

NOVEMBER 24, 1977

**HOW CONSUMER VIDEO-RECORDER FORMATS MATCH UP/106**

Calculator programs speed tuned-circuit design/ 118

Microprocessors in action: keeping apple orchards healthy/ 125

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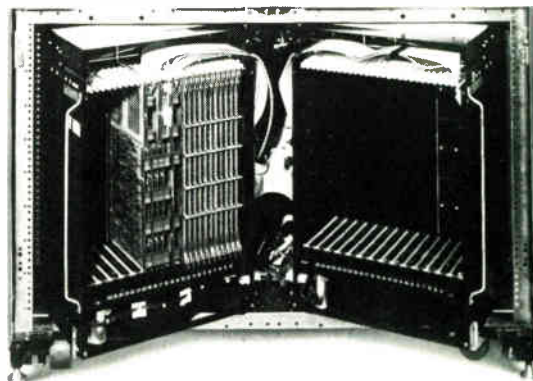
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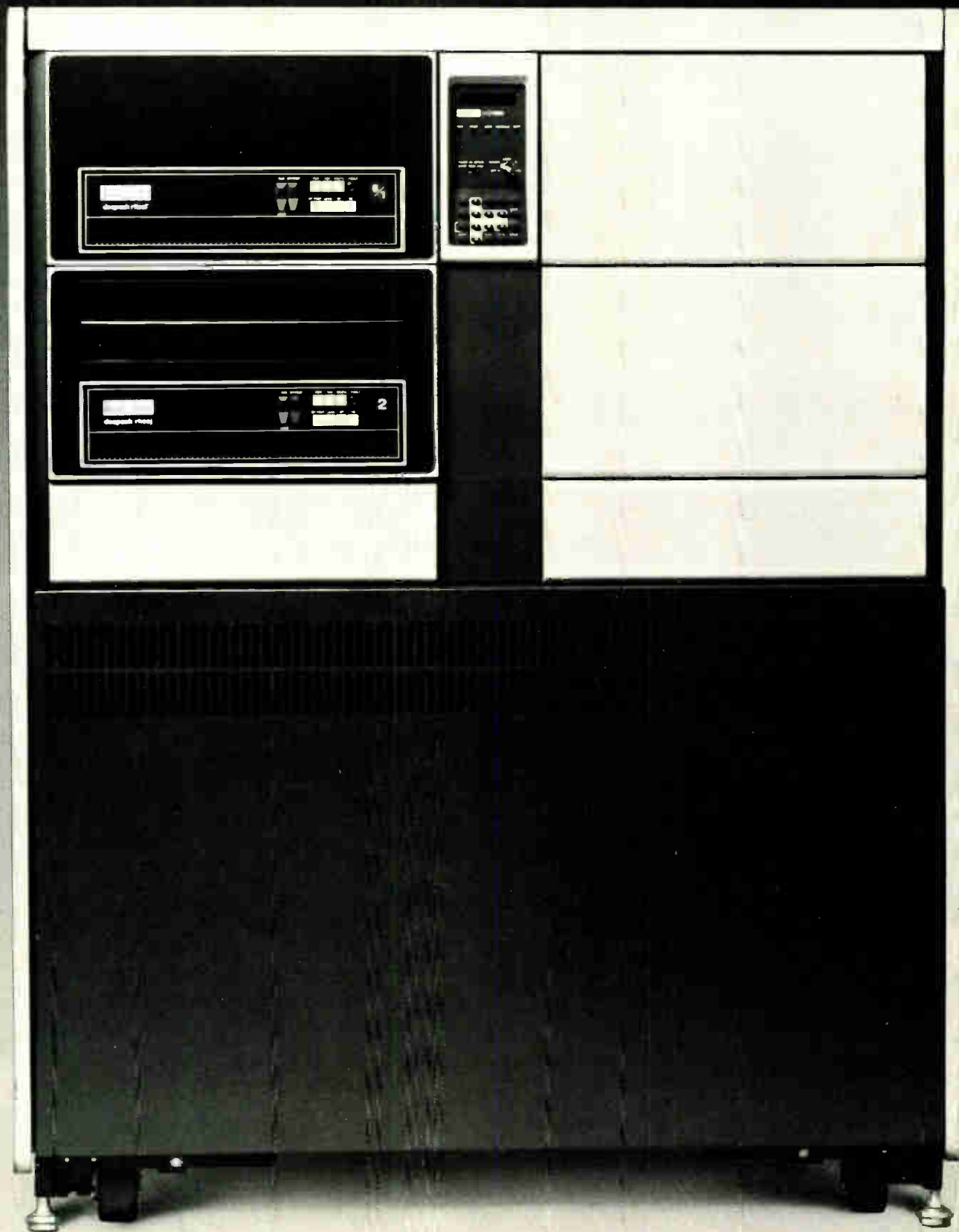
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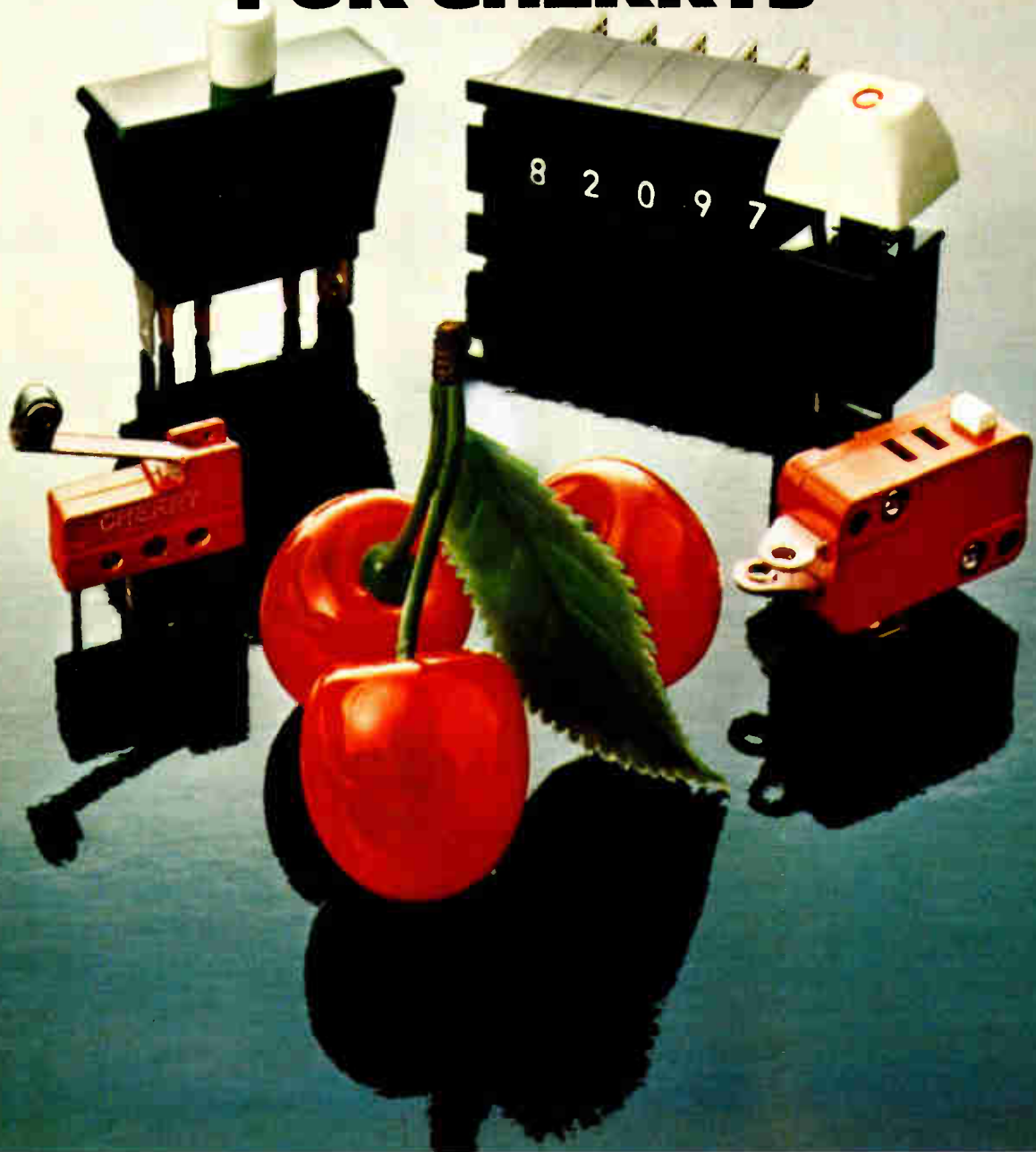
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## 41 Electronics Review

MEMORY: Minifloppy gets two heads for 0.4-megabyte store, 41  
MICROPROCESSORS: Zilog offers broad range of languages, 42  
Motorola one-chip microprocessor could be most powerful, 43  
SOLID STATE: Signetics plans processor-compatible converters, 44  
INDUSTRIAL: Robot sets sights on objects on table, 46  
INSTRUMENTS: Microprocessor drops microwave counter price, 48  
MICROCOMPUTERS: Son of LSI-11 is smaller, cheaper, 50  
AUTOMOTIVE: Microcomputer gets job on production line, 52  
NEWS BRIEFS: 52  
COMPANIES: Government may win IBM case, 54

## 65 Electronics International

JAPAN: Electron beam scans 2- $\mu$ m patterns directly, 65  
THE NETHERLANDS: Air force adopts digital network from Collins, 66  
AROUND THE WORLD: 66

## 75 Probing the News

COMPANIES: Motorola makes microcomputer comeback, 75  
CONSUMER: Audio world gets the word: digital, 78  
BUSINESS: Slowdown has little effect, 81  
THE IEEE: Can Getting, Hogan heal the rift?, 84  
PACKAGING & PRODUCTION: Ceramic carriers make inroads, 86  
GOVERNMENT: NASA's star continues to wane, 90

## 99 Technical Articles

INDUSTRIAL: IR-reading vidicons map clearer pictures, 99  
CONSUMER: Two formats go head to head in VTR confrontation, 106  
DESIGNER'S CASEBOOK: Limiter controls phone-line signal power, 114  
Synchronous timing loop controls windshield wiper delay, 115  
CIRCUIT DESIGN: Cascaded tuned-circuit design simplified, 118  
MICROPROCESSORS: Monitor optimizes apple-tree spray cycle, 125  
ENGINEER'S NOTEBOOK: LED array forms low-cost scope display, 128  
Variable oscillator reacts to magnetic-flux changes, 130

## 141 New Products

IN THE SPOTLIGHT: C-MOS converters resolve 12 bits, 141  
Multimeter delivers extra functions, 144  
MICROPROCESSORS: 4-bit slice acts as sequencer, 148  
SUBASSEMBLIES: Smart display offers low drain, 154  
INDUSTRIAL: 10-channel RTD scanner sells for \$595, 166  
PACKAGING & PRODUCTION: Software aids pc-board design, 175  
COMPONENTS: One-pole, 20-A mercury relay sells for \$6, 188  
INSTRUMENTS: Meter resolves 0.1 microhm on 1-m $\Omega$  range, 194  
COMMUNICATIONS: 3-in-1 modem provides direct phone link, 200  
MATERIALS: 220

## Departments

Publisher's letter, 4  
Readers' comments, 6  
News update, 8  
Editorial, 12  
People, 14  
Meetings, 30  
Electronics newsletter, 35  
Washington newsletter, 59  
Washington commentary, 60  
International newsletter, 63  
Engineer's newsletter, 132  
New literature, 226  
New books, 234

## Services

Employment opportunities, 238  
Reader service card, 253

## Highlights

### Cover: Pyroelectric TV tubes defeat flicker, 99

Recent technological advances have improved the picture from pyroelectric vidicons, which read the infrared radiation from heat-emitting bodies in order to produce a thermal image. A big gain is the provision of a flicker-free image under all conditions.

Cover collage by Art Director Fred Sklenar.

### Sun shines on Motorola-Austin, 75

The Austin, Texas, summer of 1976 was a bleak one for Motorola's metal-oxide-semiconductor microcomputer division, with key employees leaving and production problems growing by the day. Now prized contracts with GM, Ford, and Chrysler are in hand, the problems have been licked, and devices are rolling off the line.

### Calculator designs tuned-circuit arrays, 118

Designing cascaded tuned circuits requires a series of complex calculations, but the figuring can be turned over to a calculator. This first part of a two-part series gives the programs for designing single and synchronous tuned circuits.

### Microprocessor aids apple growers, 125

Using data from environmental sensors, a microprocessor-based computer located in the orchard can predict the severity of apple scab, a common fungus infesting apple trees. Thus growers can apply fungicide less frequently but more effectively. Another in the Microprocessors in Action series.

### And in the next issue . . .

Microcomputer roundup: the new chips, the new applications . . . where the action is at this year's International Electron Devices Meeting . . . fluorescence boosts usability of liquid-crystal displays.

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**V**ideo cassette recorders have already been identified as the hottest new consumer electronics product to come along since color television. What's more, they are one of the most important developments affecting TV broadcasting. The VTR, in effect, makes the consumer a broadcast executive, deciding when a program will be seen or watching one program while taping another.

For the technical details on the two most important competing consumer VTR designs, we went to Sony Corp. and Victor Co. of Japan. That meant an assignment for our man in Japan, Charlie Cohen. You'll find his report on page 106.

As *Electronics'* Tokyo bureau chief for some dozen years, Charlie is known for his thoroughness in researching an article as well as for his rare grasp of the Japanese language—spoken and written. He needs these assets in putting together the complex story of technological progress in Japan.

Fortunately, Charlie, who has his engineering degree from the University of Tokyo, knows his way around Japanese electronics companies as well as he knows the confusing streets of Tokyo and Osaka. As a Sony research manager once confided, "He knows more about what's going on in my company than I do."

**T**he equations that characterize the behavior of cascaded inductance-capacitance tuned circuits were developed by and written in a form convenient to theoreticians. Their interest was explaining and optimizing tuned-circuit properties.

Engineers, however, have the task of making the circuits work in specific applications. That's why Al

Hayes, author of the two-part series on cascaded tuned circuit design that starts on page 118 in this issue, turned the equations into design formulas that can be solved on a programmable calculator.

"There's nothing I like better," he says, "than to take a set of theoretical equations having little or no practical use, and to convert them into a set of useful cookbook-type formulas that can be quickly and accurately solved with the great tool now available to the engineer: the calculator."

"An engineer's prime function," he continues, "is to transform the theory into meaningful results. That's what differentiates the engineer from the physicist. And the calculator is the tool that permits the engineer to fulfill his function."

Hayes became a radio amateur at age 13, and this "had everything to do with my becoming an engineer." He graduated from MIT in 1942 and during the postwar years held a variety of jobs. He first worked in the basic technical and editorial fields, holding positions with the American Radio Relay League and then as editor for CQ magazine. Later he went to Emerson Radio, as senior project engineer working on military projects, and Ampex Corp. where he worked mostly on audio-circuit design. After 15 years with Lockheed in California working on rf circuits and systems, Hayes, in 1968, began consulting work, which has now turned into his full-time profession.



November 24, 1977 Volume 50, Number 24 97,133 copies of this issue printed

Published every other Thursday by McGraw-Hill, Inc. Founder: James H. McGraw 1860-1948. Publication office 1221 Avenue of the Americas, N.Y., N.Y. 10020; second class postage paid at New York, N.Y., and additional mailing offices.

Executive, editorial, circulation and advertising addresses: Electronics, McGraw-Hill Building, 1221 Avenue of the Americas, New York, N.Y. 10020. Telephone (212) 997-1221. Teletype 12-7960 TWX 710-581-4879. Cable address: MCGRAWHILL NEW YORK.

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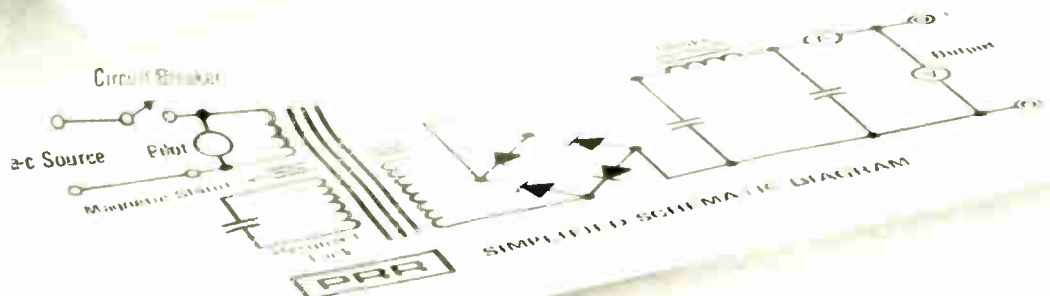
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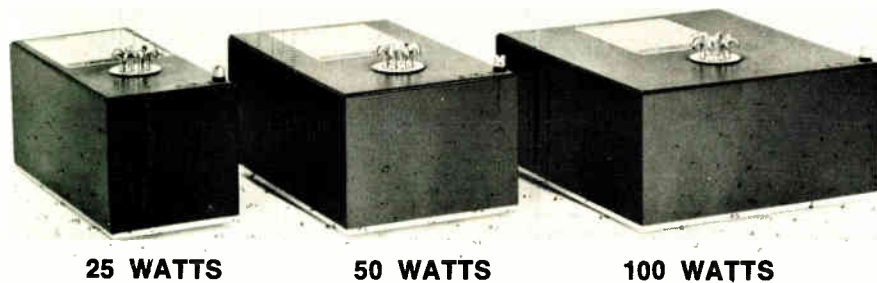


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6 Circle 6 on reader service card

World Radio History

## Readers' comments

### It's safer

**To the Editor:** With regard to the resettable electronic fuse [Designer's casebook, Sept. 15, p. 117], I feel it's rather dangerous to be able to defeat the fuse merely by holding down the push button.

A better scheme would be to have the push-button supply current connected only to the relay and not to the load. Simply disconnect the side of the push button directly connected to the load and reconnect it to a resistor,  $R_4$ , whose value is equal to  $R_2$ . Connecting the free end of  $R_4$  to the junction of the coil and  $R_2$  completes the modification.

Esther Finlay  
Vancouver, B. C.  
Canada

### Conspicuous omission

**To the Editor:** I read with interest your article "Converters adjust to LSI, bi-FET op amps emerge" [Oct. 27, p. 112], in which you quoted a list of companies that already have or are about to have microprocessor-oriented converter products on the market.

It should be noted that the only company to have announced and already have in volume production a fully microprocessor-compatible converter subsystem was conspicuously absent from that list. The company is Signetics and the product is the NE5018, a complete 8-bit digital-to-analog converter with voltage reference, output operational amplifier, and data latches.

In addition, Signetics will soon be announcing a series of microprocessor-oriented analog-to-digital converters, as well as expanding its line of digital-to-analog products.

Peter Guest  
Interface Product Line Manager  
Signetics Corp.  
Sunnyvale, Calif.

■ We are well aware of Signetics' efforts in microprocessor-compatible data converters, and we apologize for the obvious omission on our part. For more about the converter chips forthcoming from Signetics, "Converters designed for microprocessors," beginning on page 44.

Electronics/November 24, 1977

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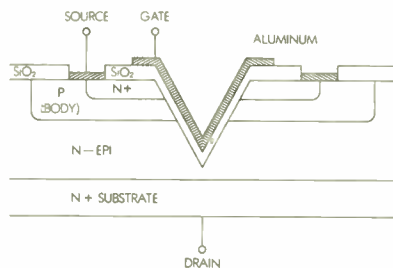
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Cross-section of Fairchild's VMOS power transistor.

	Package	PD	ID	BVDSS
2N6657	TO-3	25 W	2.0 A	60 V
2N6658	TO-3	25 W	2.0 A	90 V
FVN2	TO-39	6.26 W	2.0 A	60 V
2N6661	TO-39	6.25 W	2.0 A	90 V

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Device Type	Package	PD	ID (max)	BVDSS	$R_{ds(on)}$
FVPI	TO-3	25 W	2.0 A	60 V	6
FVP2	TO-39	6.25 W	1.5 A	60 V	12

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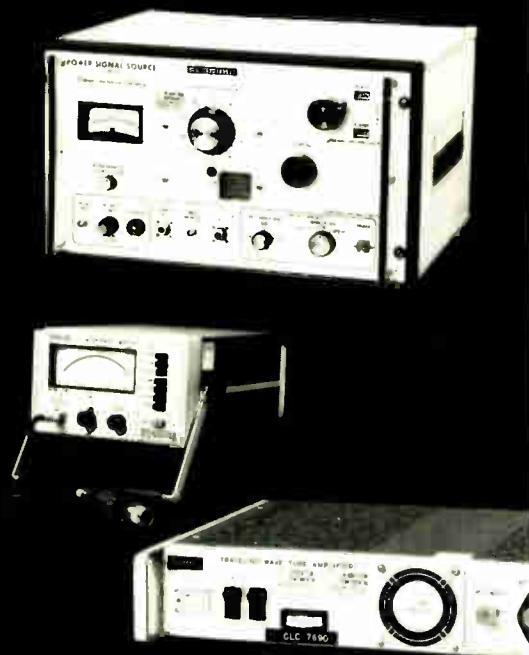
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## News update

■ Sperry Rand Corp.'s Sperry division in Great Neck, N. Y., is delivering to the Air Force samples of a nonvolatile random-access memory said to be 30 times harder to nuclear radiation than present integrated circuits and produced with the metal-nitride-oxide-silicon process. The military is eager to obtain MNOS memory arrays that are radiation-resistant and can perform in severe environments [*Electronics*, May 13, 1976, p. 30].

Developed under a \$650,000 contract from the Defense Nuclear Agency and the U.S. Air Force Weapons Laboratory at Kirtland Air Force Base in New Mexico, the 256-bit memory has a write cycle time of 2.8 microseconds, or three times the write speed of present MNOS electrically alterable read-only memories, claims William Rubin, the Sperry division's research director.

"The technology has matured to the point that we're seeking immediate funding for pilot production," Rubin notes. He believes the next phase of funding will be first to translate the lab parts into production designs and next to develop memory designs that incorporate these chips for various applications in strategic missile and satellite programs. Full production-quality nonvolatile MNOS ROMs could be available in 12 to 18 months.

■ The U. S. Army recently accepted the first U. S. Roland missiles off the assembly line of the Hughes Aircraft Co.'s manufacturing facility in Tucson, Ariz. The armament for the U. S. Roland short-range all-weather air defense system, the missile is designed to knock out of the air low-level attackers trying to sneak in under radar detection. It represents the first major European-designed weapons system selected for production for the U. S. Army [*Electronics*, Jan. 22, 1976, p. 68].

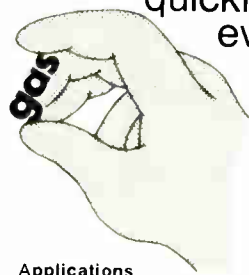
The U. S. Roland missile is interchangeable with the European version, and more than 90% of the firing-control unit's replaceable parts are interchangeable.

Bruce LeBoss

Gas Sensing Semiconductor

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8. Air Pollution Monitor

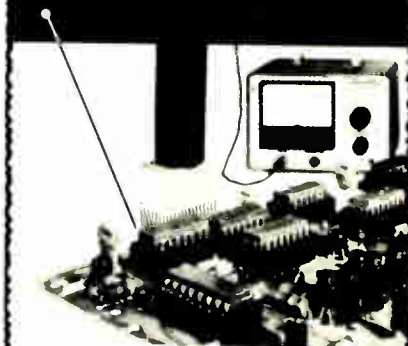
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# RCA first in CMOS.

## First in CMOS microprocessors.

RCA 1800 combines elegant COSMAC architecture with CMOS benefits. Result: the performance you want — plus maximum flexibility with minimum parts count.

**Cost-effective COSMAC architecture.** Since our CDP1802 CPU accepts compact 1-byte instructions, you need less memory. Registers store data with 1-byte access. And they act as pointers, so individual instructions don't need addresses.

**Built-in I/O.** The CPU has interrupt, DMA, flags in and bit control out, so you need less I/O. And we offer a wide range of low-cost I/O devices, including our unique 2-mode UART.

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For more information, contact your local RCA Solid State distributor. Or contact RCA Solid State headquarters in Somerville, NJ; Sunbury-on-Thames, Middlesex, England; Quickborn 2085, W. Germany; Ste.-Anne-de-Bellevue, Quebec, Canada; Sao Paulo, Brazil; Tokyo, Japan.

**When you say CMOS, say RCA first.**

### The RCA 1800 Microprocessor Family

CDP 1802	COSMAC CPU
CDP 1821S	1024x1 High-speed RAM
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CDP 5101	256x4 Industry-standard RAM
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CDP 1824	32x8 RAM
CDP 1831, 2	512x8 ROM (with or without latch)
CDP 1833, 4	1024x8 ROM (with or without latch)
CDP 1852	Byte I/O
CDP 1853	I/O decoder
CDP 1854	UART
CDP 1856, 7	Bus buffer/separators
CDP 1858, 9	Address latch/decoders
CDP 1861	TV interface

#### Coming in 1978

CDP 1823S	128x8 High-speed RAM
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And these major parts: 4K RAM, 4K EPROM, 1-chip COSMAC microcomputers — all in CMOS.

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The Texas Instruments TTL Data Book has most of the Schottky and Low-Power Schottky parts you need for most designs. Most. The Advanced Micro Devices book has the rest.

The 625-page AMD Schottky and Low-Power Schottky Data Book. It fills in all the blanks with a whole new generation of parts: Complex MSI/LSI, optimized to fit today's microprocessor and memory-oriented system architecture.

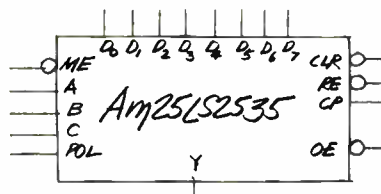
Many of these parts combine several functions in space-saving 20-pin packages. They'll create all kinds of new room on your PC boards. They'll cut your power usage dramatically, take away half your interconnections, and make your systems much, much faster.

These new parts are catching on so fast we've been getting alternate source commitments even before we can get them on the market. So when you're designing high performance digital systems, remember — don't do anything until you check both books.

**The Advanced Micro Devices Schottky and Low-Power Schottky Data Book. Powerful solutions to microprocessor and memory design problems. Send us the coupon and we'll send you the book. (File it under "Schottky," right there next to that big gold one.)**

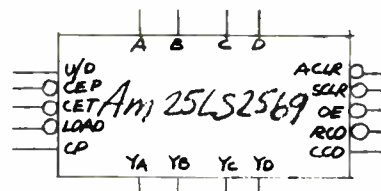
## For example:

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It does the work of a 54/74LS169A plus a three-state buffer plus two or three gate packages. Figure it out. You save lots of space. Add to that a savings of about 40% of your power, 40% of your time, and the total is mighty impressive.



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# Advanced Micro Devices

Bipolar LSI. N-channel, silicon gate MOS. Low-power Schottky.  
 Multiple technologies. One product: excellence.



## IEEE: a house divided . . .

Once again the election of officers for the Institute of Electrical and Electronics Engineers has underscored the deep division within the institute's ranks. One side favors professional, socio-economic programs and the other side is opposed to them. As usual, the vote also drove home the horrendous apathy among members.

Despite the wide publicity surrounding this year's election, the placing on the ballot of a well-known and outspoken industry executive, and the numerous reminders to vote, fewer than 50,000 of the nearly 140,000 eligible to vote returned usable ballots. What, one wonders, does it take to get IEEE members interested enough in their organization to respond?

At any rate, neither the division within the minority nor the apathy among the majority will disappear overnight. It appears that with this election the IEEE has reached a pause in its five-year-long effort to become a professional as well as a technical organization. It has not been an easy transition, and in fact, the transition is not yet complete.

Therefore the friction between those demanding a faster-acting U. S. Activities Board and those wanting a more deliberate pace will continue. Even the anticipated pause in the coming year is controversial. Is it a time to take stock and renew professional efforts or will it be simply a period of benign neglect of member needs?

Some years ago "Engine" Charlie Wilson, the Secretary of Defense in the Eisenhower Administration, caused a row when he said

that what's good for General Motors (his former company) is good for America, meaning that good auto business creates jobs, paychecks, and a demand for more cars.

Today, the newly elected top officials of IEEE appear to be saying that what's good for the electronics industry—more business and/or R&D spending—is good for engineers. True, full employment of engineers with a future promising more of the same tends to put the lid on engineer dissatisfaction and restore the don't-rock-the-boat syndrome.

But we think that times have changed. What's good for engineers should be decided by engineers. They should have more of a say about their career than before, rather than being told what's good for them, and that includes decisions from inside as well as outside the U. S. Activities Board.

What the officers of the institute must now decide from all the noise out there is the true signal from engineers. Indeed, one of the most difficult problems hampering professional activities has been the design of a means of picking up and decoding signals from the members. And the first step in that direction has been taken with an extensive survey of membership opinions.

If there is to be a pause in professional activities this year to take stock, let it be the time to develop ongoing communication with the members. Otherwise, an organization in which the articulate members are an evenly divided minority and the majority of members are not communicating will be virtually ungovernable.



# Meet the 250-MHz portable with 5 mV/div sensitivity at bandwidth

**In high performance portable oscilloscopes, Tektronix offers you the most complete selection.**

Designed to service high speed computers and communications systems, the TEKTRONIX 475A is the latest addition to our line of portable oscilloscopes. With 250-MHz bandwidth and 5 mV/div sensitivity, you can accurately detect glitches, minor variations or aberrations in high frequency waveforms.

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Consider the capabilities of the 475A when evaluating portable scopes for your service applications:

- 250-MHz bandwidth.
- 5 mV/div sensitivity.
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- delayed sweep to view waveform segments downstream from the trigger.
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- 8 x 10 cm crt for high-signal resolution.
- \$3450 (add \$445 for the Option 44).

When combined, these capabilities offer you the most performance for your dollar.

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With it, you can make timing measurements faster than with conventional procedures. Together the 475A and Option 44 provide you with an economical, portable package for your field service needs.

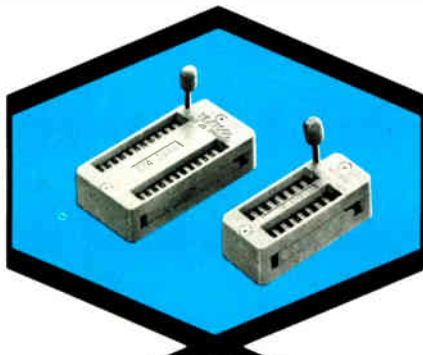
For more information or a demonstration of the high-performance TEKTRONIX 475A, contact a Tektronix Field Engineer near you or write Tektronix, Inc., P.O. Box 500, Beaverton, Oregon 97077. In Europe write Tektronix Limited, P.O. Box 36, St. Peter Port, Guernsey, Channel Islands.

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## ZIP DIP® II SOCKET/RECEPTACLE SERIES

### IMPROVED TEXTOOL SERIES INCREASES VERSATILITY AT COMPETITIVE PRICES

The ZIP DIP II socket/receptacle series offers all the advantages of TEXTOOL's original zero insertion dual-in-line package models plus increased socket versatility and reduced receptacle pricing.

The ZIP DIP II socket features an enlarged entry for use with an even wider range of devices and a flat top plate for easier entry and extraction. Contacts are on even 100 mil spacing (300-400-600 mil) for more convenient mounting on standard hardware.

A built-in "stop" insures that the ZIP DIP II handle can't be easily over-stressed. Top mounted assembly screws facilitate the replacement of damaged or worn internal parts. TEXTOOL has strengthened both hardware and plastic for increased reliability and screw mounting of the socket to the ZIP DIP II receptacle makes possible a more positive locking system.



The ZIP DIP II receptacle (left) has all the features of previous ZIP DIP receptacles, yet at a lower price. It virtually eliminates mechanical rejects, is a disposable plug-in unit requiring no soldering and has a typical life of 25,000-50,000 insertions. The receptacle is ideal for high volume hand testing and, since replacement time is eliminated, a test station can process literally millions of devices before it must be replaced.

*Detailed information on these and other products from TEXTOOL . . . IC, MSI and LSI sockets and carriers, power semiconductor test sockets, and custom versions . . . is available from your nearest TEXTOOL sales representative or the factory direct.*



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## People

### Business software makes for problems, Hosler charges

Jay R. Hosler makes a very good living as a computer systems consultant. However, he says things that make him less than popular among suppliers of these systems to small businesses.

Most of the hundreds of suppliers "are unable to provide a system for small businesses that works well," says the 39-year-old Woodland Hills, Calif., veteran of 20 years in computer services. "It's not the hardware, which in many cases is superb, but the so-called standard software packages."

**Inflexibility.** The software for even such simple chores as inventory control and keeping track of payroll, billing, and accounts receivable just does not live up to the flexibility that is promised, Hosler says. Quite often, they cannot handle all the special needs even users in the same business have. "What suppliers call a simple change in programming turns out to call for a software specialist," Hosler continues, and will cost much more money than the user ever figured. "Don't get into electronic data processing unless you have \$100,000 to spend, or you'll run out of money," he warns.

Hosler was making these irrelevant statements earlier this month in Los Angeles at Interface West, a conference and exposition dealing with small computer systems and applications. Although his views certainly did not please the systems suppliers who exhibited there, "users will appreciate his level of candor," one of the show's organizers said, while seeming to wince a bit. Hosler has been a full-time consultant for less than a year, after finishing almost four years as chief systems scientist working on retailing systems for TRW Communications, and he is nothing if not candid.

**Not so easy.** "It all looks so easy, potential users don't want to hear how tough it is," he says. "Even something that sounds as easy as varying the number of characters in a printout line often turns out to

mean redoing most of the program." Other changes, such as those involving the nuances of different businesses accounting schemes, need even more expensive work.

"You can't start with a one-of-a-kind software package and end up with what a small business needs," he says. "They all get down to individualized packages, or they don't do the job they're designed for." One result is that "a class of free-lance software consultants who know a specific system is making a very good living following up on initial sales and cleaning up the snafus." In fact, Hosler expects that "computer screw-ups will reach catastrophic proportions."

They could be minimized if manufacturers would agree on having absolutely standardized programs and users would settle for fewer variations, he says. "But the evidence is we're going the other way as customers demand even more diversity."

### Cheaper testers will improve LSI, says Megatest's Bisset

If users inspected incoming devices themselves instead of farming the job out to testing services, the data they would feed back to suppliers would soon be getting them better large-scale integrated circuits, asserts Stephen Bisset, a 27-year-old electrical engineer from Australia. About 2½ years ago, he helped start Megatest Corp., an LSI-tester manufacturer in Sunnyvale, Calif. Last month, Megatest introduced a low-cost tester with a base price of only \$26,000 [*Electronics*, Nov. 10, p. 29].

"Users will now be able to justify in-house testing economically, and the amount of data being fed back to the semiconductor manufacturers will climb dramatically," Bisset claims. "This data will, in turn, enable the makers to tighten up on their own test programs and catch failures before they are shipped."

**Users limited.** The number of different companies performing tests has been relatively small, he points out, precisely because of the high



**"We saved \$42,000 by cutting down redrawing time the first year we switched to reprographic techniques."**

**Earl Lind, Graphics Supervisor  
Solar, an International  
Harvester Group, San Diego.**

"Solar makes gas turbines. Big ones. And they are shipped all over the world. Generally, each customer orders a slightly different version of the basic engine.

"Before we switched to reprographic techniques, we would redraft the entire drawing, even if the change was no more than 10%. Now we make a blowback from microfilm or create a same-size photo copy, opaque unwanted detail, then redraft as required. Or—if the changes are going to be minor—we reproduce it on wash-off film and let the drafter wet-erase what is not wanted and then draw in the new details.

"We figure—even with the limited mechanized processor we had when we first went to reprographics—that we saved \$42,000 in engineering drafting time the first year. And that saving was in spite of the fact that we had to start up a new facility and hire two technicians to run it.

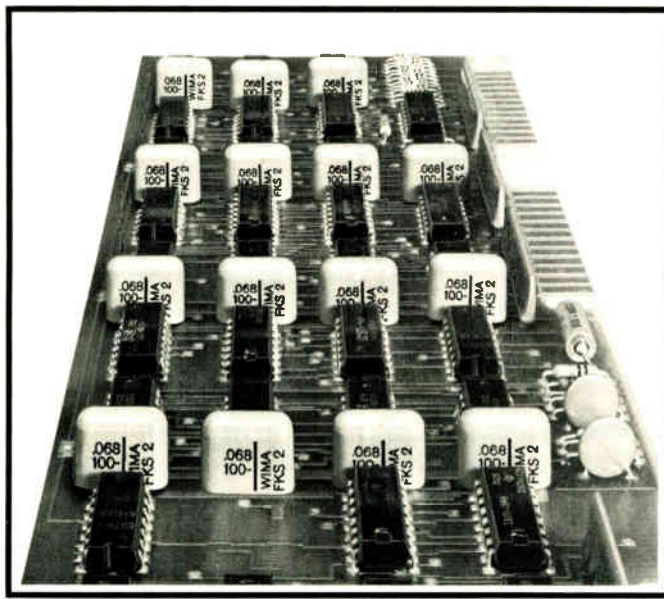
"Later we installed a Kodak Supermatic processor and relocated our drafting reproduction area next to our photo lab and copy camera area. As a result, we've found that we're saving about 50% of the processing time for the photo lab and the copy camera facility. Everything we turn out—from publicity photos to engineering drawings—is going through the Supermatic processor."

**Reprographics can help you, too.**

Send for more details about Solar's use of reprographic techniques, plus, a complete listing of Kodak products and other applications. Write: Eastman Kodak Company, Graphics Markets Division, Dept. R04804 Rochester, N.Y. 14650.

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# New Film-Foil Capacitors for low capacitance purposes

Features: High dielectric strength with high temperature stability. Cast resin encapsulation ensures complete moisture resistance. Aluminium foil electrodes and polyester dielectric.

**WIMA FKS 2** 5 mm lead spacing  
1000 pF to 0,015  $\mu$ F. Very low self inductance.  
Ideal where size is critical.

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Solid end contacts with low inductance. 1000 pF to 0,1  $\mu$ F. Space saving, general purpose range.



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**Tester.** Stephen Bisset says new instrument tests any LSI package with 40 pins

price of the testers. The price has been high because the testers have tried to be universal devices, able to handle all parts, Bisset states. Moreover, the new testers operate "without reducing the quality of testing," he says. In other words, they test for the same things the more expensive instruments test for.

Low price tags should win many more over to the new generation of equipment, themselves built with LSI devices and with real-time emulation modules that replace the buffer memory of the large programmable systems and duplicate the device under test. Indeed, Megatest's president predicts, his company should do \$5 million worth of business next year, largely with the new systems, a sizable jump up from this year's \$1 million.

Bisset came to the U.S. about eight years ago and got a BEE degree from California Institute of Technology. After working for Hewlett-Packard Co., he went to Intel Corp., where he was the architectural designer for many of the 8080 family of peripheral devices.

He expects to get involved in testing almost everything. "So far, we haven't run into a digital part with 40 or fewer pins that can't be tested with our system," he says.

# hp MEASUREMENT COMPUTATION NEWS

product advances from Hewlett-Packard

NOVEMBER 1977

## HP's new System 45: an efficient way to handle a small department's computing needs

In its compact, desktop-sized chassis, HP's new Series 9800 System 45 blends the speed and power of a minicomputer with the friendliness and convenience of a programmable desktop calculator. System 45 incorporates in a single package the high performance hardware and accessibility that scientists, engineers, designers and managers need to solve computational problems right in their own work area.

In less than 35.1 kilograms (77.5 pounds) System 45 integrates:

- an interactive keyboard with alphanumeric, control, editing, and special function keys.
- a dual processor that provides overlapped processing for increased throughput.
- a CRT with high-resolution graphics capability and an alphanumeric mode that offers an 80-character, 24-line screen.
- two built-in, 217k byte, high-speed tape transports, one of which is optional.
- 16k bytes of read/write memory expandable to 64k bytes.
- a unified mass storage that permits available storage devices to be addressed with device independent commands.
- ready-made I/O capability for BCD, bit parallel, bit serial, real-time clock and HP-IB interfaces.
- a powerful language—ANSI standard BASIC, with FORTRAN-like capabilities available on command—plus a library of utility and application programs.

For scientific computation and data analysis, System 45 handles data characterizations, statistical and numerical analyses, and other complex routines.



HP's new System 45 is an integrated system with built-in peripherals that provide a new level of speed, power and flexibility: easy-to-use turnkey system uses enhanced BASIC.

For computer aided design, System 45 places the entire design process directly under your control. It lets you display parts tables, parts cross sections, or produce complete drawings.

For data acquisition, System 45 interfaces directly with instrumentation, with 15 levels of interrupt for flexible control.

For business administration, System 45 lets you increase efficiency in various areas of business such as: forecasting, in-

ventory control, payroll, optimization and even text processing.

System 45 is also expandable. To meet your needs in the future, HP offers you an extensive line of peripherals including: flexible disks, large fixed discs (up to 50M bytes), a full page printer, plotters and more.

For more information, check B on the HP Reply Card.

## IN THIS ISSUE

Large P-N junction displays • SOS  $\mu$ P in two new 180 cps printers • New flexible synthesizer

# New signal source combines choice of waveform and high accuracy with easy programming

Extend signal capability of popular 8654 and 8640 generators down to 10 kHz

Its very wide frequency range of 0.001 Hz to 50 MHz makes the 8165A the fastest waveform generator of its kind. Output amplitude and signal quality satisfy many analog and digital applications. Its easy-to-use HP-IB interface ensures rapid system integration at minimum cost.

The 8165A programmable signal source generates precision sines, square waves, pulses and triangles. Crystal control provides a frequency accuracy of 0.001% across the entire range.

Its variable, 20V peak-to-peak amplitude, and clean, 5 ns transition time pulses are perfect for digital applications. Amplitude and offset are programmable with 2% accuracy to 5 MHz.

Microprocessor control sets new standards in operator convenience. Keyboard and LED's together with the instrument's high accuracy, allow direct entry and display of desired waveform parameters.

In systems, the intelligent 8165A cuts software development costs and computer

time. Keystroke programmable means identical control sequences for front panel and bus-entered commands. Programming mnemonics for all keys are indicated on the front panel. Error detection and learn mode are also provided.

The 8165A stores parameters for 10 complete waveforms. An entire waveform can be stored and subsequently recalled simply by pressing two panel keys or by a single program step. Batteries provide storage of all parameters for up to four weeks.

External trigger, synchronous gate, counted burst, VCO, FM and optional sweep modes provide the flexibility to use the 8165A in many different applications. The selectable 50 ohm source may be disabled, inverted or operated in dc mode. All specifications are guaranteed from 0 to 50°C for full confidence in system applications.

*For more information check K on the HP Reply Card.*



New HF down converter now covers test applications in the 10 kHz to 11 MHz band.

A new down-converter, HP 11710B, translates signal inputs of 50.01 to 61.00 MHz from RF signal sources such as the HP 8654 and 8640 to the 10 kHz to 11 MHz frequency range. This wider frequency coverage provides a convenient extension to other applications such as IF testing at 262 kHz.

The 11710B preserves both the AM or FM modulation of the input signal. In fact, it permits higher FM peak deviations than the generators themselves.

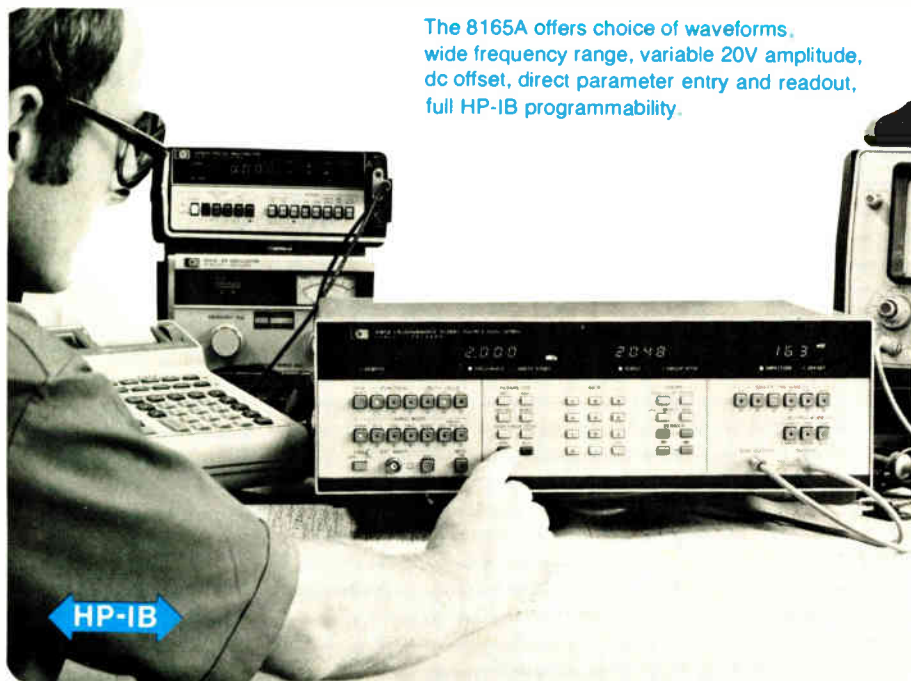
Output flatness is  $\pm 0.5$  dB referenced to 4 MHz and level accuracy is  $\pm (1 \text{ dB} + \text{input level accuracy})$ . Harmonics are greater than 35 dB below carrier (dBc) and spurious signals are below  $-60$  dBc.

The internal reference oscillator is stable enough to yield a drift of less than 0.05 ppm/hr. and typical overall frequency accuracy of  $\pm 2$  ppm.

A function selector allows straight-through switching so the total range (0.01 to 1100 MHz) of the signal source is available at the 11710B output port. Source inputs are tracked from 0 to  $-107$  dBm in the down-converted mode and there is less than 1 dB loss in the straight-through modes.

*For more information, check M on the HP Reply Card.*

The 8165A offers choice of waveforms, wide frequency range, variable 20V amplitude, dc offset, direct parameter entry and readout, full HP-IB programmability.



## Extensive program support for HP 67/97

Hewlett-Packard presents a large selection of problem-solving software for personal programmable calculators. The software works with the HP-67 and HP-97 calculators to provide solutions for a wide range of applications including engineering, science or business.

You can solve your computational problems without writing programs—by using the Application Pacs. And with our Users' Library Solutions, you follow the easy step-by-step instructions to enter the program yourself.

**Application Pacs.** Each Pac contains an instruction manual with up to 25 pre-programmed magnetic cards. Current Pacs include Statistics, Math, Business, Surveying, Games, Electrical and Mechanical Engineering—plus the new Navigation, Civil Engineering and Clinical Lab Pacs. They save you time and trouble researching, writing, debugging and documenting.

**The Users' Library.** Over 1000 HP-67/97 programs and over 5000 easily modified HP-65 programs are currently available from the Library.

**Users' Library Solutions Books** A series of comprehensive books containing the most popular programs from our Users' Library covering applications in Engineering, Home Construction Estimating, Aviation, Energy Conservation and more. Each booklet contains 10 to 12 programs.

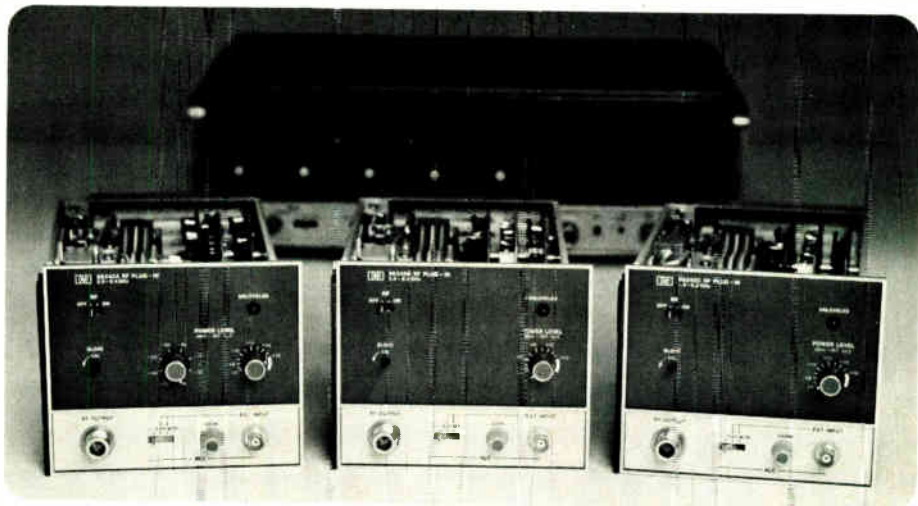
*For more details on these calculators and these programs, check A on the HP Reply Card.*



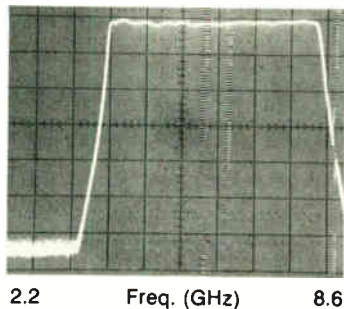
New software solutions for the HP-67 and HP-97 have been added to help increase your problem solving potential.

MEASUREMENT COMPUTATION NEWS

## New sweeper plug-ins offer expanded wideband performance



Double-octave and communications band RF plug-ins for HP 8620C sweeper provide 2.0 to 8.6 GHz frequency coverage.



Insertion characteristics of 4-8 GHz bandpass filter. Lower rejection band (left portion of trace) shows freedom from harmonics in HP 86240B RF source.

Three new RF plug-ins with double-octave frequency coverage have been added to the HP 8620 Sweep Oscillator family.

The new HP 86240B covers 2.0 to 8.4 GHz with up to 20 mW output (leveled to  $\pm 1/2$  dB), yet its harmonic content at 10 mW output is more than 50 dB down. This is achieved by incorporating a YIG filter into the same magnet housing containing

the oscillator-tuning YIG sphere. The high power is achieved through use of a 100 mW GaAs FET amplifier ahead of the YIG filter.

Model 86240A, the non-filtered version of the 86240B, delivers over 40 mW output, has competitively low harmonics, and is attractively priced.

With frequency coverage from 3.6 to 8.6 GHz, the new 86240C is the ideal upconverter for RF distortion analysis of 4, 6 and 8 GHz microwave radio links. Group delay is  $\leq 1$  ns over 30 MHz sweeps, and linearity is  $\leq 0.5\%$ . This plug-in delivers 40 mW output and has 10 MHz FM bandwidth for noise loading applications.

*For more information on these and other RF units for the 8620C sweeper, check N on the HP Reply Card.*

## HP Journal features NMOS-II

An article of interest, regarding HP's on-going research and development in LSI technology, is featured in the November 1977 issue of the HP Journal. It deals with HP's NMOS-II process, which made possible the high-performance, large-scale integrated circuits for fast 16-bit micro-

processors, 16k read-only memories and a variety of special purpose random-logic chips.

The newest product featuring NMOS-II is the System 45 (cover article).

*For your copy of the HP Journal, check P on the HP Reply Card.*

# New logic state analyzer is portable, totally programmable

## Can signature analysis make your service operation more efficient?



A new small but powerful logic state analyzer interacts with its user through an easy-to-master keyboard. And, it's programmability option provides the capability of a functional automatic digital test station.

The new 1602A logic state analyzer was designed for ease of use in production, field service and engineering. The layout of the keyboard leads you through a natural progression of keystrokes and entries are displayed, enabling you to check their accuracy every step of the way.

For use in design and troubleshooting of digital systems, the 16-bit wide and 64-word deep memory operates at clock speeds to 10 MHz, allowing the instrument to capture virtually any 64-word sequence in a system.

Measurements of system activity are displayed on the analyzer's LED readout in hexadecimal, decimal, octal, or binary format, eliminating the need for base conversions by the operator.

For more consistent and repeatable measurements, the HP Interface Bus op-

tion allows you to make automated functional tests of digital systems. The HP-IB option makes the 1602A totally programmable and able to dump its 64-word memory into the bus on command, for analysis by a desktop computing controller such as the HP 9825A.

Simplicity of use is also apparent in the quick connect and disconnect standard edge connector on the probe. Point-to-point probing on new equipment installed with similar connectors is now fast and easy. The single pod contains all 16 data lines, clock, qualifier and ground.

Weighing only 4.5 kg (ten pounds), it is small enough to fit into a briefcase. The price is small, too.

For more details, check E on the HP Reply Card.

There's a good chance that it can. HP and over 100 other companies are currently implementing this new digital service strategy. And, they are cutting repair times, reducing spares inventories and streamlining documentation.

Today's microprocessor-based products are tough to troubleshoot. Tomorrow's digital products may be tougher, and the costs of board exchange, the traditional digital service strategy, tend to escalate rapidly in fast-growth, high-technology product lines.

Design signature analysis into your new products. Document the troubleshooting procedures with the appropriate signatures. Then, use the HP 5004A Signature Analyzer for component-level troubleshooting:

- on-site
- at the field office
- at the service center
- on the production line

This portable tester detects and displays unique signatures associated with nodes in digital products. By comparing actual signatures to correct ones as shown in the product manual, a technician can backtrack to the faulty node in a malfunctioning product.

Check into signature analysis. Make your service operation more efficient and prepare for the future at the same time.

For a data sheet and an application note, check J on the HP Reply Card.



Many companies are streamlining field service of microprocessor-based products by troubleshooting to the component level with the 5004A signature analyzer.



## New 4½ digit autoranging DMM with 1 mΩ, 1 μV dc, 10 μV ac sensitivity

The new HP 3466A 4½ digit, six-function autoranging digital multimeter combines low cost with high accuracy for both bench and field use.

Dc measurements can be made from 1 μV to 1.2 kV with a mid-range accuracy of ±0.03%. True rms ac measurement range is from 10 μV to 1200 volts with a mid-range accuracy of ±0.03% over a 20 Hz to 100 kHz bandwidth.

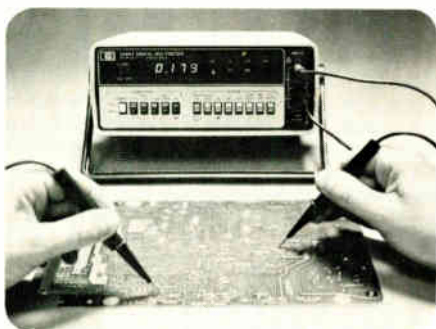
Ac and dc current measurement range is 10 nanoamps to two amps. Resistance range is 1 milliohm to 20 megohms with a mid-range accuracy of ±0.03%.

An ohm zero adjustment on the front panel is provided. Milliohms may be offset on the front panel, allowing the zeroing out of test leads when making printed circuit, transformer, coil, or switch contact measurements.

A new diode test measurement capability is offered. The 3466A DMM displays the voltage drop across the diode junction in the forward direction, allowing the user to measure and identify germanium, silicon, light-emitting and Schottky diodes in units of volts, even though the instrument is in the ohms function.

The standard HP 3466A includes rechargeable, lead-acid batteries which provide 8 hours of continuous use. Option 001 offers ac power only. Should battery power be required in the future, the DMM can easily be modified in the field.

*For more information, check H on the HP Reply Card.*



Because of its ability to make wideband selectable ac plus dc true rms voltage and current measurements, the new HP 3466A digital multimeter can also measure such signals as digital pulse trains and sinusoidal waveforms.

## Hard copy made easy with two new smart printers



A "smart printing" algorithm selects the optimal path and speed for the print head of two new printers. You also get high resolution print that is crisp, clear and readable—even on the sixth sheet of a multiple-part form.

Two new "smart" printers operating at 180 characters per second are now available from Hewlett-Packard. Both printers are controlled by a silicon-on-sapphire (SOS) microprocessor system designed by HP. The HP 2631 is designed for environments requiring a low-cost, high-performance printer. The HP 2635, with a keyboard, is suited to interactive environments.

The microprocessor control optimizes data manipulations, and printing and control functions. Consider the path taken by the print head. It is fast and bi-directional, that is, the printer chooses the most efficient direction to print: right to left or left to right, increasing throughput as much as 50%. By the time one line is printed, the next several lines have been processed and stored in a buffer.

When ten or more adjacent spaces have been detected within a line, the head speeds to the next printable character at an accelerated rate of 450 cps.

The HP 2631/2635 offer as standard

features those capabilities that are often optional on other printers. For example, there are three print modes that can be intermixed on a line—normal, expanded, (for titles and headings) and compressed. Vertical line spacing is variable under program control; the choices are 1, 2, 3, 4, 6, 8 or 12 lines per inch.

Both printers support the entire US ASCII 128-character set, including control codes which are accessible through the display functions. Use of a 7-column by 9-row dot matrix allows printing of true descenders, commas, semi-colons, and underlining. The printers also accommodate subscripts and superscripts.

A variety of interfaces are available including HP-IB, 8-bit duplex, 8-bit differential, and a general purpose parallel interface for OEM applications.

*For more information, check F on the HP Reply Card.*

# New HP-IB switches for automatic test systems



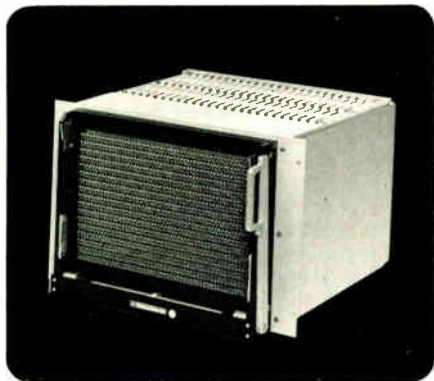
The availability of individual HP-IB switch products gives you modularity and flexibility in the design of your automatic test equipment (ATE) system.

These microprocessor-based switch products provide a flexible, high-performance and cost-effective solution for computer and desktop controller-based systems.



Up to 8 switch mainframes are controlled by the microprocessor-based **HP 9411A Switch Controller**, also capable of performing comprehensive self tests and fault isolation of all signal relays in the switching units.

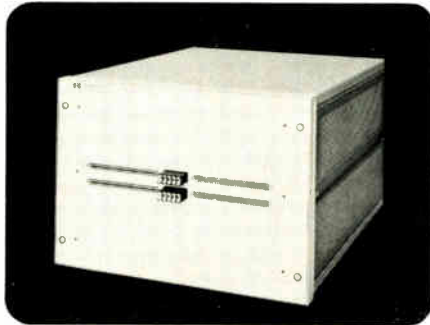
Three new switches provide commercially available solutions to an important part of the ATE system—connecting the system to the unit-under-test (UUT).



**HP 9412A Modular Switch** provides high-density, multi-function switching of signals up to 10 MHz. The built-in interface panel eliminates the massive cabling normally found in ATE switching configurations and significantly improves signal performance. The 9412A accommodates five types of switch cards in any combination up to a total of 25 cards.



**HP 9413A VHF Switch** provides flexible high-frequency switching of pulse and video signals up to 500 MHz. The unit accommodates up to 12 coaxial switch modules of two types: dual  $1 \times 4$  or single  $1 \times 8$ .



**HP 9414A Matrix Switch** provides maximum flexibility for high-density, high-performance switching, allowing any UUT pin to be switched to any instrument in the ATE system. The 16-input Matrix Switch can be configured in 30-pin increments (UUT pins) up to 120 pins, expandable to 240 pins.

New automatic test systems are also available from Hewlett-Packard complete with HP-IB hardware and new software. The system controller is the HP 1000 with HP's powerful Real Time Executive (RTE) operating system. RTE allows concurrent program preparation and testing. Comprehensive test program languages are available including BASIC, FORTRAN IV and TESTAID-III for digital testing.

*For more information on individual HP-IB switch products and the new generation HP automatic test system, check L on the HP Reply Card.*

## Current tracing: a better way to detect supply to ground shorts

You've got a tight schedule to meet and those five bad boards on your desk can make the difference. Unfortunately, every one of them has a power supply to ground short and you don't have the time it takes to repair them. Each of the boards is valuable, so you don't want to scrap them, but it would take a couple of hours to fix each one and when you were finished, chances are the circuit traces would be damaged, IC legs cut and resoldered, or worse.

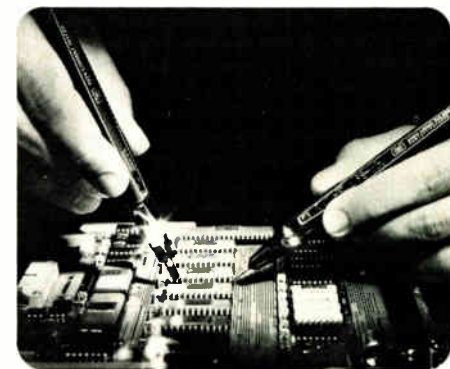
Well, there's a better way—current tracing. This technique allows you to find  $V_{cc}$  to ground shorts in minutes, using two powerful hand-held IC troubleshooters from HP.

One, the 546A Logic Pulser, is connected between supply and ground on the unpowered faulty board and push-button programmed to output a 100 Hz pulse stream. The pulser delivers 650 mA current pulses that are easy to trace right to the one faulty point on the board.

The 547A Current Tracer allows you to find faults based on one simple principle: current flows to the lowest impedance point in a circuit, in this case a short between  $V_{cc}$  and ground. So, just adjust the sensitivity control so the tracer's lamp is about half-brilliance and follow current pulses to the fault.

No board scrapping, no trace cutting, no unnecessary unsoldering and still the boards are repaired in a fraction of the time possible using any other method.

*For more information, check C on the HP Reply Card.*



**HP's 546A Pulser and 547A Tracer help locate logic damage to the circuit under test.**

## Sliding load for 3.5mm coaxial lines operates from 2.0 to 26.5 GHz

For impedance measurements in coaxial transmission lines, the ultimate standard for a matched line is a sliding load. By sliding the load element along the line, its own small reflection effect can be eliminated.

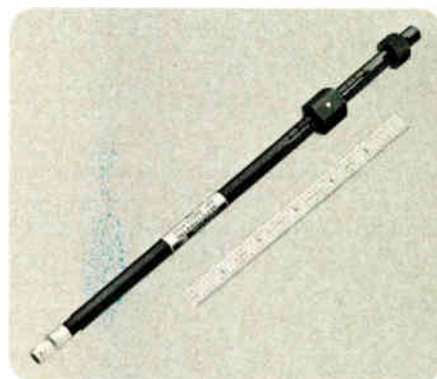
Since the new APC-3.5 connector now permits design activity in 3.5 mm coaxial lines above 18 GHz, HP's new 911C sliding load will provide for more accurate measurements from 2.0 to 26.5 GHz.

The 911C features interchangeable APC-3.5 fittings—either male or female connectors may be checked. For minimum discontinuity, the center con-

ductor slides and locks. The movable terminating element has 5.5 cm travel—greater than  $\lambda/4$  at the lowest operating frequency.

The connector and transmission line reflection coefficient for the female configuration is  $<.02 + .001 \times f$  (where  $f$  is frequency in GHz) 2 to 26.5 GHz. The male version is  $<.02$  across the full band. For the load element itself, the maximum reflection coefficient is  $<0.01$  from 2 to 10 GHz and  $<0.035$  from 10 to 26.5 GHz.

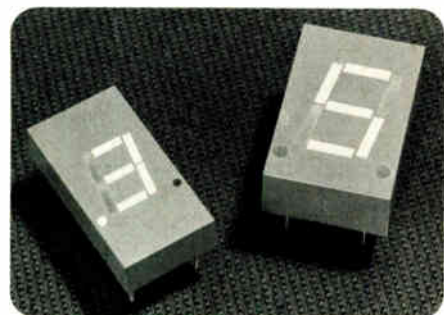
*For details, check D on the HP Reply Card.*



New sliding load provides well matched termination for APC-3.5 component test.

## HEWLETT-PACKARD COMPONENT NEWS

### New displays with high light output



New large junction seven-segment displays are categorized for luminous intensity.

Now available from Hewlett-Packard are new, high-efficiency red, and yellow displays designed for use in high light ambient conditions.

Output is typically 2300 millicandellas per segment at 100 mA peak, 20 mA average. These displays are designed for use in instruments, airplane cockpits, weighing scales and point of sale terminals.

The seven-segment displays offer a wide viewing angle and are easily mounted on P.C. boards or sockets. DIP spacing is the industry standard 7.62 mm

(0.3 in.) on 2.54 mm (0.1 in.) centers.

The HDSP-3530/4030 are 7.62 mm (0.3 in) high while the HDSP-3730/4130 are 10.9 mm (0.43 in). These devices utilize high efficiency LED chips made from GaAsP on a transparent GaP substrate. The LEDs have a large area P-N junction permitting higher peak currents.

*For more specifications, check I on the HP Reply Card.*

### HP publishes optoelectronics applications manual

Practical solutions to the most common applications problems of optoelectronic devices are fully analyzed in Hewlett-Packard's *Optoelectronics Applications Manual*, one of the first books on these versatile design tools from a leading firm in the field.

The *Manual* covers such subjects as photometry/radiometry, contrast enhancement in visible displays, and reliability of optoelectronic components and their mechanical handling.

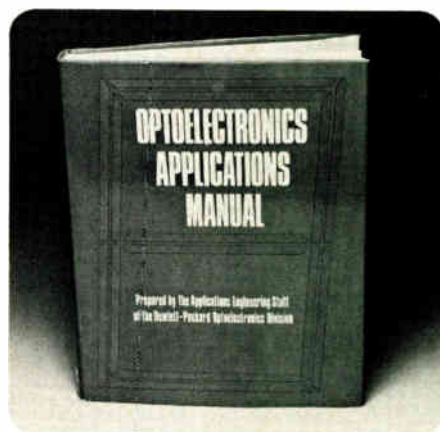
Designed both as a practical guide to the use of optoelectronic devices and as a foundation for the development of new de-

sign ideas, this volume demonstrates the broad potential for these components that exists in systems being designed today.

Of special interest to experienced designers is the *Manual's* treatment of CTR degradation, a controversial and frequently misunderstood subject among users of optically coupled isolators.

Members of the applications engineering staff of the Hewlett-Packard Optoelectronics Division were involved in the preparation of the *Manual*, published by McGraw-Hill.

Copies are available from your HP franchised distributor.



# Flexible synthesizer uses $\mu$ P for FDM testing and other applications requiring precision signal source

The new 200 Hz to 80 MHz HP 3335A Synthesizer/Level Generator is designed for frequency division multiplex (FDM) testing as well as traditional synthesizer applications such as testing filters, mixers, phase detectors, attenuators or modulators.

With a resolution of 0.001 Hz and amplitude flatness of 0.15 dB over its entire range, the 3335A is useful for applications including testing of low-density carrier, radio baseband, high density cable carrier, in R & D, and in production tests. For automated instrumentation systems, the unit includes the HP Interface Bus as standard.

Microprocessor control provides flexibility in this moderate cost, high resolution synthesizer. In the sweep mode, the microprocessor computes the individual frequencies on each side of the center frequency and then controls automatic, manual and single sweep modes. At turn-on, the  $\mu$ P sets the instrument to 1 MHz and minimum amplitude so output loads will not be damaged.

Up to ten different instrument settings including frequency, amplitude, sweep width and center frequency may be stored in the ten memory registers for later recall—useful in a production environment where a specific list of repetitive test functions must be performed.



New microprocessor-based frequency synthesizer is used in applications wherever a high resolution, precision amplitude test signal is needed.

The 3335A synthesizer may be used as a tracking generator for the HP 3745A/B Selective Level Measuring Set for fast, accurate loop-back measurements and for end-to-end measurements. For unattended performance checks of systems on-line or for offset tracking of systems off-line, the generator/receiver system may be controlled via the HP Interface Bus.

Standard version of the 3335A synthesizer provides 50 and 75-ohm unbalanced outputs. Other options accommodate North American and CCITT communications applications.

For additional information on the synthesizer, check G on the HP Reply Card. For details on the 3745A/B SLMS, check O on the HP Reply Card.

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**COMPUTATION**

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November/December 1977

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System 45 .....	\$11,500	HDSP-3530 4030 .....	\$2.05
546A .....	\$175	(Qty. 1000)	
547A .....	\$350	HDSP-3730 4130 .....	\$2.25
911C .....	\$720	(Qty. 1000)	
1602A .....	\$1,800	5004A .....	\$990
Opt. 001, add .....	\$300	8165 .....	\$6,000
2631 .....	\$3,150	9411A .....	\$2,350
2635 .....	\$3,450	11710B .....	\$950
3335A .....	\$7,000	86240A .....	\$3,750
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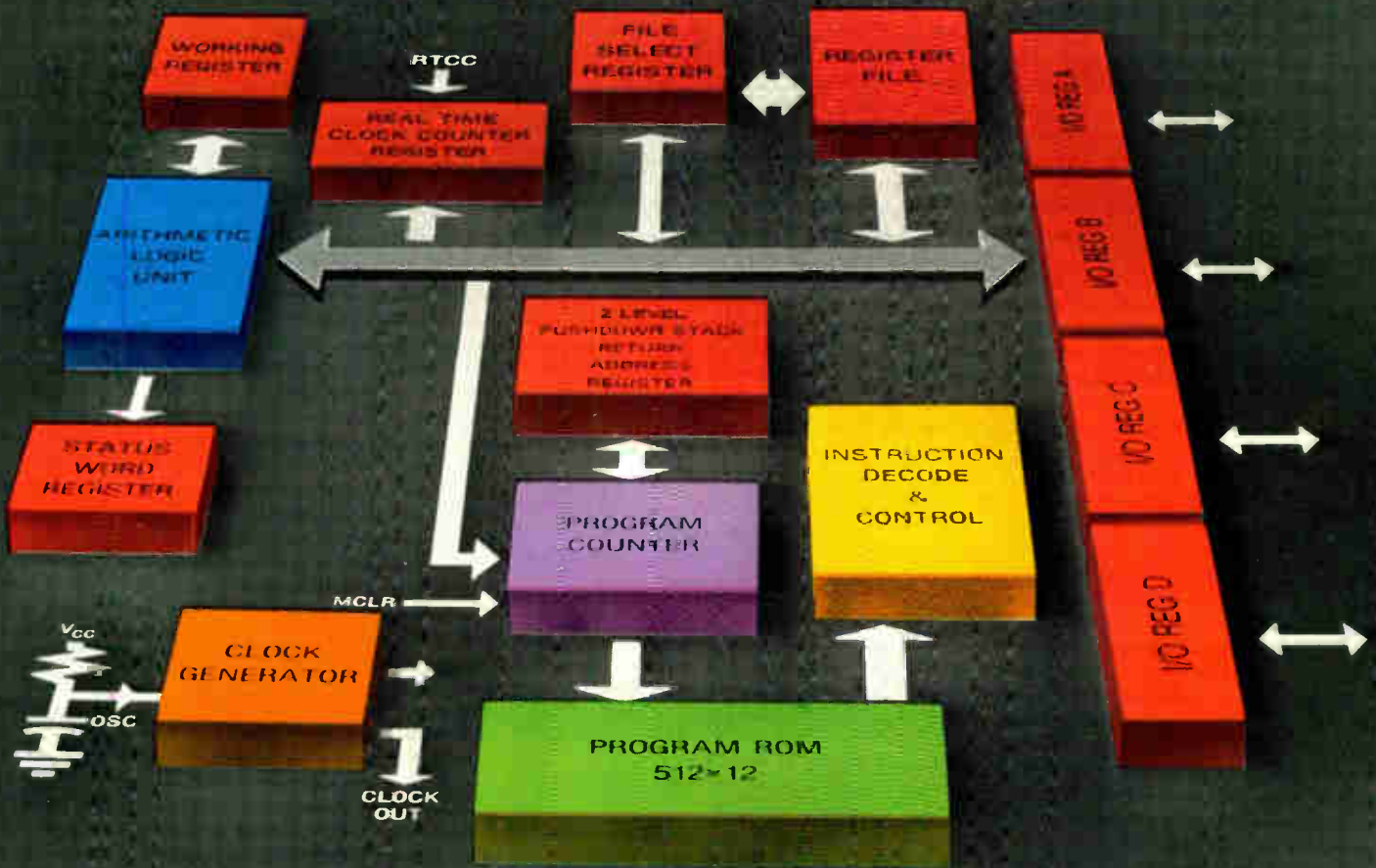
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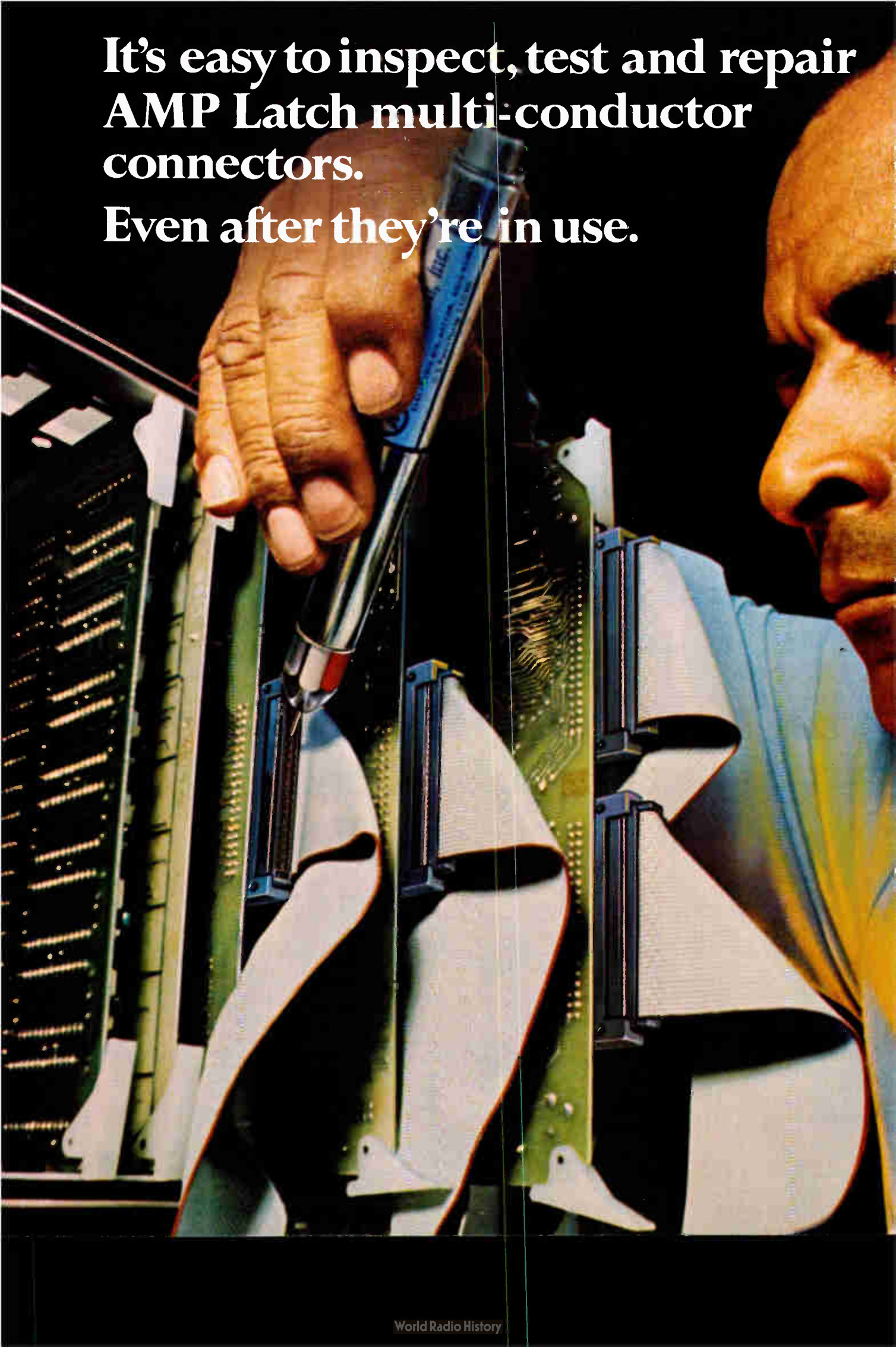
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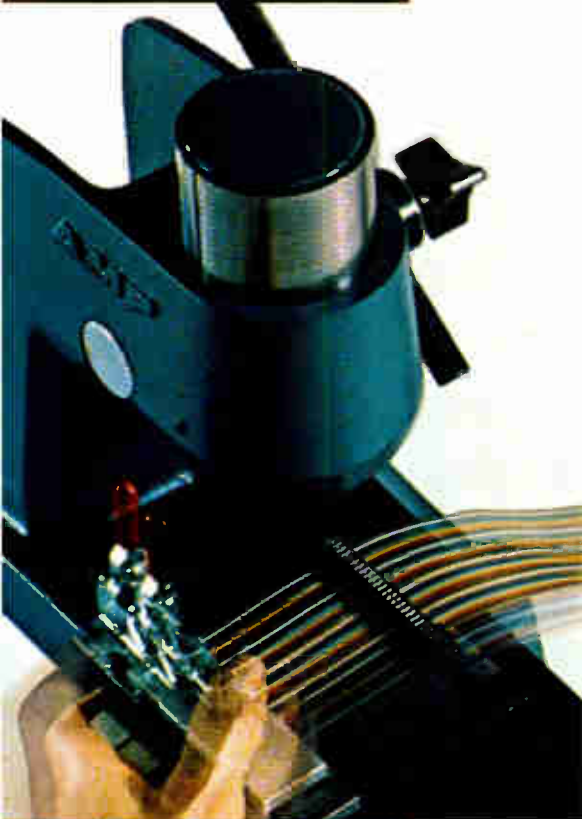
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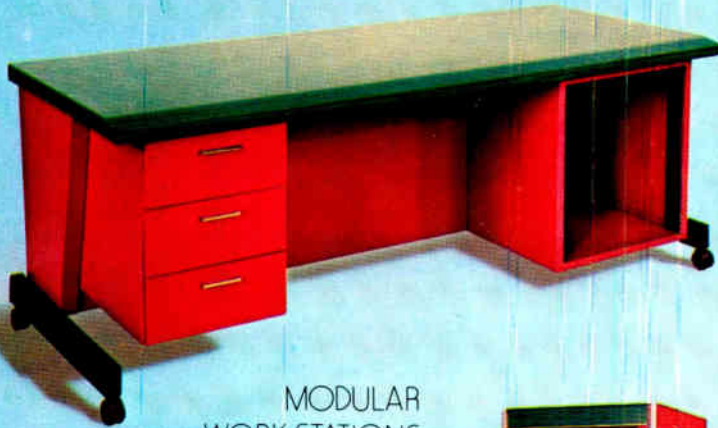
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## Meetings

**Electro-Time/77 U. S.—Design and Manufacture of Electronic Watches**, International Society for Hybrid Microelectronics, Florida Chapter, Marco Beach Hotel, Marco Island, Fla., Dec. 1-2.

**Semiconductor Interface Specialists Conference**, IEEE, Carillon Hotel, Miami Beach, Dec. 1-3.

**Chicago Fall Conference on Consumer Electronics**, IEEE, Ramada-O'Hare Inn, Des Plaines, Ill., Dec. 5-6.

**International Electron Devices Meeting**, IEEE, Washington Hilton Hotel, Washington, D. C., Dec. 5-7.

**National Telecommunications Conference**, IEEE, Marriott Hotel, Los Angeles, Dec. 5-7.

**1977 Winter Simulation Conference**, IEEE, National Bureau of Standards, Gaithersburg, Md., Dec. 5-7.

**Miami International Conference on Alternative Energy Sources**, U. S. Energy Research and Development Administration et al., Fontainebleau Hotel, Miami Beach, Dec. 5-7.

**Computer Networks Symposium**, National Bureau of Standards, Gaithersburg, Md., Dec. 15.

**1978 Winter Consumer Electronics Show**, Electronic Industries Association, Las Vegas Convention Center and Hilton Hotel, Las Vegas, Jan. 5-8.

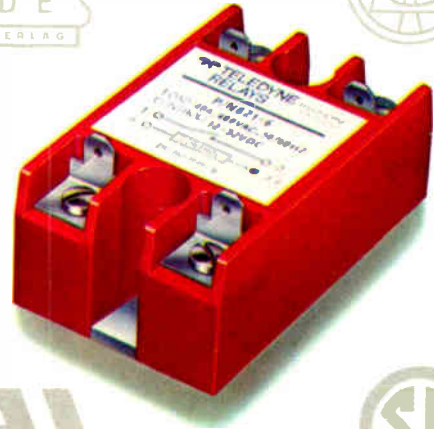
**Conference on Integrated and Guided Wave Optics**, IEEE, Salt Lake Hilton, Salt Lake City, Utah, Jan. 16-18.

**Reliability and Maintainability Conference**, IEEE, Biltmore Hotel, Los Angeles, Jan. 24-26.

**Power Engineering Society Winter Meeting**, IEEE, Statler Hilton Hotel, New York, Jan. 29-Feb. 3.

**International Solid State Circuits Conference**, IEEE, San Francisco Hilton, San Francisco, Feb. 15-17.

# Our International Connection



The European market demanded a high voltage AC solid state relay with a challenging combination of performance features such as:

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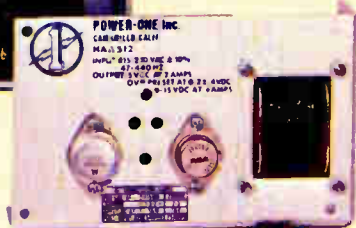
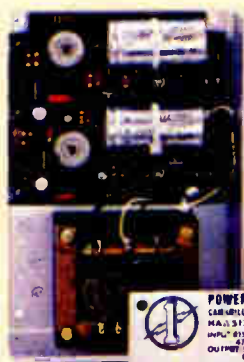
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Power-One shipped its first open frame power supply in May, 1973. We've now crossed the quarter-million mark. Over 100,000 units were delivered last year alone. That makes Power-One the largest producer of open frame power supplies in the world.

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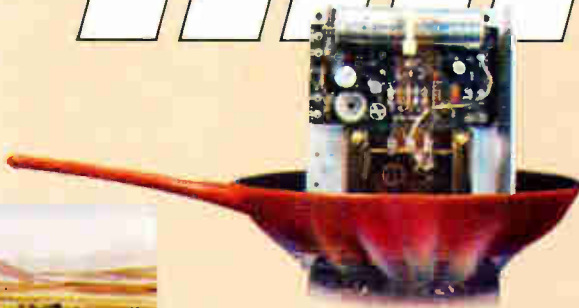


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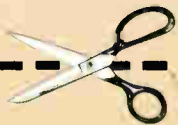
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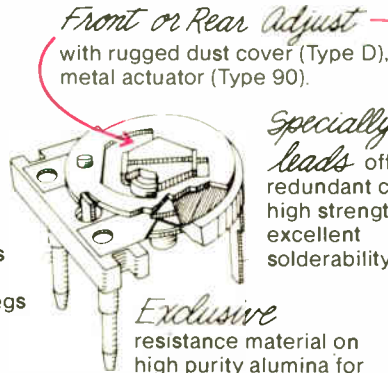
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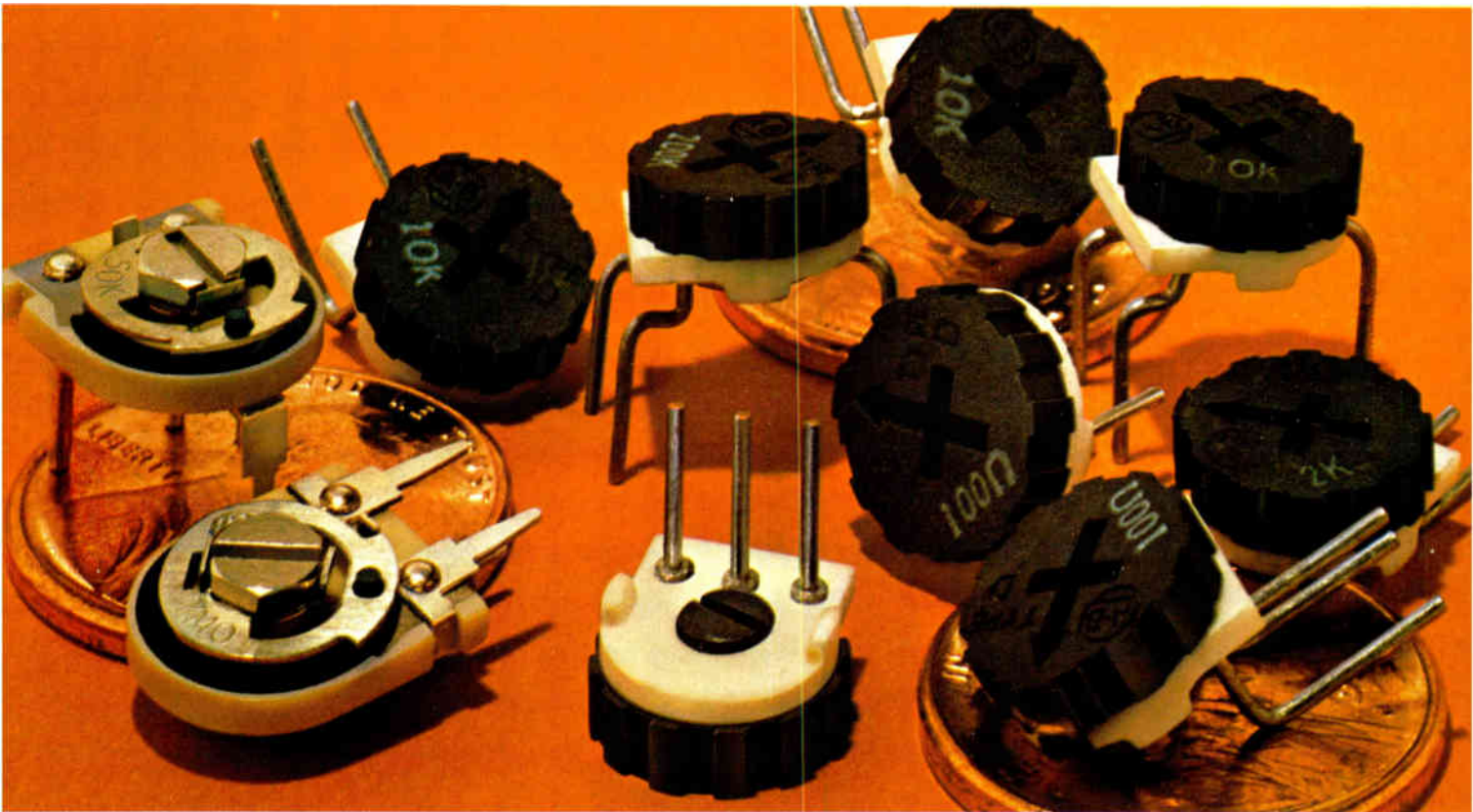
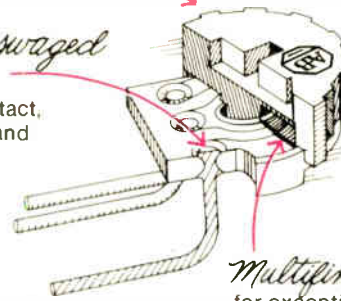


*Specially swaged leads* offer redundant contact, high strength and excellent solderability.

*Exclusive* resistance material on high purity alumina for low TCR and CRV. Typical TCR for Type D is less than  $\pm 35$  PPM/°C.

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## **HP producing daylight LEDs for outdoor display**

The light-emitting diode is coming out of the dark to compete with liquid-crystal, incandescent, gas-discharge, and other display technologies for daylight applications. That is the view of Hewlett-Packard Co., which is selling discrete **red and yellow LEDs that can be viewed in direct sunlight or in ambient lighting as bright as 10,000 foot-candles.** To get that performance, HP has developed a high-contrast gray package and high-efficiency chips with large, active pn junctions.

For direct viewing in sunlight, however, the customer would use a commercially available acrylic neutral-density gray filter to block out the sun's rays. The seven-segment displays are aimed at automotive, avionic, instrumentation, and measurement markets.

## **Analogic to sell I/O subsystems to end users . . .**

Analogic Corp., which has been quietly supplying analog input/output subsystems on an OEM basis to such firms as Intel, Zilog, and Texas Instruments, is about to enter the end-user market with its own series of I/O subsystems for the TI TM-990 16-bit microcomputer family. The Wakefield, Mass., company is not saying much in advance of a formal introduction Nov. 30., **but the input board is believed to be built around the firm's MP 6812 modular data-acquisition system.** The output board is expected to use Analogic's MP 1480 industrial digital-to-analog converter module, offering 12 bits of current or voltage output.

## **. . . as Analog Devices races for same market**

Meanwhile, Analog Devices Inc., in Norwood, Mass., is racing to have similar I/O subsystems ready for the TM-990/100 next month instead of next February as planned earlier [*Electronics*, Sept. 15, p. 33]. **There are three boards in the Analog Devices line.** The RTI-1240 analog input board has up to 32 single-ended or 16 differential channels. The RTI-1241 offers those same channels, the same optional resistor programmable-gain instrumentation amplifier, and two 12-bit d-a converters and optional 4-to-20-mA current loop outputs. The third board, the RTI-1242, includes eight software-programmable high-current logic driver outputs and eight analog output channels using 12-bit d-a converters. Only the 1242 will be ready in December; the others, in January.

## **Japanese VLSI chief to speak on first day of IEDM conclave**

Engineers at the International Electron Devices Meeting in Washington, D. C., Dec. 5 to 8, will be treated to something besides the sessions on circuit and device technology that are the meat of the conference. The special feature: a scheduled appearance on Dec. 5 of **Yasuo Tarui, head of Japan's VLSI laboratory.** Tarui, one of the most knowledgeable semiconductor specialists in Japan, will offer a comprehensive view of Japanese semiconductor technology, concentrating on present and future large-scale and very-large-scale integration techniques.

## **Bay State group aims to flight taxes, fill jobs**

Concerned with problems they say are inhibiting their growth in the state, executives of 37 high-technology companies have formed the Massachusetts High Technology Council to try to solve those problems. **At least 20 member companies are from the electronics industries,** with Ray Stata, chairman and president of Analog Devices, serving as council president.

Council estimates for 1983 show that for every job created in Massachusetts by high-technology companies, one will be created outside the state

by those same companies. Stata says the council will work with government and educational institutions to better match the skills of the labor force with the needs of member companies and to slow state and local spending to relieve the individual tax burden.

## **MicroNova enhanced for communications market push**

In an effort to sell its microNova microcomputers in the communications and industrial markets, Data General Corp. is announcing 11 hardware products and 7 software packages. Most of the software is from the firm's minicomputer line. Communications enhancements include control and multiplexing boards that, together with control and emulation software, **will allow the microNova to communicate with IBM-compatible systems** over various high-speed protocols.

## **Subsystem ATE market to reach \$162 million by 1980**

The automatic test equipment market for subsystem testing is expected to grow from \$78 million last year to \$162 million in 1980, a compound annual growth rate of over 20%, forecasts Prime Data Inc. of San Jose, Calif. In its new 201-page report, "Subsystem Testing," the market-research firm predicts **U. S. manufacturers' shipments of ATE for circuit-board testing will more than double** from \$62 million in 1976 to \$135 million in 1980, with hybrid testers accounting for \$69 million.

## **New design center developing custom 16-bit processor**

Perkin-Elmer Corp.'s Data Systems Group in Tinton Falls, N. J., is developing a custom 16-bit microprocessor tailored to the needs of its Interdata (small computers), Wangco (mass storage devices), and Terminals (video displays and printers) divisions. **The n-MOS processor is expected to be available in 1978**, as its design and architecture are already defined. Circuit detail and implementation of the design are under way at the group's new LSI Design Center, the nucleus of which is the former Precision Micro Design Inc. of Scotts Valley, Calif., acquired last month.

## **Multipplier chip from Raytheon to be accurate to 0.1%**

Monolithic analog multipliers are generally accurate to within only 1% or so. But Raytheon Semiconductor of Mountain View, Calif., using proprietary circuit techniques, **is about to introduce a chip that compensates for nonlinearity, holding it to as little as 0.1%**, which is as good as that offered by many modular devices. Priced at \$6.50 in hundreds, the upcoming RC4200 is targeted for use in low-distortion audio modulation circuits, voltage-controlled active filters, and precision oscillators. It is a current, rather than a voltage, device and produces an output that is the product of two input currents divided by a third.

## **Addenda**

Look for Allen-Bradley Co. to **move its domestic components manufacturing from Milwaukee to El Paso and San Antonio, Texas**, over the next three years. The reason: none of its competitors' resistor plants is in a big industrial city, and it figures it can save about 60% on labor by phasing out over 1,200 Milwaukee jobs. . . . RCA Corp.'s major businesses are all profitable **except for RCA American Communications Inc.** in Piscataway, N.J., says president Edgar H. Griffiths. But, he adds, Americom "probably will cross into profitability in 1979."



# While others promise to improve 2901 Bit-Slice performance, Signetics delivers the promise.

**Introducing the Signetics 2901-1. It's 30% faster than the 2901, and distributors have it now.**

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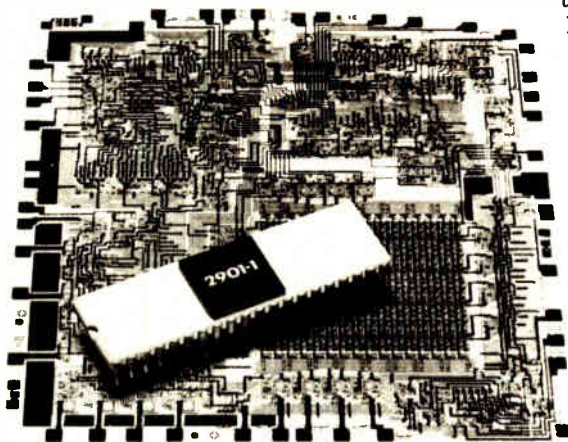
It's great for emulating minicomputers—or for designing high-performance controllers for tape/disk systems and communications networks. And it's available today in large production volume.

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There are many good reasons to select the Signetics bit-slice for your high-performance application. Aside from the fact that the part is very reliable, available today and 30% faster than the 2901 — Signetics provides unmatched product support.

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82S115*	Bipolar PROM 512x8	82S16*	Bipolar 256x1 RAM
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82S146/147*	Bipolar PROM 512x8 (Fast)	8T28*	Non-inverting Bipolar Quad Bus Transceiver
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82S184/185*	Bipolar PROM 2048x4	8T98*	Inverting Bipolar Hex Tri State Buffers
82S190/191	Bipolar PROM 2048x8	8T98*	Inverting Bipolar Hex Tri State Buffers
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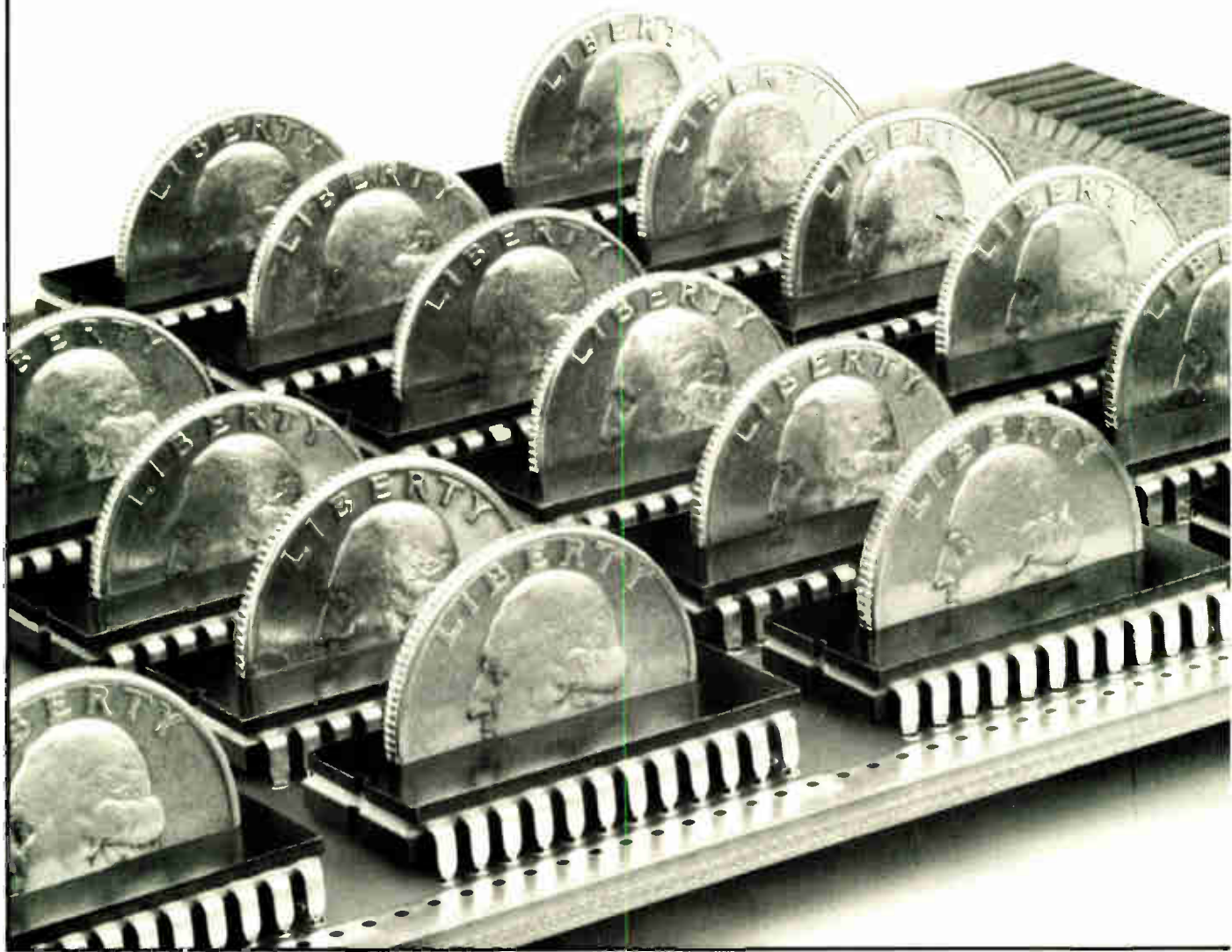
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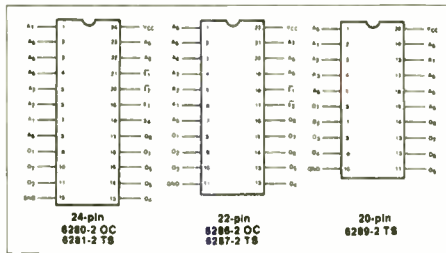
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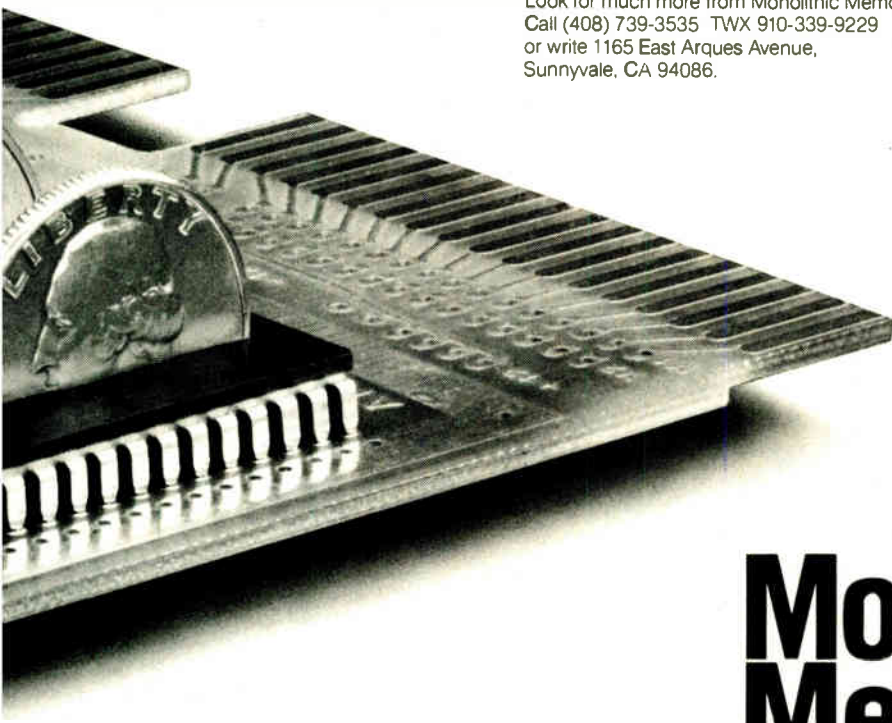
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Circle 40 on reader service card



## Two heads give minifloppy on-line 0.4-megabyte store

Shugart drive unit reads both sides of 5 1/4-inch disk without flipping it; other makers likely to follow suit

Two heads are certainly better than one for the midget minifloppy disks, since a read/write head for each side of the disk means twice the storage capacity. And for Shugart Associates Inc., it means nearly a half megabyte of storage on a 5 1/4-inch-diameter flexible disk—not bad for what started out last year as a low-cost source of about 110 kilobytes of memory for word processors.

"Users want more on-line capacity," says W. Ferrell Sanders, vice president of marketing at Shugart in Sunnyvale, Calif. "Since we put two heads on our standard [8-in.] floppy drive in April, people have been asking when we would do it on the minifloppy." The miniature disk's unformatted capacity with double-density encoding is 437.5 kilobytes. Formatting reduces this capacity to about 320 kilobytes.

**No flipping.** Merely using both sides of the disk is not new. Information Terminals Corp., the Sunnyvale, Calif., media maker, sells its two-sided Flippy minidiskette to drive makers like Wangco Inc. and Pertec Computer Corp.'s icom division. But the user must flip the disk over, like a phonograph record.

But "having a lot of storage is not as important as having it on line," maintains George H. Sollman, director of product management at Shugart. "People don't want to flip a disk over, any more than they want

to slip a new one in."

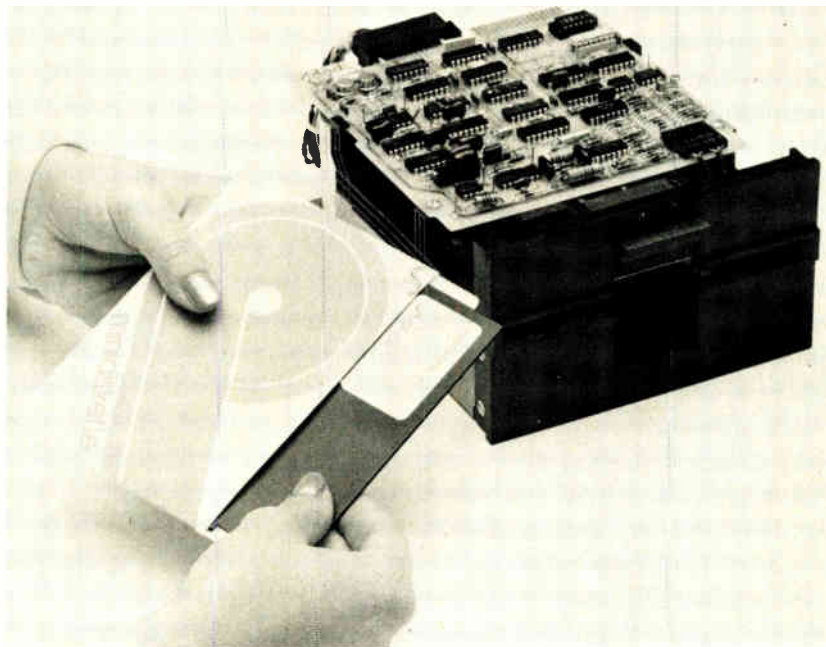
Others agree that customers are hungry for on-line storage. Says Ray Brooke, flexible-disk program manager in Pertec's Microsystems division, Woodland Hills, Calif., "We have to promise all new customers that our forthcoming double-sided drive isn't far off." At Wangco, product marketing manager Barrie Clark is looking to go double-sided on his standard floppy the first part of next year, with the two-headed minifloppy to follow shortly after.

While Shugart can claim compatibility between its new double-sided model 450 and its older model 400—single-sided disks can be "played" on the 450—manufacturers using the

Flippy technology might have trouble. According to Sollman, by originally one-upping Shugart with 40 tracks instead of 35 on their disks for more storage, both Wangco and Pertec may have sacrificed compatibility with a double-sided future. This is because, for assembly purposes, "the heads must be offset by at least four tracks," Sollman says.

With the heads offset, the tracks must be offset too. The 40th track on the under side of the disk lies in toward the disk's center, where track 44 would be on a single-sided disk. Bit densities are the highest there, and data is not reliable enough.

The question of reliability at position 44 is not challenged. Says



**Doubling up.** Shugart's model 450 minifloppy drive records on both sides of the small diskette. Up to 437.5 kilobytes can be recorded using double-density encoding.

Wangco's Clark: "We plan to drop back to 35 tracks per side when we go to two heads. We're not worried about compatibility between [our older flipped] single- and [the new] doubled-sided disks; after all, data on the flip side of the disk would run backwards on a two-headed drive."

**Still readable.** However, Pertec's Brooke says it wants to be able to read its present 40-track diskettes. Accordingly, the head positioner in its drive will be able to travel to the 44th track position. But, counters Sollman, "the window in the [polyvinyl chloride] envelope protecting the diskettes doesn't extend far enough to allow a head to reach the 44th position; special envelopes could be made up, but if a standard

diskette was ever used, it would destroy a head's spring gimbal."

Besides simply adding another head, Shugart improved the access time of its model 450 to 25 milliseconds track to track, as opposed to the 400's 40 ms, and also reduced the error rate to one bit in  $10^9$  from 1 in  $10^8$  for recoverable errors. Shugart expects the doubled-sided drive to phase out the one-siders, since the features represent a premium of about only 25% over the cost of the single-sided drives.

The model 450 drive has a unit quantity price of \$450, while the 400 sells for \$355. Discounts to original-equipment manufacturers reduce these numbers to \$320 and \$255 in quantities of a hundred. □

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## Microprocessors

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### Microprocessor-maker Zilog offers wide choice of programming languages

With the introduction of compilers for high-level Cobol and Fortran [*Electronics*, October 27, p. 34], hard-charging Zilog Corp. soon will have six languages for all of its microprocessors, including the pace-setting Z-80, the upcoming Z-8 one-chip controller, and the Z-8000 16-bit machine. Next month it will announce business and scientific versions of Basic, which will be followed by two members of its own high-level family of systems-oriented languages called PLZ.

In offering a wide choice of applications-oriented and system-implementation languages, the high-flying Cupertino, Calif., company is putting more pressure on its microprocessor competitors. The reason, for the move, declares Ralph K. Ungermann, executive vice president, is that "high-level languages will be absolutely essential in the next few years" as microcomputers get designed into more complex systems. "If you don't offer them, you'll be locked out of the market."

He adds that Zilog is going to high-level languages because in any microcomputer system, software

amounts to most of the cost. A high-level language lets a user cut those costs, he says. Thus, Zilog, as a software-oriented chip maker, believes it has an edge. But its competitors are following suit. Intel Corp., for one, is about to unveil a Fortran compiler to add to its PL/M applications-oriented language for its microcomputers and could have other languages on the way.

Most microprocessor companies offer only low-level assembly languages that merely instruct the processor through routing and branching routines, with no block structuring. These inflexible programs cannot cope with increasingly sophisticated applications.

**Program arsenal.** In the compilers for block-structured, high-level languages, Zilog presents the applications engineer with an arsenal of applications-oriented programs. But even these "solve only half the problem, because many systems engineers want to write their own software," Ungermann explains. "You have to have a system-implementation language—a high-level language for operating systems."

Zilog thinks that the PLZ family meets the three basic criteria it has established for such a system-implementation language for microprocessors. "You have to get into the architecture of the machine," Ungermann explains. "You have to deal with interrupts; you have to have the ability to write inside the machine and write in a high-level language." Secondly, the language has to generate very efficient code, because microcomputers have limited address capability. Finally, the compiler must be simple to implement, since a microprocessor-based system has a limited memory.

**Characteristics.** Such systems languages must also have high-level structures, instead of the routing and branching of assembly languages, says Charlie Bass, software department technical director. For PLZ, Zilog aimed at three structural characteristics: how to declare the data, how to control the program flow, and how to manipulate data. The first two characteristics are handled by a specially devised syntax common to all the PLZ languages in the family, Bass adds. Only the third will differ from the other programs in the family.

The first two family members that Zilog has put together are the PLZ/ASM assembly language and the PLZ/SYS systems language. Due next year from the semiconductor maker are one for dynamic allocation of data for large list-processing applications, one for elaborate mathematics for scientific applications and one for text processing. Since the PLZ/ASM is an assembly language, "you have the full power of the Z-80 available to you," Bass says.

The common syntax among the PLZ family programs should be easy for anyone familiar with any Algol-like language, such as Pascal or PL-1, he continues, and "I can teach them within one hour." The entire grammar for the common syntax fills only two 8½-by-11-inch pages. The important thing is that the user "can translate that syntax onto the machine with no loss of efficiency," Bass says. □

## Microprocessors

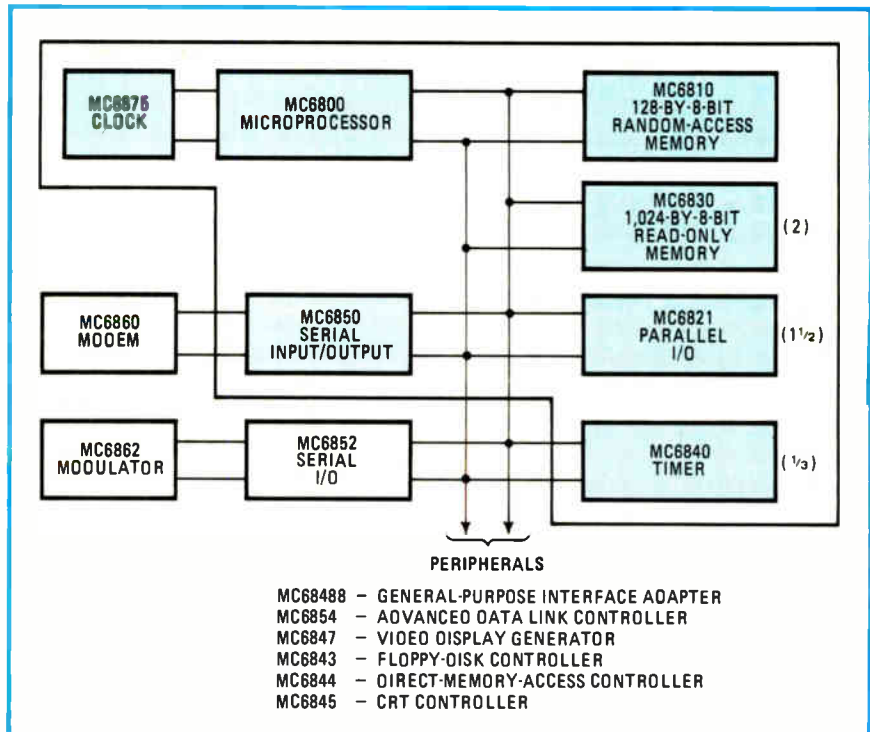
### Motorola promises powerful one-chip

Semiconductor makers have been quick to turn their microprocessor development efforts toward the aspect of the business they like best: churning out high volumes of low-cost single-chip parts. Motorola Inc., however, has taken its time. While its new MC6801 will be a late entry in the one-chip microcomputer derby [*Electronics*, Sept. 29, p. 69], it should be the most powerful one yet.

To be available in samples in July, 1978, the Motorola device is designed to combine most of the functions of the six-chip-minimum MC6800 system while retaining the full software compatibility that allows it to take advantage of existing peripherals. But Motorola has added several new features that set it above its competitors as a stand-alone controller.

For example, the 6801 offers its parents' 72 instructions and sports several more, including an 8-by-8-bit hardware multiply that hints at a 16-bit internal arithmetic capability—allowing a system designer to pare his memory requirements and enhance his throughput. "We'll still offer 1.0-, 1.5-, and 2.0-megahertz speeds," says Gary J. Summers, marketing manager for n-channel MOS microcomputers at the firm's Austin, Texas, facility (see p. 75), "but throughput will be substantially greater because of the new instructions."

The part also features an innovative serial input/output capability that lets it work in serial and parallel modes simultaneously. Up to 30 lines can be used for I/O when the device is configured as a stand-alone controller, or it can be expanded to address a full 8,192 bytes of additional memory. In either case, two I/O lines can be channeled back into the chip's serial I/O section. That means two 6801s can communicate using only two lines, instead of the usual 8 or 16, leaving as many as 56 lines in a paired system free for other



**Full.** Motorola's 6801 single-chip microcomputer has the 6800's processor, clock, and serial I/O functions plus 128 bytes of RAM, 1,024 bytes of ROM (twice the capacity of the 6830 ROM), 1½ times the 6821's parallel I/O, and timer functions.

### Motorola plans high-end microprocessor too

Motorola is not ignoring the high end of the microprocessor business—it is also readying a beefed-up version of its MC6800 system. For the new MC6809, the firm is discarding the software common to the rest of the family in favor of 85 new instructions with 255 operation codes. Source codes, however, have not changed, so that existing development tools can be used.

The 2-megahertz part, which will hang onto the 6800's 8-bit data bus, is designed around 16-bit internal processing—a technique Motorola expects will cut the operating system's memory by 40% and double its throughput. Also, the Austin, Texas, design team has increased the number of addressing modes to 16 and quadrupled register space. Other improvements include a memory-ready pin to allow the fast part to work with slow memory, a processor-busy pin, and better interrupt handling, such as fast interrupt-request and -acknowledge pins, and vectored interrupts. The transistor-transistor-logic-compatible chip, to be sampled in the third quarter of next year, will operate from a +5-volt supply and boasts an on-board clock.

input/output needs of users.

Two more lines can be used for an on-chip, 16-stage clock-timer that can measure incoming pulses in addition to performing the classic timing function. "With the extra timer line, the 6801 can respond to events as well as initiate them, a feature that could count frequencies in television tuners or revolutions on a tape deck," Summers adds.

Memory matches that of the biggest one-chippers, with 2,048 bytes of masked read-only memory on the chip. The firm has doubled the standard scratchpad random-access memory to 128 bytes. "But we don't plan to offer an erasable programmable ROM version of the 6801," Summers says. "Instead, we'll offer a companion part with erasable-PROM, RAM, timer and I/O

that can be used either to emulate the 6801 or as extra memory." The microcomputer also has a standby mode that lowers power while maintaining 32 bytes of RAM. □

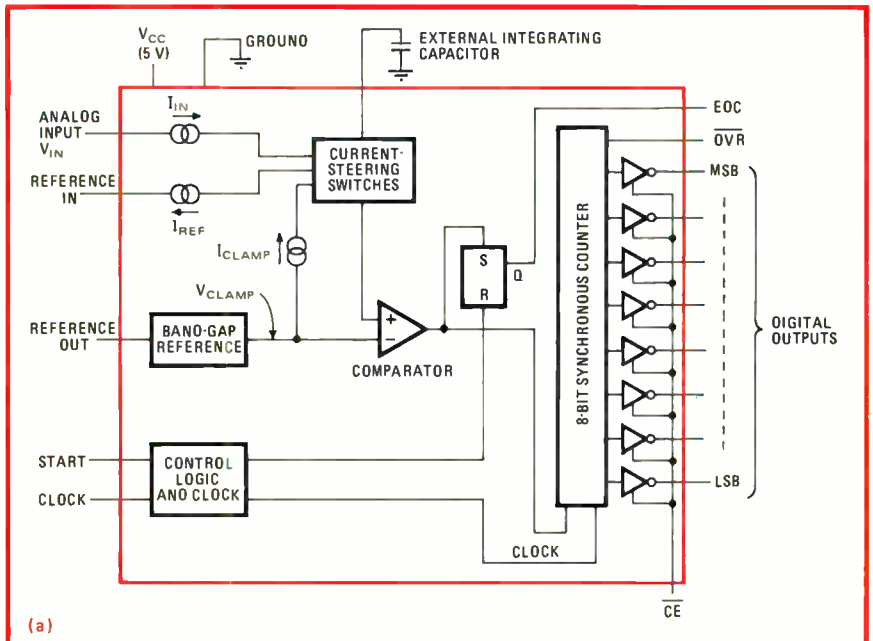
**Solid state**

**Converters designed for microprocessors**

Compatibility with microprocessors is quickly becoming the dominant requirement for data converters, as both semiconductor and hybrid manufacturers scramble to get suitable devices on the market. So it is no surprise that a half dozen 8-bit monolithic chips from Signetics Corp. feature such compatibility. A relative newcomer to the converter field, the Sunnyvale, Calif., firm disclosed its plans earlier this month at the Midcon/77 show in Chicago.

The company is not alone in developing the devices, which, with their  $\pm 0.2\%$  accuracy, could handle many chores in medical and automotive applications, as well as others in process control and data transmission. Others working on new monolithic units include Motorola Semiconductor, National Semiconductor, Analog Devices, Precision Monolithics, Texas Instruments, and Intersil. "Microprocessor compatibility enables the converter logic to be controlled by software, minimizing the circuitry required for system operation," says Narpat Bhandari, a senior scientist in Signetics' Analog division.

Heading his firm's list is a pair of integrating analog-to-digital converters that are the first to use a new triple-slope conversion technique that provides inherent automatic zeroing, says Bhandari. They are also the first commercial monolithic converters built with a low-power Schottky process, a technology traditionally serving digital devices but used here to afford circuit complexity coupled with high speed. Rounding out Signetics' a-d converters is a successive-approximation unit built with the even denser linear inter-



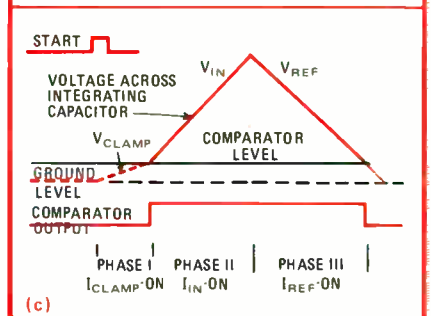
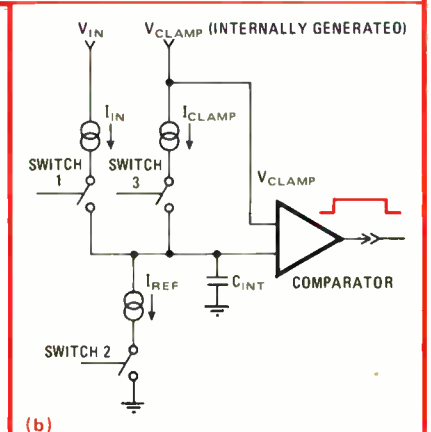
**Monolithic.** A-d integrating converter, a, from Signetics needs only one external component. By internally raising the comparator threshold, b, the converter creates a third slope (labelled  $V_{clamp}$  in c) that helps to zero the output automatically.

grated-injection-logic process.

In digital-to-analog converters, available the first quarter of 1978, Signetics plans to build on its recently introduced 5018, the first self-contained 8-bit d-a chip to be microprocessor compatible. There will be a current-output version and a pair of self-contained 8-bit units with extra-tight accuracy.

For interfacing directly with a microprocessor's data bus, Signetics' triple-slope a-d converter, (a) in the diagram, has buffered three-state outputs, as well as lines for such functions as signaling end of conversion and chip enabling. Moreover, it needs only one out-board part—the capacitor required for integration; voltage reference, and clock, usually added externally, are on chip.

Also saving parts that would have to be added for auto zero is the triple-slope technique. "This extra slope avoids having to switch the capacitor voltage to zero at the start of the conversion," explains Bhandari. The slope is created by clamping the inverting input of the comparator at an internally gener-

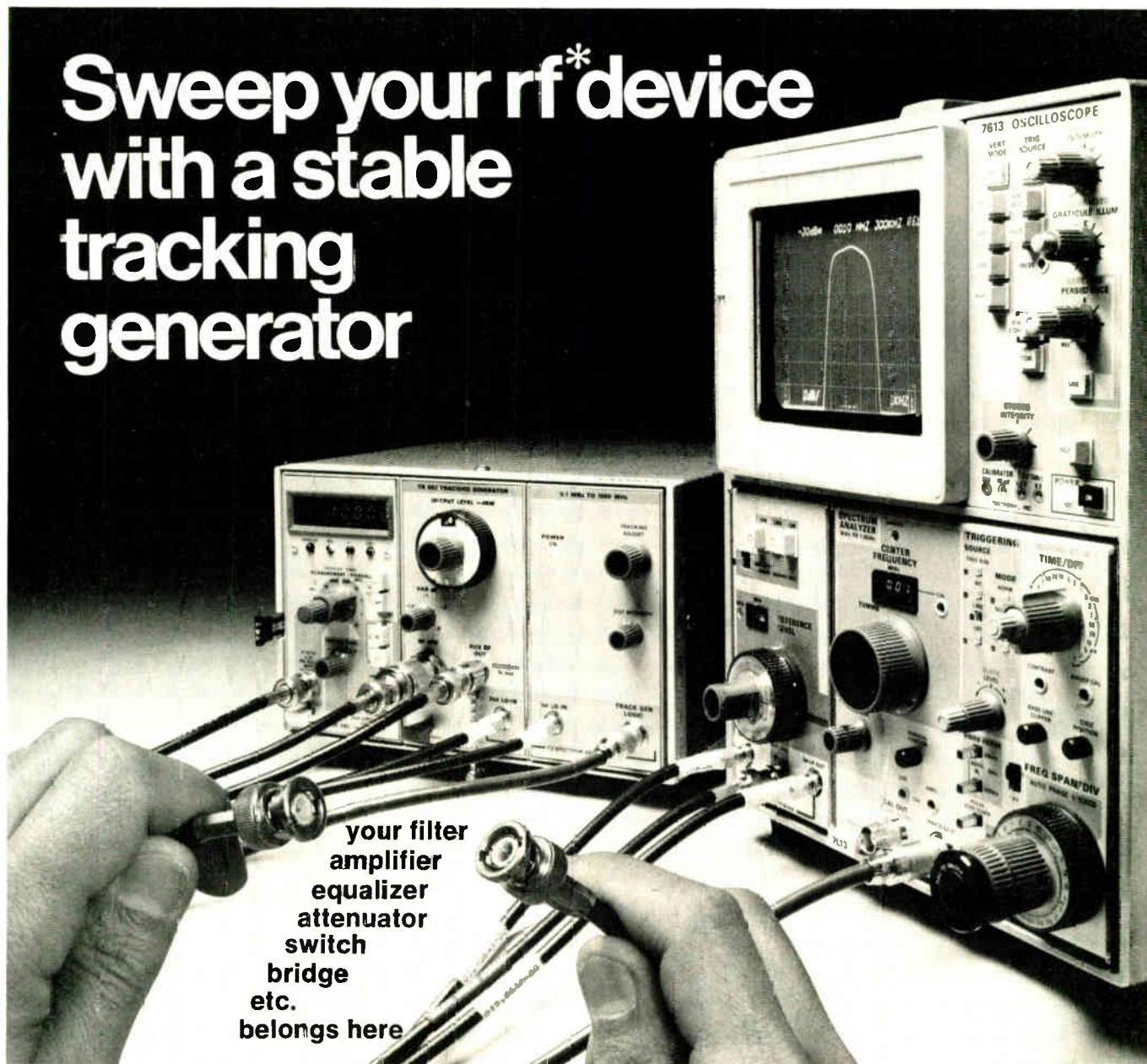


ated voltage, as shown in (b), "raising its threshold to several hundred millivolts."

Except for its initial operation, triple slope is much like the conventional dual-slope integration technique. At the start of conversion, the clamping current charges the capacitor. When the voltage reaches the clamping level, the comparator goes



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high, the clamping current turns off, the input current turns on, and the counter starts counting.

Designated the 5030 and the 5031, the triple-slope chips can convert inputs of from 0 to 2 v in 10 milliseconds to an accuracy of within  $\pm 1/2$  least significant bit, and they operate from a single 5-v supply. The 5030 has its on-chip reference brought out (so it may be used for radiometric conversions), while the 5031 offers overranging. Bhandari expects Signetics to have samples in the first quarter of 1978.

The third a-d chip—the successive-approximation device—is still under development. Besides an on-chip clock and reference, it will include three-state output buffers needed for direct microprocessor compatibility. It will handle inputs from 0 to 10 v, and complete a conversion in about 40 microseconds.

Signetics' current-output version of its 5018 d-a converter, the 5118, will have a high-compliance output for driving loads directly. Settling time will be under 200 nanoseconds.

Additionally, there will be a pair of microprocessor-compatible d-a converters, the 5019 and the 5119, with 9-bit accuracy, or  $\pm 1/4$  LSB, rather than the more usual  $\pm 1/2$  LSB. □

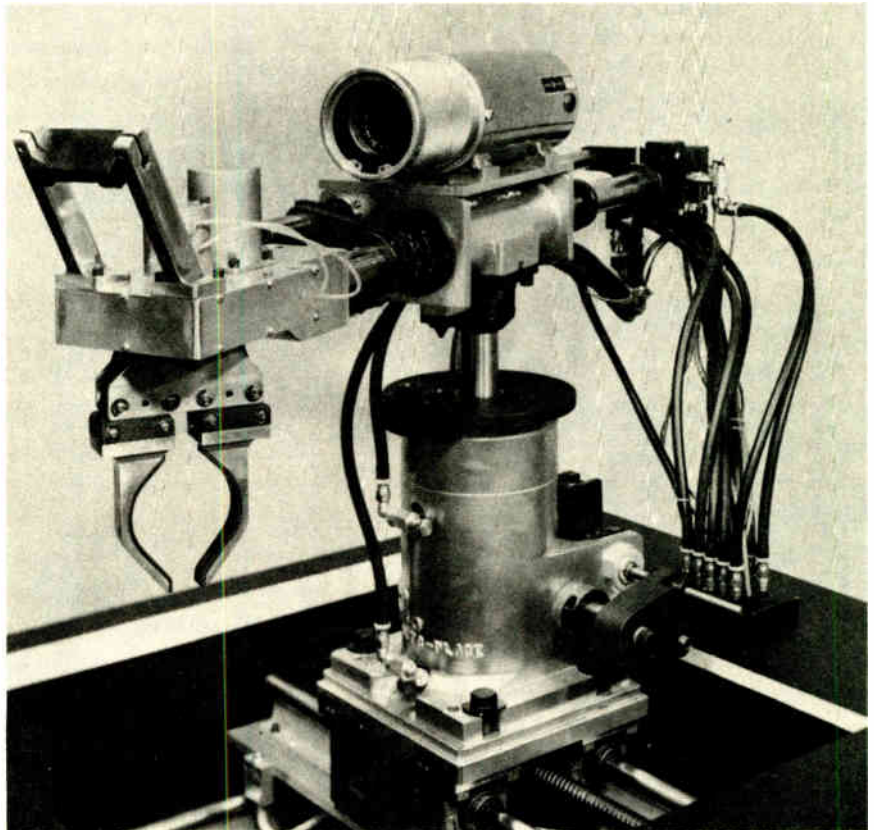
## Industrial

### Robot sights objects on table

A small Troy, Mich., firm is gambling that there is a market for a robot that shoots craps. Basically an articulated arm and hand fastened to a table moving along two axes, the robot was the star of this month's Autofact (for automated factory) meeting in Detroit.

Auto-Place Inc. was able to get its production prototype to continuously load a cup with dice and dump them out. It could also search the playing field for the dice and report the number of spots exposed on each before picking them up and dropping them back into the cup.

The application is trivial, but the



**Armed.** Mirror above two-fingered hand of 2-ft-high Auto-Place robot projects field of view into camera atop 55-in.-long arm. Microcomputer then controls arm and hand moves.

promise is real: by outfitting a robot with a microcomputer and a pair of television cameras, Auto-Place has given a simple manipulator arm the ability to "see" what it is doing and make decisions based on what it has seen. That is an advantage that the firm hopes to parlay into the first commercial robot that can find parts on a moving conveyor. It will ship its first AP-C2 robot, as it is called, to one of Detroit's auto companies early next year.

**New character.** Robots, of course, have already found their niche in many monotonous or unhealthy manufacturing applications, where, programmed to go through a specific series of gripping and moving actions, they continue doing the same job. Now, "provided with a sense of 'vision,' the blind robot takes on a completely new character," says Ronald D. Potter, operations manager for the firm. "It can change its programmed sequence of motions, or its motion end points, based on the visual feedback."

The Auto-Place unit will command a hefty \$50,000. That is five times the price of the Series 50 robot that is at the heart of the system. The difference pays for two cameras, a microcomputer, servo-driven X-Y table, rotary hand, interface electronics, and software.

**Solid-state camera.** One General Electric TN2000 solid-state video camera is positioned above the conveyor to give the microcomputer an image of 188 by 244 picture elements, which it uses for controlling the X-Y motion that places the robot hand directly over the part. The second camera is mounted on the robot arm with the image, used to orient the robot's hand to the part, reflected to it by a mirror.

In its Detroit demonstration, Auto-Place used dice on a stationary field. The microcomputer employs simple edge-detection techniques, taking only fractions of seconds both to find the dice on the black background and orient the robot hand to the square objects it was to pick up.

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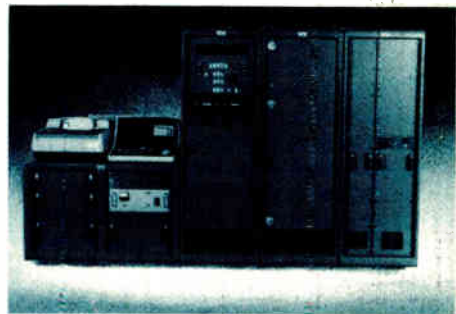
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"The first camera just looks for the leading edge of the object and directs the robot arm to it," Potter says. "Then we rotate the arm-mounted camera about its axis to line up the edge of a die with a line of picture elements. Then the head rotates to the same angle that the camera does. This eliminates the problem of loading a complete frame of picture elements into memory and analyzing it with complex pattern recognition software."

**Basic program.** The firm uses an Imsai 8080 microcomputer programmed in Basic for its prototype, but will change to Intel's System 8020 microcomputer for production versions. Interface between the microcomputer and its two cameras is

confined to a single printed-circuit board that carries a potentiometer-set threshold control to convert the video signals to binary ones and logic to count picture elements and scan lines, indicating to the computer where in the camera's field of view the part is located.

Besides controlling the motion of the robot and the small electric motor that rotates its orientation camera, the microcomputer can perform area-summation calculations—hinting at the inspection tasks the system can do. Earlier vision-equipped robots sold by the firm have not had the search and find capability, but have been used to pick up and inspect parts, including thermometers and timing mechanisms for munitions. □

in California makes the point: it has just one microwave circuit module instead of the three found in previous models, and it costs \$4,500 or so instead of around \$6,000.

The modules involved are essentially harmonic mixers for making a series of frequency conversions from which the unknown frequency is identified and subsequently counted. But the model 5324A counter needs only one of them to mix the unknown input with harmonic frequencies. In place of the other two, it uses a pair of digital counters and a microprocessor, which also allows the designers to throw in an amplitude-measuring capability.

**Single sampler.** The 5324A relies on a single thin-film microwave sampler circuit, shown in the block diagram. The sampler is driven by the unknown input signal and by the output from the sampler driver, which consists of a series of frequencies harmonically related to the instrument's main synthesizer. The output of the sampler consists of sum and difference frequencies created between the unknown input and the harmonics. This output is then converted down to a range of intermediate frequencies. But only one of these frequencies is within the i-f amplifier's bandwidth. This frequency is the one counted in counter A.

The problem now is to determine which harmonic was mixed with the unknown input and whether the i-f frequency is a sum or difference frequency, so that the unknown input frequency can be determined. This is the microprocessor's job. A second synthesizer output, offset by a known amount  $\Delta f$  from the main synthesizer, is then mixed with the unknown. The resulting frequency is counted in counter B.

Two multiplexers also play roles in the system. One switches between the two synthesizers, connecting each to the sampler driver. The other switches the i-f output to one of the

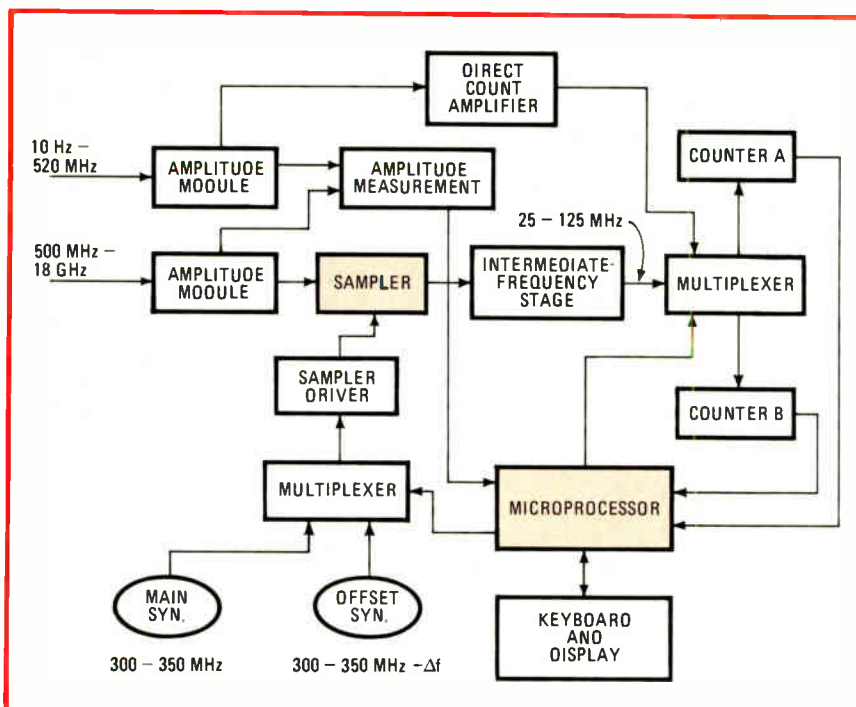
**Simpler.** With the inclusion of a microprocessor, just one sampler is needed in HP's model 5324A microwave counter to make the series of frequency conversions from which the unknown frequency is determined.

Instruments

Microprocessor calculations drop price of Hewlett-Packard microwave counter

A major reason for the continued high price of microwave test equipment is the continued high price of microwave circuitry. But costs drop significantly when calculations that

the microwave circuits do in analog fashion are instead done by a microprocessor. A new microprocessor-based microwave counter from Hewlett-Packard's Santa Clara division



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## Electronics review

two counters. The microprocessor then can take the two results from counter A and B and, knowing the frequency offset  $\Delta F$ , can calculate which harmonic is being mixed with the unknown and thus can calculate the unknown frequency input.

With this scheme, the counter can measure input signals, applied through a type N microwave connector, up to 18 gigahertz. Signals down to 10 hertz also can be measured by applying the input to a separate type BNC input jack and measuring the signal frequency directly in counter A.

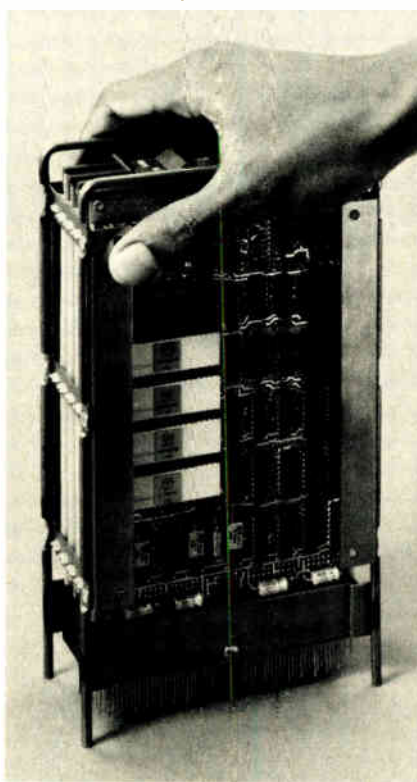
**Amplitude level.** The microprocessor also enables the counter to measure and display signal level. It does this by using a peak-detecting diode to compare the input signal level with that of a known output of an internal 100-kilohertz oscillator. To compensate for individual diode characteristics over the full 10-Hz to 18-GHz frequency range, the characteristic of the diode is stored in a read-only memory. The microprocessor refers to the stored characteristic curve for data at the measured frequency to determine the correction factor to be applied to the amplitude measurement.

Amplitude is displayed in decibels referred to 1 milliwatt on the right-hand side of the light-emitting diode display, while the left-hand side displays the unknown frequency. For frequency-only measurements, the display shows unknown frequencies to 11-digit precision, which corresponds to 1 hertz at 18 GHz. □

## Microcomputers

### Son of LSI-11 is smaller, cheaper

If Digital Equipment Corp.'s LSI-11 microcomputer was anything when announced back in February 1975, it was small and cheap—under \$1,000 for a central processor unit with memory. The 16-bit computer-on-a-board has done well, chalking up sales of 16,000 units. But the advance of large-scale-integrated



**Handful.** DEC's new LSI-11/2 microcomputer, with its four boards mounted in its backplane/cardcage, drastically undercuts the original LSI-11 in price and volume.

circuitry could not be ignored, and DEC's second-generation design, which relies on 16,384-bit random-access-memory chips, slashes both price and size—in some configurations to nearly a quarter the older system's volume—and appeals to a broader range of original-equipment manufacturers than its predecessor.

**Slimmed down.** "We've removed some of the price, form factor and memory density arguments that were used against the LSI-11," says Jack MacKeen, microcomputer product line manager in DEC's Components Group, Marlboro, Mass. Adds technical support manager John L. Hughes, "OEMs can build the new LSI-11/2 into places the LSI-11 couldn't go."

The LSI-11/2, introduced this month [*Electronics*, Nov. 10, p. 25], knocks about \$3,000 off the price of its parent. It costs \$3,815 in single quantities for a processor, 32,768 16-bit words of RAM, a board with four

independently programmable serial line-interface units, plus a board with circuitry for implementing the IEEE 488 instrument bus. This much microcomputer fits on just four boards, slid into a four-slot backplane/cardcage. By comparison, an equivalent LSI-11 requires 16 boards, and the boards are twice as big. The new version will be available in quantity by March.

MacKeen predicts "a gradual replacement of [the LSI-11] with the LSI-11/2, but I still foresee one or two years of life in volume for the LSI-11." Most likely to buy the LSI-11s are those who have already designed them in.

**New entry.** There is also a dramatic change at the low end of the LSI-11/2 product spectrum. A DEC spokesman admits the company "didn't feel comfortable" with the entry level price of the LSI-11. So the entry level for the LSI-11/2 has been cut to \$459 in 50-unit quantities. This buys a central processor on a single board that DEC has designed without memory. The cheapest LSI-11 comes in at \$990 but this is for a CPU and 4,096 words of RAM.

Why no memory on the new board? Rolando Estevearena, LSI-11 market and product planning manager, points out that this accommodates users who build their own memories or have unusual combinations of memory types.

The circuit boards for the LSI-11/2 measure 8.43 by 5.18 inches instead of the 8.43 by 10.37 inches of the LSI-11 board. The basic four-chip microprocessor set is the same, but four to six LSI circuits replace 19 packages of series 7400 transistor-transistor logic for interfacing the CPU to the microcomputer bus. This package reduction, plus the use of 16-kilobit RAMs instead of the LSI-11's 4-kilobit RAMs, "contributes dramatically to the price and volume reductions," says MacKeen. DEC is offering various memory options. A board will accommodate 4,096, 8,192, 16,384, or 32,768 words of 16-bit RAM and include on-board refreshing. The CPU and an 8-kilo-word-by-16-bit memory sells for \$851, ranging to \$1,643 for a

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processor plus 32 kilowords by 16 bits of memory (in quantities of 50).

Also being announced with the LSI-11/2 is a new version of the RT-11 real-time operating system that supports four high-level languages—Fortran, Basic, APL and Focal. Esteverena stresses the new micro-computer is fully compatible with all other PDP-11 software. □

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## Automotive

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### Microcomputer gets assembly-line job

Last month, Ford Motor Co. put its electronic engine control in the public's hands, equipping its Lincoln Versailles with an onboard computer that controls ignition timing and exhaust gas recirculation. But the firm has started using the same microprocessor that is at the heart of the engine control microcomputer as a manufacturing tool as well. The 12-bit metal-oxide-semiconductor device that Ford developed jointly with Tokyo Shibaura Electric Co. (Toshiba) has gone to work on six test stands on a new distributor production line at Ford's Ypsilanti, Mich., parts plant.

**Low-cost potential.** For Ford, it is the first step toward using the same computers in the factory as it ships under the hood—a goal that is several years away because the auto units are still too simple. "We're interested in applying the EEC [electronic engine control] to manufacturing for two reasons," says David F. Moyer, director of Ford's Systems Research Laboratory, which designed the microprocessor. "Its cost will be low because we'll be buying millions of them for cars, and its rugged package will be ideal for the factory environment, which is as severe as the vehicle's."

For handling the test-stand chores, "we expect the down-the-road EEC to have increased process-control capability," adds Richard H. Sherman, a research engineer.

And the Dearborn, Mich., car maker's use of microcomputers on

## News briefs

### Zenith reorganizes top administration

On the heels of a third quarter loss of almost \$3 million, Zenith Radio Corp. moved earlier this month to strip the power from its chairman and president, John J. Nevin. While retaining the chief executive slot at the Chicago firm, the ailing Nevin will yield the title of president and chief operating officer to Revone W. Kluckman, formerly senior vice president of manufacturing and material. The board of directors also brought back retired chairman Joseph S. Wright to head a newly formed executive committee. The moves apparently stem from a series of poor decisions that led to a declining market share, a position that Zenith sought to correct by slashing prices, laying off a quarter of its domestic work force, and moving some assembly operations offshore [*Electronics*, Oct. 13, p. 69].

### Clarke to become AIL's president

Cutler-Hammer Inc.'s AIL division in Deer Park, N. Y., a manufacturer of advanced electronic and microwave systems, will have a new president come Jan. 1, 1978. John P. Clarke, vice president for operations, will succeed Winfield E. Fromm, who has been appointed corporate group vice president of Cutler-Hammer's newly formed Instruments and Systems Group. In addition to AIL, the group includes electronic test equipment manufacturer Ailtech in Farmingdale, N. Y.; semiconductor components producer Yig-Tek in Santa Clara, Calif.

### GT&E installs third fiber-optic system

This month General Telephone and Electronics Corp. will start installation of its third fiber-optic communications system in less than seven months. It will install a 6.5-mile fiber-optic system between Brussels and Vivoorde, Belgium, jointly with the Regie de Télégraphes et Téléphones, the government organization that owns and operates Belgium's telecommunications net.

Initially, two glass fibers will carry 480 simultaneous telephone calls, but by mid-1979 more advanced units will connect two more of the cable's seven fibers bringing the capacity to a total of 2,400 simultaneous telephone calls. GT&E will provide the equipment.

the new distributor line underscores a second goal: to introduce functional testing at steps along the manufacturing process. "Typically, the manufacturing process is tested for dimension—which is easy to blueprint—and not for function; functional control is now pretty much confined to end tests," Moyer points out. "We need computers to back that functional measurement further into the process, and microcomputers lower that cost."

At Ypsilanti, distributor testing has been handled for the past four or five years by a pair of 16-bit mini-computers that test finished products and report the results to a third, 32-bit host computer. The two remote minis, each hooked to about a dozen separate test stands, drive the distributors dynamically through their operating range. "But when we expanded the lines, we found it more

cost-effective to use microcomputers, one on each test stand," Moyer says.

Ford has also added another microcomputer on the new line upstream from the test stands, to check the calibration of the distributor's centrifugal advance mechanism. This test is run when the distributor is only 20% complete, when it is less costly for Ford to reject a faulty part. It is also possible to adjust how the mechanism is put together even before the first parts come off the line. The centrifugal mechanism alters spark timing as a function of engine speed, relying on weights attached to springs on an assembly that spins. The mechanism is adjusted by bending the post to which the springs are attached.

**Averages.** "The microcomputer is programmed to keep a running average of the speed at which the weights fly out," Moyer explains;



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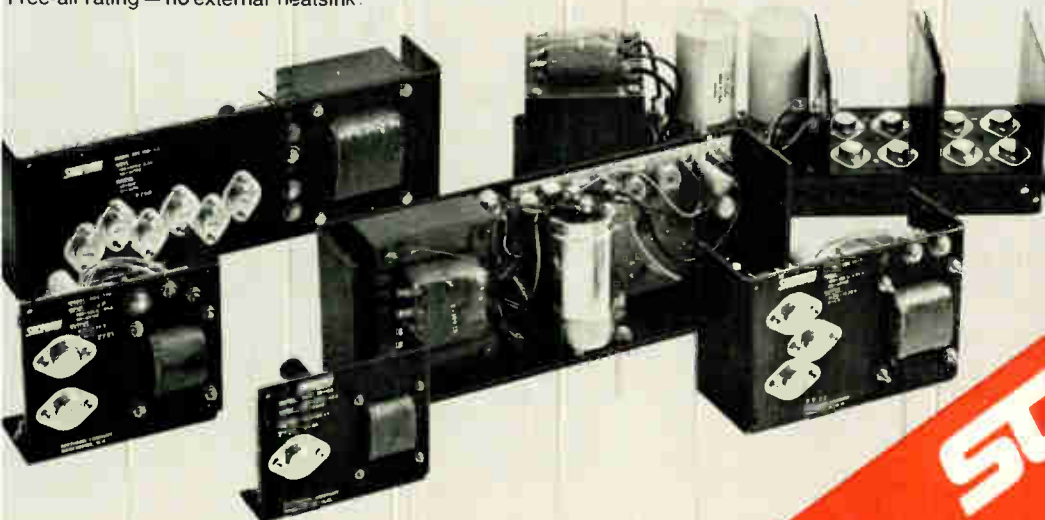
Single Output				Single Output			
Model	Voltage ± 5% adjustable	Output Current (A <sub>dc</sub> ) @ 40°C*	Price	Model	Voltage ± 5% adjustable	Output Current (A <sub>dc</sub> ) @ 40°C*	Price
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SOC 2-6	2V	6.0	58	SOC 15-13	15V	13.0	149
SOC 2-10	2V	10.0	72	SOC 24-1.0	24V	1.0	35
SOC 2-18	2V	18.0	113	SOC 24-2.2	24V	2.2	58
SOC 2-25	2V	25.0	149	SOC 24-3.5	24V	3.5	72
SOC 5-3	5V	3.0	35	SOC 24-6.6	24V	6.6	113
SOC 5-6	5V	6.0	58	SOC 24-9	24V	9.0	149
SOC 5-10	5V	10.0	72	SOC 28-0.8	28V	0.8	35
SOC 5-18	5V	18.0	113	SOC 28-2.0	28V	2.0	58
SOC 5-25	5V	25.0	149	SOC 28-3.1	28V	3.1	72
SOC 12-1.6	12V	1.6	35	SOC 28-6	28V	6.0	113
SOC 12-4.0	12V	4.0	58	SOC 28-8	28V	8.0	149
SOC 12-6.0	12V	6.0	72				
SOC 12-11.0	12V	11.0	113	<b>Dual Output</b>			
SOC 12-15.0	12V	15.0	149	SOC 15D-1	12V to 15V	1.0	\$ 50
SOC 15-1.5	15V	1.5	35	SOC 15D-2	12V to 15V	2.0	76
SOC 15-3.0	15V	3.0	58	SOC 15D-4.5	12V to 15V	4.5	115
SOC 15-5.0	15V	5.0	72	SOC 15D-6	12V to 15V	6.0	154

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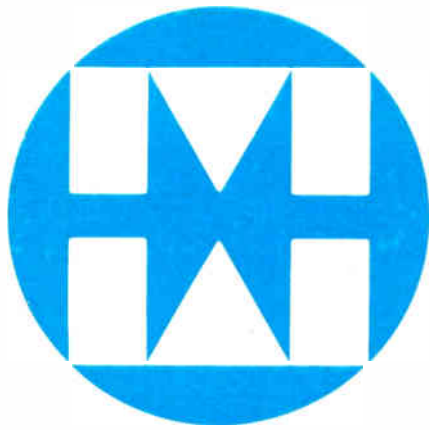
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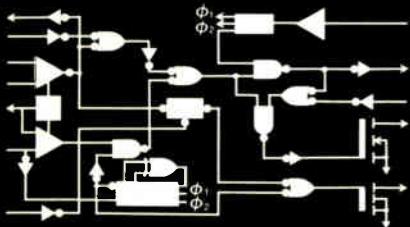
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## Electronics review

from this, it computes where the bend should be and actually controls the making of the bend.

Ford's next step is to simplify the factory microcomputer—now an eight-board system that relies on the host computer for the test procedures for about 150 different distributor models produced at Ypsilanti. "All computation is now done in the microprocessor at the test stand, but we want to bring some of it to the host," Sherman says. "That way, the microprocessor can concentrate on measurement and control, leading us to an even simpler microcomputer."

Also, Ford plans to change the communications system from a system polled by a head-end computer to one that is decentralized, giving each microcomputer the ability to put messages on a common bus. □

## Companies

### Government may win case against IBM

Recent Government testimony in the antitrust action against IBM Corp. has made the outcome clear, says an attorney closely following the suit. "In my view, the Department of Justice now is concluding a winning case," reports J. Thomas Franklin, a specialist in computer litigation at the Boston law firm of Sweeney & Franklin.

**Key assumption.** So certain is Franklin of the result that he advises computer firms "to base your business strategy on the assumption the government will win the case." The Boston lawyer analyzed the antitrust action for the Computer and Communications Industry Association, an Arlington, Va., organization of independent manufacturers and suppliers, at its meeting last week in Beverly Hills, Calif.

What has convinced Franklin is the testimony starting last summer of Alan McAdams, the prosecution's chief economic advisor. In pulling together rambling evidence already presented, McAdams provided what Franklin calls a "new perspective

that IBM has maintained its monopoly power largely by strategies intended to avoid product-to-product competition."

McAdams offers numerous examples of IBM's strategy of announcing advanced equipment that does not and will not exist, in order to keep customers away from smaller competitors. One was the 3705 communications controller in 1972, which McAdams claims knocked out the Memorex 1207 unit that offered more functions and was 40% cheaper. "This noncompetition was more effective than if IBM had marketed and delivered a real product," says Franklin. He also cites McAdams's testimony alleging that the company blocked Xerox's entry into the general-purpose computer market, and that General Electric Co. lost out to IBM's nonexistent products in the time-sharing computer business.

Avoiding competition in these ways is a theme that greatly helps the government draw a critical distinction between valid and illegitimate competition, Franklin believes. Thus, McAdams's testimony aids what Franklin feels is the central part of the Government's case—"the intent issue, on which the court will judge whether IBM acted illegally."

The result of the competitive dearth, says Franklin, is that non-IBM firms show pre-tax losses of more than \$1 billion for 1960 to 1972, while the industry behemoth's profits exceeded that figure.

**Relief.** The possibility of interim relief, or a temporary court injunction against IBM practices, was raised at the CCIA meeting, both by Franklin and by participants. A confidential proposal by the association to the Department of Justice is said to ask that IBM disclose details of its new products and interfacing at the time of first customer solicitation. Since CCIA members sell products plug-compatible with IBM, this policy would serve to keep the competitive situation at status quo, pending the decision of the trial, Franklin observes. The Government case winds up soon. IBM starts its defense in early 1978 and should complete it in one to four years. □

Electronics/November 24, 1977

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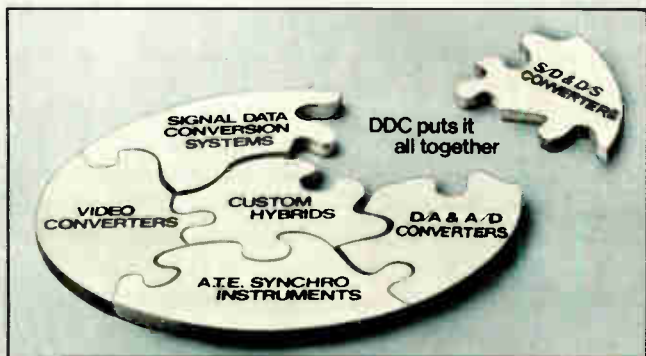
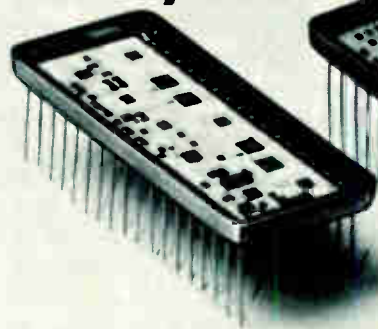
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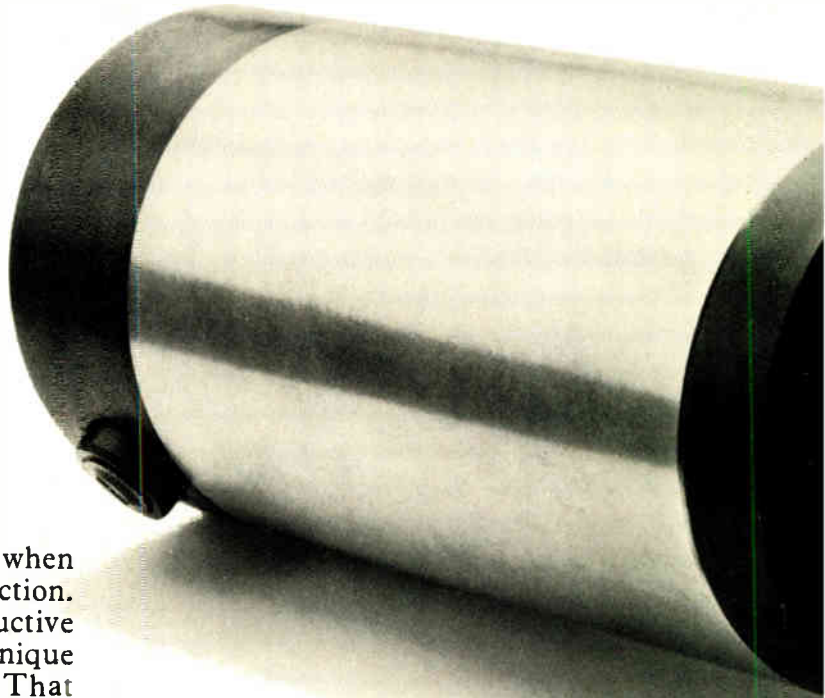
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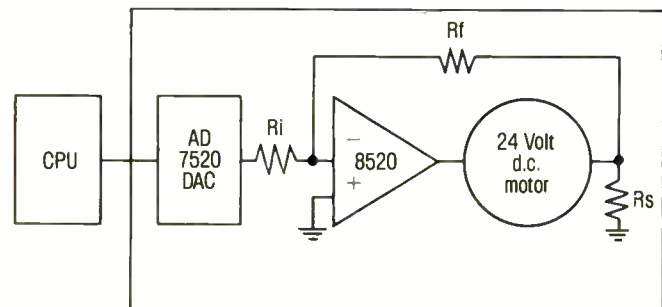
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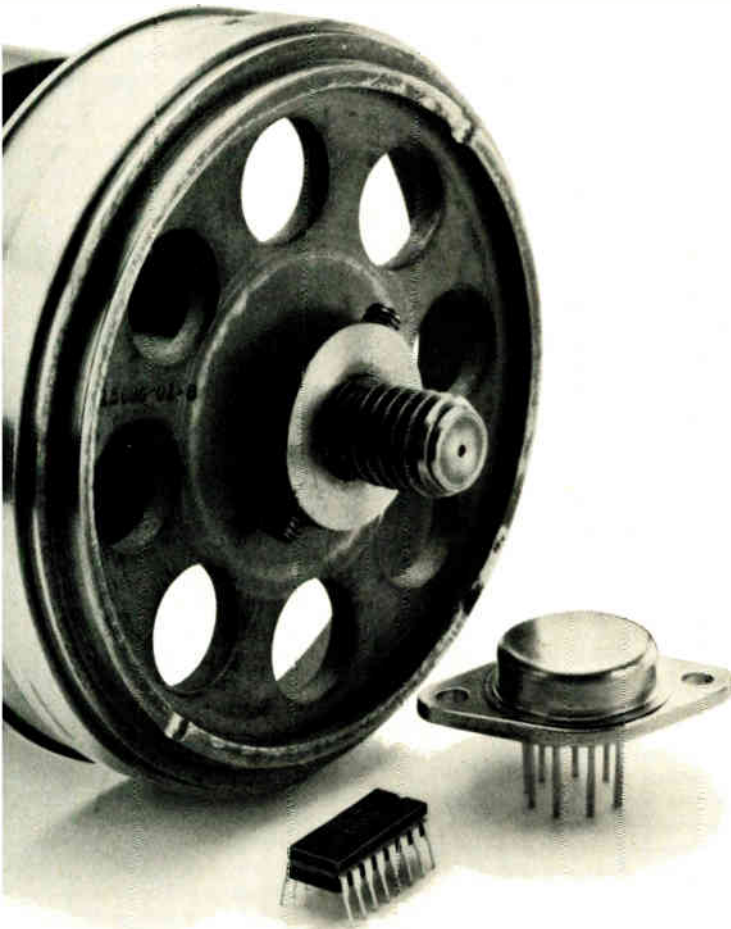


The block diagram above includes the use of a AD7520 to control the 8520 and shows a digitally programmable power driver.

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## **White House budgeting more research money . . .**

Federal support of basic research in electronics and other technologies will rise in the fiscal 1979 budget that goes to Congress in January, **reversing a steady decline of several years**. Presidential science adviser Frank Press says a comprehensive White House review of Federal agency research support is complete, and "its results will be reflected in next year's" R&D budgets. Budget figures on an agency basis are still being juggled, but high-technology areas like electronics will benefit most, according to an official in Press's Office of Science and Technology Policy. Military research is likely to be a major beneficiary; the National Aeronautics and Space Administration, whose future role is under separate review, is expected to gain little (see p. 90).

## **. . . and seeking new incentives for industry R&D**

The prospect of increased Federal incentives for industry to increase R&D investment and reduce the lengthening lead time between R&D and product development was also held out to engineering academy members by the White House science chief. A new Federal policy on industrial research and development is being developed, Press says, and corporate R&D vice presidents are being asked about the impact on their efforts of Federal regulations on "competition, taxation, licensing, patent policy," and related issues. **But a new Carter policy in this area will not come quickly.** The reason is that the OSTP staff has been cut to 22 as a result of a White House reorganization, and Press's office must coordinate its effort on behalf of research with the Commerce Department and the White House Domestic Policy Group.

## **FAA charged with releasing proprietary data**

The Federal Aviation Administration is being accused of abusing the Freedom of Information Act by releasing to anyone who requests it—including foreign organizations—proprietary "technical data furnished in confidence by manufacturers" to support FAA type-certification of equipment. The accuser is the Aerospace Industries Association. Its president, Karl G. Harr Jr., wants Congress or the FAA's parent Department of Transportation to amend or clarify the law to differentiate government-owned information from proprietary data furnished so that an agency can perform its statutory function. "A simple FOI request can secure for a foreign requester technical information which the manufacturer owning the information **cannot disclose without an export license from the State Department,**" Harr charges. One result: reduced reliability and safety of aircraft systems if hardware is made by unqualified sources.

## **Distress sales of 23-channel CBs seen through Dec. 31**

Watch for unprecedented distress sales of 23-channel citizens' band radios through Dec. 31. That possibility follows the Federal Communications Commission's refusal earlier this month **to change a Jan. 1 sales cutoff date** for radios type-accepted before Sept. 10, 1976. FCC and industry estimates place U. S. 23-channel inventories between 4 million and 5 million units clogging the market. After the cutoff, FCC and industry officials agree, sales of "used" 23-channel units are expected to continue, since the FCC's enforcement powers are limited and its prohibition exempts sale of used transceivers or those that have been returned under warranty, traded in, or rebuilt.

## Justice won't let AT&T off the hook

*Telecommunications equipment makers got good news when they received early this month their first positive statement of Carter Administration policies on the ongoing antitrust action against American Telephone & Telegraph Co. and the development of a competitive market. Suspicions have been growing in Washington that Attorney General Griffin Bell might accept an out-of-court settlement of the suit, thereby discouraging developing competition. But the Justice Department's John Shenefield, the new assistant attorney general for antitrust, ended such suspicions in his recent address to the Federal Bar Association. Key points made by Shenefield before the FBA, where Federal Communications Commission lawyers and lobbyists listened carefully, follow.* **Ray Connolly**

A decade ago, we had essentially one phone company that gave you everything it thought you should have. There were few viable options. There was no Carterfone, no specialized carriers, no domestic satellites, . . . and no computer rules. As a telephone industry spokesman recently told the House subcommittee, his business 10 years ago was a "closed economic system."

### No settlement

Substantial battles and competitive controversies are looming across the FCC's horizon. In the telephone industry, the biggest and most obvious upcoming battle is, of course, the AT&T litigation. Contrary to what you think you have heard, that very important case isn't moving to Capitol Hill, it is not going to be transferred to the commission, and there aren't going to be any half-baked settlements. Instead, the case is very quickly getting into shape and will be litigated vigorously.

We also expect to be heavily involved in major "son of Carterfone" developments at the FCC. . . . Developments like these pose substantial, interesting competitive questions. The message that I want you all, especially those of you from the Federal Communications Commission, to carry away is that when you confront such questions, "think competition."

If anyone or thing is to "blame" for competition in this field, I expect one could blame the enormous changes in American society that took place after the various "closed economic systems" were set up in the '30s and '40s. In telecommunications, however, underlying forces for change achieved greater velocity, because they coincided with very rapid technological change. The advent of computers and data

communications as important modern business components triggered customer demand for a wide range of new terminal and transmission capabilities and services.

To its credit, the FCC sincerely tried to at least accommodate some of these sweeping changes. Had they not done so, however, do you seriously believe that all forward movement would have been halted? Market forces, new customer demands, and new technologies are strong imperatives even the most intransigent of regulators would find difficult to stop.

### Limiting regulation

What we must try to do in this last quarter of the 20th Century is find ways to minimize if not eliminate regulatory friction. In the communications field perhaps this is easier than in others. Here, competition does not have to be "destructive" of existing firms for the reason that the total pie at stake is not static, but instead rapidly growing. A burgeoning technology, moreover, has the effect of creating new, additional economic pies each year—new commercial opportunities. All the terminal competition AT&T confronts, for example, aggregates significantly less than just one year's incremental growth [for AT&T].

It is important to focus not on who provides what, but on service as a whole. It should be a matter of regulatory indifference whether service to the public is provided by company A or company B or by both companies combined. So long as the requisite service is provided overall, regulators should not intervene in an effort to thwart or channel the ordinary forces of the marketplace.

When the FCC is implored by established firms to take special steps and to parcel out special economic protection, the FCC's watchword or reply, without some special reason, should be "Be quiet." This in essence is what the commission has said over the past decade in the face of carrier suggestions that the competitors be eradicated, and the abundance of new competitive services and the absence of any telephone industry collapse bear witness to the wisdom of this general policy.

I come into the telecommunications policy business with few preconceived notions or biases due to extensive experience. The feature that is most striking to novices like myself is that those who are most vociferous in opposing "further experiments with competition" have done so well and prospered in the face of the competition we have already.



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Electronics / November 24, 1977

## **UK government supporting work with electron beams**

Determined to stay in the race toward submicrometer dimensions in very-large-scale integrated circuits, the United Kingdom is buying three electron-beam machines from Cambridge Scientific Instruments, an early pioneer in the field. Two of the \$450,000 machines will be purchased by the Department of Industry for the Plessey and General Electric research centers. The third, bought by the Science Research Council, will be at the Rutherford Laboratory, near Oxford, for the use of the universities of Edinburgh, Southampton, Surrey, and Sheffield. Cambridge Scientific Instruments first produced electron-beam equipment in the late 1960s, **but government funds ran out, and a key project leader, Philip Chang, left for the U. S. to join IBM Corp.,** the present electron-beam front runner. In the UK effort, both direct exposure on wafers and mask making will be examined, and in addition the work is intended to develop electron-beam hardware and software.

## **Japanese study sees good trade position in technology items**

In terms of comparative trade advantages with the U. S., Japan is strong in communications equipment and radios and television sets, says a recent study of the Ministry of International Trade and Industry. Assessing high-technology manufactured goods, Japan puts itself ahead in most categories of finished products. **The U. S. has no strong electronics areas, says the study, which uses five rankings from strong to weak.** Japan rates itself as weak in computers, while the U. S. is considered only moderately strong. In electrical and electronic medical equipment and instruments, the U. S. is termed average and Japan weak. Besides communications equipment the U. S. is called moderately weak in all consumer items. Semiconductors and other electronics products not considered finished goods are excluded from the MITI study, a summary of which was released in Washington by the U. S.-Japan Trade Council.

## **Longines exports 8080-based optical readers**

Longines, part of the billion-dollar-a-year Swiss watch group ASUAG, is taking diversification efforts in computer peripherals a step further by marketing its range of 8080-based optical readers in France. **The products, including mark and character readers, were first introduced in Switzerland a year ago.** Longines also has started to tackle the German market and plans are to sell throughout Europe eventually. The firm says it has gathered considerable electronics and computer-related experience through its watch activities, where various sports timers use microprocessors.

## **Vidicon picks up color images from monochrome film**

Color television technology will soon make it possible to replace expensive and quick-to-fade color-film microfiches with inexpensive and permanent black-and-white substitutes that will provide improved color images. Hitachi Electronics Co. will pull this rabbit out of its hat with the help of its frequency-separation single-pickup-tube color camera. In the microfilm system, **the stripe filter usually on the vidicon faceplate is inserted near the film plane in the still camera that makes the microfiches.** The filter produces density changes in film. During readout, the vidicon faceplate picks up the pattern of stripes on the film, which is the same size as the usual stripe filter. Thus the camera output is a standard NTSC color signal for viewing on a nearby monitor or for transmission to a remote monitor.

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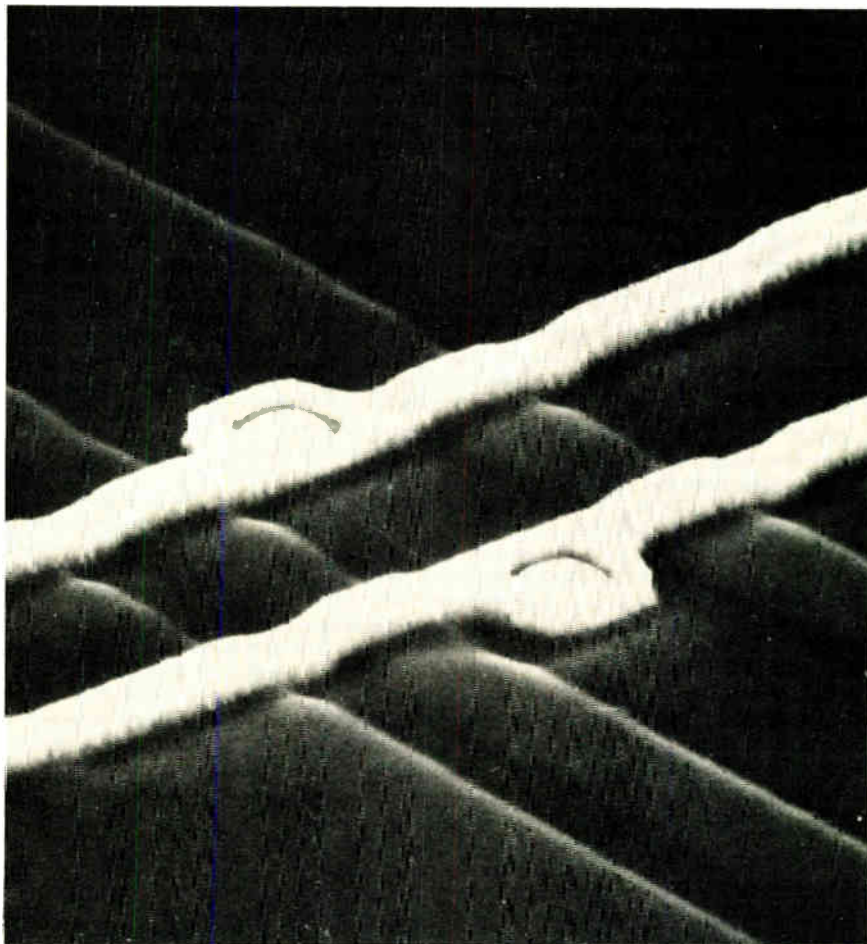
## Electron beam scans 2- $\mu\text{m}$ patterns directly onto Japanese wafers

Japanese researchers have taken two major steps along the road to electron-beam fabrication of very-large-scale integrated circuits. With direct electron-beam exposure of photoresist on wafers, they have fabricated a 1,096-bit memory with a minimum line width of 2 micrometers. They also have used electron-beam exposure to produce a complete set of 2- $\mu\text{m}$  masks for an improved version of an experimental 65,536-bit random-access memory.

These advances at the Musashino Electrical Communication Laboratory are at least in line with equivalent work in the U. S. For example, IBM Corp. has a production line of direct-exposure electron-beam machines that are routinely producing 2.5- $\mu\text{m}$  minimum line widths. The company says these machines can be easily extended to pattern geometry with 1- $\mu\text{m}$  detail [*Electronics*, Nov. 10, p. 96]. Moreover, the Japanese mask fabrication is easily as good as the work going on in the laboratories at IBM and Texas Instruments Inc.

The 1-k memory is the prototype for the lab's 65-k devices [*Electronics*, April 28, p. 68], so it had already been produced with conventional masks and with masks made with electron beams. However, direct electron-beam exposure offers two big advantages. It improves the precision with which extremely fine patterns can be laid down. Since no masks are used, short production runs—for instance, for mainframe computers—and design changes become more feasible.

**Disturbing.** Bombardment of the chip by the electron beam of about 20 kilovolts does disturb the wafer's crystal surface, so processing changes are necessary if satisfactory yield is to be obtained. Researchers at the laboratory, which is part of the Nippon Telegraph and Telephone Public Corp., have worked out several such changes. Among them



**Mighty fine.** Japanese direct-scanning electron-beam system produced this 2.5- $\mu\text{m}$ -wide word line and 2- $\mu\text{m}$ -wide bit line. Photo was taken through a scanning electron microscope.

is a positive-resist-and-liftoff of aluminum metallization to provide process masking equivalent to negative resist, which is not available for chips. When spread on a wafer that varies in flatness, the available negative photoresists develop either breaks or pinholes. Also, processing schedules are optimized to anneal out surface damage caused by the electron beam. As a result, the researchers say they can hold transistor threshold voltages and other characteristics to the same tight specifications they maintain for optically exposed devices.

The electron-beam masks of 9

rows of 10 devices each are fabricated on 75-millimeter-square glass plates. They were produced with an electron-beam unit using a control system modified by the laboratory to give a resolution of 0.03  $\mu\text{m}$  over a 2- $\mu\text{m}^2$  area. For large areas, the target stage is moved and exposure is carried out in two or more steps [*Electronics*, Dec. 23, 1976, p. 48]. The fabrication time is about a sixth that required with optical-pattern generators.

The masks promise higher yield than optically generated versions because they are more precise and have cleaner, sharper edges. The

precision within a mask has been held to  $\pm 0.1 \mu\text{m}$ , and registration between masks to  $\pm 0.2 \mu\text{m}$ . □

**The Netherlands**

## Air force opts for Collins digital network

Security and survival are the watchwords of military communications systems, and the Royal Dutch Air Force had them fixed firmly in mind when it ordered its new pulse-code-modulated digital voice network from Rockwell International's Collins Radio Group. To go into opera-

tion early next year, the system will provide virtually unbreakable encryption of digital communications. Transmissions will be digitized at eight switching nodes and sent over microwave links.

The Dutch system is a complete digital net, except where voice subscribers are linked by land lines to the switching nodes. Initially, there will be some 8,200 voice subscribers and 170 data subscribers, including teletypewriters, at 2,400 bits a second. The system will be fully compatible with analog networks and can be directly interfaced with digital facilities.

But secure communications do not mean much if the message cannot

get through. To ensure its survival, the Dutch system, called Ascon for automatic switched communications network, has several key features. For one, there is an automatic routing scheme built into each of the eight switching nodes that provides 800 different ways to send a message around Ascon.

The configuration of the nodes also contributes to the ability to survive. The arrangement is one of two slightly overlapping diamonds with radio links then running from all adjacent nodes. An abstraction using lines for the links would look much like a cube.

With this configuration, every node will have microwave links connecting it to each of three other nodes, which improves chances of communication if part of Ascon were to malfunction or be damaged. In the standard grid setup for microwave links, the nodes on the peripheries are connected to only two other nodes. Moreover, Ascon subscribers with communications of sufficiently high priority may have lines to several nodes.

**Keeping costs down.** As well as minimizing the problem of antenna placement in the flat, densely populated Netherlands, the cubic configuration will cost less than a checkerboard grid. The air force will be paying \$13 million for hardware, software, and installation.

To keep costs low, Ascon relies on off-the-shelf hardware, including switching nodes using computer-controlled digital tandem switches with a capacity of 1,536 channels from Collins of Richardson, Texas. It is designed for 100% growth by the addition of only four nodes, which would make what might be called a double cubic configuration.

Independent of the processors controlling the switching nodes is a supervisory and control system called Syscon that monitors all transmission and switching equipment for troubleshooting and security maintenance. It can isolate malfunctions, and it can give a full overview of radio-link and multiplexing capability—including anticipation of complaints and failures. □

## Around the world

### High-frequency parts give trimmer dc-to-line inverter

Low-frequency power from high-frequency components is the slimming secret of an inverter design worked out by the Electrical Research Association of Great Britain. The input circuit is a high-frequency, pulse-width-modulated inverter followed by a high-frequency, potted-core transformer, which steps the secondary up to the peak output voltage and provides isolation. The output feeds a cyclo-inverter—a bridge-like arrangement of silicon controlled rectifiers in which the logic capability of the device is exploited to reduce the frequency down to a dc-to-1-kilohertz range.

Basically, the SCR bridge directs several cycles of the high-frequency input to one output terminal to produce half of the output cycle, then directs the same number to the other terminal. The result is an output frequency that is an integral submultiple of the input frequency. Solid-state optoisolators convey gating signals from the transformer primary winding to the output circuitry, and triggering on both pulse edges keeps the circuits locked in synchronism. Thus the transformer never sees the low-frequency component of the output wave, so it can operate at 20 kHz.

The research association has developed a miniature inverter pack for a peripheral manufacturer and will expand its technique to other applications if sponsors come forward. Researchers point out that 20-kHz switching transformers with useful current outputs of several amperes have already been developed for switching power supplies, which have been shrunk by techniques similar to those used with the inverter.

### IC regulator for power supplies includes diodes

Including rectifying diodes on the same chip as a series-pass regulator makes building a regulated supply chiefly a matter of adding a transformer and an electrolytic capacitor. To build its new regulator integrated circuit, SGS/Ates of Italy puts a collector sink and a base diffusion around the anode diffusion. An emitter area is diffused into the anode region to decrease the gain of the parasitic diode formed by the collector substrate junction. These measures reduce the diode's leakage by a factor of 10.

To be available in the U. S., the chip, the L 192, will first come in a 250-milliampere version with a pair of rectifier diodes. A 500-mA version with a four-diode rectifying bridge will follow. Output voltages for the L 192 can be 5, 21, 15, or 24 V. Load regulation for a 200-mA change in load current is 0.5% of the output voltage. Line regulation is better than 65 decibels at a 15-V output voltage. Price will run around 50 cents each for quantities of 10,000 and up, according to a company spokesman.



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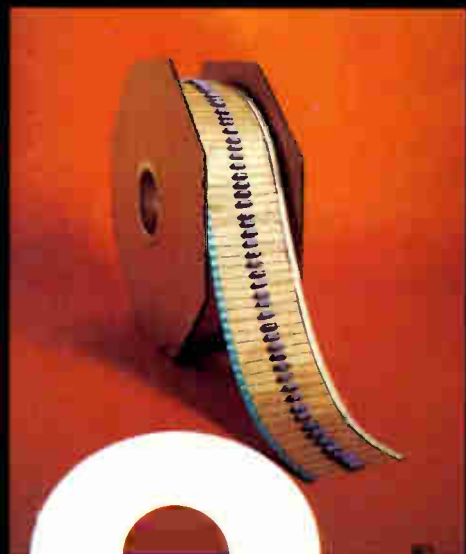


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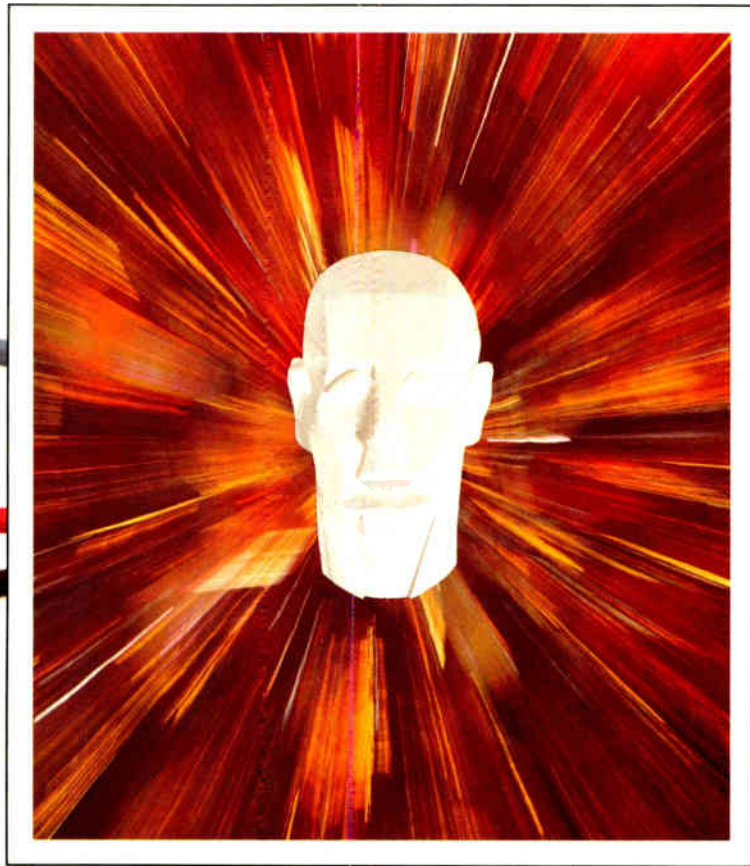
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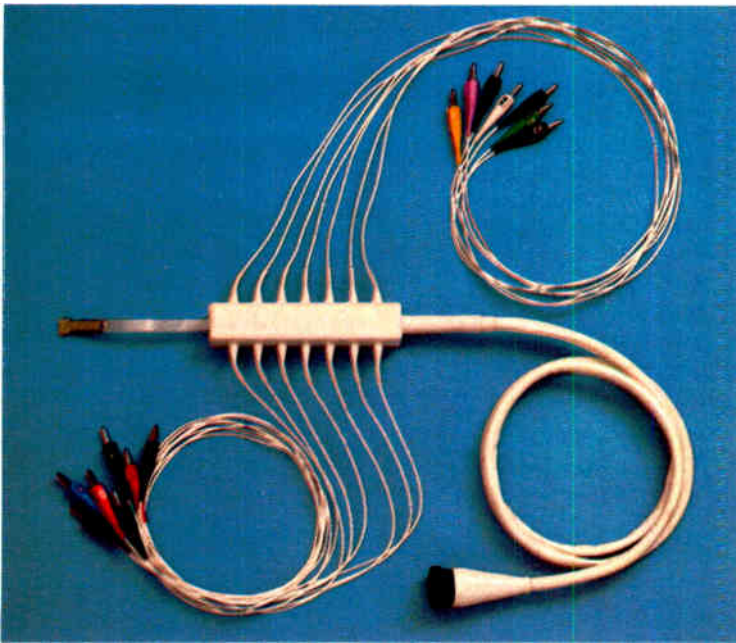
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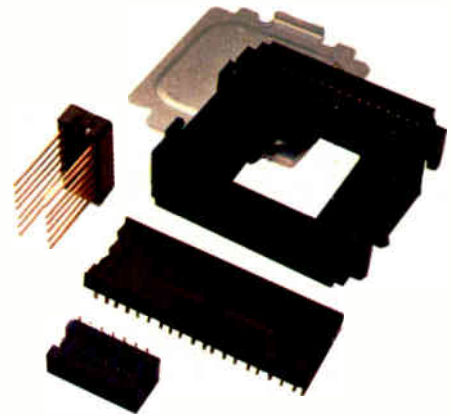
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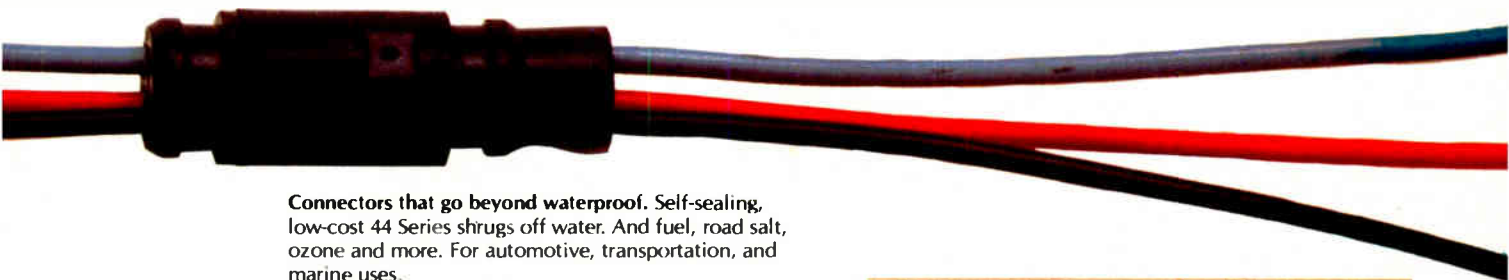
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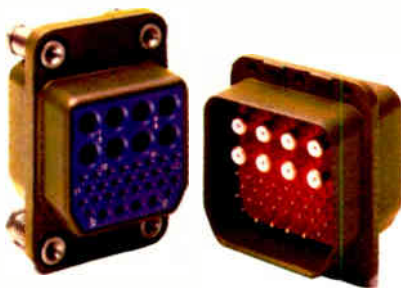
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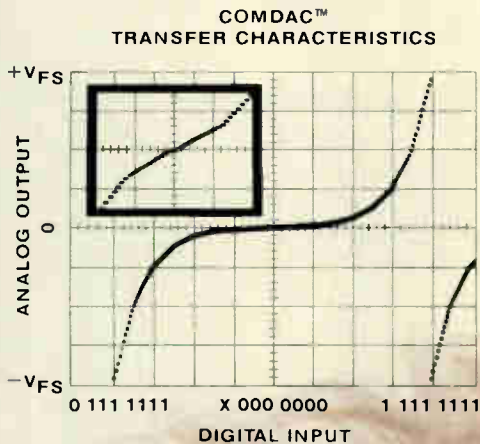
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Circle 72 on reader service card

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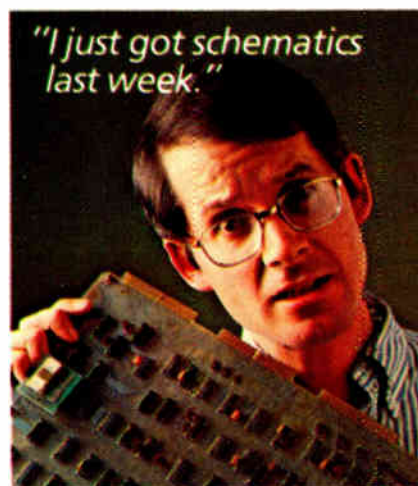
"I can't get near the computer."

"I need more programmers."

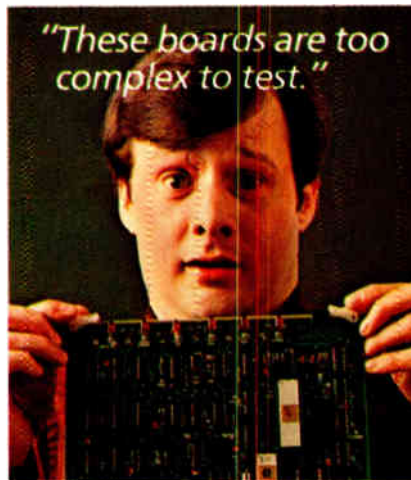
"I just got schematics last week."



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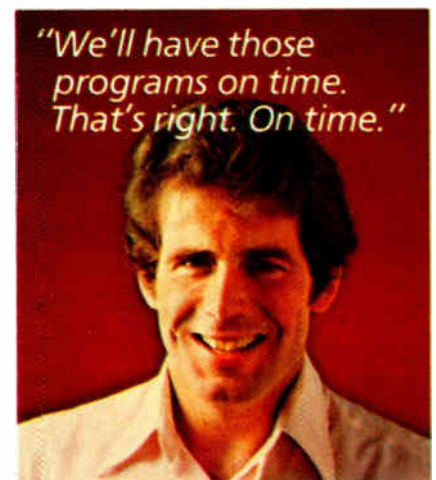
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## Micros ride high at Motorola

Microcomputer division, once suffering from critical production woes, now is prepared to ship more parts in 1978 than anyone else

by Laurence Altman, Solid State Editor

The summer of 1976 was bleak for Motorola's MC6800 microcomputer group. The group's design and wafer unit had moved from Phoenix, Ariz., to the new facility in Austin, Texas, and the line wasn't yielding. Billings—that is, shipments—in August and September ran dangerously below bookings, always a sign of deep trouble in a factory, and key people were deserting.

Meanwhile, Motorola's 6800 was being designed into systems, and users were clamoring for their parts. Delinquencies were piling up, even for major customers.

Adding to the pressure caused by the production problems, Motorola was competing for the big prize—the General Motors microcomputer con-

tract, slugging it out against the toughest competition in the business. To be successful, Motorola would clearly have to fix the problems in the factory since the division would have to supply annually 10 million-plus complex integrated circuits to an automobile manufacturer known as a stickler on quality and very tough on vendors that slipped schedules. In short, could Motorola turn it around?

Success. Motorola could and did. Today, its Austin microcomputer line has one of the highest large-scale-integration production capacities in the world. Billings are tracking bookings better than in any other previous period. Delinquencies in the 6800 line are lower than in

any other product line in the corporation with the exception of a few mature discrete lines. Yields and reliability (0.007 failure rate) on microcomputer chips are among the best in the industry, leading to a fourfold increase in output over the last 12 months. The result: not only did Motorola get the GM contract, potentially worth tens of millions of dollars a year, but it landed the lion's share of Ford's engine control program, beating out competition that included Intel Corp. and Texas Instruments Inc.

That is why Colin Crook, microcomputer operations director, can say flatly, "Motorola's Austin plant will ship more microcomputers in 1978 than any other facility in the world." And to the charge that the huge auto contract will gobble up Motorola's microcomputer supply capacity for years, making it little more than a captive supplier to one or two customers, Crook says, "With our yields and production capability, if we had another contract the size of General Motors', we still wouldn't fill our capacity."

Central to the turnaround in microcomputers at Austin, most observers agree, is Crook. "Eighteen months ago, our production line was a disaster area," he recalls. "If we didn't solve our problems fast, we'd lose everything we'd built up in microcomputers over the previous two years."

Crook reached into Motorola's highly successful standard com-



**Riding an upcurve.** Motorola's Daniels, Goldman, Crook, and Summers are the men running the successful microcomputer production and design facility at Austin, Texas.

## Probing the news

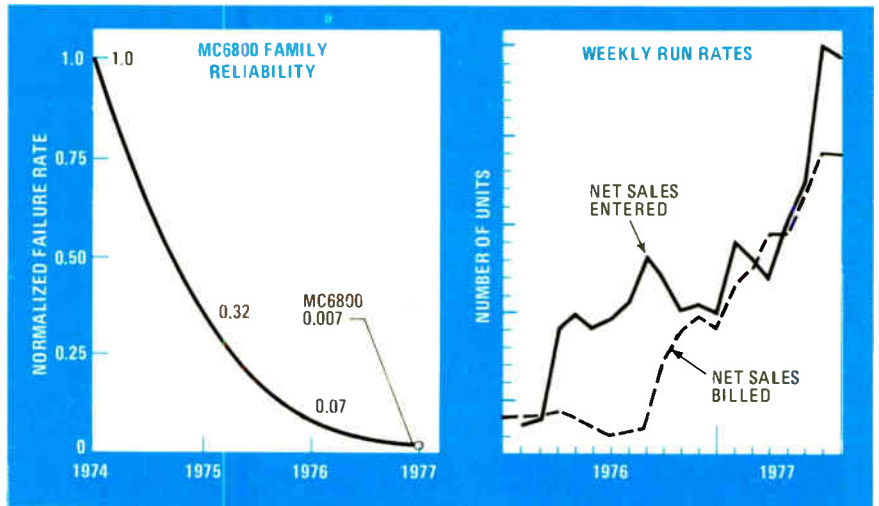
plementary-MOS products group to find the men he needed. He took Murray Goldman out of C-MOS manufacturing and put him in charge of the group's production. He took Gary Daniels, senior C-MOS design engineer, and made him head of the design team. He has brought in young, aggressive marketing types like Gary Summers from the San Francisco Bay area. And he put microcomputer production on a daily priority schedule.

The results were quick and dramatic. By January 1977, six months after the low point, Motorola's microcomputer production was matching the steep curve of increased bookings (see chart at far right), and new designs were coming out of the factory with unprecedented yields and remarkable reliability levels.

**Standard base.** With the GM and Ford contracts under its belt and factory production racing along, Motorola is now turning to the standard-product market to broaden its base of microcomputer penetration. "We view our coming auto production experience as an opportunity to drive our standard-product chip costs down," Crook says. "With our anticipated volume, we can become the most aggressive microcomputer chip supplier in the business."

To this end, Motorola's microcomputer design group is launching a wide-ranging product entry program. According to Daniels, the chip design manager, "The key to our new product development is family compatibility. All our new CPUs, single-chip microcomputers, and complex peripherals use the same 6800 software and development systems. That goes for our one-chip 6801, all the way to our new 16-bit 6809. A user can move up the ladder with 6800 designs without major new system software development."

If Motorola stays on schedule, the new chips will indeed extend the 6800 family into all areas of microcomputer design. Coming in the first quarter of 1978, for low-end controllers, is the 6801 one-chip microcomputer, which consists of an 8-bit central processing unit, clock gener-



**Telling the tale.** Failure rate of the MC6800 microcomputer, left, has dropped dramatically since 1974. At the same time, gap between orders and shipments has been closed, right.

ator, and driver; 2,048 bytes of program read-only memory and 128 bytes of random-access memory (as much as any one-chipper); and 30 input/output lines and two 16-bit timer functions. Next, for medium-performance minimum-chip applications, there is the already available two-chip 6802/6846 system, as powerful as the standard six-chip 6800 configuration. The 6802 combines the functions of the 6800 CPU and clock and the 6810 RAM, while the 6846 ROM-combination chip is equivalent to two 2-k 6830 ROMs, one half of the 6820 peripheral interface adapter, and one third of the 6840 programmable timer module.

Then there is the host of new peripheral controllers developed either at Motorola or at Hitachi, which has a 6800 second-source agreement with Motorola. There is a floppy-disk controller, a direct-memory-access controller, a cathode-ray-tube controller, a combination ROM-I/O-timer chip, an advanced data-link controller, and a general-purpose interface adapter for interfacing the 6800 bus with the IEEE 488 bus. Also coming in the peripheral area is a unique video-display generator chip that provides all horizontal, vertical, and burst timing, all refresh addressing, and all signals for generating alphanumeric and graphic signals, both black-and-white and color.

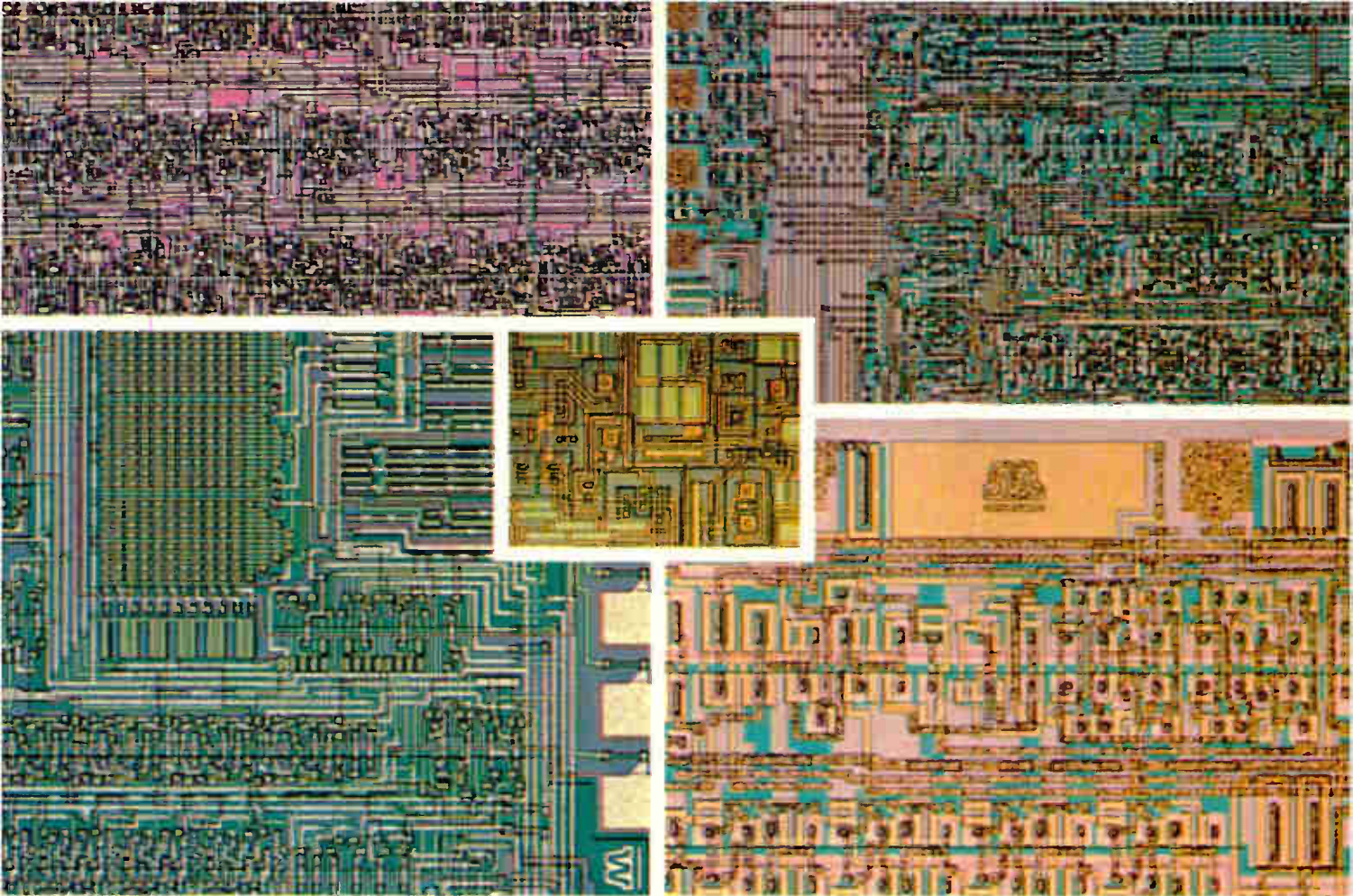
Finally, there is the 6809 16-bit CPU, which with 6800 peripherals and memory can implement designs in the middle and high end of the

minicomputer scale. Capable of 10 times greater performance than the original 6800, it will be available during the third quarter of 1978, along with the one- and two-chip systems.

**Silicon systems.** In the future, Crook believes, the microcomputer revolution will cause major dislocations in the traditional computer industry. "To be successful in the microcomputer business," he says, "you must realize that it's different from any other business that exists today. It is not like the semiconductor business and it is not like the traditional computer business. The ability to map ever more sophisticated computing systems onto silicon each year is a concept whose implications may not be fully realized, even by some people who are responsible for making it happen. Success will come to those who understand the relationship between the silicon and the system. Nothing short of a merging of the two entities into a tightly knit unit will achieve success."

Motorola is well along on developing the technology and system designs required for the next generation of microcomputer products. High-performance scaled MOS processes capable of 10 times better performance than today's processes and more powerful architecture to better utilize this increased circuit capability are top priority programs both at Motorola's new production lines in Austin and at its sister systems group in Phoenix. □





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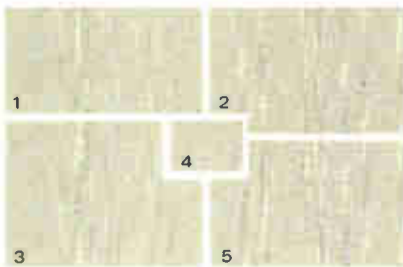
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World Radio History

Circle 77 on reader service card

Consumer electronics

## Audio world gets the word: digital

Other Japanese firms follow Sony to market with PCM recording and playback schemes

by Charles L. Cohen, Tokyo bureau manager

It's only a matter of time until all stereophonic recording will be done with digital techniques. That's the message from Japan, where several manufacturers are rushing to market with systems that use lasers to play back plastic disks whose audio signals are pulse-code-modulated [*Electronics*, Sept. 29, p. 42].

The mass market of the future will most likely center around standard 30-centimeter disks because they can be mass-produced inexpensively the same way they are now made for analog recordings. But the key word is "standard"—until there is industry-wide agreement on specifications, PCM disks will be impractical and the answer will be tape.

American observers agree with this assessment. Alex DeKoster, senior acoustic engineer at Acoustic Research Inc. of Norwood, Mass., a leading maker of stereo equipment, points to agreement among hardware makers as key. Beyond that, says DeKoster, "I'm tremendously impressed with the dynamic range of PCM audio. Although it will start out as an expensive toy, demand will force the price down. I think it's the audio of the future." He estimates that it will take three or four years for expensive consumer playback systems to catch on, then another

five or six years before the price dips to the average consumer's level.

At Fisher Corp. in Chatsworth, Calif., engineering manager Herbert Lippold, while agreeing that standardization is vital, also is concerned about how such an audio system is supported—that is, what and how much software is made available.

**Takeoff point.** Though quick standardization of the medium may be a pipe dream, what PCM audio has going for it, beyond the technological advances and the marketing ability of the industry, is the fact that its time may be here. Analog technology is mature and no great advances are expected; digital technology, on the other hand, has progressed to the point where all the needed components are at hand, and price reductions in many of the key components are expected. What's more, video tape recorders have just reached the takeoff point, making them available as basic building blocks, and semiconductor lasers—the missing link in disk systems—appear poised to move from lab to production line. Finally, phase-locked-loop synthesizers and crystals for tight control of both tape and disk drives are in good supply.

The beauty of pulse-code modulation in digital recording systems is

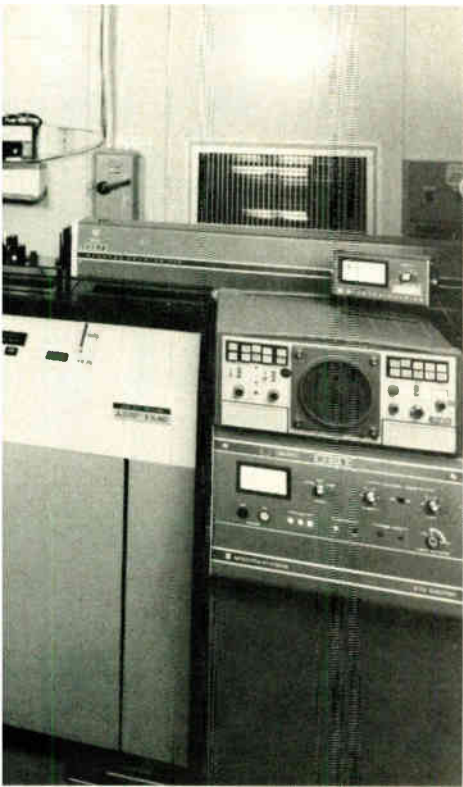


**At the controls.** Technician works on laser disk recorder being developed by Mitsubishi. Company has displayed three experimental systems—two using tape, one using disks.

that frequency response and dynamic range are essentially independent of the characteristics of the disk or tape, and there is no crosstalk between channels. Furthermore, signals are retimed during playback, completely eliminating all wow and flutter. In all the systems announced so far, frequency response is flat within a fraction of a decibel to 20 kilohertz, and dynamic range is at least 85 dB—superior to that of any room that might be used for listening to the music and about 20 dB greater than that of most analog systems.

Early PCM recording systems for professional use all have tape as their recording medium, and initial consumer units will continue the trend. A start has been made by Sony Corp., which is offering consumers a PCM adapter for use with its two-hour Beta Format video tape recorders for \$1,920.

Experimental adapters with similar characteristics have been shown by Victor Co. of Japan, Matsushita Electric Industrial Co., and Mitsubishi Electric Corp. Mitsubishi also has shown another system in which



VTR was combined with electronics designed especially for PCM audio recording and playback, resulting in an audio-video unit the size of a video tape recorder alone.

Experimental disk playback systems, separate from VTRs, have been shown by Mitsubishi, Sony, and Hitachi Ltd. Audio manufacturer Pioneer Electronic Corp., which has just set up a joint venture with MCA Inc. to produce industrial video disk systems, has said it has worked on audio PCM disk systems in its lab. And Matsushita has hinted that it is a member of the group that has developed an audio PCM disk.

**Similarities.** Despite the completely different technologies used, the basic PCM coding scheme for both disks and tape can be identical, meaning digital program material on tapes and records may be converted from one to the other by digital processing with no loss in fidelity. Sony followed this course in the consumer PCM video tape adapter that it announced in September and the experimental PCM disk system that it showed later the same month.

Mitsubishi, on the other hand, showed two tape systems and one disk system, each with a slightly different coding scheme. Mitsubishi

uses 12-bit coding on its disk system, compared with 13 bits on its two tape systems and on Sony's tape and disk systems. The advantage is that 12-bit data converters are much less expensive than those offering 14-bit resolution. But a shift from hybrid to laser-trimmed monolithic devices should create major price reductions in both analog-to-digital and digital-to-analog converters.

**Differences.** A basic difference between the Sony and Mitsubishi philosophies is in the method of recording information on disks. Mitsubishi employs frequency modulation—actually, frequency-shift carrier. This technique uses several cycles of what would be the white level on a video disk for 1, several cycles of what would be the black level for 0, and several cycles of what would be extended sync-pulse frequency for sync between PCM words. Redundancy bits are added to the coded audio to catch errors, and the sample is repeated to correct errors, so that loss of sync is rare.

Sony, on the other hand, employs a direct recording scheme for disks similar to that used for computer tapes. Much higher-density recording is achieved, but complex sync plans must be used because there is a much greater risk of losing sync.

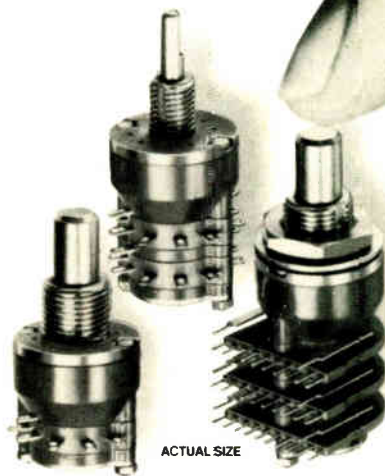
Although each company thinks its own system is best, all agree that a standardized format is needed to achieve success with prerecorded disks. Hitachi engineers think similarly but feel it will be a while before the time is ripe for standardization. Therefore they are putting all their efforts into developing basic hardware, including a channeled-substrate injection laser made with planar technology. Hitachi claims to be the only company with a practical semiconductor laser for disk playback, though other companies claim they too will have lasers by the time standards are agreed upon and companies are ready to begin production. Meanwhile, Hitachi is using for its experiments a PCM format developed by its subsidiary, Nippon Columbia Co., to record master tapes for conventional long-playing records on a 2-inch lateral-scan video tape recorder. □

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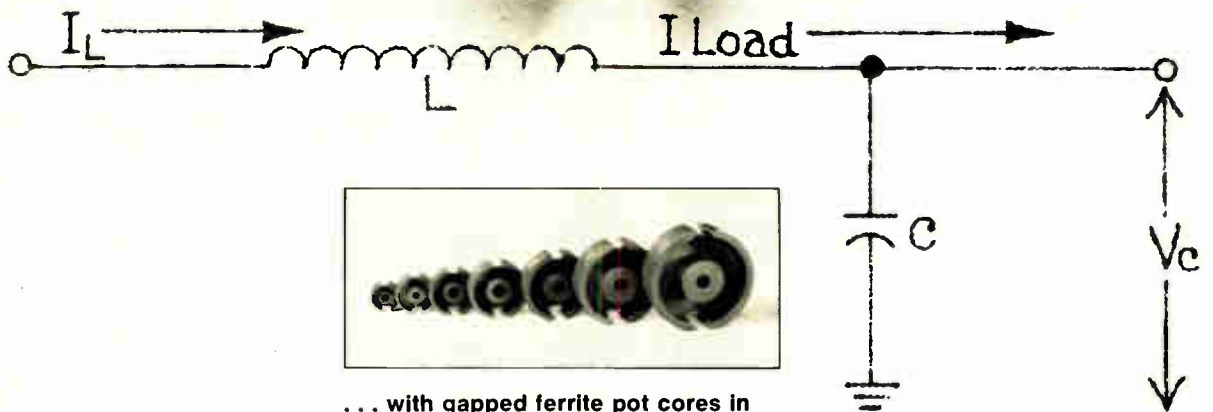
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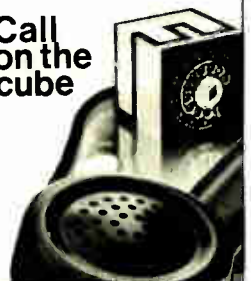
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Business

# Electronics shrugs off slowdown

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Semiconductor makers' consensus is for 18% to 20% increase over last year as computer and component sectors also show strength

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by Howard Wolff, Associate Editor

Although the U. S. is experiencing a slowdown in its economic growth rate during the second half of 1977, the electronics industries appear to be sailing through in good shape. Semiconductor makers see 1977 as a year of reasonable sales growth, and other industries—such as computers and components—are enjoying very strong years.

Setting the tone for the semiconductor outlook is Charles M. Clough, marketing vice president for Texas Instruments Inc.'s Semiconductor Products group in Dallas. "Business in the last half of the year will be stronger than the first," he says. "Growth for 1977 will come in pretty much as we expected—around 18%." And unlike 1976, this year's fourth quarter will be up strongly over the third quarter, he adds.

Computer companies, particularly those in the peripherals business, are the stars of TI's scenario. Fourth-quarter computer-industry bookings will at least match those of the third quarter, and the first quarter of 1978 will be up. "We expect to see a booking rate that's up 15% to 20% over our 1977 rate," Clough says. There is a slump in the consumer market, however, which Clough attributes to seasonal vagaries; but sales to auto makers are still strong, mirroring the sales of automobiles themselves.

In Silicon Valley, "business is reasonably good," according to E. Floyd Kvamme, vice president and director of operations at National Semiconductor Corp., Santa Clara, Calif. "I think the industry has been in the most general increase it's ever been in." He predicts "steady, albeit

slow, growth" into the early part of next year, with "demand increasing on a fairly good slope." Like Clough, he pegs the computer industry as the hot area, with demand for memories high. Kvamme's expectation for 1977 is a 20% increase, based on National's June-to-June fiscal year.

Wilfred J. Corrigan, president of Fairchild Semiconductor, Mountain View, Calif., agrees that 1977 saw reasonable growth. Computer business has been good for Fairchild, too, with equipment business and video games also strong. But consumer business has averaged out as "pretty tough," Corrigan says, because of Fairchild's problems with digital watches.

There also were soft spots for Advanced Micro Devices Inc., Sunnyvale, Calif., which president Jerry Sanders says has grown by 50% this year over 1976. Sanders explains that, though AMD's earnings are up, things could be better: heavy invest-

ment in research and development and in yield-improving methods have not produced as quickly as expected, and AMD also has opened major domestic and overseas facilities that are still to earn their way. Sanders sees 1977 winding up with a 12% to 15% industrywide increase for semiconductor business and 20% for integrated circuits.

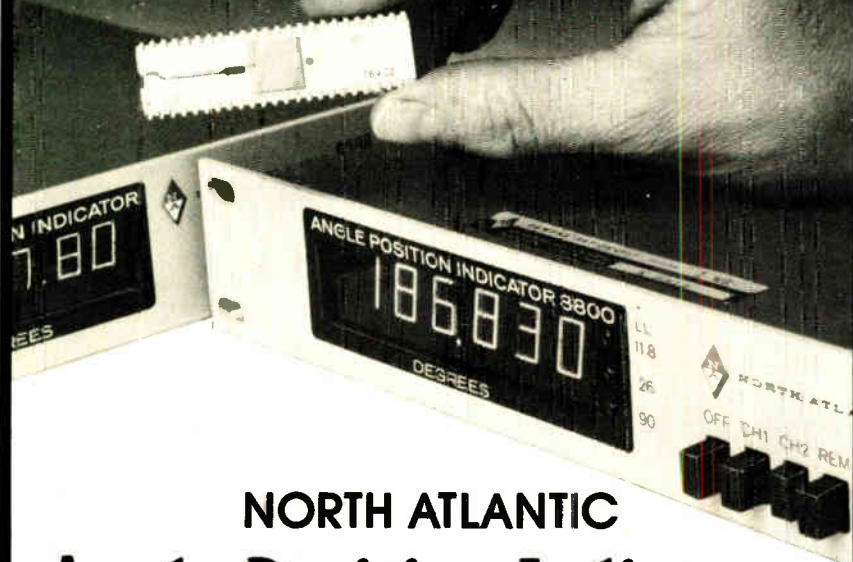
**Question marks.** John R. Welty, senior vice president and general manager of Motorola's Semiconductor group, Phoenix, says that a slowdown in the second half kept 1977 from achieving its predicted 20% to 25% increase—"it will end up more like 16% to 18%"—and that 1978 will bring "lingering question marks in the world market that will hold semiconductor growth to about 10%." He is seconded by Bernard V. Vonderschmitt, vice president and general manager of RCA Corp.'s Solid State division, Somerville, N. J., who also anticipates only 10%

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**A good year.** That's the verdict from TI's Clough (right) and IBM's Cary (below). Both also expect the trend to carry into 1978.



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## Probing the news



**Not bad.** For Fairchild's Corrigan, 1977 was a year of reasonable growth.

to 12% growth for 1978 after what he estimates at 15% for this year.

The vista enjoyed by computer makers is a lustrous one. IBM Corp., Armonk, N. Y., chalked up records for gross and net in its third quarter, which ended Sept. 30. Chairman Frank T. Cary says the reason is "the volume of outright purchases of data-processing equipment—also a record for any quarter."

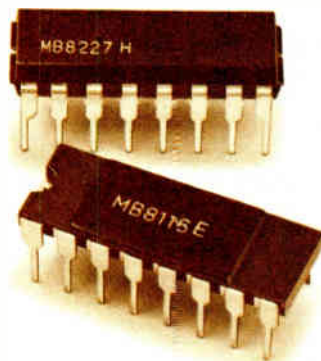
Detroit's Burroughs Corp. sees similar strength. President Paul S. Mirabito says orders in the third quarter increased 14% over last year's quarter, while backlogs have increased 28% since the beginning of the year. And Robert L. Puette, marketing manager for Hewlett-Packard Co.'s Data Systems division, Cupertino, Calif., says business has been "exceptionally strong."

**Big gains.** For Digital Equipment Corp. of Maynard, Mass., the first quarter of fiscal 1978, just ended, saw a 48% increase in total operating revenues over the same quarter last year, to \$302.6 million. And for rival Data General Corp. in Southboro, Mass., the year was outstanding, says senior vice president Herbert J. Richman. Fiscal 1977, which ended Sept. 24, was a year of \$254,687,000 in sales, compared with 1976's total of \$178,753,000.

Perhaps the brightest outlook is for components. Joy and optimism are unalloyed at Allen-Bradley Co.'s Electronics division in Milwaukee, where shipments are up 26% and the plant is working three shifts a day, six or seven days a week, and still can't meet demand. □

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The IEEE

## Can IEEE's rift be healed?

That's the question facing Getting and Hogan as they prepare to take over as president and executive vice president

by Gerald M. Walker, Senior Editor



**The victors.** Ivan Getting, far left, is the new president and C. Lester Hogan the new executive vice president of the IEEE.

It has been called both "a disaster" and "reassuring," but whatever the personal opinions, the election is over for the Institute of Electrical and Electronics Engineers. The question that remains: can two high-level executives from California—Ivan Getting, president of Aerospace Corp., and C. Lester Hogan, vice chairman of Fairchild Camera and Instrument Corp.—manage the severely split institute as president and executive vice president?

The reason for the wide divergence of reactions—and the reason for the deeply divided membership and the closeness of the vote—is the continuing conflict over how to run professional activities.

Staunch supporters of an activist stance view the results as a setback, especially with Hogan's narrow victory as a petition candidate over Carlton Bayless, division manager for Pacific Telephone and Telegraph Co. Bayless was nominated by the board of directors to succeed himself.

Supported by a collection of industry executives and university deans, some of whom had held IEEE positions, Hogan made no bones

about his disagreement with the way in which the U. S. Activities Board has been spending the \$1.5 million in dues allotted it from U. S. members [*Electronics*, Aug. 4, p. 20]. Bayless, on the other hand, has backed the institute's move into social and economic programs, though he is considered a moderate compared to engineering consultant Irwin Feerst, who lost to Getting, the board's nominee.

**Close vote.** To members who agree with Hogan's criticism of USAB, the result is reassuring, but it is not the mandate desired by the Good Government Group that financed Hogan's campaign. The vote was 24,793 for Hogan and 24,644 for Bayless. Getting received 28,161 to 21,753 for Feerst.

Now that the smoke from this acrimonious campaign has cleared, Hogan has modified his stance somewhat. "I stated my views strongly to make certain there was no doubt, about them," he maintains. "But I will not force my personal point of view onto the institute. I am prepared to represent the feelings of the members. I have no special commitment to the Good Govern-

ment Group. My only obligation is to reunite the membership."

However, Hogan very quickly began working to get someone of his choice selected as vice president of USAB. He also expects to have a say in the selection of a permanent general manager, if that position has not been filled by the time Hogan takes office on Jan. 1.

Getting is faced with the task of keeping the board of directors in one piece after the hard feelings that Hogan generated with his comments about the poor quality of leadership in the IEEE. However, he blames the controversy on the tone of Feerst's attacks on the board.

Like Hogan, Getting insists he has no intention of dismantling USAB. "A positive program is needed," he says. "Professional registration is a chief issue at present, and I think we can have it resolved by the end of 1978."

As for Feerst, who has made the race as a petition candidate for president three times, he hints that this election may have been his last try.

"As engineers, we should now recognize it's time for a new design instead of trying to fix the present one," he says.

The only vote that was not close was for a proposition calling for submission of all board-nominated candidates for office by May 1 and all petition candidates by June 1 instead of July and August. It passed by 3 to 1. Two others, to reduce the number of regions to seven and to put all dues increases to a membership vote, did not get the necessary two-thirds majorities to pass. □



Just what you expect from the CMOS leader

# Get greater 8-bit latch selection from Motorola

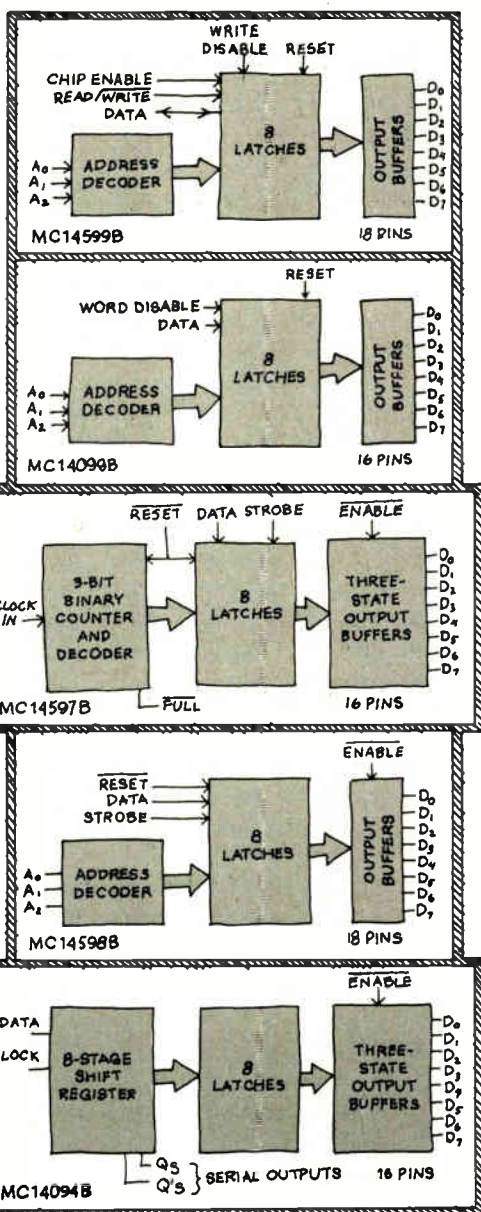
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**MC14599B**, similar in many respects to the MC14099B, has significant difference in the input, a three-state *bidirectional* input which provides communication optimized for bus expansion and readily allows information retrieval. The MC14099B and MC14599B are available now.

**MC14598B**, a bus-oriented addressable latch,



also is similar to the MC14099B, but it has three-state outputs capable of driving bus lines. The output buffers drive either one TTL load or four LSTTL loads. The MC14598B is scheduled for introduction this month.

**MC14597B** is a bus-oriented 8-bit latch and counter at the input for stepping data into the latches. Outputs are the same as those of the MC14598B. The MC14597B also is due out this month.

Last to be introduced (December), but by no means least, is the **MC14094B**, second sourcing the CD4094B. This device actually amounts to an eight-stage serial shift register, with a storage latch for each stage which strobes data to parallel B Series three-state outputs.

There it is. Just what you should expect from the CMOS leader. For information on Motorola's CMOS 8-bit latches, write to Motorola Semiconductor Products Inc., P.O. 20912, Phoenix, Arizona 85036, or circle the reader service number.



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Packaging & Production

# Chip carriers are making inroads

New technique, in which leadless ceramic devices are mounted on ceramic mother boards, means less weight than DIPs or hybrids

by Jerry Lyman, Packaging & Production Editor

A relatively new packaging technique is quietly muscling in on the market for complex, high-density electronic functions heretofore the preserve of component-laden printed-circuit boards and multichip hybrid integrated circuits. The reason: that new technique—mounting leadless ceramic chip carriers on a ceramic mother carrier—means smaller and lighter though denser systems and better thermal and electrical performance and reparability than does the DIP-pc approach.

The chip carriers, developed by 3M Co. of St. Paul, Minn. [*Electronics*, March 17, p. 81], are now being produced by 3M and Kyocera International Inc., San Diego, Calif. They are square, cofired ceramic packages with gold bumps on their bottom face. They are made the same way as high-reliability ceramic dual in-line packages but are much smaller.

At first, the packages, which have 16 to 64 input/output counts, are reflow-soldered to some type of interconnect substrate. In 1975, 3M developed simple ceramic multilayer boards for mounting four chip carriers on a substrate the size of a dual in-line package. That ceramic mother board had side-brazed leads that could be inserted into holes on a large pc board. Then came other ceramic-mother-board approaches that interfaced the mother carrier directly with a connector.

The ceramic mother boards are presently available from 3M and Kyocera. But because of delivery problems, some firms have to make their own while buying the chip carriers from those suppliers.

There are four pioneer users of the new technique. Texas Instruments

PACKAGING COMPARISONS				
	Weight (grams)	Area (cm <sup>2</sup> )	Yield	Cost
Printed wiring board	52	81	high	low
Chip carrier/mother carrier	12	12	high	medium
Hybrid	10	6	low	high

Inc. in Dallas, Honeywell Aerospace in St. Petersburg, Fla., and RCA Corp.'s missile and surface radar operation in Moorestown, N. J., all use it in products for the military. The fourth, Motorola Inc.'s Fort Lauderdale, Fla., operation, apparently is the first to incorporate it in commercial systems.

In papers delivered late last month at the International Symposium on Microelectronics in Baltimore, TI and Motorola pronounced themselves well satisfied with the new technique: not only does it permit packing densities approaching those of multichip hybrids, but it permits them to pretest the chips mounted on the carriers and thus avoid the low hybrid yield that is caused by low chip yields.

In putting together a hypothetical circuit containing 20 digital ICs (see table), Texas Instruments compared three techniques: DIP and pc board, chip carrier and mother carrier, and multichip hybrid. Not surprisingly, TI calculated that the combination of chip carrier with mother carrier would weigh less and occupy less space than the pc board, yet would have the same high yields. As for cost, it ranks second to pc boards.

Says Texas Instruments' Jon Prolog: "With increased automation,

the chip-carrier method could approach the cost of the pc board. And, though it will never eliminate the complex multichip hybrid, which is the ultimate in high density and performance, it is indeed an attractive alternative."

At Motorola, says Subash Khadape, "we are taking steps to reduce carrier assembly costs on pocket pagers and two-way radios." Motorola buys its chip carriers in a 330-piece array that is snapped apart along scribed lines. For the future, the firm's manufacturing engineers are considering automatically wire-bonding identical chips into each chip carrier of the array. Then the loaded chip carrier could be split into individual carriers, tested, and reflow-soldered to individual mother boards.

**Big reduction.** The size and weight advantages of the chip carrier over DIP counterparts are considerable. On average, chip carriers available today are a sixth the size of DIPs. And TI says that it has found it a simple matter to obtain size and weight reductions of 60% in assembled circuits.

Another point made by TI is not widely known. That is the thermal improvement achievable with a chip-carrier—mother-carrier assembly:

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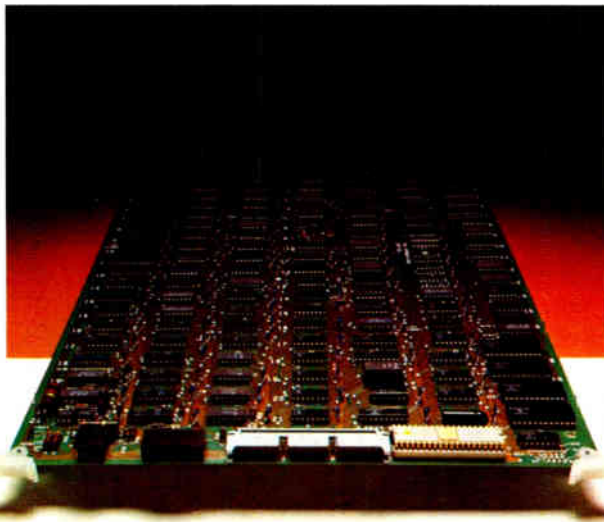
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Circle 87 on reader service card

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## Probing the news

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TI's thermal analysis indicates that one particular unit using conventional pc board assembly had a junction temperature of 125°C, while the functionally equivalent chip carrier assembly registered 99°C. This improvement is due to the superior thermal conductance of ceramic—more than two orders of magnitude above that of G-10 printed-circuit material.

**Removable.** Finally, the chip carrier is distinctly easier to repair than the pc boards. Extremely large DIPs are very difficult to remove without damaging the board. In a series of tests, TI subjected an array of chip carriers reflow-soldered to a mother carrier to a simulated repair cycle in which a chip carrier was removed and replaced an average of 15 times before it or its mother carrier was damaged.

Texas Instruments and Motorola have used the technique in a variety

of applications ranging from the exotic to the commonplace. For example, designers at TI have applied the new packaging concept extensively to avionic and missile packages using both custom and standard chip carriers and mother carriers. In a charge-coupled-device integrated reformatter package, the Dallas company's designers use five custom chip carriers plus one standard chip carrier on a 10-conductive-layer cofired ceramic substrate with a brazed-on lead frame. One of the chip carriers houses one custom CCD, two custom complementary-metal-oxide-semiconductor drivers, and one transistor. In TI's arrangement, four of the carriers are mounted on a pc board.

Also at TI, eight CCD memory chips are packaged in eight chip carriers and reflow-soldered to a thick-film mother carrier. This scheme allows 524,288 bits of memory to be packed into 7% of the space required for a conventional pc board assembly.

For a missile, TI's designers go to a custom, circular mother carrier to house a microprocessor, read-only and random-access memories, and input/output buffer devices all on chip carriers. In this system, chip-carrier packaging techniques reduce volume by 67% and weight by 75%. Because of these reductions, it was possible to cut the length of the missile itself.

Motorola also has some novel applications of the technique. In one circuit using chip carriers, a purely resistive substrate mounted on a carrier with a transparent cover is laser-trimmed to fine-tune an active filter. In another small chip-carrier—mother-carrier system, Motorola's designers have mixed leadless inverted devices in with chip carriers.

**Failure-free.** For its part, RCA's Missile and Surface Radar division has been using chip carriers, chiefly in avionics programs, for about four years. John Bauer, manager of design and development, says, "Re-

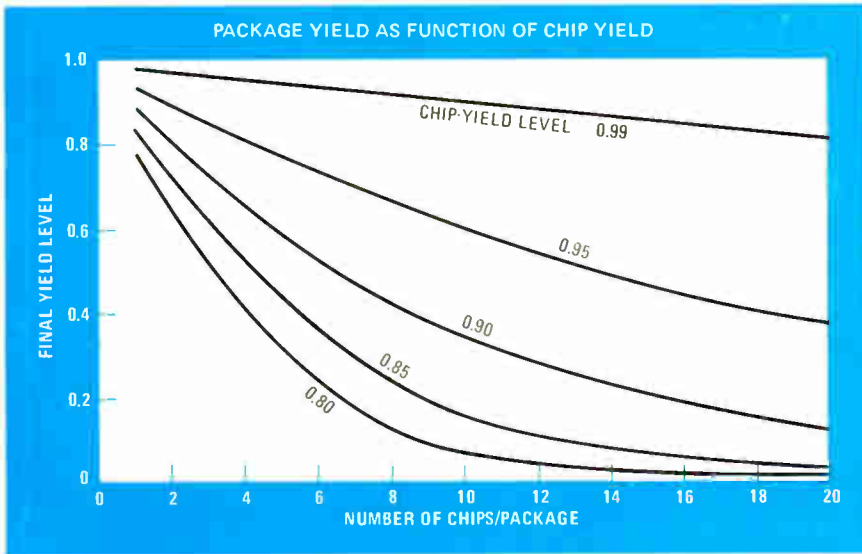
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Chicago's Commonwealth Edison uses Ramtek color graphic displays for rapid display and status reporting of pipelines, valves, pumps, and other generating station data. A clear, color-coded display is updated every 5.0 seconds, giving near-instantaneous visual scan-log-alarm functions, bar graphs, one-line piping diagrams, flow status, etc.

Before the Ramtek systems were installed, status reporting was by hardwired mimic boards, black and white alphanumeric CRTs and typers.

The Ramtek system not only costs less, it also allows more information to be presented to the operator in a form that is quickly and easily under-

stood. This results in better operator efficiency, and faster alarm reaction time. In Commonwealth Edison's 16,000 Megawatt system, thirty Ramtek color graphics displays will be utilized.



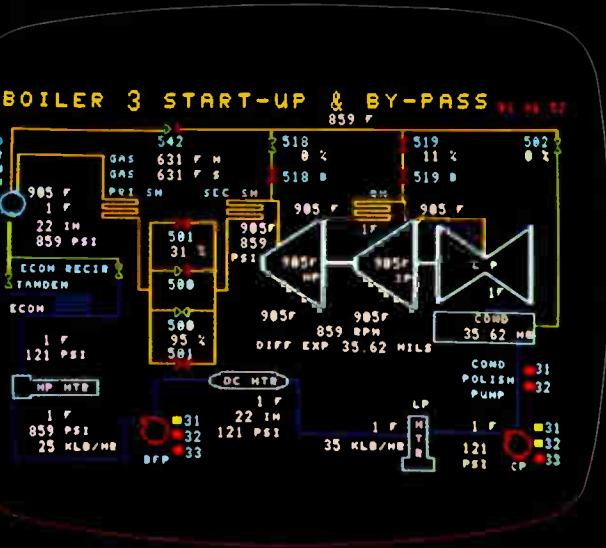
liability has been excellent, and no consistent failure mechanism has turned up in either carrier or mother board." The division has an advantage: it can buy many of the chips it needs already packaged and tested from RCA's Solid State division. And both RCA and Honeywell Aerospace

are experimenting with a package that combines the film-carrier chip-handling process with the ceramic-chip-carrier packaging process, permitting automatic bonding of the chip on film to the carrier's cavity, which is then sealed.

Honeywell's experimental work

comes after about two years of using the chip carriers with its own ceramic mother boards. Calvin Adkins, a senior designer on many of the division's military programs, says: "We went to this technique when our hybrid substrates got larger than 2 by 2 inches. At this point it was difficult to seal the overall hybrid, and the chip carriers, each with its own hermetic seal, solved the problem. No field failures have been reported in systems built around the chip carrier." Honeywell is trying to use only four sizes of carriers: devices requiring 16, 18, 24, and 48 pinouts.

Will the chip carrier win a larger following? The success of the concept, says Motorola's Khadape, "hinges on two vital factors: standardization and automation." Some progress has been made in standardization [*Electronics*, March 17, p. 81] but much remains to be done in automating the mounting and soldering of chip carriers to mother carriers. □



Commonwealth Edison monitors on-off, full-empty, flow status, and other parameters on a Ramtek FS-2400. Color is assigned for steam, water, no-flow, and oil flow to differentiate visually between materials and status. On the RM-9000, resolutions from 240 lines x 320 elements to 512 lines x 640 elements are available.

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Government

## NASA's star to continue falling

Frosch, on the job as administrator just five months,  
to maintain agency's emphasis on terrestrial applications

by Ray Connolly, Washington bureau manager

Until the space shuttle becomes operational in 1980, aerospace electronics contractors see few new business opportunities at the National Aeronautics and Space Administration. It is an agency plagued not only by declining budgets and staff reductions but also by a White House almost indifferent to its wants. Few industry officials believe that Jimmy Carter's new NASA administrator, Robert A. Frosch, can or will be permitted to alter that image.

Carter's stated goal for NASA is to make more and better use of existing technology for terrestrial applications. Frosch, not yet on the job five months, and now beginning to discuss details of his post, is following that line. "We have come out of 20 years of development in space," he says, "and we have a tremendous technological capability which has only begun to be applied to terrestrial—that is, remote-sensing—applications." He sees NASA's future as "maturing the use of space" for such applications.

Such observations by the 49-year-old physicist are being interpreted by industry to mean no new major programs and a decline in research-and-development money. In their absence, NASA appears ready to continue with ongoing unmanned programs like the Tiros-N prototype meteorological satellite set for a 1978 launching [*Electronics*, July 7, p. 76] and the Nimbus-G, to go up the same year for experimental air and water pollution monitoring.

Frosch tends to confirm such industry fears when he observes that "after we have consolidated and sensed payoffs" from such programs, "we will be in a position to under-



**Looking to land.** NASA administrator Robert A. Frosch wants to "mature the use of space" for remote-sensing applications.

stand what it is we can do with the shuttle. Then we can begin to think about a next step."

**Next steps.** Satellite engineers, for example, should start to think about the impact of the shuttle in terms of cheaper and better engineering, Frosch says. "You are no longer putting a satellite on an expendable vehicle, doing the best you can with it, and then kissing it good-bye. You can truly assemble things in space, check them out, and then retrieve them later" for maintenance or repair. "We've talked a good deal internally about what that means, but I think we are just beginning to think about it. It's an area in which industry might be very useful."

With the new Department of Energy now in the Washington limelight, corporate technology managers question how much White House support NASA can count on.

They note that Frosch—no newcomer to Washington's bureaucratic wars, having served as assistant Navy secretary for R&D during a decade of Pentagon duty—was not even appointed until more than six months after Carter's election, when the fiscal 1978 budget hearings were already well advanced in Congress.

In an October forecast of the NASA market over the next five years, the Electronic Industries Association projected a budget decline that "will likely continue through 1982." Apparently, NASA's needs will be subordinated to Carter's goal of balancing the budget by 1981.

Frosch himself is still laboring with problems he found on his desk on joining NASA. Chief among them are the \$4.017 billion appropriation for fiscal 1978 that one headquarters staffer notes "doesn't even cover inflation factors" and a directive to cut agency personnel by 500 jobs to 23,237 by the end of the fiscal year while at the same time hiring 425 minority or female workers. Although Congress lopped only \$17 million off Carter's revised budget request, most of that—\$13 million—fell on research and development.

Nor has Frosch been helped by declining public and press interest in NASA since the end of the lunar-landing effort. "In talking with industry and related groups," he says, "I find there is tremendous interest in applications and science programs, but people feel they haven't heard about those things. They have heard about some, but only a little, and have seen little interpretation about what those new programs mean" in terms of benefit to the nation. □

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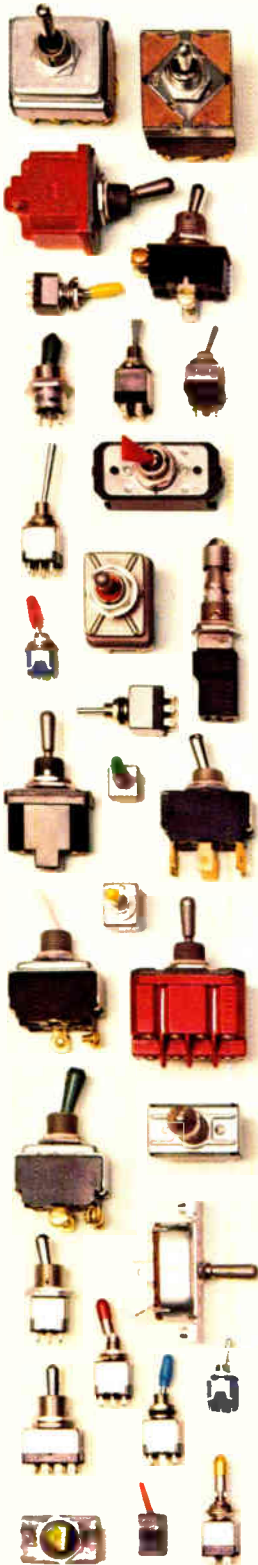
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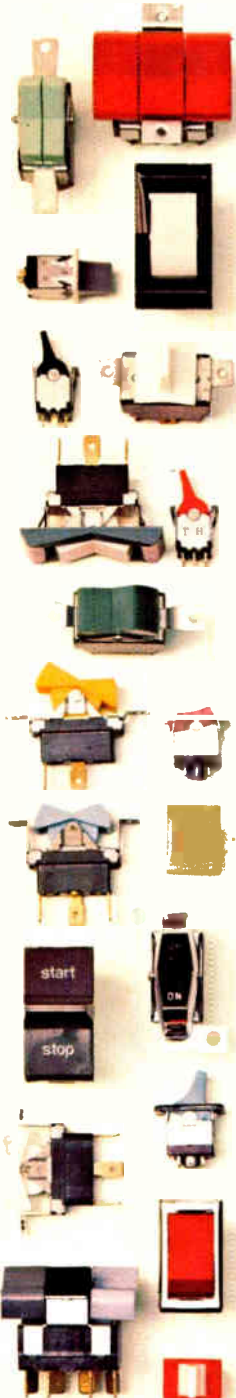
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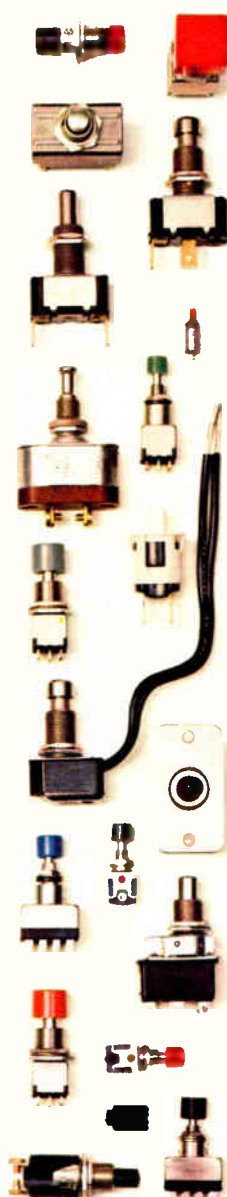


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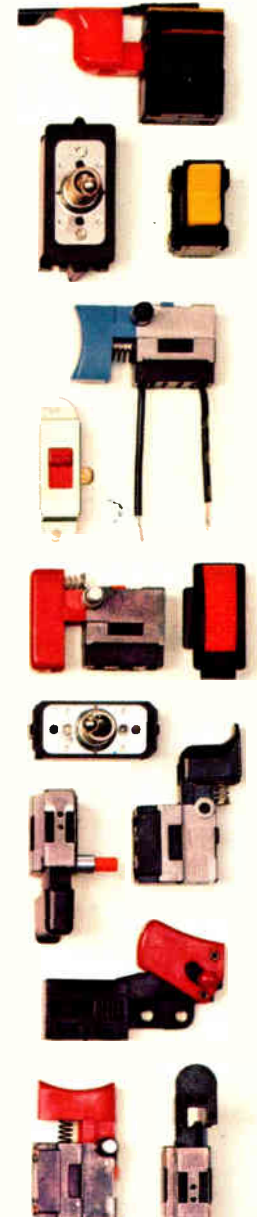


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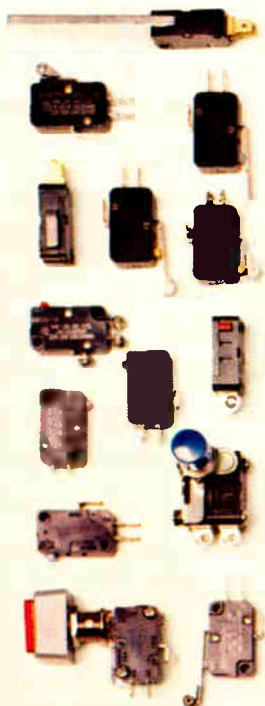
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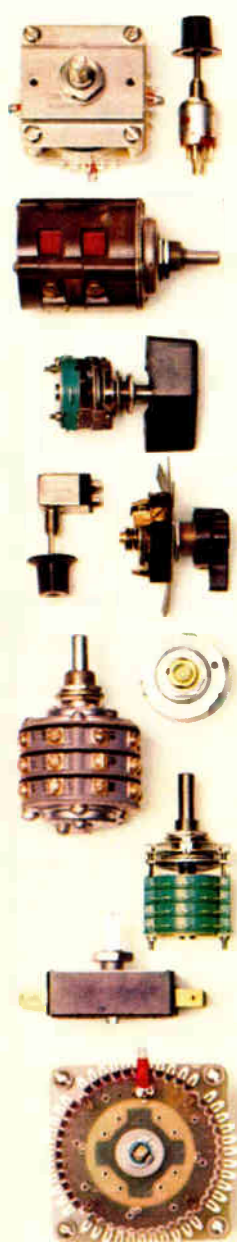
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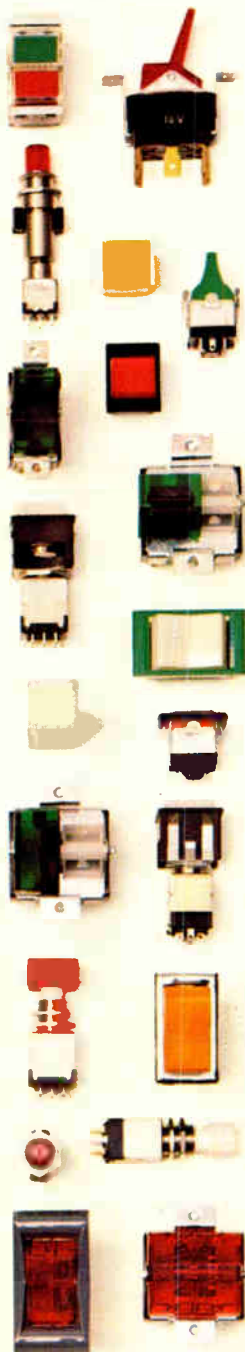
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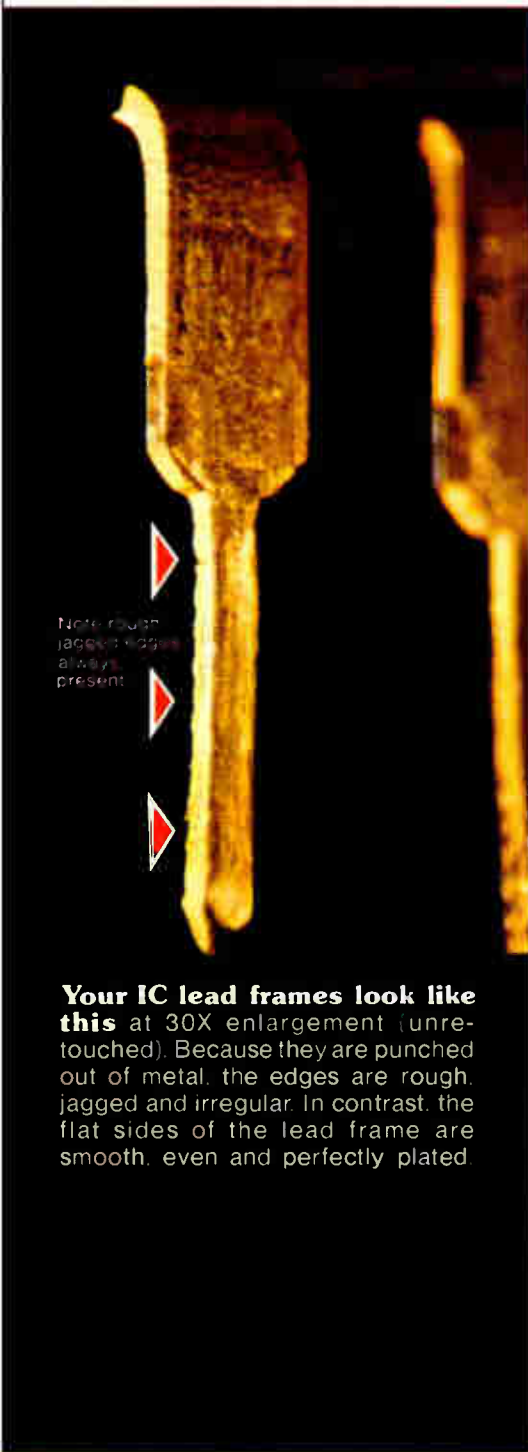
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UNRETOUCHED

# MICROPHOTOS



**Your IC lead frames look like this** at 30X enlargement (unretouched). Because they are punched out of metal, the edges are rough, jagged and irregular. In contrast, the flat sides of the lead frame are smooth, even and perfectly plated.



## THEIRS

**An ordinary edge-bearing socket contact** after 5 insertions of DIP lead frame. Contact has been spread apart to show inside faces of contact. Notice how the contact has scars and abrasions from rough, irregular edge of IC lead frame. Electrical contact is degraded and resistance is increased. Reliability is obviously reduced.

Lead frame in place in an ordinary edge-bearing contact.



## OURS

**ROBINSON-NUGENT "side-wipe" socket contact** after 5 insertions of DIP lead frame. Contact has been spread apart to show inside faces of contact. See how the Robinson-Nugent contact—because it mates with the smooth, flat side of the IC lead frame—retains its surface integrity. The 100% greater lead frame contact results in continuous high reliability.

Lead frame in place in RN "side-wipe" contact.



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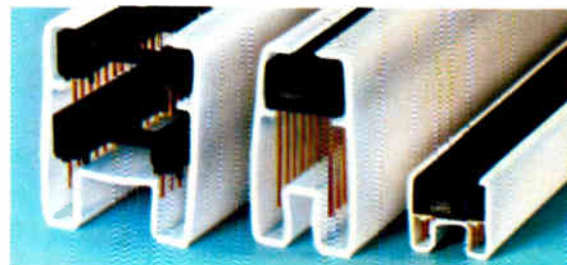
# expose 'junk' socket problems

## **Secret of RN high reliability 'side-wipe' DIP sockets revealed by microphotos**

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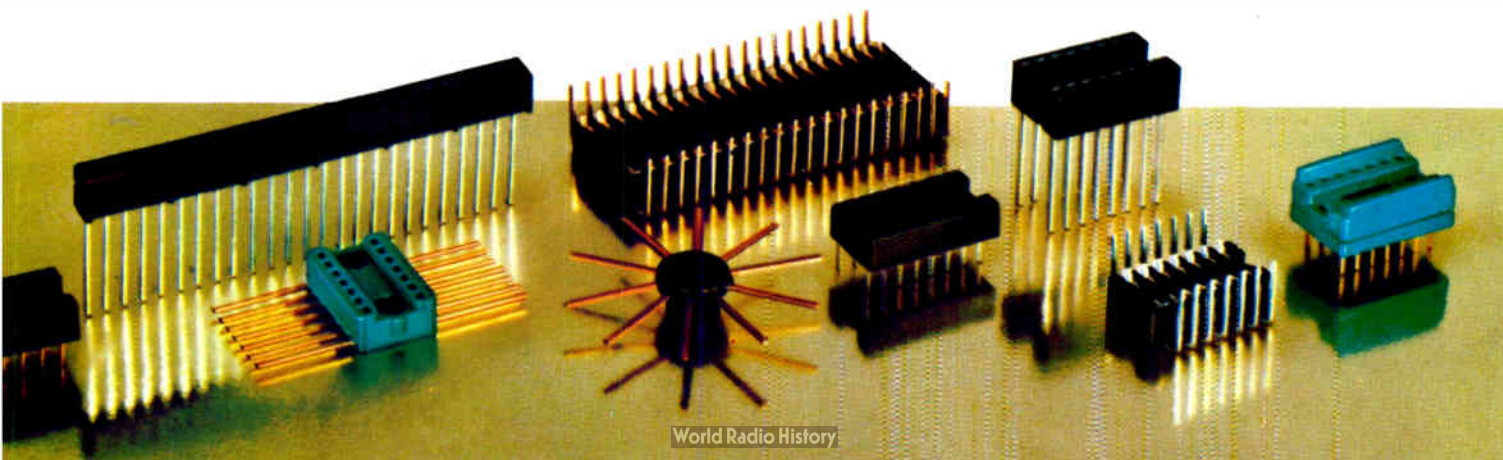
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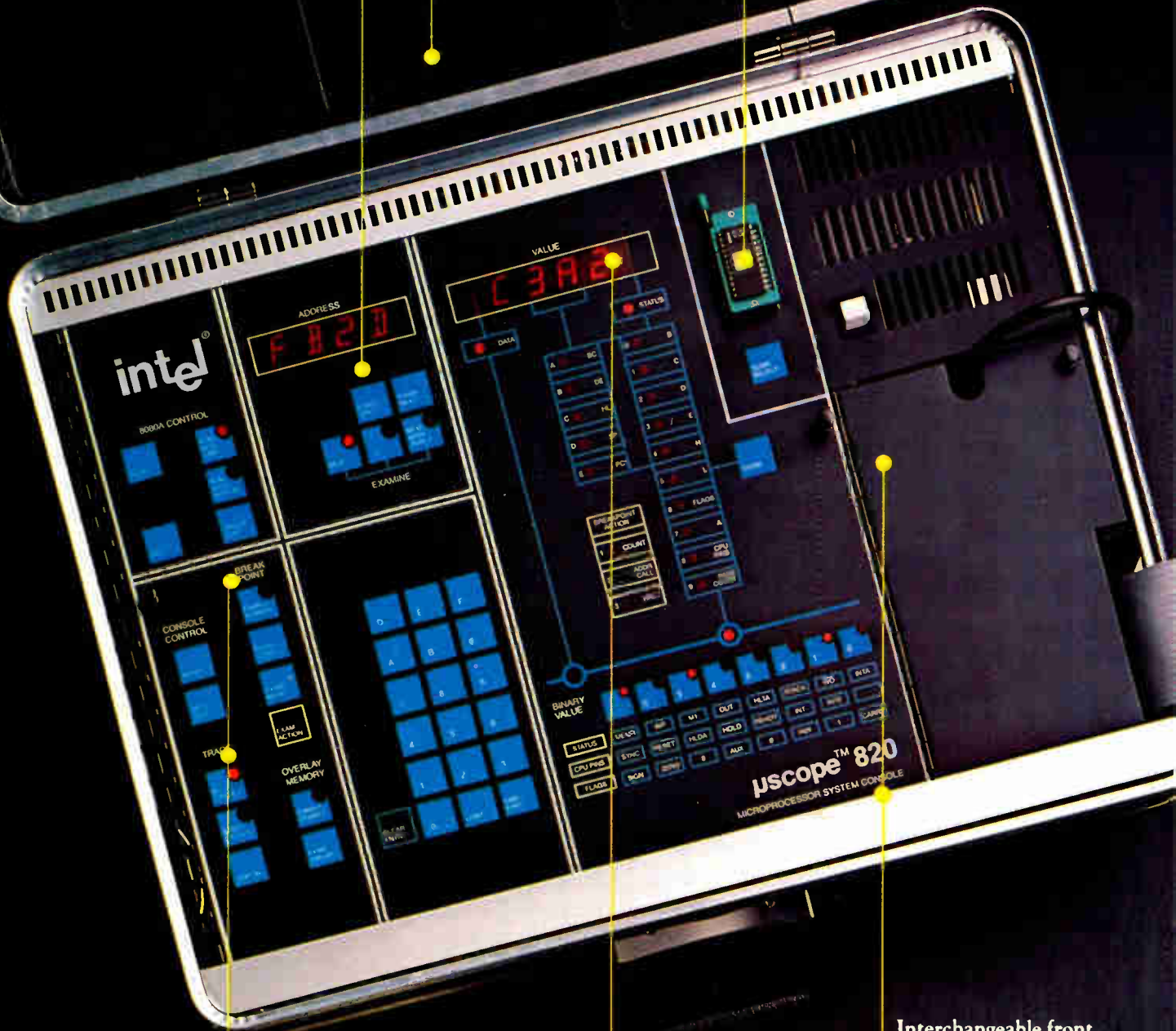
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Built-in high level diagnostics speed and simplify isolation of even the most difficult system problems.

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Extensive prompting simplifies operation for test and service personnel, minimizes training time.

**Interchangeable front panels, personality cards and personality probes**  
 $\mu$ Scope 820 adapts to a variety of microprocessors. Probe plugs directly into system microprocessor socket.

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Unlike logic analyzers, the  $\mu$ Scope 820 console provides a genuine solution for test and service personnel. It provides the same inside look at system operation that you get with a logic analyzer. But the  $\mu$ Scope 820

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Until now the only way to get this kind of diagnostic capability was to use your Intellec® Microcomputer Development System. Now we've taken the Intellec features that have proven most useful for field service and production-level system checkout and have packaged them in this self-contained 20-lb attache case. That's portability.

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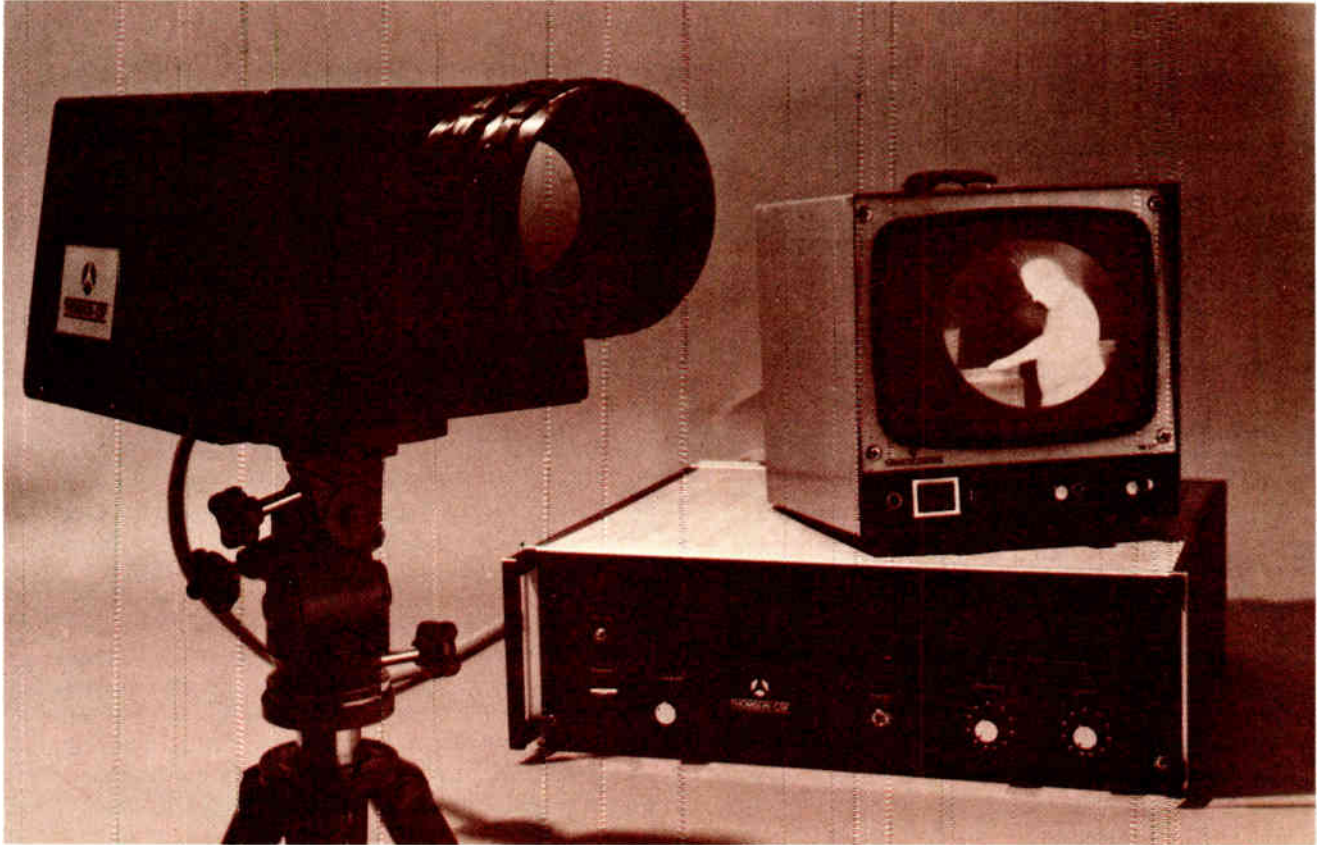
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# Today's infrared-reading vidicons map clearer pictures

To provide a flicker-free picture, new thermal-sensing system uses an image-difference processing technique

by A. G. Shephard, *Thomson-CSF Electron Tube Division, Boulogne-Billancourt, France*

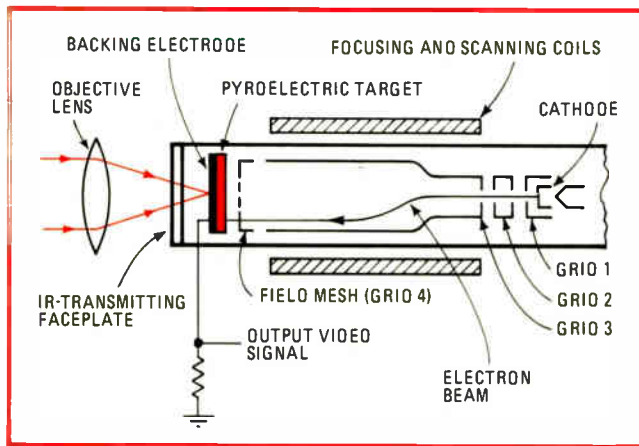
□ Fighting a forest fire, examining a woman for breast cancer, and checking electronic circuitry for hot spots all have something in common. They can benefit by the added dimension of information provided by a pyroelectric-target television tube that uses the infrared radiation emitted by the object on which it is focused to produce a "heat picture." Such a thermal image may appear on a standard TV monitor (above) and will provide a view of how any heat-emitting system or phenomenon—including the human body—is functioning at the time the image appears.

The technology that goes into the thermal tubes is not that different from that of conventional TV-camera tubes. Processing signals from the IR spectrum does require special attention to reading the temperature

changes that activate the tube's target area and to providing modulation of the incoming radiation when the object is not moving across the field of view.

The thermal imaging that results can find widespread applications in the medical, industrial, and surveillance fields. Such pyroelectric vidicons solve the problem inherent in detectors used in conventional thermographic camera systems, which convert the incoming radiation to voltage and require supercooling to reduce the noise to an acceptable level. A new thermal-imaging tube, the Pyricon, solves another serious problem: provision of a flicker-free image under all conditions.

The Pyricon's construction (Fig. 1) resembles that of a standard vidicon, a small TV-camera tube. The significant differences are the IR-transmitting window and the



**1. Basic structure.** A camera incorporating a Pyri-con tube and simple focusing system shows the similarity between an infrared-reading vidicon and a standard visible-light vidicon. The only real differences are an IR-transmitting faceplate and a pyroelectric target.

target's pyroelectric material, which is sensitive to IR light rather than visible light (see "The pyroelectric effect and poling," p. 103). The lens focuses incoming thermal radiation onto the target, which absorbs heat energy. This absorption creates a temperature distribution that in turn causes electrostatic charges to appear on the surface of the pyroelectric target.

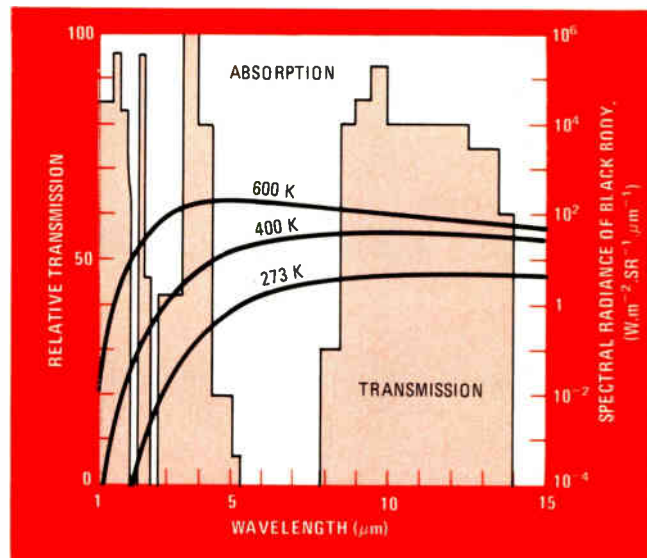
### Reading the thermal image

The resulting potential distribution, which reproduces the thermal image, can be read by an electron beam as in a standard vidicon. In effect, the reading cancels the potential distribution by depositing charges on the target's face—a process called charge compensation. The initial potential at a particular point of the target determines the quantity of charge deposited there. These charges produce the video output signal by capacitive coupling to the backing electrode, which is an evaporated metal layer on the opposite face of the target.

Since the pyroelectric effect depends upon changes in temperature on each part of its target, a pyroelectric tube will not pick up an image from a steady-state object—the temperature will vary over the target, but it will remain constant at each particular point. Of course, if the object is moving, or if some form of IR pulsing illuminates the scene, there is no problem. Otherwise, there must be some means of moving the image on the tube's target or some way of modulating the incoming steady-state radiation. This important consideration will be discussed below.

Another factor to consider is that certain IR bandwidths are strongly attenuated by the atmosphere (Fig. 2). However, some bands do transmit well at certain wavelengths, called atmospheric-transmission windows. So the pyroelectric tube's faceplate and the camera's lens are chosen for optimum performance at these wavelengths (Fig. 3).

To insure that no image information is lost, the scanning electron beam must be able to read all positive and negative charges appearing on the surface of the target. Thus the basic potential of the target surface must be sufficiently high so that even the most negative potential



**2. Transmission windows.** When viewing distant objects, infrared radiation is strongly attenuated by the atmosphere. Black-body spectral radiation curves for common temperatures are superimposed to show the importance of transmission "windows."

variations will still permit beam access.

Two different operating modes can be used. However, the anode-potential-stabilized mode, in which the target potential is held close to that of the anode, results in relatively low sensitivity. So almost all thermal-imaging systems use the cathode-potential-stabilized mode. Positive charges raise the target potential up to a positive potential, which is close to the cathode potential. The pedestal potential, which must be constant over the target surface, is greater than the variations in potential caused by increases and decreases in the target's temperature, so the electron beam can always read the target.

In the presence of a thermal image, the signal current is the sum of the pedestal current and the current caused by the temperature variations in the pyroelectric target. In the absence of a thermal image, the beam will deposit electrons that lower the target potential by a value equal to the pedestal. Then a minute pedestal current flows through the target.

### Producing pedestal potentials

Two means of generating the pedestal potential are commonly used, each having particular advantages and disadvantages. In one, positive gaseous ions deposited on the target surface generate the pedestal. The ions are created by the electron beam striking gaseous molecules, which can come from a gas reservoir in the tube or from gas introduced in bulk into the envelope during fabrication. The reservoir is generally the preferred mechanism, as it allows complete control over the tube in all operating modes. Increasing the reservoir-heater supply voltage (variable between 2 and 5 volts root-mean-square) increases the number of free gas molecules and thus the number of positive ions.

The other technique for generating the pedestal potential uses a gasless tube. The cathode is pulsed negatively during horizontal flyback so that the electron beam strikes the target with sufficient energy to create



## What thermal-imaging systems actually see

A common misconception is that shades of gray or various colors in a display of a thermal-imaging system indicate different temperatures. Although sometimes true, it is far from being so in all cases.

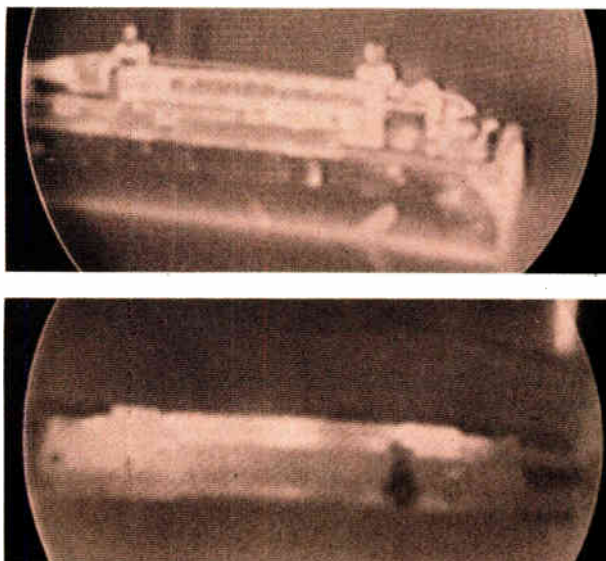
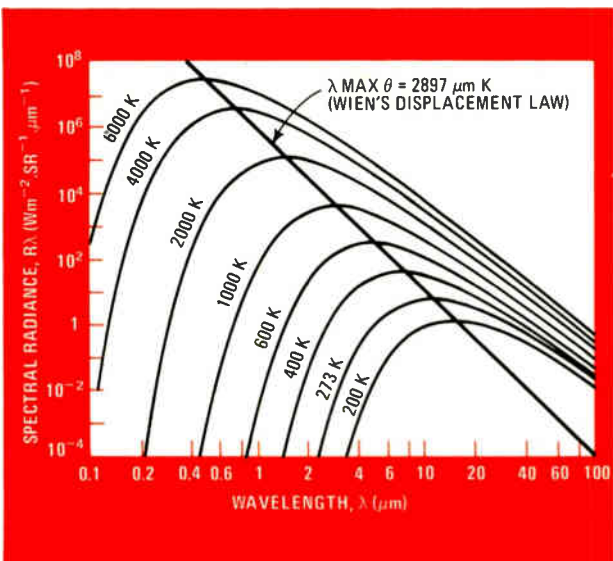
Passive thermal imaging systems detect electromagnetic radiation spontaneously emitted by all objects at temperatures above 0 K. Consider the ideal case known as the black body: a substance that absorbs all radiation incident upon it at all temperatures and then radiates it. Although such a black body can never be realized, a hollow sphere with a small opening is a close approximation. Any radiation entering the opening undergoes many attenuating reflections and is almost completely absorbed.

The spectral distribution of the radiation intensity of radiation emitted from black bodies for various temperatures is shown below. Radiation for all black bodies at identical temperatures is the same, so that the total energy radiated by a black body (the area under the curve) is characteristic of its absolute temperature,  $\theta$ . The relationship is expressed as  $R = \sigma (\theta^4 - \theta_0^4)$ , where  $\theta_0$  is the absolute temperature of the surroundings and  $\sigma$  is a constant. The target of a pyroelectric vidicon detects a change in this energy caused by an apparent change in

the object's temperature, so long as the change in infrared radiation is within the spectral range of the system.

However, the black body is an idealized case. With actual objects, there is great variance in the emissivity (the ratio of the energy emitted by an object to the energy emitted by a black body at the same temperature). Although the emissivity of human skin at room temperature is close to unity, the emissivity of polished metals is only a few tenths. Moreover, the emissivities of objects of the same material but of different surface finishes can differ.

Although general-surveillance tasks and medical diagnostics are relatively straightforward, industrial and scientific applications may contain hidden pitfalls. For instance, the different emissivities and spurious reflections of the different materials used to construct a complex object such as a traveling-wave tube can give a completely false idea of temperature distribution. This is shown right: on the top is a photograph of a traveling-wave tube; below are two images of it reproduced by the Pryicon showing the apparent temperature distribution before and after the traveling-wave tube was sprayed with flat-black paint. Such techniques render the emission characteristics approximately constant over the whole surface of the object.



secondary electrons with an emission coefficient greater than one. The loss of the negatively charged electrons results in an increase in positive charge on the target surface, which produces the required pedestal.

Two principal techniques are available for modulating incoming radiation to produce changes in radiation power impinging on the target. They are necessary when the camera is focused on a stationary object that is in a steady state. The choice is:

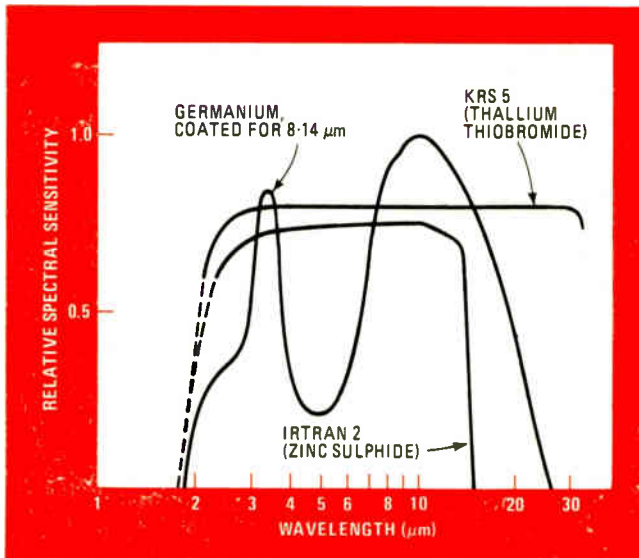
1. Moving the image on the target by panning the camera or nutating the lens—rotating it without changing its orientation.
2. Interrupting the flux of radiation falling on the target by chopping with a sectored disk or similar device.

The first method was commonly used in the early thermal-imaging cameras because it is easy to accom-

plish. However, the constant movement of the image on the target means that the image on the TV monitor also moves. Electronic compensation can stabilize the display, but residual movement is often visible, and objects that are relatively warm with respect to the rest of the scene leave "comet tails" and smears. In addition, eliminating the fixed-pattern noise caused mostly by small irregularities in the target material is difficult.

Chopping the incoming radiation is preferred, since it provides a stable image and fixed point of view. It is not used in most of the available cameras because it requires signal processing not found in standard video cameras—although this processing is simple to implement.

The problem with chopping is that the raw output signal is from the tube is of alternating polarity. When the chopping disk is open, a warm part of the scene heats



**3. Targeting materials.** Pyricon pickup-tube performance can be optimized for different atmospheric-window regions in the infrared spectrum. A target material, such as germanium coated for operation in the 8-to-14- $\mu\text{m}$  region, provides a high spectral sensitivity.

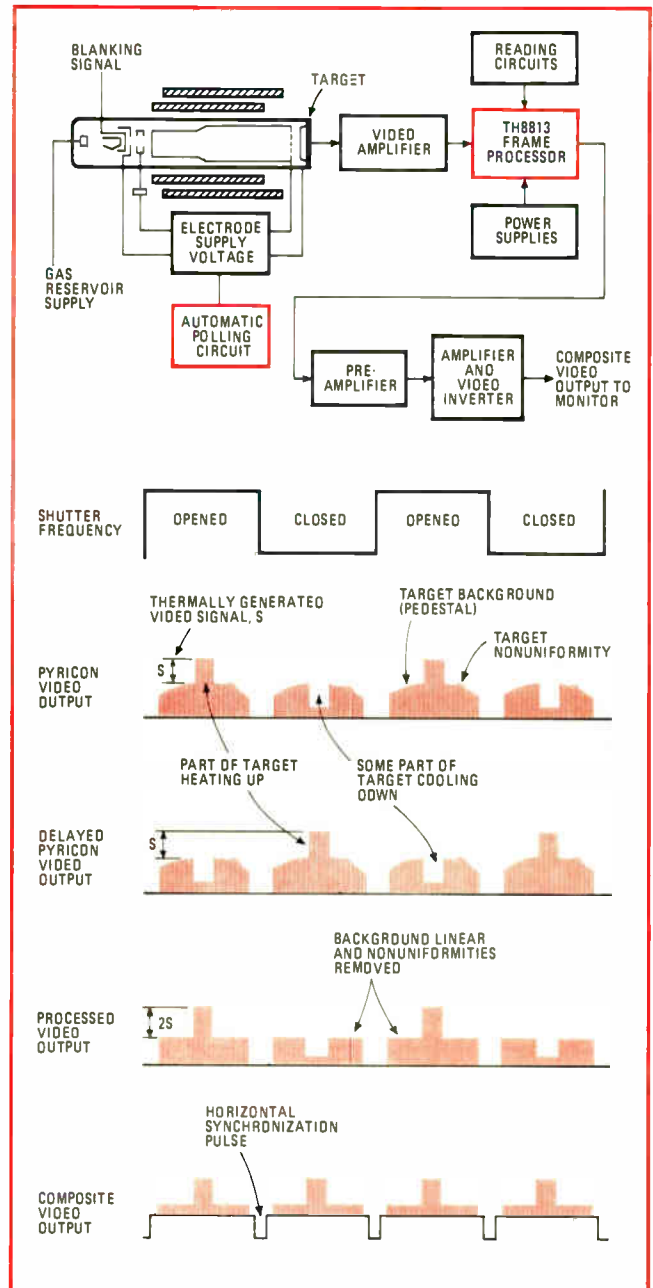
up the corresponding area of the target and produces a signal of a certain polarity. When the chopper cuts off the radiation, the target's warm part starts to cool, producing a signal of the same form but of opposite polarity. The TV-monitor image would, of course, be completely unusable because it would consist of alternating hot-is-white and hot-is-black fields.

Even inverting alternate parts of the signal would not be completely satisfactory, as the pedestal signal would still alternate in polarity, causing a heavy flicker. Simple subtraction of the pedestal before inversion does not work because it would require a rigorously uniform pedestal signal. Moreover, fixed-noise patterns, caused by pedestal variations as well as by target irregularities, would still be visible.

### Eliminating flicker

The Pyricon camera system uses an image-difference processing technique that eliminates flicker. A synchronous motor drives a sectored disk, which chops the incoming thermal radiation at 25 or 30 hertz depending on whether the European or American standard frame rate is used. The video amplifier's signal feeds into a frame processor (Fig. 4), which stores and compares alternate fields (half images) to produce an output signal in which the fixed-pattern noise has been removed and the video component doubled. The circuitry also flattens and reduces the pedestal. Then it inverts alternate fields to give a constant-polarity video signal in which the small pedestal is alternately positive and negative. The signal then passes into two parallel black-level-control circuits, where both pedestal signals are brought to a standard black level of the output signal.

As in standard video cameras, various synchronization and blanking pulses are added to give a 625- or 525-line interlaced standard video signal. Consisting of eight shades of gray, the signal can be displayed directly on any commercial monitor and can be recorded on stan-



**4. Flicker-free operation.** Chopped radiation from the tube's video amplifier is fed into the frame processor, which stores and compares alternate image fields to remove fixed-pattern noise, double the video component, and flatten and reduce pedestal voltage.

dard video-tape equipment. The gray shades range from white (hottest) to black (coolest), but it is important to note that they may not correspond exactly to the temperature distribution on the object from which the image is drawn (see "What thermal-imaging systems actually see," p. 101).

The black-and-white signals can be processed further in a colorizer and fed to a standard color monitor to give real-time color-coded isotherms, or other types of specialized display. The basic technique is relatively straightforward. Each of the eight possible levels in the gray scale is allotted a 3-bit code, black being 000 and white 111. The camera signal is sampled at a

## The pyroelectric effect and poling

The operation of the pyroelectric vidicon is based on the properties of certain types of crystals, called ferroelectrics, that are electrically polarized in a well-defined direction, known as the polar axis. The degree of polarization is temperature-dependent. The magnitude of this pyroelectric effect increases with temperature until what is known as the Curie point is reached. Beyond this, the polarization disappears.

Another effect of heating or cooling a thin slice of a ferroelectric crystal is to create an accumulation of charge in a direction perpendicular to the polar axis—a positive charge when the crystal is heated, and a negative when it is cooled. Moreover, the charge is proportional to the variation in polarization caused by the temperature change.

As well as increasing the pyroelectric effect, temperature increases rapidly hike the crystal's dielectric constant, which reduces the efficiency with which the charges can be read by the electron beam in the vidicon. Therefore, the maximum useful pyroelectric effect is obtained at a temperature somewhat below the Curie point. For triglycine sulphate, a commonly used material, the Curie point is 39° C, and the maximum useful temperature is between 35° C and 37° C.

Since the pyroelectric effect results from electric dipoles inside the material lining up with the polar axis, it is at a maximum when all the dipoles are oriented in the same direction. This orientation may be achieved by a process called poling, which consists of applying a strong dc electric field across the crystal.

To obtain this dc field in a pyroelectric vidicon, its target is bombarded with high-velocity electrons. Secondary-electron emission stabilizes the target surface next to the fine mesh screen, (grid 4 in Fig. 2) at mesh potential—typically between 225 to 275 volts. The resulting electric field correctly aligns the dipoles.

A tube that needs poling will give images in which the sensitivity is not constant, causing gray, contrastless areas, a marbled appearance, or sets of closely spaced, parallel lines. The standard procedure is to carry out the 1-minute poling operation just after turning on the camera—although if it has been off for only a few minutes, repoling is often not necessary. A user-controlled push button triggers special circuitry in the camera control unit that automatically ensures the required electrode voltage-switching sequence. Unless such an accident as target overheating occurs, poling need not be repeated during operation.

5-megahertz rate, giving 500 samples per TV line. The appropriate code for each sample goes to a color monitor where each bit in a 3-bit word controls one of the three guns in the color tube. Thus, 111 results in all three guns working (white), whereas 000 means none are working (black). 100, 010, and 001 result in only one gun working, giving the basic red, green, or blue of the color tube. Other combinations will result in two guns working, giving well-defined composite colors.

### Assessing performance

As with all imaging systems, the best way to appreciate performance is to look at the displayed image. Even photographs give serious image degradation especially when printed, as in this article.

However, an idea of system performance for the Pyricon may be gathered from the table. These figures are for a 625-line, 50-field-per-second image. The camera had a chopper and a frame store, so the image was in a fixed field of view and flicker-free. Slightly better performance can be obtained with panning—if the panning speed is carefully adapted to the target's characteristics. But such a technique is obviously too tedious for everyday operation, and of course it does not provide

a fixed field of view for the observer viewing the image.

The first figure in the table, the scanned target area, is highly significant. The smaller the target scanned, the less the signal current and resolution.

The irradiation change for which signal current is given typically is equivalent to an object's temperature difference of about 15° C. So signal levels are obviously very low in pyroelectric vidicons when small temperature resolutions are involved. It is for this reason that very careful preamplifier design and noise-elimination techniques such as frame storage are essential.

The two spatial resolutions are given for a minimum resolvable temperature of about 0.3° C. As these two parameters are interrelated, Fig. 5 will give a better idea of the Pyricon's performance. Curve 1 is for the panning mode, and curve 2 is for chopping. The scanned target area was 4.3 square centimeters, and the good-quality coated infrared lens was opened to an F stop of 0.7. The object was an infrared IR test chart with characteristics almost like that of a black body. It consists of a 300-K background with slightly warmer bars superimposed.

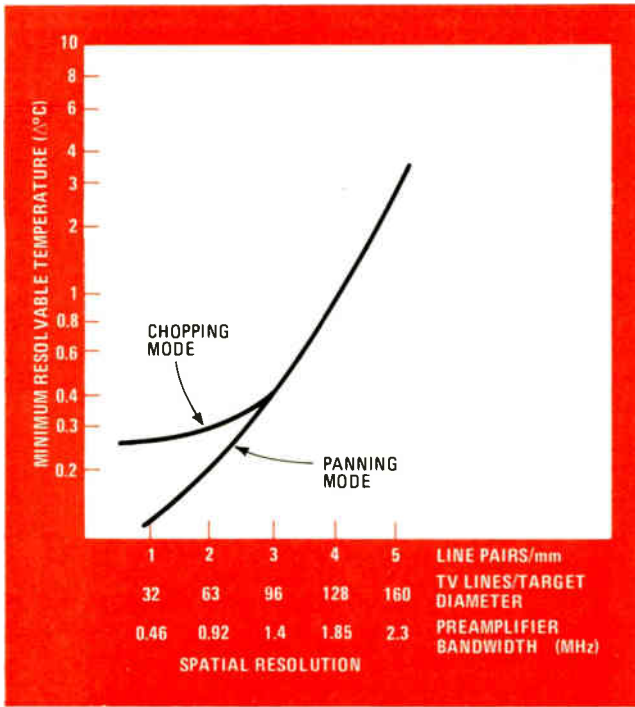
The gamma characteristic is the same as that of any optical system. It refers to the slope of the target-irradiance/signal-current curve.

The responsivity figure permits calculating the signal current that will be obtained for a given change in target irradiance. For example, consider the TH 9840, a Pyricon tube with a coated germanium window. If it has an intrinsic responsivity (S) of 4 microamperes per watt, and if it receives radiation in the bandwidth 8 to 14 micrometers, then a change in irradiation ( $\Delta E$ ) of 1 w per square meter will give a signal current ( $i_s$ ):

$$i_s = A \times \Delta E \times S$$

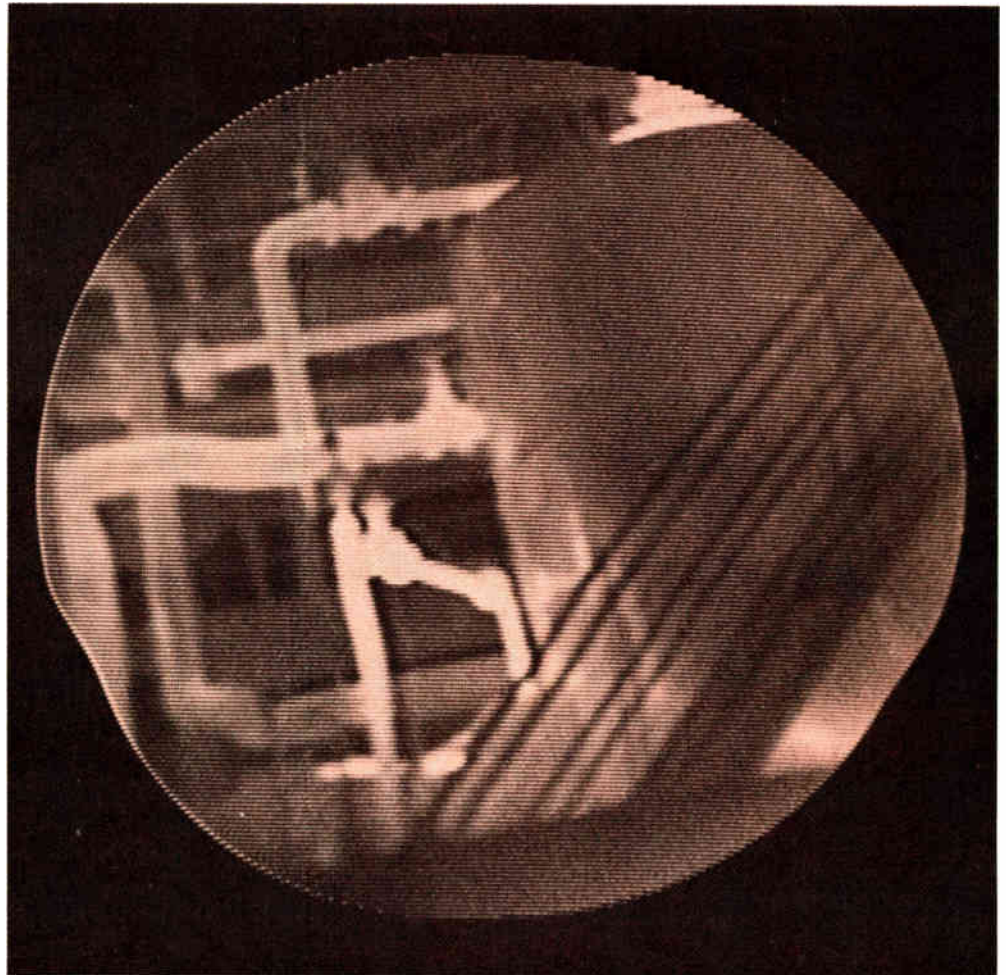
TABLE: PERFORMANCE CHARACTERISTICS

Scanned target area	4.3 cm <sup>2</sup>
Signal current (change in irradiance of 10 W/m <sup>2</sup> )	> 17 nA
Resolution at modulation transfer function of 50%, 20 ms after irradiation	> 2 line pairs/mm
Limiting resolution	> 6 line pairs/mm
Average gamma	1
Intrinsic responsivity (8 μm < λ < μm)	> 3.5 μA/W.



**5. Imaging IR chart.** Scanning an 18-by-25-millimeter area of an infrared test chart having characteristics nearly those of a black body shows the minimum resolvable temperature in panning and chopping modes as a function of spatial resolution.

**6. Locating losses.** Ineffective thermal insulation in buildings shows up as white areas in the photograph taken from a Pyricon tube display. On a scale of eight gray tones, the areas of excessive heat losses show up as white; the coolest areas are black.



where  $A$  is the  $4.3\text{-cm}^2$  scanned area.

$$i_s = (4.3 \times 10^{-4})(1)(4 \times 10^{-6}) = 17.2 \times 10^{-10} \text{A}$$

The overload characteristics of the Pyricon also are good, since signal saturation occurs only with a target radiance exceeding  $40 \text{ w/m}^2$ . This corresponds, for example, to a lens opened to an  $F$  stop of 1 and an object temperature of  $85^\circ\text{C}$ . At higher temperatures, the lens should be stopped down to its lowest value and then opened progressively. If the tube is overloaded, its target will become depoled.

### Applications abound

Pyroelectric vidicons may be used in active or passive environments. In active applications, which are chiefly scientific and industrial, a source of infrared radiation must illuminate the scene of interest.

Passive applications are much more common, because only self-emitted IR radiation (in the  $8\text{-to-}14\text{-}\mu\text{m}$  spectrum) is needed. Such emissions are inherent in human bodies, trees, buildings, etc. Thus the Pyricon thermal-imaging tubes are well suited for medical, industrial, and security applications.

The detection of breast cancer is perhaps the most widely known use of thermography, but it is far from being the only medical application. The heat radiated by a given area of skin depends mainly on two factors: the blood flow beneath the surface of the skin and the

condition of the surface of the skin. Medical thermography makes use of the fact that any change in skin texture or any problem that alters the blood flow will cause a change in real or apparent surface temperature.

For example, a severe burn will change the skin texture and therefore its emissivity. Careful use of thermographic equipment can give a rapid assessment of whether a burn is likely to heal or has already started to do so, indicating well in advance whether grafting is needed. Subsequently it can be used to give early evidence concerning the success of grafting operations by indicating if normal blood circulation is returning.

Any anomaly in blood circulation causes a change in the body's surface temperature, and this fact opens up a host of other applications for thermography. Among them are detecting thrombosis and locating partial blockage of arteries, checking the success of surgery, showing the extent of permanent circulatory damage prior to amputation, indicating if and where surgery would be used to remove varicose veins, and determining the efficiency of drugs such as pain killers that affect the blood circulation.

Thermal television systems using the Pyricon tube promise to come into their own for surveillance and inspection chores from a moving vehicle. Because no special cooling is required and because the equipment can operate in any position with no moving parts and with little or no maintenance, the systems are perfect for

long-term surveillance and inspection jobs in a rough mobile environment. An interesting application is in forest fire control, where an airborne camera can "see" through the smoke in order to map out centers of combustion not visible to the human eye.

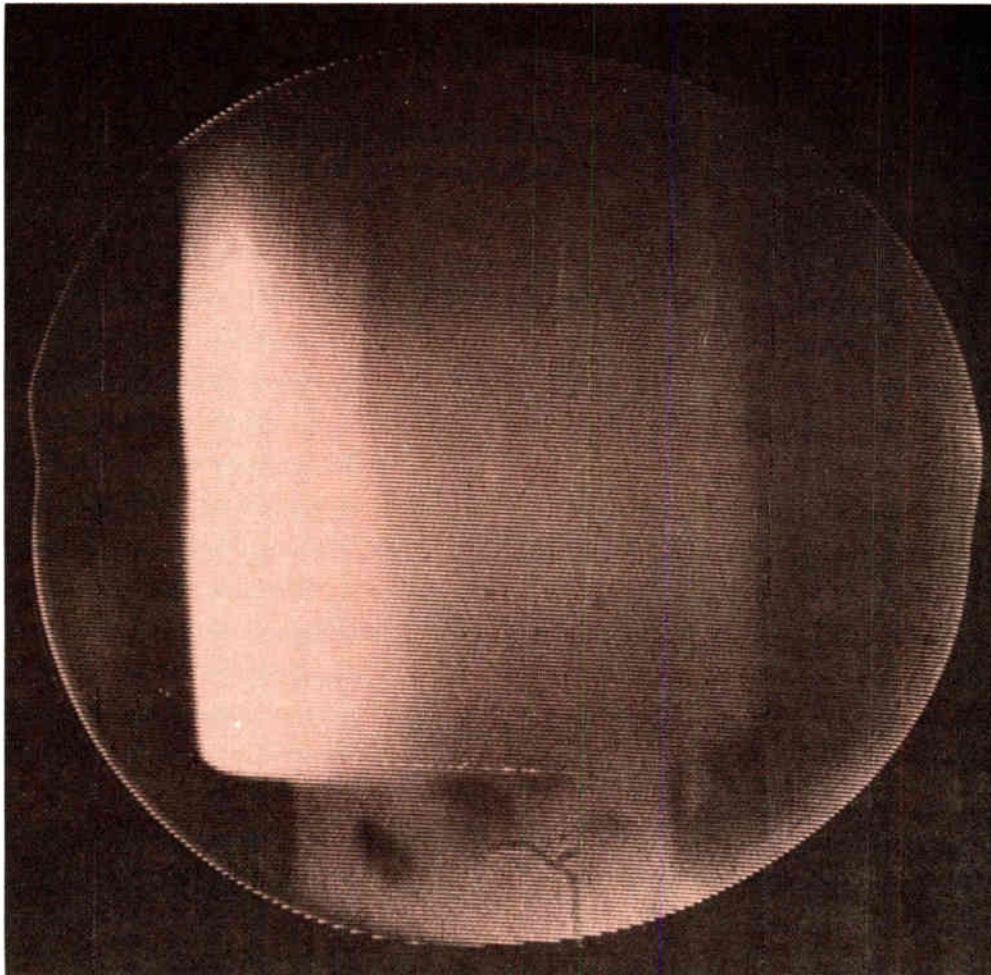
### Industrial uses

Thermal imaging cameras are also used to check high-voltage lines, since poor connections and faulty insulators heat up. They can locate leaks in pipelines and gas ducts and heat losses in buildings (Fig. 6).

Another application is checking the homogeneity of cast concrete. Density changes or microcracks cause uneven surface temperatures (Fig. 7). Thermal imaging can also locate discontinuities when concrete is heated by such sources as the sun. What's more, these camera systems can locate overheating in electrical and electronic circuits and can check aerodynamic heating of test objects in a wind tunnel.

In general, surveillance and industrial inspection applications are similar to those of mobile inspection. But they are less physically demanding because the equipment is mounted in a fixed location and is buffered from bad weather, shock, and vibration.

In industrial applications, fixed Pyricon cameras can be used to control the quality of plastics and other materials. Sections containing bubbles or cracks can be weeded out and the surface finish checked. □



**7. Heat stopper.** Real-time thermal imaging pinpoints microcracks in structures. Here, heat applied to the left of the test sample diffuses through it until it meets with a microcrack that otherwise would not be visible to the naked eye.



## Two formats go head to head in consumer VTR confrontation

Sony's Beta Format and Victor Co. of Japan's Video Home System, vying for position in the U. S. and Japanese consumer markets, differ significantly in physical layout and signal-processing methods

by Charles L. Cohen, *Tokyo bureau manager*



**1. VTR picture.** The two main consumer video cassette recorders are Sony's Beta Format (far left), and Victor Co. of Japan's VHS (left). Other adherents include Matsushita with extended-play VHS (above left) and Sanyo with Beta Format (above right).

□ To bring video tape recording to the point where it stands on the threshold of a potentially huge consumer market, Japanese engineers—primarily at Sony Corp. and Victor Co. of Japan—have had to steer an ingenious and inventive course between the complex NTSC color standards, the state of the magnetic-recording art, and the price the consumer is willing to pay.

Poised at the \$1,000 price barrier and sure to duck under it in the coming year, home video cassette recorders should become one of the hottest high-ticket consumer products since the introduction of color TV receivers some 20 years ago. In the forefront are two similar but nonetheless incompatible systems—Sony's Beta Format and Victor's Video Home System (VHS). The major American and Japanese television makers are now aligned with one or the other of these (Fig. 1), even though there are a couple of other VTR systems available (see "The other two VTR entries," p. 113).

Tape economy is the name of the game in consumer VTRs. While video tape technology has been around for decades, and audio tape technology for even longer, the breakthrough represented in these newer formats is in high-density data recording rivaling that of the most sophisticated computer storage systems, yet at a price consumers can afford. Compared with the commercial

machines standardized in 1969 by the Electronic Industries Association of Japan, the present VTRs use almost 80% less tape per hour in their standard-play modes. For one thing, these machines have exceptionally narrow video tracks; for another, unlike previous tape recorders, they lack guard bands between adjacent tracks (Fig. 2). Other means are used to avoid crosstalk between tracks, and the two systems embody slightly different solutions to the problem.

Recording and playing time, however, is the major difference apparent to the consumer between the Sony and JVC formats. Sony initially aimed for one hour, which had been more or less the expected playing time for consumer VTRs. But JVC went after two hours, the duration of the longest programs broadcast on Japanese TV. Both have since developed extended-play VTRs: Sony a two-hour model, and Matsushita Electrical Industrial Corp. a four-hour version being produced in Victor's VHS format for American companies.

Between the two 1/2-inch-wide-tape formats there are of course a number of basic similarities dictated by the fundamental nature of magnetic-tape recorders (see "What makes consumer VTRs run," p. 108). Both use what they call a two-headed helical scan to increase relative speed between recording heads and tape. The

## What makes consumer VTRs run

Video tape recorders use the same laws of physics as audio tape recorders—in fact, a narrow track along one edge of the video tape operates in exactly the same manner as conventional audio tape recorders, but at a slower speed. The big problem for VTRs is that the conventional NTSC video signal includes frequencies above 4 megahertz and below 30 hertz.

To record the high frequencies, the tape must slide over the head at a speed of 6 meters a second or faster. Yet the wavelengths of the magnetic fields recorded on the tape are so short that submicrometer head gaps are required and head-to-tape spacing must be even smaller.

No consumer VTRs have yet been made in which the tape moves at 6 m/s. Rather, all have been of the helical-scan type, which combine slowly moving tape with rapidly moving tape heads. The tape spirals around a revolving drum, generally for exactly half a turn, and the tape heads are attached to the edge of a rotating disk. This setup allows the tape head, traversing a circular path with the same radius as the drum, to scan diagonal tracks on the tape at the high speed required to record the video signal. Tape speed need only be fast enough to provide the desired track pitch and is orders of magnitude slower than recording speed.

Consumer VTRs are not capable of directly recording

the composite NTSC video signal and color subcarrier, which therefore is disassembled into baseband luminance and subcarrier chrominance signals before being recorded. Even so, the almost-17-octave frequency range of the luminance signal is too much for normal recording techniques, and a narrow-band frequency modulation technique is used to decrease it.

The chroma subcarrier signal is translated into the frequency range below 1 megahertz and recorded as an amplitude-modulated signal. The fm video signal in the 3-to-5 MHz band also serves as the ac bias for the chroma subcarrier.

Along one edge of the tape is a single or a dual (stereo) audio channel. Audio recording is completely conventional. Often, a separate erase head is mounted just before the audio head to facilitate dubbing a new audio signal alongside the video signal.

Along the other edge of the tape is the control track—normally a 30-hertz square-wave signal—which synchronizes playback with recording on the tape.

The normal sequence of recording includes a full-track erase head before the drum. Video signals are recorded as tape passes over the drum, and soon after it leaves the drum, the audio and control track signals are recorded simultaneously.

tape slips along a track that runs spirally around half the periphery of a drum. This drum consists of a concentric stationary layer or layers and a spinning section that makes 30 revolutions per second. Attached to the edge of this spinning disk are two heads that record successive diagonal tracks of video information across the tape. The heads and the tape travel in the same direction.

Like other color VTRs that preceded them, these two systems have to cope with video frequencies ranging from 30 hertz to more than 3 megahertz. So they record the luminance signal as a frequency-modulated signal in the 3-to-5-MHz band and translate the chroma signal into an amplitude-modulated signal below 1 MHz. The use of narrow-band fm makes it feasible to record the luminance signal, which spans a frequency range of almost 17 octaves and, in addition, provides low-noise playback. The chroma signal is translated into the unused frequencies below the lower sideband of the fm signal, which in turn provides the high-frequency bias required for recording the chroma signal.

### Rejecting the crosstalk

As mentioned earlier, these are the first color video tape recorders to eliminate the guard bands between adjacent tape tracks. Their absence increases interference between tracks, which is further magnified because the individual tracks are slightly less than 60 micrometers wide, narrower than in previous VTRs.

Worse yet, the video-head width is greater than the track width, which makes crosstalk inevitable in the playback signal. During recording of a single track, the full width of the head writes on the tape. But when the next track is recorded, the excess width of the preceding track is wiped off and recorded as part of the next track,

so that tracks are recorded to full width with absolutely no space in between. Thus, it is necessary to provide a high level of crosstalk rejection to maintain clean recording and playback signals.

Interference between fm luminance signals on adjacent tracks is avoided by shifting the azimuth of the two heads in opposite directions from the perpendicular to the track. For the very short wavelengths at which the luminance signals are recorded, variation in azimuth between recording and playback heads causes high loss and, as a result, rejection of adjacent track signals.

However, azimuth shift does not work for the lower-frequency chroma signal because this misalignment causes very little loss at the longer wavelengths involved. Instead, the Sony and Victor recorders use different phase-shift or phase-inversion schemes. In essence, the phase of the chroma subcarrier is so manipulated during recording and playback that the chroma signal of one track cancels out any noise it may cause in the playback of the following track.

The final problem to be solved is interference between the second harmonic of the chroma signal and the luminance signal on the same track. Since the second harmonic of the chroma signal is recovered from the demodulated luminance signal, it can cause moiré patterns on the picture tube. This problem is eliminated by selecting a subcarrier such that the phase of its second harmonic differs by 180° on successive horizontal lines of the picture, making the pattern barely visible. (The same technique is used to reduce the visibility of the 3.58-MHz subcarrier in television broadcasts.) Both VTR systems therefore had to be designed in such a way that the chroma subcarriers simultaneously satisfy conditions for rejecting adjacent-track interference and



COMPARING VTR SPECIFICATIONS

	EIA-J Type 1	U-matic	V-cord II (Long Play)	Betamax (Beta Format)	Matsushita 1 head, $\alpha$ wrap	VHS 2 hr (4 hr)
Tape type	$\gamma$ -Fe <sub>2</sub> O <sub>3</sub>	CrO <sub>2</sub>	Co $\gamma$ -Fe <sub>2</sub> O <sub>3</sub>	CrO <sub>2</sub>	$\gamma$ -F <sub>2</sub> O <sub>3</sub>	Co $\gamma$
Tape width (mm)	12.65	19.0	12.65	12.65	12.65	12.65
Tape thickness ( $\mu$ m)	30	27	20	20	26	20
Tape coercivity (Oe)	300	500	550	600	300	550
Video-track width ( $\mu$ m)	110	85	60	58.5 (29.2)	48	58
Video-head gap ( $\mu$ m)	0.7 ~ 1	0.7 ~ 0.8	0.5 ~ 0.6	0.45	0.6	0.35
Tape speed (cm/s)	19.05	9.53	7.387 (3.694)	4.0 (2.0)	5.21	3.34
Head-drum diameter (mm)	115.8	110	81.3	74.5	48	62
Relative speed (m/s)	11.1	10.4	7.73	6.9	9.09	5.8
Audio-track width (mm)	1.0	0.8	1.0	1.05	0.4	1.0
Control-track width (mm)	0.8	0.6	0.8	0.6	0.7	0.75
Playing time (min)	60	60	60/120	60/120	100	120
Tape area (m <sup>2</sup> /hr)	8.68	6.5	3.38/1.69	1.83 (0.9)	2.38	1.52 (0.76)
Luminance signal (MHz)	f m 3.1 ~ 4.5	f m 3.8 ~ 5.4	f m 3.1 ~ 4.3	f m 3.5 ~ 4.8	f m 3.1 ~ 4.6	f m 3.4 ~ 4
Chroma subcarrier (kHz)	767	688	688	688	688	629
Head configuration	2-headed helical	2-headed helical	2-headed helical plus 3rd head	2-headed helical	1-headed helical	2-headed helical
Used by	All mfrs. (commercial)	Sony plus others under license	Sanyo Toshiba	Sony Sanyo Toshiba Zenith (U.S.) Sears/Sanyo (U.S.)	Matsushita Quasar (U.S.)	Victor Co. of Japan Matsushita Hitachi Sharp Mitsubishi RCA (U.S.) Magnavox (U.S.) Sylvania (U.S.)

conditions for rejecting luminance-signal interference within the same track.

Both the extended-play version of the Sony Beta Format, also available from Sanyo Electric Co. and Tokyo Shibaura Electric Co. (Toshiba), and the extended-play version of the VHS, being produced by Matsushita Electrical Industrial Co. for RCA Corp., Magnavox Consumer Electronics Co., and GTE-Sylvania Inc. in this country, use similar techniques to double playing time by halving tape speed. This halves track width with negligible effect on writing speed.

**Narrowing the tape head**

Consequently, the head width must be cut in half, although the gap distance can remain the same. Since tape-head width of both standard- and extended-play versions of the two types is somewhat greater than track width, reduction in width is actually somewhat less than half—from about 60  $\mu$ m to about 35  $\mu$ m.

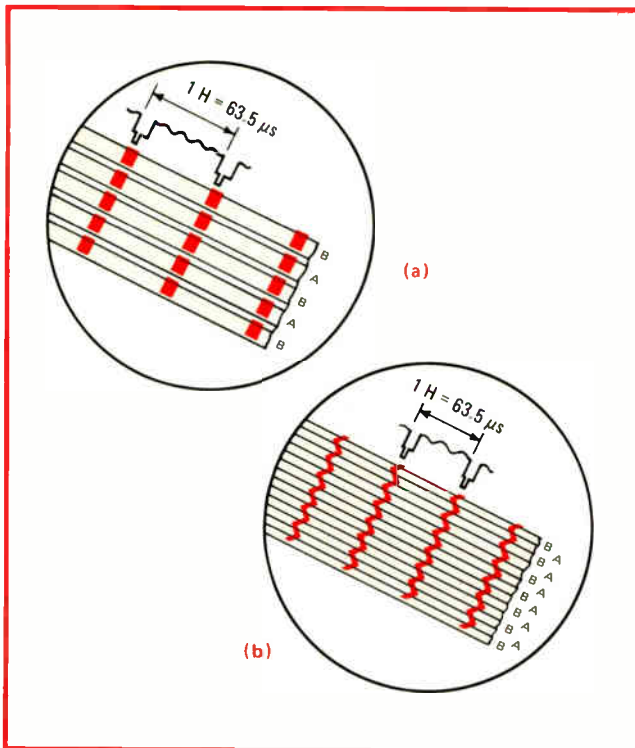
The major effect of the narrower head is that the signal is 6 decibels lower, with a signal-to-noise ratio that is about 3 db poorer than that of a standard-play unit. Halving tape speed has much more significant consequences, though. The horizontal sync pulses, which are neatly aligned on the original formats, are no longer aligned on the extended-play formats and generate increased crosstalk along two vertical bands about a quarter of the way from each side.

In these extended-play VTRS, rejection of interference from the adjacent track is augmented by offsetting the entire fm signal by half the horizontal frequency on alternate tracks. This arrangement interleaves the frequency spectrum of the track being played back and that of adjacent tracks and greatly reduces the visibility of any interference.

Both the Beta Format and the VHS extended-play versions improve s/n ratio by including in the luminance channel nonlinear preemphasis—de-emphasis noise-reduction systems resembling those used in audio tape disks. Preemphasis is increased beyond the usual value for high frequencies, but the nonlinear circuit prevents overmodulation when the high-frequency part of the signal also has high amplitude.

On the playback, a de-emphasis nonlinear circuit restores the signal to its original form while reducing noise. Sony claims that its noise-reduction circuit provides 6-db improvement in s/n ratio, so that even after subtracting the 3-db loss created by the narrower tracks, the ratio comes out ahead by 3 db.

Although head widths of normal- and extended-play machines differ, there is no problem in trying to play a tape recorded at normal speed on an extended-play machine, provided, of course, the machines are in the same VTR format and the machine incorporates normal speed. The narrower heads scan the center portion of the recorded tracks, resulting in a signal output drop of 3 db



**2. Dropping the guard.** Major advance in tape-saving technique for consumer video recorders required narrowing tape and eliminating guard bands between tracks (a). New format (b) also features skewed azimuth of alternate tracks for interference-rejection.

compared with output on a normal play, while interference from adjacent tracks falls considerably.

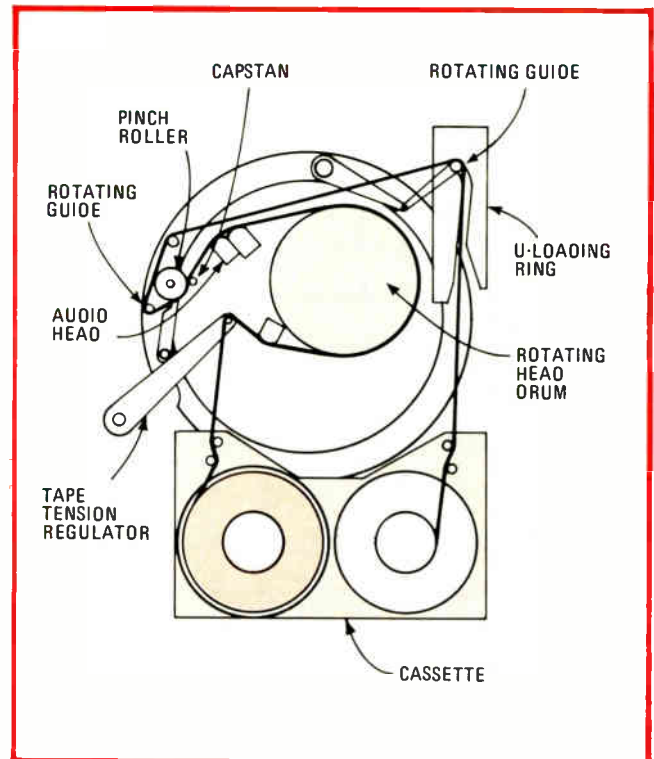
Neither is there any problem playing a tape recorded on an extended-play machine at normal speed on a normal-play machine, again provided that the machines are in the same VTR format. As before, the major effect is a 3-db reduction in signal output compared with the output from a tape recorded on a normal-play machine. Interference from adjacent tracks is reduced because there is an unrecorded band between the tracks left by the smaller head on the extended-play machine.

However, tapes recorded on an extended-play machine at extended-play speed can only be played back on another extended-play machine of the same format.

### Beta Format and VHS compared

While the two Japanese VTRs have achieved the same basic goals—a means for shifting the time of TV programs and storing broadcasts the consumer wants to retain—there are important differences between them. The differences are in choice of basic dimensions, tape speed, tape-loading mechanism, rotating-drum operation, cassette size, and signal-processing design. It is these factors that make the two systems incompatible.

Sony's Betamax VTR set a new standard for consumer color video cassette recorders when the company started sales in May 1975. Tape consumption was by far the lowest of any recorder on the market, cassettes were the smallest, and the price was the lowest. Betamax had one-hour playing time, and this led to the development of an extended-play version called Beta Format that has a



**3. Loaded for Beta.** The cassette-loading scheme for the Beta Format recorder is an adaptation of the U-loading arrangement developed for commercial VTRs. Each loading pole is a pair of rods, one parallel to the drum, one not.

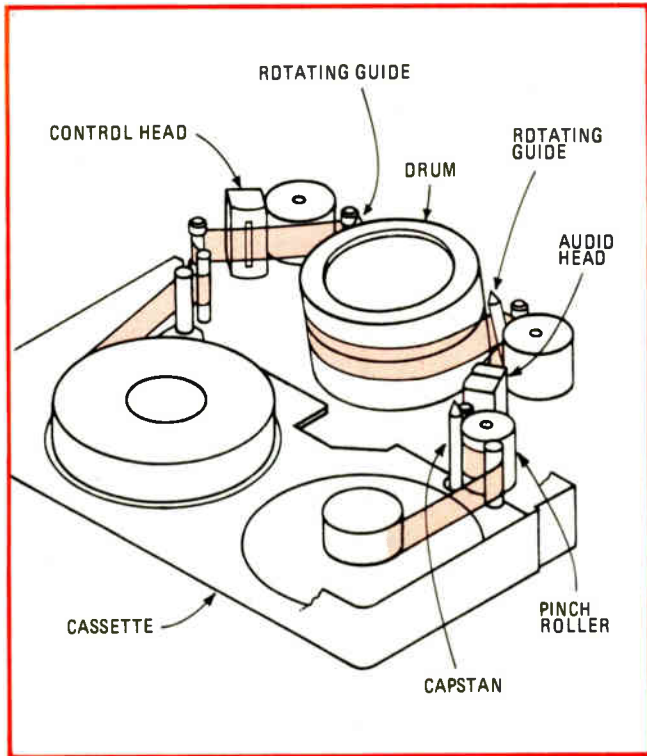
two-hour recording and playing time. (Sony has stated that a cassette with 50% thinner tape giving three hours of playing time will be forthcoming.) Some extended-play machines can also play back tapes made on earlier one-hour machines, but most of them will probably be extended-play only.

The Beta Format was developed by the company in cooperation with Toshiba and Sanyo. Sony is now also producing units for Zenith Radio for sale in this country on a private-label basis.

In developing its VHS cassette recorder, Victor Co. of Japan aimed for a small and light machine with two hours of recording and playing time. Use of state-of-the-art, high-density recording and a simplified mechanism that would be easy to manufacture were also important design goals. Besides Matsushita, a number of other Japanese companies have joined the VHS camp, including Hitachi Ltd., Sharp Corp., and Mitsubishi Electric Corp, as well as RCA, Sylvania, and Magnavox in the U. S., the last three going with the four-hour extended-play units produced by Matsushita.

Basic choices in the Betamax system are a tape speed of 40 millimeters per second and a head-drum diameter of 74.49 mm. Track width is 58.5 μm. Writing speed on the Beta VTRs is 6.9 meters per second.

Victor, on the other hand, has a tape speed of 33.4 mm/s and a head-drum diameter of 62 mm that makes it the smallest yet for a two-headed color VTR. Video track width is 58 μm. The low tape speed and small drum make it possible to fit enough 20-μm-thick tape for two hours of playing time into a cassette



**4. Simple loading.** Victor's VHS cassette-loading configuration is new for VTRs. Its advantage is that it produces a somewhat simpler tape path with a correspondingly simpler arrangement of mechanical parts, so that cartridge insertion easily positions the tape.

measuring only 188 by 104 by 25 mm. Sony's cassette measures 156 by 96 by 25 mm (see table).

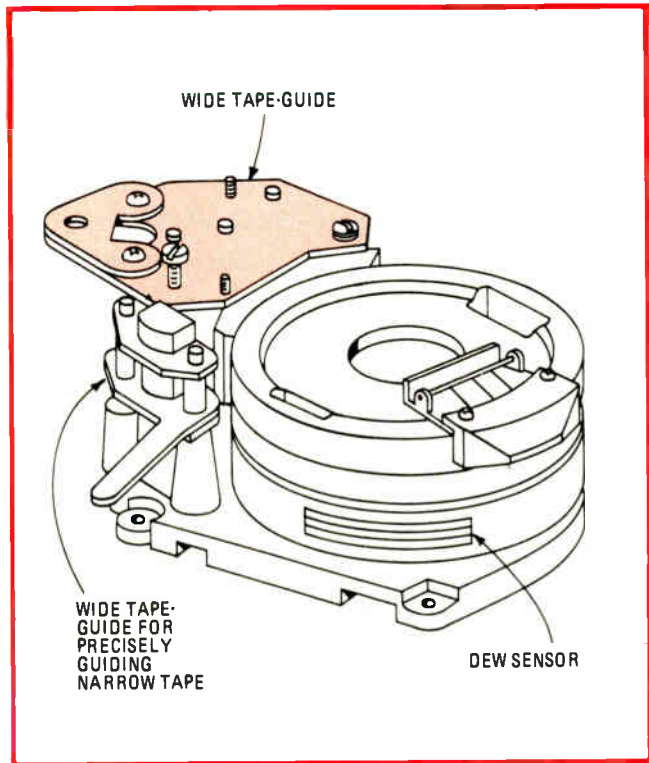
The disadvantage of the small drum is a reduction in the relative speed between the heads and the tape that slows writing speed to only 5.8 m/s. Such slowness decreases the minimum recordable wavelength of the highest fm frequencies to only 1.1  $\mu\text{m}$ , which tightens the requirements on the heads, tape, and circuits.

#### Tape-loading differences

The tape-loading mechanism on the Beta VTR is a modification of that pioneered by Sony for use on its earlier U-matic recorders. Most of the components associated with loading and controlling tension of the tape are mounted on the so-called U-loading ring, which is parallel with the baseplate and surrounds the rotating-drum assembly.

However, the ring is made highly eccentric with respect to the drum in order to leave space within it for the erase, control, and audio heads, and the capstan. During loading, the U-loading ring rotates about 270°. A rotating guide and a pinch roller, which enters the cassette when it is inserted into the VTR, travel with the loading ring and pull the tape around the drum and against the audio and control heads (Fig. 3a). A tape tension regulator not on the U-loading ring pulls the tape coming directly off the supply reel so that it runs over the full-track erase head and also makes contact with the drum over a full 180°.

Unlike the U-matic approach, the tape-loading system used in the VHS recorder differs entirely from that used



**5. Japanese guide.** Sony's wide tape-guide is designed to keep the thin tape accurately in position and facilitate the use of narrow audio and control tracks. The guide also makes it possible to interchange cassettes made for Beta Format machines.

in previous cassette recorders. A parallel loading method is used, in which two so-called loading poles with a short stroke of only 80 mm rapidly load the tape. Two stoppers with V-shaped notches hold the loading poles in the desired position, ensuring high stability. Since the loading pole stroke is short, the amount of tape pulled from the cassette is small, eliminating the danger of applying excessive force to the tape.

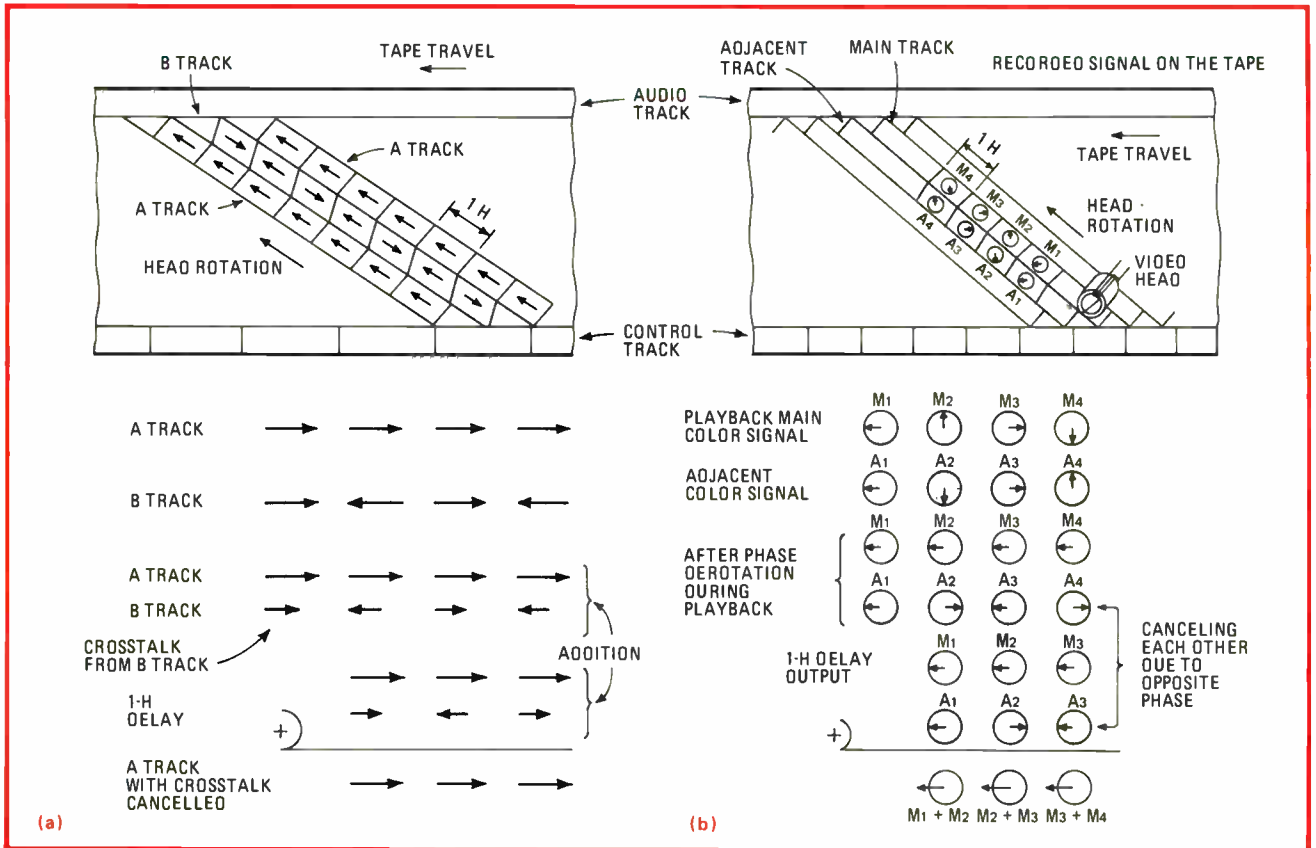
As shown in Fig. 4, in the play mode the tape path is very simple. Insertion of the cartridge positions the tape between the capstan shaft and the pinch roller, so that a minimum of motion suffices to bring the pinch roller to bear against tape and capstan.

The rotating drum on Beta Format VTRs is a three-piece sandwich, with a wheel carrying two heads rotating between two stationary drums. An air film between the wheel and the tape helps decrease friction between the tape and the drum. The lower drum has a precise ridge to guide the tape helically around the drum assembly.

#### Rotating-drum operation

Attached to the upper drum is a guide that rests very gently—with a 1- or 2-gram force—on the upper edge of the tape in order to keep the lower edge in contact with the lower guide. This arrangement not only prevents the tape from meandering but also compensates for variations in its width.

The tape passes over a full-width erase head before passing over the drum, then runs over control and audio heads on leaving the drum. Wide tape-guides (Fig. 5) accurately maintain the position of the thin tape and



**6. Cancelling.** Crosstalk elimination techniques counterbalance phase shifts in the chroma signal. In Sony's method (a), phase of alternate horizontal lines on B track is inverted. Victor's (b) involves 90° phase shifts for each successive horizontal line.

facilitate the use of the narrow audio and control tracks.

The Victor VHS drum is divided into a lower and an upper section. The lower section has a ridge for guiding the tape, and since the edge of the tape follows this ridge obliquely along the drum, it must be a precision fabrication. The upper section of the drum carries two video heads attached diametrically opposite each other. The rotating upper section of the Victor drum is wider than the rotating portion of the Sony drum and thus provides a wider air film that reduces friction more than in the Sony design.

Tension on the tape at the capstan is less than 100 grams, compared with the 300 to 500 grams recommended in the EIA-J Type 1 VTR standard for 1/2-in. tape players. Thus, there is a generous margin for tape protection even for the very thin, 20- $\mu$ m tape used. Overall, the Victor deck was designed to be as compact as possible.

### Differences in signal processing

Both the Beta Format and VHS video cassette machines record TV luminance and chrominance signals in the same, standard fashion. They differ on the method of eliminating chroma crosstalk from track to track on the tape.

Sony developed what it calls a phase-inversion recording method to eliminate crosstalk between chroma signals on adjacent tracks by interleaving their frequency spectrums (Fig. 6). This method entails dividing alternate tracks on the tape into A and B groups and

processing them in a manner that rejects interference between them.

The chroma signal for the first track, which is an A track, is recorded without changing phase relationships for the individual horizontal lines in the field. The chroma signal for the next track, which is a B track, is processed so that the phase of alternate horizontal lines is inverted before recording (see Fig. 6). It is implemented by a simple circuit that switches between two ends of a transformer secondary whose center tap is grounded. Because the phase is reversed for alternate lines, switching frequency is exactly half the horizontal frequency. During playback, the phase of the chroma signal is further processed to restore the original phase relationships.

Then, to make it possible to reject adjacent-track interference, the signal being reproduced is added to the signal from the previous line delayed by one horizontal period in the delay line. To repeat, because the A track signal received no phase processing during recording, it requires none during playback. The B track signal for alternate horizontal lines was inverted during recording and so requires inversion again during playback—processing that of course also inverts associated interfering signals picked up from the A track.

Thus, the sum of the interfering unprocessed B signal from the A track and the signal from the previous unprocessed B line delayed by the horizontal period is zero. The output of the B track, though, is the sum of the signal being played back and the signal from the

## The other two VTR entries

Two other color video tape recorders for consumers are made in Japan and sold in the U. S. Both also use half-inch tape. The V-Cord II, developed by Sanyo Electric Co., is produced by it and Tokyo Shibaura Electric Co. The VX-2000 is available only from Matsushita Electric Industrial Co. and is sold in America by Quasar Electronics, a Matsushita subsidiary.

In configuration, the V-Cord II is quite like Sony's Beta-max, except for a larger head-drum diameter. It is basically a one-hour machine. Track width is 61 micrometers, but the need for guard bands increases track pitch to 97.2  $\mu\text{m}$ . Tape speed is 73.872 millimeters per second, making for somewhat more than twice the tape consumption of the standard-play Victor VTR and slightly less than twice that of the standard-play Sony VTR.

To get two-hour operation, the V-Cord II halves tape speed by skipping every other video field during recording. But this method of course halves vertical resolution and so can give a jerking motion to any images moving rapidly up and down.

In order to provide both one-hour and two-hour operation, the V-Cord II has three heads. The two heads for one-hour record and playback are on diametrically opposite sides of the drum, much as in other two-head recorders. For two-hour operation, one of these heads records every other field and the second is inactive. During playback, the same first head reads the field it recorded, but then a third head, slightly offset from the second one, reaches forward and plays back the same field a second time for display on the picture tube, instead of catching the missing second field. It is necessary to reach forward because of the tape's motion during the 1/60-second interval between

adjacent fields of the NTSC video transmissions.

Matsushita's VX-2000 differs from the other three in that it has only one head—a scheme originally developed by Toshiba more than 20 years ago. This arrangement also makes for a smaller drum because the tape is wrapped spirally around its entire periphery—called alpha wrap, from its resemblance to the Greek letter alpha. In the two- and three-headed recorders, the tape goes only halfway around.

Inclusion of a plastic cylinder that is slightly larger than the recorder head drum in the VX-2000 cassette permits great simplification by almost totally eliminating the tape loading mechanism. The cassette differs, too. It has a tape loop and tape reels stacked one above the other, rather than side by side as in two-headed designs. But as a result it is much larger than the cassettes in other recorders, measuring 44 by 146 by 213 mm.

Also contributing to the comparative largeness of the cassette is a tape speed of 52.133 mm/s—faster than that used by Victor to achieve the same two-hour playing time and therefore requiring more tape. Track width is only 48  $\mu\text{m}$ , less than in the normal-play Victor and Sony VTRs. Track pitch, though, is increased to 73  $\mu\text{m}$  by the guard band, so that, like the V-Cord II, this recorder does not utilize magnetic tape efficiently. The guard band is necessary because the azimuth of the head cannot be changed for successive tracks, as can be done with two heads.

The 52.13-mm drum of the VX-2000 is the smallest used on any Japanese helical-scan color recorder. But the geometry differs from that of two-headed machines, and track width for a given tape speed is comparable to that of two-headed machines having twice the drum diameter.

previous horizontal line, according to the company.

In the new Victor method of eliminating crosstalk between adjacent tracks, the phase of the chroma signal along a given track, which is equivalent to a full TV field, is shifted 90° for each successive horizontal line in the field. Direction of the 90° phase shift is reversed for successive tracks. This recording scheme also produces a chroma signal whose second harmonic component appearing in the luminance signal is barely visible.

In Fig. 6a, the phase of the first horizontal line signal on the M track, line  $M_1$ , is indicated by an arrow. The phase of the second horizontal line,  $M_2$ , is 90° ahead of  $M_1$ , and the phase of  $M_3$  is another 90° ahead of  $M_2$ . However, the phase of successive horizontal lines on the adjacent A track rotates 90° in the opposite, or counterclockwise, direction.

During playback, the signal phase of each successive horizontal line is rotated 90° in the direction opposite that during recording to restore it to the same phase as in the original signal. This successive phase shift during recording and playback permits rejection of crosstalk during playback.

Two aspects of signal processing in the Victor VHS differ from that in other VTRs. First, double limiting is used during playback to prevent the effects of overmodulation, which show up as high-amplitude black-level noise for 3 to 5 microseconds following a sharp transition from black to white. Second, Victor enhances the ampli-

tude of the color carrier reference burst before recording to increase its s/n ratio during playback.

During playback, the high-frequency components of the fm luminance signal are normally smaller in amplitude than the low-frequency components. Usually the amplitude of all components is leveled to the same value in the limiter, but at an abrupt black-to-white transition the fm signal consists of large-amplitude, low-frequency components with small-amplitude, high-frequency components superimposed on them. These last, under certain conditions, may become lost during limiting, making it impossible to demodulate them and leading to a reversal of signal polarity.

Victor's solution is to use a double limiter circuit. High- and low-frequency portions of the fm signal are separated by high- and low-pass filters with gentle slopes. Then, the high-frequency portions only are amplified and limited at a higher level. Limited high-frequency portions are recombined with the low-frequency portions, and the reconstituted signal is limited, thus preventing loss of the high-frequency components.

In the VHS, the color burst is enhanced 6 dB at playback. This procedure provides a 6-dB improvement in burst s/n ratio. Since noise in the color burst is translated into phase jitter in the color-processing circuits, the improvement in s/n ratio goes a long way toward eliminating color errors. □

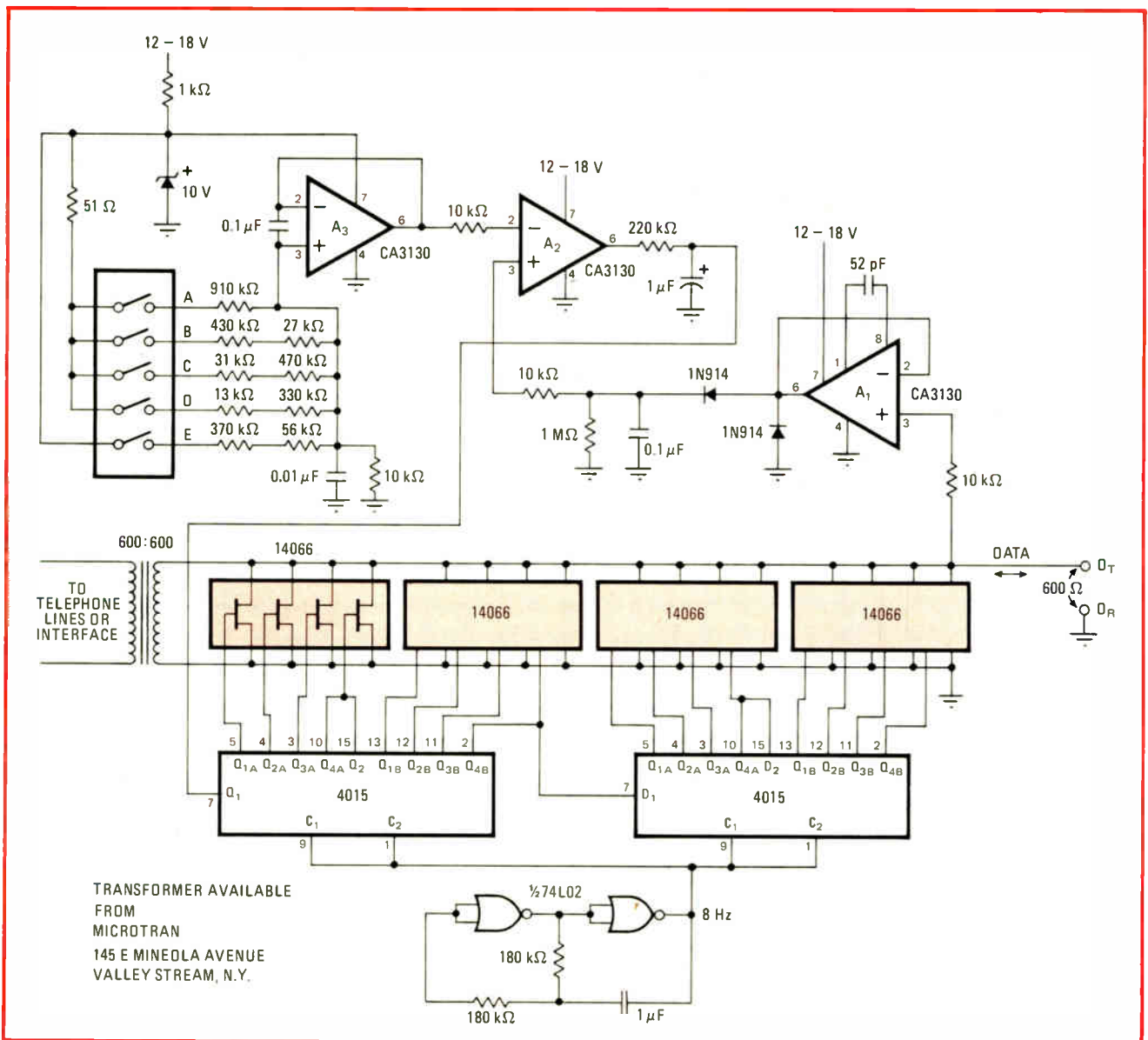
## Adjustable limiter controls telephone-line signal power

by Tom Hilleary  
HMS Corp., Shawnee Mission, Kansas

To minimize crosstalk and other unwanted line radiation on telephone lines, it is often necessary to limit the input power of the data or voice signals, and to do so without

amplitude distortion. This circuit does so by using two shift registers to monitor the relation of a set reference to the input signal amplitude (which is directly proportional to power at constant line impedance) and then divert some input current from the line transformer's primary winding whenever necessary. The limiter is effective when used with any constant-current data source. It provides 0 to -12 dBm of limiting and is accurately adjustable to 1 dB.

As shown in the figure, data or voice signals having a maximum amplitude of 1.4 volts at 0 dBm are applied to operational amplifier  $A_1$ . The output of  $A_1$  in turn feeds



**Digital limiter.** Circuit provides 0 to -12 dBm of signal attenuation. Relative amplitude of constant-current data signal to set reference determines number of logic 1s generated by  $A_2$  into 4015 registers over a given time. Signal above threshold loads more 1s into register, turning on more transmission gates as register is clocked and thus diverting the input current away from the primary winding.

the noninverting input of comparator  $A_2$ . The desired limiting (reference) level is set by five switches, operated in accordance with the table.  $A_3$  is a voltage follower and passes the reference voltage to the inverting input of  $A_2$ .

$A_2$  compares the peak value of the input signal to the reference and when the reference voltage is exceeded generates a logic 1 for the data input of two 8-bit 4015 shift registers. The 4015s are configured as a single 16-bit device that is clocked at an arbitrary 8-hertz rate. If the input signal is mostly larger in amplitude than the reference, the shift register is periodically loaded with more 1s. Conversely, low-amplitude signals introduce more logic 0 signals into the register.

Thus, as the signal power rises above the value desired, more register outputs are activated and themselves activate more of the 14066 transmission gates, each of which when switched on places approximately 100 ohms across the transformer winding. As a result, more of the input current is diverted through these shunt paths, limiting the current though the transformer's primary and the induced voltage in its secondary. If the signal power drops, the shunts are in essence removed, allowing more of the signal to pass. Either way, the current output is constant, so that the effective line

DIGITAL LIMITER					
$O_T$ PEAK LEVEL (dBm)	CLOSE SWITCHES				
	A	B	C	D	E
0					
-1					
-2					
-3					
-4					
-5					
-6					
-7					
-8					
-9					
-10					
-11					
-12					

impedance as seen by the data source does not change.

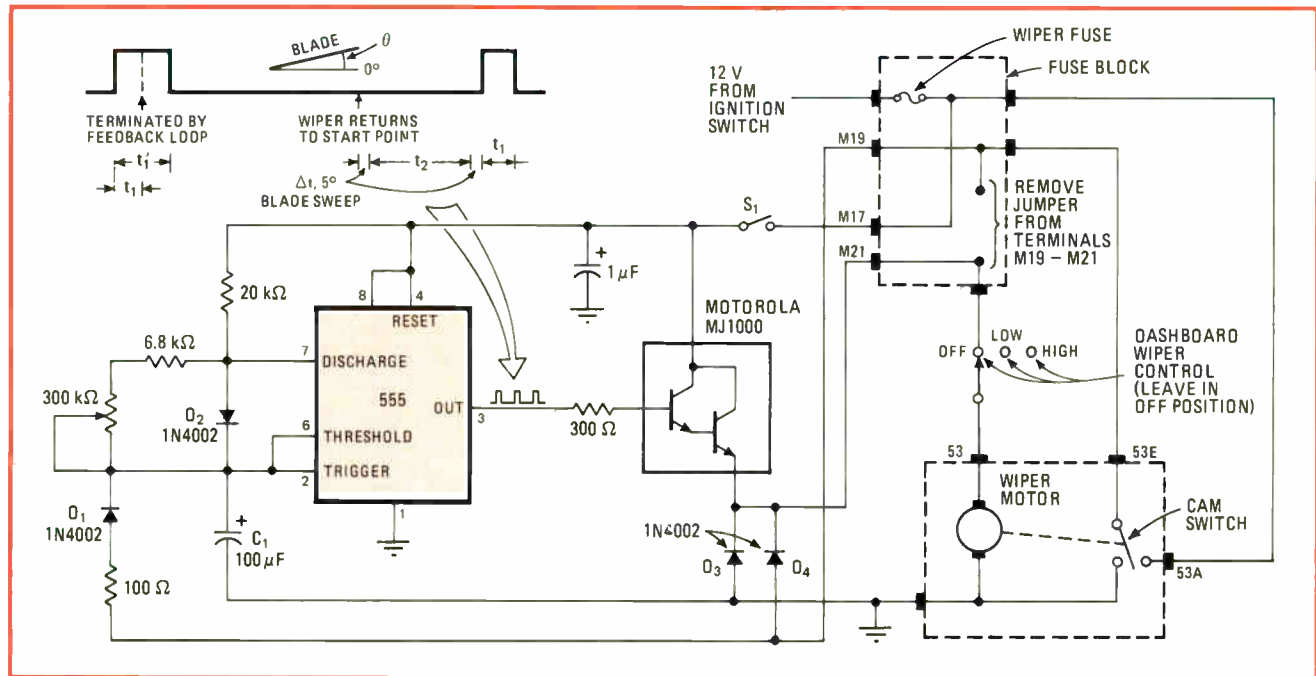
The sampling rate and the RC integrator following  $A_2$  between them control the circuit's response time. Either or both may be altered for a specific application. □

## Synchronous timing loop controls windshield wiper delay

by John Okolowicz  
Honeywell Inc., Fort Washington, Pa.

A 555 timer can control an auto's windshield-wiping rate by providing a selectable delay time between wipes. The timer uses a feedback signal from the cam-operated switch within the wiper motor to synchronize the delay time to the position of the wiper blades, as measured from their starting point.

With synchronization, the minimum delay time can still be reliably kept to nearly zero (normal delay for



**1. Wipe-rate selection.** Control over the time between sweeps in negative-ground windshield wiper systems is done by the 555 and a synchronous feedback loop. Delay time can be varied from 0 to 22 seconds. Synchronizing the feedback to the wiper blades' position ensures that sweep rate will be independent of variations in wiper speed. Terminal block notations are for Volkswagen Rabbit.

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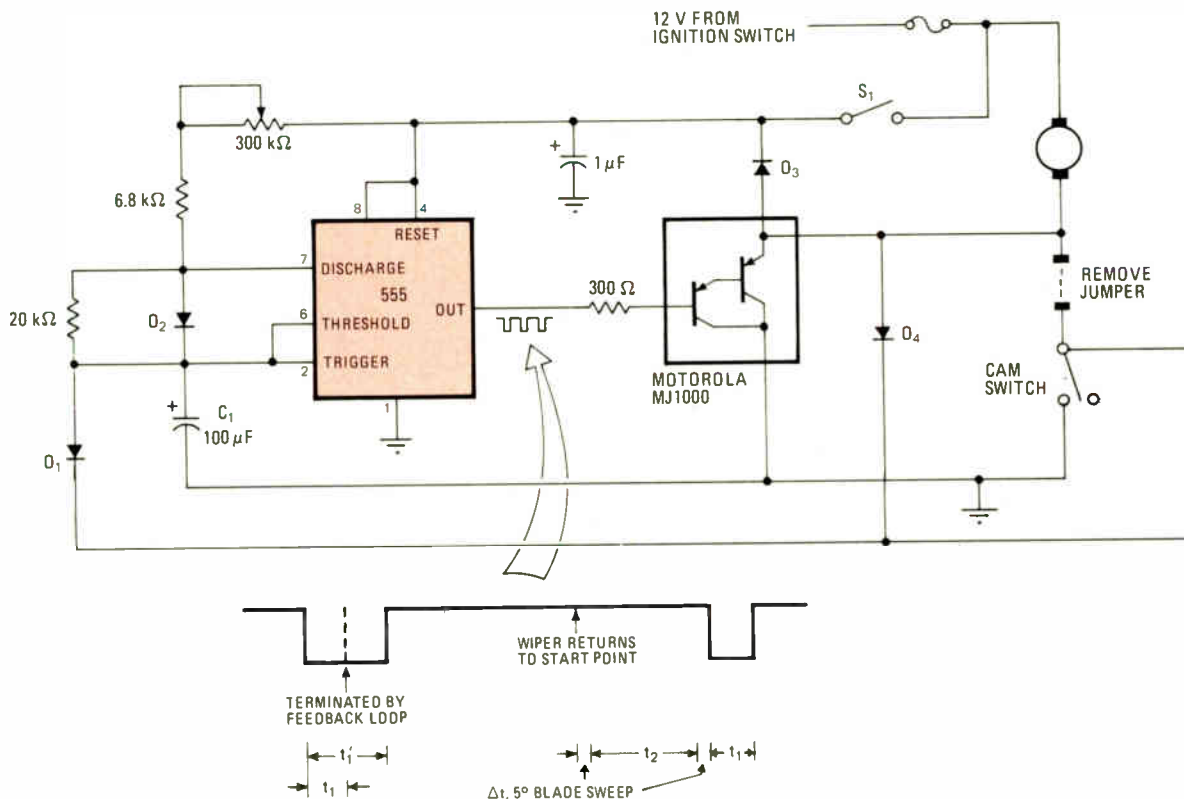
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**2. Positive-ground system.** Suggested modification for many General Motors vehicles and other autos with positive-ground system uses same number of components as standard system. Wiper motor is energized by completing ground connection. Note that diodes  $D_1$ ,  $D_3$ , and  $D_4$  are reversed with respect to the polarities shown in Fig. 1 and that pulse-train polarity from 555 output is inverted.

standard systems), which is best for heavy rain. In addition, it ensures that the delay time is independent of the wiper speed across the windshield. Further, the maximum delay time in this circuit can be set to about 22 seconds, which is suitable for mist or light drizzle, or to any value desired, by suitable selection of the 555's timing components. This circuit offers a better approach to synchronous-delay wipers than those that use silicon controlled rectifiers in parallel with the cam switch, because cam-switch voltage is affected by dirt and grease.

The circuit shown in Fig. 1 is for a Volkswagen Rabbit, but it can be used in any car that has one end of the wiper motor always grounded (which requires a positive energizing voltage). As shown, the 555 assumes the high state on power-up ( $S_1$  initialized), driving the MJ1000 Darlington amplifier, which in turn energizes the wiper motor. As the blades traverse through an angle of approximately  $5^\circ$ , the cam switch is engaged to the 12-volt ignition-line voltage. Thus a feedback voltage is presented to the trigger threshold port of the 555 through  $D_1$ . This voltage exceeds two thirds of the supply voltage on the 555; as a result, the output voltage at pin 3 falls at time  $t_1$ , which is less than the normal pulse width time usually controlled by the 20-kilohm resistor and  $C_1$ .

Normally,  $C_1$  would now begin to charge, but because the voltage supplied to the cam switch remains high, the

555 simply sits in the low state. Meanwhile, both wiper blades reach the far end of their sweep and begin to move back toward their starting position.

As the blades approach within  $5^\circ$  of their starting point, the cam switch disengages from the ignition voltage and moves back to ground. Now  $C_1$  begins its slow discharge through the 300-kΩ potentiometer. Note that  $t_2$ , the delay, is measured from the time the wiper moves within  $5^\circ$  to the time the 555 fires again. Triggering occurs once  $C_1$  discharges to less than one third of the supply voltage.

$D_1$  prevents  $C_1$  from discharging through the cam switch, and  $D_2$  allows independent selection of times  $t_1$  and  $t_2$ .  $D_3$  provides suppression of the back voltage produced when the MJ1000 turns off; without the diode, the 555 will be retriggered falsely.  $D_4$  allows normal operation when the circuit is not activated and also prevents the MJ1000 from shorting to ground through the cam switch.

Some cars have a reversed wiper-motor configuration. Thus one end of the wiper motor is always connected to the positive ignition-line voltage and so requires a connection to ground to energize it. Figure 2 shows a suggested modification of the wiper-delay circuit to handle such cases. □

Designer's casebook is a regular feature in *Electronics*. We invite readers to submit original and unpublished circuit ideas and solutions to design problems. Explain briefly but thoroughly the circuit's operating principle and purpose. We'll pay \$50 for each item published.

# Calculator programs simplify design of cascaded tuned circuits

Part 1 of two-part article sets forth procedures for single and synchronous tuned networks

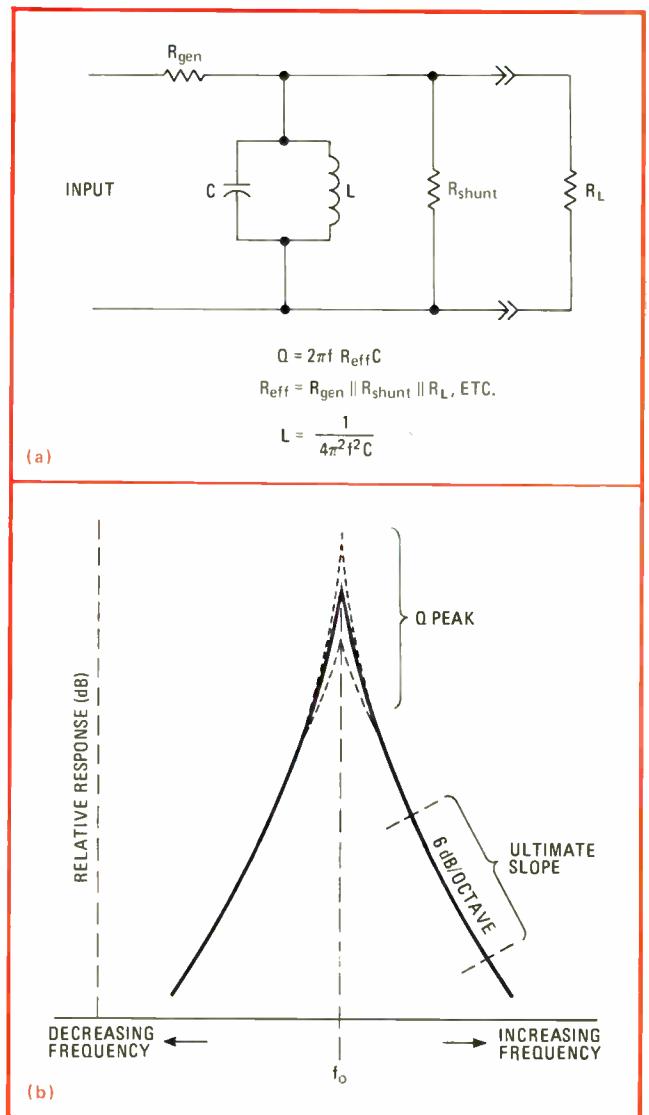
by Albert E. Hayes Jr., Fullerton, Calif.

□ Engineers charged with the task of designing cascaded tuned circuits with specific characteristics have traditionally faced a series of complex and tedious calculations involving trial-and-error procedures and the juggling of many variables, such as Q, inductance and capacitance, frequency, bandwidth, and so on. With the advent of the programmable calculator, however, much of the time and tedium can now be eliminated.

This two-part article describes a family of programs for the HP-67/97 scientific calculator that simplify the task of designing cascaded tuned LC circuits of the synchronous, Butterworth, and Chebyshev types. Essentially, the design for each kind of circuit is reduced to a simple step-by-step procedure.

## Single tuned-circuit calculation

The cascaded tuned-circuit equations are derived from an extended analysis of the single tuned circuit, which will therefore be discussed first. Design is simple,



**1. Single tuned circuit.** Single-stage ( $n=1$ ) LC circuit is easily analyzed for  $R_{\text{gen}}$ ,  $L$  or  $C$  (a). Frequency response is characterized by the ultimate slope of circuit (6 dB per octave) and the amplitude of the relative-voltage peak, which is a function of circuit  $Q$  (b).

TABLE 1: HP-97 PRINTER LISTING OF SINGLE TUNED-CIRCUIT PROGRAM

001	CF1	030	RTN	059	RTN
002	CF0	031	*LBL E	060	*LBL 2
003	CLX	032	RCL 1	061	RCL 2
004	R/S	033	X <sup>2</sup>	062	RCL 1
005	*LBL A	034	RCL 4	063	÷
006	Pi	035	X	064	RCL 3
007	X	036	1/X	065	÷
008	2	037	EEX	066	STO 4
009	X	038	3	067	DSP 4
010	STO 1	039	X	068	EEX
011	RTN	040	DSP 3	069	6
012	*LBL B	041	R/S	070	X
013	STO 2	042	EEX	071	R/S
014	RTN	043	3	072	EEX
015	*LBL C	044	X	073	6
016	SF 1	045	DSP 1	074	X
017	FO?	046	R/S	075	DSP 1
018	GTO 1	047	*LBL 0	076	R/S
019	STO 3	048	R/S	077	GTO 0
020	RTN	049	GTO 0	078	R/S
021	*LBL D	050	*LBL 1	079	*LBL d
022	SF 0	051	RCL 2	080	EEX
023	F1?	052	RCL 1	081	6
024	GTO 2	053	÷	082	CHS
025	EEX	054	RCL 4	083	X
026	6	055	÷	084	GTO D
027	CHS	056	FIX	085	R/S
028	X	057	DSP 1		
029	STO 4	058	STO 3		

INSTRUCTIONS

- Key in program
- Initialize  
RTN, R/S
- Enter resonant frequency (KHz) and quality factor  
( $f_o$ ), A, (Q), B
- Enter either effective shunt resistance (ohms) or tuning capacitance (microfarads)  
( $R_{eff}$ ), C or (C), D  
To enter capacitance in picofarads: (C), f, D
- Press C to find the effective shunt resistance (ohms), or press D to find the tuning capacitance (microfarads)  
If the result is desired in picofarads, press R/S after D
- Press E to find the inductance, L (millihenries)  
If the answer is desired in microhenries, press R/S after E

because single tuned-circuit analysis is based upon only two equations:

$$Q = 2\pi f R_{eff} C \quad (1)$$

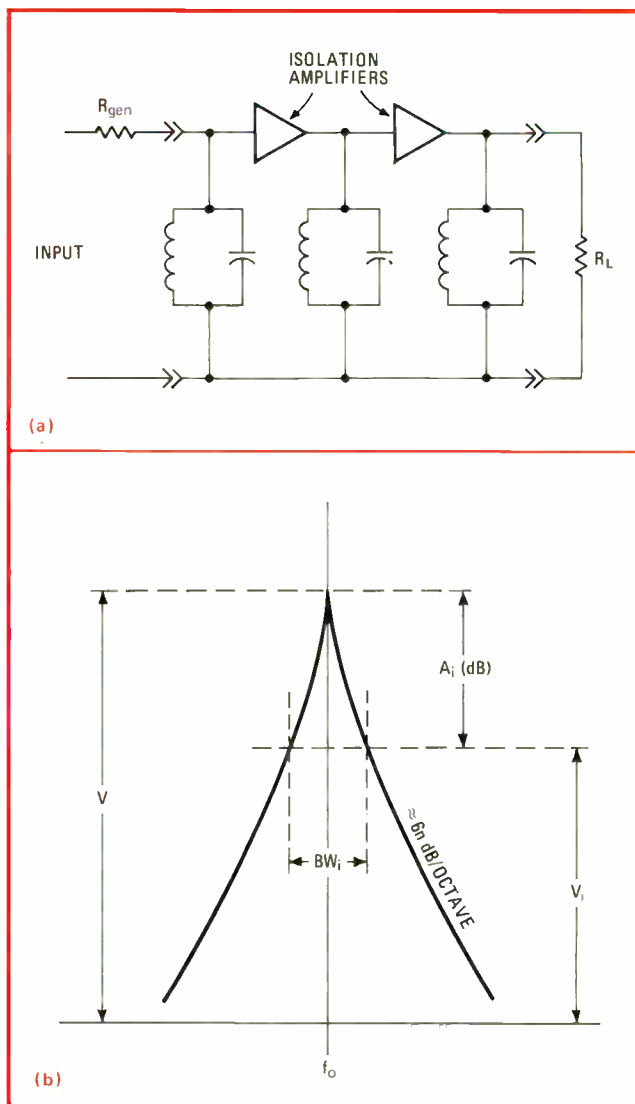
$$L = 1/(4\pi^2 f^2 C) \quad (2)$$

where:

Q = loaded quality factor

f = resonant frequency

$R_{eff}$  = parallel impedance of the source, resonant-



**2. Synchronously tuned circuits.** When several tuned circuits are joined by means of isolating amplifiers (a), they yield an overall response characteristic equal to the product of the responses of the component circuits (b). Ultimate slope is 6n dB per octave. Program makes it easy to design a synchronously tuned array.

circuit, and load resistance (effective shunting resistance)

C = tuning capacitance

L = inductance (in millihenries if C is in microfarads or in microhenries if C is in picofarads).

For a specific frequency ( $f_o$ ), the program for the single tuned circuit finds  $R_{eff}$  and L when Q and C are known; when Q and  $R_{eff}$  are known, it finds L and C. Although the calculation is simple, the program is important because it is needed for the design problems that will be introduced in subsequent sections. Table 1 shows the program as generated by the HP-97 printer.

A representative problem is the calculation of the L and C components in a tuned circuit that has a resonant frequency of 459.62 kilohertz and a Q of 118.83. This resonant circuit is used in an intermediate amplifier developed from Butterworth design formulas, which will be discussed in Part 2. From any of several tuned-circuit

**TABLE 2: CASCADED CIRCUIT NOTATION**

$A_i$	= attenuation, in dB
$A_i$	= attenuation, from peak value, at $BW_i$ , in dB
$A_j$	= attenuation, from peak value, at $BW_j$ , in dB
$A_x$	= attenuation, from peak value, at $BW_x$ , in dB ( $A_x$ and $BW_x$ are unknowns)
$BW_i$	= bandwidth between the $-A_i$ (dB) points on a response curve
$BW_j$	= bandwidth between the $-A_j$ (dB) points on a response curve
$BW_x$	= bandwidth between the $-A_x$ (dB) points on a response curve ( $A_x$ and $BW_x$ are unknowns)
$V$	= voltage measured at peak of response curve
$V_i, V_j$	= voltage measured at the $-A_i, -A_j$ (dB) points on a response curve ( $A_i = 20 \log_{10} V/V_i$ )
$f_o$	= center frequency (nominal frequency of passband)
$(f_a)_m$	= resonant frequency of higher-tuned circuit of mth pair
$(f_b)_m$	= resonant frequency of lower-tuned circuit of mth pair
$n$	= number of tuned circuits in system
$m_{max}$	= number of pairs of tuned circuits in system if $n$ is even, $m_{max} = n/2$ if $n$ is odd, $m_{max} = (n + 1)/2$
$Q_m$	= Q of mth pair of tuned circuits

charts and nomograms found in numerous engineering handbooks, it may be determined that a tuning capacitance on the order of 500 pF is reasonable at this frequency.

The program is started by pressing the RTN and R/S keys, followed by 459.62, EEX, 3, A, then 118.83, B. The value of the capacitor is then entered as 500, f, D. Pressing C yields an  $R_{eff}$  of 82,295.7 ohms, but it may be that this value is too high for the particular application. In this case, therefore, a value of 5 kilohms is assumed, and C and L are recalculated.

The program is restarted by pressing RTN, R/S, followed by 459.62, EEX, 3, A, 118.83, B, 5000, C. The capacitance is found by pressing D. Its value this time is 0.0082 microfarad, not an unreasonable number. Pressing R/S yields a more exact value expressed in picofarads (8,229.6). Pressing E yields an inductance of 0.015 mH; pressing R/S, 14.6  $\mu$ H. With the procedure having been gone through twice, the most practical values for R, L, and C have now been found.

Single tuned circuits will have a frequency response as shown in Fig. 1b, where the region designated "ultimate slope" will be 6 decibels per octave of frequency change, and where the height of the peak is a function of the Q.

Having reviewed the single tuned circuit, now consider a string of such circuits. Synchronously tuned, n-stage circuits produce a peaked frequency-amplitude response. Consequently, their applications are largely confined to narrow-band communications circuits and some types of

control systems requiring a very narrow bandwidth without stringent requirements for off-frequency signal rejection.

### Synchronously tuned cascades

The most primitive arrangement is two or more parallel resonant circuits separated from each other by isolating stages, driven from a source having a resistance  $R_{gen}$ , as shown in Fig. 2a. The terminating impedance of the tuned-circuit array is assumed to be resistive. If all the tuned circuits are resonant at the same frequency, they are said to be synchronously tuned.

The amplifier stages serve to eliminate interaction between adjacent tuned circuits, allowing each circuit to act as an isolated entity, with an overall response characteristic equal to the product of the responses of each stage. To accurately predict this new circuit response, a brand-new set of equations, necessarily more complex than for a single tuned circuit, must be solved.

The frequency response of the n-stage array shown in Fig. 2b has a shape similar to that shown in Fig. 1b, except that its ultimate slope is approximately 6n dB per octave and the height of the Q peak varies in proportion to the average Q of the several circuits. Generally, it is most convenient and practical to design a synchronously tuned array so that all tuned circuits have the same Q.

In the mathematical derivations in this and subsequent sections, the notation in Table 2 is used throughout. For an n-stage, synchronously tuned circuit, the classical equations are:

$$x = (BW_i/f_o) Q \quad (3)$$

$$V/V_i = (1 + x^2)^{n/2} \quad (4)$$

$$\theta = \tan^{-1}(BW_i/f_o) Q = \tan^{-1}x \quad (5)$$

where  $V/V_i$  is the attenuation ratio at the bandwidth ( $BW_i$ ) end points, and  $\theta$  is the phase shift between the current at  $f_o$  and the current at the bandwidth end points.

Using Eq. 3 through Eq. 5, the program, shown in Table 3:

- Finds the value of n (the number of tuned circuits—often determined to be a noninteger) for a given  $f_o$ ,  $V/V_i$ , and  $BW_i$ , at an estimated value of Q ( $Q_{est}$ ).  $Q_{est}$  is a realistic (attainable) value of loaded Q.
- Rounds off n to the next highest integer (if initially a noninteger), then calculates the  $V/V_i$  for that n.
- Proceeds to calculate the new circuit Qs required to find the originally specified value of  $V/V_i$  at the new value of n.
- Calculates the phase shift,  $\theta$ .

The program first finds x from Eq. 3. The entered value of Q must be selected on the basis of knowledge of the tuned circuits at the  $f_o$  in question. The number of tuned circuits is then found by manipulation of Eq. 4. This equation becomes:

$$(V/V_i)^2 = (1 + x^2)^n$$

Taking the logarithm of the equation:

$$n \log(1 + x^2) = 2 \log(V/V_i)$$

**TABLE 3: HP-97 PRINTER LISTING OF SYNCHRONOUS PROGRAM**

001	*LBLA	037	*LBLD	073	R/S
002	STO3	038	RCL5	074	GTO0
003	RTN	039	RCL6	075	*LBLa
004	*LBLB	040	2	076	RCL3
005	2	041	÷	077	÷
006	0	042	Y <sup>X</sup>	078	RCL8
007	÷	043	LOG	079	X
008	10 <sup>X</sup>	044	2	080	X <sup>2</sup>
009	STO1	045	0	081	1
010	R↓	046	X	082	+
011	STO4	047	DSP1	083	√X
012	RTN	048	RTN	084	RCL6
013	*LBLC	049	*LBL E	085	Y <sup>X</sup>
014	STO2	050	RCL1	086	LOG
015	RCL4	051	2	087	2
016	RCL3	052	ENT↑	088	0
017	÷	053	RCL6	089	X
018	X	054	÷	090	R/S
019	STO7	055	Y <sup>X</sup>	091	*LBLb
020	ENT↑	056	1	092	2
021	X	057	-	093	0
022	1	058	√X	094	÷
023	+	059	RCL3	095	10 <sup>X</sup>
024	STO5	060	X	096	2
025	LOG	061	RCL4	097	RCL6
026	RCL1	062	÷	098	÷
027	LOG	063	STO8	099	Y <sup>X</sup>
028	2	064	R/S	100	1
029	X	065	RCL4	101	-
030	X↔Y	066	X	102	√X
031	÷	067	RCL3	103	RCL3
032	INT	068	÷	104	X
033	1	069	TAN <sup>-1</sup>	105	RCL8
034	+	070	R/S	106	÷
035	STO6	071	*LBLO	107	R/S
036	RTN	072	0		

**INSTRUCTIONS**

- Key in program
- Enter design parameters: resonant frequency, bandwidth, attenuation (dB), and estimated Q  
( $f_o$ ), A, ( $BW_x$ ), ENTER, ( $A_i$ ), B, ( $Q_{est}$ ), C  
The number of tuned circuits required (n) is displayed
- Press D to find actual attenuation (A)
- Press E to find the Q required to attain the original design value of attenuation
- Press R/S to calculate phase shift ( $\theta$ )
- Enter arbitrary bandwidth and find attenuation at that bandwidth, or enter arbitrary attenuation ratio and read the bandwidth for that attenuation ratio:  
( $BW_x$ ), f, A----→(A) displayed  
or ( $A_x$ ), f, B-----→( $BW_x$ ) displayed
- Repeat preceding step as necessary to generate response plot
- Units of f and BW are arbitrary, but must be consistent throughout run

or, after division by  $\log(1 + x^2)$ :

$$n = \frac{2 \log(V/V_i)}{\log(1 + x^2)} \quad (6)$$

Substituting Eq. 3 into Eq. 6 yields:

$$n = \frac{2 \log(V/V_i)}{\log[1 + (BW_i Q_{est}/f_o)^2]} \quad (7)$$

This equation is evaluated by the calculator. The attenuation is then found by evaluating Eq. 4 in its initial form. The new circuit Qs are calculated by combining Eqs. 3 and 4:

$$Q_{req} = x f_o / BW_i = \frac{[(V/V_i)^{(2/n)-1} - 1]^{1/2} f_o}{BW_i} \quad (8)$$

Finally, the phase shift is determined using Eq. 5.

In accordance with conventional engineering practice, this program, as well as those to follow, characterizes the attenuation in decibels ( $A_x$ ), rather than as a voltage ratio ( $V/V_x$ ). In every case, the program computes  $V/V_x$  from  $A_x$ :

$$V/V_x = 10^{A_x/20} \quad (9)$$

With the array of tuned circuits defined by the synchronous program, either the attenuation at an arbitrary bandwidth ( $BW_x$ ), or vice versa, can be computed from:

$$A_x \text{ (dB)} = 20 \log\{[1 + (QBW_x)^2/f_o^2]^{1/2}\}^n \quad (10)$$

or:

$$BW_x = (f_o/Q)[(V/V_x)^{2/n} - 1]^{1/2} \quad (11)$$

These two equations are also evaluated by the program.

Assume a requirement for a tuned cascaded circuit to provide a 2-megahertz bandwidth at the 3-dB points, at a center frequency of 140 MHz. From experience, it is known that a Q of 25 is easily attained at 140 MHz.

Enter the synchronous program into the HP-67 and key in 140, A, 2, ENTER, 3, B, 25, C. The calculator will indicate that six tuned stages are needed. A calculation of the actual attenuation with  $n=6$  is performed by pressing the D key. This yields an answer of 3.1 dB, certainly close enough to the original 3-dB requirement. If, however, greater accuracy is desired, pressing the E key will yield a value of 24.5, the precise value of Q needed for the required 3-dB attenuation. Pressing R/S will initiate the phase shift calculation, which gives an answer of 19.3°.

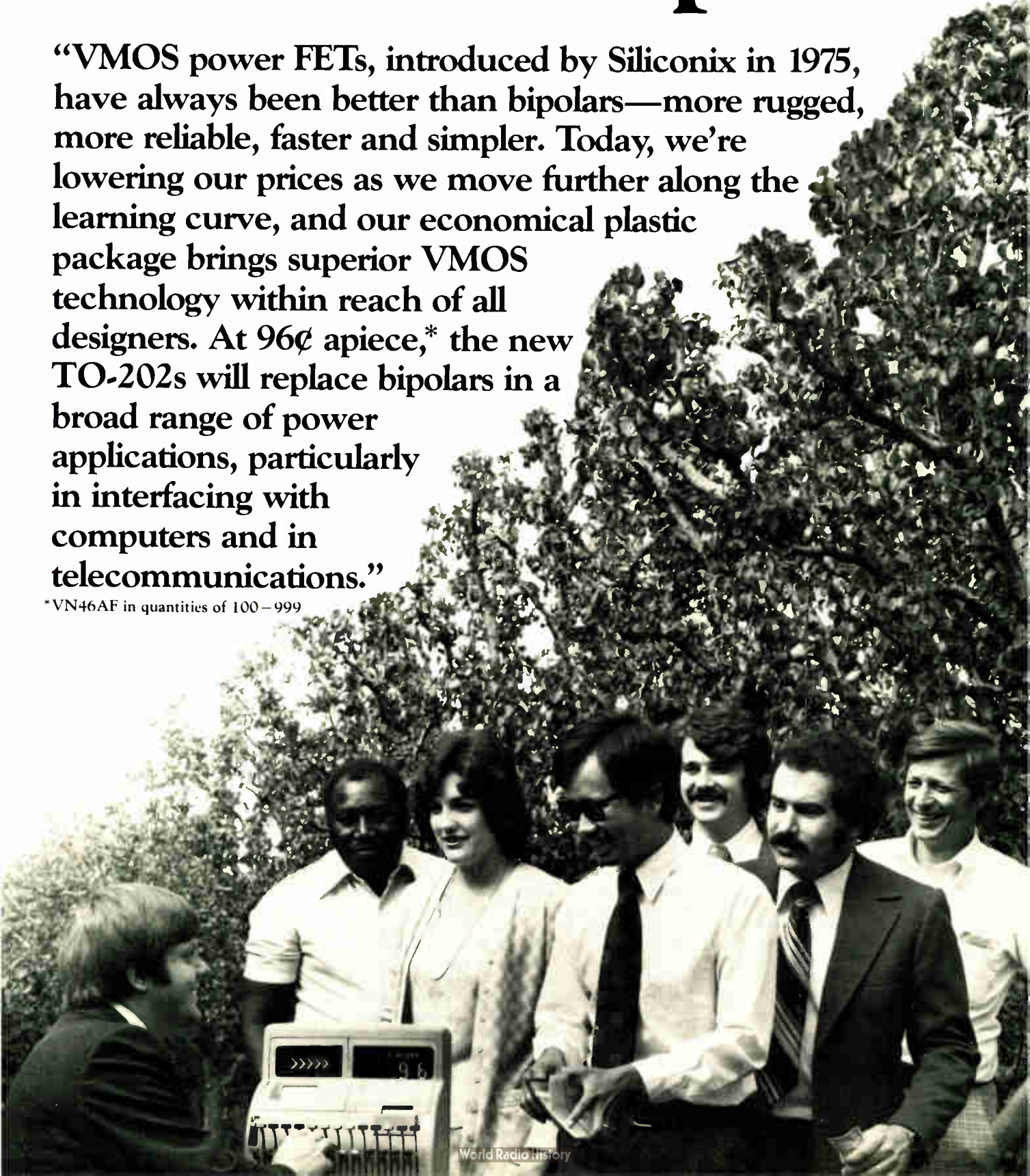
More information can be obtained—for example, the attenuation at the 3-MHz band edges or the bandwidth at the -60-dB points. For the former, it is necessary only to key in 3, f, A, giving an answer of 6.3 dB; for the latter, keying in 60, f, B, gives a bandwidth of 17.2 MHz. By repeating these last two steps, a complete response curve can be developed.

For applications where the sharp crest of the synchronously tuned response is not desirable, a wider, flat-topped response may be attained by tuning each circuit of a cascade to one of several frequencies above and below the nominal center frequency. A discussion of the procedures used to attain these flat characteristics requires examination of the Butterworth and Chebyshev responses and will appear in Part 2, in the next issue. □

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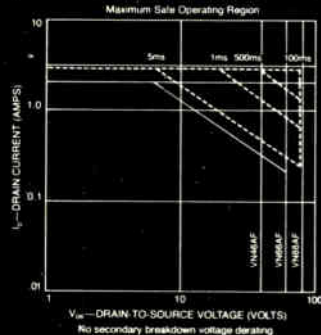


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2N6657	TO-3	25W	60	3.0V
2N6658	TO-3	25W	90	4.0V
2N6659	TO-39	6.25W	35	1.8V
2N6660	TO-39	6.25W	60	3.0V
2N6661	TO-39	6.25W	90	4.0V

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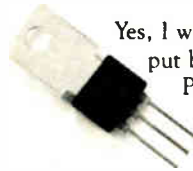
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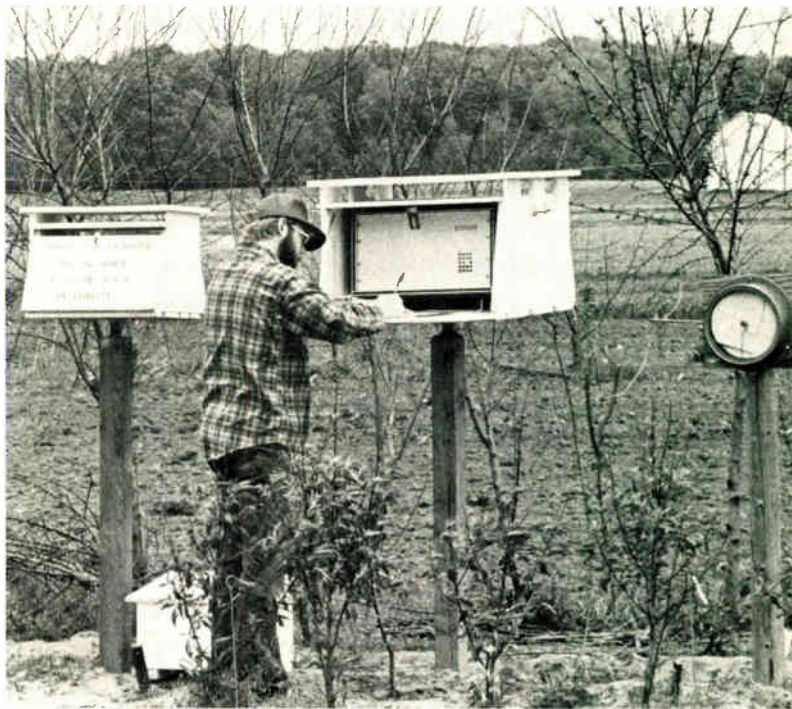
## Monitoring system optimizes apple-tree spray cycle

by P. David Fisher and Sigurd L. Lillevik,  
Michigan State University, East Lansing, Mich.

□ Growers of apples, the second most popular fruit in the U.S., have an enemy in apple scab, a fungus that attacks the leaves of apple trees every spring. To combat it, growers apply fungicide sprays or dusts regularly 12 to 15 times a year. But now they may have found a friend in the microprocessor: an alternative approach to apple scab control, using a microprocessor-based system, is being tested that will likely mean fewer but more effective fungicide applications—which should, in turn, mean reduced costs and environmental damage.

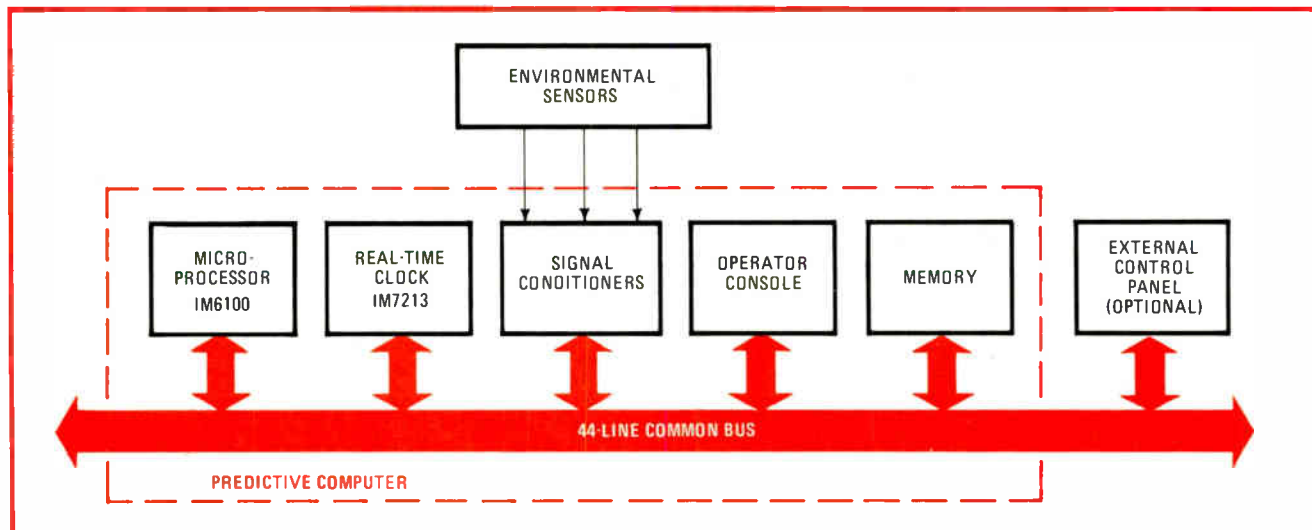
The system comprises a small special-purpose computer, built around a microprocessor, and field sensors that measure and record three environmental variables, plus allied signal conditioners. Using a program stored in its memory, the computer predicts the severity of apple scab attacks so that the grower can apply fungicide when it is most effective. The program consists of a table of fungus severity versus the three environmental variables—average air temperature, hours of leaf wetness, and relative humidity (which, when high, extends the hours of leaf wetness).

Manual use of the table—the work of D. W. Mills of Cornell University—was tried, but it proved too slow and cumbersome because of the considerable amount of data gathering and calculation needed. A microprocessor-based system, on the other hand, can collect the data

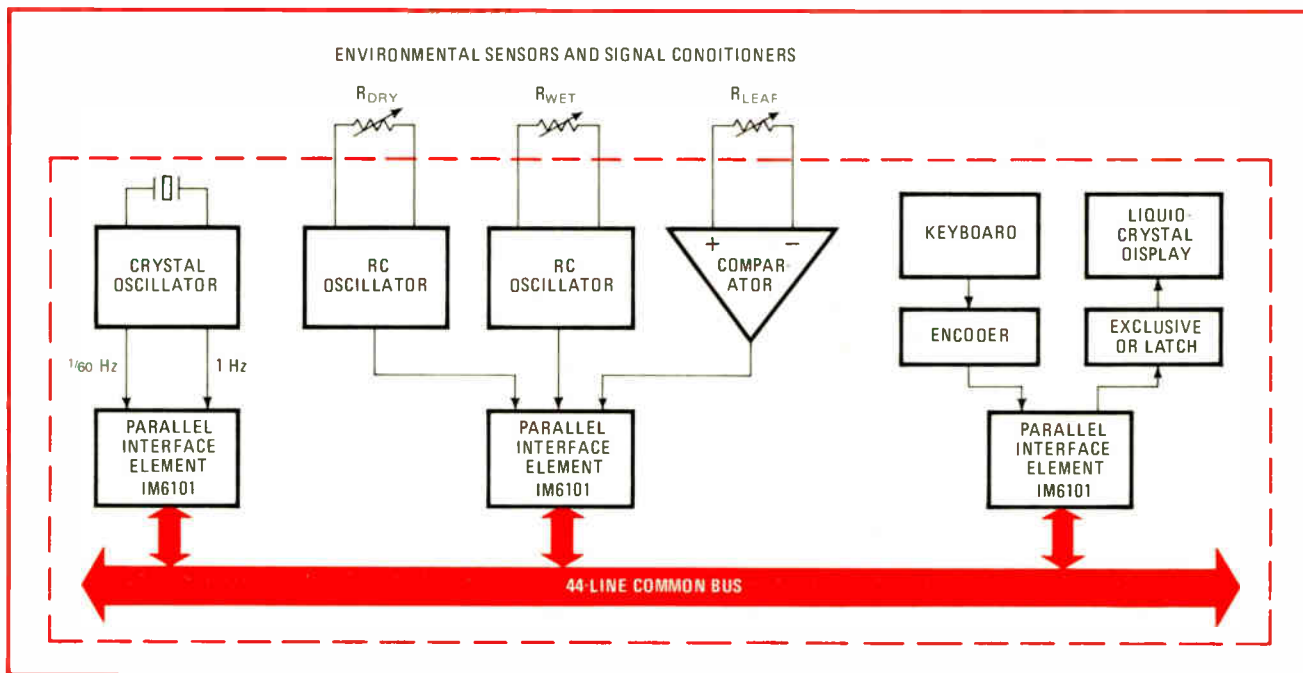


**1. Apple protector.** This movable, microprocessor-controlled instrument, shown in an orchard, predicts severity of fungus attacks on apple trees. Manual instruments for measuring temperature and humidity are grouped about the new unit, which replaces them.

automatically and be interrogated on the spot for an instant prediction—and it requires less than one hour of training to operate properly. Further, it can be moved easily. Because of these advantages, as well as the fact that the projected unit cost of about \$500 can readily be recovered in a single growing season, most growers



**2. Busing data.** Simplified diagram of microprocessor-controlled predictor of apple scab fungus shows all major system blocks linked by a 44-line common bus. Most of the bus is taken up by an Intersil IM6100 single-chip C-MOS microprocessor.



3. Apple PIE. System clock, environmental sensors and signal conditioners, and operator console are tied to the system bus through peripheral interface elements. These devices provide addressing interrupts and controls for peripheral functions.

should quickly adopt it. In addition, the system can be modified for use against other crop diseases, making it an even more attractive solution to the problem of apple scab infestation.

To test the feasibility of using microprocessors to predict attacks of apple scab, as well as other crop diseases, a prototype system has been designed, built, and installed in an orchard. The self-contained special-purpose computer, connected to field sensors, resides for the entire growing season in a relatively open frame, mounted on a pole (Fig. 1). As depicted in Fig. 2, five major sections constitute the basic instrument; a sixth is optional. Since each section uses complementary-metal-oxide-semiconductor logic, the entire instrument consumes very little power—60 milliwatts—and therefore operates easily from a battery for prolonged periods.

A bus shared by 44 lines links the sections and the sensors. It makes the system both expandable and flexible, since memory, input and output lines, and so on, can be freely added or deleted. Also, the bus helps isolate failures, thus simplifying maintenance.

The microprocessor is Intersil Inc.'s single-chip IM6100. It has all the advantages of C-MOS (low power consumption, wide voltage supply range, low temperature sensitivity, and so on), and it executes Digital Equipment Corp.'s PDP-8/E instruction set as well. With resident machines and operating systems available, the latter feature eliminates the need for a cross assembler. Moreover, much application software already exists for the PDP-8/E.

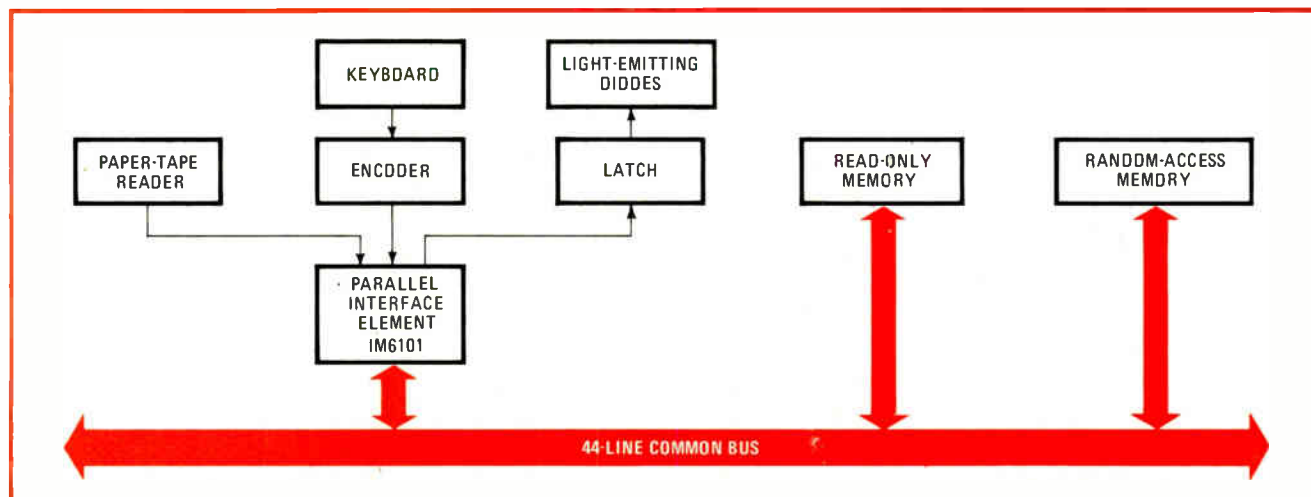
Furthermore, the IM6100's 40 pins can act as a subset of DEC's omnibus, allowing the direct use of many peripherals. In addition, a PDP-8/E can be used as an IM6100 emulator, greatly speeding up prototype development for other applications. These reasons, together with Intersil's complete line of support chips for its central processing unit, led to the selection of the IM6100.

### Peripheral interfacing

To minimize external logic for the microprocessor, three programmable interface devices (Intersil's IM6101) are used to address, interrupt, and control the peripherals, like the operator console and the optional control panel, as well as the sensors. (These devices, of course, can do the same for peripherals added for other applications, like universal asynchronous receiver/transmitters and first-in, first-out registers.) Because the properties of these chips are programmable—that is, polarity assignment, vectored interrupt addresses, and so on—input/output implementation is greatly simplified.

The real-time clock in Fig. 3 uses a single chip (IM7213) having a 4.193404-megahertz crystal oscillator and count-down circuitry with both 1-hertz and 1/60-Hz outputs. Each output triggers a vectored interrupt, by means of a peripheral interface element, to routines that control data acquisition and scab-prediction updates.

The environmental sensors record ambient and wet-bulb (for relative humidity) temperatures along with



**4. External control.** Optional external control panel can be used both in maintenance work on the instrument and in development for other applications. The control panel can load in new programs from an external computer or minicomputer, or supply diagnostic tests.

degree of leaf wetness, and the signal conditioners translate the data into digital signals. Both temperature sensors use linear thermistors to vary the frequency of individual RC astable pulse oscillators as the air temperature varies, and the oscillators trigger vectored interrupts to the appropriate counting software. A look-up table in the software correlates wet- and dry-bulb temperatures with the relative humidity. As for leaf wetness, the appropriate sensor biases a comparator on or off, and the computer uses the signal from the comparator, together with its real-time clock, to determine the hours of leaf wetness. Hence the signal conditioners replace the traditional scheme of analog multiplexer and analog-to-digital converter.

The operator console section includes a 25-station keyboard and a four-digit, alphanumeric, liquid-crystal display. A single-chip encoder (74C923) debounces switch closures, provides two-key roll-over protection, and maintains a last-key register. Its data-available signal triggers another vectored interrupt, via a peripheral interface element, to a routine that reads the keyboard and services the command. For example, an operator may use the keyboard and display to inspect or change the date or time, as well as to interrogate the data base or obtain a forecast and a histogram.

Lastly, the semiconductor memory contains read-only memories in its higher addresses and random-access memories in its lower addresses. The application program (Mills's table) resides in roughly 1,096 bits of ROM. Additionally, a battery-backed 1-k RAM provides portable, permanent storage for histograms of the scab forecasts. Growers may then remove the memory card from the computer and later receive a hard copy of the histogram.

The external control panel, the optional sixth section of the instrument, aids both development for other appli-

cations and maintenance. The IM6100 has a dedicated control panel interrupt request and a control panel memory-select line. Therefore control panel programs reside in their own unique memory, separate from main memory. Furthermore, control panel routines may access main memory through indirect reads and writes. Thus an external control panel can display all IM6100 registers, alter them, and read or write into main memory.

#### External control

The panel, shown in Fig. 4, includes a high-speed paper-tape reader and interface, a 25-station keyboard and encoder, a latch with light-emitting-diode indicators, and its separate solid-state memory. The control panel program performs three functions: it accesses IM6100 registers and main memory; it deciphers binary paper tapes by means of a loader program; and it performs a set of diagnostic tests for maintenance.

During development, battery-backed RAMs, instead of ROMs, can make up the program memory. A PDP-8/E with an operating system can assemble the application program, which would then be loaded through the control panel into memory. After the normal debugging period, the application would be programmed into the ROMs, and the control panel would be removed until needed for diagnostic testing.

The application program executes three independent, real-time tasks under priority interrupt scheduling. The real-time clock task has the highest priority. It maintains the date and time and initiates the apple scab prediction updates. Data acquisition is second. Lowest in priority is servicing an operator. When the grower uses the keyboard, this task decodes the request and executes the command—change time, display data, predict scab status, etc. The tasks operate independently, and the peripheral interface devices coordinate their scheduling. □

## LED bar-segment array forms low-cost scope display

by Vernon Boyd

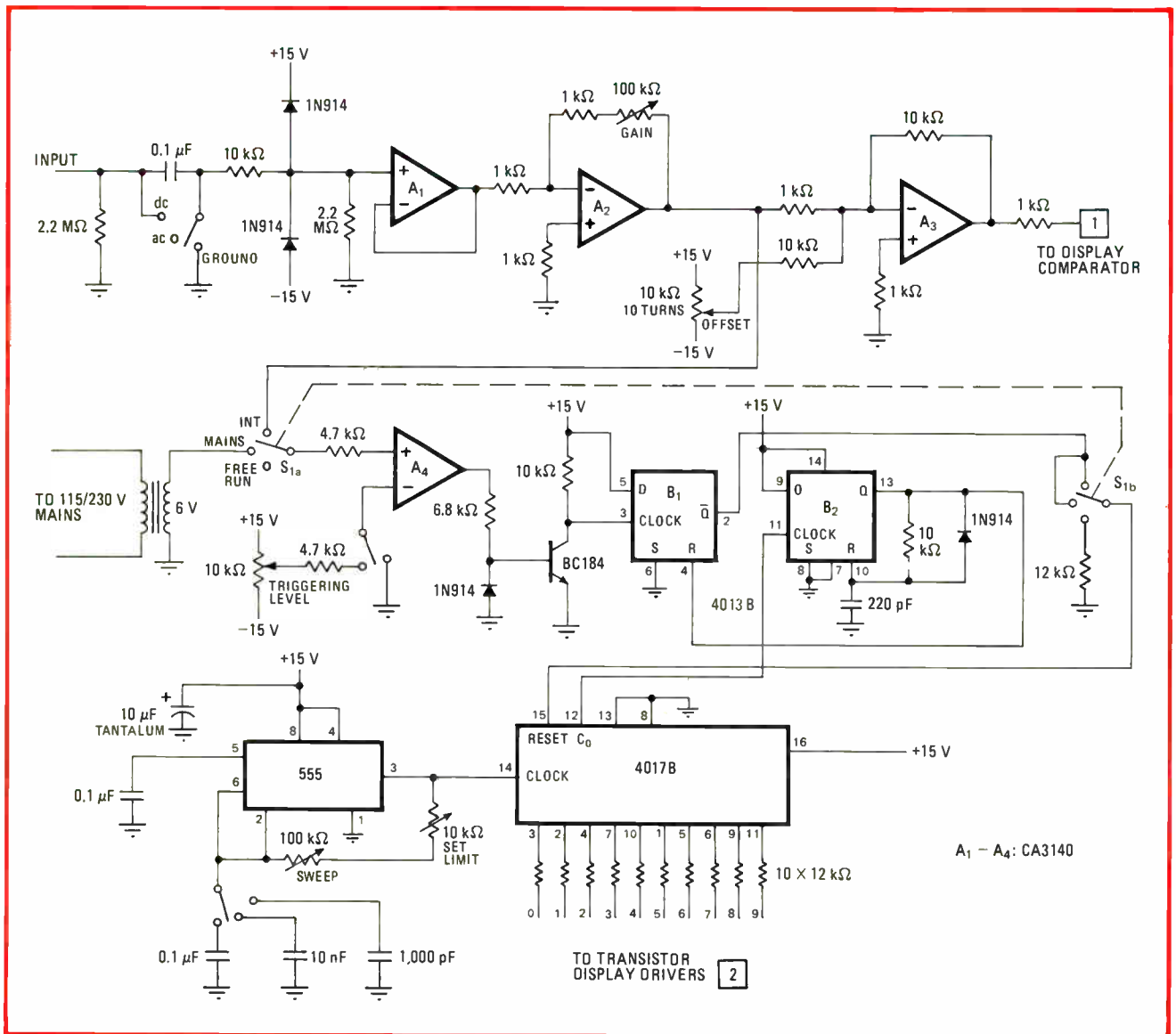
The Welding Institute, Abington, Cambridge, England

Building a small, low-powered, and low-cost oscilloscope for simple monitoring applications is easy, especially if light-emitting diodes are used in place of the cathode-ray tube. This circuit uses 10 bar displays, each containing

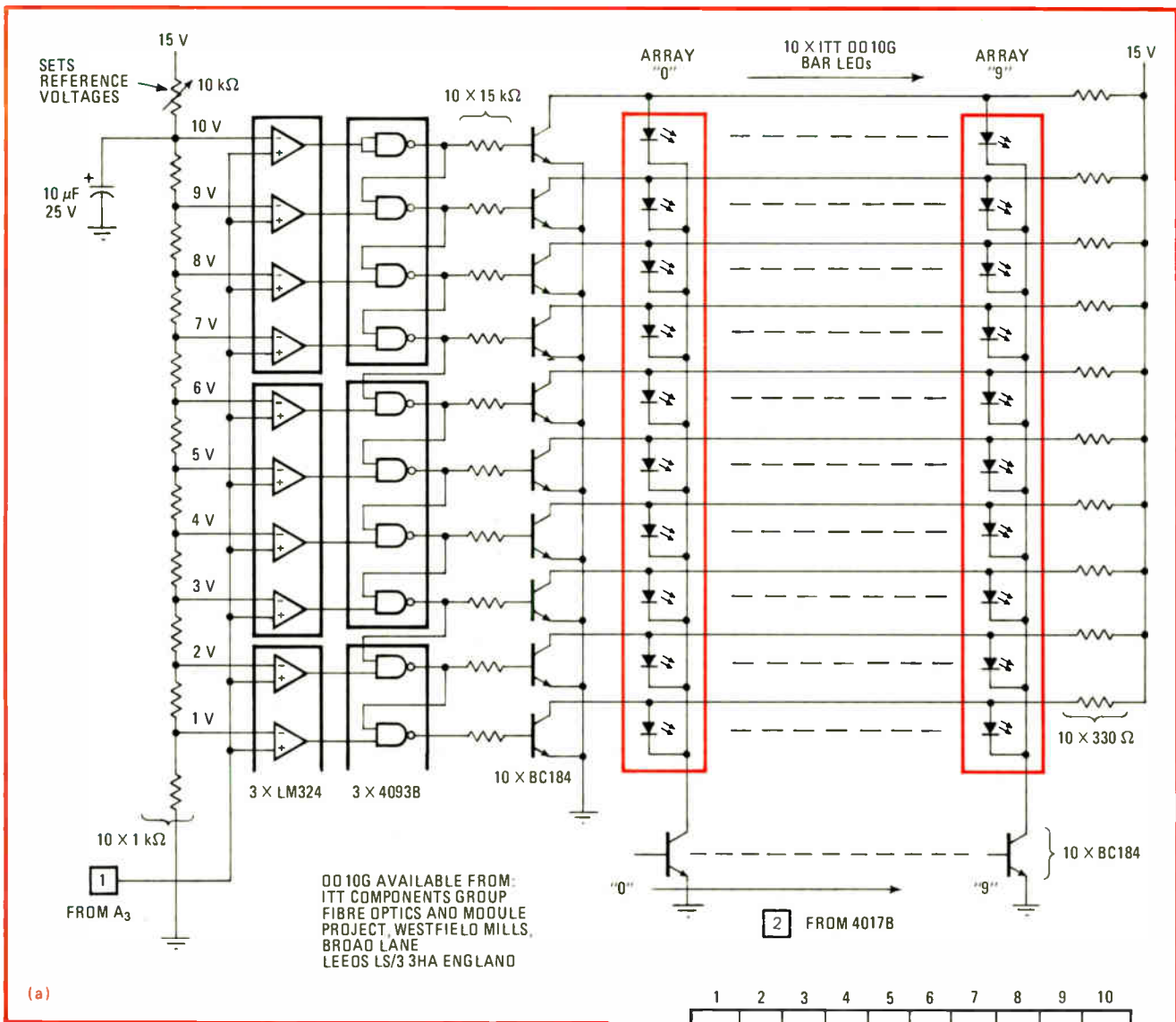
10 LEDs, to form a 100-dot viewing matrix. With this configuration, of course, resolution is only 10% in both the X and Y axes, but it can be improved by adding additional displays and expanding the driving circuitry.

As shown in Fig. 1, the signal-processing and logic circuits for the scope are straightforward. The signal-path circuit is extremely simple and has all of the options usually expected—ac and dc input coupling, variable Y-axis gain, and offset control. The signals to be observed pass through amplifier  $A_1$ , are amplified up to 100 times by  $A_2$ , and are inverted by  $A_3$ , and then pass through to the display comparator.

The trigger and timing circuits are not complicated,



**1. Signal, timing, and logic.** Driver circuits for scope's LED bar displays are straightforward. Input circuit can process ac or dc signals and has variable Y-axis gain control.  $A_1 - A_3$  is input-signal path.  $A_4$ ,  $B_1$ , and  $B_2$  provide sync for 555 clock generator and 4017 counter, which strobes bar displays. Circuit has internal, free-run, or power-line triggering option. Maximum sweep rate with 555 is 10 kHz.

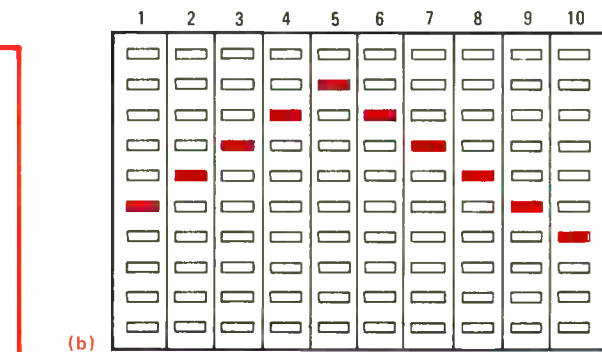


either. During any sweep, the 4017 Johnson counter steps at a rate controlled by the 555 timer and strobbs each bar display in turn. A<sub>4</sub>, B<sub>1</sub>, and B<sub>2</sub> synchronize the counter's location to the sweep rate.

A<sub>4</sub> is triggered either by the signal (internal mode) or by the 60-cycle power-line input. In the free-run mode, A<sub>4</sub> is not required. These three modes are selected through S<sub>1a</sub>, which is ganged to S<sub>1b</sub>. The trigger level can be set by the 10-turn potentiometer at A<sub>4</sub>'s input.

A<sub>4</sub> drives the 4013 D-type flip-flop circuit, composed of B<sub>1</sub> and B<sub>2</sub>, through a transistor buffer. The 4013 ensures that triggering on repetitive waveforms will be reliable, for it is reset at the end of any display sweep by the final stage (C<sub>0</sub>) of the 4017. This event causes B<sub>2</sub> to reset B<sub>1</sub>, which in turn resets the 4017.

As shown in Fig. 2, the bar displays are driven by ten LM324 comparators and a ten-gate NAND decoder. The chain of reference voltages, each separated by 1 volt, are generated by a string of 10 resistors and a 10-kilohm calibration potentiometer. These resistance values must be changed to accommodate the Y-axis resolution required. For example, if there are 20 elements in the Y



**2. Display.** Comparators, NAND gates, and transistors drive bar displays as each is strobed in succession (a). Amplitude of Y-axis signal determines which of 10 LEDs in each display is illuminated during sweep. Typical sine wave is displayed on 100-dot matrix (b).

axis (two 10-bar displays vertically mounted one above the other), the resistances must be selected to provide 0.5-v increments. Also, the Y-axis expansion must be implemented with additional comparators and gates. The NAND gates ensure that only one LED can be activated at any given time.

Expansion of the X axis is a bit more elaborate, but

not overly difficult. Simply cascading additional 4017s will not do, however, as two output states will occur, one for each driver. Consequently, these states must be decoded using NAND gates.

The 555 clock generator will sweep at a maximum rate of 10 kilohertz. For faster sweeps, a different clock circuit is needed. The comparators' frequency limits must also be well above the sweep rate. □

## Variable oscillator reacts to magnetic flux changes

by V. Vijayakumaran Nair  
Vikram Sarabhai Space Center, Trivandrum, India

An oscillator employing a saturable-core reactor can detect small changes in the intensity of any magnetic field that cuts through the reactor's windings. The oscillator utilizes core hysteresis in order to generate a frequency that is directly proportional to the magnetic field component along the inductor's longitudinal axis.

As shown in (a), two 2N3020 transistors form a simple astable multivibrator that oscillates at a frequency of 11 kilohertz in the absence of an external magnetic field. The inductor, L, in the collector lead of Q<sub>1</sub> has a core made from  $\mu$  metal, a commonly available, high-permeability magnetic alloy with the characteristics shown in (b). The  $\mu$  metal consists of nickel, iron, copper, and manganese. Placed around it is an insulating layer of phenolic resin impregnated with paper or cloth, of a kind frequently used in coil forms. As shown in (c), 800 turns of AWG 36 wire, wound over the insulator, gives L a value of a few millihenries.

Circuit operation may be understood from (d). Disregarding any external field for the moment, and assuming an arbitrary start time of t<sub>1</sub>, at which point Q<sub>1</sub> is on and Q<sub>2</sub> is off, current will build through L at the rate of  $i = (V/L)t$ , where V is the supply voltage and t is the time. Generated in the coil is a magnetic field of intensity H<sub>s</sub>, in a direction determined by the corkscrew rule. As the field increases, the level of flux density also increases. As t<sub>2</sub> approaches, the current rises to a value sufficient to saturate the  $\mu$  metal (H<sub>sat</sub>). The flux density reaches B<sub>sat</sub> and remains at that value.

As a result, the inductance drops to that of an air-core inductor, because the core permeability is proportional to  $\Delta B/\Delta H$ . Thus, at t<sub>2</sub>, the current increases almost instantaneously towards an infinite value, and as Q<sub>1</sub>'s base current is about  $V/(R_1 + R_3)$ , too little to keep the transistor in conduction, Q<sub>1</sub> is eventually cut off.

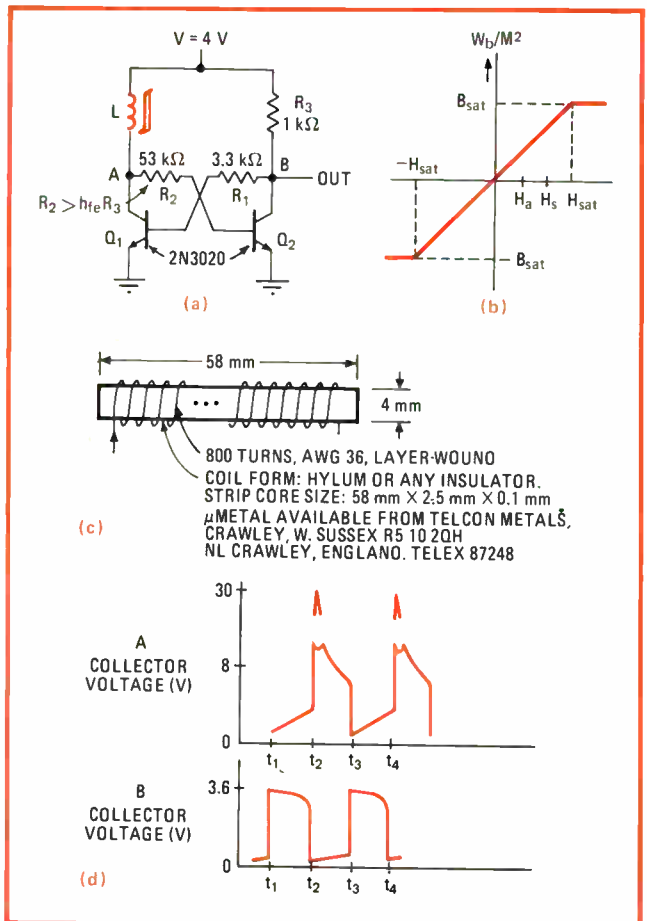
The base current into Q<sub>2</sub>, which is approximately equal to  $V/R_2$ , is not quite enough to turn this transistor on, however. But as Q<sub>1</sub> turns off, an induced electromotive force, much greater than V, is produced across the inductor, giving rise to enough additional current to turn Q<sub>2</sub> on and keep it conducting. Q<sub>2</sub> remains on until t<sub>3</sub>, when the induced current, which has been falling from time t<sub>2</sub> with a rate equal to  $-L/R_2$ , finally decreases to near zero. The collector of Q<sub>2</sub> rises, bringing Q<sub>1</sub> into conduction, current builds in L, and the process repeats.

Consider an external field with intensity H<sub>a</sub> along the

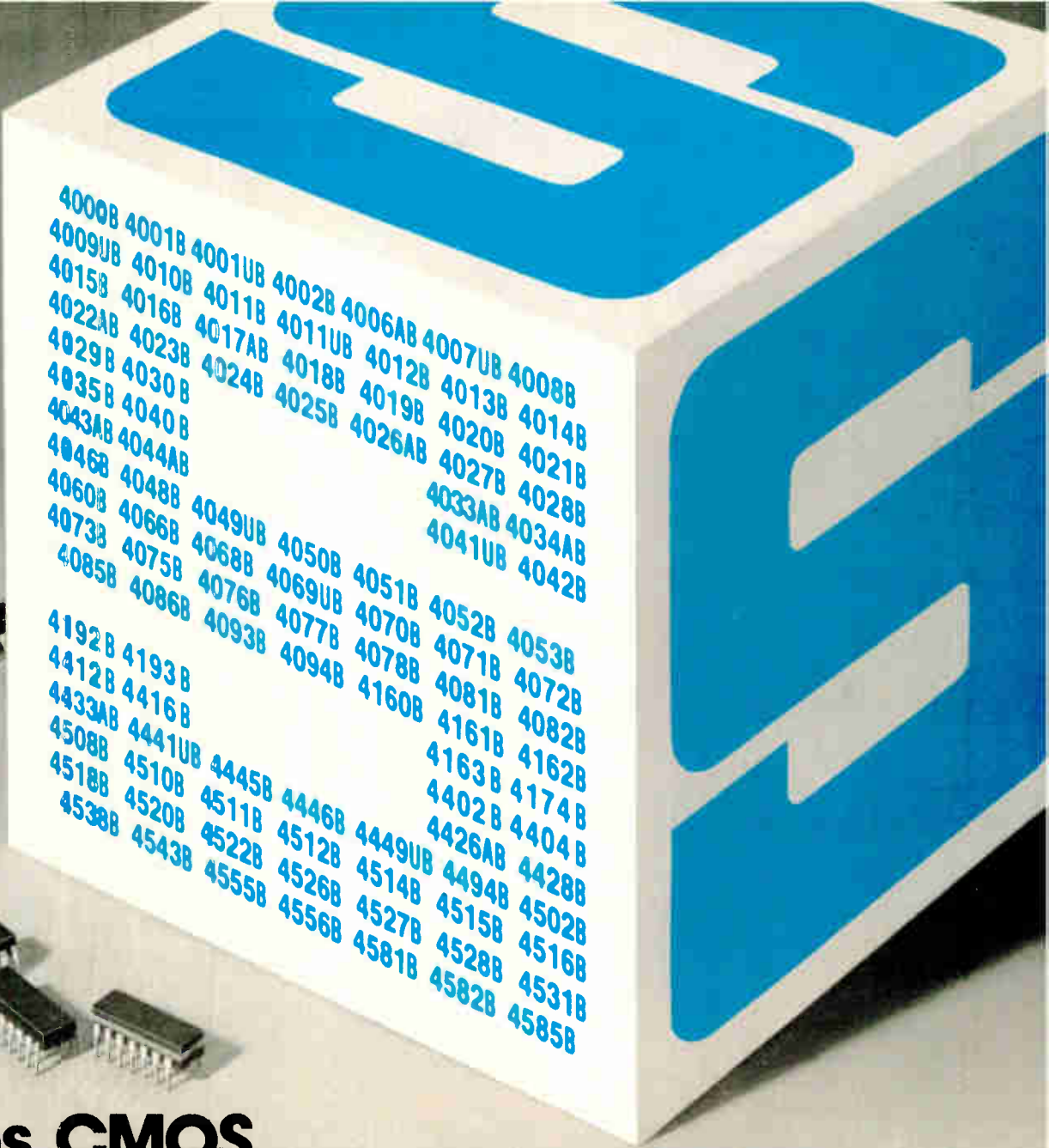
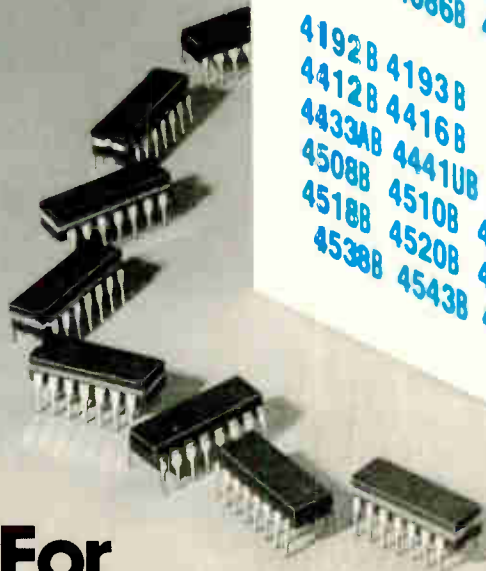
axis of the coil such that the actual field causing a flux change is equal to  $H_s \pm H_a$ , depending on the direction of the external field. When H<sub>a</sub> is opposing the field, the current takes longer to bring the total field to a value equal to H<sub>sat</sub> between times t<sub>1</sub> and t<sub>2</sub>; hence the oscillator's frequency will be lower than with no external field present. Similarly, when H<sub>a</sub> is in the same direction as H<sub>s</sub>, the core will reach saturation sooner, and the cycle will be speeded up, causing a rise in frequency.

The frequency will increase from 8 to 14 kHz for an external field change of  $\pm 0.4$  oersted. This change can be obtained merely by rotating the coil in a horizontal plane from the east-west to the north-south direction of the earth's magnetic field. □

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**Field sensitive.** Saturable core reactor enables oscillator to detect change in any magnetic field whose flux lines cut reactor windings (a). Oscillator frequency is determined by the core saturation time (b). Inductor is made of  $\mu$  metal, insulated core form, and 800 turns of high-gauge wire (c). Timing diagram details operation (d).



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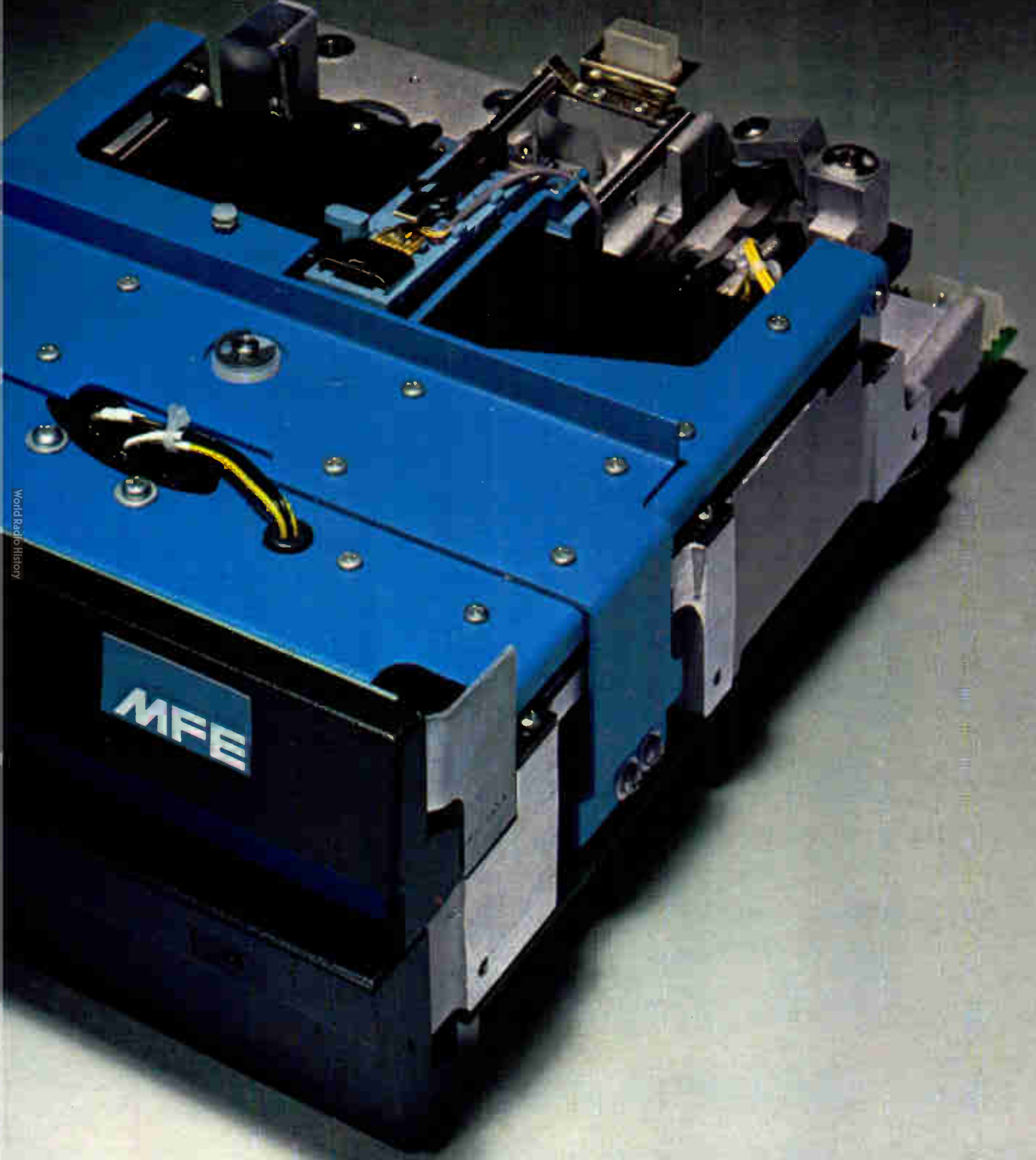
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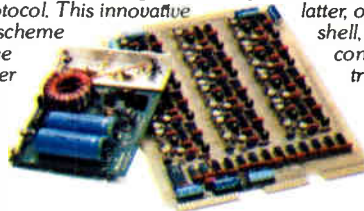
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But the details cover page after page of the data sheet. Let us leave something for your reading. Please call or write for information or a demonstration. Microtest Systems, Inc., 1188 Bordeaux Drive, Sunnyvale, CA 94086. (408) 745-7000. TWX: 910-339-9325.

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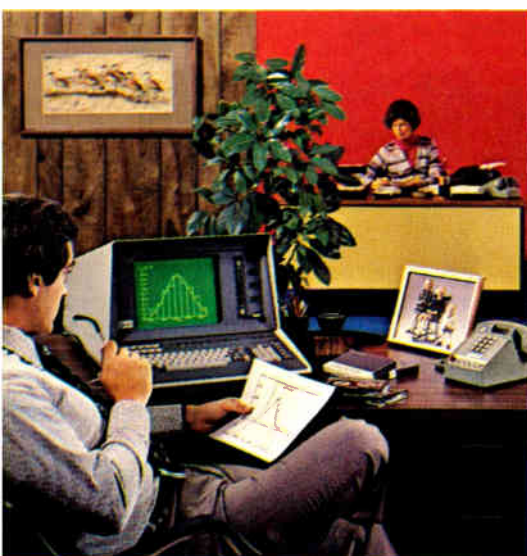
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World Radio History

# C-MOS converters resolve 12 bits

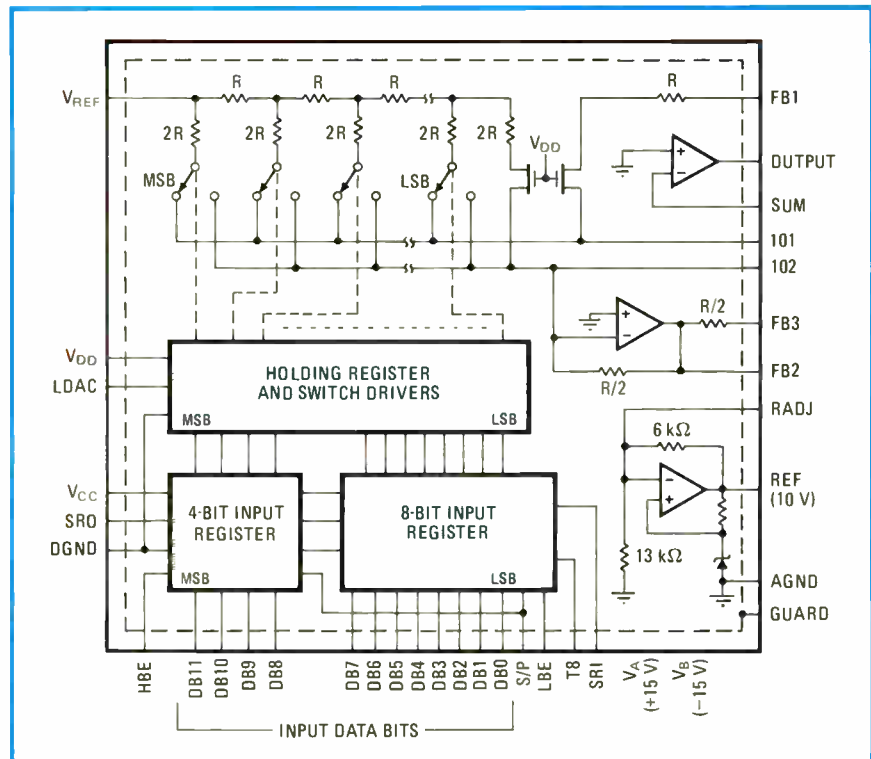
Hybrid digital-to-analog units are the first such equipment to combine direct microprocessor compatibility with the low power dissipation of C-MOS

by Larry Waller, Los Angeles bureau manager

As manufacturers of test instrumentation and process and industrial systems seek better overall performance, more accurate data conversion components—particularly at the 12-bit resolution level—are needed. Furthermore, rapid incorporation of microprocessors make compatibility of these converters without hooking up extra external interfacing components another important objective. To get these features in a pair of new digital-to-analog converters now being offered in prototype, Beckman Instruments, Inc. employs a hybrid approach that uses a thin-film resistor network for current weighting and a separate complementary-metal-oxide-semiconductor chip for low power dissipation. Thus Beckman has the first single-package microprocessor-compatible d-to-a converters that offer 12-bit accuracy and the milliwatt power consumption of C-MOS circuitry.

"The key to this performance is a mature thin-film technology that allows achieving linearity and tracking specifications," says Lyle F. Pittroff, product marketing manager for hybrid microcircuits. "We knew we could combine thin-film on the same substrate with C-MOS without compromising performance of the switches." Beckman developed the converters in an 18-month program, and plans to introduce additional a-d models in January.

In contrast to monolithic converter producers that put the resistor switching ladder on the circuitry chip itself, Beckman felt this design makes laser trimming too difficult. "The ease of trimming the ladder by dividing it from the chip enables us to attain accuracy to within 1/2 least-



significant bit," says Lerdy Little, senior product engineer responsible for the converter design.

"By working both pieces separately, we're able to keep tighter tolerances," he says. Also, he says, Beckman found that it could "hold the geometry and separate the resistor ladder and C-MOS chip all within a 125-mil-square substrate, above which size costs skyrocket." He believes the converters should attain an operating life of 100,000 hours.

Of the two converters, series 7545 is a multiplying model with a four-quadrant configuration, implemented by bipolar digital proportioning of an ac external reference. It can be used to accommodate tran-

sistor-transistor-logic or C-MOS standard supply levels where digital and analog subsystems operate on different supplies, Pittroff says.

The more complex series 7546 provides complete general-purpose conversion with self-contained 10-volt dc reference and the operational amplifier and feedback circuitry to achieve up to 5 milliamperes of output drive capability. It incorporates preadjusted zero offset for the output buffer amplifier and a biasing amplifier for bipolar operation.

For microprocessor compatibility, both models offer a double buffering input feature with separate input and holding registers. Here, two input registers can accept a 12-bit



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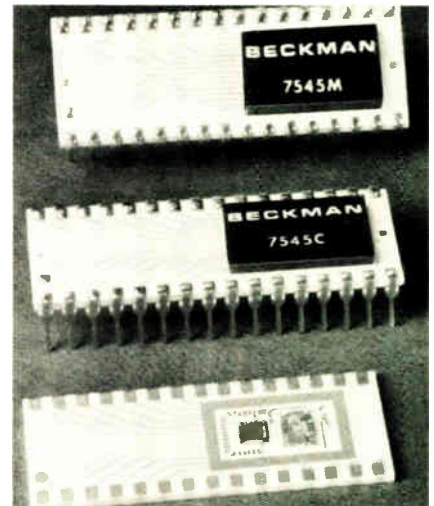
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## New products



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For TTL-C-MOS compatibility, both input registers have translators which take TTL inputs using a +5-v supply or C-MOS inputs with from +5- to +15-v levels. Separate power supply lines for both holding and input registers allow flexibility without compromising linearity, according to Pittroff. Both series operate in serial or parallel input modes and can be switched from one to the other. The registers are switch updated upon command through enabling lines or for continuous conversion by permanently enabling transfer lines for parallel operation.

Internal configuration of the converters has the thin-film nichrome resistors deposited on an alumina substrate. The separate C-MOS chip contains input level translators and shift registers, the converter-switch holding register, switch drivers, and analog switches. It is silicon nitride passivated for both commercial and military versions. The commercial unit is available in a polymer sealed package, guaranteed over a 0 to 70° C range. Military models have a hermetically sealed package, over -55° C to +125° C.

The two converters will be available in quantities during January. Prices for commercial versions are \$21.90 for the 7545 and \$43 for the 7546, in hundreds.

Beckman Instruments, Inc., Helipot Division,  
2500 Harbor Blvd., Fullerton, Calif. 92634.  
(714) 871-4848, Ext. 1126 (338)



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EM1124

# Multimeter delivers extra functions

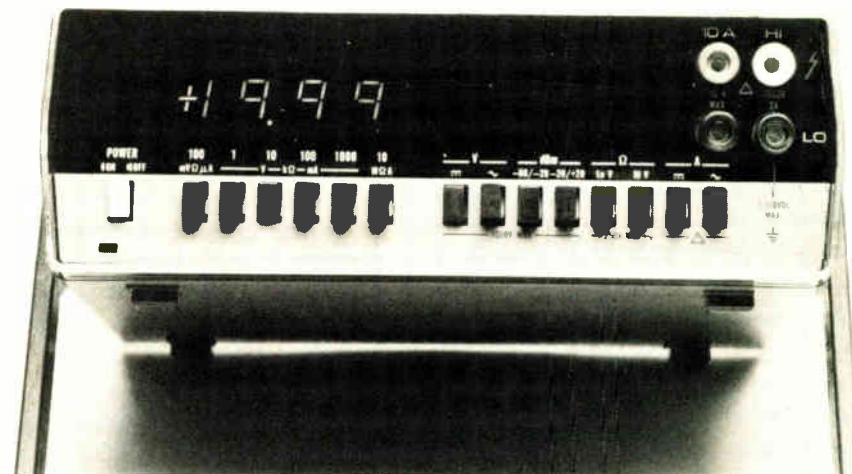
3 $\frac{1}{2}$ -digit instrument selling for \$279 offers full capability including direct dBm and true-rms readings and a 10-ampere range in current measurements

by Lawrence Curran, Boston bureau manager

With prices for 4 $\frac{1}{2}$ -digit multimeters in the range from \$200 to \$300, why would a company bring out a 3 $\frac{1}{2}$ -digit instrument selling for \$279? According to Harold Goldberg, president of Data Precision Corp., it is because users are looking for a variety of functions. He calls his company's 1750 a "bells and whistles model—an extra-function instrument that provides just about any measurement anyone using a digital multimeter would want."

Data Precision is probably the leading supplier of 3 $\frac{1}{2}$ -digit multimeters. "Traditionally, we've emphasized low cost," Goldberg explains, "but here we've gone to the user who wants full capability." Besides the traditional functions in an instrument with dc accuracy to within 0.1% for high-precision applications, the model 1750 offers these extras: direct dBm and true root-mean-square readings, high and low excitation in resistance, and a 10-ampere range in current measurements. Goldberg expects the dBm feature to be especially attractive to users in the audio and telecommunications fields, observing that the latter is growing rapidly as a market for multimeters.

The unit measures dc volts in five ranges from  $\pm 100$  microvolts to  $\pm 1,000$  volts and ac volts in five ranges from 100  $\mu$ v to 1,000 v rms, with a frequency response of 20 hertz to 20 kilohertz. In dc current, (six ranges) the meter covers from  $\pm 100$  nanoamperes to  $\pm 10$  amperes rms; in ac (six ranges), from 100 nA to 2 A, with the same frequency response except for the 10-A range, where the frequency is 20 Hz to 1 kHz. High and low excitation resist-



ance measurements are provided in six ranges from 100 milliohms to 20 ohms, and the direct-reading dBm function is from -60 to plus 20 dBm.

The model 1750 also offers a sensitivity of 100  $\mu$ v, overload protection 100% overrange, and automatic zero. Goldberg says that in addition to the extra functions, the unit "has the one thing that most people working in relatively unknown voltage environments want. It's forgiving; it allows mistakes and won't blow up in your face." Specifically, the instrument will withstand 1,000 v dc or ac rms continuously applied, and the ohms function is protected electronically against 250 v dc or rms ac continuously applied, says Robert Sheinfein, vice president of sales.

Weighing just 3 pounds, including its field-installable batteries and carrying handle, the instrument is fully portable. The drop-in nickel-cadmium battery pack is a \$20 option that provides 8 hours of operation

before requiring recharging by the built-in recharger.

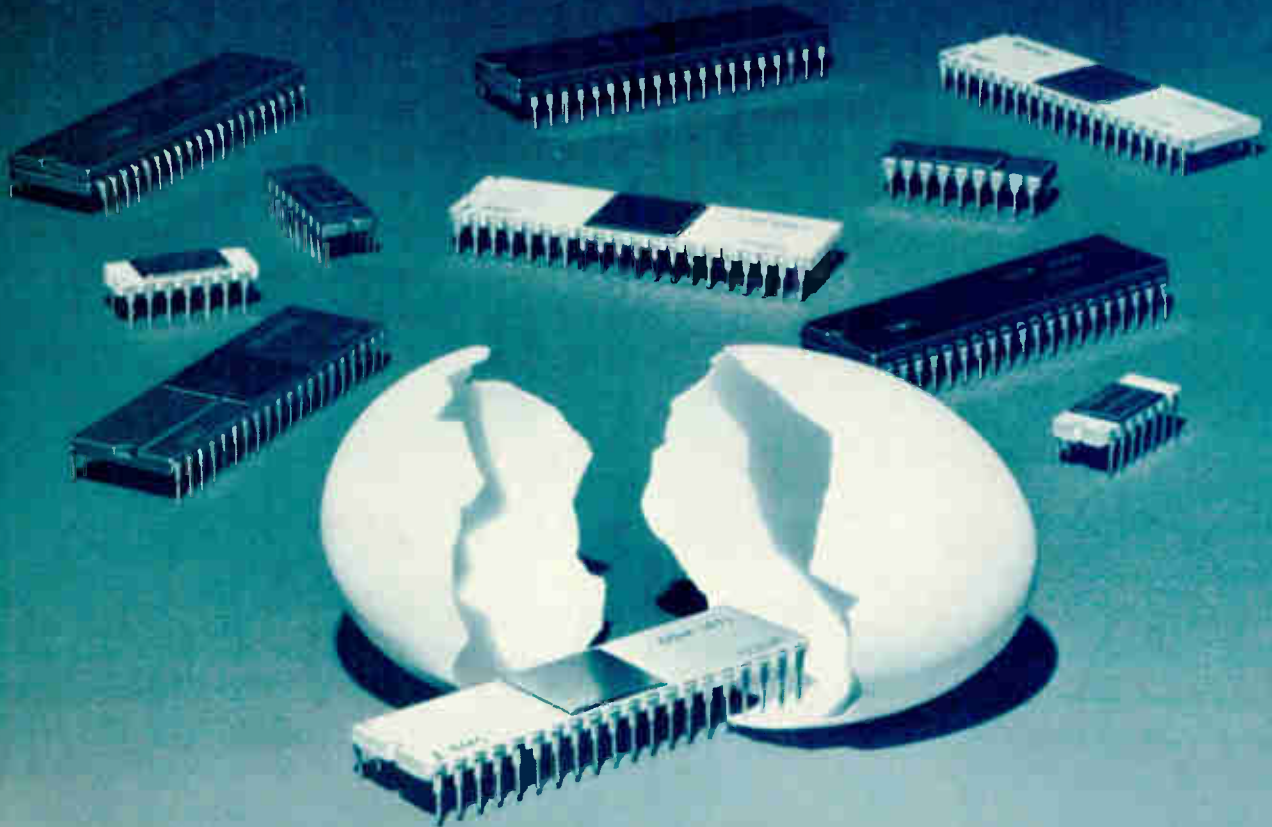
The \$279 price covers the basic and extra functions, plus test leads, detachable line cord, spare fuse, instruction manuals, full test data, certificate of conformance, and one-year warranty. Options other than the drop-in battery pack include optically isolated binary-coded-decimal outputs and a high-efficiency extra-bright light-emitting-diode display for high ambient-light environments. Both the standard and extra-bright LEDs are 0.43 inch high.

Summing up, Goldberg says: "We've added a lot of functions at the expense of one digit, but we've found that people are looking for functions. We can't give the db accuracy commensurate with a 4 $\frac{1}{2}$ -digit instrument, but 3 $\frac{1}{2}$ -digit multimeters are the most widely selling ones today."

Delivery is from stock.

Data Precision Corp., Audubon Road, Wakefield, Mass. 01880. Phone Robert Sheinfein at (617) 246-1600 [339]

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Circle 145 on reader service card

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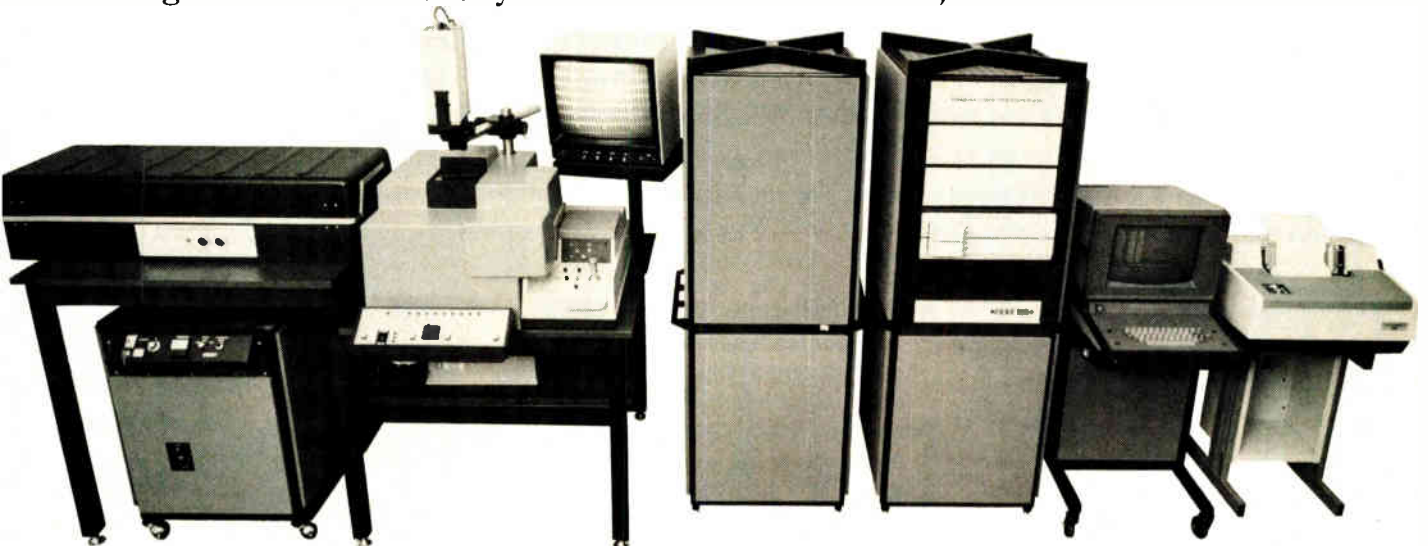
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# TERADYNE

## New products

is a 4-bit microcomputer with a cycle time of 4 microseconds. Included on the chip are 1,024 bytes of read-only memory, 64 4-bit words of read-write memory, input/output circuitry, and a clock oscillator. The unit's input sensing lines have TouchControl compatibility, which means that they can be easily interfaced to capacitive switch devices. A seven-segment display decoder and light-emitting-diode drivers are also included in the single-chip architecture. A version of the computer that will drive vacuum-fluorescent displays is also available.

The chip's firmware consists of 51 instruction codes, including skips similar to those in the DEC PDP-8 minicomputers instead of conditional branching.

American Microsystems Inc., 3800 Homestead Rd., Santa Clara, Calif. 95051. Phone Tom Edel at (408) 246-0330 [364]

## One-board computer is compatible with F8 systems

Capable of being used as a stand-alone board for low-volume production, as a low-cost development system, or for real-time emulation of pilot production and field testing, the OCM/1 is a one-card computer for use with F8-based systems. The computer comprises four major sections: processor, memory, input/output, and interrupt. The processor section consists of a 3850 central processing unit, a 3853 static memory interface (SMI), a clock generator, and reset circuitry. The memory section is capable of using several different types of memory chips. The board is supplied with a kilobyte of random-access memory and sockets for various read-only memories.

The I/O portion of the computer is made up of the 3850 and a 3851 program storage unit (PSU), each containing two 8-bit I/O ports. Sockets for additional interface circuitry are provided to allow a maximum of eight I/O ports. An additional port allows the unit to communicate with a teletypewriter.

The standard OCM/1 incorpo-

rates two interrupts and two timers—one in the PSU and one in the SMI. Two additional interrupts and timers may be added. The basic machine, in unit quantity, sells for \$295. It is available from stock.

Fairchild Camera and Instrument Corp., Instruments and Controls Division, 1725 Technology Dr., San Jose, Calif. 95110 [365]

## Z80-based computer works with 8080 support boards

The MM1-ZCPU microcomputer board is built around the Zilog Z-80 microprocessor yet is fully compatible with the MM1 family of support boards originally developed for use with computers built around the Intel 8080A. The new board has space for 4,096 bits of erasable read-only memory and 1,024 bits of read-write memory. It operates at a clock rate of 2 MHz. Among the support boards available for it are a 16-k erasable PROM board, a 16-k dynamic random-access-memory board, a 4-k nonvolatile RAM board, a 4-k static RAM board, and six analog and digital input/output boards. The MM1-ZCPU sells for \$350 in single quantity and has a delivery time of 30 days.

Control Logic Inc., 9 Tech Circle, Natick, Mass. 01760. Phone (617) 655-1170 [363]

## Disk system for PACE unit speeds software development

A disk-operating system for PACE microprocessor development system substantially reduces the time required to assemble, edit, and execute programs. Designated the IPC-16P/840, the system comprises a dual floppy-disk drive in a standard enclosure, an interface circuit subsystem card, and a read-only-memory card. The disk-operating system provides comprehensive file-management capability, support for assembly programs, editors, linking loaders, utility programs, and diagnostics. It may be installed on any IPC-16P PACE microprocessor devel-

# Monsanto

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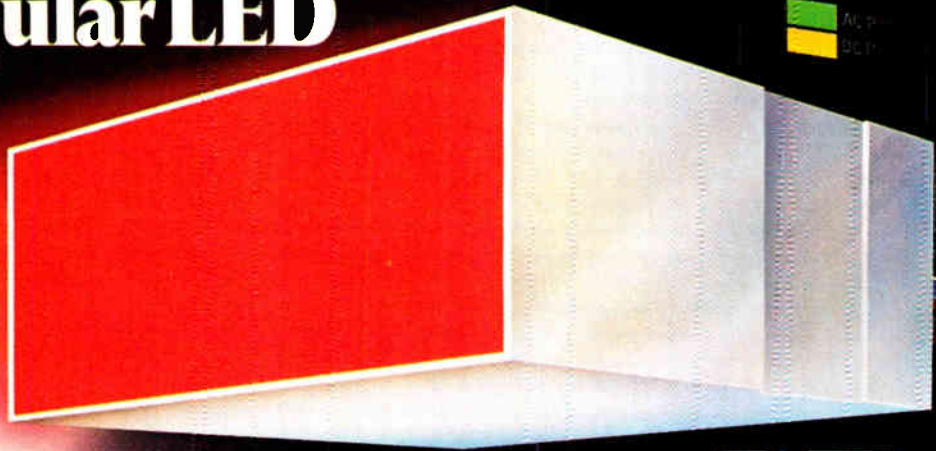
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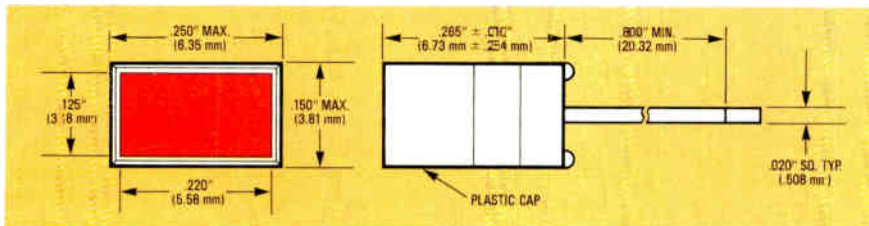
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**Monsanto:**  
the science  
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World Radio History

Circle 151 on reader service card

## New products



opment system with 12 kilowords of read-write memory and a heavy-duty power supply. It sells for \$4,500 including the dual-floppy-disk subsystem, a disk interface card, a PROM card, and cables. The unit has a delivery time of 30 days.

National Semiconductor Corp., Microcomputer Systems Group, 2900 Semiconductor Dr., Santa Clara, Calif. 95051 [367]

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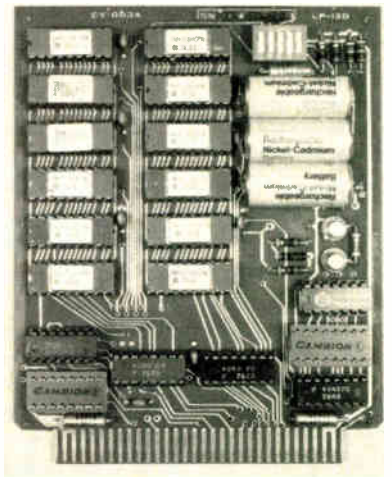


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## C-MOS memory module stores 1,024 12-bit words

The latest addition to the LP-12 family of low-power microcomputer boards is a read-write memory module with a capacity of 1,024 12-bit words. Built using complementary-metal-oxide-semiconductor random-access memories, the LP-12D can be strapped for address block recognition and RAM-select signal generation, enabling it to simulate the 6312



read-only memory for prototyping purposes. Other features of the LP-12D include write-protect capability and optional on-board batteries for nonvolatility. In unit quantity, the memory module sells for \$280 without the battery and \$310 with it. Delivery time is four weeks.

Cybertek Inc., 222 150th Ave., Madeira Beach, Fla. 33708 [366]

## Database-management system runs on microcomputers

Micro-Seed, a data-base-management system for the Xitan microcomputer, will support both hierarchical and network data structures. It includes a program that prepares disks for data-base loading.

Technical Design Labs, Research Park, Bldg. H, 1101 State Rd., Princeton, N. J. 08540 [368]



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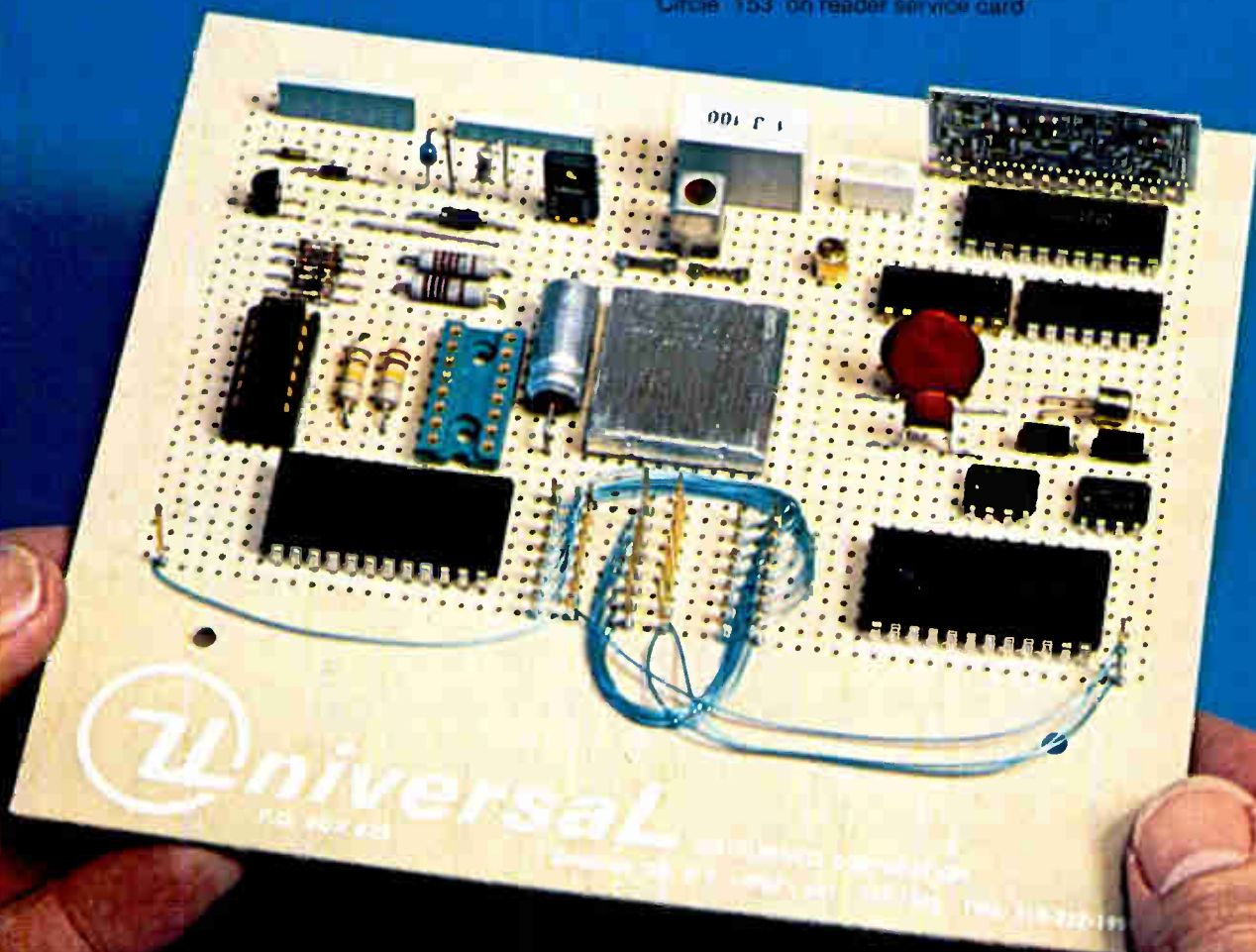
floppy disk memory, and entered thru a high speed tape reader/punch. Data for continuous production control and executive monitoring can even be called up on remote CRT displays.

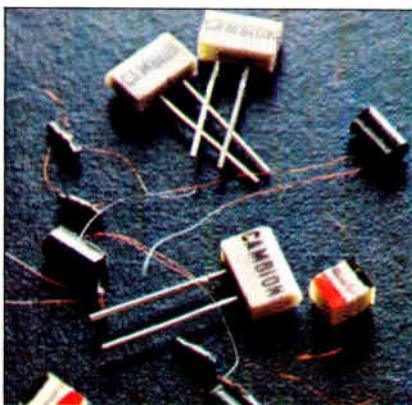
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## New products

Subassemblies

### Smart display offers low drain

Microprocessor-run module for computer systems includes character generator

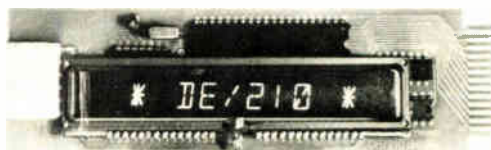
Vacuum-fluorescent technology appears in a series of smart microprocessor-controlled displays, designed for use with any microcomputer-based system. Digital Electronics Corp. has three models in its DE/200 series of intelligent, random-access displays.

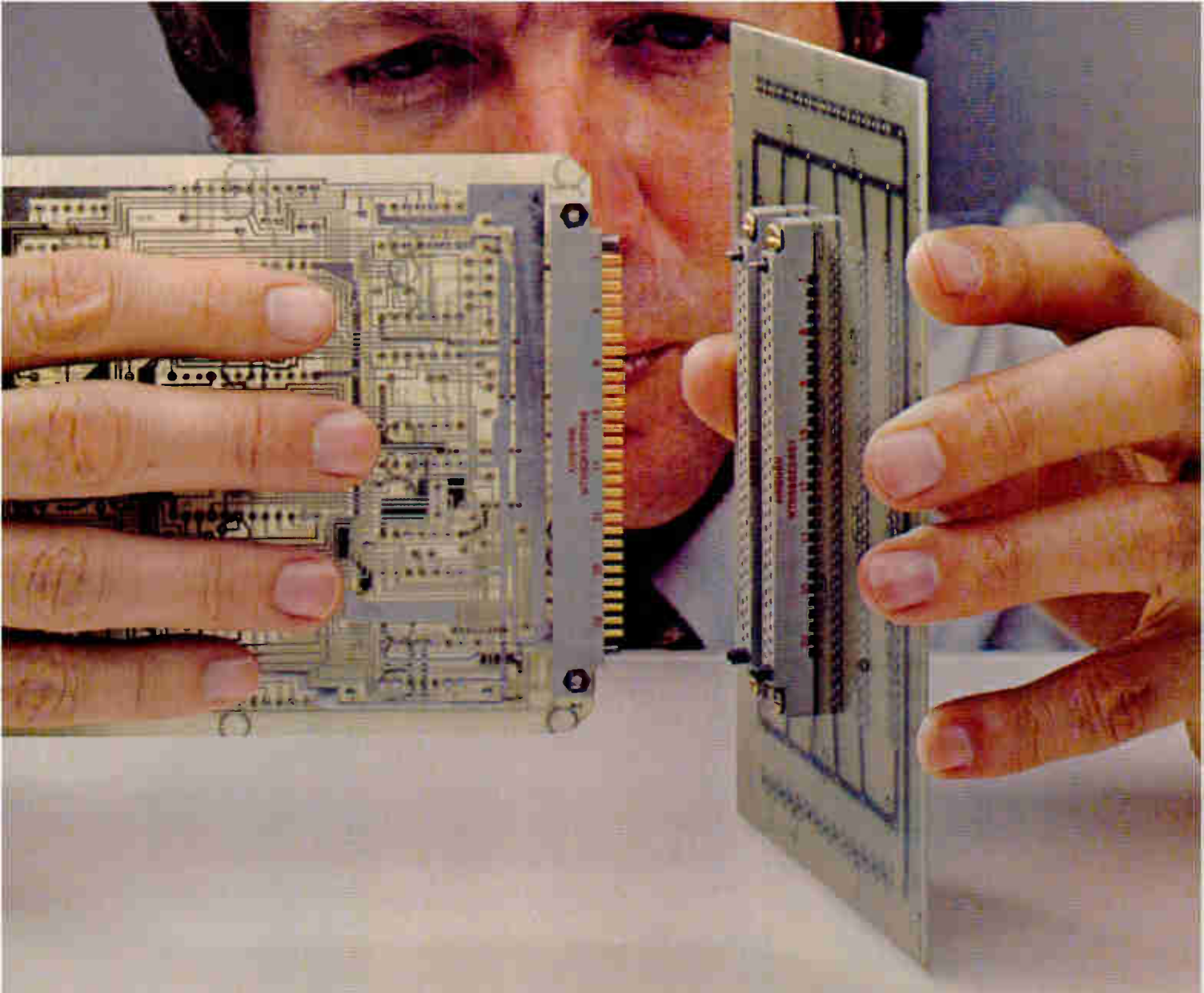
These alphanumeric, single-line display modules offer low power consumption and 14-segment character design that permits clear and readable messages, even under high ambient light conditions. The natural blue-green color of the characters can be filtered to blue, green, or yellow by use of acetate or acrylic filters.

The microdisplay models, DE/210 (10-character positions), DE/220 (20-character positions), and DE/232 (32-character positions) all include an on-board microprocessor that incorporates a character generator, display buffer, and refresh logic. The display incorporates both parallel and serial interfaces, offering universal compatibility with bus-oriented microprocessor systems and with serial data devices.

Since all character positions are uniquely addressable, the display can be selectively updated in accordance with the host system's requirements. Display changes are instantaneous, with no line-shift effect. Full ASCII character sets are augmented by period-insertion capability (period and comma on the DE/210 and DE/220) in the same character space.

Display evaluation kits (shipped with each initial display module ordered) include a data cable, power connector, and complete documentation. Mounting kits complete with bezel, filter, and hardware are optional. Power supplies are available with either +5 volts ac or





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Circle 155 on reader service card

## **AirBorn, Inc.**

4321 AirBorn Dr., Addison, Texas 75001, 214/233-2000

## New products

110/220 v ac input, Digital says.

Interfacing to a computer-based system is simple, requiring a minimum of control and "hand-shaking" in a bus-oriented system. Each microdisplay represents as few as one output address to the host system.

As parallel output devices, each microdisplay is latched, requiring

little, if any, additional circuitry to be connected to the data bus of most 8-bit microcomputer systems. In a bidirectional bus scheme, each microdisplay may be used to return status or data to the host system upon request, as well as receive data codes and control codes.

In serial operation, each microdisplay is an output-only device. All

data and control characters are applied to the display in a 10-bit format, having 1 start bit followed by 8 data bits and 1 stop bit.

Each of the DE/200 microdisplays has exactly the same interface configuration, permitting interchangeability of displays with no changes in the interface. In quantities of 100 and up, the displays are priced at \$99, \$140, and \$199 each for the DE/210, DE/220 and DE/232, respectively.

Digital Electronics Corp., 415 Peterson St., Oakland, Calif. 94601 [381]

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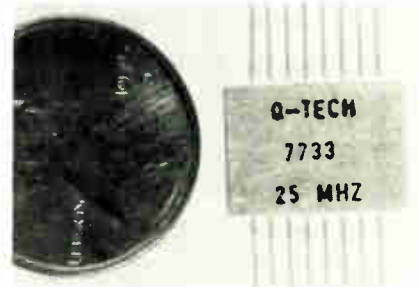
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Hybrid clock oscillators  
occupy less than 0.04 in<sup>3</sup>

A line of clock oscillators that operate at frequencies from 1 hertz to 30 megahertz is available in flat packs ranging in size from 0.375 by 0.500 by 0.110 inch up to 0.625 by



0.625 by 0.100 in. The oscillators are thus well suited for use in high-density circuitry such as that built on multilayer boards. In hundreds, the clock oscillators sell for \$38 each. They have a delivery time of six to eight weeks.

Q-Tech Corp., 2201 Carmelina Ave., Los Angeles, Calif. 90064. Phone (213) 820-4921 [387]

Fast 8-bit a-d converter  
has three-state outputs

Designed for interfacing with 8-bit microprocessors, the MN5150 is a complete 8-bit analog-to-digital converter with three-state outputs. The unit contains a built-in reference

# The Complete Solution to your F3870 and F8 Design-In Problems

## The Formulator Development System

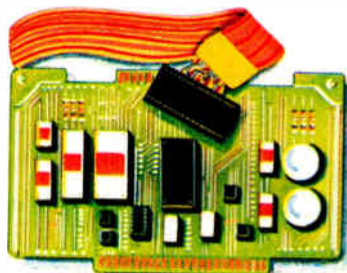


The Formulator family is designed to allow easy, efficient software development and real time hardware simulation of F8 or F3870 based systems. It is supported by a complete line of functional modules including memory, I/O and simulation cards that plug directly into the Formulator cardframe.

The Formulator can, itself, be used as the system breadboard. It provides microprocessor hardware, plus card slots for breadboarding your system. Thus the entire system may reside within the Formulator or in a combination of external and internal configurations.

## In-Circuit Emulation

To develop, test and debug F8 and F3870 based products, Fairchild offers simulation options that extend the functional features of the micro-



processor from the Formulator to the 40-pin socket on your breadboard. This allows complete ROM firmware development, real-time symbolic debugging of your breadboard and freezing of ROM codes during the breadboard stage.

## PROM Prototypes

The 3870 Emulator is a PROM-based substitute for the F3870 microprocessor. The Emulator measures 5" x 7" and contains two 2708 or 2716 EROMs in place of the F3870 so ROM codes can be verified and easily changed if necessary.



The F3870 Emulator plugs directly into the F3870 40-pin socket in the production prototype via a short cable.

## Powerful and Complete Software

The software consists of an operating system, utility programs and diagnostic routines; a monitor, text editor, assembler and debug package. It includes linking loader and relocating assembler and will operate in interactive or batch mode. The result is an easy to use, reliable, fast and extremely efficient capability for microprocessor based system development.

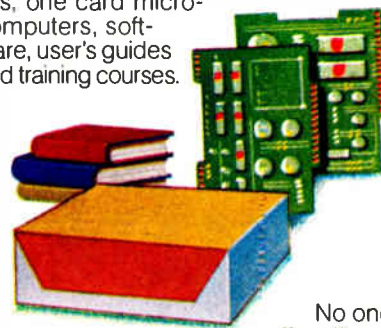
## The Formulator-Floppy Disk Marriage

An inexpensive plug-in module interfaces the Formulator with up to four plug-compatible ICOM Floppy Disc Drives, providing over one megabyte of storage. If you prefer other Floppies an application note provides the information necessary to modify Drivers for your system.



## And That Isn't All

There is a lot more to Fairchild's line of design aids: PCB modules, memory options, PROM programmer, application and peripheral options, design kits, one card micro-computers, software, user's guides and training courses.



No one offers the extensive F8 and F3870 support that you can get from Fairchild. Just ask us about it.

Fairchild Instrumentation and Controls, a division of Fairchild Camera and Instrument Corp., 1725 Technology Drive, San Jose, California 95110 (408) 998-0123, Ext. 220.

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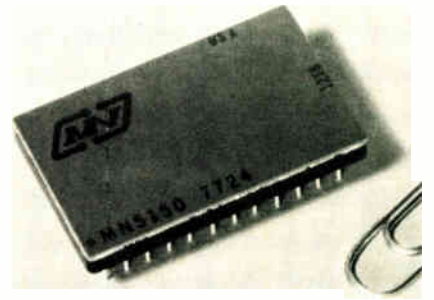
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## New products



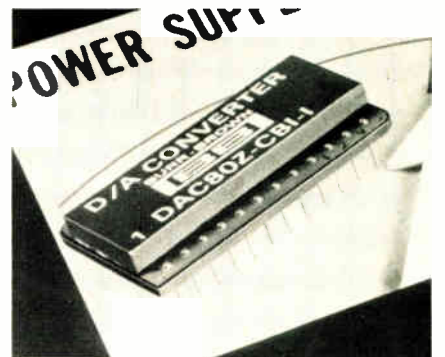
source and features a conversion time of 2.5 microseconds. It is housed in a 24-pin hermetic dual in-line package for easy mounting on the same board as its controlling microprocessor.

Seven user-selectable input ranges are provided:  $\pm 2.5$ ,  $\pm 5.0$ ,  $\pm 10.0$ , 0 to 5, 0 to 10, 0 to  $-5$ , and 0 to  $-10$  v. Regardless of which range is selected (by the appropriate strapping of various pins), the converter is guaranteed to have no missing codes over its operating temperature range. For the standard \$75 MN5150, this range is from  $0^{\circ}\text{C}$  to  $70^{\circ}\text{C}$ . For the MN5150H, which costs \$149, the range is  $-55^{\circ}\text{C}$  to  $125^{\circ}\text{C}$ . Delivery of all units is from stock to four weeks.

Micro Networks Corp., 324 Clark St., Worcester, Mass. 01606. Phone John F. Munn at (617) 852-5400 [383]

12-bit d-a converter runs off  $\pm 12$ -V supplies

The DAC80Z digital-to-analog converter is similar to other units in the DAC80 family, except that it allows operation from  $\pm 12$ -volt supplies, the company says. The other models





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For more information on the 1200, and hundreds of other power supplies, write for our 26 page catalog.

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Circle 160 on reader service card

# If this magazine is worth your time, it's worth 54¢.

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## New products

require ±15 v. The new 12-bit converter will settle to within 0.01% of final value in 300 nanoseconds (in its current-output mode) and meets all its specifications with power-supply voltages from ±11.4 to ±16.0 v. Housed in a ceramic dual in-line package, the DAC80Z sells for \$19.50. Delivery of the converter is from stock.

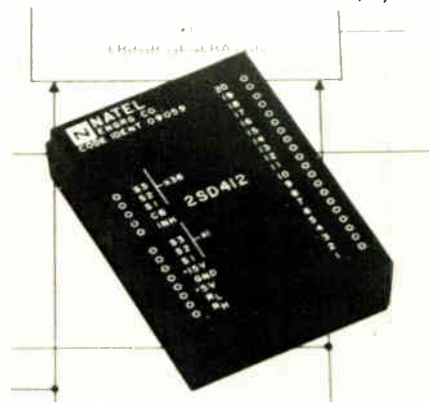
Burr-Brown Research Corp., P. O. Box 11400, Tucson, Ariz. 85734. Phone Joe Santen at (602) 294-1431 [385]

## 20-bit synchro-to-digital converter fits in one module

A two-speed, 20-bit synchro-to-digital converter with a maximum error of 0.001° at a speed ratio of 36:1 occupies only one standard module measuring 2.6 by 3.6 by 0.8 inches. Competitive units require two or even three modules to do the same job, according to the manufacturer. The model 2SD412 requires two power supplies—5 v and 15 v. Total power consumption is 3.5 watts for the version with standard transistor-transistor-logic outputs and 2 w for the unit with low-power TTL outputs.

The 2SD412 accepts pairs of either three-wire synchro or four-wire resolver signals plus a reference input. The reference frequency is 400 hertz; for 60-Hz operation, a separate transformer module is available. Standard inputs are 11.8, 26, and 90 v root mean square, and the reference can be either 26 or 115 v rms.

The standard unit sells for \$1,195







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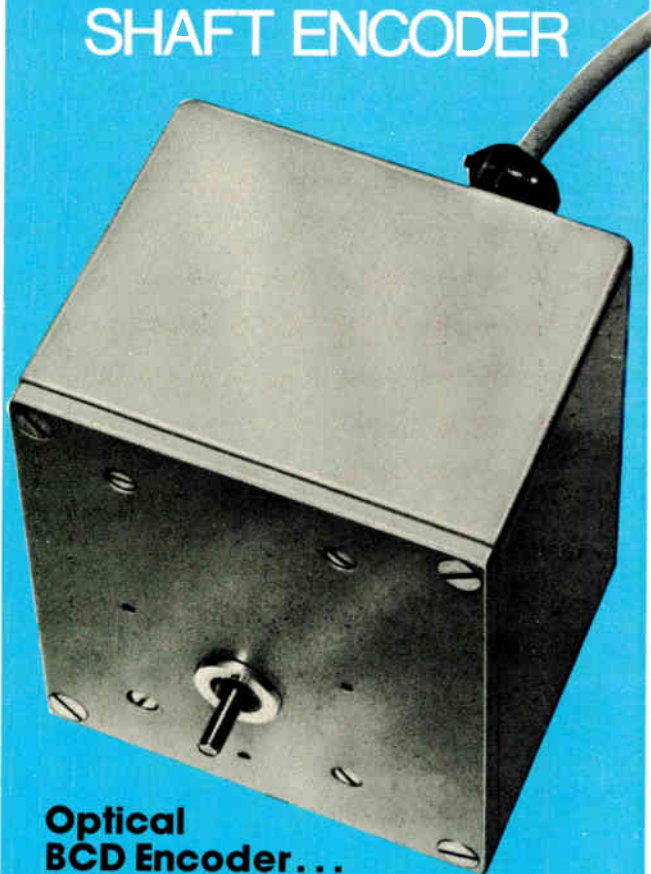
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### New products

in small quantities and is available from stock to 45 days. Special units, with extended temperature range and high-reliability components, are also available. A 16-bit converter is offered for applications that do not need the resolution of the 20-bit device.

Natel Engineering Co., 8954 Mason Ave., Canoga Park, Calif. 91306. Phone (213) 882-9620 [386]

### Gould introduces 18 switching power supplies

Gould Inc. is introducing 18 switching power supplies, including 12 5-volt models designed for the telecommunications and data-processing areas. The SMG series includes units with power ratings from 8 to 2,250 watts. In addition to the 5-v models, which are available with current ratings from 1.6 to 450 amperes, there are three 12-v supplies and three 24-v units.

Gould Inc., Electronic Components Division, 4601 North Arden Dr., El Monte, Calif. 91731. Phone (213) 442-7755 [384]

### TOPICS

#### Subassemblies

**The Singer Co.'s, Kearfott Division, Little Falls, N. J.,** has improved its Trigac VI C70 4773 digital-to-synchro/resolver converters in several ways. Among the improvements are protection from static electricity and transformation ratio as a function of angle constant to within 0.25%.

... **Burr-Brown Research Corp., Tucson, Ariz.,** is now selling its popular ADC82 8-bit analog-to-digital converter in a Q-screened version. Q-screening is Burr-Brown's stressing and testing sequence, which is appropriate when extremely high product reliability is needed. ... **Micro Networks Corp., Worcester, Mass.,** has slashed the prices of its MN2000 series voltage references by 20 to 36%. Prices now go as low as \$28 each in hundreds.

# The New Giant in optoelectronics

**Affiliation with Siemens  
gives Litronix all you  
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**On OCTOBER 18,  
1977,** Siemens A.G., an \$8 billion per year firm, acquired an 80% interest in Litronix through a wholly-owned subsidiary — bringing financial stability, new technologies and dozens of new products to the American firm.

Foremost among the new technologies and products are LCD displays, high-power infra-red emitters, green, yellow and red GaP LEDs, and a full line of photo detectors. Nearly all types of optoelectronic products will now be available from Litronix.

Litronix will operate under its own name and market all products in the U.S. and abroad through the same distributors and sales representatives as before.

## **All resources devoted to components**

Litronix ceased manufacture of calculators and digital watches in January 1977. All the design and production capability once devoted to these products is now directed entirely to components. The component portion of the company's business has always been highly successful. Now, operating from a strong financial position, Litronix will resume its place as

the leading source of advanced, cost-effective optoelectronic components.

## **New, advanced products coming fast**

Already in 1977 Litronix has developed 21 new products. With the recent affiliation, new product development is being further accelerated. The company's line of displays, lamps and other opto devices is being broadened and upgraded. Special emphasis is being placed on "intelligent" displays and indicators — devices which incorporate a display and integrated logic in the same package.

The recently introduced DL-1416 alphanumeric display, which interfaces exactly like a RAM, is an apt example. Such devices eliminate need for much associated interface and logic circuitry — simplifying design and producing a sizable net saving in the production cost of customers' products. Litronix is the uncontested leader in this promising extension of optoelectronic integration.

When you have need for virtually anything in optoelectronics, contact Litronix at 19000 Homestead Road, Cupertino, California 95014. Phone (408) 257-7910.

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## New products

Industrial

### 10-channel RTD scanner sells for \$595

Getting temperature data from an array of resistance temperature detectors into a computer is not as simple as it might at first appear. First the RTDs must be excited, then their outputs must be amplified and linearized, and finally they must be converted to digital form and fed into the computer. Also, unless users want to use one computer per RTD, some form of multiplexing must be used at some stage or other in the proceedings.

The model SL115 RTD scanner is designed to perform all of the analog functions mentioned above, with a few extras thrown in for good measure. It will scan up to 10 detectors, thus performing the multiplexing function. It checks all of them for continuity and warns if a line is broken. It excites the devices, compensates for lead resistance, linearizes and amplifies the outputs, and

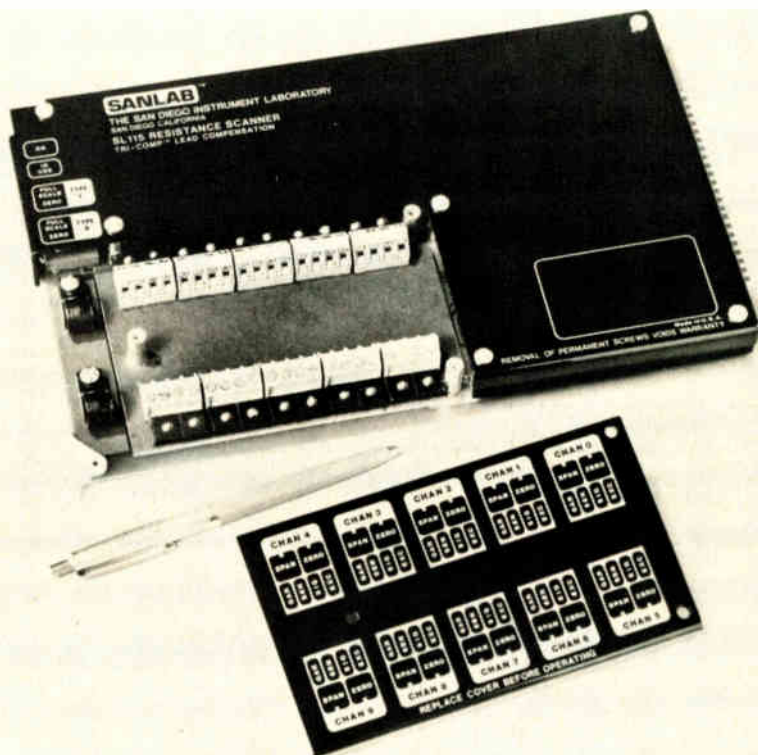
provides filtering to reduce noise. All this it does for a 10-piece price of \$595, or less than \$60 per channel.

Other key features of the SL115 are output sensitivities adjustable from 1 mv/°C to 100 mv/°C, individual zero-trim potentiometers for each channel, compatibility with transistor-transistor-logic voltage levels, and scan rates up to 20 channels per second. The board can accommodate two-, three-, and four-wire hookups while providing active common-mode-noise rejection. It plugs into a standard 6.25-inch card slot on 1-in. centers.

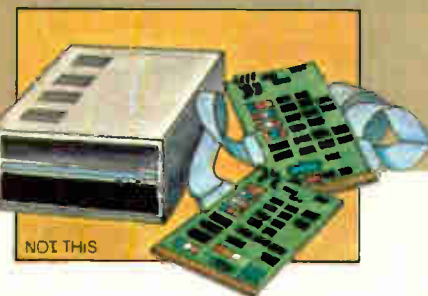
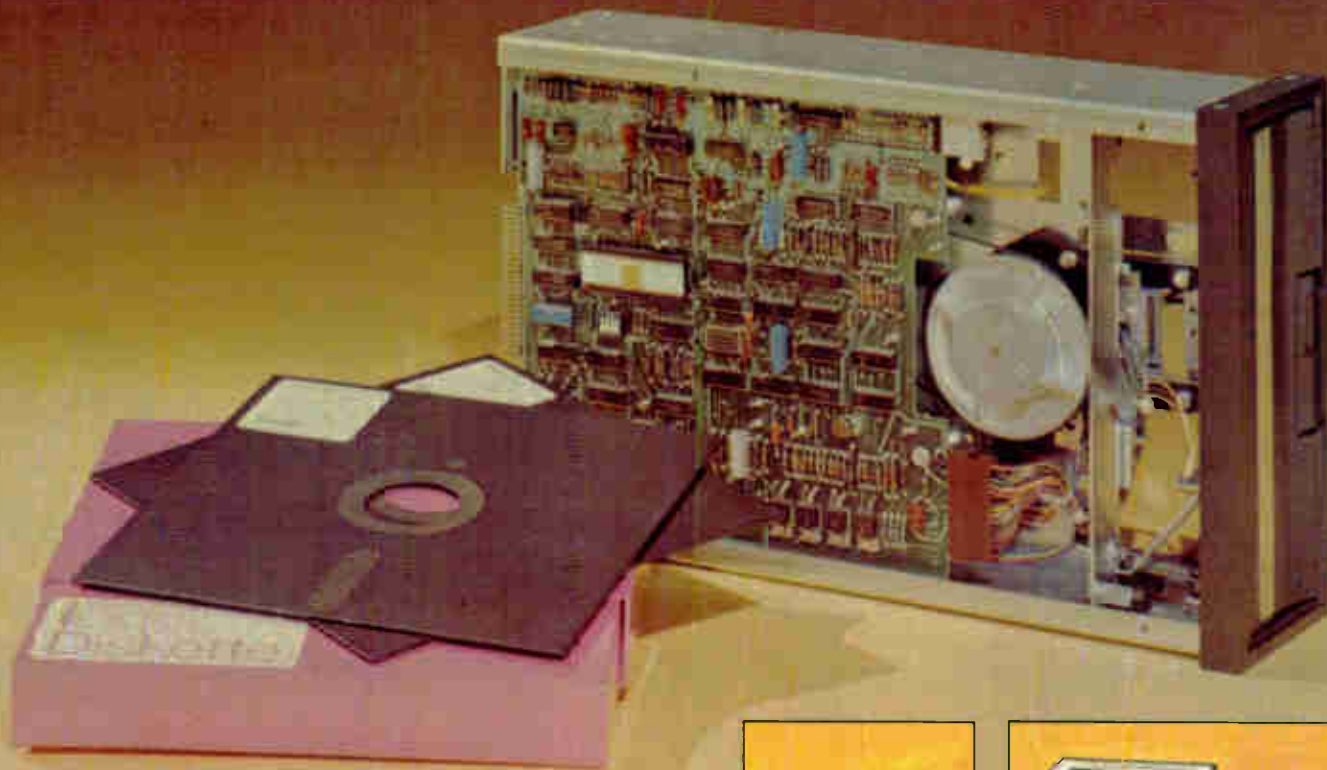
San Diego Instrument Laboratory, 7969 Engineer Rd., San Diego, Calif. 92111. Phone (714) 292-0646 [371]

### Matched thermistors work well in gas chromatographs

Suitable for use in gas-chromatographic equipment and other thermal-conductivity instrumentation, a series of matched thermistors is designed to operate in the self-heat mode. Typical units in the series are the G112, G126, and G128, with



# iCOM's Intelligent Floppy.



## Controller/Formatter built-in. Packaging problems designed out.

When designing a floppy disk into a compact microcomputer-based system, engineers have been plagued with the problem of where to mount the controller/formatter cards and associated cables.

Our new FD5200 Intelligent Floppy™ solves this packaging dilemma by mounting all circuitry, including the single chip LSI controller/formatter, as an integral part of the disk drive chassis. A neat idea!

The 8 bit bi-directional bus makes it simple to integrate the iCOM® FD5200 into any system. Accrued benefits include: reduced hardware costs, smaller size, shorter assembly time, easier software development, improved reliability and lower maintenance. A mighty impressive list!

### Compatibility to IBM 3740 Format... and Others

The special LSI controller/formatter chip provides the complex logic needed to write data on the diskette in IBM 3740 format—or other user selected formats as well. Another big plus is a phase-locked-loop for data and clock bit separation, and address word detection, which maximizes data reliability.

### Pertec Makes the Driving Easy...

Since a floppy disk drive system is only as good as the mechanics, we use our field proven Pertec drive with three step-per-track head positioning for better accuracy and the unique head retract system for longer media life.

### Why iCOM®?

iCOM® part of Pertec Computer Corporation, is one of the world's largest manufacturers of Microperipherals®. Thousands of our floppy disk systems are operating reliably in the field. And many major computer manufacturers have incorporated iCOM® floppies into their systems. Which means we deliver—and will be around to give you service whenever and wherever you may need it.

### Speaking of Delivery... and Price

Our new FD5200 Intelligent Floppy™ is available now at a unit price of just \$795. Naturally, OEM discounts are available.

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Electronics / November 24, 1977

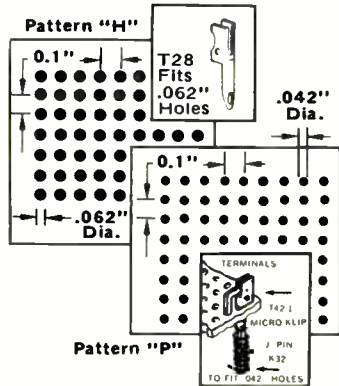
Circle 167 on reader service card

167

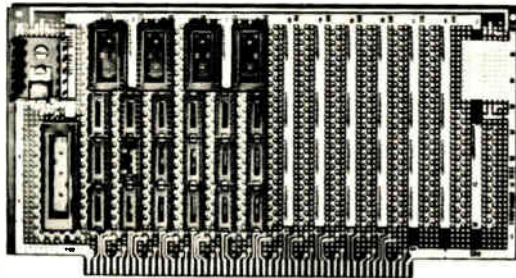
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Circle 168 on reader service card

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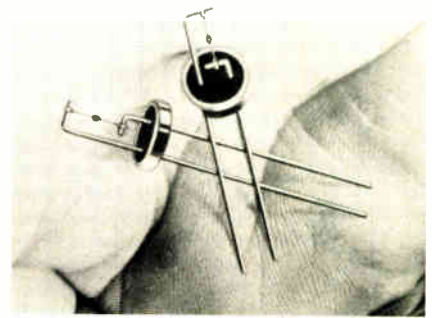
NICHICON AMERICA CORPORATION  
Division of NICHICON CAPACITOR LTD., Kyoto, Japan  
6435 N. Proesel, Chicago, Ill. 60645 (312) 679-6530



168 Circle 263 on reader service card

World Radio History

## New products



resistance values at 25°C of 8,000, 2,000, and 100,000 ohms, respectively. The thermistor beads are mounted on hermetic stems and are available with standard or custom housings.

Fenwal Electronics, 63 Fountain St., Framingham, Mass. 01701. Phone Nicholas Spiro at (617) 872-8841 [373]

Sealed load cell operates  
in tension and compression

A sealed load cell in the shape of an S beam is available in models that can handle both tensile and compressive loads from  $\pm 100$  to  $\pm 1,000$  pounds full scale. Maximum nonlinearity is 0.05% of full scale, and unidirectional hysteresis is 0.03% of full scale. Zero balance is within 1% of full scale, and the maximum temperature effect on the zero balance is 0.0008% of full scale per °F. Because they are sealed, units in the SSB301 family are unaffected by humidity, sand, or dust.

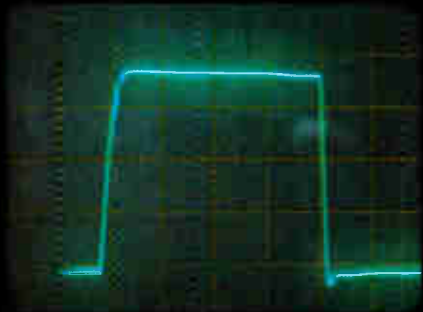
Celeco Transducer Products Inc., 7800 Deering Ave., Canoga Park, Calif. 91304. Phone Philip Gindes at (213) 884-6860 [375]

Pressure transducer has  
sensitivity of 25 mV/psi

EPG-400 series low-range pressure transducers are high-sensitivity devices that provide outputs as high as 25 millivolts per pound per square inch. Available with full-scale ranges from 2 to 50 psi, the transducers are hermetically sealed and are constructed of stainless steel. They can

Electronics / November 24, 1977

# How fast can you measure rise time, fall time and pulse width?



576867903

FUNCTION

TRIGGER STATUS

STATUS

GATE TIME MULTIPLIER

10

DANA SERIES 9000

MICROPROCESSING TIMER COUNTER

## Your way.

(About 5 minutes.)

1. Connect signal to scope.
2. Adjust trace intensity.
3. Adjust focus. 4. Select VOLTS/DIV range.
5. Select TIME/DIV range. 6. Adjust vertical gain to fill screen for location of 10% & 90% points. 7. Locate 10% point. 8. Locate 90% point. 9. Determine horizontal displacement between 10% & 90% points. 10. Multiply displacement by horizontal scale factor.

That's RISE TIME. Only 9 more steps and you've got PULSE WIDTH and FALL TIME.

## Our way.

(About 5 seconds.)

1. Connect signal.
2. Push  button for RISE TIME. 3. Push  button for PULSE WIDTH. 4. Push  button for FALL TIME.

The rest is automatic.

## Your move.

Give us a call and we'll tell you how the Dana 9000 Microprocessing Timer/Counter can solve your measurement problem the easy way.

# DANA<sup>®</sup>

**Others measure by us.**

Dana Laboratories, Inc., 2401 Campus Drive, Irvine, CA 92715  
Phone: 714/833-1234

Circle 264 for Product Demonstration  
Circle 169 for Literature Only

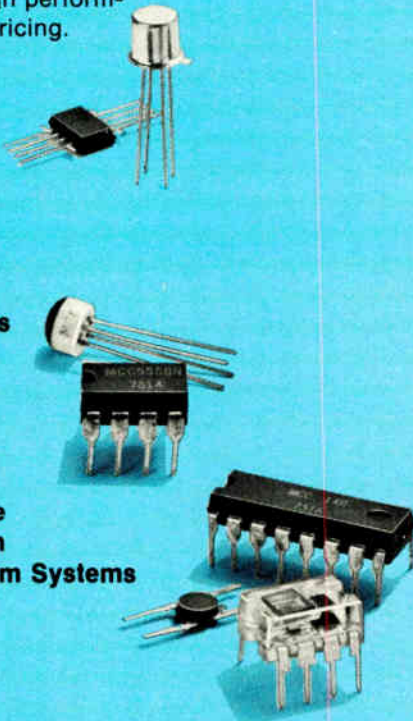
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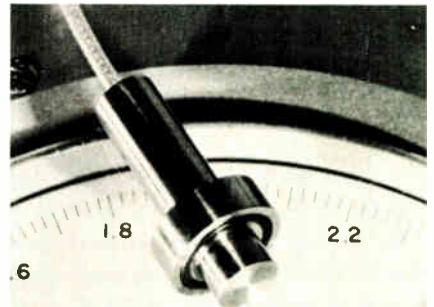


## MICRO COMPONENTS CORPORATION

99 Bald Hill Road • Cranston, R.I. 02920

Circle 170 on reader service card

## New products



therefore be used in some corrosive media.

The standard units are thermally compensated over the range of -40°C to 121°C and have nominal resonant frequencies of 10 kilohertz and above. Units with accuracies to within 0.25% and 0.50% of full scale are available. In small quantities, EPG-400 devices sell for \$395 each. Availability is from stock to four weeks.

Entran Devices Inc., 145 Paterson Ave., Little Falls, N. J. 07424. Phone (201) 785-4060 [374]

Bidirectional counter runs at 60,000 counts/minute

The model 7903 Countroller is a solid-state, bidirectional, predetermined counter that can handle rates up to 60,000 counts per minute. Fast, automatic reset is a standard feature, making the counter suitable for the control of machinery with fast recycle operations. Models with four or five digits are available. They use light-emitting-diode readouts 0.375 inch high for easy readability



Electronics / November 24, 1977

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# THE 'TELETYPE' MODEL 43: IT'S SO GOOD YOU HAVE TO SEE IT TO BELIEVE IT.



The Teletype model 43 teleprinter doesn't just look good. It works even better.

Delivering true 30-character per second throughput, upper and lower case printing in a 132-column format, the model 43 has an exclusive, Teletype-developed 9-wire matrix impact printhead mechanism. This unique feature provides superior service life as well as exceptional print quality, even on multiple copies.

Under the cover, we kept hardware and moving parts to a minimum for maximum reliability. Solid-state circuitry and only five modular components—plus a built-in test capability—mean service is not

only fast, but also simple.

What a lot of people have trouble believing, however, is the model 43's low price. Because whatever your application—time-sharing, data inquiry/response,

or communicating point-to-point over private line or the dialed switched network—the model 43 delivers printing quality, reliability and serviceability at an unsurpassed price/performance value. Plus it's compatible with systems incorporating model 33 terminals.

The Teletype model 43. No matter how you look at it, nothing even comes close.

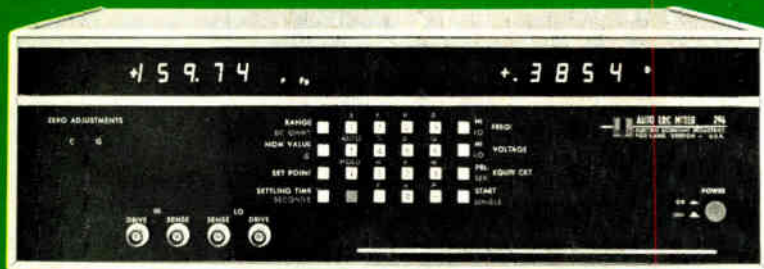


Teletype is a trademark and service mark registered in the United States Patent and Trademark Office.

World Radio History

Circle 171 on reader service card

# Testing low ESR Capacitors at 10 kHz/20 kHz



assures low "switching" power.

Due to its remarkable versatility, ESI's Model 296 Automatic LRC Meter now measures capacitors at 10 kHz or 20 kHz. You can quickly and accurately verify ESR to assure low power switching regulator power supplies. (As a dual frequency instrument the Model 296 is available with either of those higher frequencies, plus 1 kHz or 120 Hz as the second frequency.)

ESI's premier LRC tester gives you everything you could want—for now or the foreseeable future: Wide ranges, choice of any loss parameters—R, G, D or Q—with either L or C, direct reading or deviation display and field installable options. Options include dc resistance measurements and interfaces for GPIB, 11-bit serial bus, card readers and automatic handlers. Basic price (in the U. S. A. only) is \$5700.

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### New products

at distances up to 25 feet.

Most standard types of bidirectional input signal will be accepted by the 7903. Among them: 90° quadrature signals from rotary or linear encoders, two-line add/subtract signals, and two-line count/direction signals. Both reset-to-zero and reset-to-preset models are available from stock. A prewarning signal output is available as an option for such applications as the control of high-speed machines that must be slowed down before final shutoff.

Veeder-Root, 70 Sargeant St., Hartford, Conn. 06102. Phone (203) 527-7201, Ext. 422 [377]

### Temperature controllers

offer three types of output

Three new models of Pyromatic II temperature controllers provide three types of output, allowing them to cover many industrial heating and cooling requirements. The three types are dual-setpoint, dual-mode, and current-proportioning.

The dual-setpoint unit is designed for processes requiring primary and secondary levels of activation or for those in which a single instrument is required to control both heating and cooling in the same zone. The controller has two relay outputs—one for each setpoint.

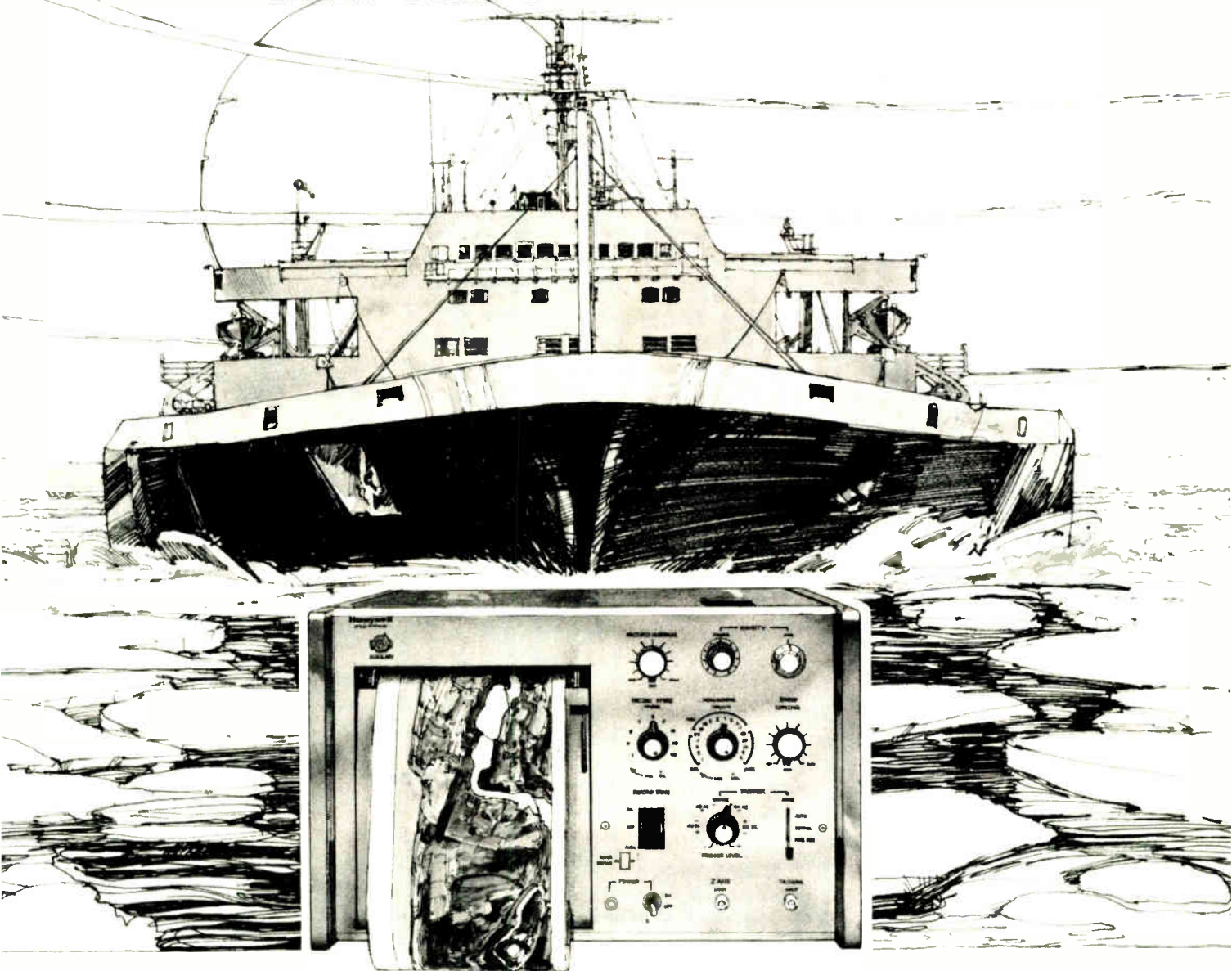
The dual-mode controller is intended for applications in which the temperature must be tightly controlled within a narrow range. It offers proportional control within a tight band and full-on or full-off control outside it.

For processes in which the Pyromatic II must operate valve actuators or SCR power controllers, the current-proportioning device delivers a 0-to-20-mA or 0-to-5-v output.

All of the new Pyromatic II controllers are solid-state devices, housed in DIN standard cases, and designed to work with thermocouples. They are priced from \$187 to \$264 each, depending upon model and quantity.

Anlor Instrument Co., 7301 N. Caldwell Ave., Niles, Ill. 60648 [378]

# OUR ICE-FLOE MAPS KEEP SHIPS OUT OF A JAM.



Ships threading their way through hazardous ice floes need all the help they can get. So aircraft equipped with infrared sensors and Honeywell 1856A Line Scan Recorders now patrol northern shipping lanes. Changes in thermal patterns detected by the sensors are converted by an 1856A into maps showing the current location of the floes.

The maps transmitted to ships provide a detailed look at ice conditions. And it is this ability to capture fine detail that explains the popularity of the 1856A. You can count on

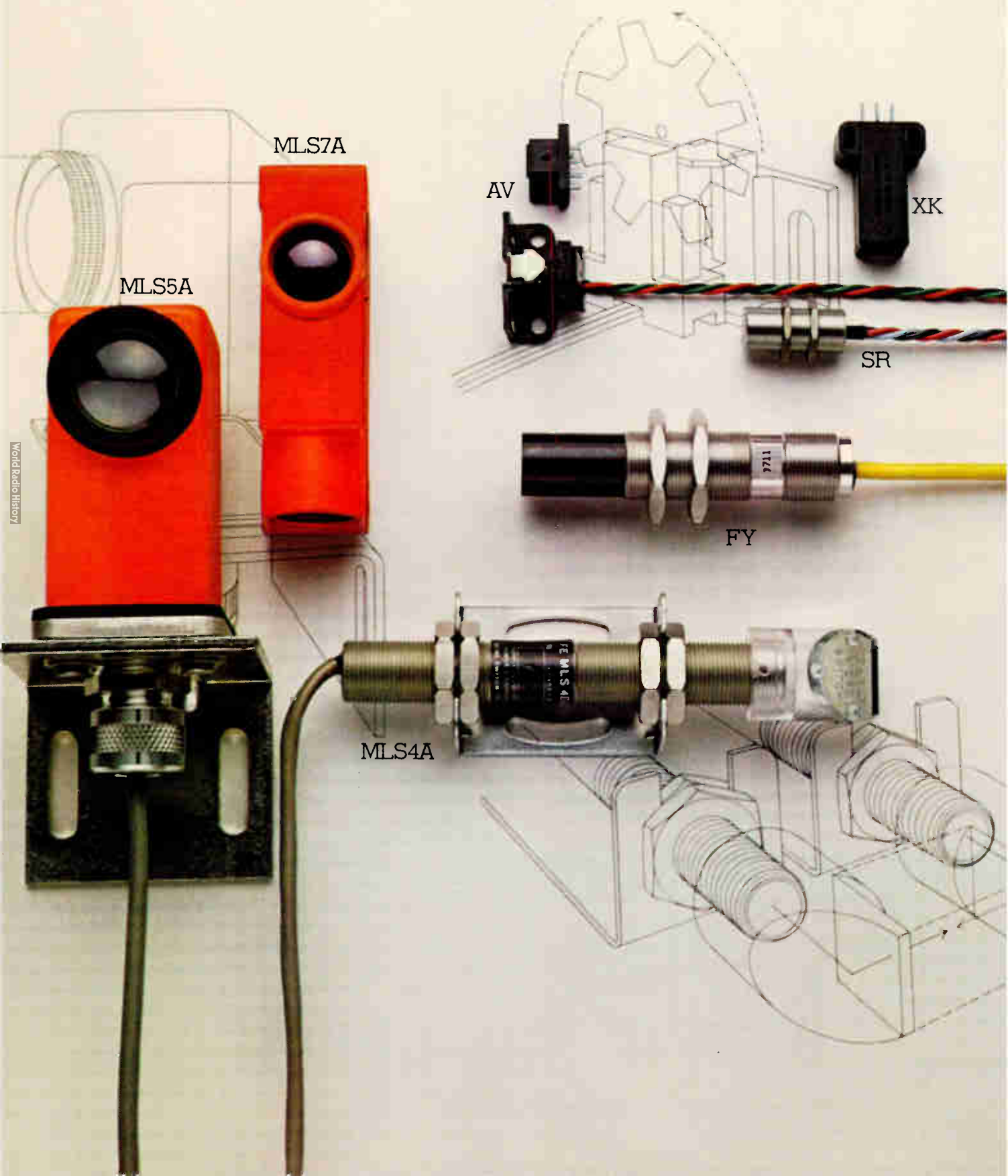
it for resolution greater than 100 line pairs per inch, scan rates up to 18,000 per second and high-performance 4-axis recording with a fiber-optic CRT. And that's just the beginning.

If your recording applications include sonar, IR or radar mapping and you need hard-copy readouts with exceptionally good contrast, don't overlook the 1856A. For complete details on this and other Honeywell instrumentation recorders, call or write: Bob Shipman, Honeywell Test Instruments Division, Box 5227, Denver, CO 80217. (303) 771-4700.

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are the ones

For years, MICRO SWITCH has been the leading maker of No Touch Controls.

That's because we're also leaders when it comes to listening to switching problems where mechanical devices just don't fill the bill. And then solving them with industry's broadest line of photoelectric and proximity controls.

For example, the ferrous-sensitive XK can detect metal targets of any thickness, either moving or stationary. There's also the vane-operated AV and the magnetically operated SR, both featuring dependable Hall-effect technology and high speed operation unaffected by dust and dirt.

You can also choose from a wide selection of solid state FY proximity sensors designed to be directly compatible with programmable controllers and solid state logic. These self-contained controls have models ranging from .14 mm diameter to 76 mm.

For materials other than metals or where distances are too great for proximity switches, MICRO SWITCH offers a complete line of photoelectric controls.

At shorter distances, choose from MLS4A controls with a range of 8 feet or MLS7A controls that can go up to 10 feet. Both are DC powered and use advanced integrated circuitry to increase reliability.

There are also models with much greater scanning ranges, like the high intensity MLS5A that goes up to 250 feet in clean air and through dust, smog, steam and other pollutants at shorter distances.

Another model provides a scanning range up to 700 feet.

And whether you need proximity or photoelectric controls, you'll be getting solid state design that delivers long life. Which is what you've come to expect from the leading maker of No Touch controls.

MICRO SWITCH will provide you with field engineers for application assistance and a network of authorized distributors for local availability. Write us for details or call 815/235-6600.

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FREEMONT, ILLINOIS 61032  
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## New products

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Packaging & production

### Software aids pc-board design

---

Program reduces design cycle, cuts errors and documentation cost

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Traditionally, the most time-consuming portion of integrated-circuit-based product development has been the design cycle—specifically, the packaging of the functions, their placement on a printed-circuit board, and the routing of interconnections. In recent years, in attempts to shorten the cycle, various portions of the cycle have been automated and brought under computer control.

Now, a new software package completes a minicomputer-based stand-alone system that is capable of automating all three elements together and reducing design cycles by as much as 50% has been developed by Calma Co.

Called Tridesign, the computer software package operates on Calma's interactive graphics systems to perform the packaging, placement, and routing of component pin assignments and circuit traces, according to E. W. Emmerich, a vice president for marketing. The software, used with a Calma interactive graphic system, produces the artwork that is needed for complex two-sided and multilayer boards.

Until now a large part of the pc-board design process had to be done manually, Emmerich says. Using a large central computer, much of the preliminary artwork drafting and all of the design and logic testing remained a manual task. Even with an interactive graphics system such as Calma's, circuit routing and device placement and layout, as well as design checking, still had to be done by hand.

With Tridesign software installed in a graphic data system, the only manual task is data entry. After that, Tridesign provides computer

support for design review, component packaging and placement, iterative design improvement, device and terminal pin assignments, sub-grid optimization, placement analysis, strategy routing, and exhaustive search-routing.

Initial data entry is also greatly simplified with Tridesign, according to Emmerich. Input required is just the logic diagram for the circuit, the geometry and dimensions of the board itself, and a list of devices to be mounted. If the devices are pre-entered, they can be recalled by part number; if not, device specifications can be used as the entry data.

After data is entered, Tridesign allows the operator to review and verify the data and to check the circuit rule violations, such as pin numbers used twice, pins missing, too many or too few connections, and the like.

The packaging cycle automatically assigns logic blocks to one or more component packages that perform the logic function. Placement of the packaged components is then done according to parameters that the user can adjust to suit circuit requirements. After automatic placement is completed, the operator can use the software to examine the layout and experiment with swapping parts to shorten net lengths.

The strategy-router program in Tridesign includes an algorithm that gives fast routing of most connections, using a strategy that minimizes circuit congestion on the board. The exhaustive search-router uses another algorithm to complete the routing of signal and power nets on the pc board.

The overall effect of using Tridesign, according to Emmerich, is a significant reduction in design time, documentation costs, and processing errors. A primary benefit, however, is the improved accuracy and efficiency of the resulting pc-board design brought about by the error-checking and optimization techniques available in Tridesign that are generally not feasible with other systems, Emmerich says.

Available now, the Tridesign software package ranges in price from

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Santa Clara, CA (408) 735-8300.

Circle 176 on reader service card

World Radio History

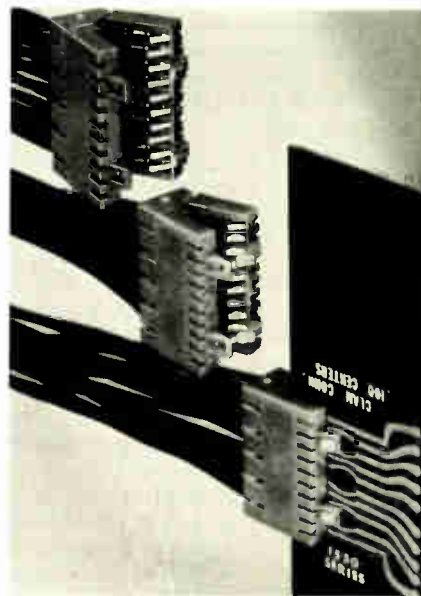
## New products

\$75,000 to \$100,000, depending on configuration.

Calma Co., 707 Kifen Rd., Sunnyvale, Calif. 94086 [391]

### Zero-force connector for pc boards needs no gold

Called the Clam connector, a zero-insertion-force unit for use at the edges of printed-circuit boards is snapped closed after insertion to develop from three to four times the loading force of standard connectors. The higher loading permits reliable connection to be made to solder-plated edge contacts, making gold plating unnecessary.



Contacts on the Clam are tin-plated brass on 0.100-inch centers. The standard insulator material is 94V2 nylon, but a material that conforms to 94V0 is also available.

Methode Electronics Inc., Dept. PR, 1700 Hicks Rd., Rolling Meadows, Ill. 60008. Phone (312) 392-3500 [393]

### IC failure analyzer uses laser to cut conductors

The model LFA destructive-failure-analysis system is designed to aid in the study of failure modes of small-

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# EMI/RFI FILTERS

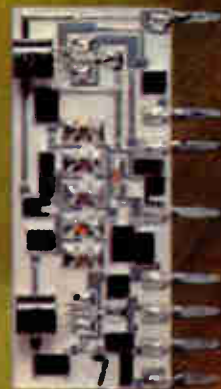


## Passive Filter Headquarters:

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Introducing the 920-D logic analyzer. Nine channels, 20 MHz and much, much more.



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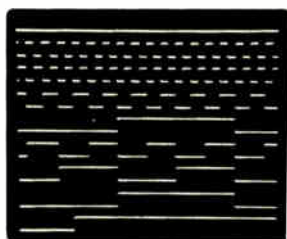
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Don't let the low price mislead you. Biomatron's new 920-D stands up to logic analyzers costing twice, even three times as much. It includes the features engineers ask for most. And combines them with 91½ pound portability, making the 920-D an ideal field troubleshooting tool.

Nine channels—not just eight—give you added capability for more applications. Use the extra channel for recording data, or to mark a trigger location. And select between trigger or clock qualifier. Attach the optional Biomatron 10-TC probe pod and you can select up to a 19-bit combinational trigger word.



The 920-D enables you to set a precise interval between the actual trigger and the start of recording, using either clock periods or number of trigger events. Or the pre-

trigger recording mode can be selected to capture data from before the actual trigger. The logic threshold level is selectable—TTL, ECL or variable. And you can record at rates from DC to 20 MHz.

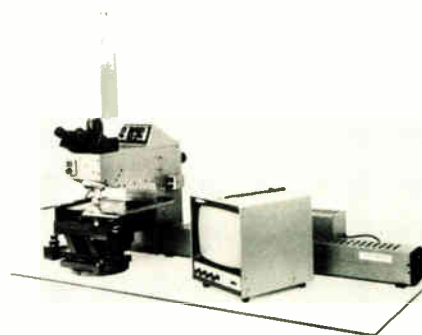
Captured data, at 256 bits per channel, can then be displayed on any single channel scope or CRT display in timing diagram format.

What more can we tell you? Plenty. Ask for the 920-D product sheet. Or give us a call to arrange a demonstration. Ask for Ed Jacklitch (408) 255-9500. Or write Biomatron, 10411 Bubb Road, Cupertino, CA 95014.

**biomatron**

Circle No. 177 for information.  
Circle No. 178 for information and demonstration.

## New products



geometry, high-density integrated circuits. It uses a pulsed xenon laser to sever the aluminum conductors on silicon wafers or chips where mechanical cutters would be too crude. It thus allows parts of the circuit to be isolated from each other until the faulty part has been determined.

The complete LFA system includes the pulsed xenon laser, a Leitz Dialux microscope head, a TV viewing system, and a probe station. It sells for \$39,000.

Florod Corp., 3341 West El Segundo Blvd., Hawthorne, Calif. 90250. Phone Marty Compton at (213) 679-8201 [392]

## Laser system examines wafers for surface defects

An automatic surface-inspection system designed primarily for use in the semiconductor industry employs a laser to monitor wafer surface quality before and after critical processing steps. The system makes a quantitative determination of the defect level by measuring the amount of laser light scattered by scratches, hillocks, spikes, fingerprints, foreign particles, and other imperfections. During inspection, the laser beam traverses the wafer surface in an Archimedes spiral. This allows it to cover the entire surface of a 5-inch wafer in 4 seconds. To check

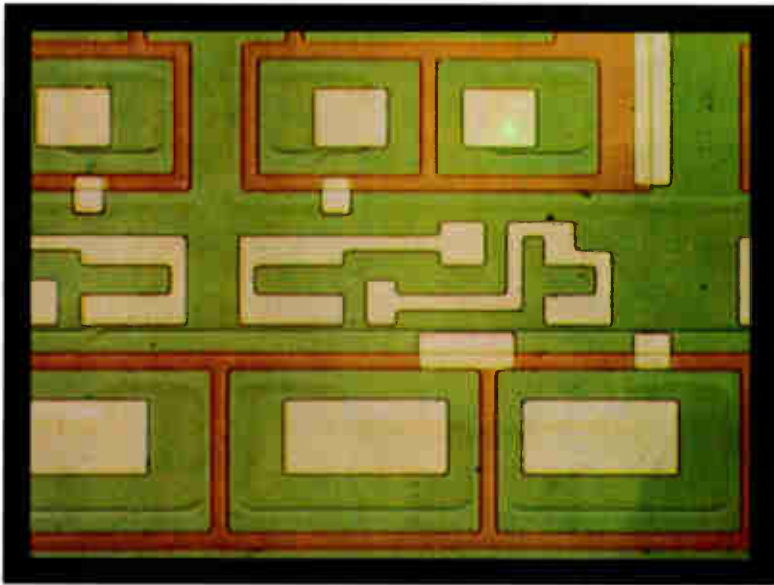


Electronics/November 24, 1977

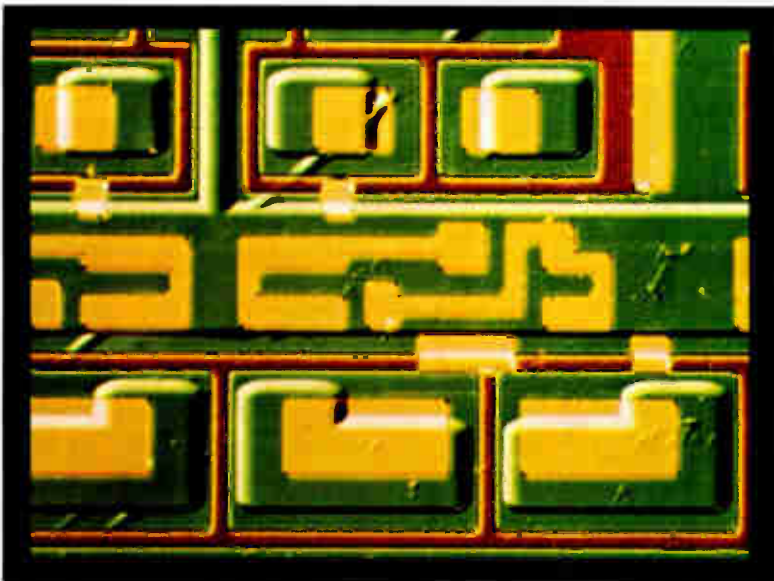


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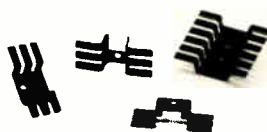
## New products

patterned wafers at any stage up to metalization, the system has a memory that stores data on standard clean wafers and compares this data with that generated by the wafer under test. The system has a delivery time of 12 to 14 weeks.

Advanced Semiconductor Materials/America, 4302 E. Broadway, Phoenix, Ariz. 85040. Phone (602) 894-1274 [394]

Low-profile heat sinks provide extra surface area

A series of low-profile heat sinks have wing-like radiators that increase their total surface area and thus their cooling ability. The units are particularly well suited for mounting on circuit boards where high-density placement of plastic-packaged power devices makes cooling a critical problem.



For applications requiring even more cooling, the 5071 unit may be stacked for multiside cooling of devices mounted in TO-220 cases. A sample assortment of the four heat sinks in the new line is available for prototyping and evaluation.

Aavid Engineering Inc., 30 Cook Ct., Laconia, N. H. 03246. Phone (603) 524-4443 [395]

Taping machine makes axial-lead components from radial

A fast axial-lead taping machine for disk capacitors and other radial-lead devices automatically removes the radial-lead components from Die Craft or other types of strips on which they are shipped, straightens and trims the leads, forms them into

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Augat developed it to give engineers a quick and easy way of evaluating the exciting new technique of fiber optic interconnection in their existing or prototype systems. The price

give you all you need to know to use it... even assuming no prior experience in fiber optics.

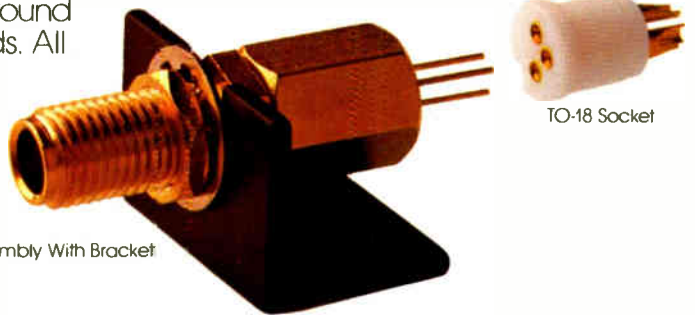
The kit contains a 5-meter length of Hytrel†-jacketed cable terminated with ferrules that have precision ground and polished ends. All connector

5 mbps over a temperature range of 0 to 55°C without drifts or inadvertent comparator switching usually associated with non-temperature referenced pre-amps.



Cable Assembly

Detector Assembly With Bracket



TO-18 Socket

is right.\* And the kits are in stock at Augat's nearly 200 worldwide distributor locations.

The combination of the kit's driver, emitter, cable assembly, pre-amp, and detector provide the necessary elements for a complete TTL-compatible digital fiber optic system. We've even included mounting brackets and sockets for convenience. And its comprehensive instruction manual will

elements feature gold-plated brass construction to ensure the integrity of shielded enclosures.

The temperature referenced pre-amp operates from dc to

All components of the kit are available separately. Standard accessories include butt splices, o-ring seals, and cables of other lengths. For more details and a list of Augat distributors, write Augat, Inc., 33 Perry Avenue, P.O. Box 779, Attleboro, Mass. 02703.



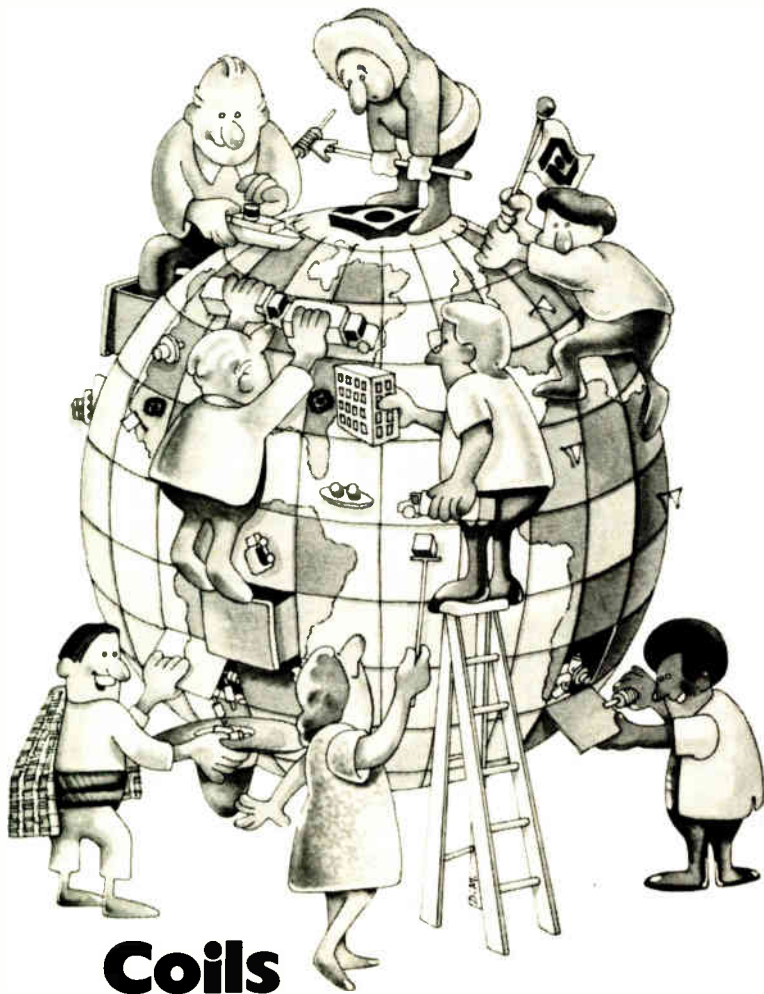
Driver and Pre-amp Modules

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Augat interconnection products, Isotronics microcircuit packaging, and Alco subminiature switches.

\*Complete Kit (No. 698-OK-002) \$190. Kit less: driver and pre-amp (No. 698-OK-C01) \$99.50

†DuPont trademark



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## New products

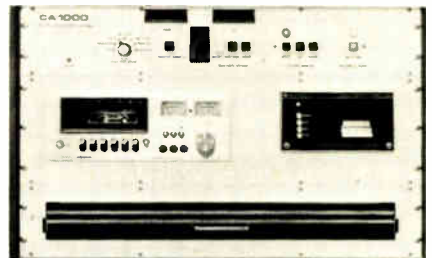
an axial configuration, and applies them to double lead tape on 0.2- or 0.4-inch spacing. The result is components ready for use in conventional sequencing and inserting machines.

The Discap Taper is a self-contained floor-mounted unit. It can handle disk capacitors with head diameters from 0.25 to 0.375 in. and lead spacings from 0.25 to 0.375 in. Continuous-feed reels are available as an option. The standard machine sells for \$24,475.

Cambridge Automatic Division, Eyelet Tool Co., 15 Erie Dr., Natick, Mass. 01760. Phone Dave Spencer at (617) 653-9002 [396]

## Analyzer checks continuity on bare or loaded boards

A circuit analyzer and test fixture combined in one package can check bare or loaded circuit boards, wired backplanes, and cable harnesses for shorts and opens. The analyzer, which programs itself from a known-good unit, can handle products up to 24 by 26 inches with up to 10,240



test points. Designated the CA-1000 circuit analyzer, it displays all its activity to the operator in real time.

Options for the tester include a printer that shows errors by printing out the opens in black and the shorts in red and a cassette deck for program storage.

Program Data Inc., 16752 Hale Ave., Irvine, Calif. 92714. Phone (714) 549-0335 [397]

## Impedance tester sorts components automatically

The GR 1658 Digibridge is an automatic, microprocessor-based, key-

# BergLance™ Wire-Wrapping Posts give a classic performance on the Lowrey Organ.

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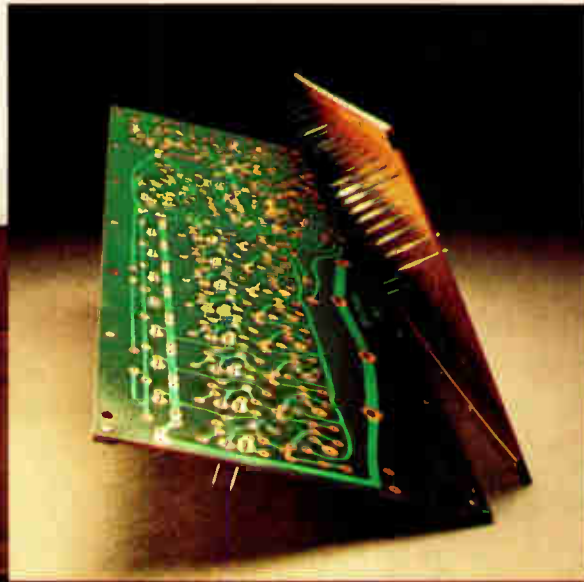
Lowrey likes it, and has used millions of BergLance posts throughout the past decade. Lowrey has found it can rely on Berg Electronics . . . to supply the product and the application machines that precisely meet its interconnection needs.

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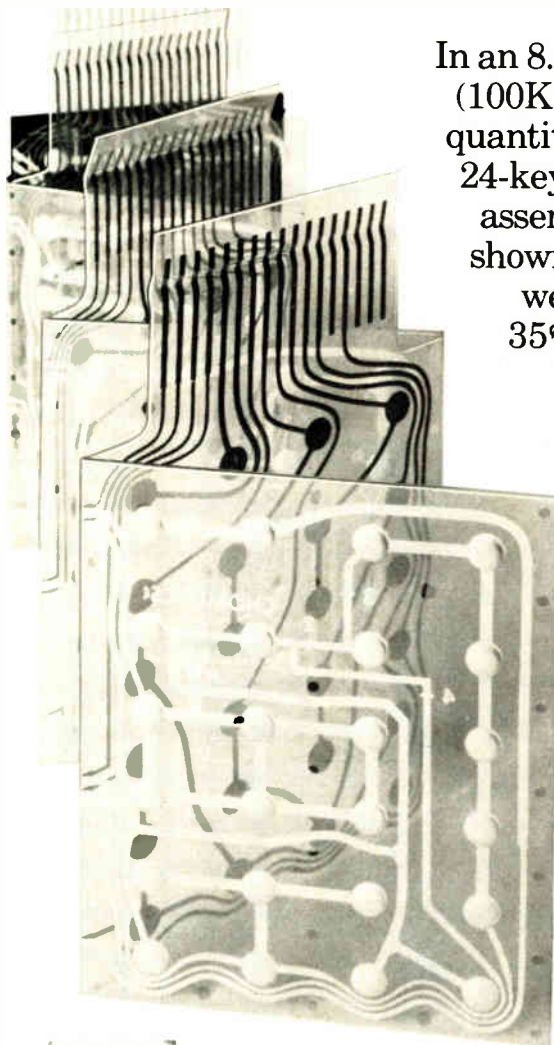
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## New products



board-controlled, impedance-measuring component tester that measures the resistance, capacitance, inductance, dissipation factor, and Q factor of various components at selectable frequencies of 120 Hz and 1 kHz. No calibration is normally required to keep the instrument within its basic maximum-error specification of 0.1%.

A novel feature of the 1658 is its provision for 10 limit-comparison bins for sorting. Both symmetrical and asymmetrical limits can be entered through the keyboard.

The machine can run in three test modes: continuous, single, and average. The average mode is useful for unstable components or noisy environments, since it can reduce errors by averaging 10 successive measurements. Three selectable display modes show either the measured values, the bin number, or the programmed limits for any bin. An IEEE 488 bus interface option provides the means for connecting the 1658 to a parts handler, a printer, or a bench-top calculator system. The 1658 sells for \$1,985.

GenRad Inc., 300 Baker Ave., Concord, Mass. 01742. Phone Thomas A. Bergendahl at (617) 369-4400 [398]

High-barrier terminal strips come in five colors

A selection of thermoplastic high-barrier terminal strips rated to handle 20 A at 600 v is available in five colors: red, green, black, blue, and off-white. The units have a 94V-0 UL listing.

Kulka Electric Corp., 520 S. Fulton Ave., Mount Vernon, N. Y. [399]



# Higher efficiency at lower cost. New VLEDs from Texas Instruments.

Compare quality. Compare performance. Compare price. Then switch to a leader and pioneer in optoelectronics, Texas Instruments. To make your changeover easier, TI uses the original Hewlett-Packard part designations. And TI offers higher brightness "A" versions.

The new TI high-intensity VLEDs are available as presented in the chart to the left. Higher efficiency at lower cost. Also available are red, yellow and green VLEDs in T-1 and T-1 $\frac{3}{4}$  sizes with wide angle, narrow angle and clear lenses.



Color	Package	TI P/N	Min. $I_f$ @		Texas Instruments 100 pc. price	Hewlett-Packard 100 pc. price
			$I_f = 10$ mA	$I_f = 20$ mA		
Yellow	T-1 $\frac{3}{4}$	5082-4550	1.0 mcd		.43	.52
Yellow	T-1 $\frac{3}{4}$	5082-4550A	2.6 mcd		.43	—
Red	T-1 $\frac{3}{4}$	5082-4650	1.0 mcd		.43	.52
Red	T-1 $\frac{3}{4}$	5082-4650A	2.6 mcd		.43	—
Green	T-1 $\frac{3}{4}$	5082-4950		1.0 mcd	.43	.52
Green	T-1 $\frac{3}{4}$	5082-4950A		2.1 mcd	.43	—
Yellow	T-1 $\frac{3}{4}$	5082-4555	2.2 mcd		.77	.85
Yellow	T-1 $\frac{3}{4}$	5082-4555A	3.9 mcd		.77	—
Red	T-1 $\frac{3}{4}$	5082-4655	3.0 mcd		.77	.85
Red	T-1 $\frac{3}{4}$	5082-4655A	3.9 mcd		.77	—
Green	T-1 $\frac{3}{4}$	5082-4955		2.2 mcd	.77	.85
Green	T-1 $\frac{3}{4}$	5082-4955A		6.0 mcd	.77	—

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VLED data sheets for all TI optoelectronics products are available on request. Applications Notes. A 32-page booklet on VLED applications including such topics as filter selection for VLEDs, display interface with the TMS 8080A system, VSWR indicator using VLEDs.

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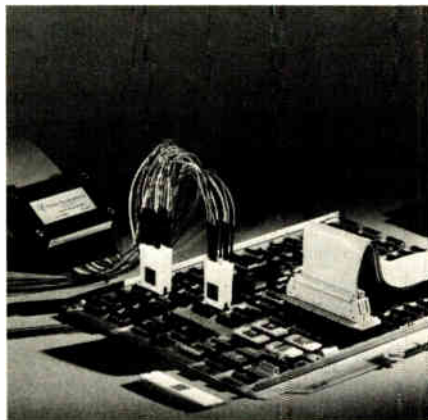
Now, you can move from hardware breadboarding through finished application software with confidence. And with the efficiency possible only with state-of-the-art support. Best of all, you can do it for hundreds or even thousands of dollars less than with other development systems.

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velop hardware designs that fully complement your software needs. This new development system combines the power of the computer with the latest logic-signal analysis techniques.

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The AMPL Lab is ideal for software development in both FORTRAN and assembly language. FORTRAN provides increased support for your benchmark evaluations, general-purpose engineering data processing and data reduction. The combined capabilities give you fully integrated software and hardware emulation for straightforward debugging, testing and firmware implementation.

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The AMPL Microprocessor Prototyping Lab and the 9900 Microprocessor Family are available at your nearby TI distributor. Call him today. Or write Texas Instruments Incorporated, P.O. Box 1444, M/S 784, Houston, Texas 77001. Or call Computer Systems Marketing at (512) 258-7305.



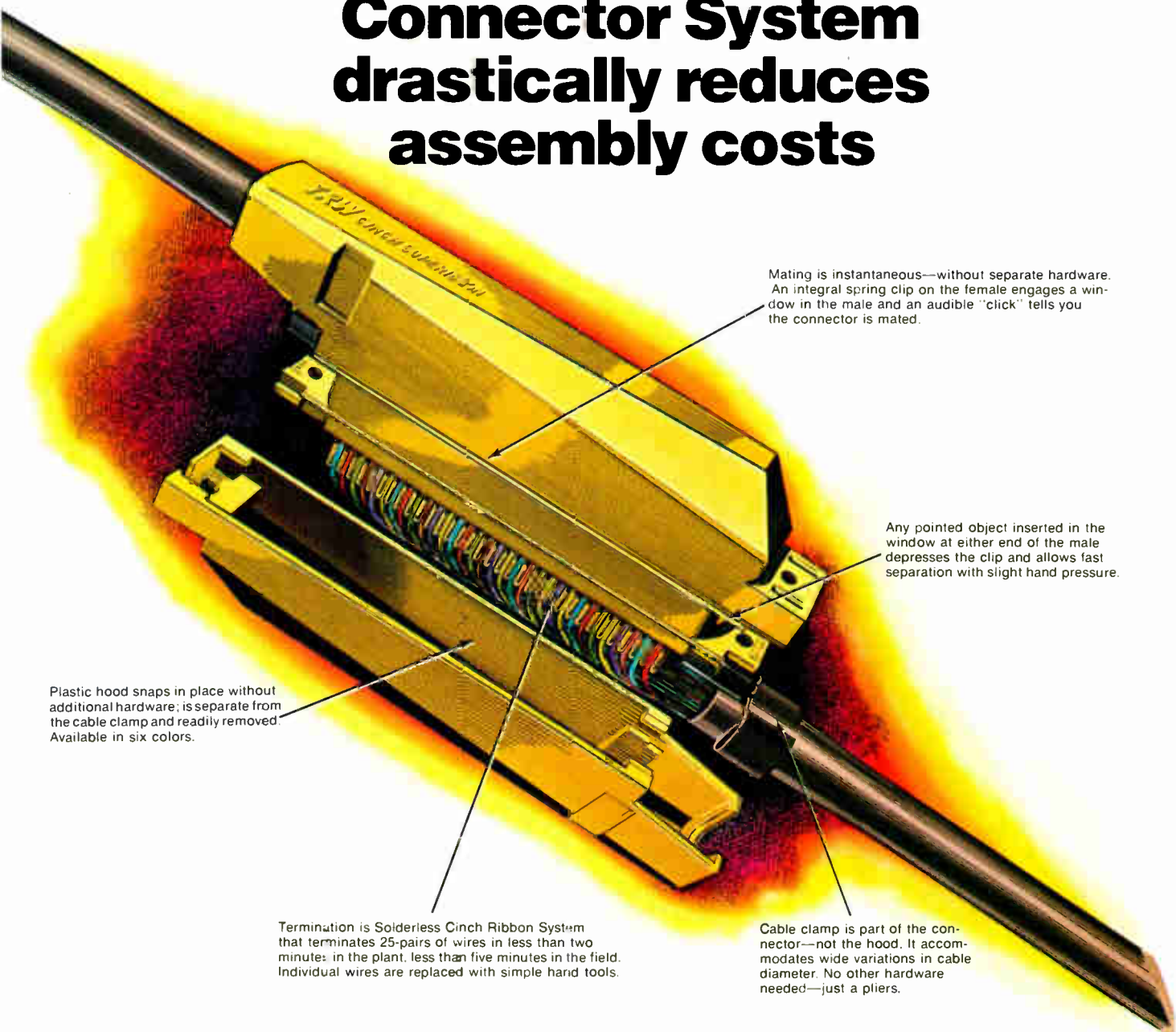
\*Trademark of Texas Instruments

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# New **SUPERIBBON**<sup>\*</sup> Connector System drastically reduces assembly costs



Mating is instantaneous—without separate hardware. An integral spring clip on the female engages a window in the male and an audible "click" tells you the connector is mated.

Any pointed object inserted in the window at either end of the male depresses the clip and allows fast separation with slight hand pressure.

Plastic hood snaps in place without additional hardware; is separate from the cable clamp and readily removed. Available in six colors.

Termination is Solderless Cinch Ribbon System that terminates 25-pairs of wires in less than two minutes in the plant, less than five minutes in the field. Individual wires are replaced with simple hand tools.

Cable clamp is part of the connector—not the hood. It accommodates wide variations in cable diameter. No other hardware needed—just a pliers.

Everything about the TRW Cinch Connectors' Superribbon System is new—except the industry-proven ribbon contact! Here are some of its other "super" design features:

- Fast panel mounting with clips that eliminate nuts, bolts, tapped holes and special tools.
- Wire restraints replace cable clamps for panel connectorization. They restrain each wire individually, at point of termination.
- Two-piece, center-entry hoods allow assembly after termination. Built-in spacers provide for four sizes of cable openings.
- Dimensions that permit intermating with or replacement of all ribbon connectors now in use.

Superribbon connectors are available in 14, 24, 36, 50 and 64 contact sizes, each with 90° and 180° hoods. Buff gold is standard color for connectors and hoods. Other hood colors are blue, orange, green, brown and slate.

For additional information, contact any TRW Electronic Components sales office or TRW Cinch Connectors, An Electronic Components Division of TRW Inc., 1501 Morse Avenue, Elk Grove Village, Ill. 60007. Phone 312/439-8800.

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<sup>\*</sup>TM TRW Inc.

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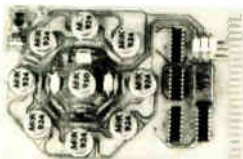
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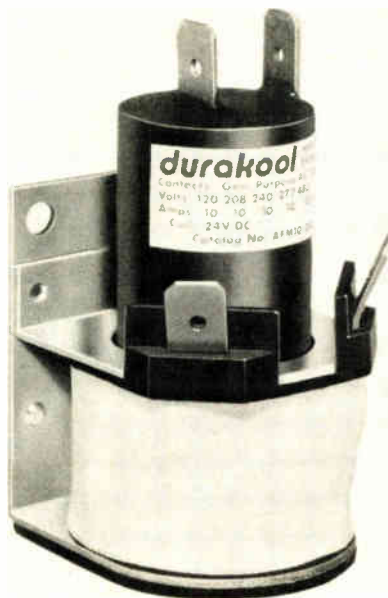
188 Circle 188 on reader service card

## New products

Components

### One-pole, 20-A mercury relay sells for \$6

A single-pole mercury-displacement relay, which sells for less than \$6 in large quantities, is available in models rated at 10, 15, and 20 A. The units are Underwriters Laboratories-tested at 480 v. The AFM relays are general-



purpose devices with lifetimes in excess of 100,000 cycles. They have all-steel hermetic bodies enclosing a high-pressure arc-suppressing gas, which dissipates heat rapidly and eliminates erosion. The units are therefore suitable for use in hot, humid, wet, contaminated, and explosion-prone atmospheres.

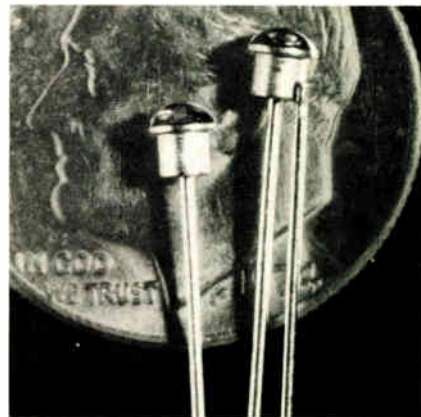
The relay is small for its type: it measures 1.25 by 2.375 by 1.313 in. Its silent mercury-to-metal contacts eliminate burning and welding, common causes of contact failure in conventional electromechanical relays.

Delivery of the single-pole unit is from stock. Two- and three-pole versions of the AFM are expected to become available in the near future, according to the company.

Durakool Inc., 1010 N. Main St., Elkhart, Ind. 46514 [341]

Light-emitting diode  
has 180° viewing angle

The OSL-1 and OSL-1S gallium-phosphide red light-emitting-diode lamps are extremely small devices with a typical luminous intensity of 1.1 millicandelas at 15 mA and a viewing angle in excess of 180°. Both lamps are packaged in a metal coaxial header; the OSL-1 has one lead, and the OSL-1S has two. The lamps can be driven by transistor-transistor-logic voltage levels. They sell for 90 cents each in hundreds

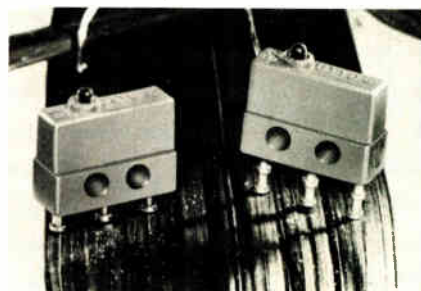


and 60 cents each in thousands.

Opcoa Division, IDS Inc., 330 Talmadge Rd., Edison, N. J. 08817. Phone (201) 287-0355 [344]

Tiny snap-action switch  
handles 7 A at 115 V ac

Although it is only 0.5 inch long and 0.2 in. wide, the B2 series snap-action switch is rated at 7 A at either 115 v ac or 28 v dc. Five terminal styles are offered, as is a choice of



Electronics/November 24, 1977

Unlike fabricated metal, GE Engineering Structural Foam can show a beautifully simple side plus an incredibly complex side together, in one piece.

Take the outside. In GE Engineering Structural Foam resin, the total effect is a clean, integrated, contemporary look. And it stays that way with excellent impact, heat or chemical resistance. Yet, while the

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That's because GE Engineering Structural Foam is so rigid, strong and stable, it supports internal components and assemblies all by itself. Costly secondary parts, materials and operations are eliminated. What's more, GE Engineering Structural Foam is double-insulated and can meet UL 94 V-O\*. Best of all,

its simple one-step molding process eliminates metal's numerous, costly production steps, and its lighter weight reduces shipping costs.

For more information, write Structural Foam Resins Section 300, Plastics Division, General Electric Company, One Plastics Ave., Pittsfield, MA 01201.

Or talk to NCR, TRW and Datapoint.

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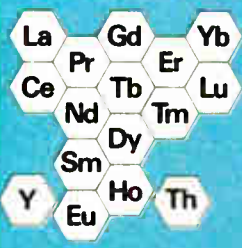
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## New products

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contact materials. The standard switch comes with silver contacts and sells for \$1.93 when purchased in 100-piece lots. A unit with gold contacts for low-level and dry-circuit switching is also available. Delivery is from stock to six weeks.

Otto Controls Division, Otto Engineering Inc., 36 Main St., Carpentersville, Ill. 60110. Phone Ronald E. Sparks at (312) 428-7171 [346]

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### Modular rotary switches are easily modified

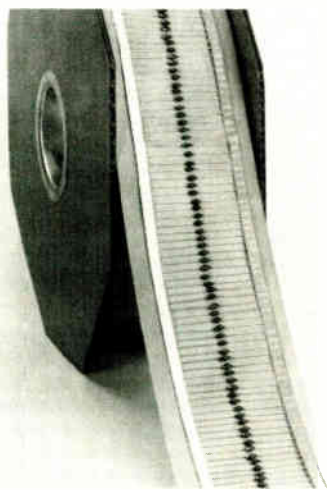
Modular rotary switches that offer the user options of assembling switches from building-block parts or ordering custom-made components can also be easily modified when necessary. Designed to control currents up to 55 A at voltages as high as 750 v, the switches may be assembled with up to six stages. Each of the stages can have multiple contacts actuated by an independent cam.

Cogenel Inc., Entrelec Division, 2 Ram Ridge Rd., Spring Valley, N. Y. 10977. Phone (914) 425-7460 [343]

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### Tantalum capacitor has 4-mm diameter, 10-mm length

Type EL solid-tantalum capacitors are very small components for use in hand-held calculators, cameras, and similar miniature commercial



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elements.



KERAMAX high temperature furnaces and LaCrO<sub>3</sub> heating elements excel where others pale by delivering higher working temperatures in oxidizing atmospheres with stability, durability, simple operation and a lower cost/service life ratio.

KERAMAX developed by Nippon Kagaku Togyo Co., Ltd. provides a new level of performance at the highest working temperatures, whether for R&D, materials testing or production.

#### Furnace Applications

- Growing single crystals of (for example), ferrite for VTR heads • High temperature properties measuring • Ceramics sintering • Metal and slag heat treatment

#### KERAMAX LaCrO<sub>3</sub> Elements

- Longer service life at higher working temperatures in oxidizing atmospheres • Lower cost/service life ratio • Near zero resistance temperature coefficients at high temperatures; negligible electric resistance change due to aging • Excellent sensitivity and stability for precise temperature control; easy operation • Automatic control ease • Allows direct electricity supply at room temperature • Silicon carbide power units applicable for KERAMAX
- Suitable for use as light source and electrodes

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Shinagawa-ku, Tokyo 141, Japan

Tel: 03-494-0471 Telex: TOK 2467455 NISMRAJ

## New products

products. The smallest unit in the family has a working voltage of 4 v dc and measures only 4 mm in diameter by 10 mm in length. Other voltage ratings include 6.3, 10, 16, 25, 35, and 50 v dc. Available capacitances range from 0.1  $\mu$ F to 47  $\mu$ F.

The resin-dipped, axial-lead components are available either loose or in reels of tape for use with automatic insertion equipment. They are rated for operation from -55°C to 85°C and have a capacitance tolerance of  $\pm$  20%.

Panasonic Electronic Components, One Panasonic Way, Secaucus, N. J. 07094. Phone Justin Camerlengo at (201) 348-7182 [345]

## HP expands its line of light-emitting-diode lamps

An expanded line of light-emitting-diode lamps, including a high-brightness T-1 version and an inexpensive rectangular unit, has been announced by Hewlett-Packard Co. The high-brightness lamps are the red HLMP-1302, which has a minimum luminous intensity of 2.0 millicandelas at 10 mA; the yellow HLMP-1402, which is rated at 2.5 mcd at the same current; and the green HLMP-1502, which puts out 2.0 mcd with a 20-mA drive. In hundreds, the high-brightness lamps will sell for 75 cents each. HP will continue to offer its present medium-brightness lamps (1.0 mcd for red and yellow, 0.8 mcd for green) at 50¢ and some new low-brightness (0.5-mcd) units at 40¢.

The new low-cost rectangular lamps (HLMP-0300/0400/0500 for red, yellow, and green, respectively) are electrically identical to the older high-performance rectangulars, but not as bright. They sell for 60¢ each in hundreds compared to 90¢ for the brighter HLMP-0301/0401/0501. These lamps will be most appropriate for use with relatively high drive current. All are available from stock.

Inquiries Manager, Hewlett-Packard Co., 1507 Page Mill Rd., Palo Alto, Calif. 94304 [347]

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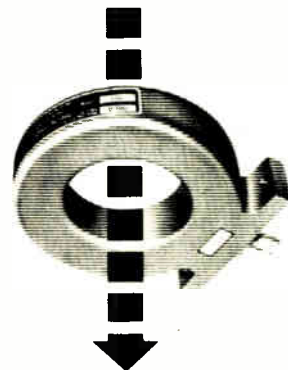
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## Wide Band, Precision CURRENT MONITOR

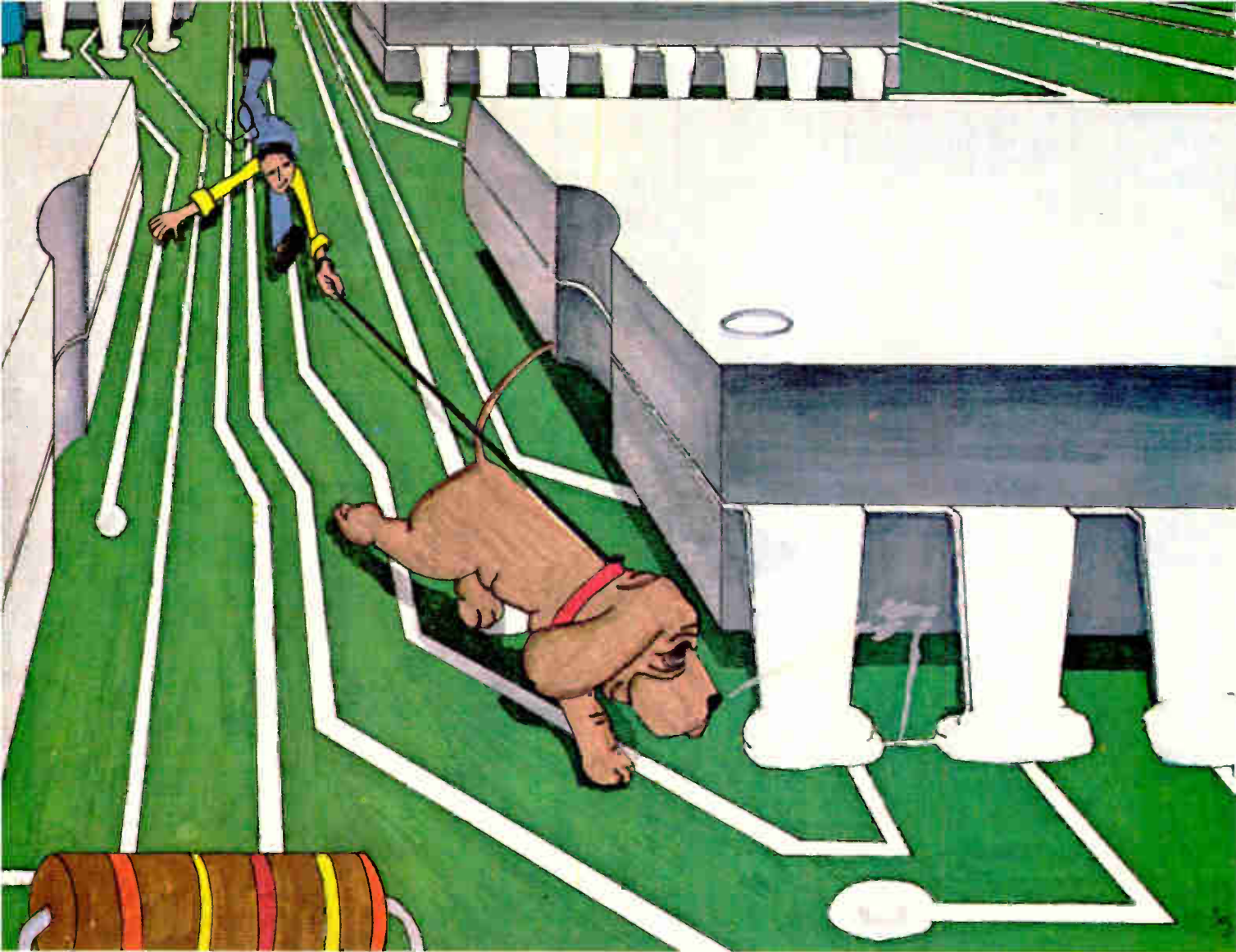
With a Pearson current monitor and an oscilloscope, you can measure pulse or ac currents from milliamperes to kiloamperes, in any conductor or beam of charged particles, at any voltage level up to a million volts, at frequencies up to 35 MHz or down to 1 Hz. This video monitor is physically isolated from the circuit. It is a current transformer capable of highly precise measurement of pulse amplitude and waveshape.

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**PEARSON ELECTRONICS, INC.**

4007 Transport St., Palo Alto, California 94303, U. S. A.

Telephone (415) 494-6444



# Track Down Your Faults With A Bug Hound.



The GenRad 2220 Bug Hound will track down your shorts, opens, bad ICs, etc. in a fraction of the time it takes you now, **including those hard-to-find shorts between power and ground.**

Even though your automatic board tester may be giving you good diagnostics, it is still only telling you the **electrical** location of the faults. Finding the **physical** location can still be a time-consuming and expensive task. The GenRad 2220 Bug Hound solves this problem by providing the repair technician with a variety of testing techniques in one self-contained little package.

It has a unique new phase-sensitive current-tracing probe\* which makes it easy to trace the correct track even when many narrow tracks are running very close together. In addition, it has a dc tracing capability, a connectivity tester, an ac current source, and a dc current source.

The GenRad 2220 is easy to use and in most applications will pay for itself in just a couple of weeks.

\*Patent Pending

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Electronics / November 24, 1977



## GenRad

Circle 193 on reader service card 193

  
**Isotronics**

**Aerovox**  
INDUSTRIES, INC.

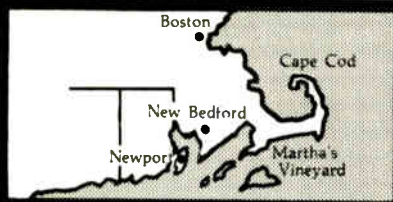
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## New products

### Instruments

## Meter resolves 0.1 microhm on 1-m $\Omega$ range

Designed to provide fast and accurate measurements on large transformers, switch gear, circuit breakers, and similar low-resistance devices, the model 4275 digital ohmmeter can resolve 0.1 microhm on its lowest (1-milliohm) range. The 4½-digit instrument has a test current of 10 amperes on its most sensitive range and features a minimum compliance voltage of 10 v dc.

It has six decade ranges, from the low of 1 milliohm up to a high of 100 ohms. Among the options available for the 4275 are automatic temperature compensation, binary-coded-decimal data outputs, and heavy-duty, industrial-grade, gold-plated Kelvin clip cable sets up to 20 feet long. These convenient cable sets easily attach to lugs while providing for accurate and repeatable measurements. The basic instrument sells for \$2,495.

Valhalla Scientific Inc., 7707 Convoy Ct., San Diego, Calif., 92111. Phone (714) 227-2732 [351]

### Logic pulser delivers 10 mA in TTL mode

The DP-1 digital pulser is a logic-probe-like device that monitors the node being probed, presets its output circuitry to pulse the node into the opposite state, and delivers the pulse when its pulse button is pushed. The unit delivers 50 mA in its C-MOS mode and 100 mA in its TTL mode, so



it can usually force the node into the desired state without any necessity for the user to desolder, unplug, or otherwise isolate the node.

When the pulse button is given a brief push, the pulser delivers a single pulse. If the button is held down for more than about 1 second,







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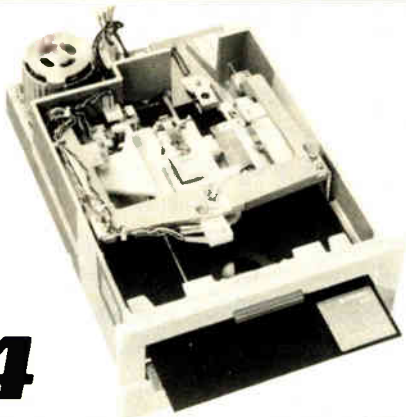
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For complete information, contact The Bendix Corporation, Electrical Components Division, Sidney, New York 13838.

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# Our YD-174

## 2-Sided Single/Double Density Floppy Disk Drive Has a Lot Going for It.

We are talking about meaningful advantages.  
The kind which spells higher profitability for OEM.

Manufactured by Y-E Data, Japan's OEM diskette drive market leader, the low-cost YD-174 provides a storage capacity of 0.56/ 1.2 M bytes. It's compatible with single-sided IBM 3740/System 32 drives, 2-sided IBM 3600/4964 drives and 2-sided double density IBM System 34 drive.

The YD-174 features a 2-sided head carriage assembly, standard ceramic R/W/tunnel erase head and flexured mounting arrangement. A simple/precise steel belt drive assures high reliability.

Contact C. Itoh for complete information on the YD-174 and entire Y-E Data product lineup.

### Specifications

Capacity			
unformatted	0.8/1.6 M bytes/disk	Transfer rate	250/500K bits/sec
IBM format	0.56/1.2 M bytes/disk	Access time	
Recording density	3408/6816 BPI	track to track	4 ms
Track density	48 TPI	settling	20 ms
		Head Load Time	50 ms

Also available. \* Key to Floppy Data Entry System (IBM 3740 series compatible)  
\* Termi-Pen (Codeless I/O terminal)  
\* Program Loader Mini (Digital Signal to/from audio signal, loaded in audio cassette recorder)

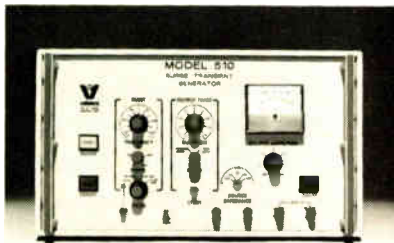


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198 Circle 271 on reader service card

### New products

markers. The markers can be adjusted, by means of front-panel controls, in both bandwidth and amplitude. They are accurate to within 0.005%. Delivery time for the 1061 is 30 days.

Wavetek Indiana Inc., 66 N. First Ave., Beech Grove, Ind. 46107. Phone Mario Vian at (317) 783-3221 [354]

Digital correlator has  
20-MHz sampling rate

The model SAI-48 digital signal analysis correlator and averager is a high-speed instrument that provides real-time processing of signals in three primary modes: correlation, enhancement, and probability. In its correlation mode it can calculate and display both auto- and cross-correlation functions. In its enhancement mode its principal function is to aid in signal recovery. And in its probability mode it computes density and distribution functions.

Key features include a maximum sampling rate of 20 megahertz, 800 points of pre-computation delay, and digital exponential averaging. The SAI-48 can also capture single-shot phenomena and has the capability to post-process computed functions. Unit prices begin at \$12,900.

Honeywell Test Instruments Division, P. O. Box 5227, Denver, Colo. 80217. Phone Frank Kasper at (303) 771-4700 [356]

30-kV power supply  
has reversible polarity

By withdrawing an interlocked plug on its rear panel and replacing it in the alternate position, the user of a 30-kilovolt power supply can reverse the polarity of the output voltage. The Wallis-Ionex S series unit delivers 1 milliampere over its range of 100 v to 30 kv dc. Its line regulation, load regulation, and ripple are all within 0.01%. The unit sells for \$890.

General Ionex Corp., 19 Graf Rd., P. O. Box 3001, Newburyport, Mass. 01950. Phone (617) 462-7147 [357]

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## New products

Communications

### 3-in-1 modem provides direct phone link

A microprocessor-controlled modem from Vadic Corp. automatically recognizes and communicates with the Vadic VA3400 modems, as well as with the Bell System's 103 and 212 modems. The new three-in-one modem, the model VA3467, also connects directly to switched telephone lines, thus eliminating the need to rent a data-access arrangement from the phone company.

The VA3467 is aimed at time-sharing firms and companies that must support 1,200-bit-per-second dial-up operations and have data-communications networks with different-type modems at remote sites. And since it offers direct connection to a single phone line, split rotors are eliminated.

The VA3467 is compatible with three distinct configurations: Vadic's VA3400 (1,200 b/s full duplex), Bell's 103 (300 b/s full duplex), and Bell's 212 (1,200 b/s full duplex). It

**The direct connection.** Seven-inch-high chassis houses eight VA3467 modems including built-in data-access arrangements.

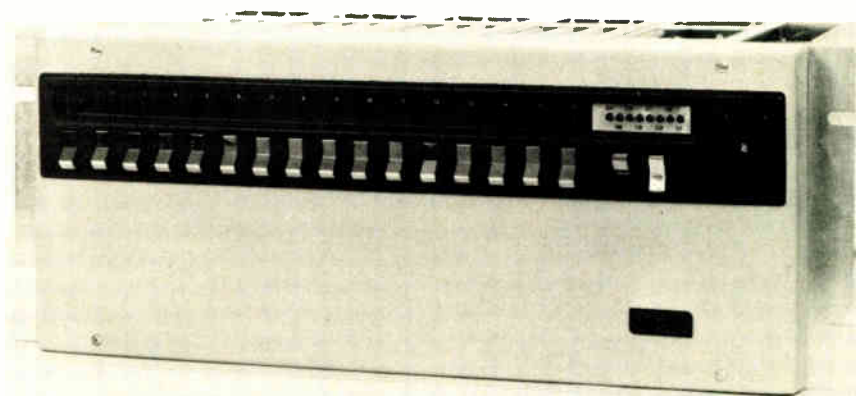
has an automatic-recognition sequence that identifies any of those calling modems without disturbing normal connect protocols—terminal-interface operation is completely transparent to the actual modem used. Another feature is the VA4367's ability to continuously test itself by turning on its transmitter, switching its receiver to the same carrier frequency, and sending a scrambled mark into the transmitter.

Other versions are available for those who do not need all three capabilities. The VA3427 combines a VA3400 and a Bell 212; the VA3437 supports a VA3400 and a Bell 103. The VA3467 is priced at \$850, the VA3427 and VA3437 at \$800 and \$700, respectively, in single units, with shipments starting in January 1978. They can be purchased from the company or leased through General Electric's Instrumentation & Communications Equipment Service group.

Vadic Corp., 222 Caspian Dr., Sunnyvale, Calif. 94086 [401]

### 75-ohm delay lines cover 0 to 2,075 nanoseconds

A line of inductance-capacitance video delay lines contains 10 variable-delay units. The 75-ohm devices have delay ranges of 0 to 10.5 nano-





## The General Purpose **EXPLORER II**

**New digital oscilloscope for low-frequency, high precision signal measurement.**

EXPLORER II is an oscilloscope in every sense of the word—for use in the same way as other oscilloscopes. It has the same sweep controls, trigger controls and amplifier controls.

What makes it different is its precision and enormously improved waveform storage capability. EXPLORER II is a digital oscilloscope. Because of this and careful human engineering, a dozen old operating problems have just disappeared.

**Great Storage:** Storage occurs at the touch of a button. The captured waveform has the same quality as live waveforms — amazing quality. There is no trace fading or blooming. If you wish, you can tuck the waveform away, out of sight, for later recall and continue to use the oscilloscope for other things in the meantime. Storage at the touch of a button means more than saving operating steps. It means no blank screen before storage.

**Automatic Persistence:** The EXPLORER always displays the last signal waveform until the next signal occurs, even when signals occur only rarely. There are no adjustments or mode switching.

**CRT Independence:** No longer is accuracy dependent on the cathode-ray tube. True voltage and time numerics for any selected point end that problem. The numbers can show differences in both times and voltages, for two selected waveform points. Accuracies and resolution are an order of magnitude greater.

**Write-through Storage:** At the touch of a switch, both live and stored waveforms are shown superimposed. This is far better than split-screen storage, which shows a stored waveform in one area of the screen and live waveforms in another. Write-through storage allows you to see changes as small as 0.025% while they are happening!

**Dual Beam:** EXPLORERS with two-channel plug-ins are "dual beam". Both signals are accepted together. There is no need for alternate sweeps or chopped sweeps.

**Cursor Triggering:** It used to be that all you could see on a 'scope was the result of an event. With EXPLORER you can see what caused an event to happen. Move the vertical marker line to any desired position. In the cursor trigger mode, this will be time zero, the time the sweep trigger occurs. The trace shows you what happened before and after the trigger.

**Easy Operation:** It's as difficult to describe the "feel" of EXPLORER II as it is to describe the feel of a great sports car to someone who has only driven "soft" passenger cars. But once you've had an hour or two of familiarization and used this new digital 'scope you'll know. You'll never want to go back to anything else.

### **EXPLORER III**

Identical to EXPLORER II, this unit incorporates an added module that contains a magnetic disk memory and a digital input/output port. To document waveforms for future reference, the diskette preserves the accuracy and resolution of the original. There is no compromise as with a photo document. For computation, the digital I/O allows interface to computers and calculators, also IEEE 488 interface.

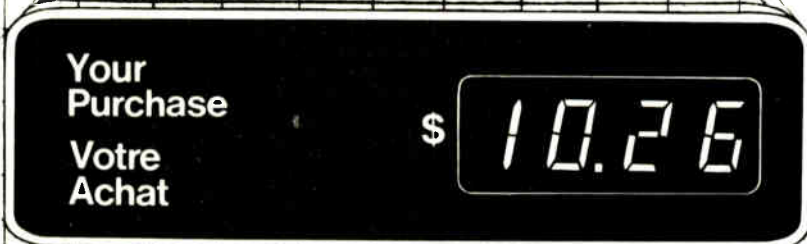
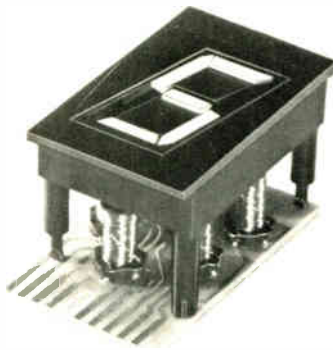


**See It Demonstrated.** To really appreciate either of these new 'scopes you have to see them in action. For complete details, including descriptive brochures, send the reader service card or call Jim Bartosch at 608/271-3333.

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Telex: 06-22007

202 Circle 202 on reader service card

## New products



seconds in 0.5-ns steps up to 0 to 2,075 ns in 25-ns steps. The delay lines are available in models that can be controlled by toggle switches, rotary switches, and strappable terminals. They provide essentially flat operation out to 5.5 megahertz. Prices for single units start at \$55.

Allen Avionics Inc., 224 East 2nd St., Mineola, N. Y. 11501. Phone (516) 248-8080 [403]

**520-MHz frequency counter sells for only \$450**

The model 1850 frequency counter is a six-digit instrument with a range of 5 hertz to 520 megahertz and a price tag of only \$450. The instrument, which will typically read to 650 MHz, has a period mode for high-resolution measurements in the range from 5 Hz to 1 MHz.



Fully autoranging in both its normal and prescale modes, the counter automatically positions its decimal point and indicates whether the reading is in kilohertz or megahertz. It is built around a temperature-compensated crystal-controlled time base.

B&K-Precision, 6460 W. Cortland Ave., Chicago, Ill. 60635. Phone (312) 889-9087 [405]

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**VS**

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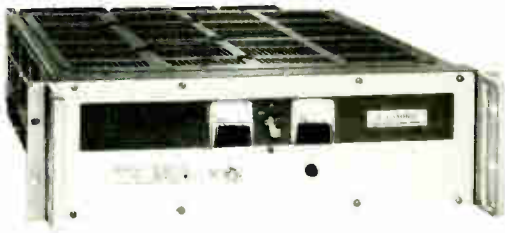
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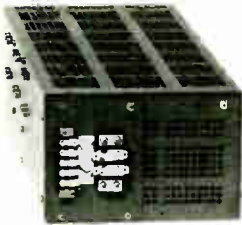
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**70%  
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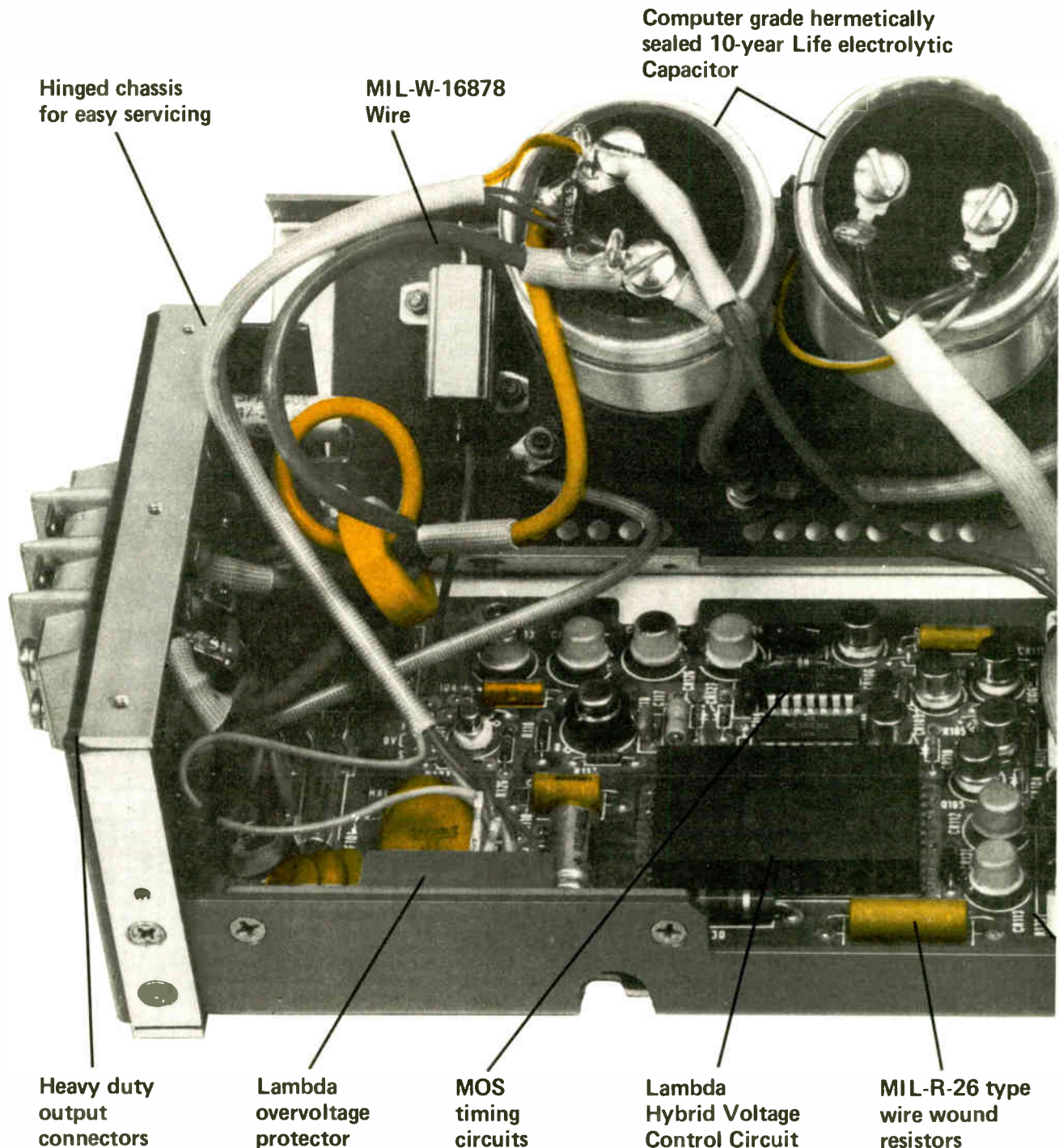
LJS-10 110/220 VAC 130-160 VDC INPUT



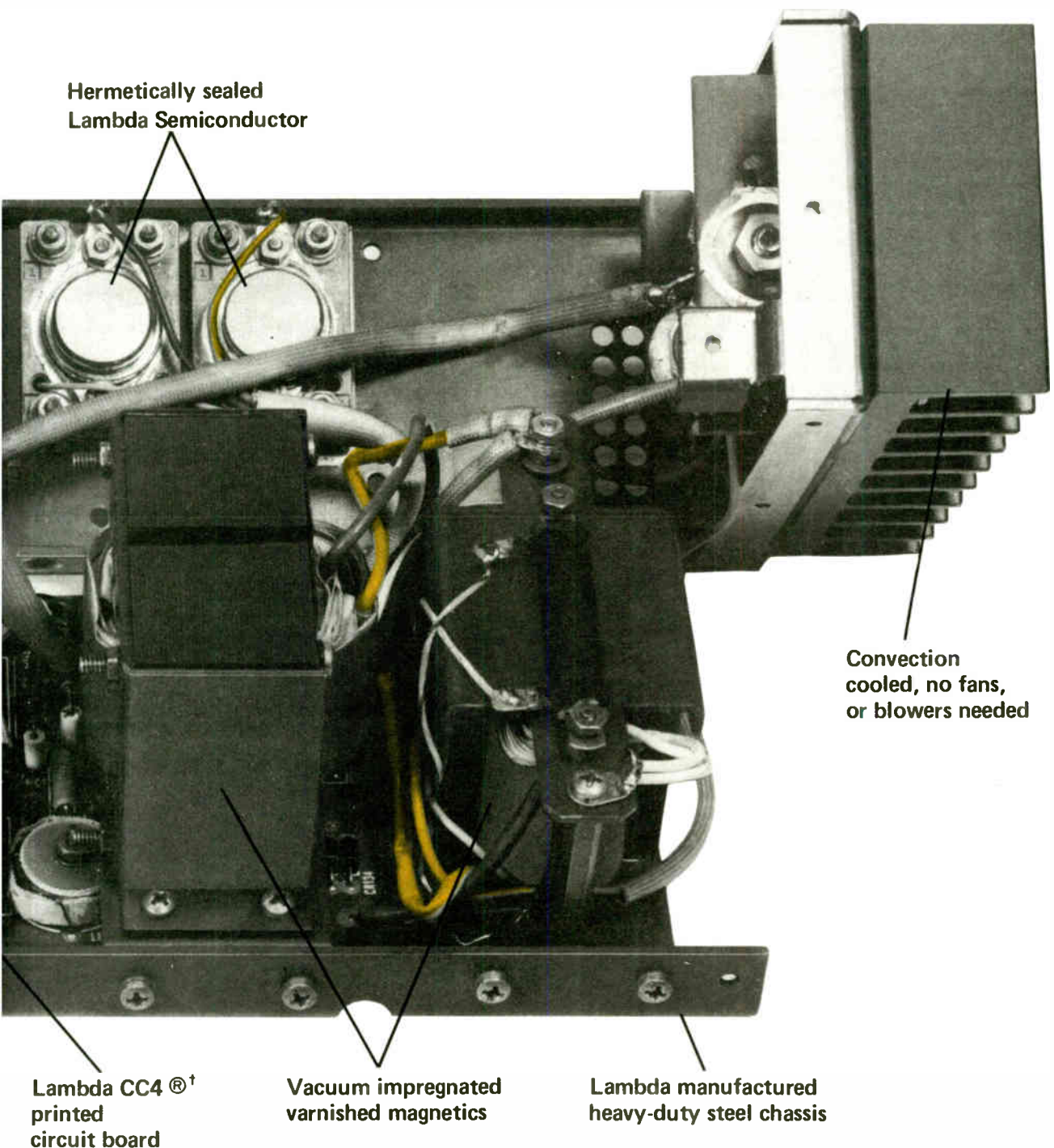
**60%  
Efficiency  
\$157**

LJS-13 110/220 VAC 130-160 VDC INPUT

# Here's why Lambda LG series the most advanced switching



# switching power supplies are power supplies in the world.



## Features of LG Series

- 91 models, 3 package sizes
- up to 110 Amps, up to 28 volts
- input 20.5-32, 44-58 VDC as well as 105-132 VAC/187-242 VAC/205-265 VAC
- hi-reliability obtained thru new advanced circuitry
- less than 120 components for LGS-5  
less than 140 components for LGS-6  
less than 160 components for LGS-EE
- convection-cooled, no fans or blowers needed
- meets mil spec MIL-I-6181D EMI conducted
- designed to meet MIL-STD-810B
- efficiency up to 75%
- density up to 1.2 watts/cu in
- 5 year guarantee
- serviceability—designed for ease of field repair
- built-in 0V shuts down inverter and crowbars output voltage
- power failure hold-up time (see curve)
- fungus proofing standard
- 20 KHz switching
- vacuum varnished impregnated transformer
- hermetically sealed Lambda semiconductors
- listed in UL recognized component index
- CSA certified

## Features of LJ Series

- 56 models, 4 package sizes
- up to 30 amps, up to 28 volts
- 20 KHz switching
- built-in 0V shuts down inverter and crowbars output voltage
- efficiency—greater than 70%
- convection-cooled, no fans or blower necessary
- serviceability—designed for ease of field repair
- power failure hold-up time: 16 msec
- AC input 105-132/187-265 VAC
- reg-0.4%
- ripple—10 mV rms
- listed in UL recognized component index
- guaranteed for 5 years

# Voltage and Current Ratings

## AC INPUT 105-132 VAC STANDARD

### 5 VOLTS ± 5% ADJ

MODEL	REGULATION (line load)	RIPPLE mV (RMS)	MAX AMPS AT AMBIENT OF				PKG SIZE	DIMENSIONS (Inches)	PRICE
			40 °C	50 °C	60 °C	71 °C			
LJS-13-5-0V	0.4%, 0.4%	10	5.0	5.0	4.0	2.8	13	4 3/4 X 1 25/32 X 6 5/16	\$140
LJS-10-5-0V	0.4%, 0.4%	10	10.0	10.0	8.0	5.5	10	4 3/4 X 1 25/32 X 7 15/16	202
LJS-11-5-0V	0.4%, 0.4%	10	20.0	20.0	16.0	11.0	11	4 3/4 X 4 5/16 X 7 15/16	247
LJS-12-5-0V	0.4%, 0.4%	10	30.0	30.0	24.0	16.5	12	4 3/4 X 6 1/4 X 7 15/16	298
LGS-5-5-0V-R	0.1%, 0.1%	10	45.0	38.0	31.0	21.0	5	3 3/16 X 4 15/16 X 15	440
LGS-6-5-0V-R	0.1%, 0.1%	10	70.0	61.0	51.0	38.0	6	3 3/16 X 7 1/2 X 15 1/8	594
LGS-EE-5-0V-R	0.1%, 0.1%	10	110.0	100.0	86.0	72.0	EE	4 15/16 X 7 1/2 X 16 1/2	715

### 6 VOLTS ± 5% ADJ

LJS-13-6-0V	0.4%, 0.4%	10	4.1	4.1	3.3	2.3	13	4 3/4 X 1 25/32 X 6 5/16	\$140
LJS-10-6-0V	0.4%, 0.4%	10	8.3	8.3	6.6	4.5	10	4 3/4 X 1 25/32 X 7 15/16	202
LJS-11-6-0V	0.4%, 0.4%	10	16.7	16.7	13.3	9.2	11	4 3/4 X 4 5/16 X 7 15/16	247
LJS-12-6-0V	0.4%, 0.4%	10	25.0	25.0	20.0	13.7	12	4 3/4 X 6 1/4 X 7 15/16	298
LGS-5-6-0V-R	0.1%, 0.1%	10	38.0	33.0	26.0	18.0	5	3 3/16 X 4 15/16 X 15	440
LGS-6-6-0V-R	0.1%, 0.1%	10	60.0	56.0	49.0	36.0	6	3 3/16 X 7 1/2 X 15 1/8	594
LGS-EE-6-0V-R	0.1%, 0.1%	10	100.0	90.0	80.0	65.0	EE	4 15/16 X 7 1/2 X 16 1/2	715

### 12 VOLTS ± 5% ADJ

LJS-13-12-0V	0.4%, 0.4%	15	2.0	2.0	1.7	1.1	13	4 3/4 X 1 25/32 X 6 5/16	\$140
LJS-10-12-0V	0.4%, 0.4%	15	4.2	4.2	3.4	2.3	10	4 3/4 X 1 25/32 X 7 15/16	202
LJS-11-12-0V	0.4%, 0.4%	15	8.3	8.3	6.6	4.5	11	4 3/4 X 4 5/16 X 7 15/16	247
LJS-12-12-0V	0.4%, 0.4%	15	12.5	12.5	10.0	6.8	12	4 3/4 X 6 1/4 X 7 15/16	298
LGS-5-12-0V-R	0.1%, 0.1%	15	24.0	20.0	16.0	11.0	5	3 3/16 X 4 15/16 X 15	440
LGS-6-12-0V-R	0.1%, 0.1%	15	37.5	35.0	30.5	23.0	6	3 3/16 X 7 1/2 X 15 1/8	594
LGS-EE-12-0V-R	0.1%, 0.1%	15	60.0	53.0	46.0	38.0	EE	4 15/16 X 7 1/2 X 16 1/2	715

### 15 VOLTS ± 5% ADJ

LJS-13-15-0V	0.4%, 0.4%	15	1.6	1.6	1.3	0.9	13	4 3/4 X 1 25/32 X 6 5/16	\$140
LJS-10-15-0V	0.4%, 0.4%	15	3.3	3.3	2.6	1.8	10	4 3/4 X 1 25/32 X 7 15/16	202
LJS-11-15-0V	0.4%, 0.4%	15	6.7	6.7	5.3	3.7	11	4 3/4 X 4 5/16 X 7 15/16	247
LJS-12-15-0V	0.4%, 0.4%	15	10.0	10.0	8.0	5.5	12	4 3/4 X 6 1/4 X 7 15/16	298
LGS-5-15-0V-R	0.1%, 0.1%	15	18.7	16.5	13.2	9.0	5	3 3/16 X 4 15/16 X 15	440
LGS-6-15-0V-R	0.1%, 0.1%	15	30.0	28.0	24.5	20.5	6	3 3/16 X 7 1/2 X 15 1/8	594
LGS-EE-15-0V-R	0.1%, 0.1%	15	47.0	42.0	36.0	30.0	EE	4 15/16 X 7 1/2 X 16 1/2	715

### 20 VOLTS ± 5% ADJ

LJS-13-20-0V	0.4%, 0.4%	15	1.2	1.2	1.0	0.7	13	4 3/4 X 1 25/32 X 6 5/16	\$140
LJS-10-20-0V	0.4%, 0.4%	15	2.5	2.5	2.0	1.4	10	4 3/4 X 1 25/32 X 7 15/16	202
LJS-11-20-0V	0.4%, 0.4%	15	5.0	5.0	4.0	2.7	11	4 3/4 X 4 5/16 X 7 15/16	247
LJS-12-20-0V	0.4%, 0.4%	15	7.5	7.5	6.0	4.1	12	4 3/4 X 6 1/4 X 7 15/16	298
LGS-5-20-0V-R	0.1%, 0.1%	15	13.5	11.5	9.3	6.3	5	3 3/16 X 4 15/16 X 15	440
LGS-6-20-0V-R	0.1%, 0.1%	15	23.0	21.5	18.5	15.5	6	3 3/16 X 7 1/2 X 15 1/8	594
LGS-EE-20-0V-R	0.1%, 0.1%	15	34.0	30.0	26.0	22.0	EE	4 15/16 X 7 1/2 X 16 1/2	715

### 24 VOLTS ± 5% ADJ

LJS-13-24-0V	0.4%, 0.4%	15	1.0	1.0	0.8	0.6	13	4 3/4 X 1 25/32 X 6 5/16	\$140
LJS-10-24-0V	0.4%, 0.4%	15	2.1	2.1	1.7	1.2	10	4 3/4 X 1 25/32 X 7 15/16	202
LJS-11-24-0V	0.4%, 0.4%	15	4.2	4.2	3.3	2.3	11	4 3/4 X 4 5/16 X 7 15/16	247
LJS-12-24-0V	0.4%, 0.4%	15	6.3	6.3	5.0	3.4	12	4 3/4 X 6 1/4 X 7 15/16	298
LGS-5-24-0V-R	0.1%, 0.1%	15	11.5	9.9	7.9	5.4	5	3 3/16 X 4 15/16 X 15	440
LGS-6-24-0V-R	0.1%, 0.1%	15	20.0	19.0	16.0	13.0	6	3 3/16 X 7 1/2 X 15 1/8	594
LGS-EE-24-0V-R	0.1%, 0.1%	15	30.0	27.0	23.0	19.0	EE	4 15/16 X 7 1/2 X 16 1/2	715

### 28 VOLTS ± 5% ADJ

LJS-13-28-0V	0.4%, 0.4%	15	0.9	0.9	0.7	0.5	13	4 3/4 X 1 25/32 X 6 5/16	\$140
LJS-10-28-0V	0.4%, 0.4%	15	1.8	1.8	1.4	1.0	10	4 3/4 X 1 25/32 X 7 15/16	202
LJS-11-28-0V	0.4%, 0.4%	15	3.6	3.6	2.9	2.0	11	4 3/4 X 4 5/16 X 7 15/16	247
LJS-12-28-0V	0.4%, 0.4%	15	5.4	5.4	4.3	3.0	12	4 3/4 X 6 1/4 X 7 15/16	298
LGS-5-28-0V-R	0.1%, 0.1%	15	9.6	8.2	6.6	4.5	5	3 3/16 X 4 15/16 X 15	440
LGS-6-28-0V-R	0.1%, 0.1%	15	17.5	16.5	14.5	12.0	6	3 3/16 X 7 1/2 X 15 1/8	594
LGS-EE-28-0V-R	0.1%, 0.1%	15	25.0	23.0	20.0	16.0	EE	4 15/16 X 7 1/2 X 16 1/2	715

# Voltage and Current Ratings

## DC INPUT 20.5-32 VDC STANDARD

### 5 VOLTS ± 5% ADJ

MODEL	REGULATION (line load)	RIPPLE mV (RMS)	MAX AMPS AT AMBIENT OF				PKG SIZE	DIMENSIONS (inches)	PRICE
			40°C	50°C	60°	71°C			
LGS-5-5-C-OV-R	0.1%, 0.1%	10	35.0	31.0	25.0	16.5	5	3 3/16 X 4 15/16 X 15	\$495
<b>6 VOLTS ± 5% ADJ</b>									
LGS-5-6-C-OV-R	0.1%, 0.1%	10	29.0	26.0	21.0	14.0	5	3 3/16 X 4 15/16 X 15	\$495
<b>12 VOLTS ± 5% ADJ</b>									
LGS-5-12-C-OV-R	0.1%, 0.1%	15	15.0	13.5	10.0	7.0	5	3 3/16 X 4 15/16 X 15	\$495
<b>15 VOLTS ± 5% ADJ</b>									
LGS-5-15-C-OV-R	0.1%, 0.1%	15	13.0	11.0	8.0	5.6	5	3 3/16 X 4 15/16 X 15	\$495
<b>20 VOLTS ± 5% ADJ</b>									
LGS-5-20-C-OV-R	0.1%, 0.1%	15	10.5	9.0	7.0	4.5	5	3 3/16 X 4 15/16 X 15	\$495
<b>24 VOLTS ± 5% ADJ</b>									
LGS-5-24-C-OV-R	0.1%, 0.1%	15	8.5	7.5	6.0	3.9	5	3 3/16 X 4 15/16 X 15	\$495
<b>28 VOLTS ± 5% ADJ</b>									
LGS-5-28-C-OV-R	0.1%, 0.1%	15	7.5	6.8	5.4	3.5	5	3 3/16 X 4 15/16 X 15	\$495

## DC INPUT 44-58 VDC STANDARD

### 5 VOLTS ± 5% ADJ

MODEL	REGULATION (line load)	RIPPLE mV (RMS)	MAX AMPS AT AMBIENT OF				PKG SIZE	DIMENSIONS (inches)	PRICE
			40°C	50°C	60°	71°C			
LGS-5-5-D-OV-R	0.1%, 0.1%	10	40.0	32.0	25.0	16.5	5	3 3/16 X 4 15/16 X 15	\$440
LGS-6-5-D-OV-R	0.1%, 0.1%	10	60.0	53.0	45.0	36.0	6	3 3/16 X 7 1/2 X 15 1/8	605
LGS-EE-5-D-OV-R	0.1%, 0.1%	10	90.0	85.0	73.0	54.0	EE	4 15/16 X 7 1/2 X 16 1/2	770
<b>6 VOLTS ± 5% ADJ</b>									
LGS-5-6-D-OV-R	0.1%, 0.1%	10	35.0	28.0	21.5	14.0	5	3 3/16 X 4 15/16 X 15	\$440
LGS-6-6-D-OV-R	0.1%, 0.1%	10	50.0	46.0	41.0	35.0	6	3 3/16 X 7 1/2 X 15 1/8	605
LGS-EE-6-D-OV-R	0.1%, 0.1%	10	78.0	67.0	56.0	42.5	EE	4 15/16 X 7 1/2 X 16 1/2	770
<b>12 VOLTS ± 5% ADJ</b>									
LGS-5-12-D-OV-R	0.1%, 0.1%	15	17.5	14.0	10.8	7.0	5	3 3/16 X 4 15/16 X 15	\$440
LGS-6-12-D-OV-R	0.1%, 0.1%	15	31.0	28.0	24.0	18.0	6	3 3/16 X 7 1/2 X 15 1/8	605
LGS-EE-12-D-OV-R	0.1%, 0.1%	15	39.0	33.5	28.0	21.0	EE	4 15/16 X 7 1/2 X 16 1/2	770
<b>15 VOLTS ± 5% ADJ</b>									
LGS-5-15-D-OV-R	0.1%, 0.1%	15	14.0	11.0	8.6	5.6	5	3 3/16 X 4 15/16 X 15	\$440
LGS-6-15-D-OV-R	0.1%, 0.1%	15	25.0	23.0	20.0	15.0	6	3 3/16 X 7 1/2 X 15 1/8	605
LGS-EE-15-D-OV-R	0.1%, 0.1%	15	32.0	28.0	23.5	17.5	EE	4 15/16 X 7 1/2 X 16 1/2	770
<b>20 VOLTS ± 5% ADJ</b>									
LGS-5-20-D-OV-R	0.1%, 0.1%	15	11.5	9.3	7.1	4.6	5	3 3/16 X 4 15/16 X 15	\$440
LGS-6-20-D-OV-R	0.1%, 0.1%	15	19.0	18.0	16.0	12.0	6	3 3/16 X 7 1/2 X 15 1/8	605
LGS-EE-20-D-OV-R	0.1%, 0.1%	15	26.0	22.5	18.5	14.0	EE	4 15/16 X 7 1/2 X 16 1/2	770
<b>24 VOLTS ± 5% ADJ</b>									
LGS-5-24-D-OV-R	0.1%, 0.1%	15	9.8	7.8	6.1	3.9	5	3 3/16 X 4 15/16 X 15	\$440
LGS-6-24-D-OV-R	0.1%, 0.1%	15	16.0	15.0	13.0	10.0	6	3 3/16 X 7 1/2 X 15 1/8	605
LGS-EE-24-D-OV-R	0.1%, 0.1%	15	21.5	18.5	15.5	11.5	EE	4 15/16 X 7 1/2 X 16 1/2	770
<b>28 VOLTS ± 5% ADJ</b>									
LGS-5-28-D-OV-R	0.1%, 0.1%	15	8.7	7.0	5.4	3.5	5	3 3/16 X 4 15/16 X 15	\$440
LGS-6-28-D-OV-R	0.1%, 0.1%	15	14.0	13.0	11.0	9.0	6	3 3/16 X 7 1/2 X 15 1/8	605
LGS-EE-28-D-OV-R	0.1%, 0.1%	15	19.5	17.0	14.0	10.5	EE	4 15/16 X 7 1/2 X 16 1/2	770

# Voltage and Current Ratings

## AC INPUT 187-242 VAC STANDARD

### 5 VOLTS ± 5% ADJ

MODEL	REGULATION (line load)	RIPPLE mV (RMS)	MAX AMPS AT AMBIENT OF				DIMENSIONS (Inches)	PRICE
			40°C	50°C	60°C	71°C		
LGS-5V-5-OV-R	0.1%, 0.1%	10	43.0	36.5	28.0	15.0	3 3/16 X 4 15/16 X 15 3 3/16 X 7 1/2 X 15 1/8	\$492.00 665.00
LGS-6V-5-OV-R	0.1%, 0.1%	10	63.0	55.0	46.0	34.2		

### 6 VOLTS ± 5% ADJ

LGS-5V-6-OV-R	0.1%, 0.1%	10	37.0	32.0	23.0	13.0	3 3/16 X 4 15/16 X 15 3 3/16 X 7 1/2 X 15 1/8	492.00 665.00
LGS-6V-6-OV-R	0.1%, 0.1%	10	54.0	50.4	44.10	32.4		

### 12 VOLTS ± 5% ADJ

LGS-5V-12-OV-R	0.1%, 0.1%	15	23.0	19.0	15.0	7.0	3 3/16 X 4 15/16 X 15 3 3/16 X 7 1/2 X 15 1/8	492.00 665.00
LGS-6V-12-OV-R	0.1%, 0.1%	15	34.0	31.5	27.4	20.7		

### 15 VOLTS ± 5% ADJ

LGS-5V-15-OV-R	0.1%, 0.1%	15	18.5	16.0	12.0	6.0	3 3/16 X 4 15/16 X 15 3 3/16 X 7 1/2 X 15 1/8	492.00 665.00
LGS-6V-15-OV-R	0.1%, 0.1%	15	27.0	25.2	22.0	18.4		

### 20 VOLTS ± 5% ADJ

LGS-5V-20-OV-R	0.1%, 0.1%	15	12.6	10.8	8.7	4.6	3 3/16 X 4 15/16 X 15 3 3/16 X 7 1/2 X 15 1/8	492.00 665.00
LGS-6V-20-OV-R	0.1%, 0.1%	15	20.7	19.3	16.6	13.9		

### 24 VOLTS ± 5% ADJ

LGS-5V-24-OV-R	0.1%, 0.1%	15	11.5	9.9	7.9	3.9	3 3/16 X 4 15/16 X 15 3 3/16 X 7 1/2 X 15 1/8	492.00 665.00
LGS-6V-24-OV-R	0.1%, 0.1%	15	18.0	17.1	14.4	11.7		

### 28 VOLTS ± 5% ADJ

LGS-5V-28-OV-R	0.1%, 0.1%	15	9.6	8.0	6.0	3.3	3 3/16 X 4 15/16 X 15 3 3/16 X 7 1/2 X 15 1/8	492.00 665.00
LGS-6V-28-OV-R	0.1%, 0.1%	15	15.7	14.8	13.0	10.8		

## AC INPUT 205-265 VAC STANDARD

### 5 VOLTS ± 5% ADJ

LGS-5V1-5-OV-R	0.1%, 0.1%	10	43.0	36.5	28.0	15.0	3 3/16 X 4 15/16 X 15 3 3/16 X 7 1/2 X 15 1/8	\$492.00 665.00
LGS-6V1-5-OV-R	0.1%, 0.1%	10	63.0	55.0	46.0	34.2		

### 6 VOLTS ± 5% ADJ

LGS-5V1-6-OV-R	0.1%, 0.1%	10	37.0	32.0	23.0	13.0	3 3/16 X 4 15/16 X 15 3 3/16 X 7 1/2 X 15 1/8	492.00 665.00
LGS-6V1-6-OV-R	0.1%, 0.1%	10	54.0	50.4	44.1	32.4		

### 12 VOLTS ± 5% ADJ

LGS-5V1-12-OV-R	0.1%, 0.1%	15	23.0	19.0	15.0	7.0	3 3/16 X 4 15/16 X 15 3 3/16 X 7 1/2 X 15 1/8	492.00 665.00
LGS-6V1-12-OV-R	0.1%, 0.1%	15	34.0	31.5	27.4	20.7		

### 15 VOLTS ± 5% ADJ

LGS-5V1-15-OV-R	0.1%, 0.1%	15	18.5	16.0	12.0	6.0	3 3/16 X 4 15/16 X 15 3 3/16 X 7 1/2 X 15 1/8	492.00 665.00
LGS-6V1-15-OV-R	0.1%, 0.1%	15	27.0	25.2	22.0	18.4		

### 20 VOLTS ± 5% ADJ

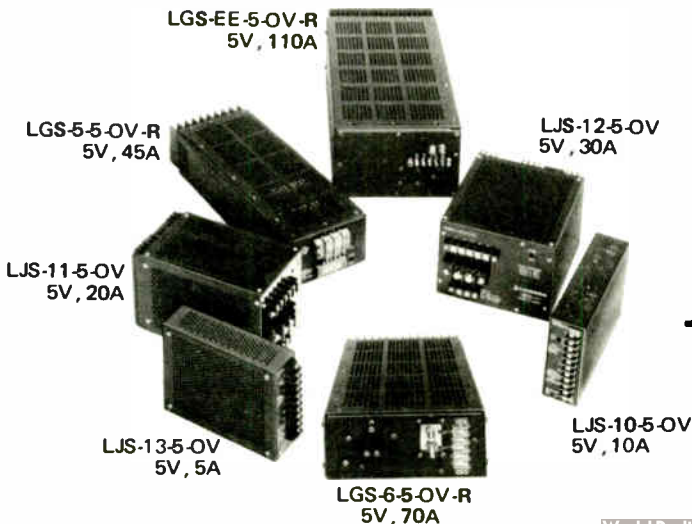
LGS-5V1-20-OV-R	0.1%, 0.1%	15	12.6	10.8	8.7	4.6	3 3/16 X 4 15/16 X 15 3 3/16 X 7 1/2 X 15 1/8	492.00 665.00
LGS-6V1-20-OV-R	0.1%, 0.1%	15	20.7	19.3	16.6	13.9		

### 24 VOLTS ± 5% ADJ

LGS-5V1-24-OV-R	0.1%, 0.1%	15	11.5	9.9	7.9	3.9	3 3/16 X 4 15/16 X 15 3 3/16 X 7 1/2 X 15 1/8	492.00 665.00
LGS-6V1-24-OV-R	0.1%, 0.1%	15	18.0	17.1	14.4	11.7		

### 28 VOLTS ± 5% ADJ

LGS-5V1-28-OV-R	0.1%, 0.1%	15	9.6	8.0	6.0	3.3	3 3/16 X 4 15/16 X 15 3 3/16 X 7 1/2 X 15 1/8	492.00 665.00
LGS-6V1-28-OV-R	0.1%, 0.1%	15	15.7	14.8	13.0	10.8		



**△ Lambda**  
switching power  
supplies come in 7  
power packages ...  
147 models ... 5 amps  
to 110 amps ... 5V  
to 28V.

# SPECIFICATIONS OF LG SERIES

## DC output

voltage range shown in tables

### Regulated voltage

regulation line . . . . .	0.1% for 105 to 132 VAC, 187-242 VAC, 205-265 VAC
regulation load. . . . .	0.1% for 0 to full load
ripple and noise . . . . .	10mV RMS, 35 mV p-p for 5 and 6V units 15mV RMS, 100mV p-p for 12 thru 28V units
remote programming resistance .	1000 ohms/volt
remote programming voltage . .	volt per volt

### Temperature coefficient

0.03% per°C

### AC input

line . . . . .	105-132 VAC, 47-440 Hz
power . . . . .	360 watts max. at 0.6 P.F. for LGS-5 750 watts max. at 0.7 P.F. for LGS-6 1100 watts max. at 0.6 P.F. for LGS-EE

**DC input** . . . . . 20.5-32 VDC, LGS-5-C packages only. Input voltage specs. comply with minimum usable voltage for lead acid batteries. 44-58 VDC. "D" models only. 145 VDC ± 10%, LGS-5, LGS-6 packages only. 64% minimum except LGS-EE-D and LGS-6-D which are 60% minimum and LGS-5-C which is 55% minimum.

**Soft-start circuit:** (LGS-6, LGS-EE only)

limits in-rush current at turn-on.

### Overshoot

no overshoot at turn-on, turn-off or power failure.

### Ambient operating temperature

continuous duty 0° to 71°C.

### Storage temperature range

-55°C to +85°C

### Overload protection

**Electrical**  
pre-set electronic current limiting at factory. Internal failure protection by means of line fuse.

### Thermal

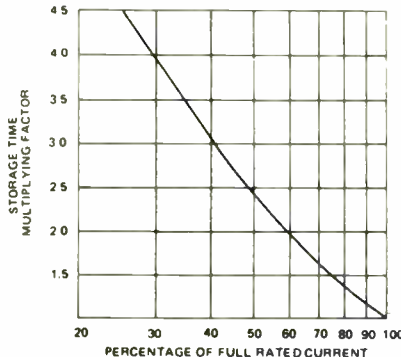
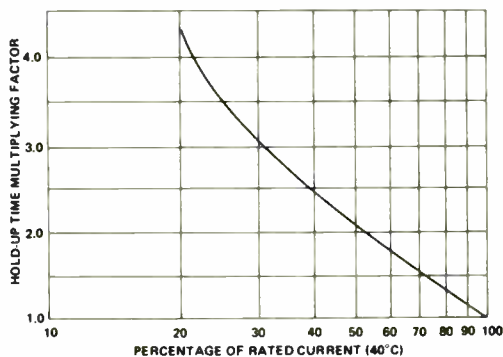
by self-resetting thermostat on heat sink.

### Overvoltage protection

built-in fixed overvoltage protection standard on all units. When a pre-set voltage is exceeded, the overvoltage protector crowbars the output and removes the inverter drive.

### Power failure

See graph for hold-up time vs load current on all units.



HOLD-UP TIME AT 100% RATED 40°C CURRENT (IN MILLISECONDS)				
MODEL	SERIES	LGS-6 LGS-6-V	LGS-6	LGS-EE LGS-6-V
- 5-OV-R		16.5	18.0	16.5 24.0
- 6-OV-R		16.5	17.5	9.4 23.0
- 12-OV-R		5.0	3.0	9.3 7.0
- 15-OV-R		5.0	4.5	8.3 8.0
- 20-OV-R		5.0	6.0	5.0 10.0
- 24-OV-R		5.0	2.0	2.6 8.0
- 28-OV-R		5.0	1.0	7.0 8.0

Hold-up times as a function of load current.

## EMI

**Conducted**— conforms to MIL-I-6181D.

**Radiated**— see graphs for performance.

## Cooling

convection cooled.

## DC output controls

simple screwdriver voltage adjustment over the voltage range.

## Input and output connections

by heavy duty barrier strip.

## Mounting

two mounting surfaces, three mounting positions for LGS-5, one mounting surface for LGS-EE. For LGS-5-C models derate current 10% for mounting positions in which the radiator fins are not vertical.

## Remote sensing

provision is made for remote sensing to eliminate effects of power output lead resistance on DC regulation.

## Fungus proofing

all units are rendered fungi inert.

## Physical Data

Package Model	Size (Inches)	Weight	
		Net (lbs)	Ship (lbs)
LGS-5	3 3/16 x 4 15/16 x 15	13 1/2	15
LGS-6	3 3/16 x 7 1/2 x 15 1/8	20	23
LGS-EE	4 15/16 x 7 1/2 x 16 1/2	26	31

## Options

### AC input

For LGS-EE models only

Add Suffix	For Operation at:	Price Qty 1-14	Price Mixed Models Qty 15 & up	Price Single Model Qty 15 & up
-V	187-242VAC 47-440Hz*	12% or \$30†	12% or \$30†	10% or \$30†
-V1	205-265 VAC 47-440Hz	12% or \$30†	12% or \$30†	10% or \$30†

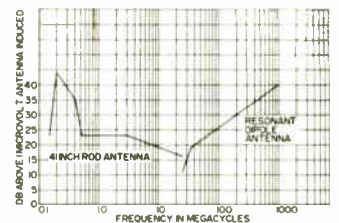
\*derate 10% at 50Hz †twichever is greater

## Accessories

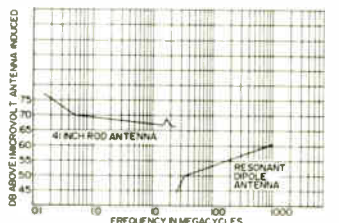
overvoltage protection built-in and standard on all models. Rack adapters available, see 1977 Lambda catalog Vol. 1.

## Guaranteed for 5 years

5 year guarantee includes labor as well as parts. Guarantee applies to operation at full published specifications at end of 5 years.



Narrow band (cw) radiated interference limits



Broadband and pulsed cw radiated interference limits



# SPECIFICATIONS OF LJ SERIES

## DC output

voltage range: refer to tables

regulation, line . . . . . 0.4% for line variations from 105-132VAC.

regulation, load . . . . . 0.4% for load variations from 0 to full load

remote programming resistance . . . . . 1000 ohms/volt

remote programming voltage . . . . . volt/volt

ripple and noise . . . . . 10mV rms, 50 mV p-p for 5V and 6V models; 15 mV rms, 100 mV p-p for 12V to 28V models.

temperature coefficient . . . . 0.03%/°C.

power failure . . . . . output will remain within regulation for 16 msec after power failure.

## AC input

line . . . . . 105-132 VAC 47-440 Hz

hold up time . . . . . 16 msec min at low line and full load, and  $V_o$  max.

## DC input

145 VDC  $\pm$  10%

## Overshoot

no overshoot on turn-on, turn-off, or power failure

## Efficiency

greater than 70% (60% FOR LJS-13) with advanced 20 KHz switching circuitry

## Ambient operating temperature range

continuous duty from 0°C to 71°C with load current ratings as shown in tables

## Storage temperature range

-55°C to 85°C

## Overload protection

### Thermal

thermostat, automatic reset when over-temperature condition is removed.

### Electrical

external overload protection: automatic factory preset electronic current limiting circuit limits the output current thereby providing protection for the load as well as the power supply.

internal failure protection: provided by fuse.

## Input and output connections

heavy duty terminal block on rear of chassis.

## Controls

DC output controls

one voltage adjustment control for single outputs.

## Remote sensing

provision is made for remote sensing to eliminate effect of power output lead resistance on DC regulation.

## Remote shutdown

capability of remote on-off control for either positive ground or negative ground output.

## Overvoltage protection

built in fixed overvoltage protection on all model outputs.

## Mounting

One mounting surface.

## Options

### AC input

Add Suffix	For Operation at:	Price Qty. 1-14	Price Mixed Models Qty. 15 and up	Price Single Model Qty. 15 and up
-V	187-265 VAC 47-440 Hz	12% or \$30*	12% or \$30*	10% or \$30*

\*whichever is greater

See Physical Data below for sizes of "V" option power supplies — The "V" option supplies sizes are larger than equivalent standard power supplies.

## Physical Data

Package Model	Weight (lbs.) net	Size (inches)
LJ-13	1.6	4 3/4 X 1 25/32 X 6 5/16
LJ-13-V	2.0	4 3/4 X 1 25/32 X 7 15/16
LJ-10	2.0	4 3/4 X 1 25/32 X 7 15/16
LJ-10-V	3.0	4 3/4 X 1 25/32 X 9 1/16
LJ-11	5.5	4 3/4 X 4 15/16 X 7 15/16
LJ-11-V	7.0	4 11/32 X 4 3/4 X 9 1/16
LJ-12	7.0	4 3/4 X 6 1/4 X 7 15/16
LJ-12-V	8.5	4 9/32 X 4 3/4 X 9 1/16

### Finish

gray, Fed. Std. 595 No. 26081.

## Guaranteed for 5 years

5 year guarantee includes labor as well as parts. Guarantee applies to operation at full published specifications at end of 5 years.

# ONLY LAMBDA'S LJ SERIES SWITCHING POWER SUPPLIES

# 50,000 HOURS MTBF\* DEMONSTRATED



LJS-12  
30A



LJS-11  
20A



LJS-10  
10A



LJS-13  
5A

\*CONDITIONS: FULL LOAD — 40°C RATINGS — 115 VOLT AC INPUT — CONFIDENCE LEVEL: 60%

## THE BROADEST LINE OF SWITCHING POWER SUPPLIES IN THE WORLD

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6

**NORTH-WESTERN REGION**  
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121 International Dr

# Announcing the 20<sup>th</sup> annual world markets forecast by the editors of Electronics

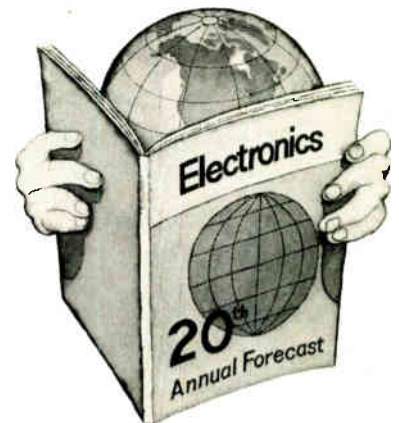
The regular January 5, 1978 issue of Electronics magazine will contain the editor's annual analysis and forecast of the international electronics market. This highly respected report is eagerly awaited each year by senior engineers and engineering management. It has become an indispensable planning tool for decision-makers around the world.

No other publication in the field prepares a world markets forecast. It is read, re-read, routed to others, saved, filed,

and referred to time and again throughout the year. Exposure to advertising is increased, especially among those levels of management which are relatively inaccessible to your salesmen.

Each year, more advertisers become aware of the potential of this issue for increased advertising productivity. The advertisers' index reads like a directory of the companies best known for their marketing acumen. Some manufacturers, in addition to their regular product campaigns, choose this issue very deliberately to carry their *corporate* messages.

*Closing date for the World Markets Forecast issue of Electronics is December 12, 1977. To be sure space is available, please reserve as early as possible.*



**Electronics Magazine** 

1221 Avenue of the Americas, New York, N.Y. 10020

# PROVEN PERFORMANCE CRYSTAL CLOCK OSCILLATORS



Motorola's K1100A leads the industry with a crystal clock oscillator that has a proven track record of more than two million units. That's right... over two million oscillators are in use by satisfied, repeat customers.

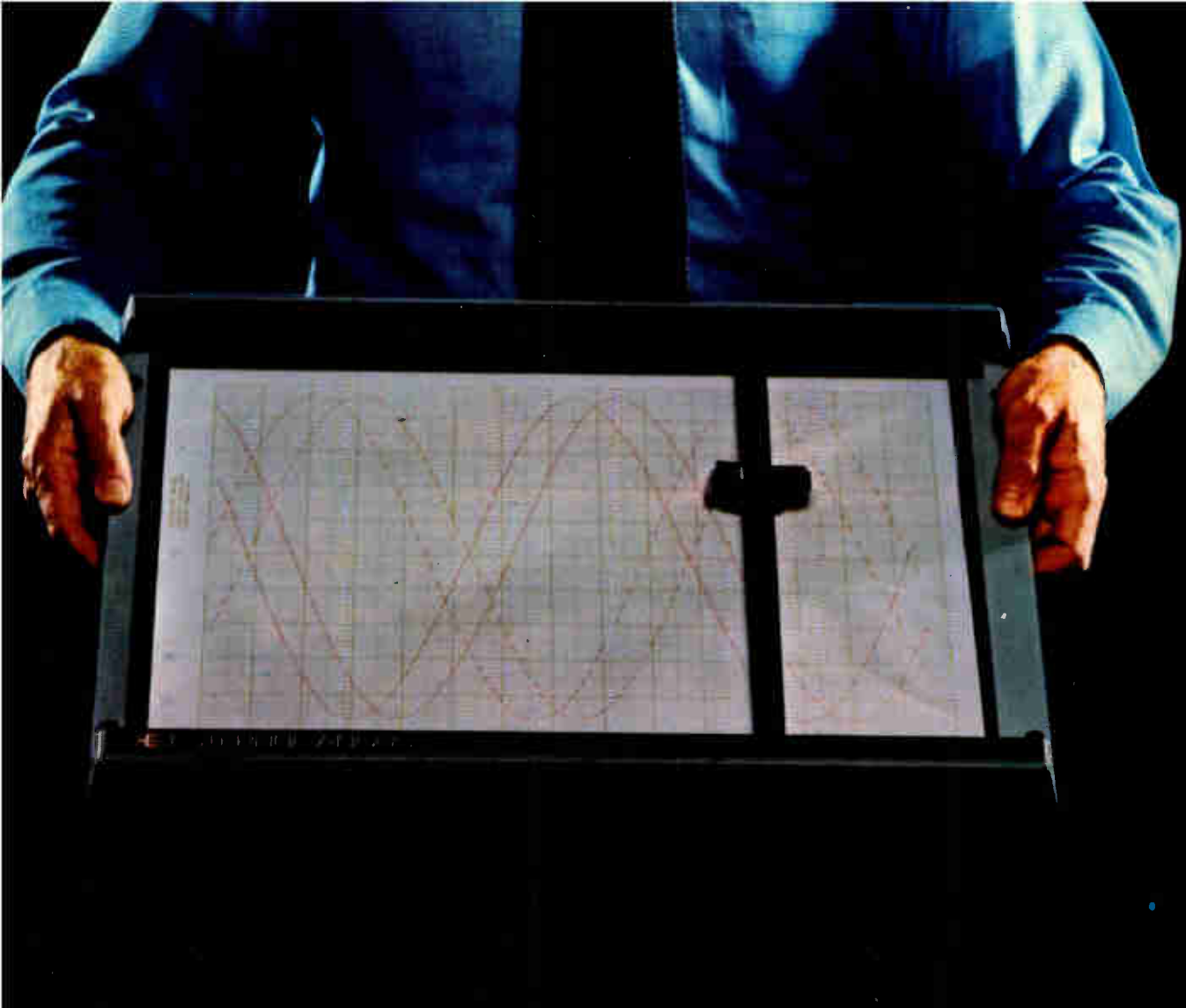
How versatile is the K1100A? With over 1200 frequencies already designed, and same-day shipment for standard stock frequencies of 4, 4.9152, 5, 10, and 20 MHz, you make the decision.

Oscillators are available from 250 kHz to 70 MHz,  $\pm 0.01\%$  stability from  $0^{\circ}\text{C}$  to  $70^{\circ}\text{C}$ , TTL-compatible, and standard +5V dc input.

For full specifications and prices on the oscillator that design engineers trust, write Motorola, Component Products Department, 2553 N. Edgington, Franklin Park, Illinois 60131.  
Or call (312) 451-1000, ext. 4183.



**MOTOROLA**  
Communications and Electronics Inc.



You're looking at an X-Y recorder so reliable that manufacturers are building the Spartan Model XY 575 into their own medical, gaging, geophysical and test equipment of all kinds. It could deliver big benefits in your product or lab in a hurry.

Esterline Angus pioneered accountability technology, so it was only logical that this X-Y has  $\frac{2}{3}$  fewer parts ( $\frac{1}{2}$  of them moving parts). Consider:

1. Extremely rapid pen response of 45 in/sec.
2. Throwaway pen and ink cartridge, mess-free. Users love it.
3. Protective features: auto-powerdown on overrange, wearout-proof feedback pot, 200 VDC common mode, and floating guarded input.
4. 45 cps pen drop for plotter applications.
5. Back-lighted grid for accurate paper alignment.

Esterline provides accountability in recording. The Model XY 575 OEM is only one of *four* great X-Y's including lab models with many ranges, time bases, and options, plus an X-Y-Y' two-pen recorder. Get Bulletin E500. Esterline Angus Instrument Corporation, Box 24000, Indianapolis, IN 46224. Tel. 317-244-7611.

## Designers found the reliable X-Y



**ESTERLINE ANGUS**

AN ESTERLINE COMPANY

# Be sure you're using the most up-to-date GE miniature lamp design data.

Out-of-date information could affect your designs adversely and new data on new lamps could lead the way to new ideas. Take a minute to check the dates on these seven catalogs be sure you've got the most up-to-date information at your fingertips, and help you pick the best GE miniature lamps for each of your design needs.

- All catalogs are free.
- Data and information is current.
- Organized for quick, easy, accurate reference.
- Saves you valuable time.



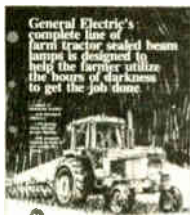
**#3-5257-R  
Halogen-Cycle Lamps**  
Revised April, 1977. The 12 pages feature greatly expanded data including lamp specifications, characteristics, design considerations and selection guide.



**#3-7070  
Miniature Lamps**  
Revised April, 1977. Features almost 100 new lamps not previously listed; covers almost 600 lamps, 40 pages.



**#3-5259R2  
All-Glass Wedge Base Lamps**  
Revised March, 1977. Contains all specifications and data for 11 newest wedge base lamps plus revised drawings and engineering specifications on the full line.



**#3-6383  
Farm Tractor Sealed Beam Lamps**  
Revised September, 1976. Four pages feature the expanded line farm equipment, including diagrams of lamp beam patterns.



**#3-6016  
Sub-Miniature Lamps**  
Revised May, 1976. Includes latest data on more than 194 lamps of 1/4" diameter and smaller, 28 pages.



**Form 5000  
Miniature, Sealed Beam  
and Glow Lamps**  
Revised February, 1976. Features 36 pages of technical lamp data covering 950 lamps, both miniature and sealed beam. Lists lamps in numerical order.



**#3-5211  
Sealed Beam Lamps**  
Revised September, 1975. Lists electrical and physical specifications, applications and numerical index in 16 pages.

## To get your free GE lamp catalogs today.

Call your local GE Miniature Lamp Products Dept. Specialist. Or write: General Electric Miniature Lamp Products Dept. #3382, Nela Park, Cleveland, Ohio 44112.

**GENERAL  ELECTRIC**

## New products/materials

A sealing glass for liquid-crystal displays provides both hermeticity and high strength because of the strong chemical bonds that form between the soda-lime glass plates and the sealing glass when they are heated together. Designated type 410, the sealing glass has relatively low glazing and sealing temperatures—on the order of 500°C. Its



most outstanding characteristic, however, is its printability. The suspended glass particles will not settle out in the jar or on the screen, and screened lines will retain vertical walls. Further, the material will not dry on the screen during coffee breaks or lunch periods.

Qualco, One First St., Los Altos, Calif. 94022. Phone (415) 964-7666 [476]

Ternary thick-film conductor compositions, Conductrox 3535 and 3567, combine many of the features of gold and platinum-gold conductors with the economy of gold-free formulas. In addition to wire-bondability by ultrasonic and thermal-compression methods, the conductors print readily and accept most solders. The resistivity of the compositions is in the range of 8 to 15 milliohms per square—lower than that of most platinum-gold and palladium-silver pastes.

Aged adhesion of soldered wires, a limiting factor with binary conductors, is not a problem with either formula. Peel strength is unchanged after aging for 48 hours at 150°C. In production quantities, 3535 and 3567 sell for 90 cents a gram and \$1.37 a gram, respectively. They are

**Aerospace technology at a  
down-to-earth price...  
the \$3 pot.**



U.S. price—\$2.95 each

### **New Spectrol Model 157 Precision Pot**

Spectrol now introduces the first low-cost, high-quality, 7/8" singleturn conductive plastic pot with features you'd only expect to find in a more expensive aerospace pot. Features like rugged machined-aluminum housing... ground stainless-steel shaft... short length behind panel (.345")... no glued joints... high-current capacity... standard linearity of  $\pm 1\%$ . Wirewound and cermet units are also available in this series, and they come in servo or bushing mounts, with a center tap option. For more information, contact your nearest Spectrol factory or authorized representative.



**SPECTROL ELECTRONICS GROUP**

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Circle 221 on reader service card

# STANDARD CUSTOMER CIRCUITS

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25 days from your design to prototype circuits
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Multiple saving by reducing circuit size 90%
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Circle 274 on reader service card

### New products/materials

platinum-palladium-silver formations and are available in jars or in throwaway plastic syringes.

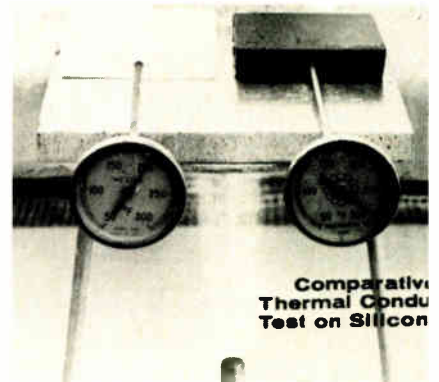
Thick Film Systems Inc., 324 Palm Ave., Santa Barbara, Calif. 93101. Phone (805) 963-7757 [477]

**A semiconductor-grade molding compound, Dow Corning 631, is a hybrid product designed to combine some of the best features of silicone and epoxy materials. Among those of its features that are usually associated with silicone are compatibility with semiconductor chips, ease of use, and moisture resistance. Among its epoxy advantages are high strength, good resistance to salt spray, and a strong lead seal.**

The material lends itself well to high-volume transfer molding and can realize cycle times of one to two minutes. It uses a cure system that has no need for nitrogen-containing catalysts—a source of contamination in conventional epoxy systems.

Dow Corning Corp., Midland, Mich. 48640 [478]

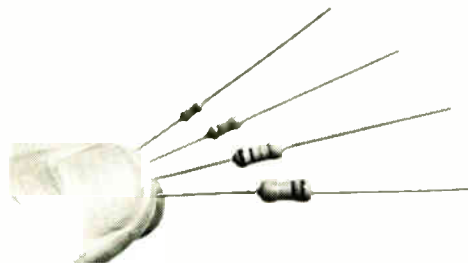
**An RTV silicone rubber with a higher thermal conductivity than conventional silicone rubbers is suitable for potting and encapsulating components from which a sub-**



stantial amount of heat is to be dissipated. Eccosil 4952 is a red, pourable composition with a thermal conductivity of 7.5 BTU-in./hr-ft<sup>2</sup>-°F (0.0026 cal-cm/s-cm<sup>2</sup>-°C). The material sells for \$4.35 a pound in 17-pound lots and is available from stock.

Emerson & Cuming Inc., Canton, Mass. 02021 [479]

## CARBON FILM FIXED RESISTORS



1/2 Watt 5% tol.  
1/3 Watt 5% tol.  
1/4 Watt 5% tol.  
1/16 Watt 5% tol.

2% Tolerance  
is available

## CARBON TRIMMER POTENTIOMETERS



1/10 Watt (8mm dia)  
1/8 Watt (10mm dia)

## BULTRONICS CORP.

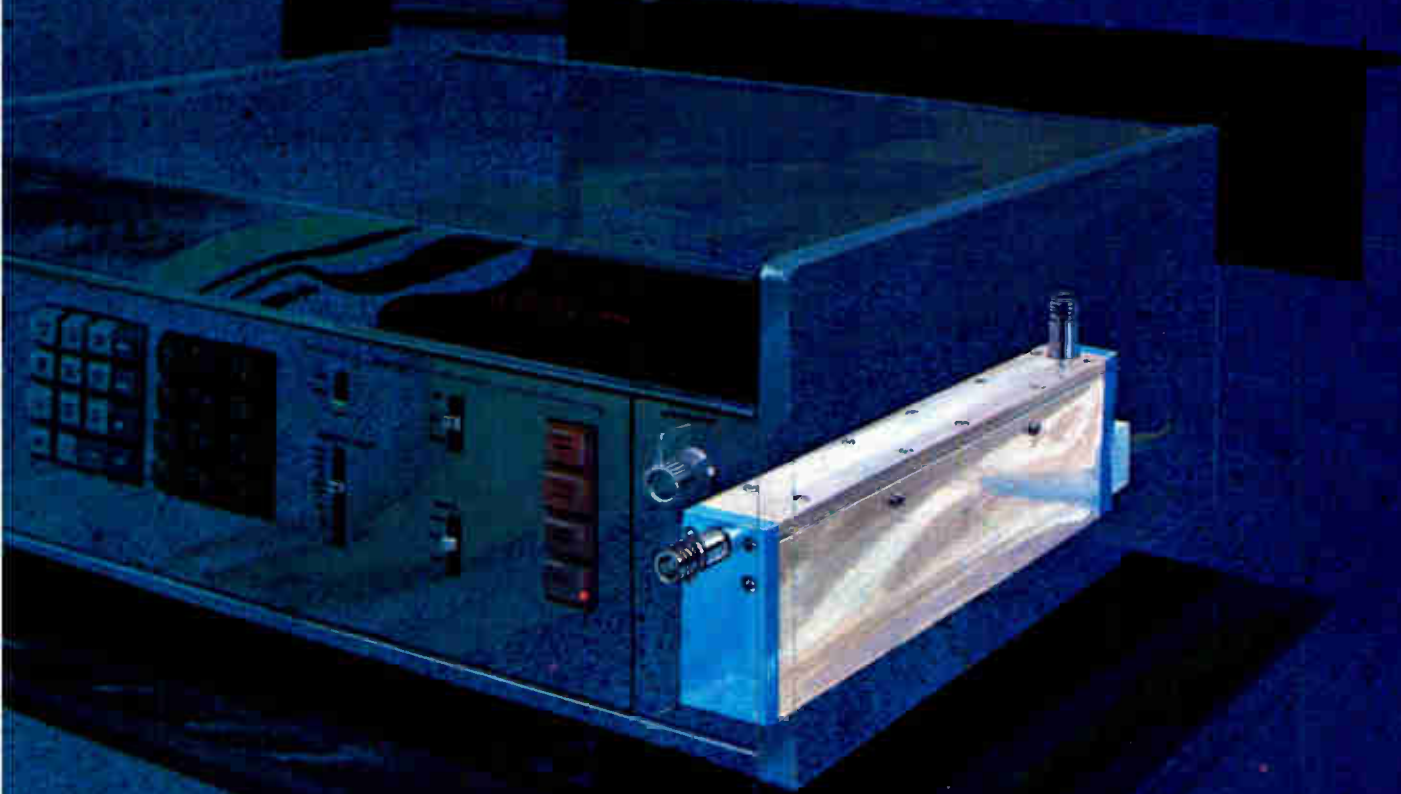
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We are looking for agents.

222 Circle 222 on reader service card



# A Programmable Attenuator that enhances your equipment...



## ...and your bottom line.

Telonic's new 8360 Series Programmable Attenuators have been designed to boost performance of automatic test equipment, without clobbering your manufacturing costs.

If you're an OEM producing instruments or test gear that need an attenuator, you've probably considered a programmable type—or perhaps are already using one. You know the benefits. Now consider the benefits of Telonic's new series.

**DIGITALLY PROGRAMMABLE**—via an integral 12-pin connector, the 8360 is totally compatible with the IEEE 488 bus (or the H-P bus)—programmed for automatic systems. Solenoid switches are magnetically latched to minimize power consumption and heat dissipation.

**THICK FILM CHIPS**—they're used in the 8360 to provide highly accurate attenuation. The distributed field concept combined with an "edge line" conductor has been field proven in thousands of attenuators. And the nature of these thick

film chips allows high R.F. power ratings—3 watts average, 1 kW peak. Frequency range is DC to 4 GHz.

**FOUR VERSIONS**—covering dB ranges of 0 to 11 in 1 dB steps, 0 to 70, 110, and 130 in 10 dB steps. And each model comes with three standard input/output connector configurations for easy adaptation to your system design. In fact, the output connector, either "N" or "SMA," can be oriented to be the output of your equipment.

**AND NOW COMES THE BEST PART**—if you're used to paying \$600 or more for a programmable attenuator, the 8360 gives you a lot of breathing room in your parts cost. With OEM discounts, you can cut that price in half—while giving your customer a better package.

**CALL TOLL FREE**—800-854-2436 (except in California) and we'll send our new attenuator catalog, take your F.O., or answer any questions you have. Telonic/Berkeley, 2825 Laguna Canyon Road, Box 277, Laguna Beach, CA 92652, Tel: (714) 494-9401



*The lab version of the 8360 includes a base for benchtop use.*

**TELONIC/BERKELEY**

Circle 223 on reader service card

# EMR

## Frequency Response Analyzers For Every Application

From the viscous elastic properties of films and fibers, to the frequency response of hydraulic actuators . . . for the open loop response of a servo system with the loop closed, or the frequency response of the Brooklyn Bridge . . . EMR has a Frequency Response Analyzer that is just right for your application.

Take the low-cost, easy-to-use Model 1312. It's ideal for production testing and basic measurements of phase and amplitude to 20 kHz. Or choose the Model 1410, the full capability, single-channel instrument that has become the industry's standard for most engineering applications. Then there's the Model 1172, the ultimate Frequency Response Analyzer featuring all-digital signal processing, fully-isolated dual measurement channels and a computer-type keyboard entry. With the Model 1180 Plotter Interface, you can plot Bode, Nyquist, or Nichols diagrams with a conventional analog XY recorder.

Let EMR solve your frequency response problems . . . call or write for details or a demonstration.

Sangamo Weston, EMR Telemetry Division  
P.O. Box 3041, Sarasota, FL 33578  
813-371-0811

SANGAMO WESTON

Schlumberger



Circle 224 on reader service card

### SUPER MINIATURE

#### Neon Glow Lamps

Circuit Volts . . . . . AC 105-125  
Series Resistance . . . . . 150K $\Omega$   
Nominal Current . . . . . 0.3mA  
Total Flux . . . . . 20mlm MIN  
Average Life Hours . . . 30,000

Dimension: mm



NL-8S

### CLEAR-GREEN

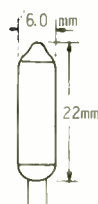
#### Fluorescent Glow Lamps

Circuit Volts . . . . . AC or DC 105-125  
Series Resistance . . . . . 33K $\Omega$   
Nominal Current . . . . . 1.6mA  
Total Flux (MIN.) . . . . AC: 120mlm, DC: 130mlm  
Avg. Life Hours . . . . . AC: 30,000 DC: 40,000



NL-35 G

Circuit Volts . . . . . AC 105-125  
Series Resistance . . . . . 27K $\Omega$   
Nominal Current . . . . . 1.5mA  
Total Flux . . . . . 90mlm MIN.  
Avg. Life Hours . . . . . 20,000



NL-21 G

### ● MAIN PRODUCT

NEON GLOW LAMP, XENON FLASH LAMP,  
RARE GAS, DISCHARGE LAMP,  
MINIATURE : BLACK-LIGHT, UV-LIGHT,  
FLUORESCENT COLOR-LIGHT.

### ELEVAM ELECTRONIC TUBE CO., LTD.

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TELEPHONE : 03 (774) 1231-5

EXPORT DIVISION : JAPAN NANOTRONIX CO., LTD.  
OTA-KU TOKYO, TELEPHONE. (03) 775-4811 TELEX 246-6583 JNANOX

Circle 275 on reader service card

# Hewlett-Packard 9830 Users

You can now dimension, sort  
and search any array that  
will fit in your memory.

With Infotek's Fast Basic III  
ROM the 256 row-column limit  
no longer exists!!!!

**Infotek Systems**

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(714) 956-9300 • TWX 910-591-2711

Circle 204 on reader service card

# TEAC'S Done It Again

## Open Reel Performance in the Cassette Mode

The TEAC R-81 has all the features you look for in a high quality data recorder, but with a big plus: 4 speeds.

Open reel data recorders offer 4-speed selection as a standard feature, but cassette types have been limited to the single speed mode.

The R-81 changes all that, giving you the convenience and simplicity of a cassette recorder along with all the options of 4-speed variability. High-frequency data can be recorded at high speed and reproduced at low speed—or low-frequency data converted to a higher frequency, for analysis by a general-purpose frequency analyzer.

There are 7 channels, too, one switchable for noise compensation (fourth channel), another for memos (seventh channel).

The R-81 also features the clean, rational styling that TEAC cassette tape decks are famous for. The front-loading configuration, with all the controls on the front panel, is ideally convenient for desk-top use. It also facilitates mounting with other equipment made to professional standards, as does the body size, which meets EIA specifications.

And the R-81 is ready to operate anywhere. In addition to AC (with adapter) and DC power sources, you have the full portable versatility of dry cell battery operation.

TEAC's done it again: advanced the art of data recording. And you're the winner.



## TEAC

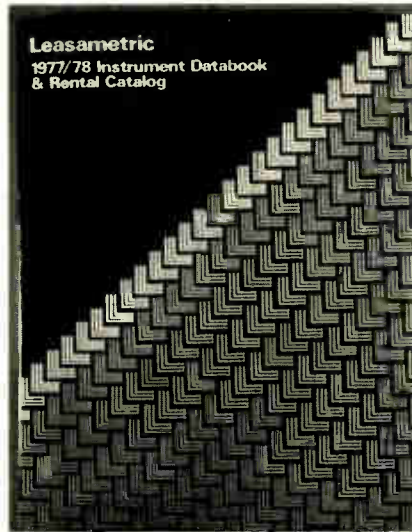
TEAC CORPORATION, 3-7-3, Naka-cho, Musashino, Tokyo, Japan

U.S.A.: B.J. Wolfe Enterprises Inc., 10760 Burbank Blvd., North Hollywood, Calif. 91610 England: International Instruments Ltd., Cross Lances Rd., Hounslow, Middx. W. Germany: nbn Elektronik Starnberg, 813 Starnberg, Max-Emanuel-Str. 3 France: Tekelec Airtronic S.A., Cite des Bruyeres, Rue Carle-Vernet 92 Sevres Holland: SIMAC Electronics, Veenstraat 20, Veldhoven Italy: A.E.S.S.E. S.R.L. Corso Lodi, 47 20139 Milano Norway: Rodland & Rellsmo A.S., Gladengveien 3A, Oslo 6 Sweden: Teleinstrument ab, Maltesholmsvagen 13B, Vallingby Switzerland: Wenger Datentechnik, Bruderholzstrasse 45, 4053 Basel Denmark: Danbit, Plantagevej 23, 2660 Scolerod Strand Australia: Jacoby, Mitchell Ltd., P.O. Box 70, Kingsgrove, N.S.W. 2208

## New literature

**Specialty transformers.** The eighth edition of Underwriters Laboratories' "Safety Standard for Specialty Transformers" contains the requirements for air-cooled transformers and reactors for general use; transformers for use with class-2 remote-control, low-power, and signal circuits; ignition transformers for gas burners and oil burners; and gas-tube-sign transformers for inert-gas tubes. Copies may be obtained at \$3.50 each, or \$9.00 for the edition plus any issued revisions. Underwriters Laboratories Inc., Attn: Publications Stock Dept., 333 Pfingsten Rd., Northbrook, Ill. 60062

**Instruments.** Thousands of instruments for rent, lease, or sale are listed in a 168-page book. All instruments, including analyzers, counters, digital voltmeters, oscilloscopes, recorders, and voltmeters, are listed with ordering and technical information. A separate section is designed



for the engineer who needs to know whether to rent or buy. Metric Resources Corp., 822 Airport Blvd., Burlingame, Calif. 94010. Circle reader service number 422.

**Solder masking.** A four-page appli-

cation note, "Solder-Masking Solder-Plated Circuits," explains how to solder-mask solder-plated and reflowed circuits. It discusses the problems encountered and the limitations on the effectiveness of this technique and provides some design ideas. Solder-Masking Reprint, The Sibley Co., Bridge Street, Haddam, Conn. 06438 [423]

**Oscillators.** A 44-page catalog provides information on crystal, temperature-compensated crystal, high-stability, voltage-controlled, and LC oscillators, with specifications for each type. Also discussed is how to select case configurations, input voltages, waveforms, and temperature ranges. Greenray Industries Inc., 840 West Church Rd., Mechanicsburg, Pa. 17055 [429]

**Industrial and scientific problems.** Ideas for solving a variety of industrial and scientific problems with

# Biggest DVM news of the year

You name it, Systron-Donner has it! Bench, portable and systems models for every conceivable 4½-digit DVM application. Every model is brand new, packed with all the features you could possibly want. Do you need a battery pack or an analog meter? Do you need to make dBm measurements on tones? How about BCD outputs or complete IEEE-488 interface capability? Systron-Donner's new series of 4½-digit DVM's offers all these capabilities and much more.



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These rugged performers for field or lab use come with all five functions (DCV, DCI, resistance, and true RMS ACV and ACI) plus autoranging. Choice of DC accuracy of  $\pm 0.05\%$  or  $\pm 0.02\%$ . Also with or without dBm. Options: Battery Pack and analog meter.

Model	DC Accuracies
7141A	$\pm 0.05\%$ ; 7141B $\pm 0.02\%$
7142A	$\pm 0.05\%$ with dBm capability
7142B	$\pm 0.02\%$ with dBm capability

digital counters are presented in the "Counting Idea Booklet." It contains sketches that illustrate how to solve problems of production-rate control, in-process monitoring, and remote flow monitoring and control. Nationwide Electronic Systems Inc., 1536 Brandy Pkwy., Streamwood, Ill. 60103 [424]

**Products and services.** A 40-page digest gives information on tapes, resins, flexible insulation and tubing, and equipment. Application information and technical characteristics are provided for each product. A service section describes how to obtain the best performance from the product and how to reduce costs. Industrial Electrical Products Division, P. O. Box 33600, 3M Center, St. Paul, Minn. 55133 [427]

**Panel meters.** Product descriptions, application information, and prices for more than 12 line- or logic-



powered digital panel meters and instruments are provided in an 80-page booklet. The booklet also offers information on how to select DPMS for a specific application. Analog Devices Inc., P. O. Box 820, Norwood, Mass. 02062 [431]

**Materials.** A 40-page catalog offering products and services for the semiconductor industry is available from Dyna-Craft Inc., 2919 San Ysidro Way, Santa Clara, Calif. 95051 [426]

**Miniature switches.** Featured in a 48-page catalog are switches and



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A workhorse series with all five functions, autoranging and a neat choice of options including BCD output, IEEE-488 bus, and rack mount. DC accuracy:  $\pm 0.02\%$ .

Model	Features
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7244A	with IEEE-488 capability



## "Thin Line" for GPIB systems—under \$1,000 loaded.

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Circle 226 on reader service card

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**2** Ours use premium components. We don't compromise the component standards we've always maintained for our function modules. An Intronics \$29 supply uses the same premium components we use in a \$300 CRT correction module.

**3** Ours are designed more conservatively. They have to be, because we back them by the same warranty, and provide the same post-sale service, engineer-to-engineer, that we have always provided in support of our most sophisticated computing modules — and we simply can't afford marginal behavior.

**4** Ours are tested more thoroughly, because we have to be certain they'll support our precision function modules (about 30% of our supplies are bought to power other Intronics modules). So we check every key parameter on 100% of our power-supply production.

**5** Ours meet your EMI/RFI needs, for virtually any environment and application . . . again, because you may be buying them to power Intronics circuits. Our modules are well filtered, and have broadband control of critical impedances.

**6** Ours have better thermal design. We've minimized hot-spot-to-case gradients, selected case materials and configurations that optimize convection transfer and insure void-free thermal continuity by incorporating the same potting technique as used on our high-rel modules.

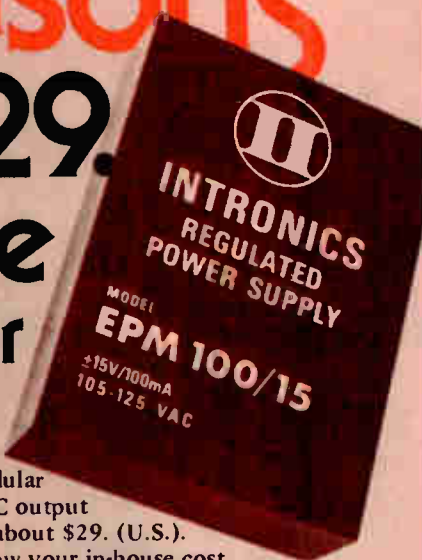
**7** We are systems designers, like you . . . and that means we design power supplies the way you would for yourself. Then we build them at high-volume rates, and share the savings with you.

**FREE** Send for this frank, no-nonsense handbook on power-supply selection and applications engineering. You'll enjoy and profit from its 20 pages of solid technical materials, plus complete data on all 78 Intronics AC/DC and DC/DC modules . . . the ones that give you more, but don't cost you more.



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## why our \$29. supplies are better than their \$29. supplies



Just about every manufacturer of modular power supplies offers a 115 VAC input/±15 VDC output design at 50 or 60 mA, with a one-piece price of about \$29. (U.S.).

In OEM quantities, that price drops below your in-house cost. But our ±15 @ 60 mA design, like all our AC/DC modules, is a much better value at the same price . . . for 7 reasons.



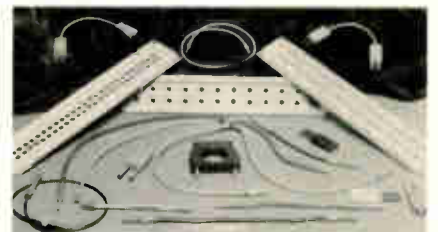
57 Chapel St., Newton, Mass. 02158 U.S.A.  
Tel: (617) 332-7350. TWX: 710-335-6835.

### New literature

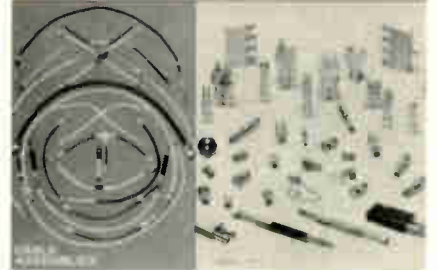
options for a wide range of actuators, bushings, and terminations. Specifications and descriptions are given for a wide variety of subminiature and microminiature switches, including toggle, rocker- and lever-handle, printed-circuit mounting, and snap-action, alternate-action, and momentary push-button. Included are an ordering guide and a list of foreign and domestic distributors. C & K Components Inc., 103 Morse St., Watertown, Mass. 02172 [425]

**Crystal testing.** A two-page application note that discusses how to characterize a quartz crystal for use in a filter or oscillator by using a spectrum analyzer and tracking generator is being offered by Marconi Instruments, Division of Marconi Electronics Inc., 100 Stonehurst Ct., Northvale, N. J. 07647 [428]

**Cables and connectors.** Information on connectors and cable assemblies in miniature- and subminiature-coaxial, and twin-axial, triaxial, and



TROMPETER  ELECTRONICS



quadraxial styles is presented in a 40-page catalog. Trompeter Electronics Inc., 8936 Comanche Ave., Chatsworth, Calif. 91311 [430]

**Magnetics.** A 14-page booklet discusses and illustrates the use of custom magnetics in modern circuits and provides application information

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Now you can get into automatic testing equipment (ATE) for well under \$10,000, total cost.

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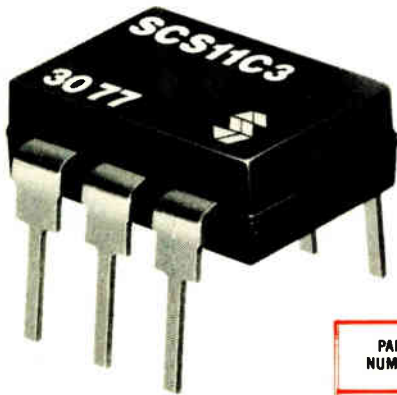
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PART NUMBER	TURN ON CURRENT (MAX) ( $I_T$ )	FORWARD BLOCKING VOLTAGE ( $V_{DM}$ @ $R_{OK} = 10 \text{ Kohm}$ )
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230 Circle 205 on reader service card

### New Literature

on wide-band, rectifier, and pulse transformers, and inductors. Poly-phase Instrument Co., East Fourth St., Bridgeport, Pa. 19045 [432]

**Electronic components.** A wide variety of control knobs, miniature switches, panel hardware, and optoelectronic devices are described in a 36-page catalog. It gives specifications and dimensional drawings for commercial and MIL-specified control knobs; toggle, rocker, lever, push-button, and slide switches; and optoisolators and photoconductive cells. Selection guides are provided for easy ordering. Raytheon Co., Fourth Avenue, Burlington, Mass. 01803 [433]

**Thick-film materials.** A review of thick-film materials designed to aid an engineer select the correct item for his production needs is contained in a six-page catalog. Base metal, gold, platinum-gold, palladium-gold, and silver conductors, and dielectric materials, cover coats, and resistors are listed with specifications, along with a recommended use for each. Plessey EMD, 320 Long Island Expressway South, Melville, N. Y. 11746 [434]

**Machine tools.** "The 1978 Directory of Machine Tools and Related Products, Motion Pictures, and Educational Materials" is a 220-page book containing information on machine tools manufactured in the U.S. The book lists every type of machine tool and related product along with the companies that manufacture them, as well as a list of trademarks and the companies that use them. In addition, the directory has a 22-page multilingual table of contents to assist users in locating various types of products. National Machine Tool Builders' Association, 7901 Westpark Dr., McLean, Va. 22101 [435]

**Industry research.** Everything you always wanted to know about information gathering but were afraid to ask about is discussed in "Competitive Intelligence for the Smaller Company." The booklet provides

Electronics/November 24, 1977





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Yes, the Dumb Terminal™ really does have two smarter brothers.

At first, they weren't quite as well known, because their Dumb Brother's smashing success was stealing the show. Although they had been selling quite well along, even without getting constant headlines, like their Brother.

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### New literature

helpful hints on finance and on what may or may not be a legal procedure. Brewster Co., P. O. Box 409, Jackson Heights, N. Y. 11372 [436]

**Peripheral systems.** A 16-page brochure details the electrical and mechanical parameters and programming considerations for Datel's SineTrac 800 series. The description, background, and user benefits of the analog-to-digital and digital-to-analog peripheral systems are discussed. Block diagrams for program interrupt modes for a-d and d-a systems and also for direct memory access modes for a-d systems are provided. Ordering guides are included. Datel Systems Inc., 1020 Turnpike St., Canton, Mass. 02021 [437]

**Switches.** Over 300 switches with photographs, line drawings, specifications, and ordering information are described in a 24-page catalog. Slide, snap-action, rotary, push-button, toggle, lead, rocker, and paddle switches are covered. Chicago Switch Inc., 2035 Wabansia, Chicago, Ill. 60647 [438]

**Data conversion.** The challenge of interfacing monolithic integrated-circuit converter designs with microprocessors and computers is featured in the "Analog-Digital Conversion Handbook." The handbook discusses a variety of interfacing techniques, including memory-managed and serial interfacing. Also covered are current designs, technologies, and production techniques employed in conversion circuits. The handbook can be obtained at \$5.95 per copy from Analog Devices Inc., P. O. Box 796, Norwood, Mass. 02062.

**Converters.** An eight-page brochure covers information on isolation voltage-to-frequency converters. It explains their best use and the resulting problem of high common-mode rejection. Absolute maximum ratings for high- and standard-isolation models and typical applications are given. Dynamic Measurements Corp., 6 Lowell Ave., Winchester, Mass. 01890 [440]

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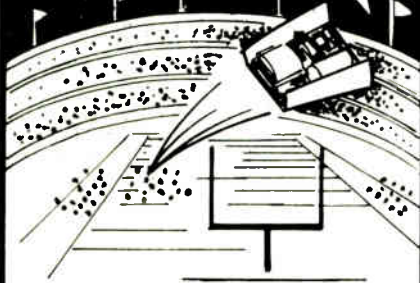
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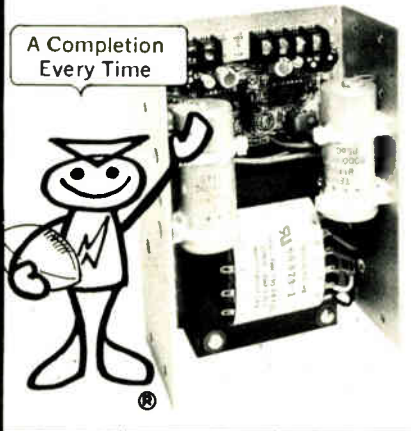
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QD12/15-3.0	±12 to ±15/3.0	79	67	64
QT-1	5/3.0 ±12 to ±15/0.5	69	66	65
QT-2	5/6.0 ±12 to ±15/1.0	89	82	79
QT-3	5/9.0 ±12 to ±15/1.0	113	104	100
QT-4	5/12.0 ±12 to ±15/3.0	159	143	133
MPS-1	5/3.0; 12/0.6 9 to 12/0.6 or 5/0.38	79	78	77
MPS-2	5/7.0; 12/1.0 9/1.2 or 5/0.75	95	91	88

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## New books

**Fuel Cells for Public Utility and Industrial Power**, Robert Noyes, ed. Noyes Data Corp. (Park Ridge, N. J.), 322 pp., \$42.00.

**Electronic Processes in Unipolar Solid-State Devices**, Dan Dascalu, Abacus Press, 624 pp., \$45.50.

**Microcomputer Design and Applications**, Samuel C. Lee, ed., Academic Press, 346 pp., \$14.50.

**Information Mechanics**, Frederick W. Kantor, John Wiley & Sons, 397 pp., \$21.95.

**Computer-Communication Network Design and Analysis**, Mischa Schwartz, Prentice-Hall Inc., 372 pp., \$18.95.

**Topics in Applied Physics, Vol. 17: Electroluminescence**, J. I. Pankove, ed., Springer-Verlag, Berlin, Heidelberg, and New York, 214 pp., \$30.40.

**Microprocessors from Chips to Systems**, Rodney Zaks, Sybex Inc. (Berkeley, Calif.), 415 pp., \$9.95 (paper).

**Angle Modulation, The Theory of System Assessment**, J. H. Roberts, Peter Peregrinus Ltd. (IEEE), 278 pp., \$27.50.

**Logic Designer's Manual**, John D. Lenk, Reston Publishing Co. (Prentice-Hall), 504 pp., \$18.95.

**Spectrum Management Techniques, Multi-Volume EMC Encyclopedia Series, Vol. 2**, Donald M. Jansky, Don White Consultants Inc. (Germantown, Md.), 200 pp., \$25.00

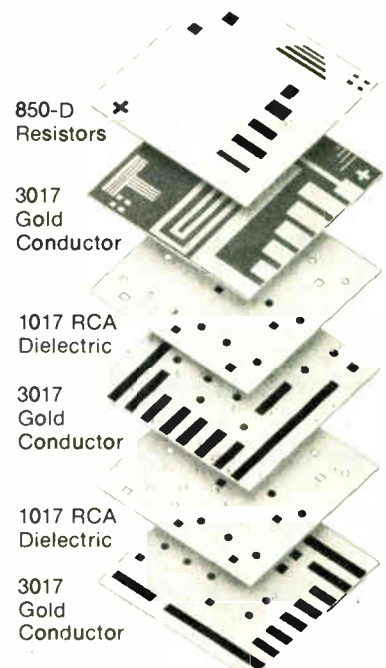
**Digital Modulation Techniques in an Interference Environment, Multi-Volume EMC Encyclopedia Series, Vol. 9**, Kamilo Feher, Don White Consultants Inc., 200 pp., \$25.00.

**Modern Crystal and Mechanical Filters**, Desmond F. Sheahan and Robert A. Johnson, eds., IEEE Press (distributed by John Wiley & Sons), 455 pp., \$12.95 (paper).

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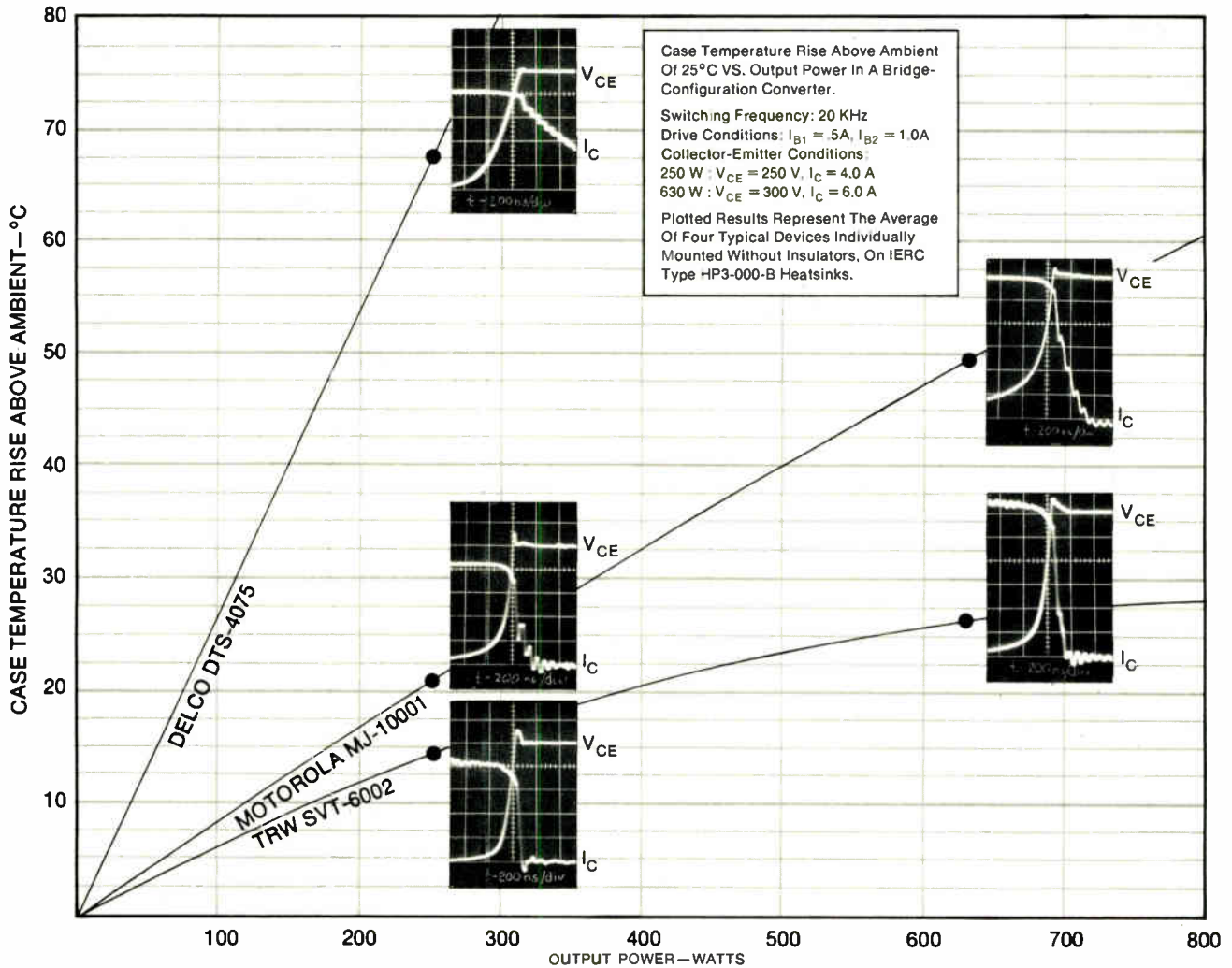
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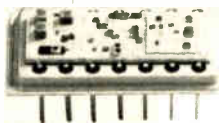
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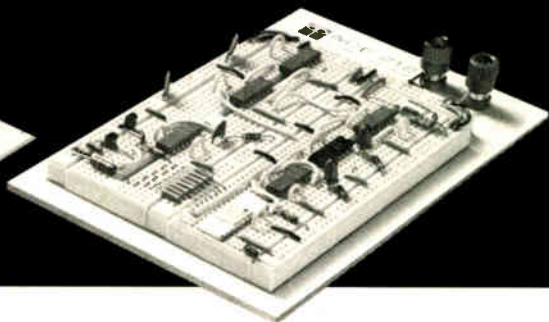
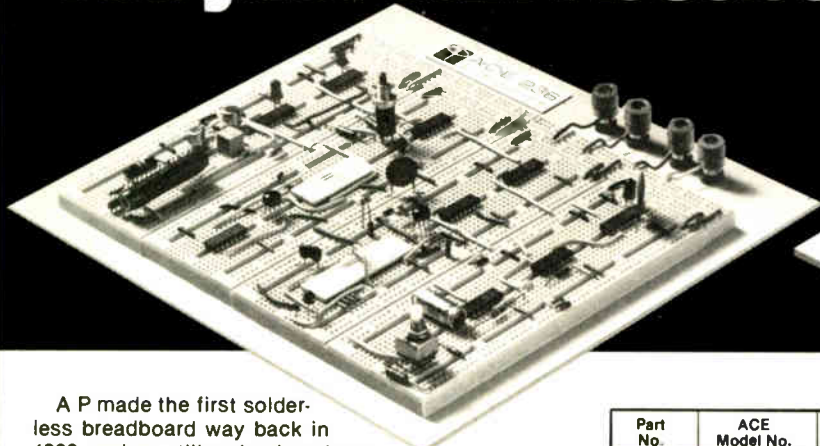
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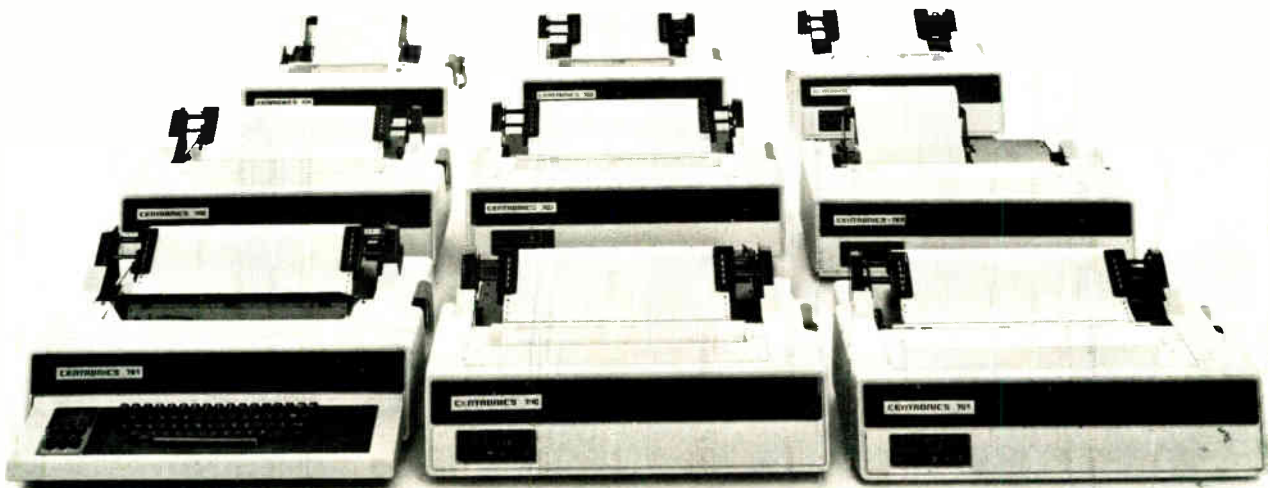
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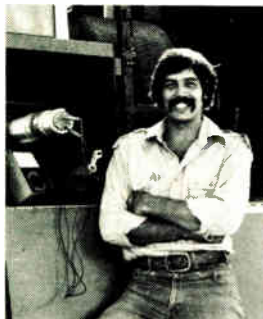
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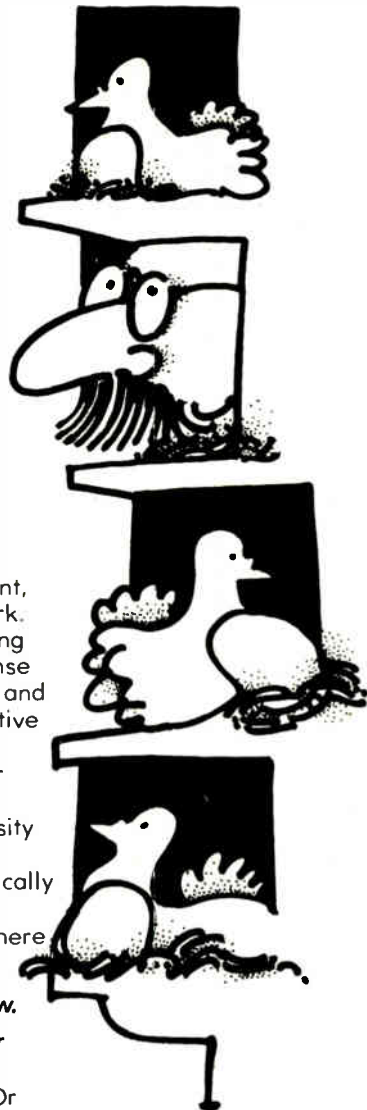
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■ Abbott Transistor Labs	6	■ Electro Scientific Industries	172	■ M.S. Kennedy Corp.	188
• Adret Electronique	64,22E	■ Elec-Trol, Inc.	91	■ Kepco, Inc.	5
Advanced Micro Devices	10-11	■ Elevam Electronic Tube Co., Ltd.,	224	■ Lambda Electronics	203-216
Airborn Inc.	155	■ EMR-Telemetry	224	■ Lear Siegler—Data Products Div.	231
■ Allen-Bradley	34	■ Electronic Navigation Industries	148	■ Litronix	163
■ American Optical—Scientific Instr. Div.	179	■ Elorg Electronorgtechica	142	• Magneti Marelli	16E
■ Amp, Inc.	28-29	■ Erie Technological Products	180	■ Matsuo Electric Co., Ltd.	14E
Amphenol North America Division, Bunker Ramo Corporation	70-71	■ Esterline Angus	219	■ MDB Systems	251
■ A P Products, Incorporated	236	■ Fairchild (Semiconductor Operations Division)	7	■ MFE Corp.	136-137
Applied Digital Data Systems	51	■ Fairchild Systems Technology	157	■ Micro Components Corporation	170
■ Augat, Inc.	181	■ Ferranti-Packard Ltd.	202	■ Micro Power Systems	77
AVX Corporation	92	‡ Ferroxcube Corp., A Div. of North Amer. Philips	80	■ Microswitch, Div. of Honeywell	174-175
The Bendix Corporation, Electrical Comp. Div.	195	■ Figaro Engineering, Inc.	8	■ Micro Technical Industries	8
Berg Electronics Div. of Dupont	183	■ Fujitsu America Inc.	83	■ Microtest Systems, Inc.	138-139
Blomation	178	■ Futek	192	■ Microwave Power Devices	34E-35E
Boonton Electronics	133	• GEC M-O Valve	61	■ Mitel Semiconductor, Inc.	54
■ Bourns, Inc.	3rd c.	■ General Electric Miniature Lamp	220	■ Monolithic Memories	38-39
‡ Bud Industries, Inc.	30	■ GE Plastics	189	■ Monsanto Company	150-151
■ Bulltronics	250	■ General Instrument, Microelectronics	27	■ Motorola Communications & Electronics	218
• Burr Brown	4E	■ General Magnetics	252	■ Motorola Semiconductor Products	85
■ Cambridge Thermionic Corp.	154	■ GenRad	193	■ Murata Mfg. Co., Ltd.	30
• Carlo Erba SA	68	■ Grayhill, Inc.	79	‡ National Connector	62
■ Centralab/USCC	177	‡ Grundy International Inc.	64	‡ NEC Microcomputers	67
■ Centronics	237	■ Hewlett-Packard	17-26	• NEOHM SPA	69
■ Cherry Electrical Products	2	■ Hipotronics	248	■ New Bedford Ind Devel Commission	194
■ Chomerics Inc.	184	■ Honeywell TID	173	■ Nichicon America Corporation	168
■ Clairex Electronics	4th c.	■ Hughes Aircraft	180, 192, 200	■ Nicolet Instrument Corp., Oscilloscope Div.	201
■ C.P. Clare International	19E	■ Icom, Inc.	167	■ Non-Linear Systems, Inc.	196
• Communication Associates Inc.	15	■ ILC Data Device Corporation	55	■ North Atlantic Industries	82
Continental Rentals, Div. Continental Resources	8, 17E	■ A.L.S. Corporation for Infotek	224	• Oscilloquartz	67
‡ Cutler-Hammer, Specialty Products Division	92-93	■ Instrumentation Engineering	47	■ Ostby & Barton	196
■ Dana Labs	169	■ Intel-Microcomputer Components	96-97	‡ Panasonic, Industrial Div.	68-69
■ Data I/O Corporation	159	■ International Microcircuits Inc.	222	■ Pearson Electronics	192
■ Delevan Div., American Precision Ind.	182	■ Intersil	56-57	• Philips ELA	5E
■ Deltron, Inc.	234	■ Interstate Electronics	229	• Philips Elcoma	6E
■ Dialight	199	■ Intronics	228	• Philips Industries	20E-21E
■ Digi-Data Corp.	191	• Italtel/SIT	31E, 36E	• Philips TMI	15E
■ Digital Equipment Components	1, 2nd c.	■ C. Itoh & Co., Ltd.	198	■ Plastics Engineering Company	158
‡ Eastman Kodak Co., Graphic Markets Division	15	• Kennedy Company	93	■ Power One Inc.	32-33

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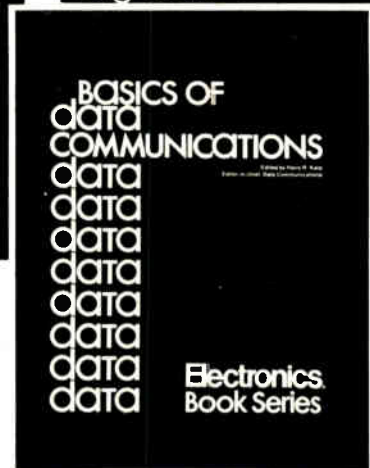
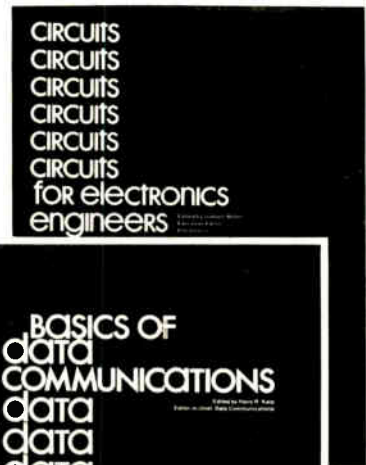
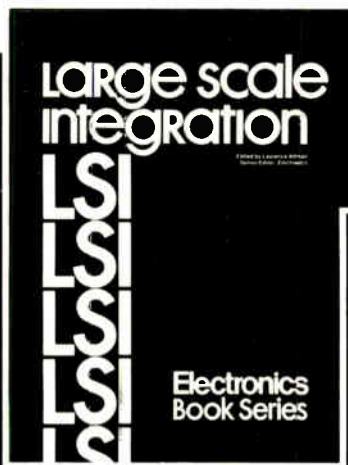
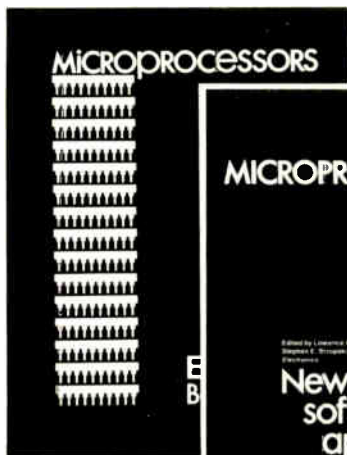


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Practical Automation	251	■ Tecnetics	160
■ Precision Monolithics Inc.	72-73	■ Tektronix	140, 13, 45
• Procond S.P.A.	18E	Teledyne Philbrick	236
Pro-Log	40	Teledyne Relays	31
‡ Profit by Air Inc.	124	Teletype	171
• Quest Automation	29E	Telonic Berkeley	223
• Racal Thermionic Ltd.	2E-3E	Teradyne, Inc.	74, 146-147
• Radiohm S.A.R.L.	23E	Ti, Components	185
Ramtek	88-89	Ti, Digital Systems Div.	186
Raytheon Co. Industrial Components	124	Textool Products, Inc.	14
• RCA Electro Optics & Devices	8E-9E	■ Theta Instruments	162
RCA Solid State	9, 49	Thick Film Systems, Inc.	234
Rhone Poulenc-Chimie Fine	190	■ TRW Capacitors	161
Riken Denski Co., Ltd.	12E	■ TRW LSI Products	134-135
Robinson Nugent, Inc.	94-95	■ TRW Power Semiconductors	235
• Rohde & Schwarz	1E	TRW Cinch Connectors	187
Sangamo Data Recorder Division	149	TRW/UTC Transformer	80
• Hans Scheffer	27E	Ultra-Violet Products, Inc.	222
Scientific Atlanta, Optima Div.	156	Union Carbide Corp., Parylene	197
• Sfernice	17E	United Detector Technology	232
• SGS ATEs	11E	United Systems Corp., Sub. Monsanto	116
• Siemens AG Munich	62	Universal Instruments	153
‡ Signetics Corporation	37, 143	Vector Electronics	168
• Silec Thomson	25E	Velonex, Inc.	198
Siliconix	122-123	Viking Industries	233
• Sivers Labs	13E	‡ Wabash Electronics	61
• Sodoco	33E	Wavetek Indiana	37, 98
Solid State Scientific	131	Wilhelm Westermann	16
Sorenson, Div. of Raytheon	53	Zero Corporation	152
Spectrol Electronics	221	<b>Classified and employment advertising</b>	
Spectronics, Inc.	230	F. J. Eberle, Manager 212-997-2557	
Sperry Univac	87	Atomic Personnel	246
• SPI ITT	24E	BBC Brown Boveri & Co., Ltd.	243
Sprague Electric	58	Burns & Roe	246
Standard Microsystems	145	Data General	241
Syston-Donner, Concord	226-227	Electro-Films	242
Syston-Donner, Data Products Div.	230	GTE Automatic	245
■ Tansitor Electronics	166	General Research Corp	242
TEAC Corporation	225	Hughes Aircraft Co.	239
		Harris Corporations	242
		ITT Systems	244
		Information Terminals Inc.	240
		Rockwell International	240
		Semtech Corporation	246
		Schlumberger Electrical Engineers	238
		Teledyne Philbrick	240
		Varian	242
		The Wescott Agency	246
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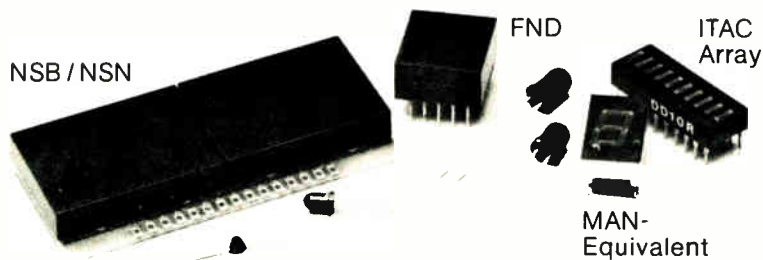
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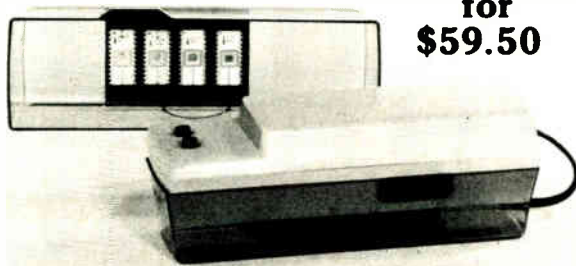


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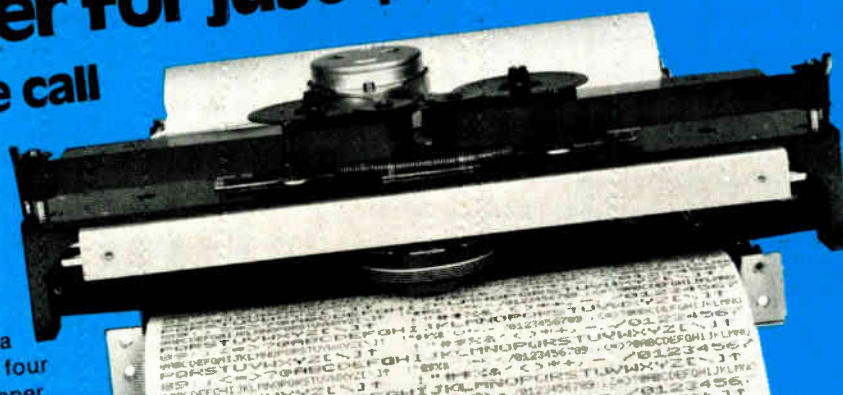
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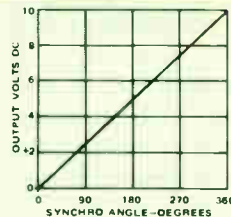
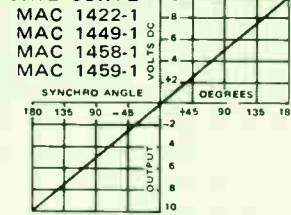
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## RESPONSE CURVE

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MAC 1461-1

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- Output short circuit protected
- Three wire inputs isolated from ground
- Package size may be altered at no extra cost
- Units can be altered to accept different line to line voltages or different operating frequencies at no extra cost
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UNIT	MAC 1422-1	MAC 1449-1	MAC 1458-1	MAC 1459-1	MAC 1460-1	MAC 1461-1
TRANSFER EQUATION	$\pm 1V/18^\circ$	$\pm 1V/18^\circ$	$\pm 1V/18^\circ$	$\pm 1V/18^\circ$	$+1V/36^\circ$	$+1V/36^\circ$
ACCURACY (+25°C)	½%	½%	½%	½%	½%	½%
ACCURACY (-25°C+85°C)	1%	1%	1%	1%	1%	1%
L - L SYNCHRO INPUT (VRMS)	11.8	90	11.8	90	11.8	90
FREQUENCY (Hz)	400	400	60	60	400	400
FULL SCALE OUTPUT	$\pm 10V$	$\pm 10V$	$\pm 10V$	$\pm 10V$	+10V	+10V
OUTPUT IMPEDANCE	$<1\Omega$	$<1\Omega$	$<1\Omega$	$<1\Omega$	$<1\Omega$	$<1\Omega$
L - L INPUT IMPEDANCE	$>10K$	$>30K$	$>2K$	$>10K$	$>10K$	$>30K$
REFERENCE VOLTAGE (VRMS)	26	115	26	115	26	115
OPERATING TEMP. °C	-25 - +85	-25 - +85	-25 - +85	-25 - +85	-25 - +85	-25 - +85
D.C. SUPPLY	$\pm 15V$	$\pm 15V$	$\pm 15V$	$\pm 15V$	$\pm 15V$	$\pm 15V$
D.C. SUPPLY CURRENT	$\pm 75MA$	$\pm 75MA$	$\pm 75MA$	$\pm 75MA$	$\pm 75MA$	$\pm 75MA$
BANDWIDTH	10Hz	10Hz	OPT.	OPT.	10Hz	10Hz
WEIGHT	6 oz.	6 oz.	6 oz.	8 oz.	6 oz.	6 oz.
SIZE	3.6x2.5x0.6	3.6x2.5x0.6	3.6x3.0x0.6	3.6x3.0x1.0	3.6x2.5x0.6	3.6x2.5x0.6

## A.C. LINE REGULATION

A new method has been developed which allows us to provide a low distortion highly regulated AC waveform without using tuned circuits or solid state active filters of any kind.

The result is a frequency independent AC output regulated to 0.1% for line and load with greater than 20% line variations over a wide temperature range.

## FEATURES:

- 0.1% total line and load regulation
- Independent of  $\pm 20\%$  frequency fluctuation
- 1 watt output
- Extremely small size
- Isolation between input and output can be provided

Specifications: Model MLR 1476-1  
AC Line Voltage: 26V  $\pm 20\%$  @  
400Hz  $\pm 20\%$

Output: 26V  $\pm 1\%$  for set point

Load: 0 to 40ma

Total Regulation: +0.1%

Distortion: 0.5% maximum rms

Temperature Range: -55° C to  
+125°C

Size: 2.0" x 1.8" x 0.5"

Other units are available at different power and voltage levels as well as wider temperature ranges. Information will be furnished upon request.

## High Precision Analog Multipliers

PRODUCT ACCURACY (MCM 1519-1)  $\pm 1\%$  OF ALL THEORETICAL OUTPUT VALUES OVER FULL MILITARY TEMPERATURE RANGE OF -55 C TO +125 C. ZERO POINT ERROR FOR ANY INPUT COMBINATION IS  $\pm 2MVRMS$



## Features:

- No external trims required
- Distortion free AC output over entire dynamic range
- Linearity, product accuracy and zero point virtually unaffected by temperature
- All units are hermetically sealed and are not affected by external fields
- High analog product accuracy and wave quality allows dual multiplier assemblies to be matched with 1% of point over the specified temperature range
- Full four quadrant operation
- Package size, power supply requirements and other specs. may be altered to your exact requirements at no extra cost.

## Specifications:

- Transfer equation:  $E_o = XY/10$
- X & Y input signal ranges: 0 to  $\pm 10V$  PK
- Maximum zero point error (X=0; Y=0 or X $\pm 10$ ; Y=0 or X=0; Y $\pm 10$ ): 2MVRMS
- Input impedance: Both inputs 20K min.
- Full scale output:  $\pm 10V$  peak
- Minimum load resistance for full scale output: 2K $\Omega$
- Output impedance: 1 $\Omega$
- Short circuit duration: 5 sec.
- Frequency response characteristics (both inputs) 1% amplitude error: DC to 1200 Hz (min.) 0.5 DB Amplitude error: DC to 3500 Hz min. 3 DB point: Approx. 10K hz Roll off rate: 18 DB/octave
- Noise Level: 5MV PK-PK @ 100K Hz approx.
- Operating temp. range: See chart
- Storage temperature range: -55°C to +125°C
- DC Power:  $\pm 15V \pm 1\%$  @ 30MA
- Dimensions: 2" x 1.5" x .6"

Type No.	Product Accuracy	Operating Temperature Range
MCM 1519-1	0.5%	-55 C +125 C
MCM 1519-2	0.5%	-25 C +85 C
MCM 1519-3	0.5%	0 C +70 C
MCM 1520-1	1.0%	-55 C +125 C
MCM 1520-2	1.0%	-25 C +85 C
MCM 1520-3	1.0%	0 C +70 C

There is No Substitute for Reliability



# GENERAL MAGNETICS • INC

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Estimate number of employees (at this location): 1.  under 20 2.  20-99 3.  100-999 4.  over 1000

1 16 31 46	61 76 91 106	121 136 151 166	181 196 211 226	241 256 271 348	363 378 393 408	423 438 453 468	483 498 703 718
2 17 32 47	62 77 92 107	122 137 152 167	182 197 212 227	242 257 272 349	364 379 394 409	424 439 454 469	484 499 704 719
3 18 33 48	63 78 93 108	123 138 153 168	183 198 213 228	243 258 273 350	365 380 395 410	425 440 455 470	485 500 705 720
4 19 34 49	64 79 94 109	124 139 154 169	184 199 214 229	244 259 274 351	366 381 396 411	426 441 456 471	486 501 706 900
5 20 35 50	65 80 95 110	125 140 155 170	185 200 215 230	245 260 275 352	367 382 397 412	427 442 457 472	487 502 707 901
6 21 36 51	66 81 96 111	126 141 156 171	186 201 216 231	246 261 338 353	368 383 398 413	428 443 458 473	488 503 708 902
7 22 37 52	67 82 97 112	127 142 157 172	187 202 217 232	247 262 339 354	369 384 399 414	429 444 459 474	489 504 709 951
8 23 38 53	68 83 98 113	128 143 158 173	188 203 218 233	248 263 340 355	370 385 400 415	430 445 460 475	490 505 710 952
9 24 39 54	69 84 99 114	129 144 159 174	189 204 219 234	249 264 341 356	371 386 401 416	431 446 461 476	491 506 711 953
10 25 40 55	70 85 100 115	130 145 160 175	190 205 220 235	250 265 342 357	372 387 402 417	432 447 462 477	492 507 712 954
11 26 41 56	71 86 101 116	131 146 161 176	191 206 221 236	251 266 343 358	373 388 403 418	433 448 463 478	493 508 713 956
12 27 42 57	72 87 102 117	132 147 162 177	192 207 222 237	252 267 344 359	374 389 404 419	434 449 464 479	494 509 714 957
13 28 43 58	73 88 103 118	133 148 163 178	193 208 223 238	253 268 345 360	375 390 405 420	435 450 465 480	495 510 715 958
14 29 44 59	74 89 104 119	134 149 164 179	194 209 224 239	254 269 346 361	376 391 406 421	436 451 466 481	496 701 716 959
15 30 45 60	75 90 105 120	135 150 165 180	195 210 225 240	255 270 347 362	377 392 407 422	437 452 467 482	497 702 717 960

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### CATALOG SHEET SPECIFICATION COMPARISONS

CHARACTERISTIC	BOURNS 3355	CTS 201*	MEPCO 46X*	PIHER PT15*
Element	Conductive Plastic	Carbon	Carbon	Carbon
Temperature Coefficient	500 PPM/°C	No Spec	No Spec	1000 PPM/°C
Contact Resistance Variation	1.0% max.	No Spec	No Spec	No Spec
Power Rating	.25 W at 70°C	.25 W at 55°C	.25 W at 55°C	.25 W at 40°C
Flammability	UL-94V-1	No Spec	No Spec	UL-94
Board Wash Capability	Yes	No Spec	No Spec	No Spec

\*Source: CTS Series 201 Data Sheet, Mepeco Data Sheet ME1004, Piher Data Sheet F-20C2 Rev 7/73



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The Clairex series of opto-isolators with a darlington output provide a wide range of controlled transfer ratios at 1 mA and 10 mA with an ultra high transfer ratio of 600% at 1 mA and 800% at 10 mA, to min. levels of 100%, 200% respectively at 1 mA and 10 mA. All units feature a 2500 volt P.V.A.C. isolation voltage.

**ABSOLUTE MAXIMUM RATINGS**  
 Maximum Temperature: 55°C to +150°C  
 Storage Temperature: -100°C  
 Operating Junction Temperature: +100°C  
 Lead-solder temperature: 260°C for 10 sec.

**EMITTER (GaAs Diode)**  
 Power Dissipation: At 25°C ambient P<sub>T</sub>: 100mw, derate linearly 1.33mw/°C  
 Maximum Voltage: V<sub>BE</sub> Reverse Voltage: 3.0 volts  
 Maximum Current: I<sub>F</sub> DC Forward Current: 60mA (continuous)

**DETECTOR (NPN Silicon Planar Photo darlington)**  
 Power Dissipation: At 25°C ambient P<sub>T</sub>: 200mw, derate linearly 2.0mw/°C  
 Maximum Current: I<sub>C</sub>: 200mA (Pulsed)

Symbol	Characteristics	CLI-10		CLI-11		CLI-12		CLI-13		CLI-14		Units
		Min	Max	Min	Max	Min	Max	Min	Max			
V <sub>t</sub>	Forward Voltage	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	volts	
I <sub>w</sub>	Emitter Current	10	10	10	10	10	10	10	10	10	mA	
BV <sub>ceo</sub>	Collector to Emitter Breakdown Voltage	50	50	50	50	50	50	50	50	50	volts	
V <sub>ce0</sub>	Emitter to Collector Breakdown Voltage	50	50	50	50	50	50	50	50	50	volts	
V <sub>ce (SAT)</sub>	Collector to Emitter Saturation Voltage	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	volts	
I <sub>sat</sub>	Base to Emitter Saturation Current	100	100	100	100	100	100	100	100	100	mA	
	Isolation Voltage	2500	2500	2500	2500	2500	2500	2500	2500	2500	volts PAC	
	Direct Current Transfer Ratio	100	100	100	100	100	100	100	100	100	%	
	Capacitance (Emitter)	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	pF	

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