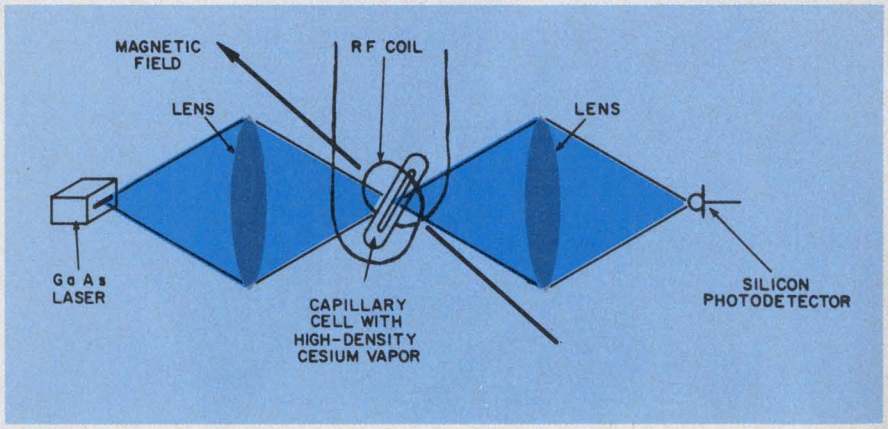


Components of the mini-magnetometer, held by the inventor, are compared with present bulky units.

Using a tiny, capillary tube filled with cesium under the high pressure, as well as a gallium-arsenide laser for the optical source and a silicon photocell for the output, Happer miniaturized the system. The critical element can be contained in a package the size of a ballpoint pen. A transistor oscillator provides the rf energy.

The development, funded by grants from the military's Joint Services Electronics Program and the Air Force Office of Scientific Research is still in the laboratory stage. But Happer says that his magnetometer has been demonstrated feasible in the laboratory.

"We have successfully pumped very small samples with cw gallium-arsenide lasers," he reports. "Eventually we hope to have a device which consists of a gallium-arsenide pumping laser and a capillary absorption cell. This combination should be very cheap and should lend itself to mass production." ■■



A tiny cell with high-pressure cesium vapor is the key component of the alkali-vapor miniature magnetometer. Optical absorption by the cell is produced by a magnetic field and rf excitation.

Noise at the front-end of an otherwise tight low frequency design is terribly frustrating. And we don't blame you for sounding off if you want to specify for lower noise and can't come up with an FET to suit your purpose.

Crystalonics new 2N6550 is a silicon, N-Channel, junction FET designed for low frequency amplifier applications, with an ultra low noise figure of 2n V/$\sqrt{Hz}$ at 1 KHz. You won't find one quieter! This device is designed to produce the cleanest signal possible at the front-end, for pure follow-through and ultimate signal clarity, so critical to military field communications. It's as silent as current technology allows, and with Crystalonics' 2N6550, you'll note a marked improvement in your prototype.

Crystalonics has been in the business of helping to solve designers' problems for over a decade. While other companies have abandoned military applications and opted for the production of commercial standards, we've stuck by our trade: high quality, innovative production with the designer in mind. Direct communication between the designer and our applications engineers is our mark.

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(continued from p. 26)

the power supply consists of three silver-zinc batteries.

A frequency band of 450 to 500 MHz is being used for the alarm transmissions. An 8-digit (32-bit) BCD code is transmitted 15 times in 1 s. Then there is a 30-s delay and the code is retransmitted 15 more times. About 1/100 mW of power is transmitted.

The bandwidth of the FM transmission is about 1 MHz, and the estimated range is about 50 ft. The batteries should last at least a year. All timing and coding circuitry is on a hybrid ceramic substrate.

In the receiver, a small processor makes a majority decision on the identity of the code, to eliminate errors caused by noise or RFI. Then a location code is added.

The result is transmitted on electric power lines on a 350-kHz carrier to the central dispatcher. The central dispatcher, a microcomputer, then analyzes the received data, searches its data banks for related information about the victim, decides on the action and notifies the correct agency over a dedicated communication link.

Some problems

"We don't yet have enough information about the effects of the human body on antennas that are worn close to the skin," Shollenberger notes. "In the current system the capacitance of the body causes about a 10-MHz frequency shift. We also have a 2-s delay built in after the button is pushed, to allow the hand to be moved away from the antenna."

Another problem is variable range, affected by such local conditions as tall buildings and vehicular traffic.

Other problems center on locating a signal in a high-rise apartment complex, preventing misuse by children and guarding against criminal use of the alarm as a decoy. In addition the best method has not yet been selected for differentiating between different types of emergencies.

The Federal agency is looking to private industry to help in developing the system. Shollenberger says: "We are interested in helping private, profit-making organizations get involved in this concept." ■■

Satellite altimeter to measure wave heights to 10% accuracy

When NASA launches Seasat in 1978, the satellite is to be capable of measuring wave height in the oceans to an accuracy of ±10%. In addition it will measure mean sea level and ocean radar backscatter coefficients (the variances in radar waves reflected back from the ocean). A radar altimeter linked to a minicomputer will make it possible to get such accuracy.

The prototype of the altimeter is undergoing system tests. It is designed to fly on a C-54 test aircraft, and the initial accuracy goal is modest: wave-height accuracy of only ±25%.

Developed by Hughes Aircraft Co. in Fullerton, CA, the altimeter uses a chirp-pulse technique. According to Richard Sidlo, program manager at Hughes: "We transmit a 3-μs pulse containing a chirped signal centered on 13.9 GHz. The chirped signal varies in frequency over a 360-MHz band."

The pulse hits the ocean surface and bounces back to the altimeter. Waves stretch the time duration of the return pulse. The pulse-stretching must be measured accurately to determine wave height. This is done by correlating the position of the frequencies in the return pulse with those in the transmitted pulse.

When the pulse is received at the altimeter, it goes through a triple conversion mixer with an output of 1.08 GHz. At this point, it is compared with a sample of the transmitted pulse that has also been converted to the 1.08-GHz range. The output of this correlator is a square pulse in time containing a signal that is the beat frequency correlation of the two chirped signals.

On to the range bin

Sidlo explains that this pulse of rf goes to a continuous filter bank, which contains 24 filters, each of 330-kHz bandwidth. These are the range-bin filters. Each corresponds to a discrete step of altitude. To keep track of this pulse of rf with a minicomputer, an additional pair of filters are used. They are known as early-gate and late-gate filters.

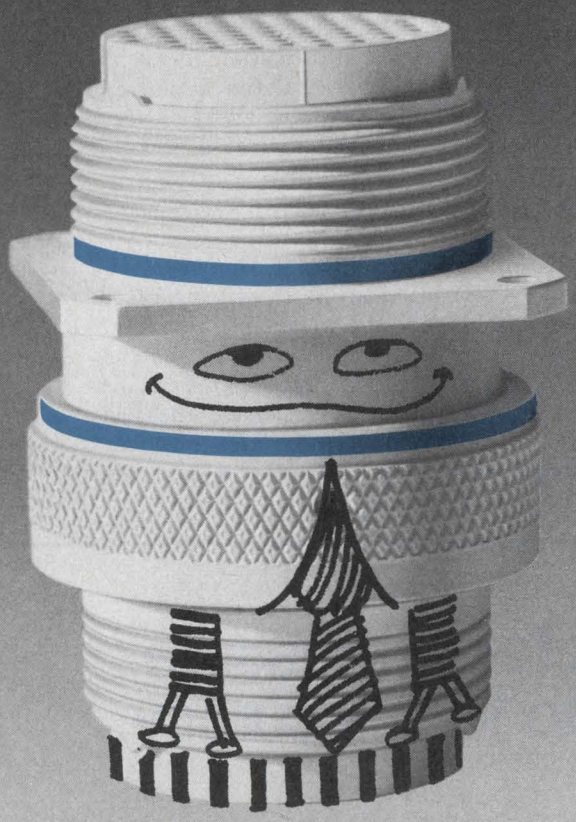
The early-gate filter tracks the leading edge of the pulse, and the late-gate filter serves as a reference toward the rear of the pulse. The early-gate filter is tuned by the minicomputer to the half-power point of the leading edge of the pulse.

A 12-bit analog-to-digital converter takes the outputs of the early-gate, late-gate and range-bin filters and sends the digital outputs to a multiplexer. The multiplexed signals go directly to the minicomputer.

The minicomputer is programmed to tune and adjust the tracking filters and to do real-time analysis of such information as wave height and ocean backscatter. In addition, on the C-54, it will control the real-time display of these parameters.

Only a small horn antenna is needed on the C-54, while a 1-m reflector will be needed on the satellite. Peak power of the breadboard prototype is 1 W. On the satellite, 2400 W will be transmitted.

The antenna beamwidth will be 1.5° on the satellite. ■■



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***dielectric retention** (re-ten'shun), n: an innovative method of retaining removable contacts in an electrical connector, incorporating a single dielectric wafer rather than individual metal contact retention clips

D.R. CONNECTOR DESIGNS

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Bendix

INFORMATION RETRIEVAL NUMBER 22

news

U.S. seeking a wrist transmitter for citizen use in emergencies

A wrist-mounted alarm for use by citizens is being investigated by the Law Enforcement Assistance Administration in Washington, DC.

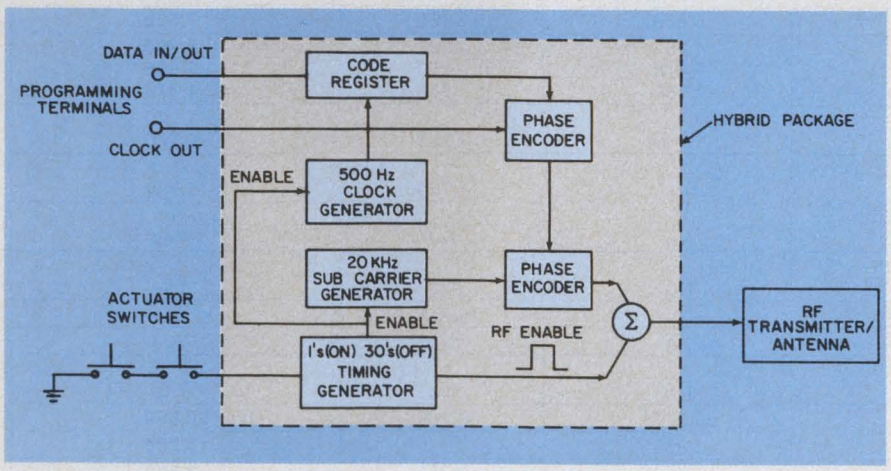
If you were the victim of a crime, a push on the button of the alarm would summon the police. If your emergency were medical, it could call the first aid squad. Or if your house was on fire, it could bring the fire company to the scene.

"We are in the earliest stages of system concept and prototype development," says George Shollenberger, manager of development at the Law Enforcement Assistance Administration. Hardware is being built to test the concept and to see what the most serious problems are.

"We know that there will be many bugs in the system," Shollenberger concedes. "The current development phase will tell us what the alternatives are for getting rid of them. We have already found, for example, that we will need a stable crystal oscillator, instead of the basic Colpitts oscillator that we are now using."

David N. Kaye
Senior Western Editor

Citizen alarm's actuator is this wrist-mounted transmitter. The printed-circuit loop-antenna transmits a coded signal to a grid of receivers. The receivers locate the signal and relate the code to a central dispatcher. Finally the proper help is dispatched to the scene of the emergency.



The wrist-mounted actuator contains most of its circuitry on a ceramic hybrid substrate. An identification code is programmed into the code register. The timing generator sends the code 15 times in 1 s and then delays 30 s before retransmitting the code 15 more times. The signal is sent on a 450-to-500-MHz carrier.

The system engineering is being done by Aerospace Corp., El Segundo, CA, and the prototype hardware is being built by Compu-Guard, Pittsburgh.

Location a problem

The problem most open for alternate approaches is how to pinpoint the victim's location. An approach under consideration now is that of a grid system of receivers. When the alarm button is pushed, a coded signal is transmitted. The receiver or receivers that pick up the signal on a grid would locate the alarm to within the spacing of the receivers. Thus, if the receivers were spaced every hundred feet and the range of the transmitter was 50 ft, location of the alarm would be to within 50 ft of the receiver detecting the signal. If more than one receiver picked it up, the location could be more closely determined by triangulation.

How it works

There are three parts to the system, as now conceived: the alarm actuator, the receiver and the central dispatcher.

The actuator sends a coded signal to the receiver. The receiver adds a location code and sends the signal on to the central dispatcher. Finally the nature of the emergency is determined and the proper emergency service is dispatched.

The alarm actuator is mounted in a wristwatch case. It contains an oscillator, an antenna, a power supply and some timing and coding circuitry. The antenna is a 1-1/4-in. loop. Timing and coding circuitry is standard CMOS, and

(continued on p. 28)

WHEN YOU HAVE
Electronic Design's
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In just a few months, the first issue of *Electronic Design's* GOLD BOOK has become the leader among all directories used in this industry. Engineers have responded enthusiastically throughout the U.S. and from all over the world — especially in Europe where they've never seen anything like it before. The GOLD BOOK has become number one almost overnight.

HERE'S HOW YOUR FELLOW ENGINEERS RATE THE INDUSTRY ANNUALS

	Annuals Consulted Within Past Month	Annuals Preferred
Electronic Design's GOLD BOOK	85%	60%
Electronic Engineer Master (EEM)	63%	42%
Electronic Buyer's Guide (EBG)	32%	8%
Thomas Register	16%	7%
Conover-Mast Purchasing Directory	2%	1%

SOURCE: Study by Dr. Eugene D. Jaffe, Associate Professor of Marketing, St. John's University, Nov. 1974. Base: respondents using directories. Totals exceed 100% due to multiple mentions.

The GOLD BOOK has revolutionized directory use patterns in this industry. Here's why: The GOLD BOOK is by far the largest, most complete one-step electronics purchasing and reference tool ever produced. And it's far easier to use. Look at these comparisons:

COMPARISON OF ELECTRONICS INDUSTRY DIRECTORIES (1974-75 editions)

	EBG ELECTRONICS BUYERS' GUIDE	EEM ELECTRONIC ENGINEERS MASTER	ELECTRONIC DESIGN'S GOLD BOOK
Number of manufacturers listed	5,800	3,165	**7,528**
Total number of products listed	4,267	3,235	**4,799**
Number of direct products listed	2,479	2,250	**2,925**
Number of cross-reference products listed	1,788	985	**1,874**
Number of distributors listed in Distributors Directory — Alphabetic	0	1,720	**5,780**
Number of distributors listed in Distributors Directory — Geographic	0	1,720	**5,780**
Is complete mailing address given each time a company is listed in product directory?	No	No	**Yes**
Is telephone number given for each company listed in product directory?	No	No	**Yes**
Are distributors listed for each manufacturer?	No	Partial[1]	**Yes**
Does manufacturers listing include FSCM numbers?	No	No	**Yes**
Does manufacturers listing include facsimile equipment by make and call number?	No	No	**Yes**
Total Circulation	30,017[3]	89,169[3]	**Over 90,000**
Overseas Circulation[2]	1,339[3]	0[3]	**13,200**
Number of ad pages	590[4]	2,752	**2,820**

[1] Paid listings only
[2] Includes Canada
[3] Standard Rate & Data; Oct. 24, 1974
[4] Includes fractionals

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MOS memories

TI's new 3rd generation 4K RAMs.

200ns speeds in 18-pin packages. And availability is now!

Texas Instruments brings you third generation 4K MOS RAMs: TMS4050-2 (200ns), TMS4050-1 (250ns) and TMS4050 (300ns). These compact 18-pin 4K RAMs offer even better board packing density than their 22-pin counterparts, as much as 70 to 100%.

Volume availability is now. The TMS4050s are in full production. They utilize the same single-transistor cell design and reliable N-channel silicon gate process as TI's popular TMS4030 4K RAM. This helps insure on-time delivery.

The TMS4050s have been made easy to use. All inputs, except clock, are compatible with Series 74 TTL, while power dissipation is kept low (420 mW operating, 0.1 mW standby, typically). A full 12-line address and single hi-level clock minimize system timing headaches. Plus, data input and output are multiplexed to provide a simple memory bus interface.

	ACCESS TIME MAX	100-999 PRICE
TMS4050NL	300ns	$19.64
TMS4050-1NL	250ns	$21.64
TMS4050-2NL	200ns	$24.62
TMS4050JL	300ns	$22.78
TMS4050-1JL	250ns	$25.07
TMS4050-2JL	200ns	$28.56

Compare prices (see insert). You can see that TI's TMS4050s offer the best performance at the lowest price. And why shouldn't they? TI has more experience in building 4K RAMs. Plus, volume production experience means lower cost-to-you – and higher PC board density.

The TMS4050-2, TMS4050-1, and TMS4050 are available through TI's authorized distributors in 18-pin plastic (NL) or ceramic (JL) packages. For data sheet, write Texas Instruments at P.O. Box 5012, M/S 308, Dallas, Texas 75222.

TEXAS INSTRUMENTS
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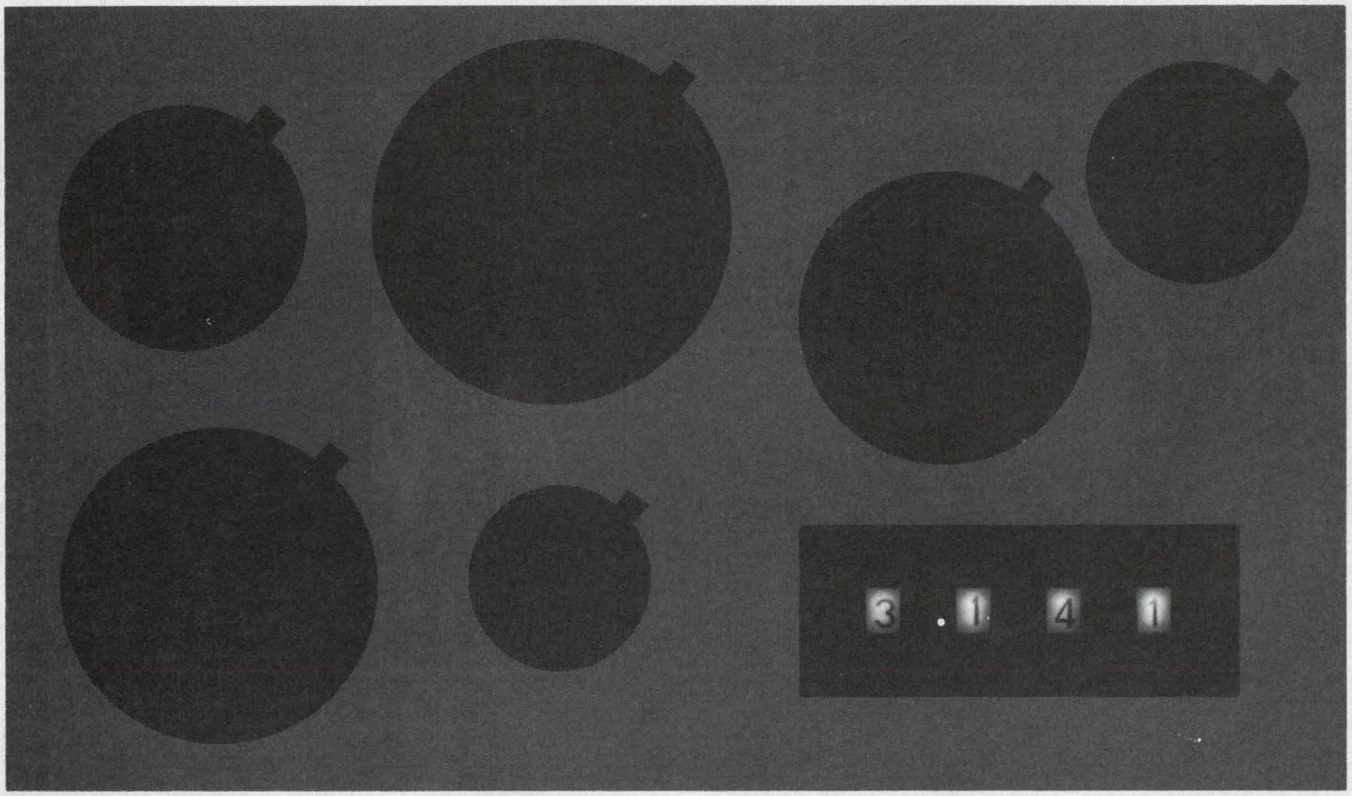
83070

All 10-turn pots look alike



in the dark.

In the dark they're all unreadable. And if you're more than three feet away, you can't even read them in the light.

Ergo our new Thumbpot. It can be illuminated to read in the dark (above), and the numbers are large enough to read 10 feet away.

In addition you can set in those numbers rapidly with finger or thumb. And you can reset any number right on the button, exactly.

The reason for these superior features is that Thumbpot is not a pot. It is an incremental voltage divider. A switch. A switch specifically designed to replace panel-mounted 10-turn pots.

Because Thumbpot is really a switch, it affords some other advantages. It is available in two sizes, with 1, 2, 3 or 4-digit readout, with or without a fixed or floating decimal point, in more than 400 standard versions. And its design is inherently more reliable and longer-lived than that of 10-turn pots.

There's much more to Thumbpot than we can cover here, however, so we urge you to request our brochure, by mail or telephone.

Thumbpot. No look-alike.

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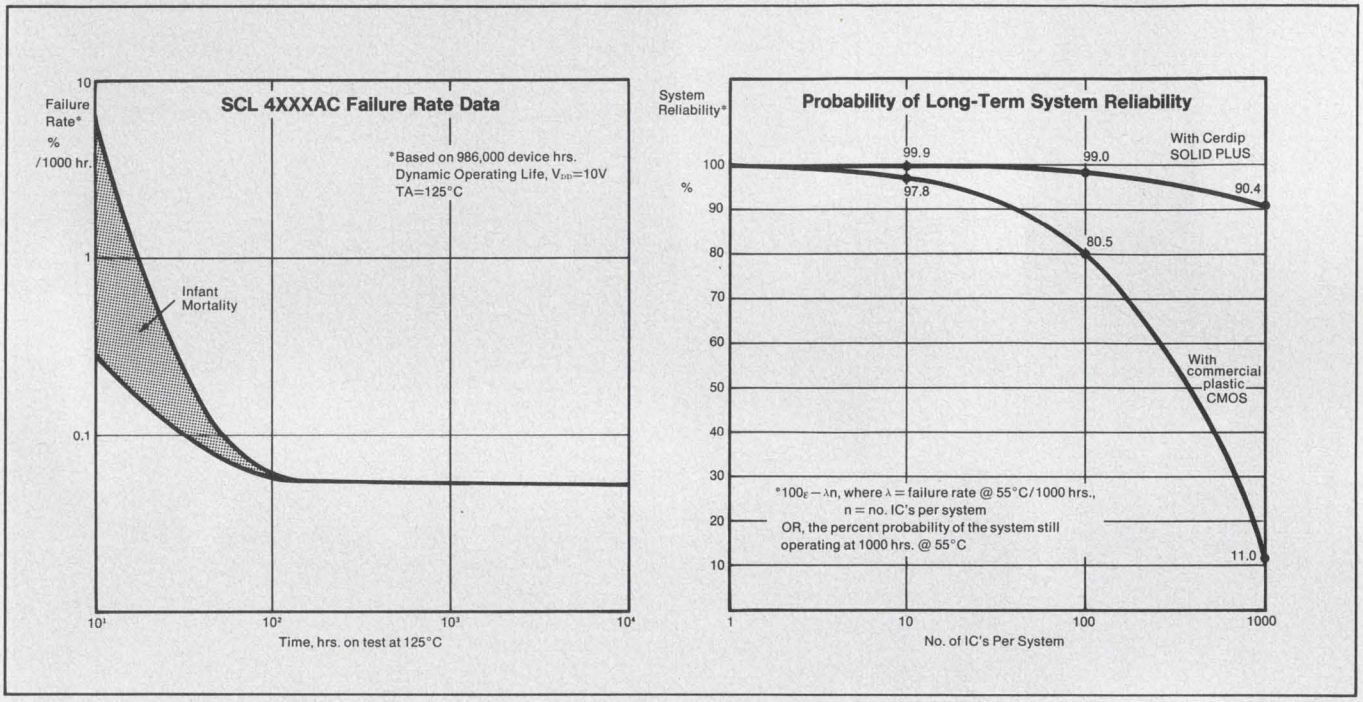
Also available from Hall-Mark G. S. Marshall Schweber

INFORMATION RETRIEVAL NUMBER 18

SOLID PLUS CMOS

An Investment In Reliability That Pays Off Big



As shown in the Failure Rate curve, mortality of CMOS IC's is greatest in the first 100 hours of service. That's the stage of life where failures cost you most, for reworking during system burn-in, and for field failures within warranty.

Our new SOLID PLUS program can drastically reduce your maintenance costs, by supplying you with Cerdip Plus devices that have been factory screened and burned-in through accelerated environmental testing. Potential infant mortality failures have been practically eliminated.

If you're now using conventional Cerdip, your total costs for devices and maintenance can be reduced by about 15%. If you're buying plastic, your total costs can be cut by more than 50%. And you may be able to reduce or even eliminate incoming inspection, eliminate your own burn-in program, and shorten system burn-in time.

Our second curve shows the kind of long-term system reliability you can expect when you choose SOLID PLUS CMOS over ordinary commercial-grade plastic. For users with moderate to large systems, your choice of the right kind of CMOS IC's should be obvious.

SOLID PLUS is available on all our 4000, 4400 and 4500 series products, at prices just a few cents above conventional Cerdip CMOS. Write or call for our new brochure and for quotations on specific devices. It's a bargain in reliability that pays great dividends.

Here's what you get with SOLID PLUS:

CERAMIC HERMETIC CERDIP PACKAGE → VISUAL INSPECTION PER MIL 883/B → PRE-CAP VISUAL PER MIL 883/B → 24-HOUR 200°C STABILIZATION BAKE → 10 TEMP CYCLES −65° to +150°C → 100% FUNCTIONAL TEST → 100% PARAMETRIC TEST → 168 HR 125°C BURN-IN → 100% FINAL TEST → SHIP TO 0.15 AQL

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The alternate source that's better than equal.

INFORMATION RETRIEVAL NUMBER 17

How to make R&D pay off. Use someone else's money, make the researcher responsible for new-business success, and form product boards to speed up decision-making.

Research and development, like love, is something everybody favors. But not everybody knows quite what to do about it. It's one thing for a company to devote an "adequate" portion of its revenue to R&D, but how effectively the company employs its R&D funds is another matter entirely.

Too often it's like seeding a lawn. We throw some seed at the earth and hope that it comes up as grass. We tend to assume that if we throw enough seed at the earth, we will get something that looks like a lawn. When seed is cheap, that may not be a bad way to grow a lawn. But R&D is not cheap. It costs a great deal of money to employ good researchers and development engineers.

Though there's never a guarantee that your research will bear fruit, you can dramatically improve the odds if you keep corporate policy concerning it flexible.

Much depends on R&D in our business. Plessey is an international billion-dollar company, acknowledged as a world leader in communications and electronics. We apply high-technology to all forms of information handling. Our current expenditure for R&D is $96 million per year—and it is increasing steadily. But we watch the return on our R&D investment. At 10 per cent of sales, this represents a substantial investment and insurance for the future growth of Plessey.

How does a company like Plessey make R&D pay off? First—let's see how other companies handle R&D.

Research and development labs in most companies are funded by corporate management. The lab manager often arbitrarily decides which of several projects he'd like his staff to work on. If his research later suggests that a project may have commercial possibilities, the project at some stage or another is turned over to another group for commercial exploitation. Usually, however, the main benefit derived from research is that it allows someone to present a paper to some learned society. That's not much of a payoff.

Sir John Clark, Chairman, The Plessey Company Limited, London.

A policy of persuasion

At Plessey, we decided that all of our research and development lab managers must persuade someone to give them money before a project is started. Put simply—we want our researchers to sell their efforts. They have to pull themselves away from the blue sky and sell their concepts to potential customers. They have four sources of funds. They can:

- Persuade the Government to sponsor a project. Come up with a new idea for handling mail, for example, and get the Government to pay for the R&D on it.
- Persuade one of the "businesses" in the company to fund them—businesses like semiconductors, capacitors, memories, hydraulics and telecommunications. They might offer, for example, the possibility of a new component, or a new technique for making something better or cheaper, or new technology that might boost the performance of older products.
- Conduct research that's not covered by an existing business. In that case, they'll have to persuade the 12 people who administer the corporate fund. Perhaps they'll create a product that necessitates the creation of a whole new division.
- Dip into a small fund that's available for "crazy ideas." We try to guard against the immediate rejection of wild whims. In fact we want to encourage them to some extent. So each lab has some "crazy money" for offbeat projects. It's not a great deal of money, but it's enough to enable somebody to fool around with something for a few months. If the idea doesn't work out, it can be dropped without embarrassment. But if it does show promise, the lab manager can then try to persuade one of the three customers I've mentioned to sponsor it. But then he'll have some evidence to support his hunches.

Probably the most vexing aspect of R&D is that you have to nurse it for a long time before it pays off. If you send a brand new baby prod-

Sir John Clark of The Plessey Company Limited

Sir John Clark is Chairman and Chief Executive of The Plessey Company Limited. He was knighted in 1971 for export services. Of special interest to American readers is that Sir John, whose father was an American citizen before becoming a naturalized British subject in 1927, is a member of the Sons of the Revolution. The aims of this society include perpetuation of the memory of men who "in military, naval or civil service, by their acts or council, achieved American Independence."

Sir John, who is 49, was previously Deputy Chairman and Managing Director of Plessey until appointed Chairman in November, 1970 in succession to Lord Harding. He is President of the Telecommunication Engineering and Manufacturing Association, an office he also held in 1965-66.

And he is one of two Plessey representatives on the Board of International Computers (Holdings) Limited, the British computer company formed jointly by ICT, English Electric Computers, Plessey and the then Ministry of Technology in 1968. ICL is the largest company outside the USA specializing in commercial and scientific computers.

Sir John is Vice President of the Engineering Employers' Federation, Fellow of the Institute of Management, Companion of the Institution of Electrical Engineers, Vice President of the Institution of Works Managers and a member of the National Defence Industries Council.

Educated at Harrow and Cambridge, Sir John saw service with the Royal Naval Volunteer Reserves during WW II. After demobilization he received his early industrial training with Metropolitan Vickers and the Ford Motor Company and then spent over a year in the USA studying the American electronics industry.

In 1962 Sir John was appointed Managing Director of Plessey, which by then included Garrard Engineering Limited and two telephone companies—Automatic Telephone and Electric Company Limited and Ericsson Telephone Limited.

In April, 1973, he was invested with the Order of Henry the Navigator (Infante de Henrique) by the President of Portugal.

His principal recreations are shooting and golf. He's a qualified helicopter pilot and often flies himself on business.

uct out into the cold, cruel world, it may not survive. That's often the result of corporate inflexibility.

Too often, we keep our engineers in boxes. We have an engineer, call him Charlie, involved in research, and he stays in the lab and never leaves. Many times it happens that Charlie develops this product, and somebody decides that Division X would be best equipped to manufacture and sell the product. So Charlie, back at the lab, says goodbye to his "baby" and Harry at Division X is given responsibility for the new product.

Well, Harry had been pretty busy on his own

project and he wasn't overly fond of this new thing anyway, so he's going to spend most of his effort on the products he knows better. And if something goes wrong with the new product, well, heck, he knew all along it wasn't that good. He could have told the brass in the first place that it didn't have much future.

But if Charlie were there, he might recognize that a minor change could fix the product. "Oh," he might say, "you like 5-volts output instead of 12-volts output? No sweat. That's easy." Charlie has an emotional stake in the product. He wants to make it work. He wants to make it succeed—just as all of us want our babies to grow up strong and healthy.

So we decided to let Charlie stay with his "baby," instead of sending it to a division as an orphan. When his product is sufficiently mature to be taken to the marketplace, we let Charlie do it. He controls his own purchasing, his own production, his own marketing, sales and distribution. He leaves the lab to run this new business.

Sometimes he comes back to the lab after his business fails to make money. He returns sadder and wiser, and this helps prevent the growth of intellectual arrogance in the lab.

And sometimes he comes back to the lab after several years of success with a new business because he has the creative itch again. He wants to develop something new.

But sometimes he stays out there with his new business and the business flourishes. In the case of one product that came out of the lab—with its "father"—we're now doing about $4 million a year and enjoying a 60% annual growth.

In most cases, the challenge in handling these new products as separate financial units is in knowing how long to keep them as parts of a new business and when to assimilate them into an existing division—if at all.

Notice that we have people flowing out of the R&D labs (and sometimes back into it). This movement is good because it pumps new blood into projects. It creates vacancies for new people, about 80% of whom are recent college graduates. We really don't want the R&D lab to expand. If we didn't contain its size, ideas would grow stagnant and people would not produce enough good products to justify the lab's existence. The average age for the R&D engineer is about 32. Most of them peak, creatively, at about 30.

Boards help 'spring' new products

Now there's another aspect of managing R&D, especially in a large corporation. How do you make sure it's flowing smoothly? And how do you make sure that different groups are not duplicating each other?

We found the solution in "product boards," organizations designed specifically to deal with product development. The product boards are charged, among other things, with learning about and nursing promising new products. They are specifically prohibited from worrying about day-to-day management problems. They don't worry about last month's bookings or snags in the production line. They push for tomorrow's products.

In essence the role of the product boards is to bring top management into the labs so that top-management decisions can be made quickly.

Four years ago we looked at our management organization and found that, like many other large companies, we had too much weight in staff positions relative to line positions. We had an overconcentration of management in the center, rather than in the wings, to the detriment of efficiency on the line, where the money is made. At headquarters, there's too much of a tendency for people to spin their wheels and play politics.

On the other side of this coin, we found that, back at the labs, people can't get decisions quickly enough from top management. So we decided to bring top management to these people by means of product boards.

We have 10 of these boards, each containing six to 10 individuals. Each board includes Plessey's Managing Director and Director of Finance. In addition, each has a division's manufacturing director and several engineers selected from that division.

Since several people on each board travel from division to division, boards can quickly spot duplication of effort and possibilities for synergism. They might find, for example, that two divisions in different parts of the world are working on identical research. They might then decide to redirect one project or, perhaps, to allow both to continue. Or they might find that one group, say, semiconductors, is developing a product that can prove extremely valuable to another, say, communications.

The real key to making R&D pay off is to make Charlie, the developer of a product, also responsible for it. Give him an emotional stake. That means getting him to persuade someone else to sponsor the product, and getting him to nurse the product along personally by controlling its business.

And when you have a number of Charlies involved, make sure you don't rob them of the authority it takes to do their job. Bring Mohammed to the mountain. Make quick top-management decisions available in the labs. ■■

Now from International Rectifier.

"Extra Margin" Fast Switching Power Transistors.

If you're chopping line voltages at 20 KHz or inverting and stepping down at high frequency, you should consider IR's two new families of fast switching, glass passivated power transistors. They can mean better reliability and lower cost in line operated power supplies.

Fast Switching Speed—Cooler Operation . . . the oscillograph shows typical fall times in the sub-microsecond range. Gives extremely low switching losses for cooler operation and higher reliability.

Lower Leakage — High Temperature Stability . . . with ICEO in the microamp range, IR devices are about one-tenth the accepted leakage rates of others. Provides the higher stability important for high performance at elevated temperatures.

High Second Breakdown — High Reliability . . . adds to our broad safe-operating area for an extra margin of safety.

Glass Passivation — Long Term Reliability . . . high reliability and long term stability is achieved by hard glass passivation. Also, if you're using chips to make your own circuits, IR's glass passivation gives you the most stable, easy to assemble chips you can start with, making your yields higher.

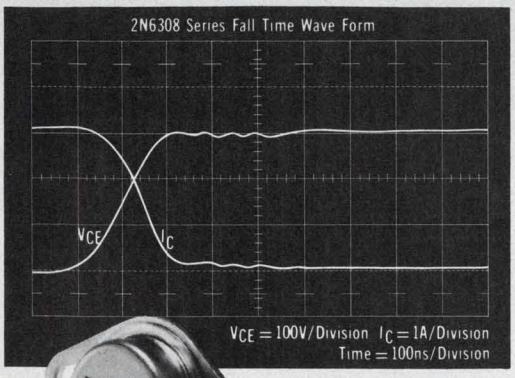
If you are paralleling devices, the tight gain, switching time and saturation voltage control of these transistors make the job easier. And through 100% testing of key parameters we can provide even closer matching if necessary.

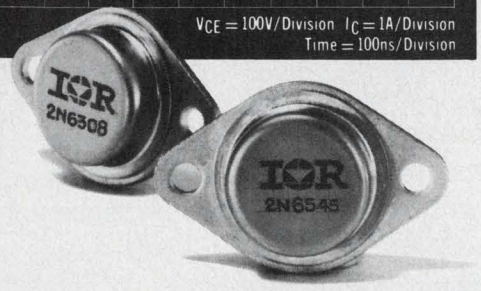
JEDEC types listed are immediately available, so contact your local IR salesman, rep or distributor today for samples. Also, ask for data on IR's other series of high gain/high voltage power transistors and power Darlingtons.

International Rectifier, 233 Kansas Street, El Segundo, California 90245. (213) 678-8261.

New International Rectifier Fast Switching Power Transistors

IR Part No.	$V_{CEO(sus)}$ (Max V)	I_C Peak (A)	h_{FE} (min/max)	@ I_C(A)	$V_{CE(sat)}$ (Max V)	@ I_C(A)	Pd (W)	t_r/t_f (μs)
2N6306	250	16	15/75	3.0	0.8	3.0	125	.6/.4
2N6307	300	16	15/75	3.0	1.0	3.0	125	.6/.4
2N6308	350	16	12/60	3.0	1.5	3.0	125	.6/.4
2N6542	300	10	7/35	3.0	1.0	3.0	100	.7/.8
2N6543	400	10	7/35	3.0	1.0	3.0	100	.7/.8
2N6544	300	16	7/35	5.0	1.5	5.0	125	1/1
2N6545	400	16	7/35	5.0	1.5	5.0	125	1/1





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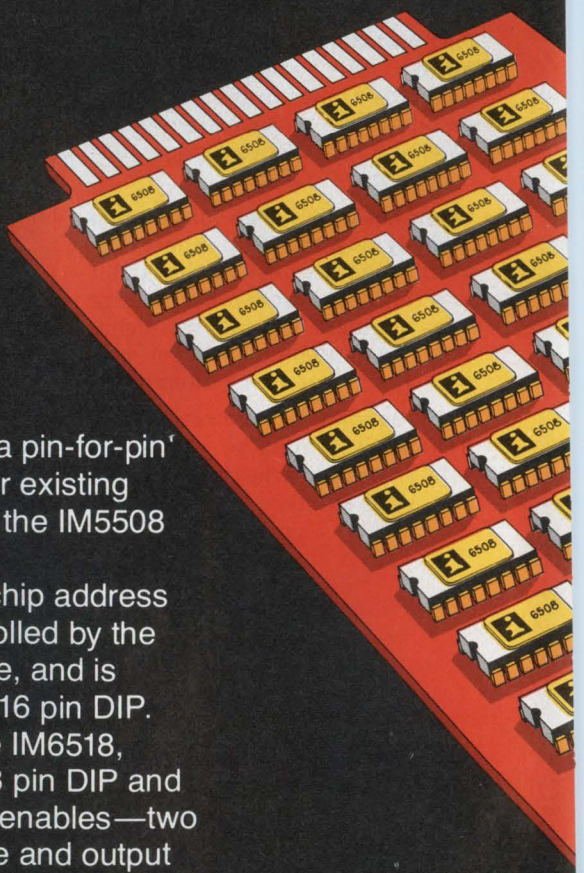
INFORMATION RETRIEVAL NUMBER 41

Intersil's IM6508 1024 bit CMOS RAM.

With the best speed/power product you can buy.



The world's first 1024x1 static CMOS RAM.

We've been producing and delivering the IM6508 for six months now, in industrial (−40°C to +85°C) and military (−55°C to +125°C) versions. Check the specs and you'll get as excited about it as we are:

Power is only 5μW total in standby, 10mW at 1MHz. Typical access speed at 5 volts V_{cc} is 200nS. And the price is right. At 100+ quantities the industrial version is $28, the military is $70.

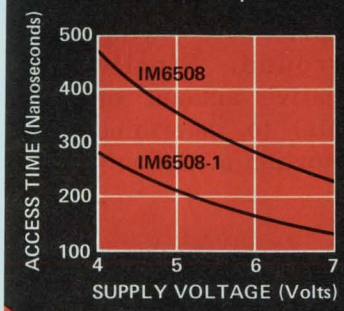
It has TTL-compatible inputs and outputs, works directly with bus-oriented microprocessors without additional power supplies or interfaces. It's a pin-for-pin replacement for existing RAMs such as the IM5508 and the 93415.

It has on-chip address registers controlled by the chip-enable line, and is packaged in a 16 pin DIP. A variation, the IM6518, comes in an 18 pin DIP and has three chip enables—two for write-enable and output buffering and one for address registers.

Intersil stocking distributors.
Elmar/Liberty Electronics.
Kierulff Electronics; Mass.
Schweber Electronics.
Semiconductor Specialists.
Weatherford.
Arrow Electronics; N.Y., Minn., N.J., Conn., Md./D.C.

The IM6508-1: Supply current 10μA.

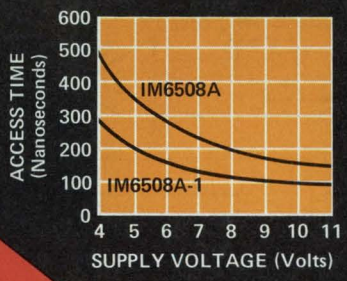
Now it really gets interesting. While the IM6508 has an I_{cc} of 100μA, we deliver a "dash-one" version that requires one-tenth that much —that is, 10μA I_{cc}. It also has significantly faster access, as shown in this speed/voltage graph comparing the IM6508 and IM6508-1 across their 4- to 7-volt supply voltage range.



Or the IM6508A: Access time below 100nS.

There's more. In addition to the above, we also are delivering the IM6508A, which operates at supply voltages up to 11 volts. At that voltage, its access time is speeded up to 150nS.

And to **really** blow your mind, there's the IM6508A-1. You guessed it: it not only has an I_{cc} of 10μA, its access time drops down below 100nS. This graph compares access times for both versions (standard and -1) of the IM6508A across the supply voltage range.



Not to mention the i38510/IM6508.

We also sell a military high-rel version made with MIL-M-38510A processing and MIL-STD-883 test methods, with electrical test conditions and limits guaranteed to Intersil's i38510 in-house-program specifications. Every such device is analyzed by scanning electron microscope, marked with its wafer-lot number for traceability, and delivered from bonded inventory.

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INFORMATION RETRIEVAL NUMBER 21

ideas for design

Squaring circuit generates second harmonic for controlled-distortion test signal

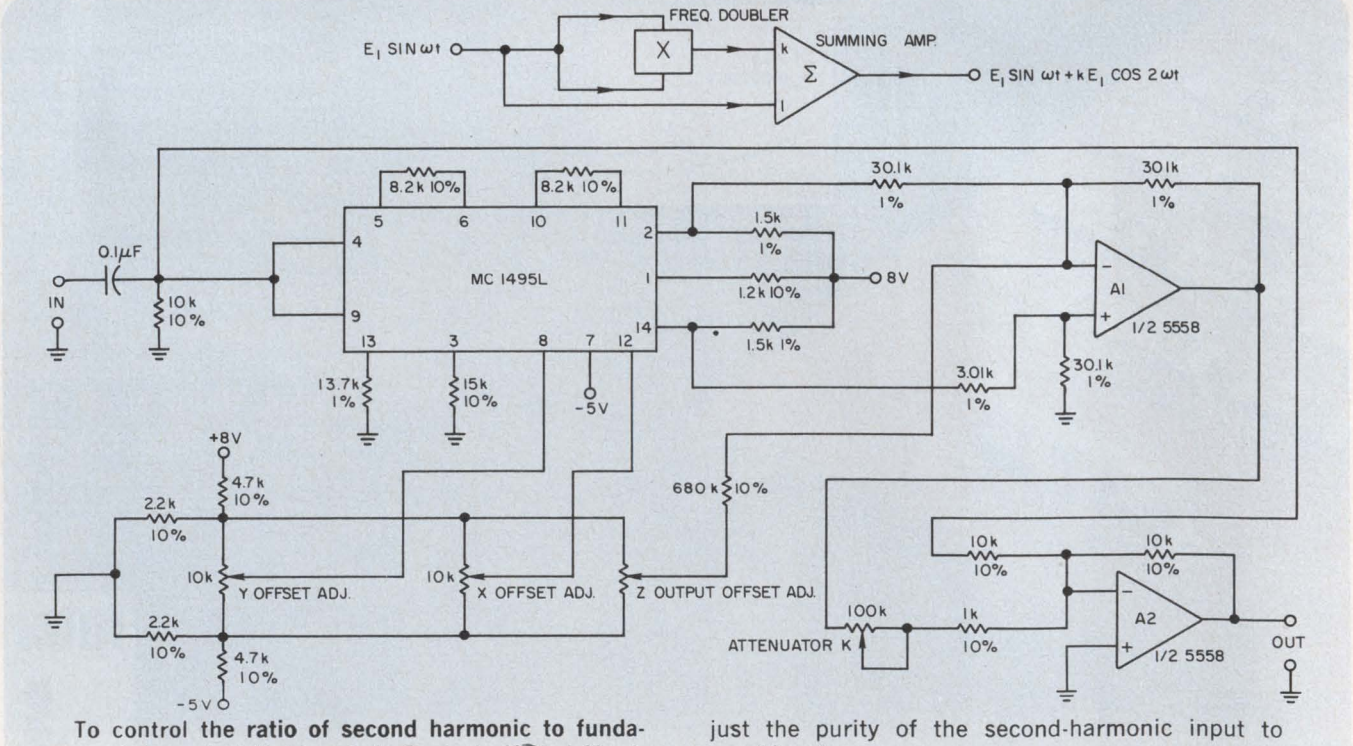
To introduce controlled second-harmonic distortion into a test signal, use a four-quadrant linear multiplier to square the input test signal and produce a doubled frequency term. The dc component also produced is balanced out with output-offset control Z after the second-harmonic frequency is adjusted with controls X and Y for best sine-wave output from A_1.

The diode wave-shaping networks usually used for generating second-harmonic distorted signals are generally limited to fixed signal amplitudes with fixed distortion. By contrast, the squaring circuit produces almost any desired amount of distortion, and it operates over a wide amplitude range.

A 5558 dual op amp amplifies and sums the original input with the selected level of second-harmonic distortion. The Z offset control is adjusted so the signal at the output of A_1 is symmetrical with respect to ground. Finally attenuator K adjusts the relative amount of second-harmonic to fundamental to determine the percentage of harmonic distortion at the output of A_2.

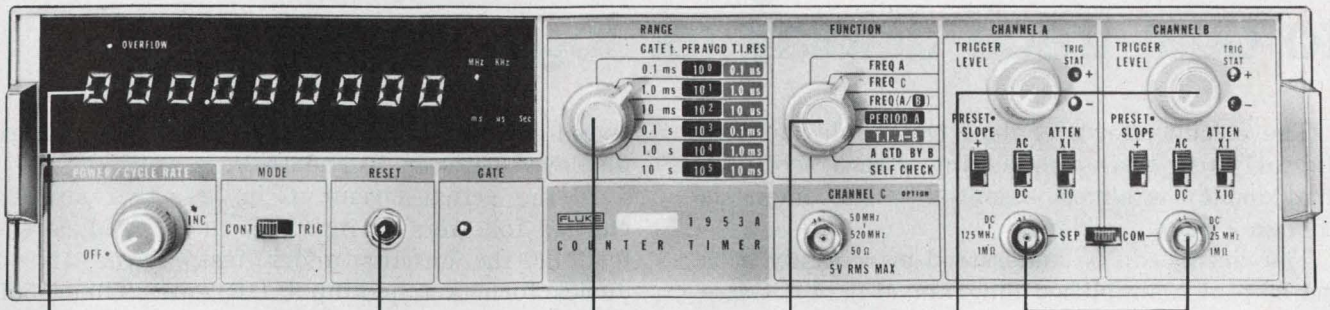
Arthur B. Williams, Manager, Analog Development, Coherent Communications Systems Corp., 85 D Hoffman Lane South, Central Islip, NY 11722.

CIRCLE No. 311



To control the ratio of second harmonic to fundamental, control K is varied. Controls X and Y adjust the purity of the second-harmonic input to amplifier A_1.

If your counter looks this good...



EASY TO READ
9-digit LED display
Large 7-segment characters
Full leading zero suppression
Automatic annunciation and overflow

DISPLAY CHECK
Pressing reset button when counter is in self check mode lights all digit segments

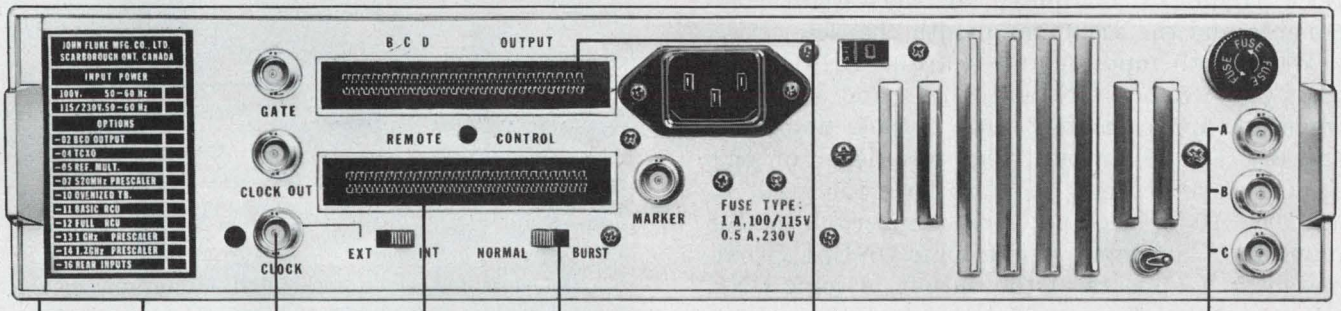
WIDE RANGING
Six choices of:
- Gate times
- Period averages
- Time interval resolution

VERSATILE
Measures:
- Frequencies
- Frequency ratios
- Period and period averages
- Time intervals
- Gateable totals
- Self check

FULL TRIGGERING CONTROL
Preset or variable trigger level controls with status indicators
Slope, coupling, and attenuation switches

TWO INPUT CHANNELS
Direct coupled amplifiers with 30 mV sensitivity

and gives you these options...



HIGHER ACCURACY
Higher stability timebase Options 04 and 10

PRESCALERS
520 MHz prescaler. Option 07
1000 MHz prescaler. Option 13
1250 MHz prescaler. Option 14

TIMEBASE MULTIPLIER
For operation from 1 or 5 MHz in addition to standard 10 MHz external reference clock. Option 05.

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Basic remote programming. Option 11.
Full remote programming. Option 12.

BURST MEASUREMENTS
Select normal or burst measurements. Burst measurements made on Freq A or Freq C modes. Option 05.

DIGITAL OUTPUT
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REAR INPUTS
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INFORMATION RETRIEVAL NUMBER 15

Circuit converts single-trace scope to dual-trace display for logic signals

The circuit shown enables the display of two digital pulse trains on a single-trace scope. A dual display is almost essential in the diagnosis of logic-circuit problems.

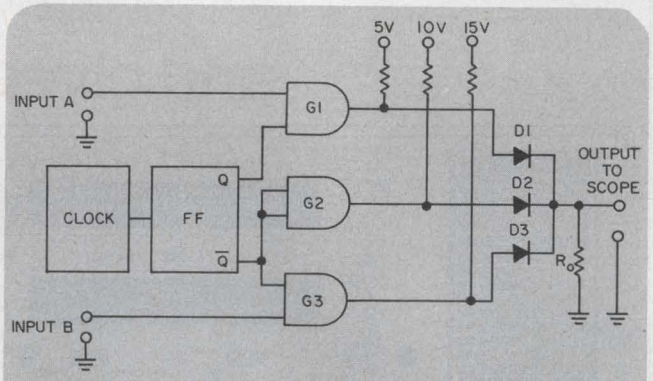
The circuit can be understood more easily with the help of a simplified diagram (Fig. 1). Gates G_1, G_2 and G_3 are open-collector AND gates. The collectors of these gates are connected to 5, 10 and 15 V, respectively, via separate pull-up resistors. Three diodes and resistor R_0 form a triple-input OR gate. The binary output levels of the OR gate are approximately zero to 5, 10 or 15 V, as determined by the particular AND gate that is ON. Gates G_1 and G_3 are switched alternately by the complementary outputs of the flip-flop. The rate of switching depends on the clock frequency. And the resolution of the display improves with a fast clock. But the upper clock frequency is limited by the circuit components and the scope bandwidth characteristics.

When both input A and B are at ZERO, only gate G_2 switches ON and OFF, and a square wave of approximately 10-V pk-pk amplitude appears at the output. The zero level of this square wave becomes the zero level for input A, and the 10-V level becomes the zero level for input B. When input A is a logic ONE, approximately 5 V appears at the output. A logic ONE at input B produces a 15-V level at the output. Thus digital signals at input A are displayed between zero and 5 V, and signals at input B are displayed between 10 and 15 V.

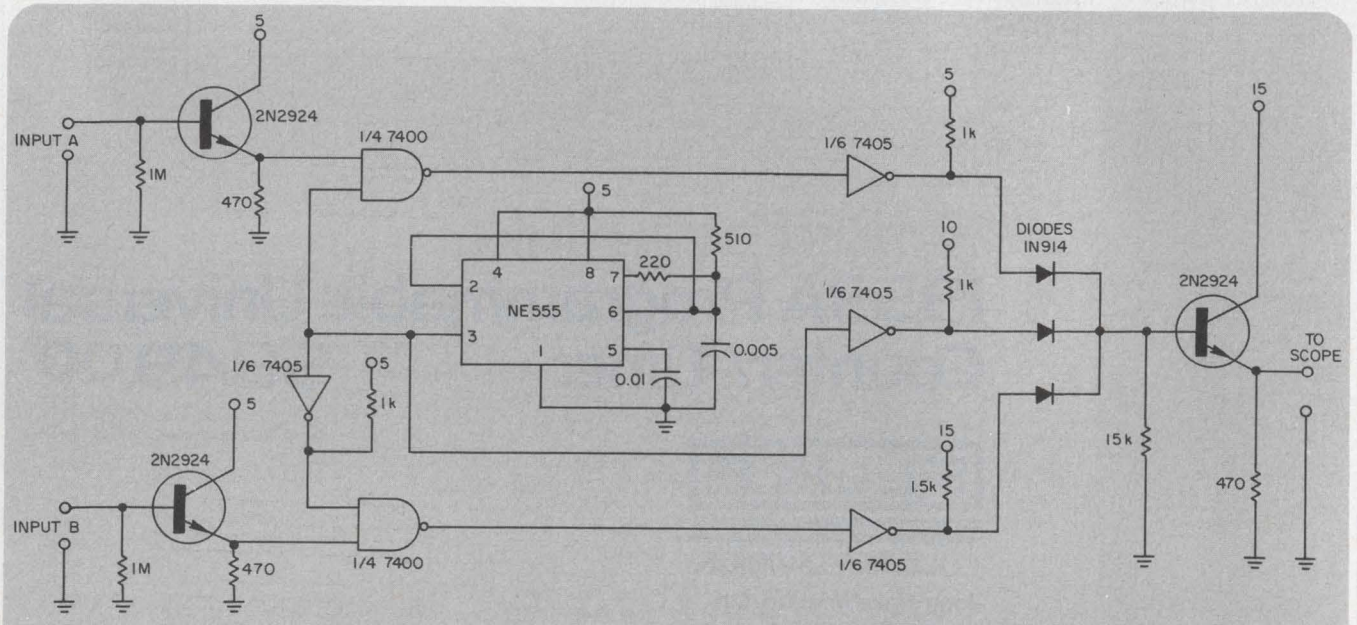
In the actual circuit (Fig. 2), two 2N2924 emitter followers at inputs A and B reduce the load on the circuits under test. Three 1N914 diodes form a triple-input OR gate. Timer 555 generates a 50%-duty-cycle square wave with about a 2-μs pulse width. Open-collector 7405 hex inverters complement the output of the timer and drive the diodes.

Vijay B. Tandon, Electro-Mechanical Designer, American Foundation for the Blind, 15 W. 16th St., New York, NY 10011.

CIRCLE No. 312



1. **A simplified electronic-switch circuit** helps to explain how two digital signals can be viewed simultaneously on a single-trace scope.



2. **The switching rate** is controlled by a 555 timer, which supplies a 2-μs width square wave.

After all the noise, the quiet logic of HiNIL and 74C CMOS keeps you on the right track.

May 10, 1869. Promontory, Utah. The rumble of wheels, the hiss of escaping steam, the shouts of the celebrating crowd filled the skies with a deafening roar when they drove the golden spike that joined the Central Pacific and Union Pacific Railroads.

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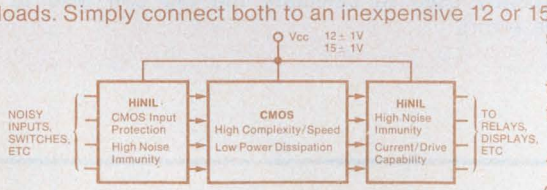

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INFORMATION RETRIEVAL NUMBER 42

Calculate capacitor tap impedance with correct expression and avoid errors

The relationship frequently used in calculating capacitor-tap impedance-matching networks,

$$R' = R\left(\frac{C_1 + C_2}{C_1}\right)^2, \qquad (1)$$

is only an approximation and often leads to large errors. The correct expression is

$$R' = \frac{(X_{C1})^2}{R} + R\left(\frac{C_1 + C_2}{C_1}\right)^2. \qquad (2)$$

The often-omitted term, $(X_{C1})^2/R$, can be extremely significant for such commonly used values of R as 50 Ω. For example, let's transform a 50-Ω source impedance to 2500 Ω to establish the proper loaded Q for a 20-MHz tank circuit that contains a coil of 2 μH. The approximate expression yields

$$2500 = 50\left(\frac{C_1 + C_2}{C_1}\right)^2$$

$$C_2 = 6.07\ (C_1).$$

At resonance

$$f_0 = \frac{1}{2\pi\sqrt{LC_T}},$$

$$C_T = \frac{1}{(2\pi f_0)^2 L},$$

$$C_T = 31.69\ \text{pF} \simeq \frac{C_1 C_2}{C_1 + C_2}$$

$$\therefore 31.69\ C_1 + 31.69\ (6.07C_1) = 6.07C_1^2$$

$$C_1 = 36.91\ \text{pF}$$

$$C_2 = 224\ \text{pF}.$$

But these values for C_1 and C_2 produce an error of approximately 40%. A more exact calculation, by use of Eq. 2, yields

$$R' = \frac{(X_{C1})^2}{50} + 50\left(\frac{C_1 + C_2}{C_1}\right)^2$$

$$R' = 930.6 + 2500 = 3430.6\ \Omega.$$

The error is even more pronounced if the value C_T incorporates capacitors other than C_1 and C_2, such as a trimmer, a voltage-variable capacitor or just stray capacitance. Suppose the extra capacitance is such that the contribution from C_1 and C_2 is only 20 pF rather than 31.69 pF. Then

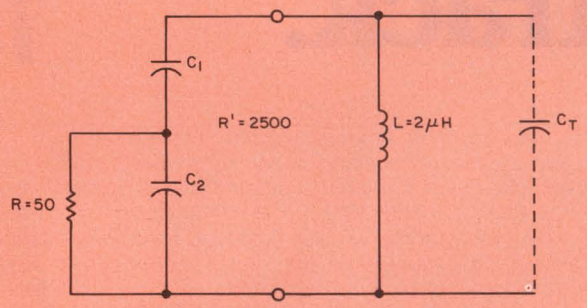
$$C_1 = \frac{20 + 20(6.07)}{6.07} = 23.3\ \text{pF}$$

and $C_2 = 141.4$ pF.

These values of C_1 and C_2 in Eq. 2 make $R' = 4834\ \Omega$—an error of over 90%.

John Hatchett, Applications Engineer, Motorola, Inc., 5005 E. McDowell Rd., Phoenix, AZ 85008.

CIRCLE No. 313



A tapped-capacitor circuit is often used to match impedances. However, the approximate equation frequently used to calculate the tap can lead to large errors.

IFD Winner of December 6, 1974

Nyle A. Steiner, 334 "L" St., Salt Lake City, UT 84103. His idea "Voltage-Tunable Active Filter Features Low, High and Bandpass Modes" has been voted the most valuable of Issue Award.

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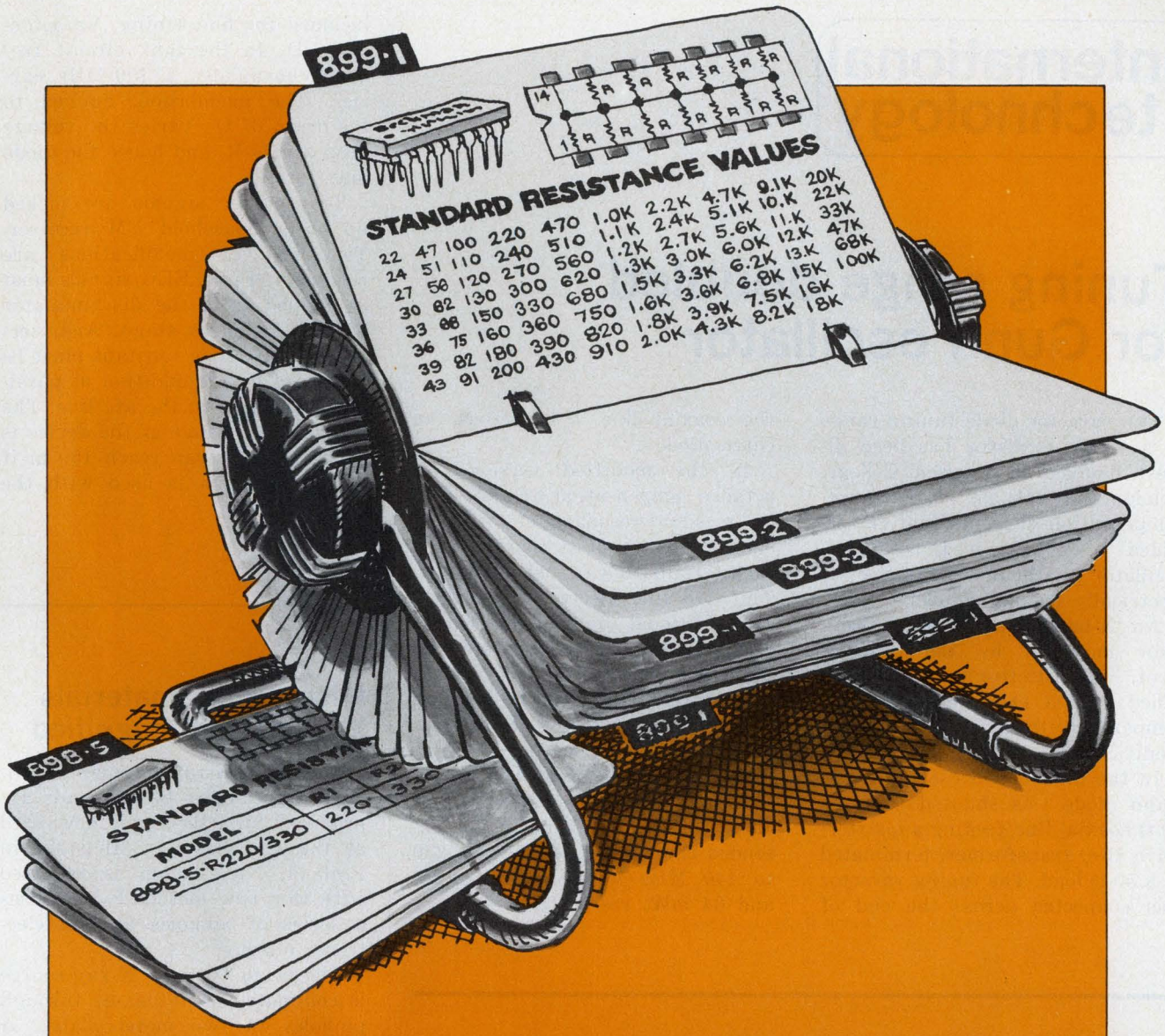

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INFORMATION RETRIEVAL NUMBER 43

international technology

Tuning range doubled for Gunn oscillator

The varactor-diode tuning range of a Gunn oscillator has been almost doubled at Chelsea College, London, through use of reactance-compensation elements that can be added to or removed from the oscillator without disturbing it electrically or mechanically.

An X-band coaxial Gunn oscillator modified by the college's Dept. of Electronics has been tuned over a range of 440 MHz, compared with 230 MHz without modification.

In the unmodified oscillator, the Gunn diode was shunted across a 50-Ω coaxial line feeding a quarter-wave 15-Ω transformer, terminated in a 50-Ω load. The tuning varactor was connected across the end of the coaxial line 1 cm from the Gunn diode.

In the modified version, reactance compensation was provided by a shunt-resonant circuit consisting of two 50-Ω coaxial lines, each terminating in a short-circuit. The two lines were connected to an additional quarter-wavelength line between the Gunn diode and the transformer. The positions of the short-circuits can be altered to adjust the Q factor of the compensating circuit without change in the resonance frequency.

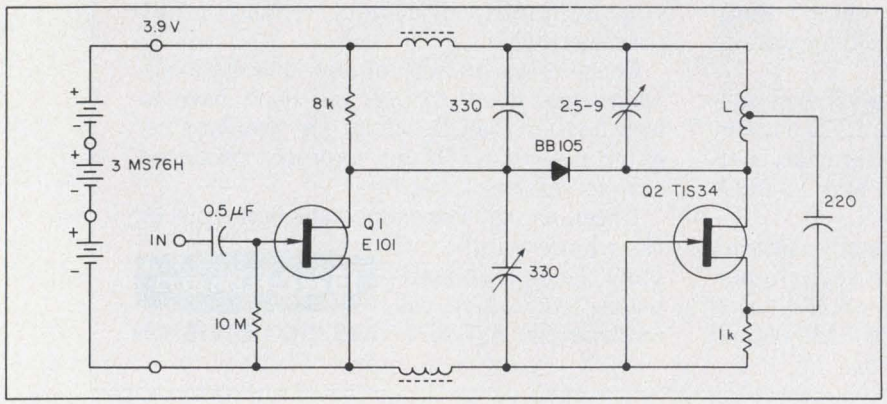
At a zero-bias frequency of 8.825 GHz, the compensation extended the tuning range from 230 to 440 MHz with outputs of 78 and 64 mW, respectively.

Simple transmitter built for EEG frequencies

A simple, low-cost biotelemetry transmitter for low electroencephalograph (EEG) frequencies and neuronal spike trains has been designed at the University of Amsterdam in the Netherlands (see figure). The input stage uses a low-noise FET for high impedance. Transistor Q_2 is a 100-MHz oscillator. Radiation is emitted from tuning coil L.

Capacitor C_4, a ceramic unit, is included for fine tuning. Varactor-diode D_1 in the tank circuit frequency-modulates a 100-MHz carrier. The modulation, applied to the drain of Q_1, varies the voltage drop across R_2 and hence the diode bias.

Transmitter signals are picked up on a household FM receiver. Two receiver modifications are necessary. First, EEG signals must be tapped from the discriminator before the audio stage. And, second, the afc time constant must be increased by the addition of parallel capacitance in the afc line. The transmission range of the device is 30 m, but this can reach 150 m if a Yagi antenna is used with the receiver.



Microscopic materials X-rayed and magnified

Magnified X-ray pictures of microscopic samples of materials are produced by a technique developed at the University of Helsinki in Finland. No vacuum is required with this new method, which uses a series of pinholes and an electronic display.

The beam from an X-ray source is collimated as it passes through pinholes in two metal plates. A sample is mechanically scanned in the beam, using an x-y raster. Rays passing through the sample without diffraction pass through a third pinhole to an X-ray counter.

The counter output intensity modulates an oscilloscope display. Its x and y time bases are synchronized with the sample scan. The relative sizes of the oscilloscope display and the sample scanned give the required magnification. The wavelength of an X-ray beam, in the region of about 5 A, permits pinholes down to 1-μm diam to be used without undesirable diffraction effects in the pinhole.

The technique is suitable for X-ray examination of materials that are difficult to obtain with the more usual diffraction-pattern methods. A beam collimated by pinholes can travel many meters in air, and it is expected that several practical applications will be possible.

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Think Small.
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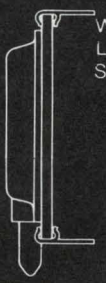
Our jolly green giants

FG-159A2
ec = eb = 35Vp-p
ic = 4.5mAp-p
ib = 3.5mAp-p



Wd. 138mm
Lg. 40mm
Segment 9.5mm

FG-139A2
ec = eb = 30Vp-p
ic = 3.6mAp-p
ib = 2.8mAp-p

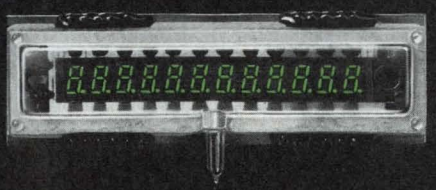
Wd. 138mm
Lg. 40mm
Segment 9.5mm

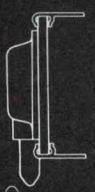
FG-99A2
ec = eb = 24Vp-p
ic = 3.5mAp-p
ib = 2.5mAp-p

Wd. 100mm
Lg. 40mm
Segment 9.5mm

Our pint-size pigmies

FG-125A2
ec = eb = 24Vp-p
ic = 2.0mAp-p
ib = 2.0mAp-p





Wd. 75mm
Lg. 26mm
Segment 5mm

FG-95A
ec = eb = 24Vp-p
ic = 2.0mAp-p
ib = 1.5mAp-p

Wd. 65mm
Lg. 24mm
Segment 5mm

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INFORMATION RETRIEVAL NUMBER 44

new products

32-bit mini with 1 megabyte of core cycles at 450 ns average, 300 ns min

Interdata, 2 Crescent Pl., Oceanport, NJ 07757. (201) 229-4040. $51,900: 128 kilobyte; $179,400: 1 megabyte; June.

The 32-bit Interdata 8/32 Megamini bridges the gap between sophisticated 16-bit units and medium-sized mainframes. Its four-way interleaved memory system, combined with high-speed Schottky logic and 32-bit data paths, achieves an average memory cycle time of 450 ns.

With dual-instruction, look-ahead stacks, the 32-bit memory cycle time is further improved to an average of 300 ns, assuming that most instructions occur in sequential addresses. The 32-bit architecture currently addresses up to 1 megabyte of main memory, with a potential to directly address up to 16 megabytes of main memory.

The 8/32 Megamini has eight stacks of 16 registers, with each register 32 bits wide. These stacks greatly simplify user input/output and operating system programming; they also enable rapid context switching.

The instruction word length is 16, 32 or 48 bits. Data word length is 1, 8, 16 or 32 bits, and arithmetic is two's complement. All data paths are 32 bits wide. The processor cycle time is 240 ns.

The main memory of the 8/32 Megamini consists of 32 kilobyte modules of 750-ns core. Instruction execution times are comparable to those for large mainframes, such as the IBM 370/158.

Of course, the mini does not have the 158's separate I/O computers. Instead the I/O system is of dual-bus architecture. The multiplexer bus, a man-machine channel, supports up to 1024 slow-to-medium-speed devices. High-speed links, such as disc, magnetic or multiple tape and multiple CPU configurations, use the DMA bus.

Each device on the multiplexer bus has its own firmware-implemented controller, which provides automatic character input/output under control of a user table without affecting the running software.

The DMA bus has three modes of operation: half-word mode of 2 megabytes per sec, full-word mode of 3.2 megabytes per sec and burst mode of 6 megabytes per sec. The DMA bus can have up to seven selector channels, with each supporting up to 16 high-speed block-transfer devices.

Two operating systems support Interdata's family of 32-bit processors. OS/32-MT is a real-time, multiprogramming, multitask OS with the ability to multiplex the CPU between several development programmers. A subset of OS/32-MT is a serial-task operating system, the OS/32-ST, which is a single-stream, batch-oriented executive.

CIRCLE NO. 303

Plug-in adds graphics output to HP-2000 minis

Intermedia Systems, 20430 Town Center Lane, Cupertino, CA 95014. (408) 996-0900. $2750; 60 days.

The Model 4416 is a single card graphics system which generates a composite video signal for display of a 256 × 256-point matrix on standard television monitors. Color and/or grey scale displays may be generated through internal synchronization with two or more generators. Refresh memory made up of 4-k RAMs permits a plotting rate in excess of 200,000 points/s. Four programmable functions provided are: set points, clear points, clear screen, and reverse video polarity. Additional software is available for character and vector generation.

CIRCLE NO. 304

Modem series offers 2400 bit/s, dial or lease

Vadic Corp., 505 E. Middlefield Rd., Mountain View, CA 94040. (415) 965-1620. From $800; 60 days.

Modem Models VA2405A, C and D of the VA2400 Series are designed for operation over switched networks and are fully compatible with Bell 201C configurations. Automatic dialing is available. For leased-line applications, the VA-2405G and K offer data transmission at 2400 bps over two-wire (VA2405K) or four-wire (VA-2405G) telephone circuits. Both models are available for use in point-to-point or multidrop applications. RTS/CTS delay is strappable for 7.1 ms for best throughput.

CIRCLE NO. 305

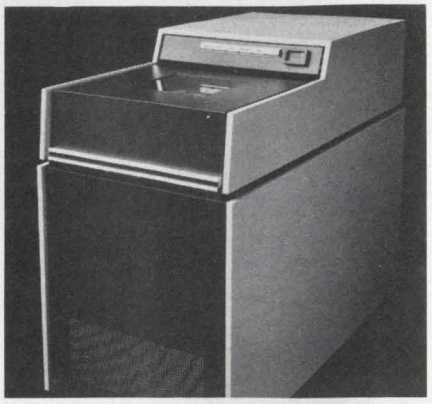
Disc-based system conserves memory use

Computer Automation, 18651 Von Karman, Irvine, CA 92664. (714) 883-8830. $29 k to 40 k; 90 days.

A typical Disc Operating System includes a Naked Mini LSI Type 2/20 minicomputer with 16K words of 16-bit core memory, a disc system with 4.92 Mbytes of storage, line printer, high-speed paper tape reader/punch, ASR 33 TTY, a paper tape software library and software disc cartridge. The DOS offers unattended batch processing as well as direct operator control at the console. A refined Fortran IV compiler conserves memory space by minimizing routine sizes. Compiled programs can run either under DOS or on Computer Automation's Real-Time Executive program, which occupies only 650 words of memory.

CIRCLE NO. 306

Disc memory system holds 45.9 Mwords



Data General, Route 9, Southboro, MA 01772. (617) 485-9100. See text; stock.

A moving head disc pack system has a capacity of 45.979 M, 16-bit words. The memory includes a controller for three additional disc drives and can transfer data at rates up to 403 kword/s. Features include 30-ms average access time. Only 30 s are needed to replace a disc pack while in operation. Manufactured to Data General specifications by Control Data Corp., the initial disc pack subsystem, which includes master drive and controller, costs $30,500. Additional drives each cost $24,500.

CIRCLE NO. 307

Mini type software now plays on a micro

National Semiconductor Corp., 2900 Semiconductor Dr., Santa Clara, CA 95051. (408) 732-5000. $5500; stock.

A floppy disc operating system for the IMP-16 Microprocessor Development Systems eliminates paper tape, cards, and other source media. Source programs are written and edited at the system keyboard, then stored directly on floppy disc, using the Source Editor. The source program may then be assembled, under operating system control, with a single command. National's DOS will run on any IMP-16P or -16L Development System with 8 k or more words of memory. A dual-drive floppy disc provides over 5 M bits of storage for system software and application programs. The package price of $5500 includes the dual-drive floppy disc, documentation, software and interface.

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And we'll give you great benefits. CPS is one of the largest suppliers of precision high voltage power supplies. Our customer benefits are ingredients for success. Like high reliability, strong performance and compact designed units, competitive prices and more.

We've added CPS 1410 to our custom commercial series. Use it for grounded-anode, precision, fiber-optic CRT applications. At –15KV, with 250 μa output current and 0.01% line/load regulation. You'll get highly stable low-noise power.

Two more models were added for analytical x-ray and CRT projection systems. They're called CPS 1591 and CPS 1601. Perfect for 30KV to 50KV applications.

Our fourth and fifth choices were designed for military and FAA applications. We call them CPS 1485 and CPS 1647. Our 1485 is designed for airborne computer terminals. The 1647 is a precision CRT supply with an electrostatic dynamic focus section as well as an anode section.

Prices you can afford. Our prices are reasonable for small quantities. Particularly *attractive* in OEM quantities. If they're right off the shelf, you'll have immediate delivery. And if you ask us for custom-built models, for commercial or military applications, we can readily build them.

We've been manufacturing high voltage power supplies for more than seven years. We believe in high quality. So we'll give you 100-hour burn-in for each product. And the assurance of a good factory quality system.

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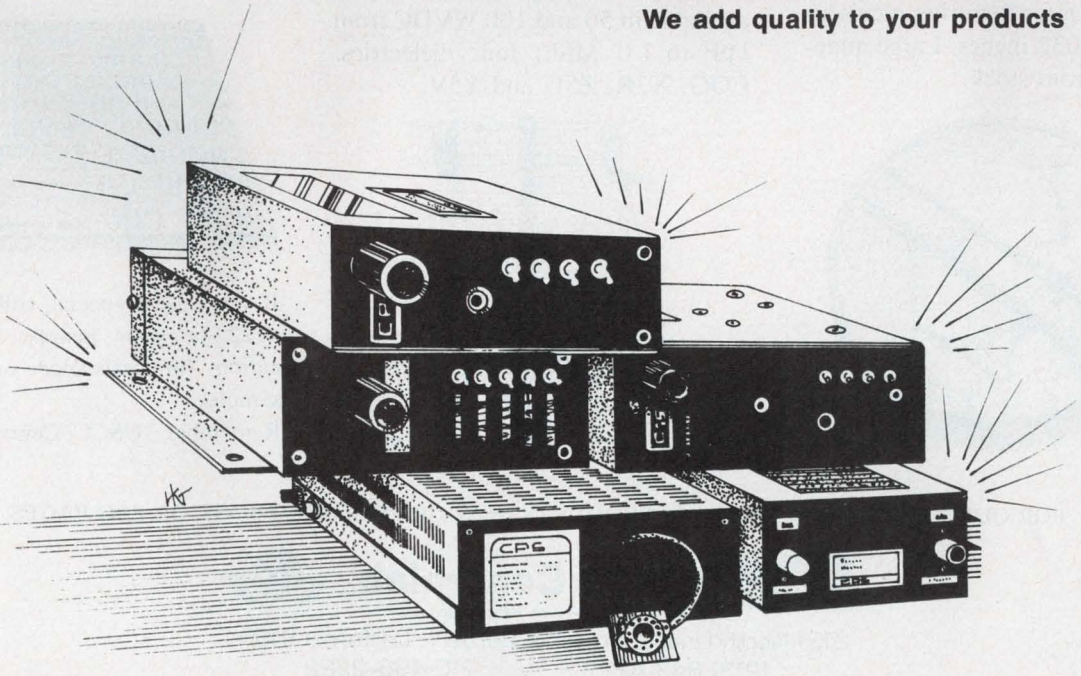
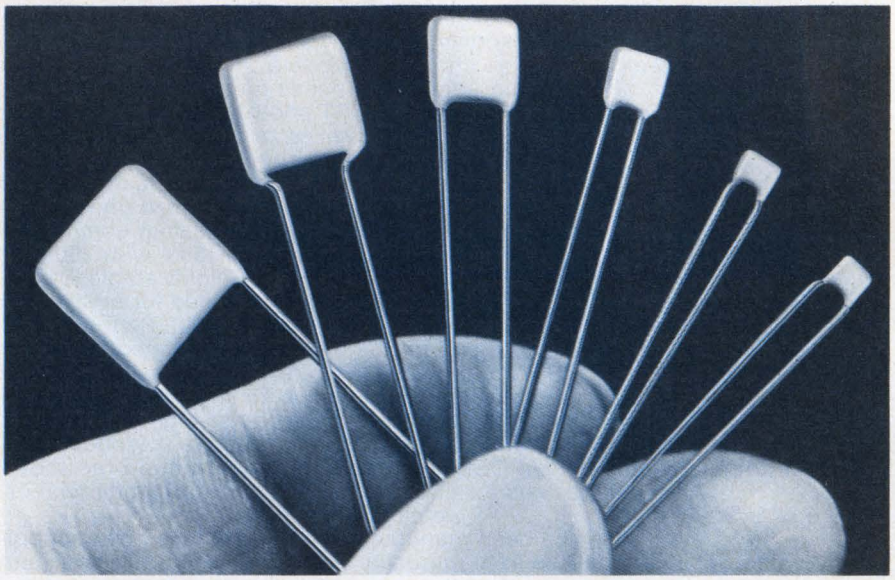
We add quality to your products



INFORMATION RETRIEVAL NUMBER 47

QUALITY IN VOLUME

When you achieve it, you can offer true competitive value. That's just what we're doing at USCC/Centralab for 1975. MONO-KAP™ radial, and MONO-GLASS axial monolithic ceramic capacitors are now available to volume users *from stock* to eight weeks. Our investment and "learning curves" last year guarantee competitive responsiveness — USCC will welcome your specials and non-stock orders. Here's an offer you haven't heard lately — your money is going to buy more at USCC. Cash in on the best values in monolithic ceramic capacitors.

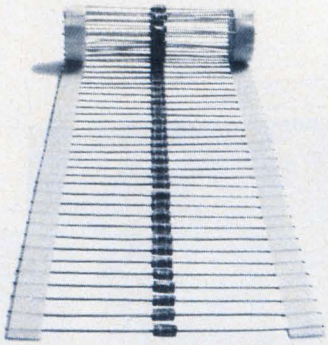


DISCRETE ASSEMBLY

MONO-KAP™ radial-leaded epoxy coated capacitors are reliable performers; they're rugged enough to work in MIL environments. 4.7 pF to 10 Mfd., 50 to 200 WVDC in 4 dielectrics, including Z5U, in a variety of case sizes featuring meniscus control to 0.032 inches. Large quantity orders from stock.

AUTOMATIC INSERTION

MONO-GLASS axials are glass encapsulated, designed for automatic PCB insertion; furnished reel-packed for high volume applications. They're available in 50 and 100 WVDC from 1 pF to 1.0 Mfd.; four dielectrics: COG, X7R, Z5U and Y5V.



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INFORMATION RETRIEVAL NUMBER 48

DATA PROCESSING

Three processors boost CRT terminal speed

Ontel Corp., 3 Fairchild Ct., Plainview, NY 11803. (516) 822-7800. $2285 (100 qty); 90 days.

A CRT terminal, the Model OP-1, contains three microprocessors which provide high speed input/output capabilities. The unit uses a central processor, a display microprocessor and an input/output microprocessor. With the central processor unit, the OP-1 can be programmed by the user for such typical applications as reservations, inventory, ticketing and many others. The system can also operate with various host computers. In less than 2 ms the display microprocessor can perform fast roll/scroll and full screen erase operations. Display functions such as video reversal, blinking and half intensity are program controlled. The input/output microprocessor simultaneously manages all data transfers between memory and input/output devices. All I/O operations are managed on a cycle steal basis. Additional features of the OP-1 are random access MOS memory expandable to 16,834 bytes: asynchronous, program controlled, communications up to 9600 bps; and 14-in. nonglare CRT. A programmable keyboard, arranged in four functional sections, generates unique codes to be read by the CPU.

CIRCLE NO. 308

PC-sized card generates graphics for Nova minis

Lexidata Corp., 807 Massachusetts Ave., Lexington, MA 02173. (617) 861-6134. From $2595; 30 to 60 days.

Using a single PC Card, the Lexidata 200 generates a mixed display containing both graphic images and alphanumeric characters. The display is formed from a 256 × 240 dot matrix and is compatible with standard video monitors. Driver software is available for Data General's SOS, RTOS, and RDOS operating systems. This software is Fortran callable and provides character generation, vector generation, graphic display, and selective erase of any part of the display.

CIRCLE NO. 309

Portable terminal operates in auto

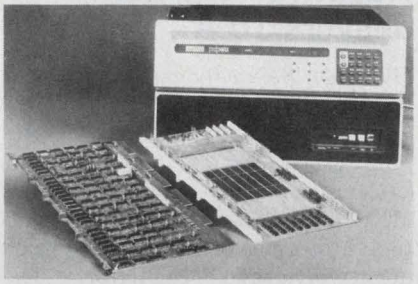
V-71

International Computer Products, 2925 Merrell Rd., Dallas, TX 75229. (214) 350-6951. $1195 (qty); 60 to 90 days.

The V-71 transaction terminal can be vehicular mounted or portable, and operates from a 10-to-16-V power source. The unit captures data on cassette tape in computer format and saves it for later use at the computer site. Three separate entries are displayed simultaneously to minimize errors. Each cassette can hold about 6000 transactions.

CIRCLE NO. 310

Additions to PDP-8/A family use core or semi



Digital Equipment Corp., 146 Main St., Maynard, MA 01754. (617) 897-5111. See text.

Two additions to the PDP-8/A series, the 8/A-200 and the 8/A-400, offer core or semi memory. The 8/A-200, a semiconductor memory machine, uses 4-k MOS chips, and is priced from $1317 (50 qty). The 8/A-400, a core memory machine, is available with 8k or 16k core stacks and priced at $1845 and $2505, respectively (50 qty). The 8/A-200 uses the present PDP-8/A single board processor, 4-k RAMs and has battery backup. The 8/A-400 contains the same single-board processor as the 8/A-200; but, uses two new single-board core memories, either 8 k or 16 k. Maximum main memory size for the PDP-8/A is 32 k. Delivery of the 8/A-200 is scheduled for September, '75; the 8/A-400 for July, '75.

CIRCLE NO. 320

Digital recorder can operate at remote sites

Techtran Industries, 580 Jefferson Rd., Rochester, NY 14623. (716) 271-7953. $760 (qty); 45 days.

A buffered digital cassette recorder, the Model 8410, provides storage for 145,000 characters per cassette; has switch selectable 110/300/ 1200/ and 2400 Baud speeds and allows remote control of all functions. A MOS buffer permits remote interrupt and character editing. The compact recorder can be used as an add-on storage peripheral, or as a communications terminal. It is plug-compatible with keyboard printers, CRT terminals, and other send/receive devices that have serial data interfaces. It is also capable of functioning as an unattended data collection terminal.

CIRCLE NO. 321

Computer graphics for ALPHA-16/LSI

Megatek, 1055 Shafter St., San Diego, CA 92106. (714) 224-2721. See text; 30 days.

A graphics display interface, designated the BP-732, is designed for Computer Automation's ALPHA-16/LSI series of minicomputers. The unit uses standard laboratory oscilloscopes or X-Y monitors as a graphics display. Self-contained semiconductor refresh memory, vector generators, and intensity control circuits provide flicker-free displays (at 50 Hz refresh rate) of points, vectors and alphanumerics. Memory may be expanded from 256 vectors/points to 1024 vectors/points. X-Y resolution is upgradable from 8 bits (±0.2% F.S.) to 10 bits (±0.05% F.S.). Prices range from $1295 for the 256 vector/point, 8 bit model to $2195 for the 1024 vector/point, 10-bit model. All models are compatible with the BP-731 X-Y Recorder Adapter for hard copy.

CIRCLE NO. 322

8-k NMOS ROMs access in 225 ns

Nitron Corp., 10420 Bubb Rd., Cupertino, CA 95014. (408) 255-7550. $18 (100); stock (NCM 6561).

A mask-programmable 8192-bit static ROM, the NCM 6560, uses NMOS fabrication to achieve typical access times of 225 ns, and 350 ns maximum. A preprogrammed version, the NCM6561, has six character conversion codes: ASCII to Hollerith, Selectric EBCDIC; Selectric to ASCII, Hollerith to ASCII and EBCDIC to ASCII. Both versions come in a 24-pin DIP, feature TTL compatibility and have a 1024 × 8-bit organization. Also both are direct replacements for like-numbered Motorola circuits.

CIRCLE NO. 349

Negative regulator delivers 10 A

Motorola Semiconductor, P.O. Box 20924, Phoenix, AZ 85036. (602) 244-3466. $14.25 (250 up); samples from stock.

Complementing the company's MPC1000 positive-voltage regulator, Motorola offers the MPC900 negative-voltage regulator. The output voltage of the new regulator can be adjusted over the range of −4 to −30 V dc; maximum input voltage is −35 V dc. Designed to deliver load currents up to 10 A without an external currrent-boost transistor, the MPC900 has an internal power dissipation capability of 100 W. With operation over a case-temperature range of 0 to 125 C and with an input voltage variation from −12 to −15 V dc, the circuit holds the output voltage (V_o) to within a maximum of 0.5% of the desired V_o. Over the same temperature range and with a load-current variation from 100 mA to 5 A, the output voltage doesn't vary more than 0.6% of V_o. Temperature coefficient of the output voltage is a maximum of 0.015% V_o/°C, and circuit protection is provided by an adjustable overload circuit.

CIRCLE NO. 350

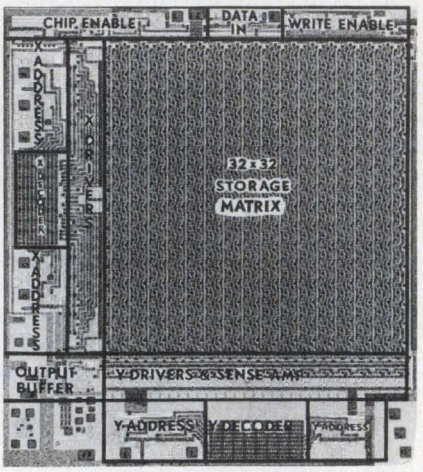
S-TTL IC raises speed, cuts power

Advanced Micro Devices, Inc., 901 Thompson Pl., Sunnyvale, CA 94086. (408) 732-2400. $4.00 to $28.31 (100).

A quad, two-input Schottky-TTL circuit—the Am25S09—can replace the 74S157 (quad multiplexer) and 74S175 (quad register). The new IC performs the same function with typical power dissipation of 375 mW for a 32% power savings. This dual port, 4-bit register accepts data from one of two 4-bit input fields and features a positive edge-triggered clock. Additionally, use of this unit can save 7.5 ns in the data-path propagation delay. The new circuit comes in a single 16-pin package.

CIRCLE NO. 354

1-k RAM access time reaches 30 ns



Signetics, 811 E. Arques Ave., Sunnyvale, CA 94086. (408) 739-7700. $65.20 (sample quantities).

A 1024-bit bipolar RAM, using standard Schottky processing, achieves a typical access time of 30 ns, the fastest to date. The new RAM comes with either open-collector or three-state outputs—the 82S10 and 82S11, respectively. Packaged in a 16-pin DIP, the RAM features TTL-compatibility and single, 5-V supply operation. Use of a pnp structure on all inputs yields an input-current level of only 10 μA. Other features include a temperature range of 0 to 75 C, supply variation of ±5% and maximum supply current of 160 mA. Maximum access and cycle times are 45 ns for address access, and 50 ns for read or write cycles.

INQUIRE DIRECT

ECL FROM cuts turnaround

Motorola Semiconductor, P.O. Box 20924, Phoenix, AZ 85036. (602) 244-3466. $39 (100-999).

The MCM10150AL, a 256 × 4-bit factory-programmed ROM (FROM), is said to fall midway between a field ROM and mask ROM in terms of cost and turnaround time. Total turnaround for the ECL FROM can be accomplished in weeks, rather than months. Programming is achieved by electrically opening metalization links on a wafer stocked at the factory; masks aren't used. The FROM has an address-input-to-data-output access of typically 20 ns and a temperature range of −30 to 85 C. A preprogrammed FROM, in the form of a 4-bit magnitude comparator—the MC10050-AL—is available as a standard example.

CIRCLE NO. 357

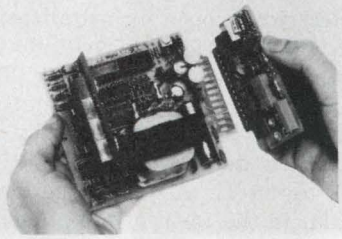
Calculator performs 286 conversions

Rockwell Microelectronic Device Div., P.O. Box 3669, Anaheim, CA 92803. (714) 632-3729.

With the Universal Conversion circuit, an MOS/LSI chip, it's possible to compute volume by multiplying meters by inches by millimeters and get the answer in cubic centimeters. The new chip—the A4521—performs 286 different standard conversions as well as five-function calculations. It has three memories and directly accesses area, volume and linear conversions from a 25-key keyboard. As a three-memory calculator, the A4521 circuit provides the basic four functions plus percentage with automatic markup and discount. Constants, chaining and repeat operations can be performed with all functions, and all calculations are algebraic. Powered from a single 15-V power supply, the A4521 circuit includes automatic display encoding and eight-segment parallel output. It is directly compatible with LED, fluorescent and gas-discharge displays. Keyboard decoding and debouncing are performed on the chip, which also has an internal oscillator/clock generator.

CIRCLE NO. 358

DPM delivers auxiliary output power



Digilin, Inc., 3521 W. Pacific, Burbank, CA 91505. (213) 846-1800. $99 (100); stock to 4 wks.

Model 4332 is a 3-1/2-digit OEM DPM and power supply, which features monolithic circuitry and a two-year warranty. The supply provides ±12 V dc at 10 mA and +5 V dc at 250 mA. Display is by 0.43-in. high seven-segment LED digits. The unit offers accuracy of 0.05%, stability of 0.005% 40-pA input bias current and 1000-mΩ input impedance (199.9 mV to 1.999 V ranges). Power dissipation is 2-1/2 W. Automatic zero and bipolar operation are standard. Panel cutout is 3.74 × 2.05 in.

CIRCLE NO. 326

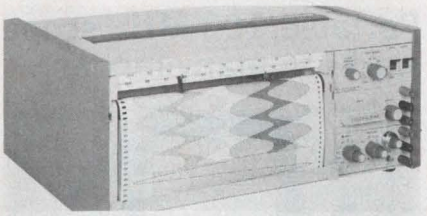
Digital unit diagnoses phone-line problems

Wavetek, 9045 Balboa Ave., P. O. Box 651, San Diego, CA 92123. $1395; 30 days.

Model 430 digital-transmission multimeter is a diagnostic tool for telephone communications that combines the functions of the frequency counter, noise and level test set, capacitance bridge and decade box with standard voltmeter functions. Pushbutton control and portable battery power are included. Signal level and noise are displayed digitally with built-in voice and program filters. Line capacitance, resistance and current are also measured quickly and accurately.

CIRCLE NO. 327

10-in. strip-chart unit uses 'no wear' pen



Gould Inc., Instrument Systems Division, 3631 Perkins Avenue, Cleveland, OH 44114. (216) 361-3315. $1650 (2 channels); 90 days.

Model 110 10-in. strip-chart recorder is available with one or two pens and excels at long-term monitoring of low-frequency signals. An outstanding feature of the unit is its fs response time of 250 ms. The unit uses thermal writing to produce clear, blue traces on special paper that does not smudge from pressure or handling. The ceramic pen tip for each channel of the 110 is virtually wear free and has a lifetime guarantee.

CIRCLE NO. 328

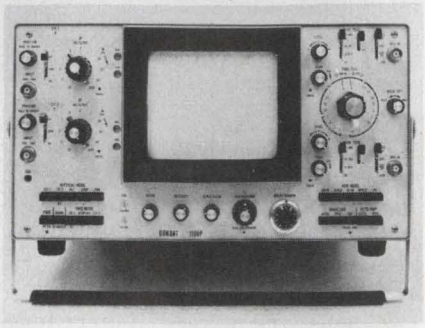
Unit checks linear ICs for dc parameters

Teradyne, 183 Essex St., Boston, MA 02111. (617) 482-2700. $11,900; 12-16 wks.

J149 linear circuit test instrument is intended primarily for incoming inspection and component evaluation of linear devices. The unit performs major dc parametric tests on a wide range of linear ICs, including voltage regulators, op amps, and comparators. Sequences can be repeated to test dual, triple and quad devices. Because test circuitry is divided among the mainframe, interchangeable programming boards and plug-in ROM modules, the J149 can be customized to test every device thoroughly.

CIRCLE NO. 329

Portable 100-MHz scope works in many modes



Dumont Oscilloscope Labs, Inc., 40 Fairfield Pl., West Caldwell, NJ 07006. (201) 575-8666. $1895 w probes.

This portable, dual-channel scope, the Model 1100P, has a vertical sensitivity to 5 mV/cm, a dc-to-100-MHz frequency response and sweep speeds to 5 ns/cm. The instrument is designed to trouble-shoot digital logic circuits. The scope's 100-MHz response is held across the entire 8 × 10-cm display from 0 to 55 C without degradation. The 1100P has a variety of operating modes: CH 1, CH 2, ALT, CHOP, ADD, MAIN, INT, DLYD, MIXED, and calibrated X-Y—each at the push of a button. The front panel has color-coded pushbuttons and panel areas to simplify operation. Pushbuttons have single functions which are selected only when the button is pressed.

CIRCLE NO. 330

3-digit DPM meets UL, CSA specs

Analogic, Audubon Rd., Wakefield, MA 01880. (617) 246-0300. $70 (1000); 45 days.

AN2531 line powered, 3-digit DPM is intended for stringent environments. The unit includes a UL and CSA approvable, low-leakage power transformer, consumes less than 1 W of power and can be custom mounted in OEM, medical and other instrumentation. The unit converts a 0 to 999 mV fs input into a full 1000-count display (gas discharge) with 0.1% accuracy, and less than 30 ppm/°C range tempco, and ±15 μV/°C offset tempco.

CIRCLE NO. 331

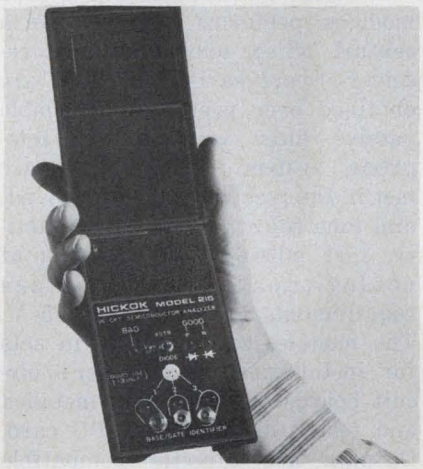
Automatic 'C' meter fits in hand

ECD Corp., 232 Broadway, Cambridge, MA 02139. (617) 492-5672. $289; stock-4 wks.

Model 100 is a hand-held, battery-operated 3-1/2-digit autoranging capacitance meter. The meter measures from 200 pF to 200,000 μF fs in 10 automatically selected ranges. Maximum resolution is 0.1 pF. Accuracy is 0.1% ± count to 200 μF, and 1% thereafter. Operation is by a single push-to-measure button.

CIRCLE NO. 332

Hand-held tester spots bad semiconductors

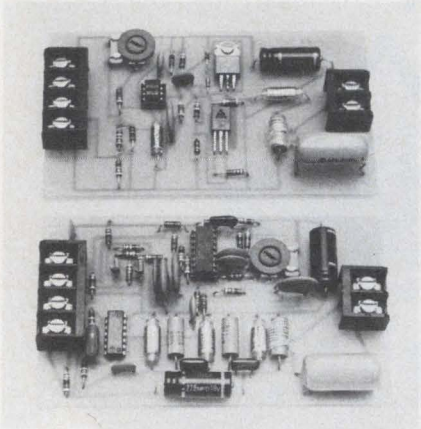


Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland, OH 44108. (216) 541-8060. $138: $4 for charger; stock.

Model 215 semiconductor tester is a pocket-sized, self-contained test instrument capable of checking npns, pnps, FETs, diodes, SCRs and unijunctions. The unit instantly and automatically determines proper lead configuration and indicates with LED displays if the semiconductor is good or bad. If good, it further identifies which lead is the base (gate for FETs) and whether npn or pnp. Solid-state CMOS circuitry greatly extends the life of the two 9-V batteries that power the compact unit.

CIRCLE NO. 333

FSK data link uses supervised carrier



Electronics Research Group, 22 Mill St., Arlington, MA 02174. (617) 646-9760. $59.

The ER-125D (transmitter) and ER-125E (receiver) are supervised carrier data links. These links use high frequency phone or ac single phase power lines to transmit and receive digital or analog data. The carrier-current data link consists of two 3 × 5 in. printed circuit cards, is available in eight channels, and all eight can be operated simultaneously on one installation. The transmitter input and receiver output (Schmitt type for chatter elimination) are TTL-compatible, the receiver output a binary duplicate of the transmitter input in locked operation. Power requirements are ac, single phase and +12 V dc for the transmitter, ac single phase and ±5 V for the receiver. The transmitter has one fine tune control; and the receiver one offset control.

CIRCLE NO. 334

Temperature controller plugs into duplex outlet

RFL Industries, Boonton, NJ 07005. (201) 334-3100. From $98.50; stock.

The series TA2 proportional temperature controllers can be installed in minutes and are designed with the plant electrician or maintenance man in mind. These controllers provide operation over a −90 to +500 C process temperature range. Simply plug the controller mounting into a standard duplex 115 or 230-V outlet. The outlet is wired so that the controller input power is fed through one receptacle and the controller output is delivered through the other. The control box contains an on/off switch, power level indicator, sensor receptacle and plug.

CIRCLE NO. 335

Adjustable speed motor drive handles up to 5 hp

Industrial Electronic Controls, 509 Buckbee St., Rockford, IL 61101. (815) 963-8988. From $525; 10 to 12 wk.

The Models 2572-1, -3, and -5 are adjustable frequency ac motor drives. They handle 1, 3 and 5 hp motors, respectively. Input is 230 V ac three-phase power at a constant frequency. The output of the drive is 0 to 230 V ac, 6 to 120 Hz. The drive is current-limited, has short-circuit protection and input/output fuses. Full rated torque is delivered over a 10:1 speed range and speed regulation is ±2%. The 2572 drive is housed in a 14 × 16 × 6 in. cabinet.

CIRCLE NO. 336

Interval timers come in wide delay variations

Syracuse Electronics, P.O. Box 566, Syracuse, NY 13201. (315) 488-4915. Under $10; 8 wk.

The SDS series timers are available in fixed and remote adjustable delay ranges with a lower unit of 0.1 s and an upper limit as high as 480 s. The timer is available for inputs of any value from 24 to 230 V ac or from 24 to 110 V dc. The units have a reset time of 50 ns during and after timing. Maximum power consumption is 2 W. Output rating is 1 A ac and 100 mA dc. The SDS timers will operate according to specs at temperatures ranging from −10 to +60 C.

CIRCLE NO. 337

Telephone tone modules form central office

Kinetic Technology, 3393 De La Cruz Blvd., Santa Clara, CA 95050. (408) 296-9305. $331 set (100 up).

A series of 14 thick film hybrid modules performs together as a central office telephone tone receiver. Space savings of 75% are obtained over previously available passive filter versions. All telephone system requirements are met in the receiver, including twist, dial tone rejection, speech immunity, fast pulsing and rejection of nonlegitimate tones. Voltage requirements are ±12 and +5 V. The modules are available in sets for installation in customer's circuit boards or completely installed and tested on a plug-in PC card. Outputs are directly compatible with TTL/CMOS logic.

CIRCLE NO. 338

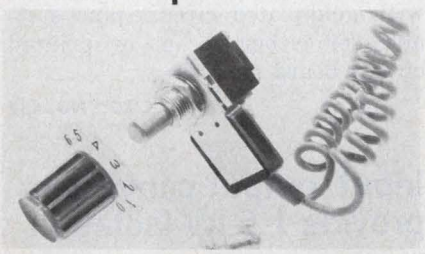
Tone receiver/xmitter operates over phone line

Acco, Datamaster Div., 929 Connecticut Ave., Bridgeport, CT 06602. (203) 225-2511. Stock to 8 wk.

The AR-4010 tone receiver and AT-4010 tone transmitter detect and transmit an amplitude modulated signal used as command or control information. Transmitter input may be either a voltage or contact closure; receiver output either closes a contact, produces a voltage, or passes current through an opto-isolator. Both the receiver and transmitter can be supplied for operation from 350 to 2820 Hz over a telephone line or other transmission medium. Both can be used in conjunction with other receivers and transmitters, each on a different frequency, to perform many functions on a single transmission link. Design features include LEDs for indication of correct signal operation and CMOS logic for low power consumption. The receiver and transmitter have a maximum reception or keying speed of up to 42 Hz, and have battery back-up to assure uninterruptible operation.

CIRCLE NO. 451

Hybrid controller handles up to 3000 W



Electramation, 866 E. 17th St., Suite 300, Santa Ana, CA 92701. (714) 541-4434. $10 (lge. qty.); stock to 4 wk.

A hybrid, thick-film circuit, the Solid-Stat, can control ac voltages from 0 to 240. The unit is available in 5, 10 and 15 A, 120 or 240 V ac versions. The molded package, void free passivation and high thermal conductivity results in a reliable, trouble-free unit, capable of handling up to 3000 W. The unit is completely self-contained and requires no additional components for operation. The Solid-Stat may be operated at full rated current, with no derating, up to 70 C.

CIRCLE NO. 452

S/d converter operates over 50 to 1200 Hz

Control Sciences, 10315 Woodley Ave., Granada Hills, CA 91344. (213) 342-3067. From $550.

The series 168C units are miniature synchro (and resolver) to digital converters. The converters occupy less than 7 in.³ and function over the frequency range of 50 to 1200 Hz without external modules. Models may be selected to provide error-free tracking rates to 10 rps (3600°/s). All standard models of the 168C series have a reference voltage range of 10 to 130 V rms. Accuracy is ±4 minutes ±0.9 LSB at 25 C, with 14 bit resolution. Standard tracking rate is 1440°/s (3600°/s optional).

CIRCLE NO. 339

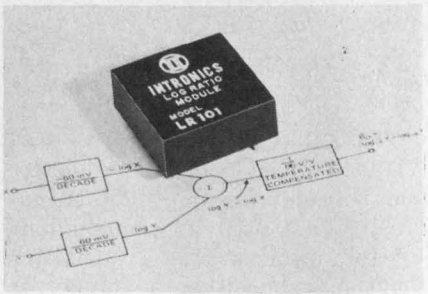
Temperature controllers operate over wide span

Honeywell, Honeywell Plaza, Minneapolis, MN 55408. (612) 870-5200. $140 up; stock to 6 wk.

Models W927A, B and C solid-state controllers are designed for computer room air conditioners and have automatic changeover from heating to cooling. They are single-input devices that operate over −40 to +150 F. A secondary sensor is not required in computer room applications because the rapid air circulation eliminates the need for reset. The units are controlled by the company's T7047 space thermostat or a T7022A1010 return-air thermostat. The W927D, E and F models are single or dual temperature-input step controllers. They are directly controlled by a space or return-air thermostat. The dual-input feature allows the use of a secondary sensor located in the discharge air. This sensor acts as a heat anticipator and provides the proper cycling rate for good temperature control. The W927G, H and J models are also single or dual temperature-input step controllers. The primary sensor is located in the boiler discharge water or discharge air duct. The secondary sensor—located outdoors—resets the discharge temperature as the outdoor temperature changes to save energy.

CIRCLE NO. 340

Log ratio modules have max error of ±10 mV



Intronics, 57 Chapel St., Newton, MA 02158. (617) 332-7350. LR101: $55, LR102: $70 (1-9); 4 wk.

The LR101 and LR102 are modular log ratio operators that produce an output voltage proportional to the ratio of two positive input voltages. For input signals from +10 mV to +10 V, the total output error is only ±15 mV (LR101) or ±10 mV (LR102). Internal temperature compensation provides an offset temperature drift of only 100 μV/°C over a 0 to 70 C temperature range. The scale factor is set for an output of 1 V/decade, so that an input ratio of 1000:1 produces a full scale positive output of 3 V, and an input ratio of 1:1000 produces a full scale negative output of −3 V. Output bandwidth is 20 kHz for 10 V input signals. The modules are housed in 1.2 × 1.2× 0.6 in. epoxy packages with gold-plated circuit pins suitable for either socket or printed circuit board mounting.

CIRCLE NO. 457

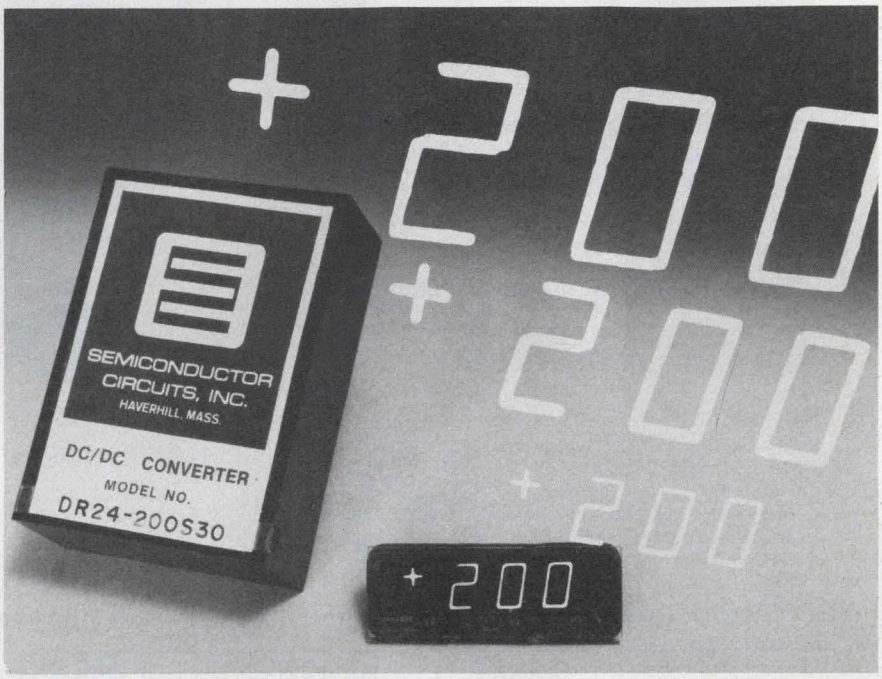
Input/output converters provide 1.5-kV isolation

Teledyne Relays, 3155 W. El Segundo Blvd., Hawthorne, CA 90250. (213) 973-4545. From $9.40 (1000-up); stock to 6 wk.

The 675 series of input/output converter modules includes a full line of ac and dc input and output units. All versions offer 1500 V rms optical isolation to protect logic lines from ac or dc power circuits. Ac output converters use zero-voltage-switching for noise reduction and have high dv/dt ratings to prevent misfires in industrial control environments. The low profile PC configuration allows both economies and great flexibility (including interchangeability) in input/output interface circuitry.

CIRCLE NO. 458

Dc/dc converters tolerate 2:1 input-voltage swing



Semiconductor Circuits, 306 River St., Haverhill, MA 01830. (617) 373-9104. See text; stock to 3 wks.

Dc/dc converters generally don't accept too much variation in input voltage. But two new encapsulated series of supplies from Semiconductor Circuits tolerate a 2:1 span in input. The DR and DC series—specifically aimed at plasma digital displays—deliver either 200 or 250 V at 30 mA.

For the DR series, inputs can range from 9 to 18 V or 18 to 36 V, depending on the model. Input for the DC covers 35 to 70 V.

Apparently the Semiconductor Circuits units are intended to compete with the 900 series from Endicott Coil Co.—units that convert 5, 9, 12 or 15 V to a nominal 250 V at 30 mA. (The 900 replaces Endicott's older 800 series.) Input variation for the unregulated 900 is limited to a maximum of ±10% or ±4% to maintain the units' specifications.

If you need the input regulation (2% line and load) provided by the Semiconductor Circuits units, you'll have to pay extra for it: The DR series sells for $45.95 to $49.95 (1-9) whereas the Endicott 900 sells for $26.60 in the same quantities. Regulators also need room, so the DR fits into a 2.5 × 3.5 × 1.25-in. case, while the 900 squeezes into a smaller 2 × 2.5 × 1.12 in.

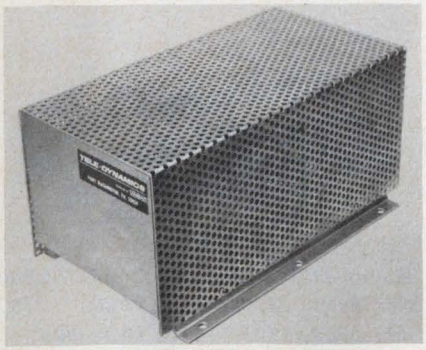
One thing to guard against with gas-discharge readouts is power-supply ripple, which raises or lowers the instantaneous nominal voltage. If the excitation voltage drops, you can lose information; if it goes too high, the display can be damaged or its life shortened. So check the readout vendor's ripple spec. In the Endicott units, ripple is listed as 2.5 V pk-pk max; for the Semiconductor Circuits units, expect 7 mV rms.

The price difference between the competing units buys you more than regulation, however. The DR and DC are short-circuit-protected and operate over −25 to 71 C with no derating. The 900 can withstand "momentary" shorts and has a standard range of 0 to 70 C with no derating.

Semiconductor Circuits **CIRCLE NO. 301**

Endicott Coil **CIRCLE NO. 302**

Regulator holds line to ±1% variations

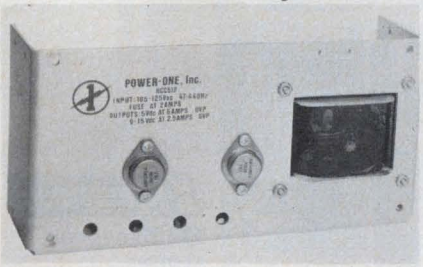


Tele-Dynamics, 526 Virgiina Dr., Fort Washington, PA 19034. (215) 643-3900. $194 (500 VA); stock.

The LR series Varax line conditioner is offered in 500 and 1500-VA models for American, European, and Japanese voltages. It provides ±1% true-rms regulation of both line and load over a broad input range (90 to 125 V for the 115-V models) with less than 5% distortion. The enclosure is designed for either wall or panel mounting. It is insensitive to line-frequency changes, has closed-loop feedback for better regulation than ferroresonant devices, and incorporates a ±3% output adjustment as a standard feature.

CIRCLE NO. 453

OEM units offered for TTL, CMOS systems

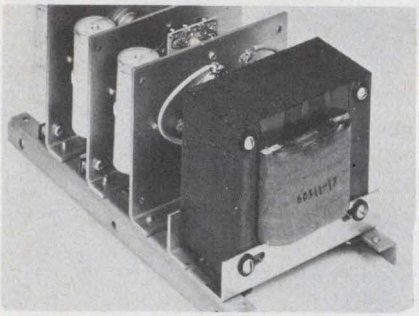


Power-One, Inc., 531 Dawson Dr., Camarillo, CA 93010. (805) 484-2806. HBB512: $54.95; HCC512: $86.95; stock.

Two new models of OEM dc power supplies are specially designed for small systems using TTL/DTL and CMOS. Each model features a 5-V output with ovp and a separate 9-to-15-V adjustable output. Line/load regulation is 0.02% and current foldback is built-in. These units are full-rated to 50 C. Output of Model HBB512 is 5 V at 3 A and 9 to 15 V at 1.25 A; that of Model HCC512 is 5 V at 6 A and 9 to 15 V at 2.5 A.

CIRCLE NO. 454

Open-frame family includes 88 members



Deltron, Inc., Wissahickon Ave., North Wales, PA 19454. (215) 699-9261. $33-$199 (25).

"Lomni" series open frame power supplies provide 88 new models with nominal voltage ratings of 5 to 28 V and current ratings from 1.2 to 38.5 A, maximum power of 400 W. The 88 new models have regulation of 0.01%, ripple and noise of 0.01%, and use an integrated circuit regulation system for good thermal and transient performance.

CIRCLE NO. 343

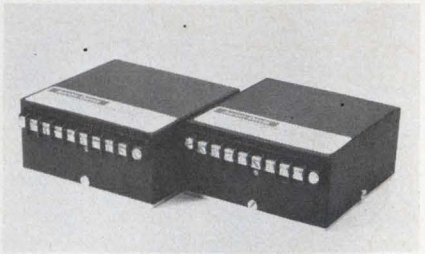
Dual outputs track or operate independently

Grumil Corp., 4626 Idlewilde Lane S.E., Albuquerque, NM 87108. (505) 265-2320. $157; stock.

The GM412 dual-output lab power supply is a constant-voltage, current-limited instrument rated at 20 V dc and 600 mA for both positive and negative supplies. Output circuitry is protected against overload, as well as positive and negative external forcing, within the limits of ±20 V and ±600 mA. Three selectable meter ranges are provided. Characteristics include 0.01% line regulation, 2-mV load regulation (NL-FL), ripple and noise of 500 μV rms, transient recovery time of 50 μs, tracking accuracy of 0.01%, and unconditional stability for all loads.

CIRCLE NO. 344

Dc/dc converters work at 75% efficiency

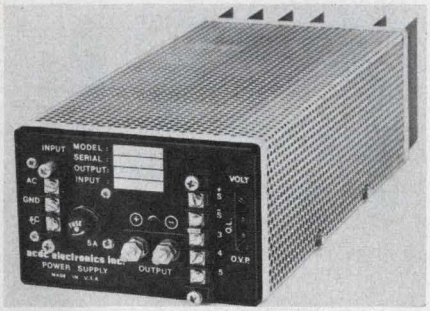


Aaron-Davis Co., Inc., 1720-22nd St., Santa Monica, CA 90404. (213) 829-1834. $175; stock to 2 wks.

The G4-25 Series dc/dc converter operates from conventional 24-V battery sources. 28 and 48-V inputs are optional. Efficiencies go up to 75%. The 25-W supply measures 4 × 4 × 2 in. Regulation is 0.5% for line and 2.0% for load. Ripple deviation is less than 0.5% of the output voltage. The converter is conduction cooled and operates over a temperature range of −20 to +71 C measured at the mounting base. Six standard models provide outputs of 5, 6, 12, 15, 24 and 28 V.

CIRCLE NO. 345

Five 150-W switchers join modular line

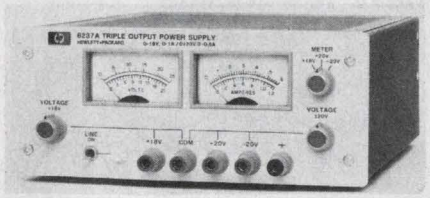


ACDC Electronics, Oceanside Industrial Center, Oceanside, CA 92054. (714) 757-1880. $275; 2-4 wks.

Five new 150-W switching-type power supplies have been introduced by the company. Ranging from 5 V at 30 A to 24 V at 7 A, these 20-kHz inaudible switchers operate from a selectable input of 115/220 to 230 V ac, (100 V ac also available) 47 to 63 Hz with 70% to 80% efficiency and 0.1% regulation. Overvoltage and overload protection on this JP Series is standard and radiated and conducted EMI is minimized by shielding and filtering. For systems applications, the output may be turned off by a single contact closure or TTL gate output. JP Series power supplies may be paralleled for high current requirements. The units weigh only 8 lb.

CIRCLE NO. 346

Bench supply gives triple outputs



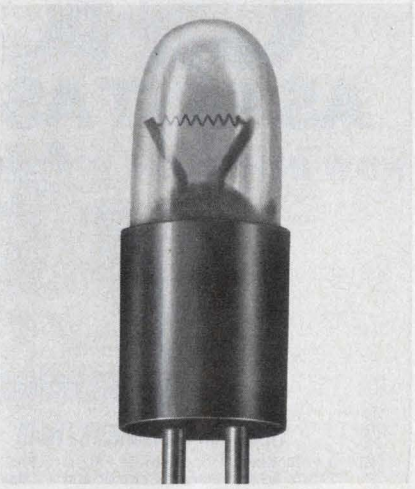
Hewlett-Packard, 1501 Page Mill Rd., Palo Alto, CA 94304. (415) 493-1501. $325; 2 wk.

This compact three-in-one dc power supply, the 6237A, delivers an output of 0 to 18 V at up to 1 A and plus or minus outputs from 0 to 20 V, each at 0.5 A. The 0 to +20 V and 0 to −20 V outputs track one another within 1%. They can also be used to obtain a single 0-to-40-V, 0.5-A current. Regulation is 0.01% +2 mV, with ripple and noise of 0.35 mV rms/1.5 mV pk-pk.

CIRCLE NO. 347

COMPONENTS

Bi-pin-based T-1 lamp has precision filament

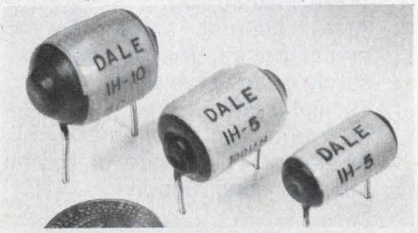


Gilway Co., Inc., 29B Cummings Park, Woburn, MA 01801. (617) 935-4442. $1.09 (1000 up); stock.

Precision-coiled filament T-1 lamps are now available with bi-pin bases. The lamps feature precision location of straight, rugged, CC-6 filaments. The lamps are suited for critical electro-optical and other close-tolerance applications. Certification to military specifications is available. The 1150-9 lamp is rated at 5 V, 0.115 A for a 40,000-h life and the 1600-9 is rated at 5 V, 0.060 A for 100,000-h life.

CIRCLE NO. 367

Filter chokes range to 100 μH, handle 10 A



Dale Electronics Inc., E. Highway 50, Yankton, SD 57078. (605) 665-9301. Under $1.00 (OEM qty); stock to 4 wks.

The IH Series, a new standard line of high-current filter chokes for PC mounting, is used for noise filtering in switching regulators, power amplifiers, power supplies and SCR or triac control circuits. The chokes have an inductance range from 10 to 100 μH and a current rating up to 10 A. Custom models are available up to 20 A. The units have a flame-retardant coating and pretinned leads.

CIRCLE NO. 368

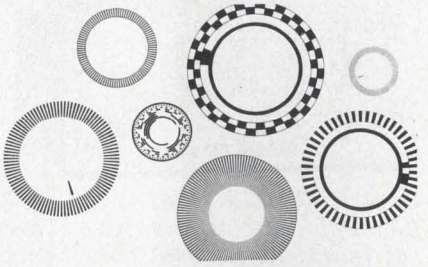
Liquid crystal displays large clock characters

Transparent Conductors Inc., 26 Coromar Dr., P.O. Box 549, Goleta, CA 93017. (805) 968-3561. See text.

Large-area liquid-crystal displays are now available in two new one-piece versions for a wide variety of digital wall clock and advertising displays. The 43.5C01 is a transmissive-mode, dynamic-scattering, 3-1/2-digit clock face with 4-in. high characters on one 5 × 14 × 1/4-in. display. This 70-in.^{2} display sells for $37 in lots of 1000. Sample prices are $98. A 2-3/4 × 7 × 1/4-in. clock face, the 23.5C01, with 2-in. high characters sells for $17 in 1000 lots, and samples are $49. Prices include connectors and a one-year warranty. Both models are also available in reflective modes. Available life data projects over a 30,000-h life.

CIRCLE NO. 369

Marked control discs have low inertia



Dynamics Research Corp., 60 Concord St., Wilmington, MA 01887. (617) 658-6100. $20 (unit qty).

Over 100 different line counts and sizes of standard discs are now available. These metrifilm discs are offered without tooling charges, and come in a variety of materials such as glass, quartz, Mylar and bi-metal. For low inertia, discs that use glass substrates only 6-mils thick are available.

CIRCLE NO. 370

XENON corporation

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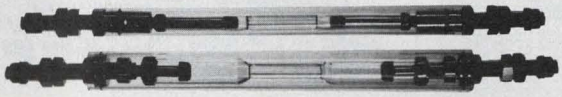
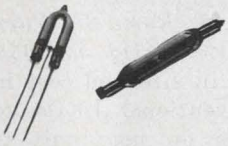
Lamps and Equipment for the Generation of Light.

FEATURES: **High Volume Production Reliability**





We can deliver a reliable product in the quantities required by the OEM user. Our lamps have consistantly higher quality, with longer and more uniform life.

In addition, we can solve the problem of having to build your own circuitry with our:

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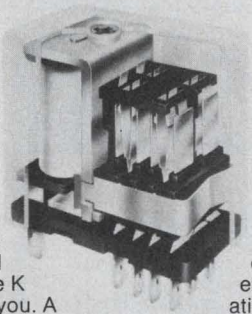
39 Commercial St., Medford, Mass. (617) 395-7634.

INFORMATION RETRIEVAL NUMBER 73

RELIABILITY. 100X COMPARABLE RELAYS.



If you can't stand miscontacts, want sensitive response, long life, a versatile 1 amp to 5 amp operating range plus UL, CSA, and VDE ratings — the K series relay is for you. A patented magnetic system develops an 11 g contact pressure and a wide contact gap. The contact spring assembly on the 2 amp type uses bifurcated contacts along with our unique lift-off system. Results: low, stable contact resistance, typically 25 milliohms; minimized bounce and chatter, approx. 1 msec; controlled arcing; low operate power requirements, nominally 400 mw (2C) to 1500 mw (6C); and long life: 10^8 mechanical operations; $>10^7$ electrical operations at 1 A 28 VDC. K relays are available in 2C, 4C, and 6C arrangements and in standard DC, AC, plastic-sealed, and power types. Solder terminal, P/C terminal, plug-in, and panel mounting accessories are also available. Want more information on this remarkable relay series? Call or write Arrow-M Corporation today.

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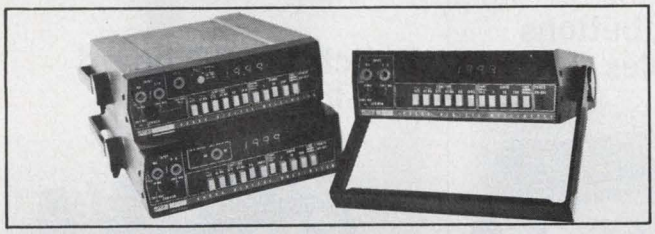
Telephone: 201·232·4260

INFORMATION RETRIEVAL NUMBER 78

Fluke Model 8000A



No other DMM offers you all of these outstanding specs in one box

- Best accuracy statement of any 3½ digit DMM: 0.1% accuracy ± 1 digit; one year accuracy time span; 25° C ± 10° C accuracy temperature span.
- Normal mode rejection: 60 dB at 50 and 60 Hz.
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INFORMATION RETRIEVAL NUMBER 72

FOR DEMONSTRATION, 183

Introducing the Brush 110 strip chart recorder–with a thermal writing pen guaranteed for life.

There isn't another strip chart recorder on the market today that can match the Brush 110's performance, ruggedness, versatility and writing dependability.

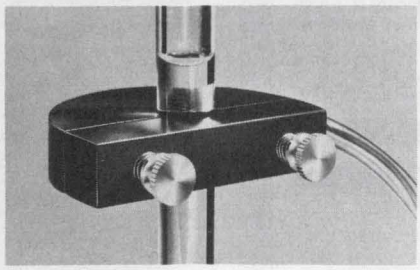
The new hot-tip thermal writing system produces clear, sharp, highly reproducible blue traces **with no smudges, no smears, no skips and no puddles.**

Before you buy, check out the remarkable Brush 110. Contact your nearest Gould sales engineer for a demonstration. Or write Gould Inc., Instrument Systems Division, 3631 Perkins Avenue, Cleveland, Ohio 44114.

INFORMATION RETRIEVAL NUMBER 79

COMPONENTS

Sensor detects liquid level in sight tubes

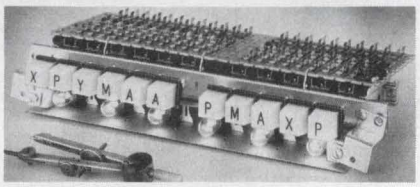


Skan-A-Matic Corp., P.O. Box S, Elbridge, NY 13060. (315) 689-3961.

A clamp-on photoelectric sensor, the S3090 Skanner, measures the liquid level inside a sight glass of virtually any liquid. The Skanner can sense the capillary edge of the fluid with a positioning accuracy of ±0.003 in. The device clamps around the outside of a sight glass with two thumb screws fitted with tension springs, and the unit can be slid easily up or down the glass. Although the Skanner is designed for a 1/2-in. dia sight glass, it can be modified to fit larger diameter tubes.

CIRCLE NO. 371

Versatile pushbuttons have to 10 poles



Oak Industries Inc., Crystal Lake, IL 60014. (815) 459-5000.

A family of lighted and non-lighted pushbutton switches, type 130, is available in low-power and power-rated versions. The low-power model can have up to 10-poles with contacts rated at 1 A, 28 V dc. The standard contact material is silver-plated brass, but a wide range of options include the precious metals. The power-rated type is available with DPDT contacts of coin silver rated 6 A, 125 V ac. Operational features include momentary, interlocking and alternate action, and mechanical or electrical lockout. The switches come in multiple banks and as complete subassemblies with lighted pushbuttons.

CIRCLE NO. 372

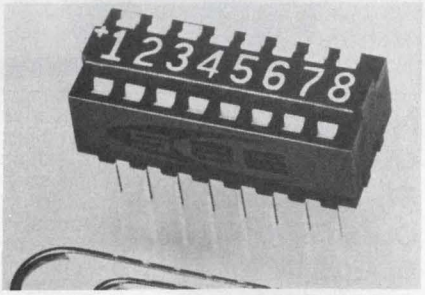
Electro-candescent unit displays large numbers

Digilite Corp., 91 Rome St., Farmingdale, NY 11735. (516) 694-6545.

Constraints in size and cost imposed by conventional LEDs and liquid crystals do not limit the Digilite electro-candescent approach. The N-10 Series of digital readouts, suitable for bezel mounting, range in size from 2 to 18 in. Larger sizes can be provided on special order. Life expectancy exceeds 50,000 h. The display offers a number of interesting properties: a choice of color, or mixed colors; a preset ability to change color, or color change in response to external stimuli; ability to change intensity with changes in the ambient temperature; and many other options. Available units operate on 110 V ac 50/60 cycle or 6, 12, or 24 V dc.

CIRCLE NO. 455

Switch for PC board has low profile

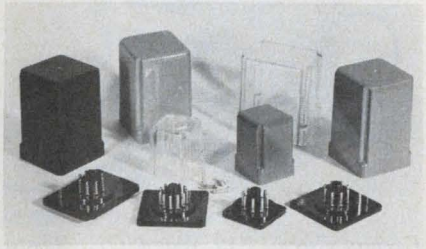


Stanford Applied Engineering Inc., 340 Martin Ave., Santa Clara, CA 95050. (408) 243-9200. $1.85; 7-SPST (1000 up); stock.

A miniature PC-mounted BCD or four-to-10-position decimal-input switch, the Series 1000 Bit, performs the same functions as slide, thumbwheel or toggle switches but occupies less space with its profile of only 0.280-in. high. The switch features large, easy-to-read characters 0.120-in. high. Custom masking and dust covers can be provided. The switch contact resistance is 100 mΩ.

CIRCLE NO. 456

Enclosures available in many sizes

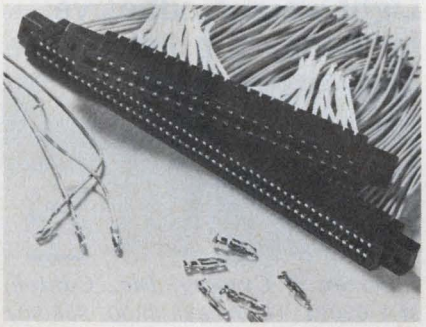


Time Mark Corp., P.O. Box 15127, Tulsa, OK 74115. (918) 939-5811. $0.39 to $0.72: polystyrene cover with 8-pin header (1000); stock.

Time Mark now offers its line of enclosures. The headers are molded in general-purpose phenolic and come in three sizes. Each size includes 8, 9, 11 or 20-pin versions. Dust covers are available in four sizes. They are molded from polystyrene, butyrate, nylon or Lexan in a variety of colors.

CIRCLE NO. 363

Card edge-connector contacts crimp to wires

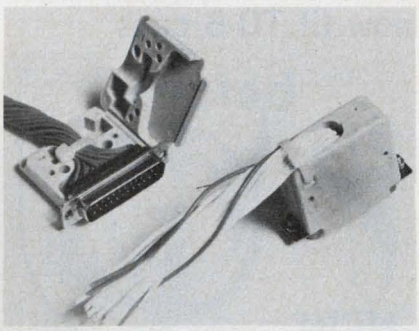


Elco Corp., Willow Grove, PA 19090. (215) 659-7000.

Elco Series 6042/6044 card, edge connectors have crimpable contacts for #22-to-30-gauge round wires. Contacts, loose or 2500 on a reel, insulators and application tooling are provided by the manufacturer for customer assembly. Connectors are available with 0.100 and 0.156-in. centers and dual-50 and dual-22 positions, respectively, with or without mounting holes and suitable for both single-sided and double-sided PC boards. Polarizing inserts on contacts, or between contacts, are available. Insulation material is polyester; contacts, phosphor bronze with gold plating over nickel.

CIRCLE NO. 364

Connector junction shell is all plastic

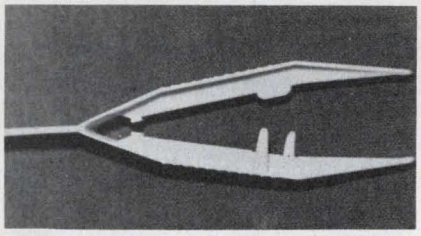


ITT Cannon Electric, 666 E. Dyer Rd., P.O. Box 929, Santa Ana, CA 92702. (714) 557-4700.

An all plastic junction shell, D-subminiature universal, is available in all five shell sizes—DA, DB, DC, DD and DE—to fit all D subminiature rectangular connectors including the Original D, Burgun-D, D*M Golden-D Mark I and the D*MA Royal D Mark III. Key features include: two-piece construction for ease of assembly, plastic ties for securing the cable firmly, straight or 90° outlet capability, nonflammable thermoset plastic with 150-C temperature capability and use of existing locking hardware.

CIRCLE NO. 365

Plastic tweezers can replace steel units



Sharon Medical Products Corp., 90 E. Industry Court, Deer Park, NY 11729. (516) 667-7350.

Plastic 5-1/2-in. tweezers can replace the more expensive stainless-steel instruments normally used for clean-room work, where small parts and components cannot be touched by hand. The tweezers have a good feel, are easy to squeeze and yet they have firm gripping power. Narrow, nonserrated tips and side guides prevent side-slip at the tips. They can be cleaned or sterilized many times, but are also inexpensive enough to be discarded after one use.

CIRCLE NO. 366

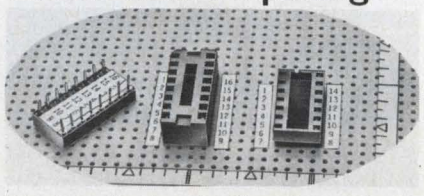
Stick-on temp recorders now fit TO-5 cans

Telatemp Corp., P.O. Box 5160, Fullerton, CA 92635. (714) 879-2901. Stock to 2 wks.

A new adhesive-backed temperature recorder, Model 505, detects overheated TO-5 components. Only 0.320 in. in dia, Model 505 contains five temperature increments, each calibrated at a specific value between 65 and 125 C. Silver-colored windows turn irreversibly black at their rated value with an accuracy of ±1%. Other Telatemp component temperature recorders are available for use with TO-3, TO-66, LSI flatpacks and DIP packages.

CIRCLE NO. 359

Marker labels fit DIP 0.1-in. center spacing

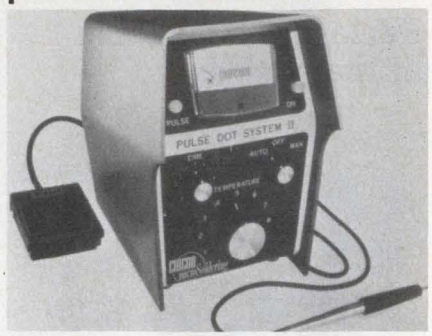


Vector Electronic Co., Inc., 12460 Gladstone Ave., Sylmar, CA 91342. (213) 365-9661. Stock.

A new line of press-on marker labels identifies DIP socket pins and circuit-board hole locations. The 14-pin DIP markers, Model MS-9, have numbers from 1 to 7 printed on one side and from 8 to 14 on the adjacent side, and the numbers are spaced on 0.1-in. centers to match the lead spacing of conventional DIP components. Strips for 16-pin DIPs and other configurations are also available.

CIRCLE NO. 360

Solder system provides precision heat control

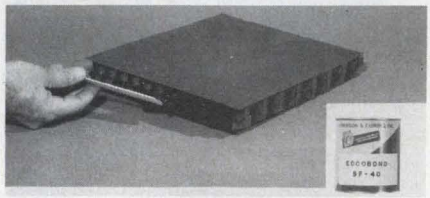


Circon Corp., 749 Ward Dr., Santa Barbara, CA 93111. (805) 967-0404.

Circon's PDS II Pulse Dot micro-soldering system provides precision control of solder, flux, rise time, temperature and total heat output with controlled heat pulses and interchangeable tips. The unit's Auto-Time control dial can set a heat-pulse interval from 100 ms to 10 s. The temperature-control dial sets heat output from ambient to 2200 F. With each depression of a pulse pedal, identical pulse duration and heat is delivered to the soldering tip.

CIRCLE NO. 361

Light-weight adhesive for honeycomb structure



Emerson & Cuming, Inc., Canton, MA 02021. (617) 828-3300. $38.50/gal; stock.

Fiberglass-resin laminates and honeycomb sandwiches, popular as structural materials in the aerospace industry, feature light weight and high strength-to-weight ratios. Thus it is desirable to use an adhesive that is also light weight and has a high strength-to-weight ratio, such as Eccobond SF40. It can seal the edges of laminates to prevent delamination when they are cut to shape, to fill the edges of honeycomb sandwiches and to patch and modify surface contours. It is an epoxy. The density of Eccobond SF40 is only 40 lb/ft^3 and yet its compressive strength is 10,000 psi and tensile-shear strength is 1500 psi.

CIRCLE NO. 362

application notes

Interfacing CMOS logic

Interfacing CMOS logic with the company's integrated d/a converters is described in an application note. An analysis of the input circuitry of various d/a converters is shown and input voltage rules are developed. Interface circuits are indicated. Also described is a complete CMOS-compatible voltage output d/a converter and a complete CMOS output 8-bit a/d converter, which can be built for under $30. Precision Monolithics, Santa Clara, CA

CIRCLE NO. 373

Removal of flux residues

Removal of rosin and resin flux residues with aqueous chemistry is the subject of a six-page illustrated bulletin. London Chemical, Bensenville, IL

CIRCLE NO. 374

Sampling oscilloscope

How to derive a maximum benefit from the use of a sampling oscilloscope is explained in a 72-page book. The book is supplemented by circuit diagrams and PC layouts. Philips Test & Measuring Instruments, Woodbury, NY

CIRCLE NO. 375

Meter relay

"Meter Magic" describes a cost-saving way to use the company's ac motor load meter relay. Beede Electrical Instrument, Penacock, NH

CIRCLE NO. 376

HP-45 calculator book

To extend the usefulness of the HP-45 advanced scientific pocket calculator, you can use the 218-page applications book that gives the most efficient keystroke sequences for solving over 200 commonly encountered mathematical problems. The book sells for $10 (plus local sales tax). Hewlett-Packard, 1501 Page Mill Rd., Palo Alto, CA 94304

INQUIRE DIRECT

Cable interconnection

"Electrical Comparisons of Scotchflex Cables" covers design considerations in the selection of cable interconnection systems for high-speed logic systems. The brochure is illustrated with charts and graphs. 3M, Electronic Products Div., St. Paul, MN

CIRCLE NO. 377

Noise reduction

Tech Tips 2-4 tells how to eliminate 120-cycle line noise and rfi in power-controller circuits that use inexpensive bimetallic switches. Westinghouse Electric, Semiconductor Div., Youngwood, PA

CIRCLE NO. 378

ROM simulator

How simple hardware can be combined with the company's 1000A ROM simulator to create powerful design support instrumentation is described in an application note. Scientific Micro Systems, Mountain View, CA

CIRCLE NO. 379

Resistance measurements

"Keeping Power Dissipation Down in Resistance Measurements" outlines the consequences of excessive power dissipation as well as how that dissipation can be kept to a minimum. Keithley Instruments, Cleveland, OH

CIRCLE NO. 380

Converter codes

A handy summary of various digital codes used in data conversion modules is given in a six-page article reprinted from ELECTRONIC DESIGN. Datel Systems, Canton, MA

CIRCLE NO. 381

Small dc motors

"Physical Properties of Small DC Motors Using an Ironless Rotor" gives a brief yet thorough explanation of these properties. Simple mathematical relations are illustrated by practical calculations. The guide can be obtained from Portescap, 165, rue Numa-Droz, CH-2300 La Chaux-de-Fonds, Suisse, at a price of s. fr. 5. or from Portescap, 730 Fifth Ave., New York, NY 10019, at a price of $7.50.

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new literature

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A 200-page guide to CMOS devices includes full technical descriptions. A cross-reference guide tracks alternate sources both by manufacturer and device function, and another guide provides instant access to all of the company's product applications. Harris Semiconductor, Melbourne, FL

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Pushbutton switches

Lighted pushbutton switches are featured in a four-color brochure. The switches described are available in either single or two-lamp models in either single or split legend designs. Illuminated Products, Anaheim, CA

CIRCLE NO. 383

Microwave devices

A 24-page short-form catalog lists over 350 microwave devices. EMI-Varian Ltd., Hayes, Middlesex, England.

CIRCLE NO. 384

Graphic recorders

The Series 2200 graphic recorders are covered in a four-page catalog. EPC Labs, Beverly, MA

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Microcomputer manuals

Two new reference manuals for designers of microcomputer control and processing systems cover design concepts, theory of operation, capabilities and applications of the Intellec 4 and Intellec 8 microcomputer development systems. The two volumes are available for $5 each. Intel Corp., 3065 Bowers Ave., Santa Clara, CA 95051

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Connectors

Eight series of precision electronic connectors are listed and highlighted in a 16-page catalog with all pertinent specifications for each group. Continental Connector, Woodside, NY

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Print/plot system

The electrostatic writing technique of the Statos off-line printer/plotter is described in a six-page brochure. Hardware features are described, as well as the JPR software that supports the system. Varian Data Machines, Palo Alto, CA

CIRCLE NO. 387

Digital panel instruments

Technical specifications and prices for digital panel instruments are contained in a four-page catalog. Nationwide Electronic Systems, Streamwood, IL

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BASIC/3000 language

Two publications—a 20-page booklet entitled BASIC/3000 Programming Examples and a 44-page BASIC/3000 Interpreter pocket guide—show computer users the full capability of the HP BASIC/3000 language. Hewlett-Packard, Palo Alto, CA

CIRCLE NO. 389

Wire terminals

An 85-page catalog describes wire terminals. Outline drawings and photographs are included. Malco, Chicago, IL

CIRCLE NO. 390

TTL/MSI devices

A 15-page, looseleaf-sized, fold-out brochure is a guide to 300 bipolar TTL/MSI devices. The guide is divided into eight sections: multiplexers and demultiplexers; counters; display products; memory products; shift registers; latches and storage registers; decoders and comparators and miscellaneous TTL products. National Semiconductor, 2900 Semiconductor Dr., Santa Clara, CA 95051

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Principles of operation of closed-loop linear and angular servo accelerometers, performance specifications and dimensional drawings are included in a bulletin. Schaevitz Engineering, Camden, NJ

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Mechanical specifications of socket logic cards, basic card dimensions and associated packaging hardware are contained in an eight-page brochure. Cambridge Thermionic, Cambridge, MA

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General-purpose relays

An updated data sheet covers Series 354 (formerly GP-1) general-purpose relays. Contact and coil data, dimensional drawings, schematics and pad layouts are included. C.P. Clare, Chicago, IL

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Microwave components

A 64-page catalog describes and illustrates microwave components and assemblies with special emphasis on stripline devices. Performance characteristics, design data, application information, outline and mounting drawings and photographs are included. Lorch Devices, Englewood, NJ

CIRCLE NO. 394

Expandable voice system

Application information, block diagrams, package dimensions, timing diagrams and I/O connections for an expandable voice annunciator system called EVA are given in a four-page brochure. Master Specialties, Costa Mesa, CA

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General specifications for digital printers, both numeric and alphanumeric, are given in a 12-page catalog. Also described are printing digital voltmeters and accessory equipment. Practical Automation, Shelton, CT

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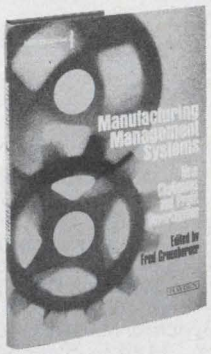

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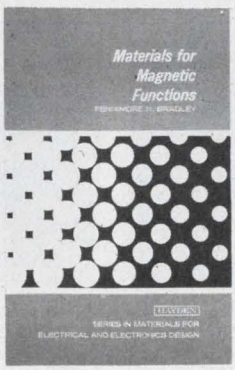

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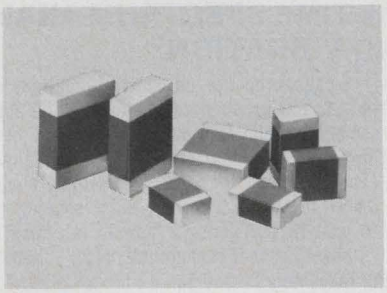

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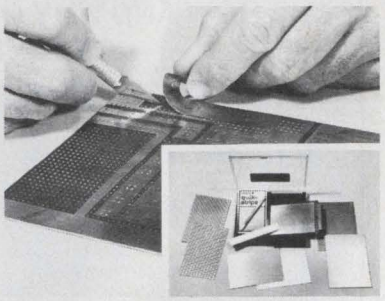

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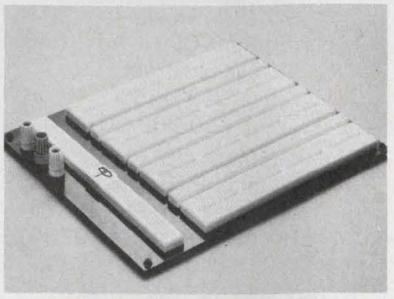

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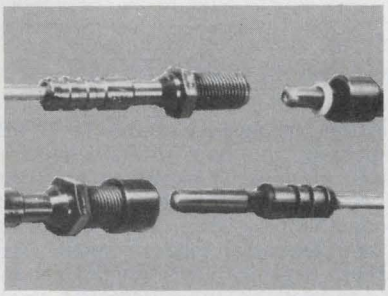

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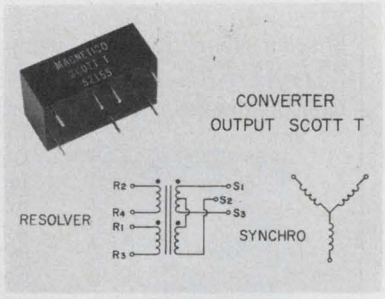

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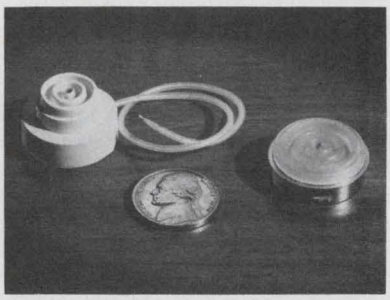

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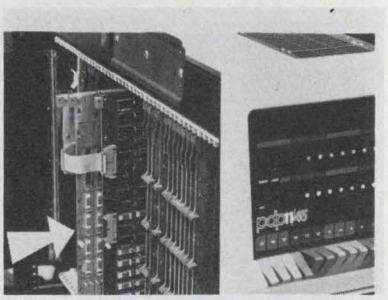

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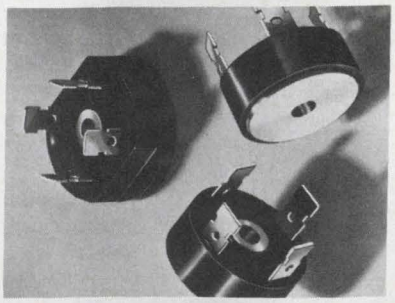

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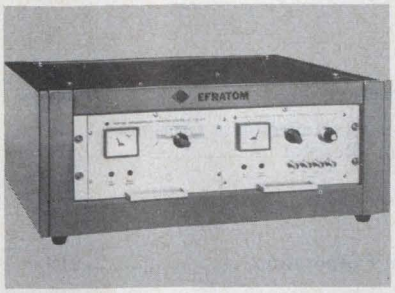

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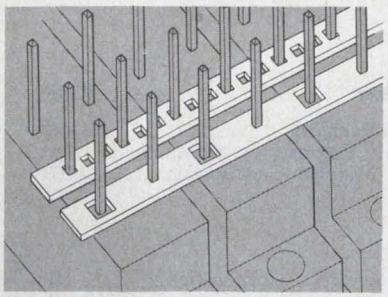

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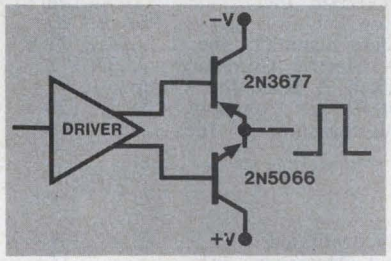

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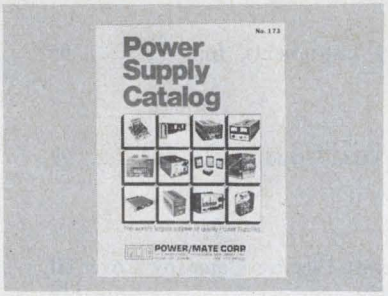

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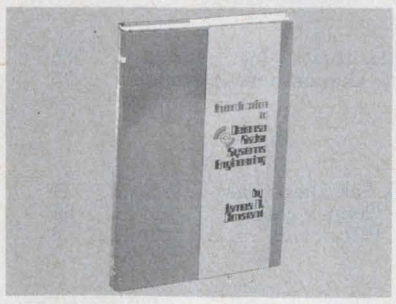

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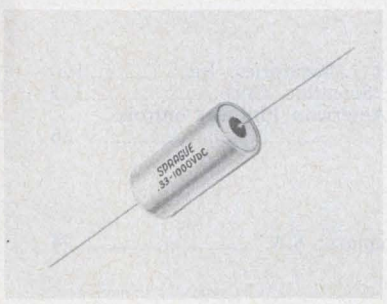

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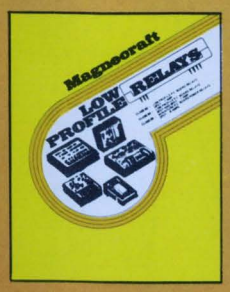
Introducing, a New Design Spectrum* of Low Profile Relays.

Engineering excellence, a tradition at Magnecraft, is reflected in our new printed circuit relays. Three low cost classes are available in stock with performance specifications including absolute reliability, long mechanical life, and a wide choice of contact configurations and switching capabilities.

Packaging flexibility includes, a truly low profile dust proof design, with a minimum height above the P.C. board, and a vertically mounted space saving version. The relays feature industry standard .1 inch grid spacing for terminals, and high density center to center board spacing. Contact arrangements include SPDT, DPDT, 4PDT, and 6PDT rated from 1 to 8 amps. Bifurcated contacts are optional on certain configurations.

These compact relays are particularly suited for communication systems, data processing equipment, automatic control systems, process control, automotive and consumer electronics.

*Family of Relays



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INFORMATION RETRIEVAL NUMBER 263

What's new in solid state...

Four RCA op amps that make the CA3130 what it is.

Our CA3130 gets many of its winning ways from four very capable relatives. Four RCA op amps that can fill special requirements you may have. If you need programmable linear gain control, check the CA3080. For high crossover frequency plus high slew rate, there's the CA3100T. For high output current and easy programmability, the CA3094E. For low power supply drain, the CA3078T.

The CA3130 is the ideal choice when you're looking for a good measure of all of these characteristics in one device. That's what makes the CA3130 so great. Its versatility comes from the unique combination of MOS/FET, bipolar and COS/MOS on the same chip. And its surprisingly low 1K price of 75¢ makes it a natural for your high-volume products.

Beyond the table, here's more typical data about the CA3130:

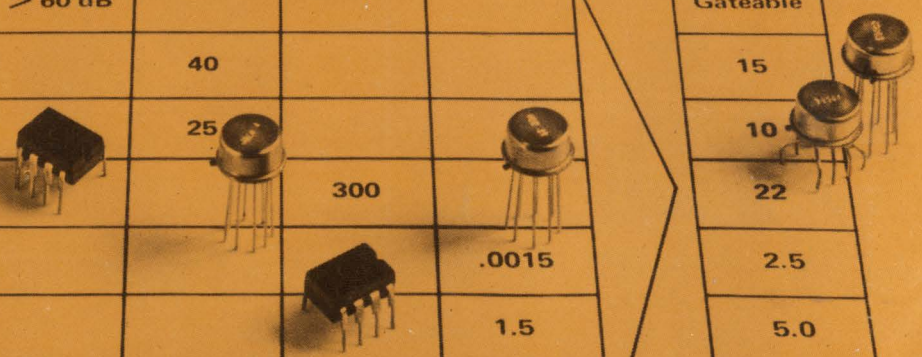
Input Impedance: 1.5 TΩ ($1.5 \times 10^{12}\ \Omega$).
Input Current: 5 pA.
Input Offset Current: 0.5 pA.
Input Offset Voltage: 0.8 mV (CA3130B).
Settling Time: 1.2 μsec.
An output voltage swing to within 10 mV of either supply rail.
Strobing terminals.

If you are interested in one or all of these op amps, contact your local RCA Solid State distributor. Or RCA.

Write: RCA Solid State. Box 3200, Somerville, New Jersey 08876; Ste. Anne de Bellevue 810, Canada; Sunbury-on-Thames, U.K.; Fuji Bldg., Tokyo, Japan.

RCA

	CA3080E	CA3100T	CA3094E	CA3078T	CA3130
Gateable plus programmable gain control	> 60 dB				Gateable
Unity gain crossover frequency, MHz		40			15
Slew Rate, V/μsec		25			10
Output, mA (peak)			300		22
Power consumption, mW				.0015	2.5
Single supply voltage required, V				1.5	5.0
Price (1K), $	0.55	1.50	0.90	1.25	0.75



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