APRIL 14, 1977

Electro77: NEW YORK EXPECTING A BIG TURNOUT/118

An SCR model for computer-aided design/100

Fast automatic wiring technique is self-testing/111

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Electronics

APPLIANCES

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Circle 900 on reader service card

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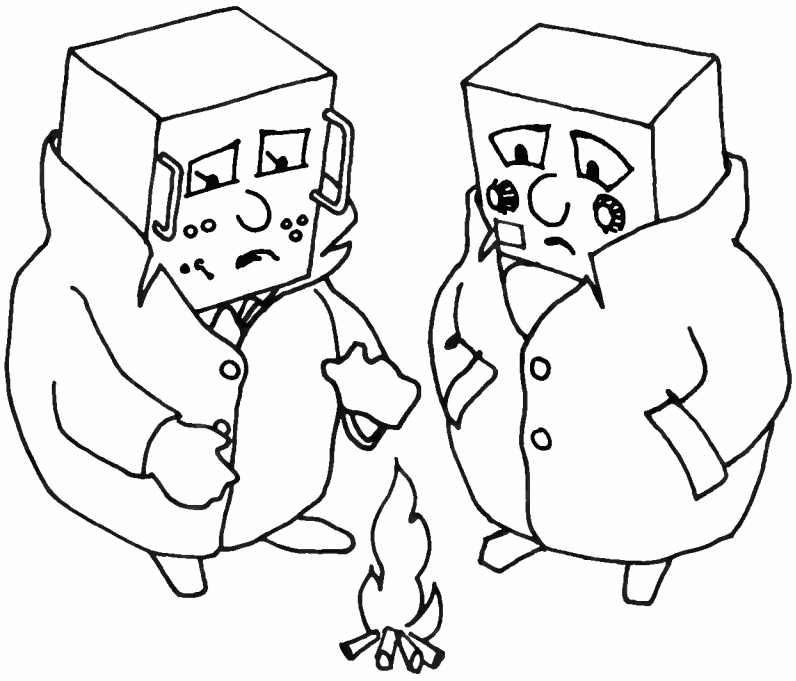

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Electronics
The International Magazine of Electronics Technology
Vol. 50, No. 8 • April 14, 1977

Highlights

Cover: LSI goes home, 91
The rush in home appliances is to replace electromechanical parts not just by solid-state controls but by large-scale-integrated circuitry. Programmable microwave ovens blazed the trail, and consumers' interest in reduced energy use and service costs is spurring appliance makers' LSI efforts.

Cover illustration is by Art Director Fred Sklenar.

IBM comes out fighting, 80
Packing together the introduction of a lower-cost, large-scale computer and a series of across-the-board price cuts, International Business Machines Corp. has roiled the dust for all its competitors. To what extent, though, there is no general agreement yet.

Automatic wiring process tests as it goes, 111
A new high-speed automatic wiring technique is the first to test its results at every step in the process. Solder-Wrap produces boards with high wiring and packing densities and very low profiles.

Sold-out Electro77 likely, 118
The IEEE's Electro show returns to the New York Coliseum with what looks to be a sold-out exhibit space. The technical sessions will cover the range from products to circuit design to careers. While microprocessors are again the favorite subject, almost every aspect of design from power supplies to bubble memories will be covered.

A report on product unveilings at Electro77 begins on p. 133.

And in the next issue . . .
LSI applications in telecommunications: a special report . . . a product update on counters . . . an easy-to-use 16,384-bit random-access memory.

Electronics

Publisher's letter

The annual show and convention of the Institute of Electrical and Electronic Engineers returns to New York on April 19, and the big question is whether the show will be more successful in New York than it has in the recent past. As we point out in the special show preview that starts on page 91, the big uncertainties still center around criticisms of the regional nature of the show, the type of people who are attracted to it, and the disinclination of some potential exhibitors to come to New York City.

Our show report presents an early look at what will be happening at the technical sessions. As you'd expect, microprocessors are going to be in for a lot of discussion, and other sessions range from computer-aided design to optical-fiber communications. All in all, 42 sessions—which include three on professional development and one on psychic research—will be held.

There's more to the show, of course. So, starting on page 133, we've assembled a preview of some of the more noteworthy products that will make their debut at Electro77.

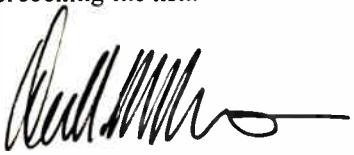
Microwave ovens are a great innovation, but, like many advances made possible by new technology, they take some getting used to. "When the microwave-oven makers say it's a whole new way of cooking, they're not kidding," comments Jerry Walker, consumer editor, who prepared the report on electronics in appliances (p. 91).

He recently borrowed a programmable microwave range for a few weeks in order to find out first hand how they perform. "My wife and I had no trouble programming the oven, but we both spent a lot of time learning what to program—how much time and what variable power setting to use for different foods," Jerry relates. "I'd advise anyone who buys a microwave oven not to plan on using it the first day. Allow 24 hours to read the operating instructions, the do's and dont's—and most important, the cook books. It's worth taking the time to avoid spoiling a meal."

The programmable feature helped Jerry in getting the hang of the range, especially in setting fast-cooking foods where a second or two makes a big difference. His wife wasn't really sure about microwave cooking. "She's an instinct cook who prefers to keep testing while something's on the stove. So the microwave range has been a challenge to her—opening and closing the door, resetting times, adding things during the cooking. Maybe the programmable capability, or at least the digital display and the countdown timer, was more of a help than she thought."

The biggest success, both Walkers agree, was vegetables, frozen and fresh, for all-around taste, appearance, and ease of cooking. The biggest flop: fish that was overdone and came out tasting like erasers.

"I suppose the success of the electronic control is that you are not aware of what it's doing," Jerry observes. "You're more concerned with adjusting to the speed—and not overcooking the fish."



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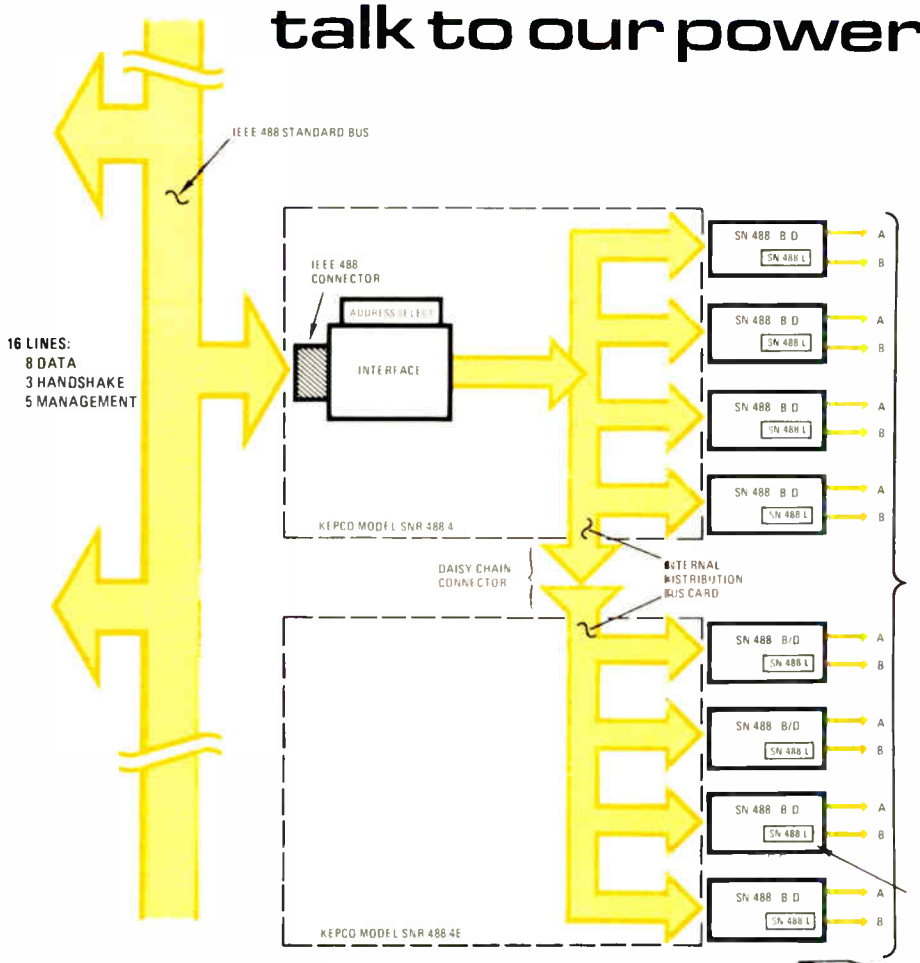

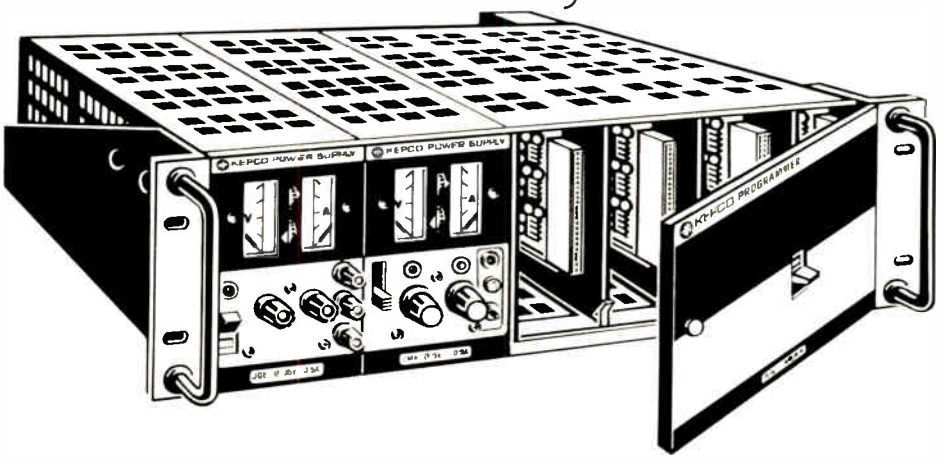

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Kepco's new SN-488 digital interface provides you with a convenient way to put our programmable power supplies on your General Purpose Interface bus. The model SN-488 responds to the "listen" instruction, provides the "handshake" interaction and gives you two addressable channels on each card. Up to eight cards can be addressed through a single bus connector.

Each channel provides 12 bits resolution with programmable range (10:1) and programmable polarity (for use with bipolar power supplies). Kepco makes hundreds of power supplies that can listen on your bus through the SN-488 interface: fast models, slow models, high voltage and low; unipolar, bipolar, voltage stabilizers and current stabilizers . . . power supplies designed for today's automatic test equipment.

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Circle 4 on reader service card

Readers' comments

Ford flies clean

To the Editor: Your otherwise timely article, "Satellite builders face lean years" [Feb. 17, p. 78], is unfortunately inaccurate in two regards. First, I believe that Ford Aerospace and Communications Corp. won a fair contest for the Intelsat 5 contract. To hint otherwise without substance presented is indeed unfair to all involved.

Second, the article incorrectly referred to Ford Aerospace and General Electric Co. as "fairly recent entries." GE has been building Nimbus and Landsat series for years, and Ford Aerospace (formerly Philco) built the world's first sophisticated communications satellite for the U.S. Army back in 1960. The company subsequently built the successful IDCSP series (predecessor of DSCAS II and III), only to be followed by the currently operational NATO communications-satellite series. (The latest NATO III-B was successfully launched at Cape Canaveral on Jan. 27.) Hardly newcomers at all, in either case.

J. T. Chiao
Sunnyvale, Calif.

■ *The article said price competition is soaring as the communications-satellite industry matures and technological capabilities equalize. Therefore, Ford's tactics in winning the bid were not considered unfair by its competitors. Ford and GE are not new to the field, since both had successful projects in the 1960s. However, until the early 1970s, they had not gone after the big commercial and military contracts. The story pointed out that their subsequent successful programs have further divided the business available.*

Who belongs to the IEEE?

To the Editor: There seems to be a mystery about why members of the Institute of Electrical and Electronic Engineers are so apathetic. To me, the answer seems quite clear, although I don't have sufficient data to prove my suspicions.

Over the past five years, I have worked for two major companies, and I have yet to meet a practicing EE designer who is a member of the

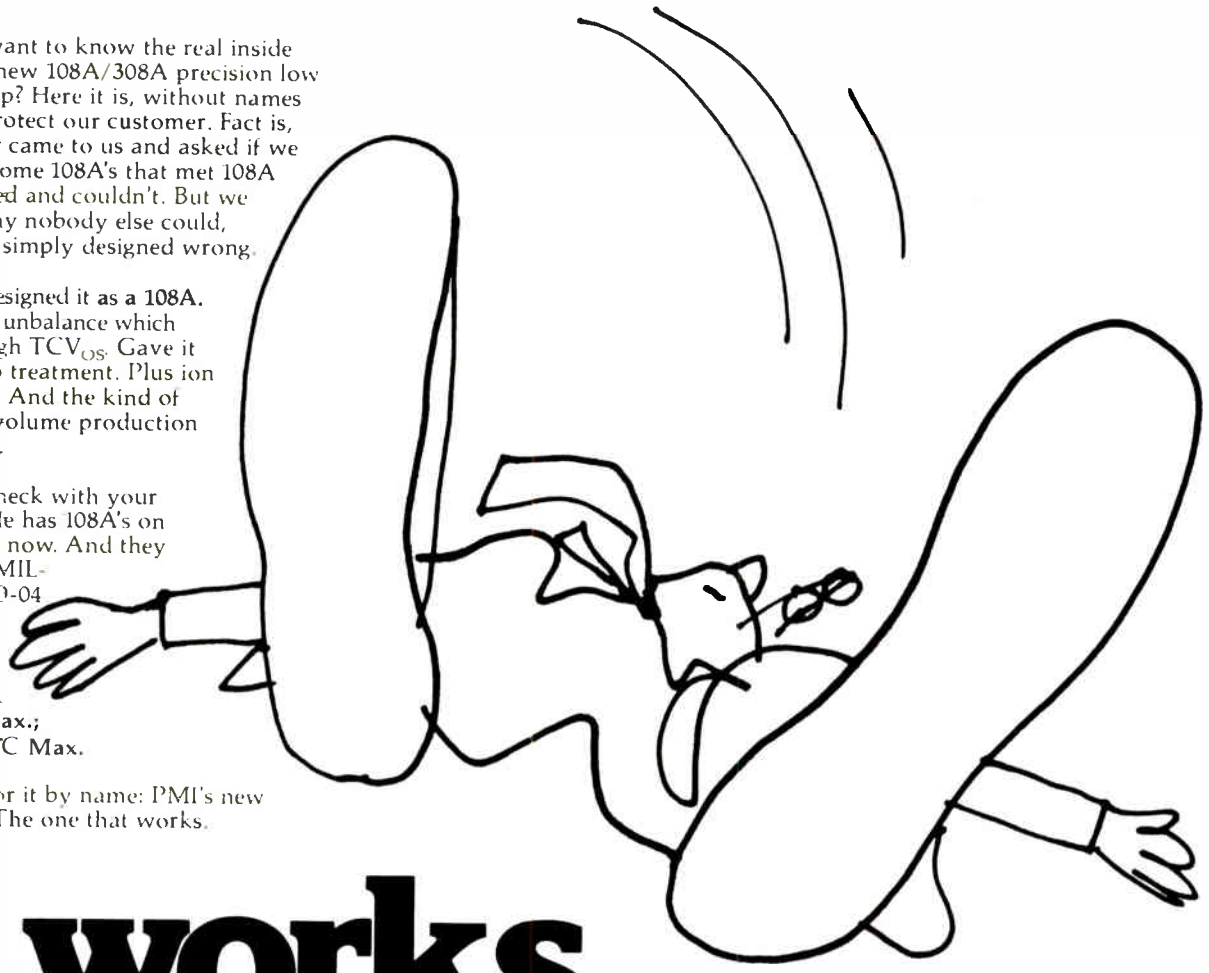
PMI announces the new 108A.

Do you want to know the real inside story of our new 108A/308A precision low power op amp? Here it is, without names in order to protect our customer. Fact is, this customer came to us and asked if we could make some 108A's that met 108A specs. We tried and couldn't. But we found out why nobody else could, either; it was simply designed wrong.

So we redesigned it as a 108A. Corrected the unbalance which caused the high TCV_{OS}. Gave it our zener zap treatment. Plus ion implantation. And the kind of pricing high volume production parts deserve.

Result? Check with your distributor. He has 108A's on his shelf right now. And they work. Up to MIL-M-38510/101D-04 specs. Processed to MIL-STD-883A Level B. V_{OS} 0.5mV Max.; TCV_{OS} 5μV/°C Max.

Just ask for it by name: PMI's new 108A/308A. The one that works.



It works.

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Readers' comments

IEEE. However, I have met physicists, chemical engineers, and managers (some of whom obtained an EE degree along the way) who are members. If this is characteristic of the organization nationwide, it seems only logical that the plight of EEs is a matter of apathy for the majority of IEEE members.

It would be quite interesting for someone to conduct a nationwide poll among practicing EE designers to find out what percentage are members of the IEEE. Also, it would be interesting to conduct a poll among IEEE members to see what percentage are practicing EE designers. If my suspicions are correct, we will have an answer to the mystery of member apathy.

Clyde T. Eisenbeis
3M Center
St. Paul, Minn.

Raster scan reconsidered

To the Editor: The article "Which data-terminal display: plasma panel or CRT?" [Feb. 17, p. 91] ignores the raster-scan cathode-ray-tube display, claiming its memory requirements are excessive. This is not true.

For a 512-by-512 matrix, we must store 2^{18} bits. This much data can be stored in 16 16,384-bit random-access memories. Refresh circuits for the RAMs are not needed, as the regular accesses for the raster scan easily meet the refresh requirements.

The entire display can be built with less than 100 integrated circuits, while the plasma panel needs ICs to drive its 1,024 X-axis and Y-axis electrodes. Even with octal drivers (if they exist), this takes 128 driver packages.

Peter T. Anderson
Electronic Educator Inc.
Burlington, Vt.

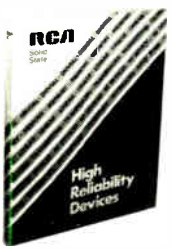
■ **The author replies:** *Most minicomputers do not have 16-k words of memory. More to the point, a raster-scan CRT will require more memory, have much the same viewing characteristics, and be somewhat more difficult to control than a comparable random-access CRT display. These are the reasons for the comment in the article and the decision not to further consider the raster-scan CRT display.*

What's new in High-Rel circuits...

RCA COS/MOS: Zero failures in 100,000,000 hrs.

RCA High-Rel COS/MOS circuits in 10 satellites have operated for over 100,000,000 device-hours —with zero failures. That's an MTTF of 108,000,000 hrs. A failure rate of 0.00092%/1000 hrs.

Meanwhile, back on Earth, we qualified 23 COS/MOS devices to QPL Part I of MIL-M-38510. Here again, zero functional rejects. MTTF was 75,000,000 hrs. Failure rate, 0.0013%/1000 hrs.



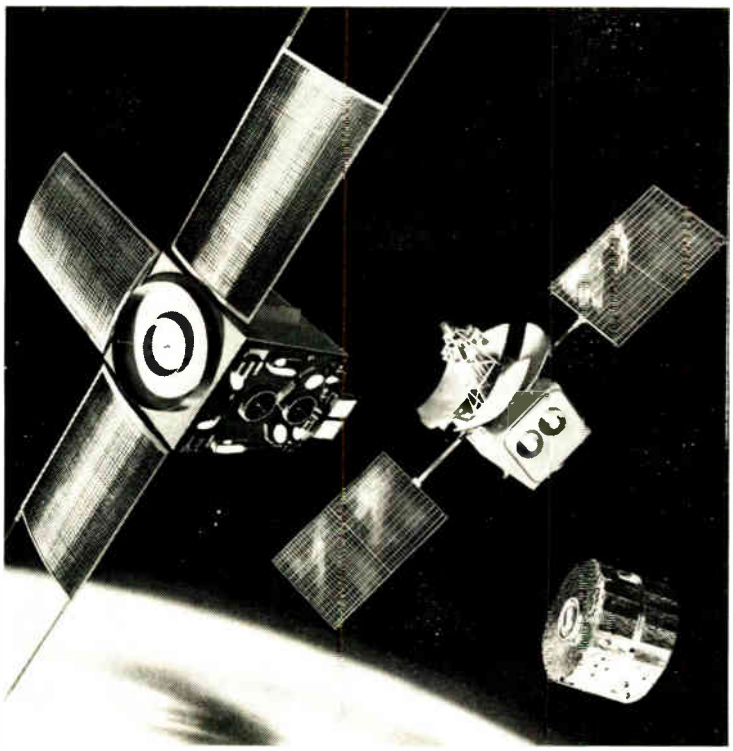
More solid proof of the inherent reliability of this technology. Which also brings you low power, high noise immunity and many other benefits. You can learn more about RCA High-Rel products in our latest High-Rel databook SSD-230. To get your copy, contact your local RCA Solid State distributor. Or RCA. If you want to discuss High-Rel COS/MOS, call Marty Vincoff in Somerville, NJ, on (201) 685-6650.

The COS/MOS devices in this table were of the CD4000 Series, processed to Class A requirements of MIL-M-38510 or MIL-STD 883.

Satellite	OSCAR-6	ITOS Series D; F; G; H	Atmospheric Explorer Series C; O; E	SATCOM Series F1; F2
Time in orbit (mo.)	32	85.5	49.5	16.5
Number of COS/MOS devices	90	168	7,200	1,652
Device-hours	2,073,600	2,585,520	85,536,000	9,812,880
Number of failures	0	0	0	0
Failure rate (%/1000 hours)	0.045	0.035	0.001	0.0092
MTTF (hours)	2,360,000	29,000,000	96,000,000	10,750,000

Total device hours: 100,000,000 (Data at 60% confidence, usage thru Nov. 1, 1976)

Failure rate: 0.00092%/1000 hrs. MTTF: 108,000,000 hrs.



Write: RCA Solid State. Box 3200, Somerville, NJ 08876; Sunbury-on-Thames, Middlesex TW16 7HW, England; Ste.-Anne-de-Bellevue, Quebec, Canada; Fuji Bldg., Tokyo, Japan.

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We make two quad receivers and one driver. The Am26LS32 receiver meets the EIA RS-422 specs; the Am26LS33 receiver meets military needs, and the Am26LS31 driver meets both.

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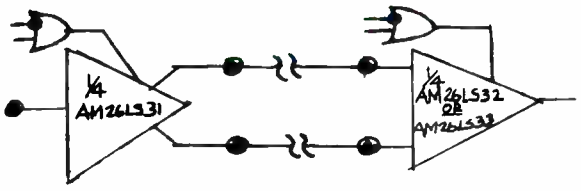

Am26LS31
1. Low output skew rate 2ns typical.
2. Input-to-output delay 12ns typical.
3. Outputs won't load the line when Vcc equals 0.
4. High output drive capability for 50 Ohm transmission lines.

Am26LS32
1. The EIA RS-422 driver—the spec is ±200mV threshold over ±7V common mode range.

Am26LS33
It has ±500mV threshold over ±15V common mode range over the military temperature range.

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1. 6K Ohm minimum input impedance.
2. High-speed 17ns typical propagation delay.
3. Failsafe mechanism that notifies the machine of transmission difficulties.
4. 30mV input hysteresis.

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All three parts are three-state output; they all work off a 5-volt power supply and they're all TTL compatible. Wow!

Now them. One competitor makes duals but no quads. Another makes quads but no military quads. And the third makes neither.

Why are we giving things away? Have we lost our senses?

No. Here's what we figure: You decide to check out our parts. We send you a free pair. You look over the data sheets. You test the parts. And you're absolutely amazed. You take out your order book and write down "One Carload of AMD's Terrific Quad Line Drivers and Receivers."

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Circle 274 on reader service card

News update

■ Some 433 jobs (all civilian) will be eliminated and another 598 jobs transferred as the result of a planned reorganization of the U.S. Army Electronics Command at Fort Monmouth, N.J. The restructuring, to be phased over a three-year implementation period, will create three new commands and, according to the Army, will result in an estimated annual savings of $6.5 million after a one-time realignment cost of about $14.7 million.

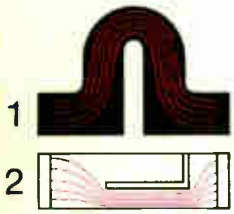
The restructuring, pending for nearly one year, sees the formation of a new Electronics Research & Development Command (Eradcom) that will perform all of the Army's non-communications electronics research, development, and acquisition functions. A new Communications Research & Development command (Coradcom) and new Communications & Electronics Materiel Readiness Command (Cercom) will accomplish the communications R&D, acquisition, and all logistics.

At Fort Monmouth, a total of 740 civilian jobs will be affected, 516 by transfer and 224 by elimination, while 16 military jobs will be transferred.

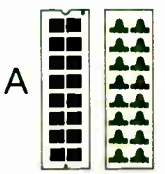
The headquarters for both Coradcom and Corcom are to be formed in fiscal 1977 at Fort Monmouth from existing ECOM resources, which at the beginning of the fiscal year were forecast to include $600 million for procurement and $373 million for R&D. The operating elements of Coradcom will remain at Fort Monmouth, and the Cercom will include all the Electronics Command's logistics elements now at Fort Monmouth and those at Fort Huachuca, Ariz., and the Sacramento (Calif.) Army Depot.

Eradcom headquarters will be located at Adelphi, Md., where the Harry Diamond Laboratories are now located. The bulk of the Combat Surveillance/Target Acquisition and Electronic Devices laboratories will continue to operate at Fort Monmouth, while the functions associated with laser and related technologies are being relocated from Fort Monmouth and Adelphi to Fort Belvoir. **Bruce LeBoss**

A revolutionary idea. Stackpole "top-hat" networks prove you can get more resistance on less real estate.



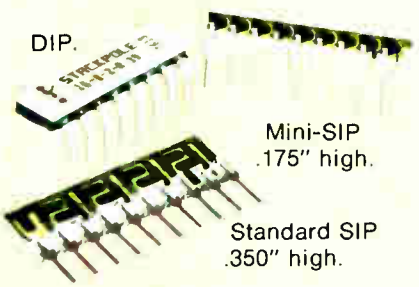
Compare (1) our "top hat" to (2) a standard "L"-cut and you see why ours dissipates more heat, faster. On a much longer resistance path.



(A) Standard thick-film networks have more hot spots, current crowding higher capacitance than (B) our "top-hat" network.

Flip our network's lid and you can see why. It's revolutionary.

The more our unit is trimmed, the better your resistance. So ratings of 200 watts/in² are very realistic.



The secret is in the simple laser cut in the middle of each "hat." In this and its horizontal geometry you get lower capacitance without hot spots, current crowding, or the other power-robbing things built into conventional networks.

Now you can get equal resistance in less space. Or greater resistor network performance in the same space.

We're out to tip our "hat" to you. With a full range of values, tolerances, sizes. In single or dual in-line networks, custom designs and even mini-SIPs that are only .175 inch high.

Ask for a free sample of a revolutionary idea. Stackpole Components Company, P.O. Box 14466, Raleigh, N.C. 27610. (919) 828-6201.

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People

Ramey: digital designs boost sales of development systems

"In five years, the market for digital development instruments will probably be as big as today's oscilloscope market"—$250 million.

That is the opinion of Jerry Ramey, the man whom the world's No. 1 scope maker, Tektronix Inc., has picked to head Logic Development Products, a newly formed business group that is going after this new market. Ramey, a 10-year Tek veteran, already has his first new-product introduction under his belt—the 8000-series microcomputer-development system [*Electronics*, March 31, p. 122]. This general-purpose system eventually will support as many as 10 to 15 different microprocessors with software-development aids and in-circuit emulation. The logic-analyzer family, which Tek introduced earlier, also has been placed in Ramey's group as a natural match for the development systems.

Spectrum. Ramey, 34, sees the new class of digital instruments spanning a spectrum of applications—logic analysis of pure hardware at one end and analysis and debugging of software at the other, with an area in between that involves tradeoffs between the two. The instruments will also introduce more interaction into the design process, Ramey continues, so the engineer can change the design as he analyzes and debugs it.

Tek had been thinking about a general-purpose development system for some time, Ramey says. "We did a lot of in-house work, and then looked outside the company before we met Millennium Information Systems at Wescon last year. We bought their basic system and redesigned it somewhat."

As of now, Ramey's major competitors are the semiconductor companies themselves, which have already offered development systems for their own devices. But, he says, many of them really would prefer not to be in that type of instrumentation business. Thus, he says, Tek is "getting a lot of activity from semiconductor manufacturers wanting us to support their products [with the microcomputer-development system]. Smaller manufacturers, in particular, gain quite a bit by having such support."

As for selling the market and keeping up with new microprocessors, Tek is in an ideal position. "We already cover most of the customer base through our oscilloscope sales, and we have the sales force and worldwide service organization in place," he says.

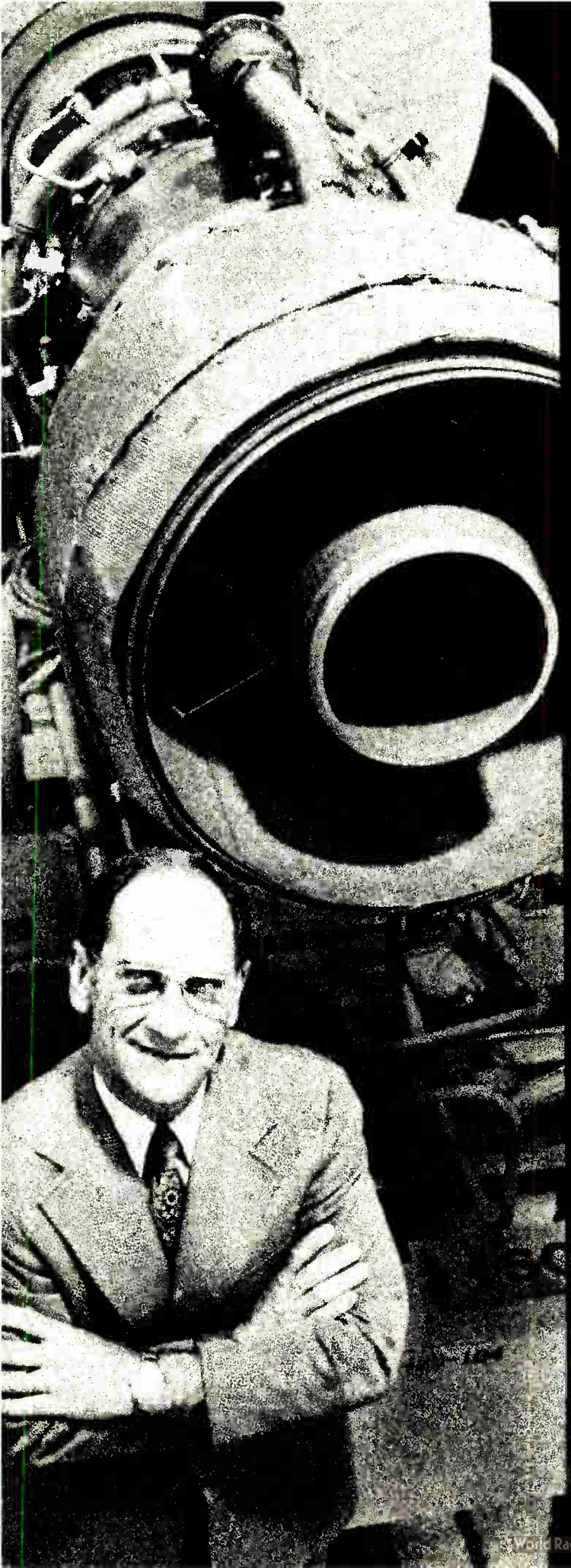
Also, as a large semiconductor customer in its own right, as well as a builder of microprocessor-based products, Tek can quickly respond to the new-device introductions, says Ramey. "We can have a new module ready [for the microcomputer-development system] by the time a new device first goes out in production quantities."

Millennium's Casilli looks beyond Tektronix coup

What comes after a four-year-old company signs an exclusive contract to supply one of the world's leading instrument manufacturers with a major product? The agreement to build Tektronix' new microcomputer-development system may be worth from $20 million to $30 million over the next three years to Millennium Information Systems Inc., Cupertino, Calif. But it will do more than provide money, says its co-founder and president Jerry Casilli.

"It gives us an opportunity to build a significant production capability, it helps build our capital base, it helps establish our company credibility, and it will lead us to any number of new business opportunities," he says. Although the agreement bars Millennium from selling other development systems, it does not bar the company from using similar technology in other products, such as production-line and field-test equipment.

Casilli adds: "Our intention is to follow the natural progression of the



"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.

VERSATILITY IN REPROGRAPHICS

Kodak

What's next. Jerry Casilli's deal with Tek promises more than dollar profits.

microprocessor revolution. We look at '75 and '76 as primarily development years. Now the people who were in development then are moving into production and will need field-support equipment in the upcoming years. And we'll follow them with the right equipment."

Involved. A former GTE-Sylvania engineer, Casilli was only 33 when he helped found Millennium four years ago. "We didn't have any firm plans, but we knew we wanted to get involved in the new technology of microprocessors, although we didn't know exactly how," he says.

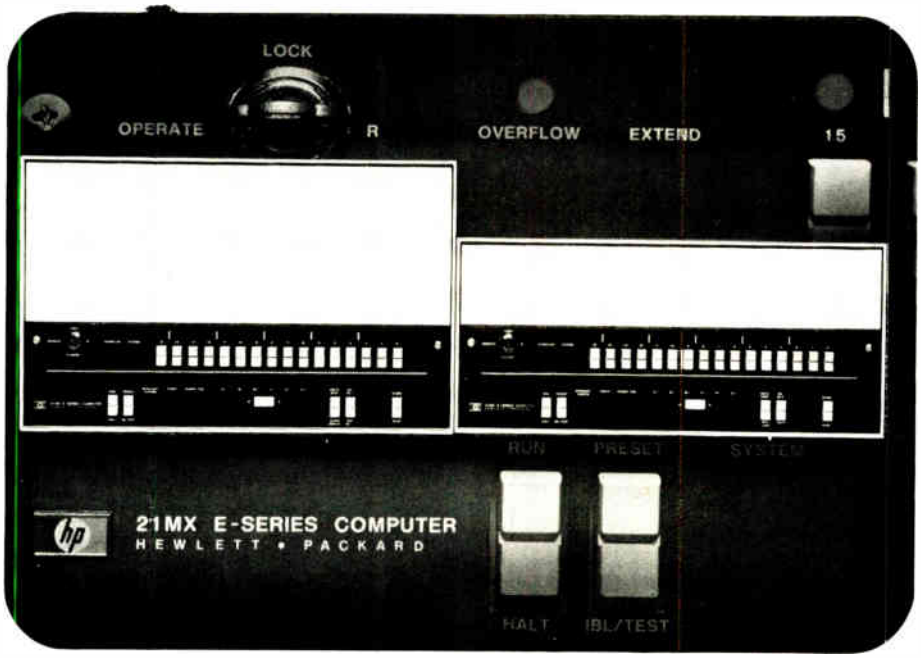
Since then, Casilli has seen Millennium products evolve through a microprocessor-based message-display system intended for shopping centers, a floppy-disk controller for use with Intel's Intellec 8 microprocessor-development aid, and, under contract to Signetics, the development system for the 2650 microprocessor. This last product led to Millennium's own Universal-One, introduced at the Wescon show last September [*Electronics*, Sept. 16, 1976, p. 91]. Shortly thereafter, Tektronix bought the rights to it.

Since then, Casilli says Tektronix has "added significant software and other improvements that have made the product even better than it was."

MEASUREMENT COMPUTATION news

product advances from Hewlett-Packard

APRIL 1977



Hewlett-Packard simplified VMT by dividing micro-instructions into two classes—those less than 175 ns and those between 175 ns and 280 ns.

New computers execute programs 70 to 100 percent faster with VMT

Variable microcycle timing (VMT) in the new 21MX E-Series 24-bit processors decreases instruction run time by dynamically allocating cycle times.

Microcode fine-tuning has brought worst-case conditions down to 280 ns.

The two new models utilize the latest in MSI technology, Schottky TTL technology plus design innovations with a minimal cost increase over the Hewlett-Packard M-Series.

The E-series also offers much more opportunity for growth. A 16k-word computer, chosen today for its economy in a dedicated application, can later become a 304k-word, multi-user, multi-programmed distributed system central computer with a full complement of supporting equipment, and, it won't be necessary to rewrite software, switch computers, or change I/O devices.

Upgrading is possible at any time. Three features make this possible. First, the user has access to 8.5k control-processor address space, sufficient to write his own operating system, if desirable. Second, to make it easy to exploit the control space available, microprogramming software is offered, including micro-assembler, micro-editor, loader, and debug

(continued on third page)

in this issue

HP's LSI repertoire now includes silicon-on-sapphire

The first accomplishment to be revealed from HP's SOS/CMOS laboratory is a new 16-bit parallel microprocessor. We call it MC² (Micro CPU Chip).

Optimized for input/output efficiency in control applications, it will bring significant performance to products soon to be featured in these pages.

An article on this high-speed, low-power, high-density chip appears in the April issue of the Hewlett-Packard Journal. For your copy, check Q on the HP Reply Card.

Universal counters

Modular design allows you to choose exactly the measurement capability that you need. Add more capability later as your needs and/or budget expand.

Universal counters are highly popular because one counter permits you to make almost any time interval and frequency measurement up to microwave. In addition to frequency, frequency ratio, period and time interval measurements that universal counters usually make, Hewlett-Packard's models offer many highly useful features to make your measurements easier, more certain or more versatile.

Depending upon the model selected, features include: outstandingly easy, rapid, and accurate trigger level setting via a full complement of controls and indicator lamps; a built-in wide range DVM to measure trigger levels as well as external dc voltages; frequency up to 1300 MHz; time interval down to 10 ns single-shot or 10 ps for repetitive events via time interval averaging; burst frequency measurements; HP-IB (Hewlett-Packard Interface Bus) operation; a portable battery pack; 50Ω input at high frequencies and an ultra stable time base.

Choose HP's 5328A universal counter for high performance, accuracy and versatility in bench or systems use. Choose the 5300B/5308A for an excellent combination of features in a low-cost portable instrument.

Check 1 on the HP Reply Card.

Current tracer locates elusive logic faults

HP's 547A Current Tracer solves some of digital troubleshooting's most difficult problems--locating low impedance faults by tracing current to sources or sinks.

With it, you can find the one bad IC on a stuck node, or pinpoint hairline solder bridges or backplane shorts, and thus troubleshoot wired-AND/OR and three-state busses...faster than before...in all logic families...without cutting circuit traces or removing good circuit elements.

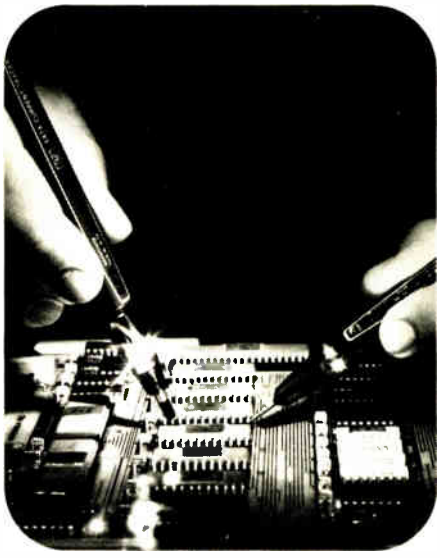
This sophisticated instrument has a precision inductive pickup sensitive only to AC currents with fast transitions (200 ns) and incorporates a wide band amplifier with adjustable sensitivity of 1mA to 1A. A single-lamp readout unambiguously displays relative current levels along the circuit.

Team it up with HP's programmable 546A Logic Pulser to get pulses wherever you'd like them in the tested circuit. It gives a single pulse, a 1, 10 or 100 Hz stream, or a burst of exactly 10 or 100 pulses, so you can quickly and easily set a system to it's 852nd clock pulse state, if needed.

Use HP's Logic Probe and Clip, too, for voltage-based troubleshooting; then pick up the current tracer and pulser to locate puzzling low impedance faults that defy easy detection by any other method.

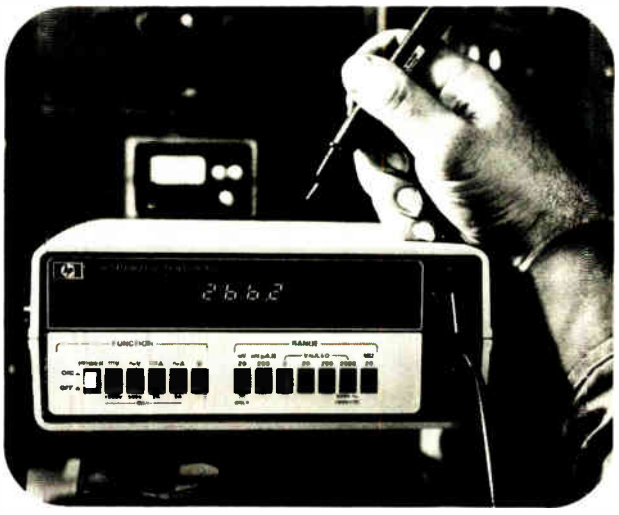
And, you can use these IC troubleshooters to locate faults right down to the bad part when you're using automated board testers.

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



Deceptively simple in appearance, the current tracer (left) and pulser (right) are sophisticated test instruments for digital troubleshooting.

Freeze the reading on the multimeter display with touch-hold probe



New design concepts have reduced the cost of the sensitive, portable multimeter. One microvolt dc sensitivity enables you to measure low-level signals from sensitive circuits or from such devices as strain gauges or thermocouples.

This new low-cost 4½-digit, five-function digital multimeter, the HP 3465B has a 'touch-hold probe' available as an accessory.

The HP 34112A probe provides greater utility by allowing the operator to focus his attention on the point of measurement in hard-to-reach circuits. The probe, which plugs into the front panel input connectors, holds the DMM reading at the touch of a pushbutton.

The 3465B has a 20-mV full-scale dc voltage range with a resolution of 1 μV. Midrange dc accuracy is ±0.02% ±1 digit. Frequency range for ac measurements is 40 Hz to 20 kHz.

The maximum resolution on ac voltage measurements is 10 μV, on measurements of current (ac or dc) it is 10 nA, and on resistance, 10 mΩ.

This high-sensitivity multimeter is packaged in a portable, streamlined carrying case with handle and is powered by AC, or with rechargeable Nicad batteries with internal charger.

Hewlett-Packard has achieved this performance level at a low cost through extensive use of computer-aided testing, laser-trimmed fine-line resistors in the attenuator, and a single-referenced bipolar A/D converter thus eliminating one reference supply. The fine-line resistors are also significant in their contribution to savings in cost and space.

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

21MX computer performance doubled *(continued from first page)*

utilities. Develop, assemble, edit and test microprograms on line. Third, it is now possible, under software control, to transfer routines from disc or other sources directly into microcode store, making the fast control processor available, dynamically, as a resource under operating system control.

The 21MX E-Series, using fully asynchronous interface with memory, allows the utilization of new memory technology as it becomes feasible, simply by changing memory boards.

The 21MX E-Series computers, distinguished by their gold trim, are offered in two models. The smaller unit, 2109A, has space for 9 I/O cards, and up to 5 memory cards (up to 80k words main memory). The 2113A will support 14 I/O cards and 10 memory cards (maximum memory 160k words).

For details, check B on the HP Reply Card.

On-line, on-location data collection with new data entry terminal

The new HP 3070A data entry terminal assures fast, easy communication between user and computer.

A data entry network can extend as far as 4 km (2.4 mi) with terminals distributed randomly along the single twisted-pair Serial Link Cable. Depending on the application, as many as 56 HP 3070 terminals can be controlled by a single "smart" HP controller board in an HP 1000 computer.

The HP 3070 also includes all the commands and protocol to communicate with HP-IB compatible devices. High noise immunity and the ability to interface a wide range of instruments to a remote HP computer makes the 3070A terminal an excellent choice for data gathering in a manufacturing environment and for test and measurement applications.

The new terminal can also be easily integrated into systems for inventory control, shipping and receiving, as well as commercial applications in banks, insurance companies and other service businesses.

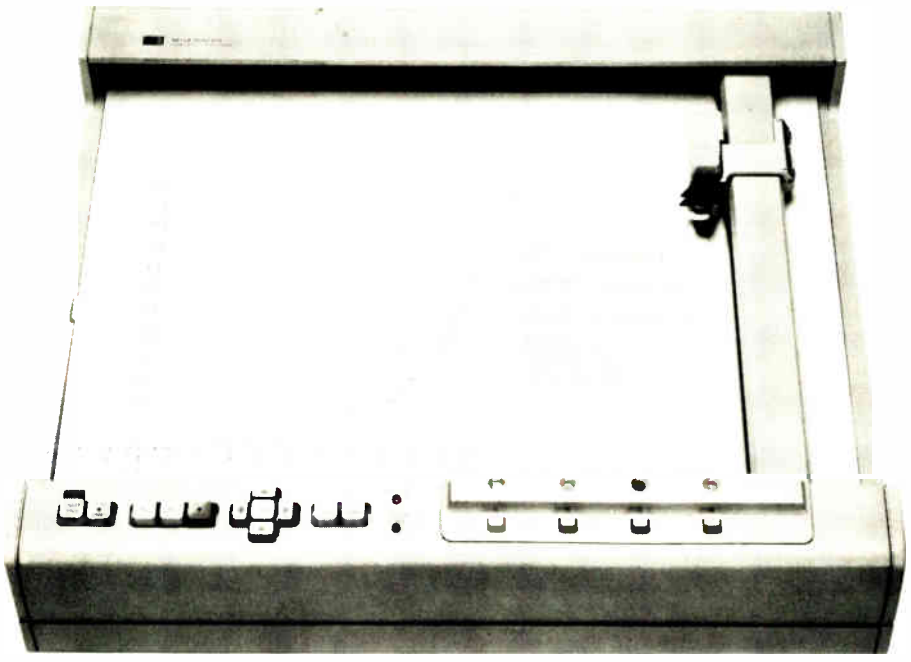
For more information, check F on the HP Reply Card.

HP-IB

The HP 3070A can be keyboard customized for use in industrial and commercial applications. It is well suited for users with little or no experience using computers.

Multi-color X-Y plotter expands uses for HP desktop computers

HP-IB



Now, you can create four-color graphs automatically. Color will enhance your graphs, make them easy to interpret, understand and explain.

HP's new microprocessor-based plotter (A-3 size), produces data in permanent, multicolor graphic form. A number of features provide excellent plot quality at higher speeds and with greater resolution than have been previously available.

In applications where curves and plots are difficult to distinguish and interpret, the 9872's four-color plotting, seven dashed-line fonts, five built-in character fonts, user-defined characters and symbol mode plotting combine to produce clear, easy-to-read plots.

Thirty-eight different instructions are built into the 9872's microprocessor to provide such features as point digitizing, labeling and character sizing directly through the plotter's HP-IB interface. (HP's implementation of IEEE Standard 488-1975) Point digitizing with the 9872A allows reproduction of charts and graphs from other sources. Window plotting is our term for describing the ability to handle off-scale data. The 9872A graphs to the point of the off-scale data and continues graphing at the point where on-scale data is again encountered. Combining point digitizing and window plotting gives you sections of your original graph at any proportion you choose for more detailed analysis.

The 9872A is designed to be especially useful in the areas of statistics, medicine, numerical control, surveying and engineering design.

Pen speed is 360 mm/sec on the X and Y axes. In program mode, pen speed may be adjusted to any one of 36 speeds beginning at 10 mm/sec. Plotting speed is typically 3/sec for 2.5 mm (0.01 in) characters. This precision velocity control produces high-quality graphics not only on paper, but on such other media as mylar or acetate.

The five character sets built in are ANSI ASCII, 9825A ASCII, and three European sets: Spanish, Scandinavian and French/German characters. Or, you can easily design your own unique characters—even a complex logotype.

Use the 9872A plotter either with the 9825A desktop computer or the newest addition, the HP 9831A.

For a four-color brochure, check M on the HP Reply Card.

New miniature easy IC probes access tight places on dense circuit boards

HP's new high impedance miniature 'scope probes connect readily either to individual pins on modern dual-in-line packages (DIP's) or to small, insulated conductors used on IC circuit boards—without the customary hazards of shorting.

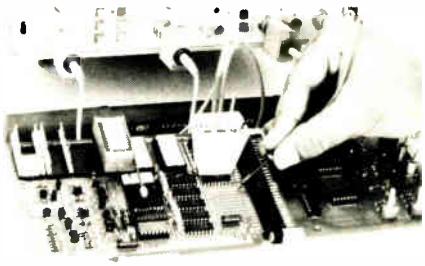
It is possible to encompass an entire DIP using the Test Clip and an accompanying set of demountable probes. The basic part of each probe can be inserted by itself into the DIP clip at any pin position, or 15 can be inserted simultaneously.

The probe itself is a small (0.1" dia. × 1.0" long) cylinder with a sharp tip. The tip is sharp enough to make contact through the insulation coating of conductors commonly used on IC circuit boards.

The series, beginning with Model 10017A, includes probes suitably compensated for most oscilloscopes with input capacitances of 9 to 14 pF and 20 to 30 pF. 1:1 probes are also available. Either 1-meter or 2-meter cable lengths can be specified.

If you need to attach directly to dual-in-line packages for high-speed measurements and the area to be tested is densely packed with today's miniaturized components, these new probes will give you easy access and decreased capacitive loading of the circuit under test.

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



The narrow shaft on the new easy IC probes makes measurements easier in congested areas of today's electronic devices and circuit boards. The probe tip can make contact at any pin of a bare DIP without the likelihood of shorting to adjacent pins.

"Entry level" business computer also handles technical computing

A new desktop computer combines scientific data analysis as well as general administrative data handling capability.

The HP 9896 is a computer system for small-to-medium sized businesses available with software to handle many commercial jobs including accounts receivable/payable, payroll, inventory control, and general ledger.

The 9896 is also used as a high performance *flexible disk* system for a wide range of computations including medical data analysis, structural and civil engineering data analysis plus general scientific problems.

Controlling the system is the new HP 9831A desktop computer (see article to the right).

The 9896 system consists of:

- the 9831 desktop computer with integral keyboard and display, read/write memory is 7,162 bytes
- two flexible disk drives for rapid access to stored programs and data
- 9871A 96-character impact printer (30 cps) provides typewriter-quality printouts
- systems desk to provide work station convenience.

You can upgrade the memory in 8k bytes up to 32k bytes. Two additional disk drives may be added; each disk provides about 500k bytes storage. Other peripherals could include a high-speed (200 lpm) printer, a thermal printer, paper tape reader and punch, card reader and data cartridge cassette memories.

Hardware and software installation options are available and are quoted on an individual account basis.

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

Fast BASIC language desktop computer with software saves you time

The HP 9831A is Hewlett-Packard's new medium-priced desktop computer. Designed to either stand alone or to be linked with peripherals in a system (such as the HP 9896 Business Information Management System described to the left), the 9831 brings a new dimension of computing power, capabilities and speed to fields of engineering, construction, medicine, and general computation.

For example, the 9831A can work through a 5-variable stepwise regression in 1¼ minutes, reduce the data from a 100-tube RIA kit in 5 minutes, or analyze a 6-story, 4-span construction frame in 7 minutes.

Internal read/write memory is 8k bytes, expandable to 32k bytes in 8k byte increments as needed. BASIC language software will get you started quickly. The String Variables capability enables the 9831 to manipulate alphanumeric data. The maximum size of each string is limited only by the 9831's memory size. Advanced Programming II operations are built in as a ROM. Much of the software pacs originally written for the HP 9830A/B are directly compatible with the 9831.

The LED display is 32 characters wide, with upper and lower case alphanumeric readout and covers the full ASCII character set.

The built-in tape drive is bi-directional. Each cartridge holds 250k bytes and has a 2,750 bps transfer rate. Search/rewind speed is 90 ips, and read/write speed is 22 ips. Average access to any place on the tape is 6 sec.

Start with the basic desktop computer. When you need the capability to handle larger data bases, adding peripherals will allow the 9831 to grow with you. HP offers 13 different peripherals for use with the 9831.

Adding an HP 98223A/B Matrix/Plotter ROM will allow you to invert a 20×20 matrix in about 8 seconds. The 98218A Flexible Disk ROM allows you to expand storage capacity; each disk holds 499,200 bytes of information, almost twice the capacity of other available disks.

The HP 9831 is a powerful, reliable, efficient, and cost-effective total package design.

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

New desktop computer has many built-in time-saving features. And, you can expand its usefulness with read-only memories (ROMs), memory, peripherals and HP developed software.

Application Pacs broaden uses for HP 67/97 calculators

All software for the HP-97 programmable printing calculator (left) and the HP-67 programmable pocket calculator (right) is completely interchangeable.

Dozens of programs in Hewlett-Packard application pacs mean that you can instantly begin using the programming power of the HP-67 or the HP-97 Programmable Calculator to solve problems in your discipline. Just pass one of the prerecorded program cards through the calculator's card reader, then follow the simple procedure outlined in the instruction book.

Application pacs are now available in the areas of electrical engineering, business decisions, mathematics, statistics, mechanical engineering, clinical lab and nuclear medicine, and surveying. And don't forget the new Games Pac, containing 19 entertaining and fun-filled calculator games like Space War, Biorhythms, and Golf.

You can write your own programs for the HP-67 and the HP-97, too. The HP-97 Programmable Printing Calculator contains 224 steps of program memory, and each programmable operation, whether one, two, or three keystrokes, occupies only a single one of these steps. Using the printer on the portable, battery-operated HP-97, you can print a program, print results, or trace an executing program.

Any program card recorded on an HP-97 can be used on an HP-67, and vice versa. All programmable operations on the two calculators are exactly alike, except that the printing functions of the HP-97 occur as special display enhancements on the HP-67.

Check A on the HP Reply Card and we will send you detailed information on both of these powerful computational tools and the software pacs.

Microwave testing to 26.5 GHz with new coaxial detectors

Two new microwave coaxial detectors are available with capabilities to 26.5 GHz. Model 8473B covers the frequency range 0.01 to 18 GHz and Model 8473C, 0.01 to 26.5 GHz.

Both detectors use the new APC-3.5 sub-miniature connector which has superior repeatability due to a rugged mechanical interface. Long life is especially important on such test accessories because of frequent reconnections. The APC-3.5 connector is fully compatible electrically and mechanically with the industry-standard SMA series.

Response is at ±0.3 dB to 12.4 GHz, ±0.6 dB to 18 GHz on the 8473B. SWR <1.5. 8473C has the same ±0.6 dB flatness to 20 GHz and follows a −3.3 dB linear slope within ±1.5 dB from 20 to 26.5 GHz. SWR <2.2.

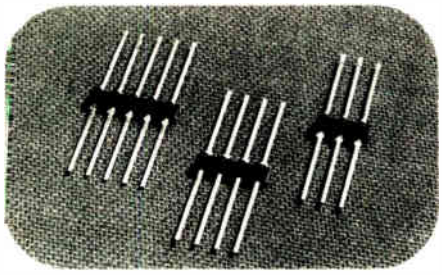
Output polarity is negative from a BNC connector. Maximum operating input is 200 mW. Matched pair and positive polarity options are available.

For details, check K on the HP Reply Card.

Coaxial crystal detectors offer flat frequency response with rugged input connector.

HEWLETT-PACKARD COMPONENT NEWS

New matched arrays for ease of insertion and alignment

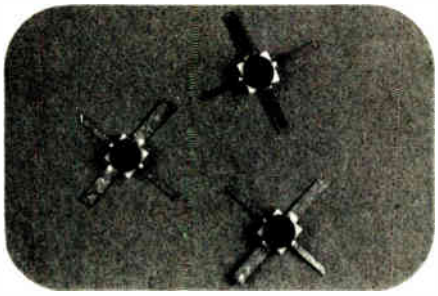


New compact subminiature red solid state lamps are available in a choice of 3, 4 or 5 elements.

The HLMP-6200 series arrays are comprised of several GaAsP lamps molded as a single bar. Arrays are tested to assure uniformity between elements and matching between arrays. Each element has separately accessible leads and a red diffused lens which provides a wide viewing angle and a high on/off contrast ratio. Center-to-center spacing is 2.54 mm (.100 in) between elements. Arrays are end stackable on 2.54 mm centers.

For more specifications, check J on the HP Reply Card.

Two low cost general purpose microwave transistors



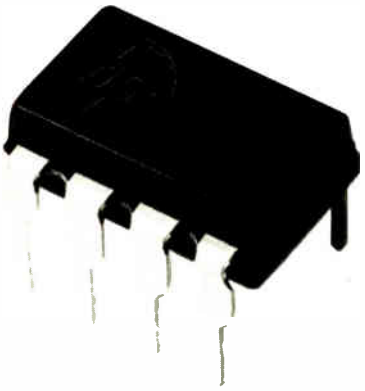
Two small signal transistors for general purpose use in the 1—6 GHz frequency range are added to the HP microwave transistor line.

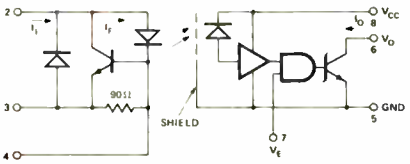
Model HXTR-2101 is a low cost, gain-specified device. At 4 GHz, tuned gain is 9 dB minimum and power output at 1 dB power compression is typically 70 mW.

Model HXTR-6105 is specified at 4.2 dB maximum noise figure and 8 dB minimum associated gain at 4 GHz. Power output (1 dB compression) at these conditions is typically 25 mW. At 1.5 GHz, noise figure is typically 2.2 dB with 15 dB associated gain.

For more technical information, check D on the HP Reply Card.

New high-speed isolator with built-in line input circuitry





Shown above is a schematic of the HCPL-2602. Applications include computer-peripheral interfacing, microprocessor system interfacing, instrument input/output isolation, analog to digital and digital to analog interfacing and the elimination of ground loops.

This new optically-coupled line receiver includes an internal input current regulator to serve as a line termination for line receiver applications. Accepting a broad range of drive conditions, the built-in regulator clamps the line voltage and regulates the LED current so line reflections do not interfere with circuit performance.

The HCPL-2602's are useful in high noise environments that conventional line receivers may not tolerate. Immunity to differential noise has been improved and the internally shielded detector provides orders of magnitude improvement in common mode rejection with little or no sacrifice in speed.

Its high speed of 10 megabits per second is limited in most cases only by transmission line speed.

For details, check E on the HP Reply Card.

New RF and Microwave semiconductor catalog aids selection of HP components

This new 128-page Diode and Transistor Designer's Catalog contains complete product specifications and design data for Hewlett-Packard's line of RF and microwave semiconductors.

Included are: HF thru UHF Schottky and PIN diodes; microwave Schottky, PIN, IMPATT and step recovery diodes; microwave bipolar and field effect transistors; devices for hybrid circuits; JAN/JANTX diodes and HP standard test programs for "off-the-shelf" high reliability semiconductors.

For your free copy, check P on the HP Reply Card.

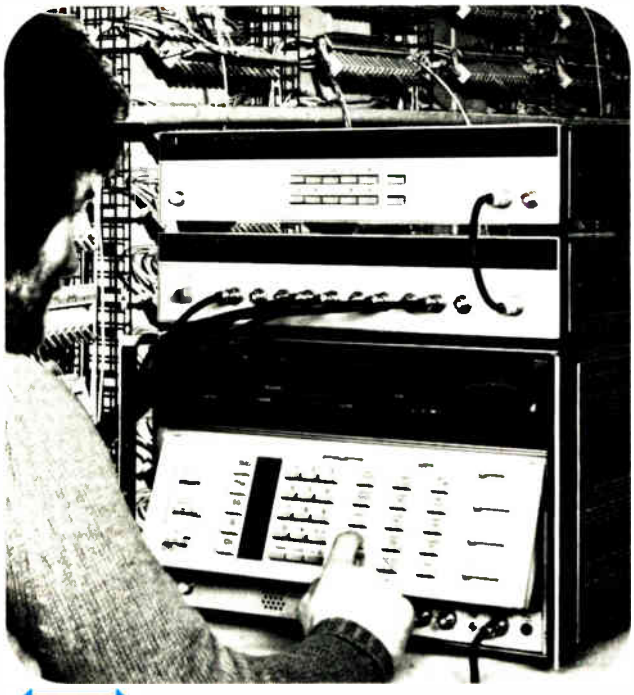
New access switch speeds measurements through a switch network

Make accurate, repeatable, RF measurements through a switch network over the frequency range 10 kHz to 25 MHz using Hewlett-Packard's new 3754A Access Switch and the 3755A Switch Controller.

The access switch is a 10-input to 1-output switch device. For applications requiring more than 10 inputs, the 3754A switches can be cascaded for up to 1000 inputs. The 111 switches required for 1000-input selection are controlled by a single 3755A controller. A 3-digit code, transmitted by the 3755A, is all that is required to select the desired signal from the large array of inputs.

The controller remotely selects the desired test-point, either manually or automatically. Manual selection is from the simple-to-operate keyboard. With HP-IB compatibility in the 3755A, the complete Access Switch/controller set-up can be remotely controlled by a desktop computer.

The access switch/Controller combination is easily integrated into a versatile signal-accessing system. Sending the control signal along the same path as the RF signal minimizes the amount of cabling required, making it easy to locate access switches remotely from the controller and to change configurations with a minimum of effort.



HP-IB

Access up to 1000 test points from one central location with the new Access Switch and Access Switch Controller.

The analog performance of the access switch (insertion loss of $< \pm 0.1$ dB and typically < -100 dB of crosstalk at 18 MHz) makes it an ideal choice for the maintenance and production testing of frequency division multiplex (FDM) systems. Both 75 ohm and 50 ohm versions are available.

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

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SSR UPDATE

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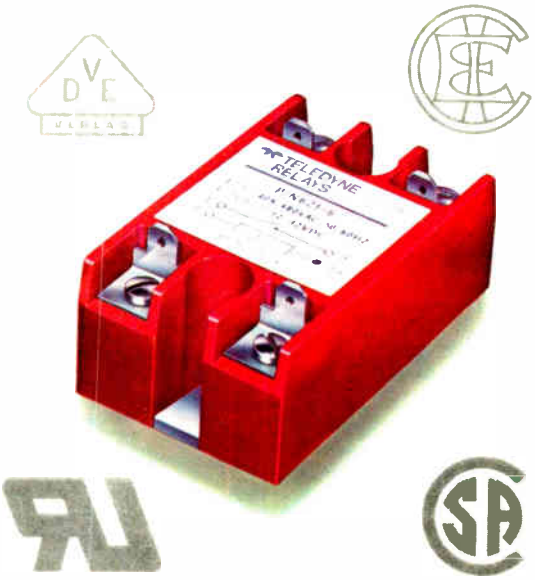

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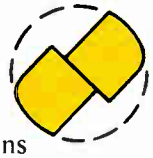

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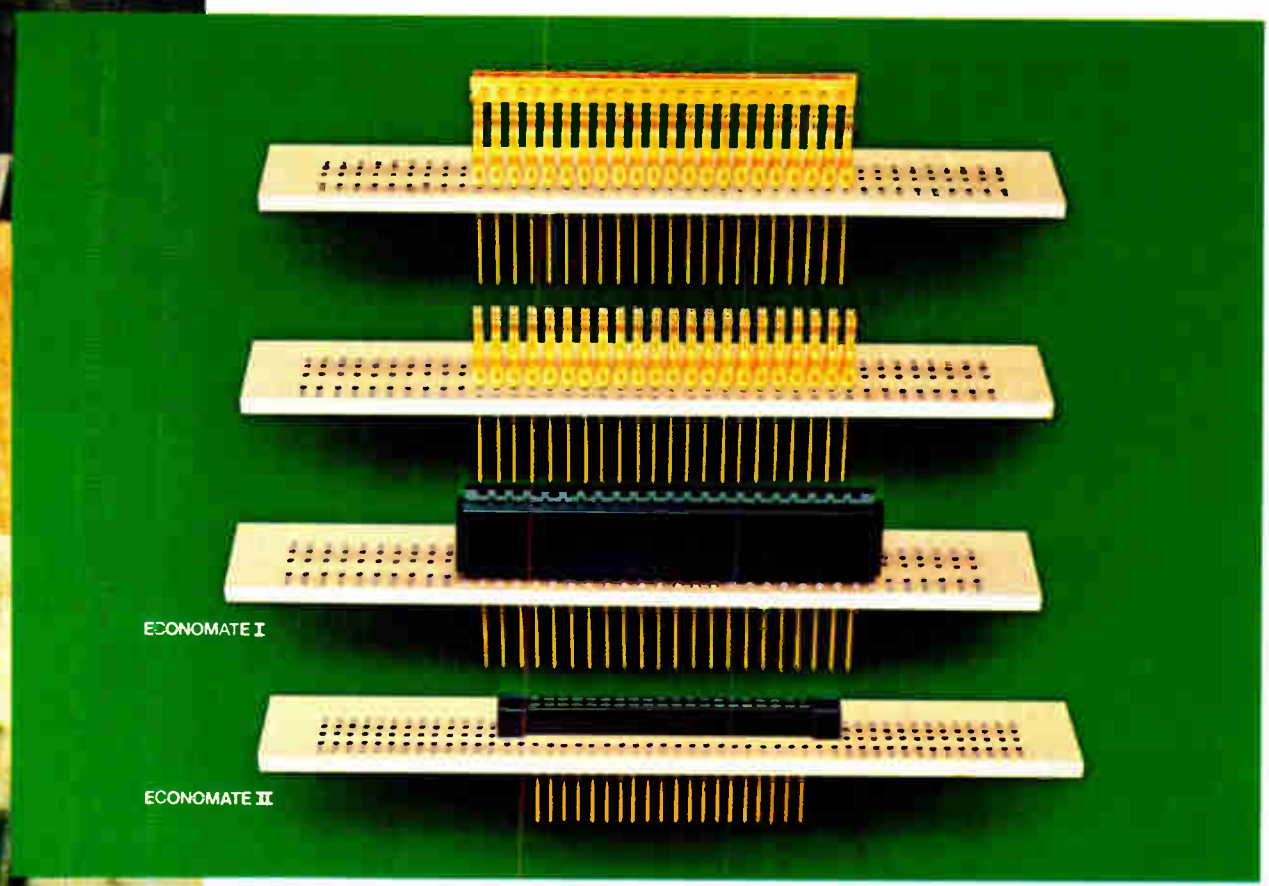

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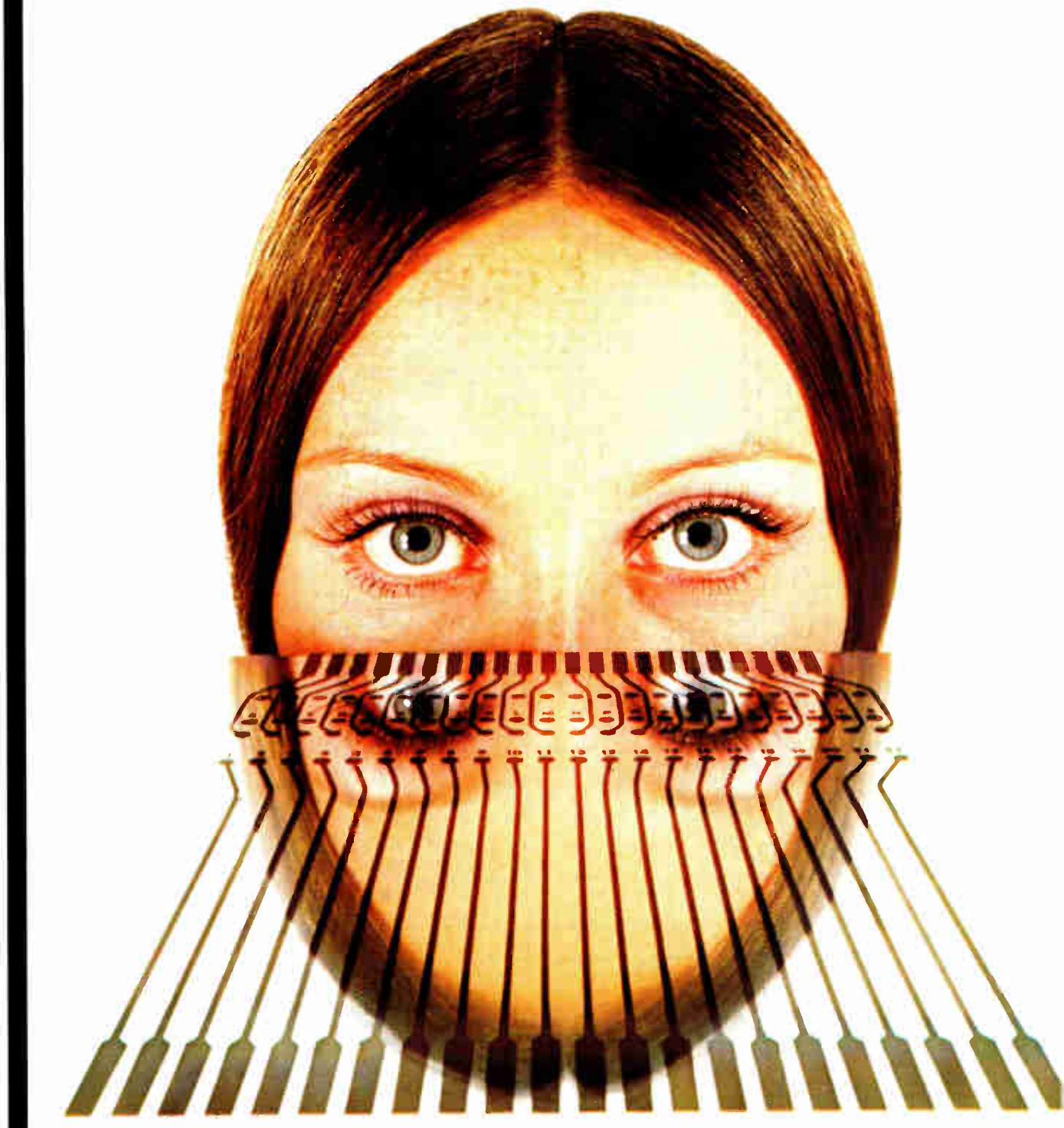

Meetings

Circuits and Systems International Symposium, IEEE, Del Webb's Towne House, Phoenix, Ariz., April 25 – 27.

Twenty-Fifth Annual National Relay Conference, National Association of Relay Manufacturers and School of Electrical Engineering, Oklahoma State University, Stillwater, Okla., April 26 – 27.

International Electric Vehicle Exposition and Conference, Electric Vehicle Council of the Edison Electric Institute, (Charles Snitow Organization Inc., New York), McCormick Place, Chicago, April 26 – 29.

Twenty-third International Instrumentation Symposium, Instrument Society of America, Dunes Hotel, Las Vegas, Nev., May 1 – 5.

Newcom '77, Electronic Industry Show Corp. (Chicago), Las Vegas Convention Center, May 3 – 5.

Eurocon 77—Communications (European Conference on Electrotechnics) IEEE *et al.*, Venice, May 3 – 6.

Third International Symposium on Silicon Materials Science and Technology, Electrochemical Society (Princeton, N.J.), Sheraton Hotel, Philadelphia, May 8 – 13.

International Conference on Acoustics, Speech and Signal Processing, IEEE, Sheraton Hartford Hotel, Hartford, Conn., May 9 – 11.

Conference on Industrial and Commercial Power Systems, IEEE, William Penn Hotel, Pittsburgh, May 9 – 12.

Design Engineering Conference and Show, ASME, McCormick Place, Chicago, May 9 – 12.

Electronic Components Conference, IEEE, Stouffer's National Center Inn, Arlington, Va., May 16 – 18.

Naecon—National Aerospace and Electronics Conference, IEEE *et al.*, Dayton Convention Center, Dayton, Ohio, May 17 – 19.

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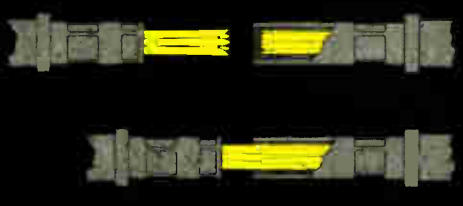
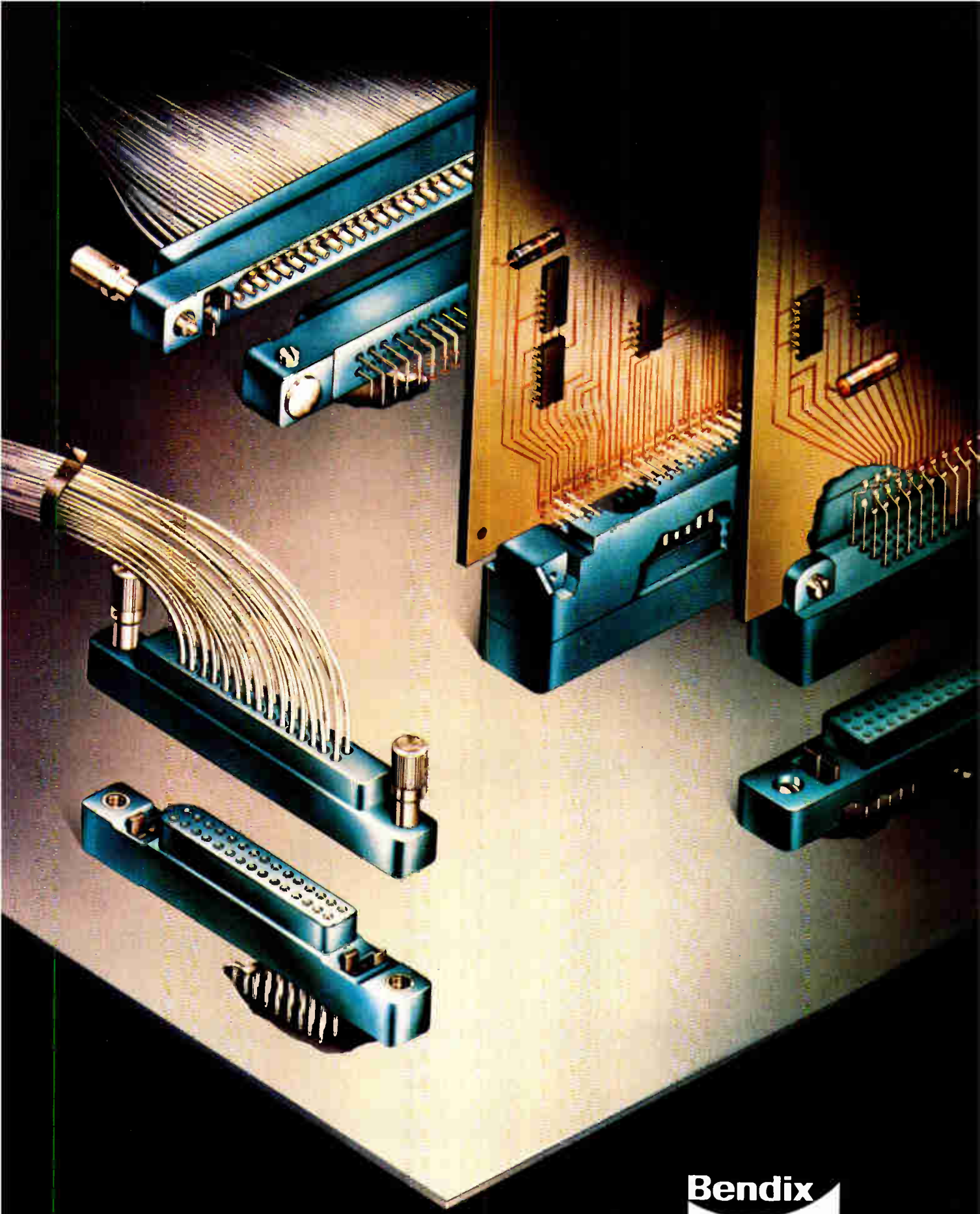


CONTACT INNOVATION



Circle 33 on reader service card

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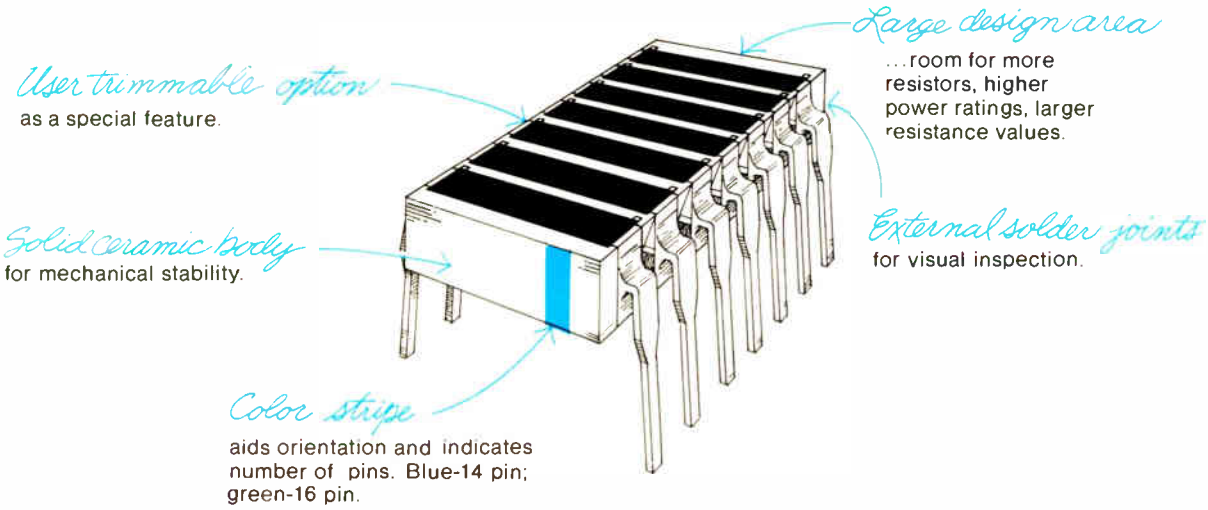

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Electronic-warfare market to reach record $1 billion level

For the first time ever, the domestic electronic-warfare market will surpass the $1 billion mark in fiscal 1977, forecasts market researcher Frost & Sullivan Inc. of New York. In a new two-volume analysis of that business, the research firm predicts the U.S. market will expand from $958.9 million in fiscal 1976 to $1.22 billion this year and will **reach another peak of $1.388 billion in 1978.**

Following a dip in fiscal 1979, Frost & Sullivan says, the market "will resume a high level of funding" and climb back to almost $1.35 billion in fiscal 1982. The industry analysts project that the market will expand by more than 71% from 1975 to 1982, for an average annual growth rate of about 8%. "The Navy and Army will show the greatest electronic-warfare growth in funding between fiscal 1975 and 1982," says the study.

During the period, it continues, the Navy's funding will grow from $224 million to $514 million "due to increased funding for ship-based electronic-warfare systems," while the market for the Army, whose prior activity was "quite low," will grow from $108 million to $232 million as the Army "is now in the midst of developing new systems."

New Pulsar watch takes pulse rate . . .

Using a unique infrared sensing device, Time Computer Inc. has introduced the first wristwatch that can monitor pulse rate accurately. On sale this week are 125 limited-edition, all-gold models priced at $2,500. Soon a four-battery stainless-steel version retailing for $500 will be available through Pulsar's usual retail outlets.

The Pulse Time Computer has a sensor mounted on the top that contains an infrared transmitter and receiver. It detects capillary flow surges in any extremity, such as a finger, **placed over both transmitter and receiver.** This signal is amplified and sent to a microcomputer that calculates pulse rate and shows it on the LED display. A flashing dot indicates when the reading is steady and accurate. Pulsar's dedicated processor is a two-chip, complementary-MOS set developed for the watch by RCA's Advanced Technology Center, Princeton, N. J. The watch also contains a standard timekeeping C-MOS chip.

. . . as company readies an LCD watch

Though Time Computer has been content to stay with high-priced light-emitting-diode-display watches, company president John Bergey has revealed that **there will be a liquid-crystal-display Pulsar on the market soon.** "Whether to use an LCD or an LED now depends on the type of watch—calculator and pulse rate watches are better with LEDs, while chronographs or standard timekeeping watches are better with LCDs." However, Pulsar will probably not offer as long a warranty (three years) on its LCD watches as on the LED models.

RCA develops radiation-hardened cells for LSI arrays

A set of standard radiation-hardened memory cells, developed by RCA Government Systems in Camden, N.J., for the Naval Research Center, speeds the design of LSI arrays that will have to operate on satellites and in other environments where total dose radiation is a problem. The division **borrowed technology from prior Army-funded programs** that led to the development of a set of silicon-on-sapphire standard cells and computer-aided design programs that automatically route the logic designed using the standard cells. "This capability," says an RCA division manager, "allows the basic tools developed for the Army to be used for a broad

range of satellite and missile programs that require radiation-hardened devices."

LCD carries readout, graph on same substrate

UCE Inc., Norwalk, Conn., is prototyping a field-effect liquid-crystal display that combines a 3½-digit readout with a 22-segment bar graph on the same substrate. **The aim is to add an analog display with rate-of-change information to the precise readout of a digital display.** The bar graph measures about 2½ inches long, and the digits are ½ inch high.

UCE operations manager Richard Borstelmann says that next on the schedule is a bar graph with 1% precision, which users probably will prefer. Borstelmann says that UCE also has developed a field-effect LCD that can tolerate multiple freezings down to −55°C, yet can still work when raised to the operating temperature of about −10°C.

HP dual-channel analyzer to sell for just $30,000

Hewlett-Packard Co. has brought out a $30,000 dual-channel signal analyzer that can perform **the same functions as computer-based systems costing $100,000 or more.** The instrument, the 5420A, uses a modified HP 21MX minicomputer to handle signals up to 25 kilohertz. It is designed to measure noise and vibration, as well as to analyze closed-loop servo systems.

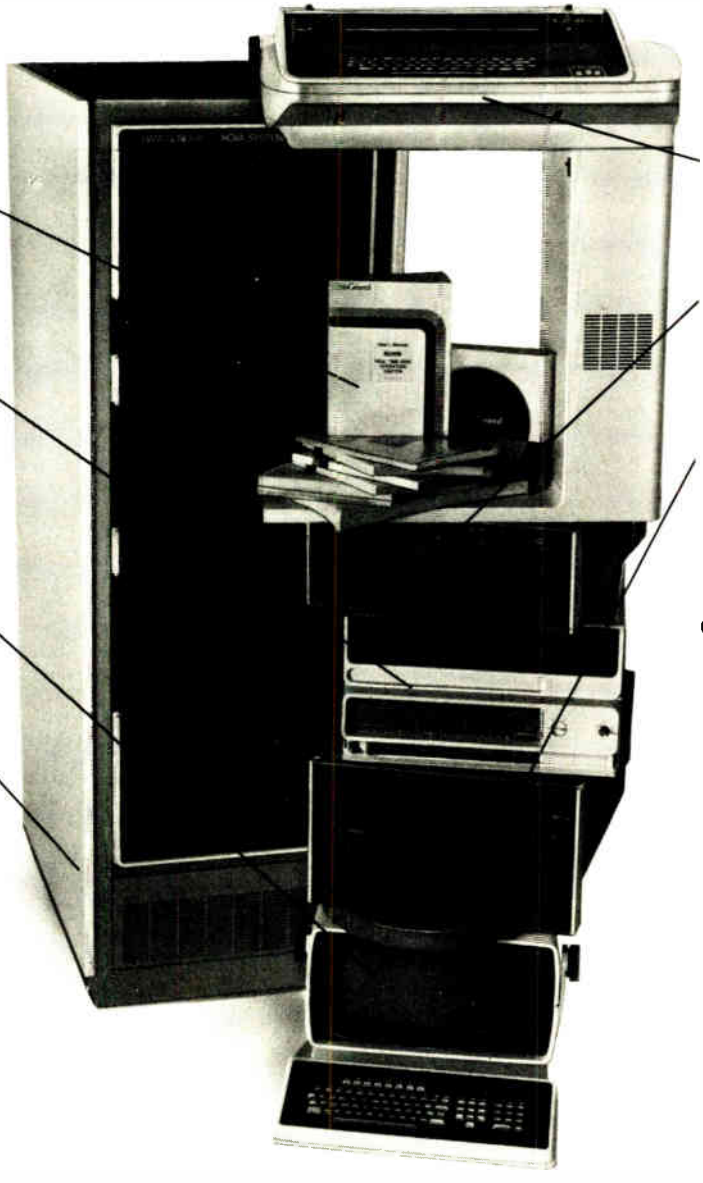
Military to test its first tactical digital fax system

The Armed Forces will soon begin field tests of their first truly tactical digital facsimile system. It is being built by Litton Industries' Datalog division in Melville, N.Y., under a $7.6 million Naval Electronics Systems Command full-scale development contract. The system incorporates Datalog's proprietary circuitry and will be used to transmit and receive messages and photographic copy over standard radio and land-line communications circuits. The high-speed system can produce typewritten pages every 15 seconds and was specified and programmed by the Joint Tactical Communications Command (Tri-Tac) to ensure standard use by the Army, Navy, and Air Force, as well as the NATO command in Europe.

Addenda

Another Japanese company plans to make videotape recorders. Pioneer Electric Corp., a maker of hi-fi equipment, says it will decide before the end of September **whether to use Sony Corp.'s Beta format or go with Japan Victor Corp.'s** VHS (for video home system). Using Beta, besides Sony, are Sanyo and Toshiba; Victor is joined in the VHS camp by Matsushita, Hitachi, and Sharp. . . . Toshiba plans to **build a color-TV production plant in the U.S.,** probably by 1978. The company says that such a plant would be a hedge against possible U.S. curbs on TV imports. . . . William J. Perry, president of ESL Inc., a Sunnyvale, Calif., manufacturer of reconnaissance systems, has resigned his post to join the Carter Administration as **director of defense research and engineering** in the Department of Defense . . . In Britain, ITT Semiconductors has produced sample quantities of a **1-bit processor designed to replace hard-wired logic in telephone relays.** Built for Standard Telecommunication Laboratories with n-channel, silicon-gate MOS process, the medium-size large-scale-integrated chip performs Boolean algebra. It has 11 outputs and 11 inputs, an internal 30-bit RAM, and five hardware-delay elements.

Here's how Data General's NOVA 3/D system stacks up against the competition.



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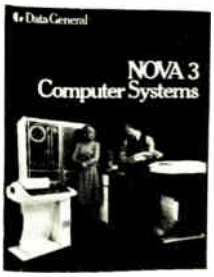

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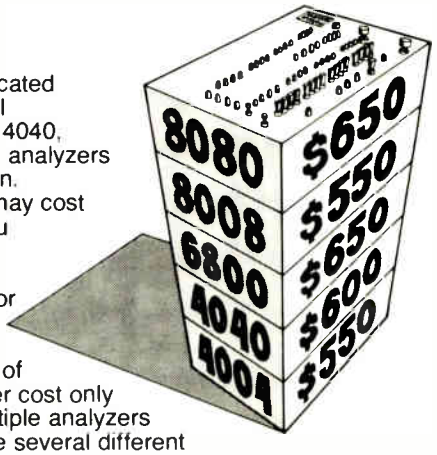

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Wiegand effect pushing its way into real products

Card reader gets tryout on Boston subway while IBM, Robert Bosch sign to explore possibilities

The Wiegand effect, the unique pulse-generating property that can be imparted to ferromagnetic wires, is attracting some high-powered backers and stimulating a growing number of practical products.

A year ago, Echlin Manufacturing Co., an automotive-parts maker in Branford, Conn., signed an agreement with John Wiegand, the effect's discoverer [*Electronics*, July 10, 1975, p. 100], to manage the development of his new technology. Echlin now has a lot of progress to report.

It has begun a field test of one of the first products, signed several would-be product manufacturers to exclusive licenses, brought a Wiegand-based automotive part to within months of marketing, and sponsored basic research aimed at better understanding of the effect.

Identification card. The first products—identification cards and card readers—were put into experimental use earlier this month by the Massachusetts Bay Transit Authority in Boston. One hundred fifty employees of an insurance company at one of the MTA's major subway stops were issued plastic fare cards in which Wiegand identification wires were embedded. These cards allow them to pass through special turnstiles that have card readers instead of coin slots.

Readers for the Wiegand wires are more rugged than those designed to read magnetic-stripe codes. Moreover, the information coded in the wire for unlocking the turnstile cannot be altered; stripe coding can. The wire receives its code before being embedded in the plastic. The wire is so small—0.25 millimeter in diameter—that it is extremely hard to find.

The four-month experiment will test how subway riders respond to monthly "commutation" cards, as well as put the Wiegand cards and readers to regular use. If the trials prove satisfactory, the MTA will buy cards and turnstiles from companies licensed by Echlin.

Licensee. Latest to become a licensee is the German automotive-parts giant Robert Bosch GmbH, which, along with Echlin, will concentrate on developing applications for cars. Earlier this year, IBM signed on to explore the effect's use in information handlers such as card readers. Already on the Wiegand wagon were Colt Industries, also for automotive uses, and Emerson Electric, for a flow meter.

Others also interested. J. David Marks, Echlin's vice president of engineering, claims that six or eight other companies are actively interested in becoming licensees. These include the Big Three auto companies as well as a medical-electronics firm.

"The attraction of the Wiegand effect," comments Marks, "is its utter simplicity. The Wiegand wires, a coil, and magnets are the basic parts to produce pulse generation without power input" (see "What's Wiegand?").

As for its own products, Echlin plans to introduce later this year an ignition-firing distributor for the "performance-car" market using a Wiegand signal to time the spark. Michael J. Sinko, advanced-products manager at Echlin, points out that

What's Wiegand?

To obtain the Wiegand effect, a ferromagnetic wire is cold-worked—twisted and stretched—and then thermally tempered. This destabilizes its magnetic properties—the wire is made of an alloy of the kind of materials used in memory cores. When the wire is put through a magnetic field, the instability causes the magnetization to switch states, and this switching, in turn, can be sensed by a separate coil of wire.

For example, a 1,000-turn coil wound on a 3-centimeter length of 0.25-millimeter-diameter Wiegand-effect wire can generate a peak-amplitude voltage pulse of 2 volts and 20 microseconds in width across a 1,000-ohm resistive load. J. David Marks of Echlin Manufacturing Co., the technology manager for Wiegand-effect development, believes the effect will eventually be able to produce outputs as high as 7 V.

The pulse is not appreciably affected by the rate at which it is generated. Wiegand wires are immune to interference by ambient electromagnetic fields, and devices using this effect can perform in temperatures from −196°C to +300°C with an output variation of less than 10%, Echlin says.

this distributor will not actually improve the performance of racing cars, but will increase reliability in the severe environmental conditions under which Wiegand pulse-generator assemblies can perform.

Research. Echlin has also sponsored a year-long basic research project by R. C. Barker at the Department of Engineering and Applied Science of Yale University. In striving for a fundamental description of what causes the Wiegand effect, Barker was also able to quantify performance characteristics well enough to predict the wire's exact performance when any of the processing parameters are changed. □

Consumer

Cable TV system from Warner Cable adds two-way service to boost program fare

Two-way cable television is being resuscitated. It has gone into the first 200 homes in a system developed by Warner Cable Corp. of New York for the Columbus, Ohio, area. By the end of the year some 100,000 homes are set to have a 30-channel service that includes standard off-the-air TV broadcasts and pay TV charged on a per-program basis.

On top of this base, Warner offers its two-way services—games, such as chess and math puzzles, played against a central computer, educational materials, and local cable programs that rely on the results of polling the viewing audience. For instance, at the inaugural telecast late last month, Warner put on a quiz show in which viewers were asked to vote on subjects while studio contestants tried to guess how the vote would go.

First chance. "This Columbus operation is not two-way cable's last chance," declares Warner Cable chairman and chief executive officer Gustave M. Hauser. "It's two-way cable's first chance. In the past, there were many promises, but the services were never really tried as a serious commercial business."

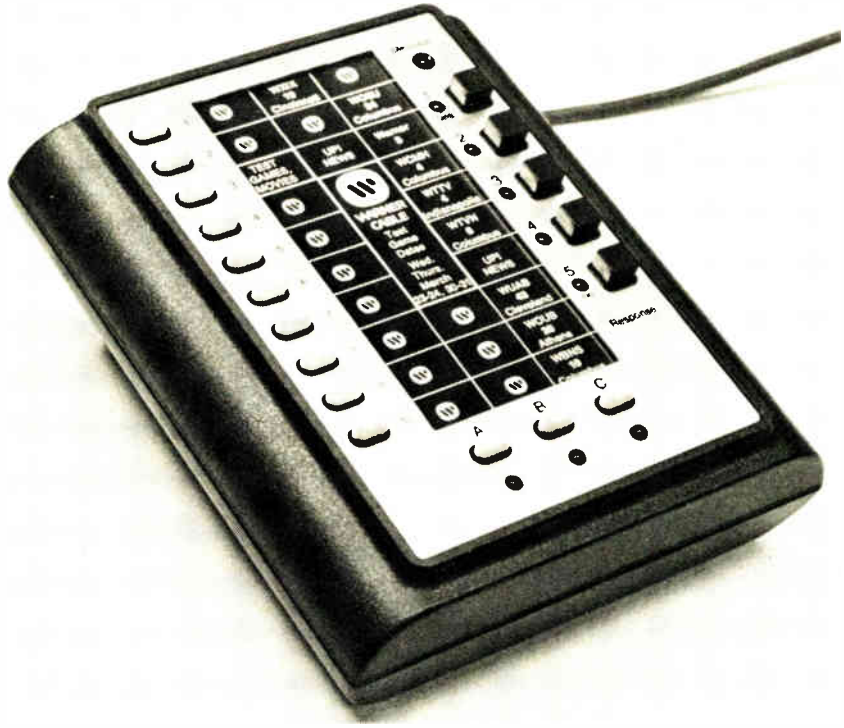
Enthusiasm among cable-TV operators for providing two-way communications services has cooled considerably since economic considerations ended the "wired nation" dream of the early 1970s. CATV has ventured little more than to add a premium fee above the flat monthly charge for a special package of programs—mostly movies and sports events. These programs are transmitted, like the rest of the programming, to decoding terminals via ordinary one-way circuits.

Hauser is convinced the two-way capability will attract subscribers and that the system will be profitable because the hardware is inexpensive. Fees for the services have not been set yet, but they will vary according to the material offered. For example, hit movies may carry a higher fee than second-run films.

Some elements of the system hearken back to the earlier two-way experiments: a central computer at the cable operator's head-end scans home terminals, records viewing status or responses transmitted as digital signals from the home receiver, and turns services on and off as ordered.

Important improvements, however, have been made in the operation and cost of the home terminal. Rather than the $500 to $1,000 signal processors with full keyboard developed in the past, the Warner terminal is a simple "calculator-style" unit that will cost "significantly less—probably not much more than a standard CATV set-top converter," says Hauser.

Made in Japan. Built for Warner by Pioneer Electronics Corp. in Tokyo, the terminal is designed around a custom large-scale-integrated circuit. Its 10 selector buttons are activated by one of three buttons controlling three different columns of services—standard TV broadcasts, Warner's special services, and pay-TV selections. Five response buttons



Two-way. Warner Cable's decoding terminal offers CATV services that allow the subscriber to respond with the buttons at the right to two-way games and queries from a central studio. The terminal is small enough to be held in one hand.

can also be used in polling subscribers, and a message light can be activated by the computer for various reasons, including security monitoring of subscribers' homes.

However, there are some services that Hauser adamantly refuses to offer. "We've tried to build in everything that has an economic use and payback," he comments, emphasizing that these services do not include an electronic facsimile-type newspaper or elaborate shopping by TV, which would require a full alphanumeric keyboard.

Have the failures of previous two-way attempts turned off CATV subscribers? "No" replies Hauser. "Consumers were never offered anything, so they are not turned off. Only the cable operators and the hardware makers who sank millions of dollars in R&D are turned off. But we believe the Columbus system will be successful. It was designed by businessmen—not think tanks." □

Instruments

Spectrometers determine material makeup by using light transformed into sound

Reviving a principle that has lain dormant since Alexander Graham Bell chanced upon it in 1881, two companies last month introduced a new kind of spectrometer for determining the elemental components of materials. The companies are Princeton Applied Research Corp., Princeton, N.J., and Gilford Instrument Laboratories Inc., Oberlin, Ohio. Their systems are called photoacoustic spectrometers, and, though both apply the same principle, they differ significantly in optical and electronic design.

Both companies agree, however, that photoacoustic spectroscopy is not merely the fastest way yet to "fingerprint" the elemental components of materials but that it yields clearer results over a wider range than ever before. The output of both is a chart-recorder trace of the absorption spectrum that is unique to each element and compound in the world. Both systems cost more than $25,000.

Discovery. Poking around in his lab one day, Bell noticed that pulsed light striking an object made it emit sound—though how this happens is not fully understood even today. This observation and the fact that the sound level depends on the light wavelength led to the new technique.

Spectroscopy conventionally measures the intensity of light of known wavelengths that is either transmitted through or reflected off the material being studied. But this measurement is often obscured by light-scattering problems and poor signal-to-noise ratios. Moreover, no single approach works equally well for liquids, solids, and gases. Transmission techniques are useless unless the material is transparent, and reflection methods, which produce marginal results at best, are the only workable techniques for solids.

Photoacoustic spectroscopy, however, handles all kinds of materials with equal ease. In PAS, light from a high-intensity lamp enters a wavelength-adjustable monochromator, and the output, chopped at a rate of a few hundred hertz, strikes the material. If the material absorbs a particular wavelength of light, its temperature rises and falls with each pulse, setting up waves of compression and rarefaction in the surrounding air—in other words, sound.

Researcher at Bell. Although some work was begun in the early 1930s on PAS for analyzing gases, no one thought to use it for solids until the 1970s. Then Allan Rosencwaig, a researcher at Bell Telephone Laboratories began publishing papers on the subject, and his publications were noticed at Princeton. Eventually, Rosencwaig left Bell and is now a consultant to Gilford.

Both of the new PAS machines have small, airtight sample cells—for either solids or liquids—and use a condenser microphone to detect the minute sound. But the Princeton system obtains a better signal-to-noise ratio than Gilford's, primarily by exposing the sample to more light. Although both units use a

Pioneer. Allan Rosencwaig became interested in photoacoustic spectroscopy in the early 1970s while at Bell Telephone Laboratories. Now a consultant to Gilford Instrument, he helped design the new kind of spectrometer seen here on the bench behind him.

xenon source, only Princeton actually chops the light mechanically—Gilford modulates it electronically. Chopping, while producing a better s/n ratio, introduces vibrational factors that must be damped out.

Since coverage of the widest possible light spectrum is desirable, the optical systems require compensation for the less-than-flat frequency response of mirrors, lenses, and detectors. Here, too, the two manufacturers have taken radically different stances.

Princeton compensates by using a reference signal provided by a pyroelectric, or heat-sensing, detector exposed to a fraction of the source light. The company claims the detector has an indisputably flat response. "It's even used for calibration by the National Bureau of Standards," declares Don Munroe, vice president and manager of the Scientific Instruments division of Princeton. Flatness hinges on the ability to absorb all wavelengths of light equally.

Allan Rosencwaig of Gilford demurs: "A pyroelectric detector, even when painted flat black, absorbs poorly in the ultraviolet region." Instead, Gilford uses a full differential approach. The difference signals produced, for example, by placing identical material in a pair of cells and adding a contaminant to one of them requires no compensation. This, Rosencwaig says, permits Gilford's instrument to operate far into the ultraviolet range—down to 200-nanometer wavelengths, a region critical to biological applications. The Princeton PAS presently goes down to about 350 nm. Tracing of the absorption spectra takes a few minutes.

Semiconductor possibilities. In addition to chemical and biological applications, PAS may be valuable to the semiconductor industry. It can determine energy-band gaps and doping profiles of materials. According to a spokesman at Princeton, several electronic manufacturers, including Texas Instruments Inc. and Intel Corp., have expressed interest in the system. □

Memories

National readies 65-k read-only memory, sets sights on 262-k device by end of 1978

National Semiconductor Corp. is circulating samples of a giant new read-only memory that is scheduled to go into production by late summer. With 65,536 bits, it is well ahead of the 32,768-bit ROMs recently introduced by Electronic Arrays, General Instrument, Mostek, and Texas Instruments.

But for National, this is just the beginning. The Santa Clara, Calif., semiconductor maker is in the final phase of designing a 131,072-bit ROM that it expects to have ready in sample quantities by the end of the year. A 262,144-bit device is in the offing for late next year.

For its 65-k ROM, National is using a newly developed self-aligning metal-gate n-channel MOS process. Containing the equivalent of 75,000 to 80,000 transistors, the 65-k ROM is squeezed into a chip measuring only 39,000 square mils—only 5% to 10% larger than ROMs half as dense (GI's 32-k part measures 36,000 mils). But density is only half the story. Access time of the fully static 28-pin part will be in the 300- to 450-nanosecond range, about equal to that of 16,384-bit parts and 350 to 500 ns faster than most fully static 32-k ROMs. One 5-volt supply is all the part needs, and its power consumption is about 6 microwatts per bit, about one fifth of that required for 8,192-bit ROMs.

Design. To achieve this combination of low power, high speed, and high density, National's engineers decided that, in terms of cell size and speed, it was important to use metal rather than silicon gates because of their inherent interconnect advantages. This technique shrank average cell size in the ROM array from about 0.5 square mil to about 0.25 to 0.29 mil^2, resulting in a reduction in chip size of about 20% to 30%, explains Dennis Morris, National's MOS LSI design-engineering manager.

To achieve another 10% to 20% reduction in chip area, National engineers adapted some of the peripheral-circuit-design techniques developed for use in random-access memories. For one thing, the part makes use of a differential sense-amplifier, which is more sensitive than the simple inverter in older ROMs. "Because this threshold-detection technique depends on differences in voltages, rather than on sensing an absolute voltage-value level, there is an improvement in speed," says Morris.

Density. Voltage swings in the array, as a result, are not as large as in older ROMs (only 0.5 V vs 4 to 5 V). This means, says Larry Jordan, memory-product marketing manager, that diffusion spacings can be tighter, resulting in a much smaller, more dense array. "With the use of these [voltage swings] and a few other tricks," Jordan says, "I think we can even get a 128-k device down to about 40,000 to 45,000 mil^2, about half what it would take with present techniques."

National engineers, says Jordan, have also been able to duplicate the one major advantage of self-aligning silicon-gate n-MOS: fewer processing steps and, thus, lower costs. They are using a self-aligning metal-gate technique in which source, drain, and gate areas are etched concurrently rather than sequentially. Because the gate area is masked, there is not much overlap between the source and drain, and only the channel has the oxide.

This results in metal line spacings and gate widths 30% smaller than those obtained with present metal-gate processing (5 vs 7.5 micrometers). Morris says that the gate-oxide is only 600 angstroms thick, equivalent to that obtained with the most advanced n-MOS silicon-gate processing used in RAMs [*Electronics*, March 3, p. 32]. "That is without any

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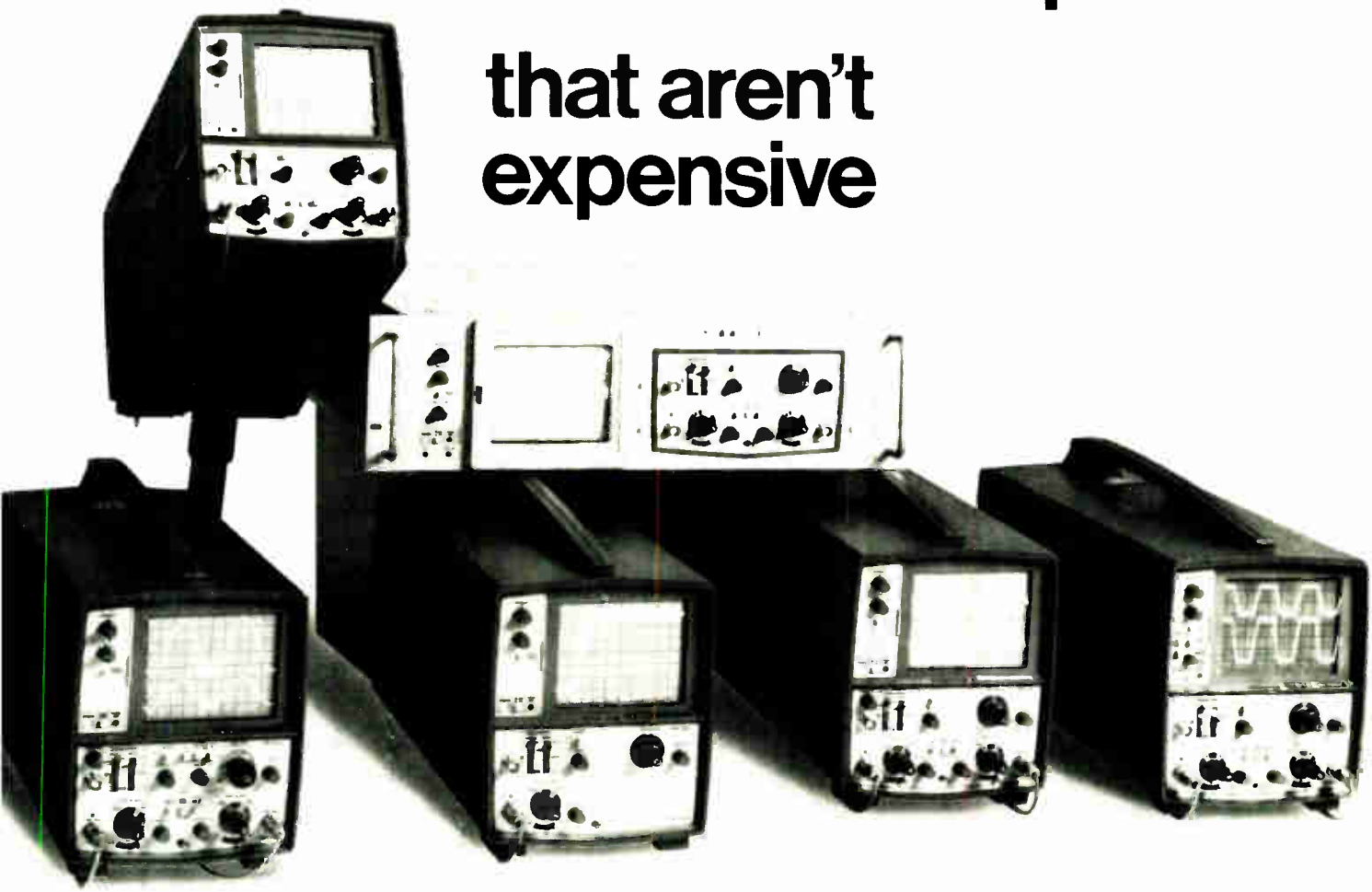

Selection on the basis of price alone often results in high cost of ownership—in many ways. If a low-cost 'scope fails after rough treatment, after a line-voltage surge, or during hot weather, and requires expensive maintenance—cost of ownership rises. Perhaps, to lower the price, the manufacturer oversimplified key circuits, resulting in poorer performance or more maintenance or both—again, cost of ownership rises. If, after a couple of years, reliability decreases and replacement becomes necessary—then again, cost of ownership rises.

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sophisticated photolithographic or scaling techniques," says Morris, "we've got a lot more room for improvement." □

Commercial

Machines to vend airline tickets

Taking their tack from the electronic tellers successfully used by the banking industry, two airlines have started setting up electronic machines to issue tickets directly to air travellers. Though passengers must hold confirmed reservations for their flights, the machines now being installed by United Airlines and Braniff International will call up those reservations, read the traveller's credit card, and produce the ticket in less than 10 seconds.

Braniff, based in Dallas, has had 10 Branimatic Centers operating in Dallas and Houston airports since February. "We expect that 83% of the tickets we write at the two airports could be handled by Branimatic," says Peter Walsh, director of real-time applications for Braniff's computer staff.

Test phase. Acknowledging that the new ticketing procedure is still in the test phase, Walsh says that "our hope is simply to leave them in, and expand to other locations." A real attraction, despite lower volumes, would be expansion to other locations than airports, such as office buildings, hotels, banks, and perhaps shopping centers. "That's very much in line with our tentative future plans," he admits. "Assuming the components will hold up in a customer environment, then it's a natural extension of the system."

United, however, has no plans to expand beyond airports. It installed pairs of its Apollo self-ticketing machines in airports in Chicago, Los Angeles, and San Francisco in December, and left earlier test units running in Cleveland. "We found that the frequent traveller will go to the machines only when there are lines at the ticket counter," says William C. Neary, manager of passenger-service planning at United's suburban Chicago headquarters. United will review the system at the end of this summer with an eye toward expanding to other airports, "but the usage level will keep us out of nonairport locations."

The unstated rub, of course, is the independent travel agent, who earns a 7% commission on every domestic airline ticket he writes. "We're not too happy about the airlines' in-city ticket offices," one agent says, "and we'd be livid about the prospect of a ticket machine in every phone booth."

The machines and their secure cabinets cost upwards of $12,000, and both airlines have installed them in pairs for reliability; one will be dropped as the hardware proves itself. Both are built around Incoterm Corp.'s standard airline cathode-ray-tube display, which prompts the passenger through the self-ticketing process and displays his itinerary for verification. Braniff uses an airline ticket printer built by Di/An Controls Inc. United's printer is from Vogue Instrument Corp.

Both systems use magnetic-card readers to capture the passenger's name and credit-card I.D. from the card's magnetic stripe. That data is used both to search the computer files for the reservation and, later, to bill for the ticket. United has chosen Mag-Tek Inc.'s motorized reader, which temporarily "swallows" the card like those used on electronic tellers and cash dispensers. Braniff chose otherwise.

"We assumed that people aren't interested in risking their cards," says Braniff's Walsh, "so we're using a slide-through reader supplied by Incoterm." As a result, Braniff has had to replace the reader's magnetic heads in each machine an average of three times in the last two months. "Customers put their cards in upside-down, backwards, left-to-right instead of right-to-left, and some actually try to pound them into the reader."

American Airlines has also looked at passenger self-ticketing. In 1970, it installed two experimental Automatic Ticket Vendors from IBM at Chicago's O'Hare field. "The

Ticketing agent. Braniff International's Branimatic ticket-issuing machine presents instructions on cathode-ray-tube display and uses slide-through credit-card reader.

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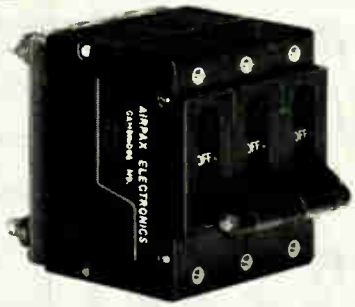

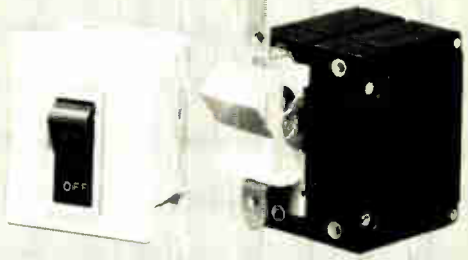

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experiment was very successful," says an American spokesman. "The problem was financing enough machines to fill our system." They were removed after three months. □

Military

House restores funds, but cuts R&D

Domestic as well as foreign politics may have produced some significant shifts in what the Administration will be able to buy in the way of research and development and weapons. The House Armed Services Committee has restored funds for five major production programs that President Carter wanted cut, while money for R&D has been reduced.

The committee early this month approved the $35.91 billion procurement authorization—a total that went along with Carter on all but $60.8 million of the $2.8 billion he sought to cut from the budget proposed by the outgoing Ford Administration [*Electronics*, Feb. 3, p. 58]. The full House should vote on the authorization before May.

Soviet buildup. The final authorization stressing production of aircraft and missiles while cutting R&D reflects "the continued buildup" in Soviet arms, explains committee chairman Melvin Price (D., Ill.). But it also reflects the effectiveness of the Texas delegation—including majority leader James C. Wright—in getting funds restored for LTV's Vought Corp., which Carter had cut. This would have effectively wiped out LTV as a major prime contractor. [*Electronics*, March 3, p. 50].

The committee put back all $77.7 million for 360 of the Army's Lance missiles plus the $24.4 million sought for the Navy's final buy of six A-7E Corsair attack planes. Nor would the House committee buy the proposed "saving" of $334 million by cutting 30 of the Air Force/McDonnell Douglas F-15 interceptors, leaving the annual production total at 108.

Similarly, it restored $35.3 million

News briefs

Matsushita to supply RCA with home video systems
RCA Corp. of New York and Matsushita Industrial Co. of Japan have reached an agreement under which the Japanese firm will supply RCA with Matsushita's Video Home System video cassette recorder/players built to RCA's specifications. Products at prices competitive with Zenith's and Sony's will appear in the U.S. in the late summer of this year, says RCA Consumer Electronics vice president and general manager Roy H. Pollack. The first RCA-labeled unit using the system will feature very-high- and ultra-high-frequency tuners and an electronic clock that permits unattended recording.

CDC expands Cyber 170 computer series
With the introduction of a new medium-scale system and a new top-of-the-line processor, Control Data Corp. of Minneapolis has expanded its Cyber 170 family of general-purpose computer systems at both ends of the performance spectrum. A Cyber 171, scheduled for first shipments in July, has a central memory expandable from 65,536 to 262,144 60-bit words and is made of dynamic 1,024-bit metal-oxide-semiconductor random-access memories. Priced at under $800,000 in its basic configuration, the 171 also can be expanded with dual processors, from a minimum of 10 to 20 peripheral processors, and from a minimum of 12 to 24 input/output channels. Having about 18 times the performance of the 171, yet using the same software operating system, is the Cyber 176 which will first be shipped in the fourth quarter. The 176's central memory, made up of static 1,024-bit bipolar RAMs, is expandable from 131,072 to 262,144 60-bit words. Typically priced under $7 million, the 176 also has an extended (core) memory subsystem for adding increments of 0.5, 1, or 2 million words.

Seek to block United Technologies takeover
Babcock & Wilcox Co. in New York has turned to Federal Court in Akron, Ohio, to avert an unsolicited takeover by United Technologies Corp. of Hartford, Conn. Calling United's tender offer of $42 per share "grossly inadequate," B&W seeks an injunction to block United's purchase of 12.6 million B&W shares. The suit charges United is violating antitrust laws, since the firms are "two of the largest American enterprises competing in the energy-equipment field." The possible $530 million-plus deal would also bring to United electronics operations like The Bailey Meter Co., Control Components Inc., and the Automated Machine division.

Burroughs super-computer starts at $3.9 million
Burroughs Corp. has released most of the details of its new super-computer, the Burroughs scientific processor, called BSP [*Electronics*, Oct. 28, 1976 p. 32]. The new machine will be available in early 1979 in three versions: a basic unit that can be coupled to the user's own large-scale Burroughs B 7800 system, plus two models that include either the B 7811 or B 7821 as systems manager. In its minimum configuration, the BSP will sell for roughly $3.9 million, or with options for up to $6.2 million. Equivalent monthly lease rates range from $129,000 to $175,000.

Using Burroughs' own current-mode logic (similar to emitter-coupled logic) and a charge-coupled-device file memory, the BSP processes up to 50 million floating-point operations per second. The 500-microsecond memory is expandable from a base of 4 million words to 67 million words. The machine's parallel processor, with 16 arithmetic elements, can handle 16 vector-oriented multiplications in 320 nanoseconds; the control processor operates at 12 megahertz and has 262,000 words of 56-bit bipolar memory.

Rockwell to produce MOS Technology processor
Rockwell International Corp., El Segundo, Calif., has obtained a license from MOS Technology Inc., Norristown, Pa., for Rockwell's Electronic Devices division to produce MOS' 6500 family of 8-bit, n-channel metal-oxide-semiconductor microprocessors.

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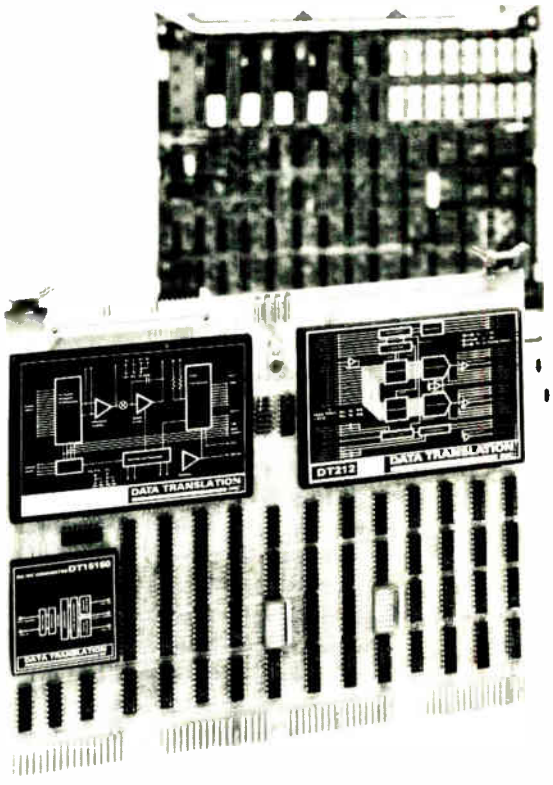

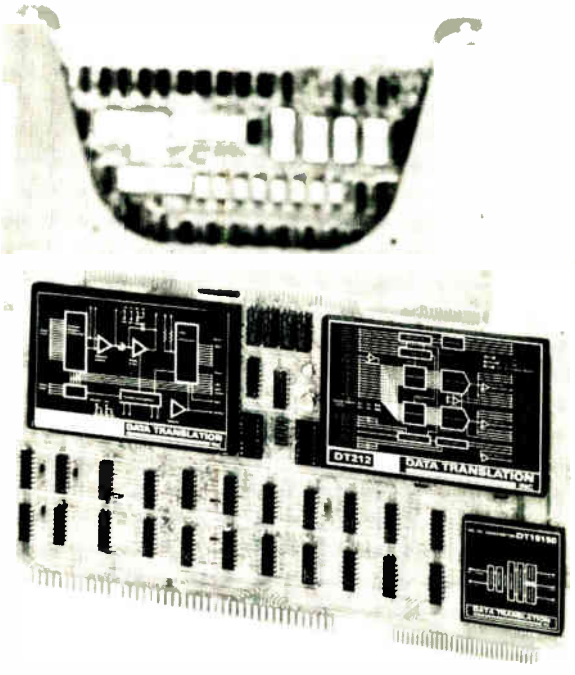

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SCIENCE/SCOPE

An advanced electric storage battery that uses nickel and hydrogen to generate power is in development at Hughes for the Air Force. For future satellite systems, these Ni-H_2 cells offer important advantages of lighter weight and longer life over the standard nickel-cadmium (Ni-Cad) types. Ni-H_2 cells are less than half the weight of Ni-Cad and are expected to have an operational life exceeding ten years in synchronous orbit (22,300-mile altitude) and 30,000 low-earth-orbit charge/discharge cycles. Cells up to 50 amp-hr capacity are being assembled within a 3.5-inch-diameter pressure vessel.

A jam-resistant radio terminal that will enable a flying surveillance, command, and control center to exchange secure, real-time information over a single network on a time-ordered basis has been delivered by Hughes to the Boeing Company. The Time Division Multiple Access (TDMA) radio terminal is the first to be built for the US Air Force's E-3A airborne warning and control system aircraft.

Spectrum spreading, frequency hopping, and error correction are among the techniques used for jam-resistance. These radios are the initial equipment in the Joint Tactical Information Distribution System (JTIDS) development, designed to provide a secure means for all four military services to exchange tactical data in real-time form.

An old pro in earth orbit, NASA's Applications Technology Satellite, ATS-1, is still in public service ten years after launch, despite an original life objective of three years. The Hughes-built satellite, originally designed for communications experiments, continues to perform mercy missions for the sick and injured in remote parts of Alaska. The satellite transmits emergency calls for help and relays doctors' instructions for treatment. ATS-1 is credited with saving at least seven lives since its launch in 1966.

Educational instructions are also relayed by the satellite: from a university on Fiji to students on many South Pacific islands. In addition, it links them to the University of Hawaii.

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An advanced IR missile seeker, built by Hughes, is undergoing a series of missile flight tests. These tests, conducted under a joint Navy-Air Force AIMVAL (Air Intercept Missile Evaluation) program at Nellis AF Base, Nevada, will determine performance characteristics for the new generation of short-range air-to-air missiles. Ten of the advanced seekers, a second seeker type, and the AIM-9L seeker are being carried on the weapons racks of Navy F-14s and Air Force F-15s. These planes are in air-combat maneuvers against F-5s over an instrumented test range.

NATO's Awacs shot down by UK

While Boeing's E-3A Advanced Warning and Control System was taking a beating in the U.S. military budget for fiscal 1978, America's troubled effort to sell it to the North Atlantic Treaty Organization collapsed as well, wiping out a projected $300 million in European electronics contracts [*Electronics*, Feb. 17, p. 31]. Britain has opted for 11 of its own Nimrod aircraft for the airborne early-warning mission at a projected cost of more than $500 million, instead of trying to find the estimated $390 million for its share of NATO/Awacs. But Boeing's loss could turn out to be Grumman Corp.'s gain. The Bethpage, N.Y., plane maker has been pushing hard to sell the UK on the idea of equipping Nimrod with the avionics package from the Navy's E-2C Hawkeye carrier-based early-warning system, although this proposal is producing hostility in Britain's avionics industry. Following the UK pullout, odds are zero that the Federal Republic of Germany, still ruffled by the U.S. rejection of its Leopard tank for NATO, will now go with Awacs.

to the Army's Hawk missile production money for Raytheon and another $276.6 million for the first six USAF ATCAS—Advanced Tanker/Cargo Aircraft—for which Boeing and McDonnell are competing. With other additions, the Carter procurement proposals were boosted by nearly $793 million to $24.83 billion.

Loser. But R&D monies were cut by an almost similar amount—$776.7 million from Carter's request for $11.72 billion. Biggest cut was the $103 million in General Dynamics' F-16 air combat fighter for the Air Force, leaving only $60 million for RDT&E. The $1.5 billion request to produce 105 planes was left whole. Proposed improvements to the E-3A Awacs were dropped by the committee, too, cutting $44 million (see "Nato's Awacs shot down by UK").

The only partial winner on the R&D side is Hughes Aircraft, which got $55 million restored for the Army's Advanced Attack Helicopter, which Carter wanted to cut back to $100 million—half the Ford request. But the House Committee's cancellation of all R&D money for the Navy's controversial extremely-low-frequency Seafarer communications program may have saved the White House some political embarassment. The system, for communicating from the shore with submerged missile-launching submarines, had been proposed for the Upper Michigan Peninsula. But Carter had promised during his campaign not to put Seafarer in Michigan, where voters opposed it. Recently Carter appeared to back off from that firm promise, saying it was "under study" at the Pentagon, angering Michiganders. The House resolved the problem by eliminating funds until the Navy can find an acceptable site—an unlikely prospect now. □

Memories

TI raises curtain on its 65-k RAM

Much to the surprise of other random-access memory makers and users, Texas Instruments has let slip the direction it intends to take to build 65,536-bit RAMs. Though samples are not expected before 1978, TI indicates that its first parts will be made with an approach similar to the single-transistor-cell design and double-level polysilicon process pioneered by Mostek Corp. for its 16,384-bit RAMs.

TI, however, apparently has yet to master the process for 16-k RAMs. It is shipping 16-k memories built with the single-level process it perfected for 4,096-bit RAMs. It is supplying only selected customers with double-level 16-k samples it admits will not be widely available until June.

A TI official labels the early reports [*Electronics*, March 31,

p. 26] of the 65-k development as "unfortunate" and comments that the firm's plans are still subject to change. Nevertheless, TI appears to be proceeding with an approach toward 65-k devices similar to the one it is now taking in the 16-k market. That is, it will use existing technology to build early, admittedly transitional, parts while readying a more advanced 65-k part that might use a different technology.

50% larger. TI's 65-k RAM will measure about 45,000 square mils, about 50% larger than the area it says its double-level 16-k memory will have. The firm has reportedly tested the 65-k RAM's cell geometries on a few test wafers—using conventional optical imaging techniques—and is confident that cell size on the new part will not exceed 0.5 square mil, about half that of its double-level 16-k device. The 65-k chip is roughly the size of the firm's present single-level 16-k part, which is generally regarded by users as too slow to be widely used and by competitors as too large to be economically viable.

TI sees the 65-k RAM built with standard lithography pushed to its limits as a transitional but viable part and expects that the optical process can achieve 3-to-4-micrometer mask lines in a manufacturing environment. It will probably be followed by a version that employs other mask-making techniques, such as X-ray or electron-beam lithography, to produce a smaller and higher-performing chip. Observers estimate that the transfer of these techniques to production lines is two or three years away.

Keeping mum. Other firms, of course, are also in the early stages of 65-k RAM development. They should also have devices ready to be shown customers some time next year, but they refuse to discuss the technical details or availability of their devices.

Moreover, they are somewhat amused that TI has revealed details of its 65-k development at such an early, and at what they regard a premature, stage. In discussing their own approaches they will only say, as Mostek has, that "ours will not be a second source to TI's [initial] 'brute force' product."

It is generally thought that 65-k memories will exhibit power requirements and performance similar to those of current 16-k offerings, will operate from but a single power supply instead of three, and will be priced at about half the per-bit level of 16-k RAMs. □

New association to work with Wema

The split between Wema and the new Semiconductor Industry Association may not be as wide as some had feared. In fact, executives of both groups are going out of their way to describe the relation between the two as "amicable" and to stress that the two groups will work together in the future.

Focus on problems. "We'll have more focus than we could have before because of the way the [new] organization is set up," says Bernard T. Marren, the executive director of the Semiconductor Industry Association and former president of American Microsystems Inc. He voices the desires of the executives of the five companies—Robert Noyce, chairman of Intel Corp., Wilfred J. Corrigan, president of Fairchild Camera & Instrument Corp., John R. Welty, vice president at Motorola, W.J. Sanders III, president of Advanced Micro Devices Inc., and Charles E. Sporck, president of National Semiconductor Corp.—who formed the semiconductor association last month.

As Wema, with its 810 electronics members and 190 associates, has grown, "its impact as a representative of any one group has become diffused," says Corrigan. As an organization "treats more subscribers," it "can't be all things to all people," admitted Wema president Ed Ferrey on another occasion. More specifically, the Semiconductor Device group within Wema,

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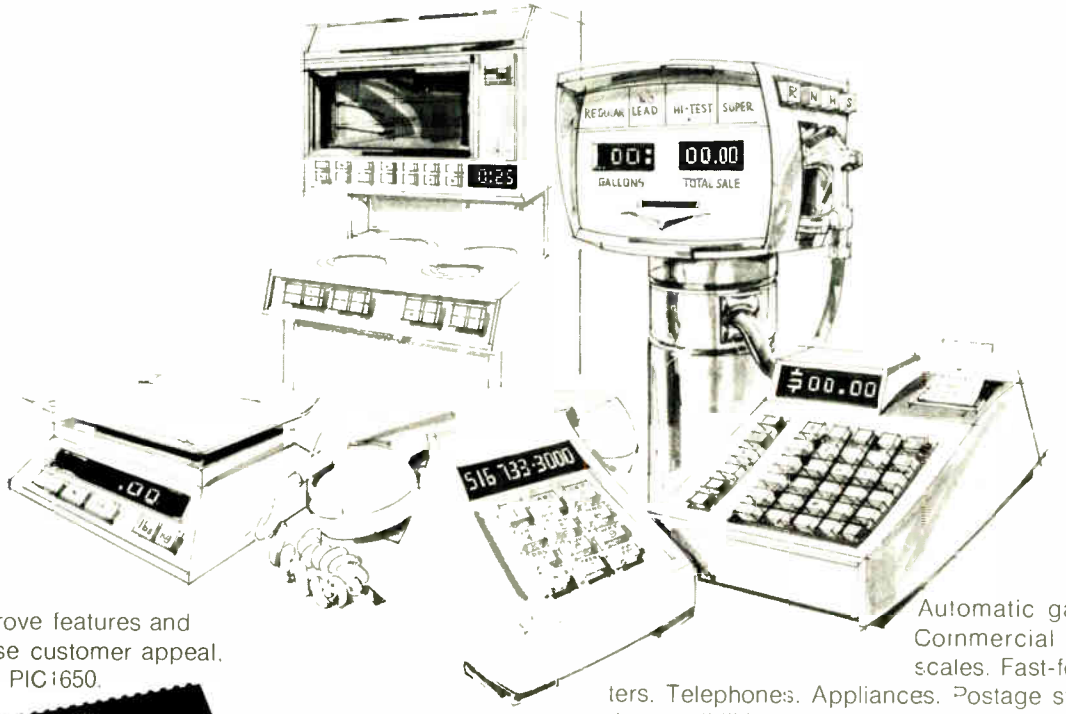

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Electronics review

which had been formed two years ago to deal with the problems of semiconductor-device makers, "was not effective, and the staff support was not adequate," says Corrigan.

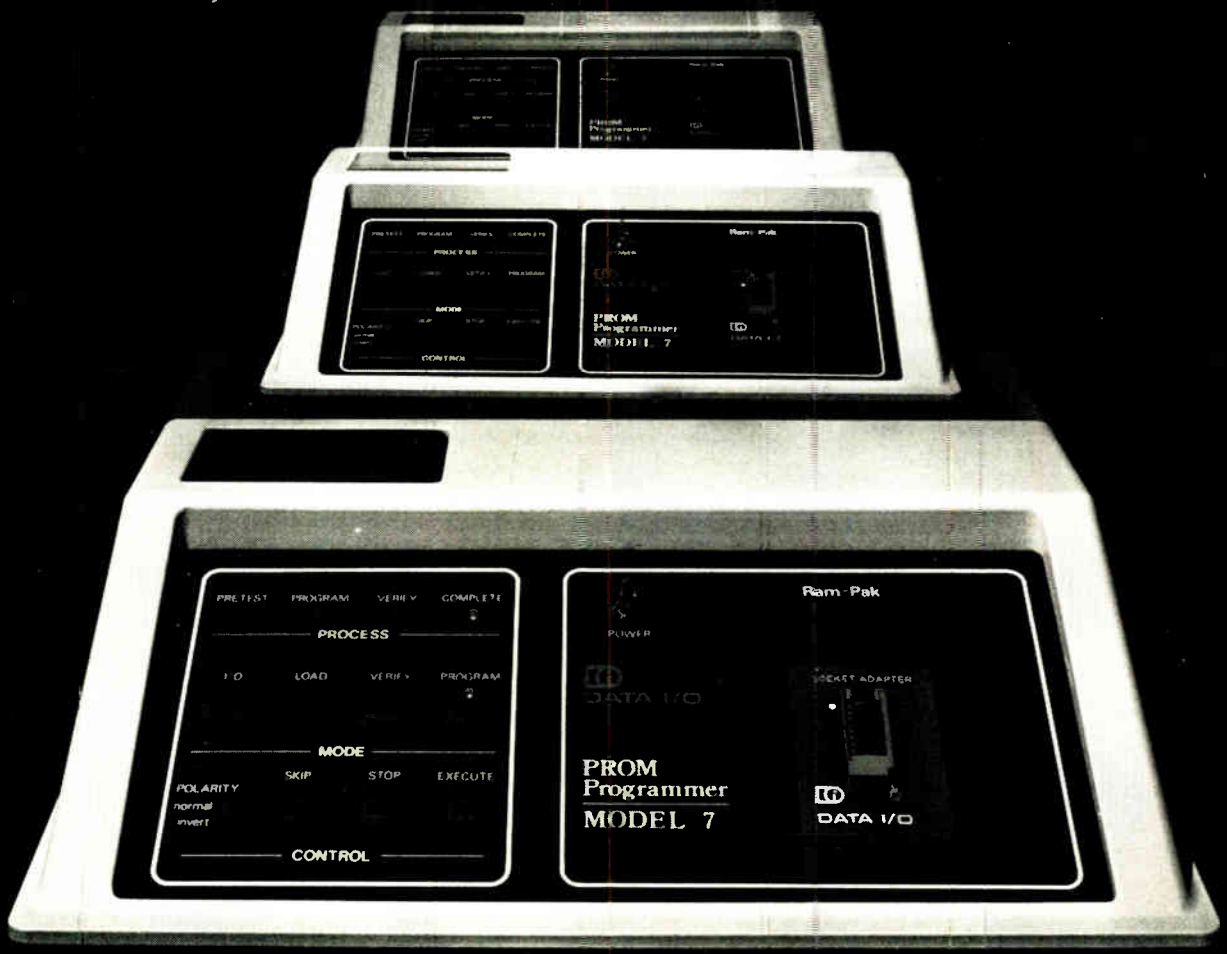
SIA will aim its lobbying efforts at Federal and state regulations and legislation that especially affect the semiconductor industry, according to Marren. In particular, it will be concerned with trade and energy matters, which Wema, too, deals with, "but in a general way," observes Ferrey.

Demonstrating their intention to cooperate, the two groups are meeting to decide how to handle the semiconductor statistical program that had been Wema's. "We will transfer [it] to SIA in an amicable fashion," says Corrigan. SIA chairman Marren also expects cooperation to be especially close over legislation at the Federal level, where the two groups "can share the same data bases."

The other piece of unfinished business between the two groups is Microfair, Wema's trade fair scheduled for October in Chicago, and intended to educate non-electronics firms in the application of microprocessors. To promote Microfair, Wema has already spent $15,000 without the authorization of its semiconductor group—an expense it may have to swallow if SIA does not agree with Wema to hold it and if Wema cannot then find another sponsor, says a Wema official.

Thirty semiconductor-device makers belong to Wema, including two or three hybrid manufacturers. Some nonmembers also participate in the statistical program. Between them, Ferrey says the semiconductor firms contribute 3.3% of Wema's dues revenues, which total more than $1 million yearly.

Marren is beginning to solicit members from among the approximately 80 semiconductor-device makers in the U.S. How far they will overlap with Wema's membership cannot yet be known, of course, but he expects SIA's five executive committee members and their companies to retain their Wema membership even after the end of the year, the period covered by their paid-up dues. □



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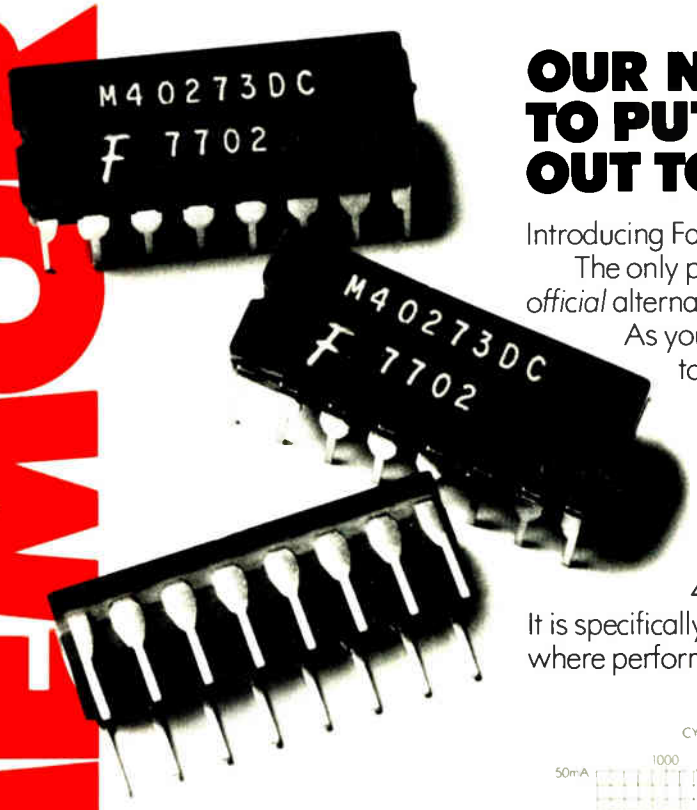

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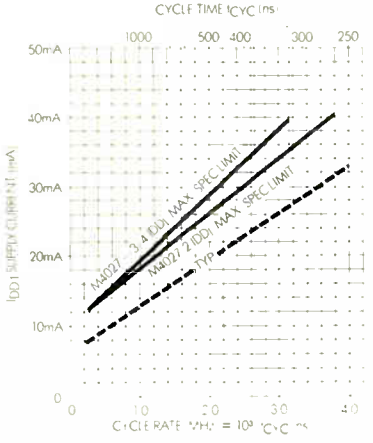

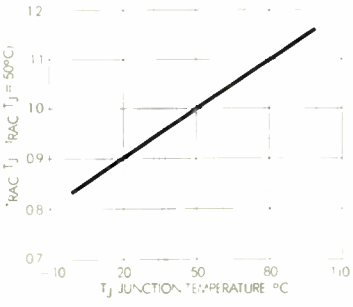

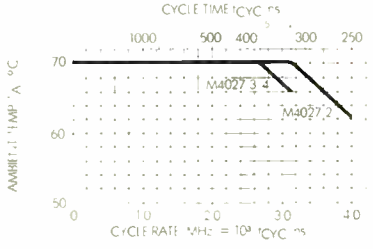

Also, it is the only 4K RAM that offers true 16K RAM compatibility.

And speaking of compatibility, you should see how it gets along with the 4096.

In most applications an M4027 will plug directly into a 4096 socket. Here are a few specs to whet your appetite:

M4027 SERIES COMPARED TO 4096 SERIES DYNAMIC RAMs

Parameter	4096 Series	M4027-2	M4027-3	M4027-4
Access Time Range	250-350 ns	150 ns	200 ns	250 ns
Row Address Hold Time Range	50-80 ns	20 ns	25 ns	35 ns
Column-To-Row-Strobe Lead Time Range	−50 to +50 ns	$\overline{CAS}$ can stay LOW to end of cycle.		
Clock High Voltage Minimum	2.7 V	2.4 V	2.4 V	2.4 V
Input High Voltage Minimum (Except Clock)	2.4 V	2.2 V	2.2 V	2.2 V
Page Mode Operation?	NO	YES	YES	YES
"$\overline{RAS}$-Only" Refresh Cycle?	NO	YES	YES	YES

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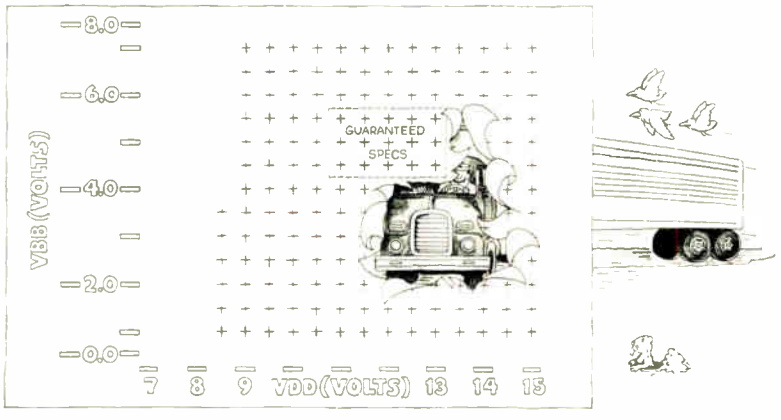

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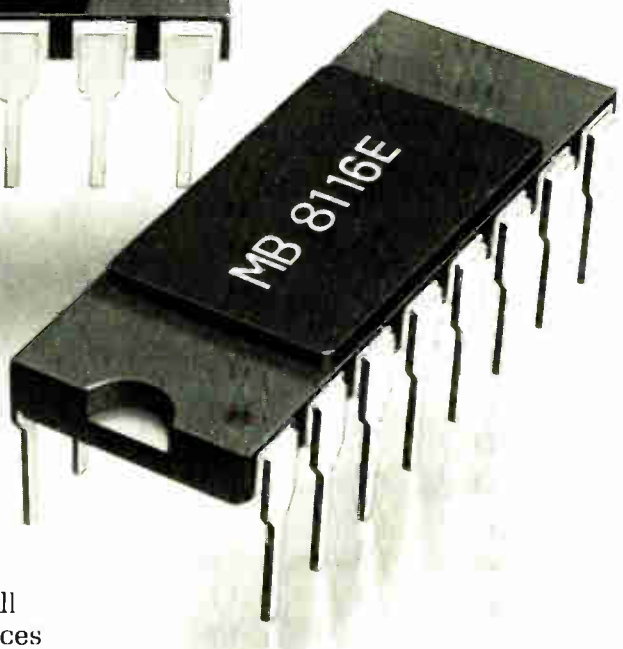

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*Pin compatible with the MK 4116 and TMS 4070 16K RAMs.

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Washington newsletter

B-1 production nod set for June with first 100

President Carter will approve limited production of the Air Force B-1 bomber by prime contractor Rockwell International Inc. in June, government sources close to the program have told *Electronics*. The delayed decision on the bomber—**which Carter now favors despite contrary campaign statements**—will authorize a go-ahead of "about 100 planes" to start, barring an unexpected "softening of the Soviet position" on mutual force reductions at Geneva arms-limitations talks in May. Carter's most recent proposals, rejected by Moscow, contemplated a phased reduction in strategic nuclear-delivery vehicles to 1,500—some 900 below the level of the Vladivostok accord, officials say.

Less is known about Carter plans for production of the air/sea/ground-launched cruise missiles—the second program agitating the Soviets—which are still in development and not scheduled for a Pentagon production recommendation before October. The Pentagon is continuing tests of the Navy's sea-launched Tomahawk version. It also continues to merge the separate Air Force-Navy programs into a single joint office, to be headed by Navy Capt. Walter Locke when it is established by the end of April. Locke, now head of the Tomahawk effort, will have an Air Force deputy.

NASA moving to restore satcom R&D capability

NASA's Goddard Space Flight Center, bolstered by a National Academy of Engineering recommendation, is moving to get back into satellite-communications research and development after a four-year hiatus. Goddard is seeking to increase its fiscal 1979 satcom R&D budget tenfold to as much as $100 million.

If approved, part of the money would be used to explore **12- to 14-gigahertz and ultrahigh-frequency direct-broadcast satellites,** respectively, for fixed and mobile two-way services to public organizations such as emergency medical services, hospitals, libraries, police, and schools. Fixed units using a 5-foot-diameter rooftop antenna would handle color-television, two-way data, and voice, while mobile units using a 3-inch whip antenna would have data and voice capability only.

DOD communications, intelligence functions merge under Dineen

The promised reorganization of the Pentagon is under way with the merger of the directorates of Intelligence and of Telecommunications and Command and Controls Systems. Heading the new office of Communications, Command, Control, and Intelligence is Gerald P. Dineen; his title is assistant secretary of defense. Before Dineen took office in early April, **he was director of the MIT Lincoln Laboratory,** which he joined in 1953. He is succeeded there by his former associate, Walter E. Morrow Jr., a space communications specialist.

OTA's Daly heads study of EDP, telecommunications

A three-month examination of U.S. policies and the state of the art in telecommunications, computers, and information transfer is being set up by Congress' Office of Technology Assessment under the direction of Robert E. Daly, its assistant operations director. With a staff of about 30, including specialists from industry and universities, the project will recommend **whether or not OTA should proceed with a full-scale evaluation program.** The effort was stimulated by congressional interest in developing an independent assessment for its use in a possible rewrite of the 1934 Communications Act, first proposed last year by the nation's telephone companies.

Washington commentary

The need to revitalize NATO

First it was France. Now it is Britain. Is the North Atlantic Treaty Organization falling apart? Not quite, but it is showing signs of severe strain. Admittedly, the United Kingdom's latest flash of independence in choosing its own less competent Hawker Siddeley Nimrod Airborne Early Warning System for its NATO forces instead of a common version of Boeing's E-3A Advanced Warning and Control System is not as severe as Charles de Gaulle's decision some years earlier to pull France out of NATO altogether. Nevertheless, the British decision to go it alone in this case is producing damaging vibrations throughout the European alliance. For example, it seems unlikely now that the Federal Republic of Germany will go the Awacs route either (see p. 46).

Coming on the heels of the Soviet Union's sharp rejection of America's new initiatives for further limiting deployment of intercontinental ballistic missiles, the situation presents President Jimmy Carter with one more dilemma. If NATO gets Awacs at all now, it appears the systems are going to have to be from the U. S. Air Force fleet.

Complaints on the F-16

Compounding America's struggle to maintain NATO unity is the mixture of disgruntlement and cost questions recently raised by Belgium, Denmark, the Netherlands, and Norway about their participation in the NATO version of the General Dynamics F-16 air combat fighter program. All four countries asked for extension at least to the end of April on the deadline for their commitments to sign purchase contracts for the plane, whose rising unit costs are now being criticized in Congress.

The four countries recently received $54.7 million in offset contracts for European production of the plane's multimode radar from Westinghouse Electric Co., Baltimore [*Electronics*, March 31, p. 53]. But Denmark only got $2.4 million of that and contends that its F-16 offset contracts overall are still far below the minimum guarantee of 58% of the price of the planes it will buy. Norway, too, like Denmark, is unhappy that larger shares always seem to be going to the Belgians and Dutch. The issue certainly seems resolvable with relative ease by shifting some contracts, yet it is producing one more strain that NATO can ill afford.

NATO is hardly Jimmy Carter's only problem, merely his newest. Yet it is one he should deal with swiftly. Britain's Awacs decision is but one more symptom of problems that first showed up years ago when France insisted on a larger share of the NATO contractual pie—and didn't get it largely because of American unwillingness to share the wealth. It was just last year, of course, that NATO's only other partner with a truly strong economy—Germany—was jolted when the U. S. rejected standardizing on the German's Leopard tank for NATO forces despite private admissions by American Army sources that the Leopard is a superior vehicle.

The F-16 selection by four of NATO's European partners did come last year as the biggest buy ever for the alliance where the use of U. S. subcontracts to offset national outlays was a significant factor. But in the opinion of some Europeans based in Washington, it included too few NATO members and came far too late. "NATO's inability to standardize on weapons systems and interchangeable spare parts is an old and pathetic joke," one East Bloc military attache observed earlier this year. "If that is an 'alliance,' then I'm King Kong. Russia doesn't need its army for NATO. Peasants with scythes and shovels could defeat it," he laughed, waving the issue aside.

Such overstatements are nothing new in Washington, particularly at East Bloc embassy receptions celebrating events such as Armed Forces Day that go largely unnoticed in Western democracies. But boastful though they may be, those statements point up weaknesses in the NATO force and weapons structures that are getting worse.

Tactics and strategy

NATO is a far less effective military deterrent to the Soviet Union in Europe than the American nuclear warheads located on these shores and under the world's oceans. Thus before President Carter begins trading down in ICBMs again, he should devote a significantly greater effort to making NATO's tactical forces work more effectively. He should do it by pushing harder for weapons standardization and then encouraging its acceptance by American's European allies by providing them with larger contractual shares, even prime contracts where the technology warrants it.

Should Carter fail to pull NATO's conventional ground and air forces together, senior U. S. military leaders privately fear the Soviets could achieve a major strategic coup—and make the existing European imbalance even worse—by agreeing to accept significant mutual cutbacks in ICBM launchers and warheads.

Ray Connolly

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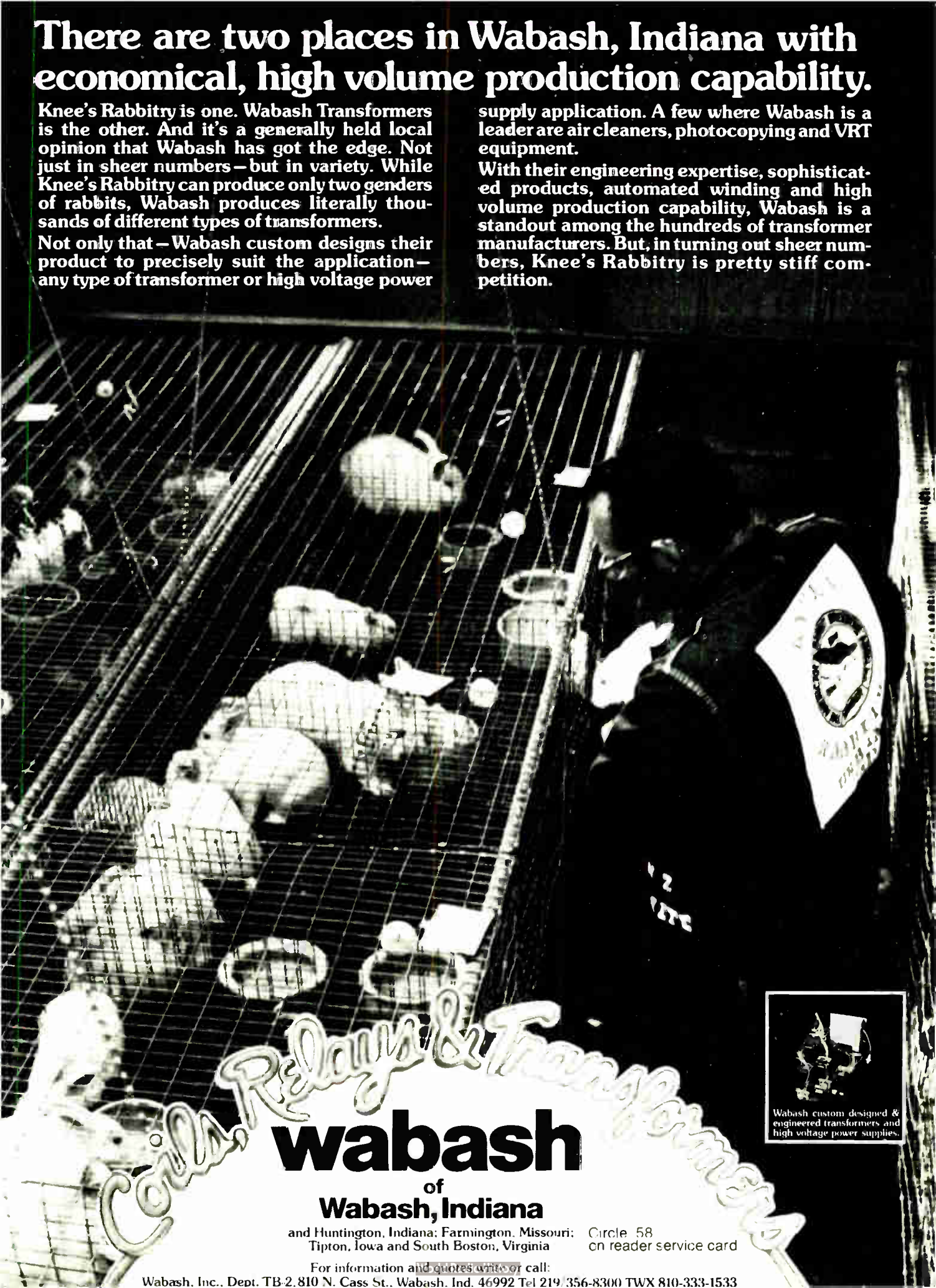

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74LS04	Hex Inverter
74LS08	Quad 2-Input And Gate
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74LS10	Triple 3-Input Nand Gate
74LS11	Triple 3-Input And Gate
74LS13	Dual 4-Input Nand Schmitt Trigger
74LS14	Hex Schmitt Trigger
74LS15	Triple 3-Input And Gate
74LS20	Dual 4-Input Nand Gate
74LS22	Dual 4-Input Nand Gate (O.C.)
74LS27	Triple 3-Input Nor Gate
74LS30	8-Input Nand Gate
74LS32	Quad 2-Input Or Gate
74LS51	Dual 2-Wide 2/3-Input And/Or Invert Gate
74LS54	4-Wide, 2-Input And/Or Invert Gate
74LS74	Dual D Flip Flop
74LS90	Decade Counter
74LS93	4-Bit Binary Counter
74LS95B	4-Bit Parallel-Access Shift Register

74LS TYPE	FUNCTION
74LS109A	Dual JK Flip Flop W/Preset and Clear
74LS132	Quad 2-Input Nand Schmitt Trigger
74LS138	3 to 8 Line Decoder/Demultiplexer
74LS139	2 to 4 Line Decoder/Demultiplexer
74LS157	Quad 2-Input Mux, Non Inverting
74LS158	Quad 2-Input Mux, Inverting
74LS174	Hex D Type Flip Flop W/Clear
74LS175	Quad D Flip Flop W/Clear
74LS194A	4-Bit Universal L/R Shift Register
74LS195A	4-Bit Parallel In Parallel Out Shift Register
74LS257	Quad 2-Input Mux, Non Inverting Tri State
74LS258	Quad 2-Input Mux, Inverting Tri State
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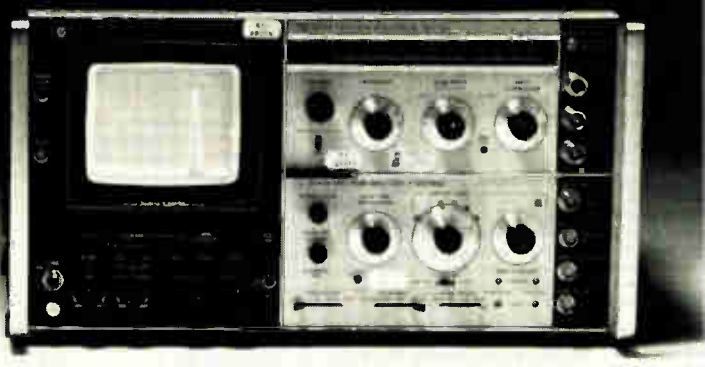

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International newsletter

French develop electrolytic cells that challenge LCDs

Researchers at the French atomic-energy agency's laboratory for electronic and computer technology (LETI) think they have hit on a materials combination—silver and an organic electrolyte that they will not disclose—that could make electrolytic cells better and cheaper than liquid-crystal displays. **In the LETI cell, display segments are realized by transparent electrodes that become opaque when a pulse of about 1 volt is applied across the cell for 50 to 200 milliseconds.**

The pulse causes a 50-angstrom layer of silver to plate out on selected electrodes, and the plating stays on them for more than 10 minutes unless an erase pulse of the opposite polarity is applied. Robert Meyer and Jacques Duchêne, who developed the cell, say it poses no particular problem for production. In contrast to LCDs, neither the flatness nor the spacing between front and rear plates of the cell is critical.

Fiber-optic link to transmit 9 km at 140 Mb/s

Standard Telephone and Cables is installing a 140-megabit-per-second digital optical-fiber link 9 kilometers long between two telephone exchanges north of London. The installation, which can handle 1,920 two-way speech channels or two color-television channels, is understood to employ two active fibers and a spare in a cable drawn through standard British Post Office ducts.

Lasers with a wavelength of 850 nanometers are installed at each end of the circuit and in each of the two repeaters. STC, which believes the setup is ahead of other systems about to be installed elsewhere in the world, wants the BPO to undertake a two-year test and monitor live telephone traffic over the link.

Interkama combines four attractions at Düsseldorf

Already more than 700 companies from 18 countries have signed up for exhibit space at West Germany's Interkama show. Billed as the biggest show for automation, Interkama will make its triennial appearance Oct. 6 to 12 at the fairgrounds in Düsseldorf. Besides the company booths in the trade-fair section, the expected 90,000 showgoers can attend the accompanying scientific congress, application seminars sponsored by exhibiting companies, and a special applied-research show that displays work going on at universities, institutes, and other research centers. **As an innovation, the congress' 30 sessions will be packed into one and a half days and will be presented twice—once at each end of the show week.**

RCA deal to bring Matsushita 4-hour VTRs to the U. S.

Lured by the prospects of a large U.S. market, RCA Corp. and Matsushita Electric Industrial Co. will, by late summer, begin selling VHS-type videotape recorders that play four-hour cassettes. The Japanese company, which will offer the VTRs under its Panasonic label, predicts that the American market could exceed 100,000 units this year and 1 million a year by 1979 or 1980. This arrangement follows closely the announcement by Zenith Radio Corp. that it will market Beta format recorders from Sony Corp.

Playing time of the cassettes for the VHS recorders, developed originally by Victor Co. of Japan Ltd., **has been doubled to four hours by cutting the tape speed in half,** the same expedient used earlier by Sony to double its cassette's playing time to two hours. Matsushita does not at present plan to offer the four-hour units in Japan, nor does any of the four other companies marketing the system.

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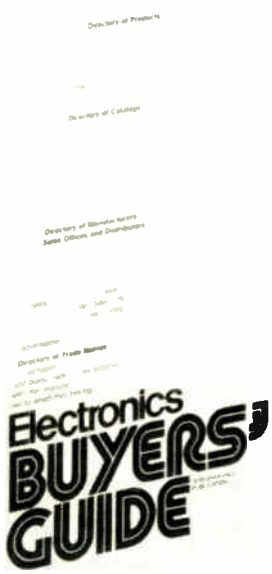

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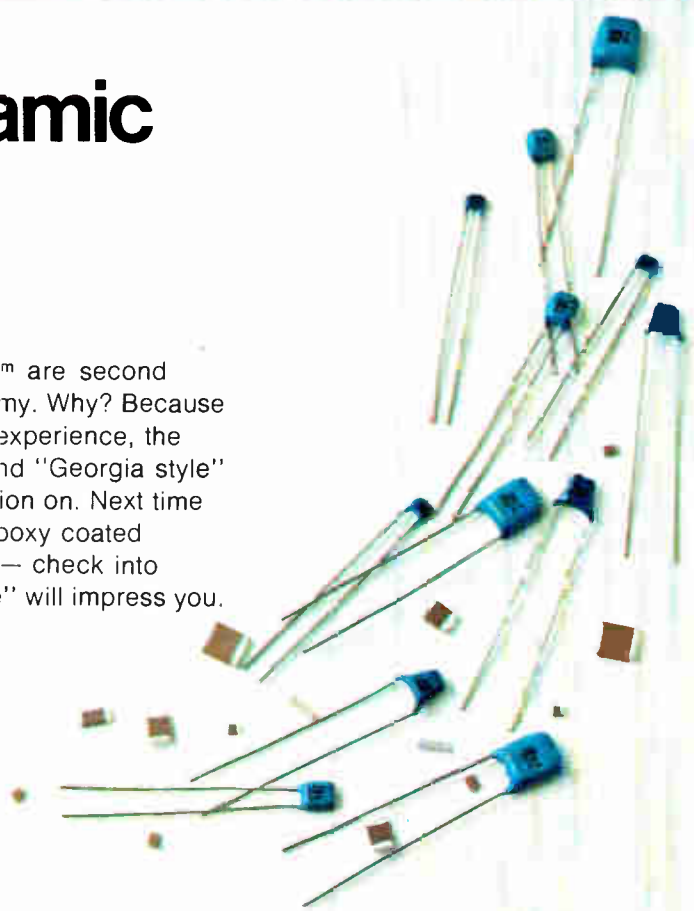

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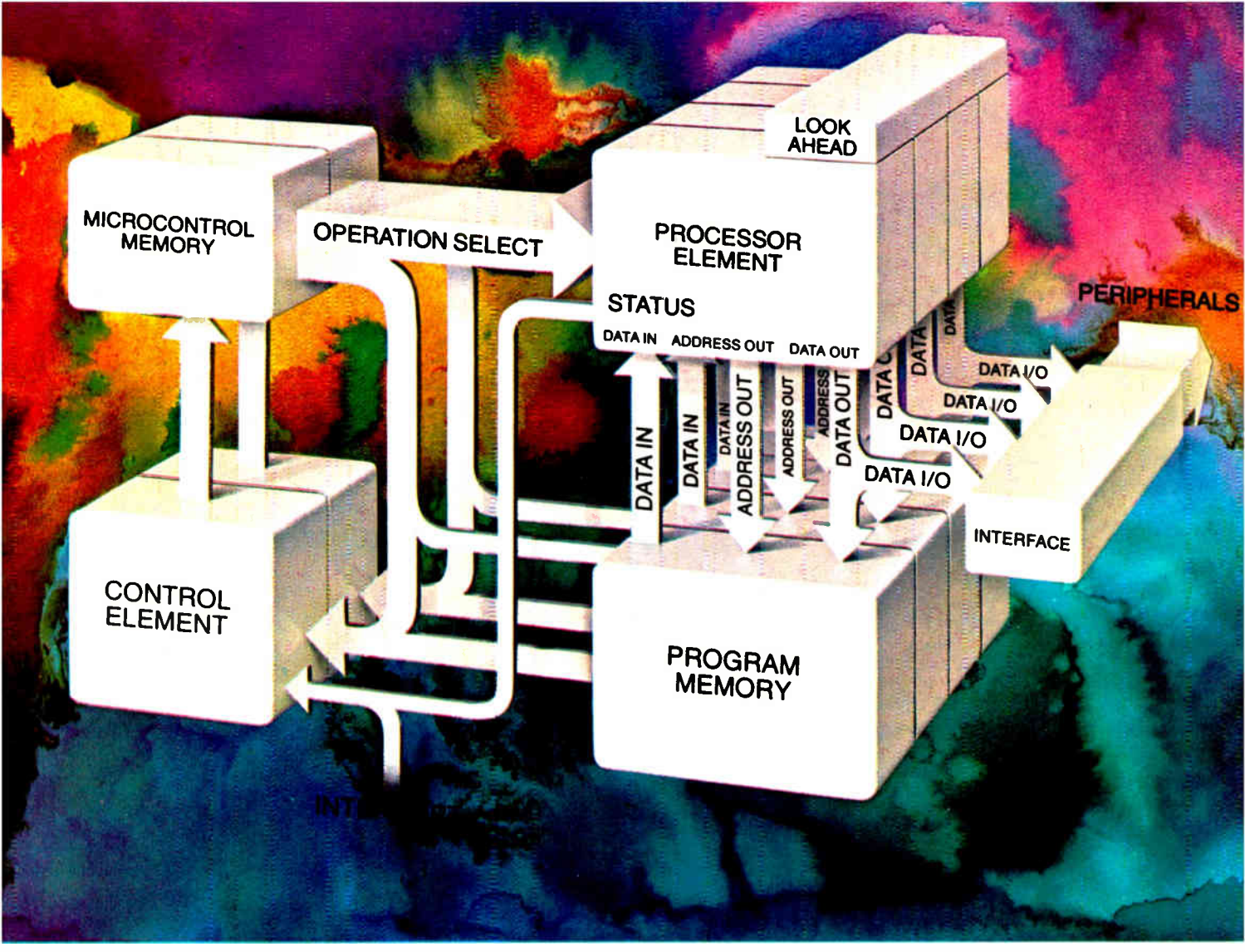

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TI's 9900 First Family

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A 4-bit slice processor element, the SN54S/74S481 is both micro and

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The SN54S/74S481 is available now in a high-density 48-pin quad-in-line ceramic package at $29.25 each for the commercial version (100 pieces).

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The new SN54S/74S482 4-bit slice control element integrates a full adder, four-word push-pop stack, source select multiplexer and address register. It offers next-address generation in 25 ns. All in a space-saving 20-pin package.

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TI Schottky PROM Line Summary

Part Number	Description	Address Access Time	Power Dissipation
SN54S/74S188	32W x 8B, O-C, 16 pins	25ns	400mW
SN54S/74S288	32W x 8B, 3-S, 16 pins	25ns	400 mW
SN54S/74S287	256W x 4B, 3-S, 16 pins	42ns	400mW
SN54S/74S387	256W x 4B, O-C, 16 pins	42ns	500mW
SN54S/74S470	256W x 8B, O-C, 20 pins	50ns	550mW
SN54S/74S471	256W x 8B, 3-S, 20 pins	50ns	550mW
SN54S/74S472	512W x 8B, 3-S, 20 pins	55ns	600mW
SN54S/74S473	512W x 8B, O-C, 20 pins	55ns	600mW
SN54S/74S474	512W x 8B, 3-S, 24 pins	55ns	600mW
SN54S/74S475	512W x 8B, O-C, 24 pins	55ns	600mW

TI Schottky RAM Line Summary

Part Number	Description	Address Access Time	Power Dissipation
SN54S/74S189	16W x 4B, 3-S, 16 pins	25ns	375mW
SN54S/74S200	256W x 1B, 3-S, 16 pins	25ns	500mW
SN54LS/74LS200	256W x 1B, 3-S, 16 pins	35ns	275mW
SN54LS/74LS202	256W x 1B, 3-S, 16 pins	35ns	275/100*mW
SN54S/74S214	1024W x 1B, 3-S, 16 pins	30ns	575mW
SN54LS/74LS214	1024W x 1B, 3-S, 16 pins	65ns	200mW
SN54LS/74LS215	1024W x 1B, 3-S, 16 pins	65ns	200/75*mW
SN54S/74S207	256W x 4B, 3-S, 16 pins	40ns	600mW
SN54LS/74LS207	256W x 4B, 3-S, 16 pins	60ns	300mW
SN54S/74S208	256W x 4B, 3-S, 20 pins	40ns	600mW
SN54LS/74LS208	256W x 4B, 3-S, 20 pins	60ns	300mW

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Input/Output Functions... simplified interfacing

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- SN74S226N – 4-Bit Bus Transceiver
- SN74S240N – Octal Inv. Bus Driver
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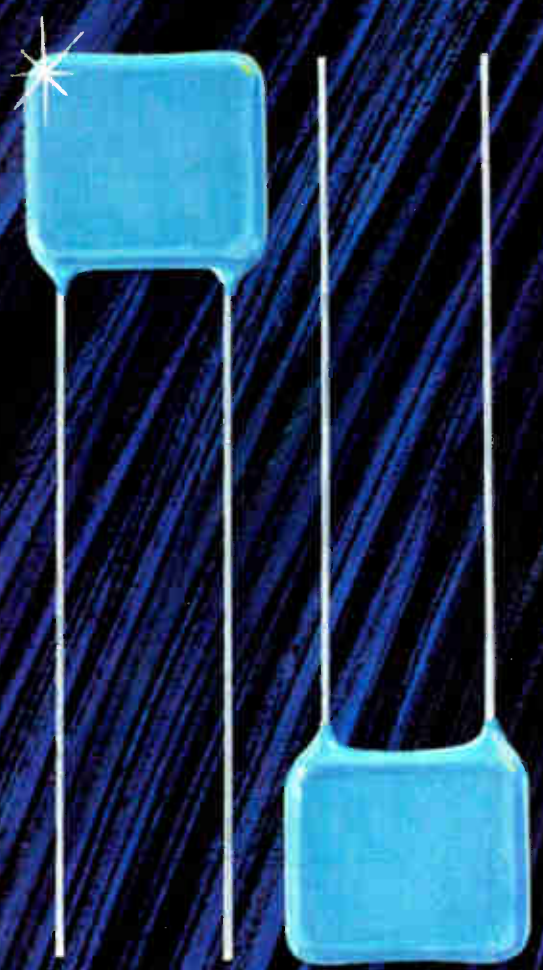

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Army sensors are getting smarter

Battlefield devices to be deployed in the 1980s can describe objects they detect

by Bruce LeBoss, New York bureau manager

"Don't fire until you see the whites of their eyes" was a good idea at Bunker Hill in 1775, but with the sophisticated and lethal arsenal in the hands of today's armies, ground commanders must quickly locate enemy assembly areas and destroy the main force before it takes its principal battle position.

Of course, the means of spotting infiltrators has come a long way since the American Revolution. In Vietnam, for example, unattended battlefield sensors were used in the demilitarized zone as part of the "McNamara Wall" to detect disturbances made by the passage of men on foot or vehicles. Now, infiltration surveillance is about to become even more effective with the development of three advanced unattended ground sensor systems the Army intends to deploy in the 1980s.

Perhaps the most ambitious of these programs is the Remotely Monitored Battlefield Sensor System. Rembass, as it is called, will use magnetic, seismic, seismic/acoustic, and infrared sensors that can be put into place by artillery shells, as well as by hand or high-speed aircraft. Present-day ground sensors cannot be distributed by artillery shells.

Like sensors used in Southeast Asia or the Middle East, Rembass sensors will detect disturbances caused by the passage of target objects and will report by data link to a distant monitoring site. Unlike prior sensors, some Rembass sensors (known as classifiers) will determine the nature of the detected object, whether personnel or a wheeled or tracked vehicle, says Col. L. C. Friedersdorff, Rembass project manager at the U.S. Army Electronics Command, Fort Monmouth, N.J.

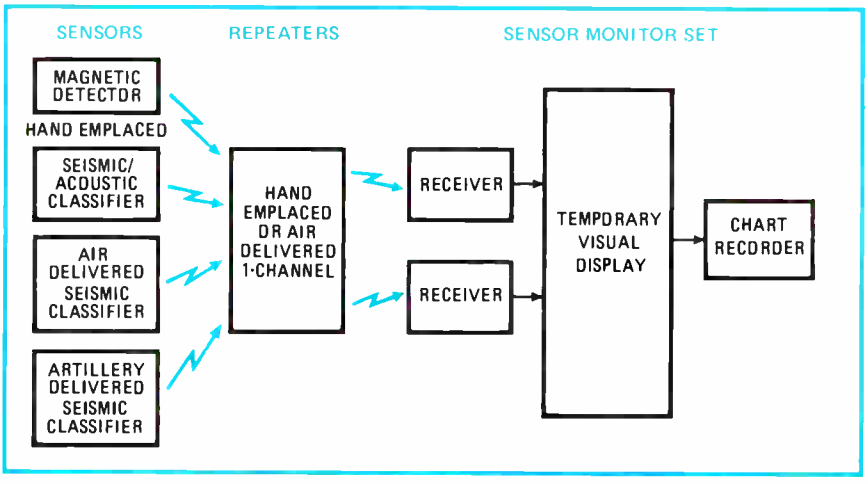
Furthermore, says Friedersdorff, "the problems with prior sensors are that they're not all-weather systems, and they have high false-alarm rates." And, since the older sensors were active radiators—always on the air—"they're highly vulnerable to jamming." By contrast, "Rembass is designed for all-weather, day-and-night operation and is a passive system. It won't send signals unless activated by a target and, therefore, its vulnerability to jamming is very low."

The program is in the system-design phase of engineering development. As part of their proposals for a fabrication contract final design plans were submitted last month by RCA Corp.'s Government Communications Systems division in Camden, N.J., American Electronic Laboratories Inc. of Lansdale, Pa., and GTE Sylvania Inc. of Mountain View, Calif.

"The design plans are under review now, and a decision for a go-ahead is set for May," Friedersdorff says. One of the three firms will be selected to fabricate engineering-development models under a 30-month contract.

If the program goes into production in the early 1980s, "it could result in many, many millions of dollars," says Wesley Brown, AEL's Rembass project manager. "Since these are expendable devices, and each division is to be outfitted with them," the Army would require many devices, he adds.

Electronic logic within the sensors rejects disturbances from unwanted sources, explains Friedersdorff. In these sensors, which are classifiers, there are hard-wired digital circuits into which features or signatures identifiable as specific targets are programmed and stored. When a target is detected, its features are extracted and processed via signal-conditioning circuits. Once classi-



Thorough job. Not only can sensors in the Army's Rembass be planted by artillery shells, but they can differentiate between wheeled or tracked vehicles and troops.

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fied, the target information is digitally coded and transmitted to a receiver/monitor at a division-level command center. There the sensor message is decoded, then recorded and displayed to an operator who analyzes the data and reports the activity detected.

The sensor-activation messages may be reported to the monitoring station through ground and airborne relays over extended distances and despite terrain barriers. "Thus, unlike other intelligence systems, Rembass can get behind hills," says Friedersdorff. "It isn't terrain- or range-limited." Additionally, he notes, Rembass sensors will stay on the air, under worst-case conditions, for a minimum of two weeks, 24 hours a day, without a battery change. The Army hopes to use long-shelf-life batteries of lithium in an organic electrolyte.

The data-transmission system and artillery-delivered sensors that come out of the Rembass engineering development will be used to provide a cost savings in the same phase of another ground sensor system called the Field Artillery Acoustic Locating System, or FAALS. It "employs a new concept for sound ranging," Friedersdorff says. In contrast with linear-array sound-ranging systems now used by the Army, "acoustic sensors, designed to detect artillery muzzle blasts and shell bursts, will be employed well forward of the forward edge of the battle area."

The FAALS sensors are activated by the enemy firings and transmit their information to a target processing center that is built around a Rolm Corp. 1602 (AN/UYK-19) minicomputer. Upon receipt of these messages, the center "time-tags" the data, sorts it into related sets, computes the location of the blast sources, and displays the resulting information.

A FAALS production design is due in February 1980 from Honeywell Inc., Minneapolis, under a $3.4 million advanced development contract, with an engineering contract slated to be awarded a month later. "The production contract should be awarded in 1983, and we hope to have the system in the field and operational by the end of 1984," Friedersdorff says.

Honeywell is responsible for the sensors, target-processing center, software, and complete systems integration and testing, including other equipment the Government will supply for the system. Among the equipment are an antenna from the Hunter Spring division of Ametek Inc. in Hatfield, Pa., artillery shells from Chamberlain Mfg. Co. in Elmhurst, Ill., and the data transmission system from Resdel Engineering Corp.

"FAALS is a fully automated system that will directly transmit messages to division artillery or to Tacfire," says Chuck P. Harman, project manager at Honeywell's Defense Systems division. "It's got state-of-the-art sensors that detect and classify acoustic signals from fired weapons. These signals are characterized and put into digital format. This helps in sorting sensor signals and in correlating them with single-event firings."

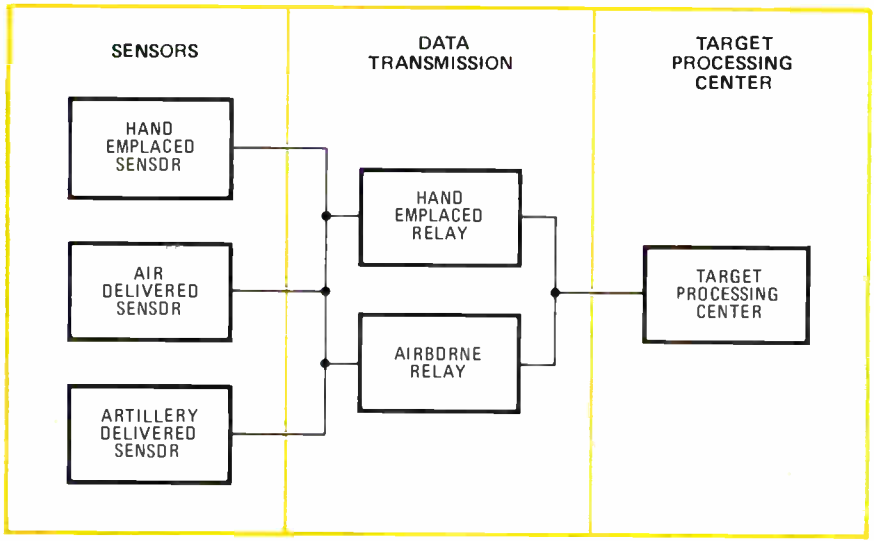
The present linear systems, notes Harman, "are good, but they take more time to deploy and can't handle the high fire rates that are expected on the modern battlefield. FAALS can handle much higher fire rates because of its data-processing facility and the target-processing center."

According to Friedersdorff, the Army plans to employ two FAALS systems for each of the Army's 16 divisions. But there are thoughts of the Army going to 24 divisions and, "the program could run into the tens of millions of dollars," Harman notes.

The third system is not as big as the other two, but the new Platoon Early Warning System will be the first to become operational. PEWS, as it is called, is a lightweight (14.75-pound) sensor system designed for the small unit.

Each set will consist of nine hand-emplaced sensors—six seismic/magnetic and three seismic/electromagnetic—and a receiver/monitor capable of monitoring each sensor by wire or radio to a range of 1,500 meters. Now in the final stages of engineering development, the system is scheduled to enter production this summer and could become operational by late 1979 or early 1980, Friedersdorff says.

General Motors Corp.'s Delco Electronics division in Goleta, Calif., is doing engineering development, and a go-ahead decision for production is expected in June with a contract to be awarded in July. "The proposed buy is for almost 4,000 systems," designated AN/TRS-2 () (V)," says Frank Dennis, the Army's assistant project manager for the system. But, "there is an additional requirement being evaluated for a little more than 1,700 systems." The total value of the initial production therefore, is expected to be about $1 million, and "that's just the start of things to come," Dennis says. □



Blast finder. For FAALs, which is to detect artillery muzzle blasts and shell bursts, sensors and data-transmission system developed for Rembass will be used to save money.

Computers

IBM price cuts cause a tremor

Slashes of 30% to 35% plus introduction of new processor trigger reactions ranging from counter-cuts to shrugs

by Bruce LeBoss, New York bureau manager

International Business Machines Corp. has donned the gloves and come out fighting. Seemingly passive as rival computer and memory systems makers ate away at its market share, the industry's kingpin is starting a price war that should affect not only manufacturers of competitive processors—especially compatible units—and add-on memory systems, but also semiconductor houses.

IBM did not just lead with a new large-scale general-purpose processor, the 3033, that has 1.6 to 1.8 greater internal performance than its current top-of-the-line system, the System/370 model 168-3. Nor did the company just price it at a markedly lower cost to users. The Armonk, N.Y.-based company also threw a series of counter-punches that included a 30% reduction on the purchase price of its System/370 models 158 and 168 and a 35% cut in the purchase, lease, and rental prices for main storage in certain System/370 models.

Then, aiming at its rivals in the small-computer camps, IBM's General Systems division in Atlanta dropped prices on certain low-end processors and associated memory by as much as 35%.

Some challengers immediately responded in kind, while others are taking more time to plan their moves. Still other computer and add-on-memory-system challengers claim IBM didn't lay a glove on them.

However, the full impact of the firm's thrust to retain its market share may not yet have been felt in both large and small systems, where another IBM move is expected soon. Speculation is that the 3033 processor, to be available in the first quarter of 1978, is not the rumored model 178 that many were expecting as the next-generation top-of-the-line processor in the System/370 family.

Storm center. IBM not only jarred its rivals by cutting prices, but it announced the 3033 processor. IBM says it is 1.6 to 1.8 times faster than fastest 370—the model 168-3.

The model 3033 has a buffer storage capacity of 65,536 bytes—double that of the 168-3—and it uses denser logic circuitry with a central-processing-circuit cycle time of 58 nanoseconds, compared to 80 ns for the 168-3. However, the 3033 is a unit processor and, unlike the 168-3 and what would be expected of the reported model 178, it cannot run in a batch or multiprocessor environment, according to an IBM spokesman. Also, the basic storage element in the main memory of the 3033 is the same 2,048-bit metal-oxide-semiconductor unit used in the older 168-3, although improvements have been made in the bipolar logic circuitry.

But it may be that not all of the 3033's capabilities have been announced. Oscar H. Rothenbuecher, a senior consultant and computer expert at Arthur D. Little Inc., the Cambridge, Mass., management consultant and engineering firm, is of the opinion that the 3033 could be a processor for a still-to-be announced 370/178, but that the full system would have parallel processors and a denser, faster memory than the 168.

That may be so, but right now the 3033 processor will sell for about $3.4 million in its basic configuration of 4 million characters of main memory, and about $3.6 million and $3.8 million in 6-million- and 8-million-character configurations, respectively. A comparable model 168-3, which would have to include 12 channels, a high-speed multiply feature, and a facility for certain software extensions, would sell at its reduced prices for about $4.3 million, $4.5 million, and $4.8 million in configurations of 4, 6, and 8 million characters of main memory.

"For years, IBM has established the threshold for what users will pay," says Jack Biddle, president of the Computer and Communications Industry Association in Washington, D.C. "Others will simply have to follow their lead. I don't think the IBM move will hurt Amdahl, and it won't stop Itel," two of the firm's attacking the System/370 model 158 and model 168 market with higher-performance compatible systems at a lower price.

Amdahl Corp., in Sunnyvale, Calif., did immediately respond to IBM's bold moves with some announcements of its own. The firm reduced by 30% the prices for its System 470/V6, a higher-performance replacement for the 370/168. It announced two new computers—one larger and one smaller than the 470/V6.

A new 470/V7 is a 4-megabyte system (expandable to 16 megabytes) that is faster than the 3033. To be first delivered in August 1978, the V7 costs $3,480,000. While IBM says its new 3033 is 1.6 to 1.8 times faster than the 168, Amdahl claims its 470/V7 is 1.8 times faster than its V6, which in turn is said to be twice as fast as the 168. The smaller Amdahl 470/V5, which will cost $2,430,000 and be available in September, is 2½ times faster than IBM's 370/158.

Burroughs Corp. of Detroit also is responding by raising performance and lowering prices of its B7800 line of non-IBM-compatible large-scale processors. Burroughs has cut the price of its 3-million-byte B7811 to $2,391,940, a 13% reduction. The dual-processor B7821, with 6 million bytes of memory, has been sliced 20% to $3,528,280. The firm has also cut the purchase price for its earlier dual-processor B7765 by about 29% to $1,953,600.

Spokesmen at Honeywell Information Systems would not comment on the IBM moves, other than to say they are still studying the announcements. But officials at Control Data Corp. in Minneapolis, which unveiled two new processors in its Cyber 170 line a few days after IBM took the wraps off the 3033, say the IBM moves will not affect them.

Itel, also expects not to be affected. Richard Lussier, executive vice president of Itel Corp. in San Francisco, says of IBM's price cuts, "It's nice they did it. I hope their shareholders like it." Though Itel markets a higher-performance, lower-priced digital computer that is a direct emulation of IBM's 370/158 and is built by National Semiconductor Corp. of Santa Clara, Calif., Lussier foresees little impact from IBM's move on Itel's leasing business, since its prices are still 30% lower than IBM's. Instead, Lussier claims the real pressure from IBM's announcement will fall on the makers of add-on memory systems.

"I don't know what we'll do. It depends on what the end-user will pay," states Richard Andreini, marketing vice president at Advanced Memory Systems Inc. of Sunnyvale, Calif. "If it means we have to reduce our costs by going to 16-k [16,384-bit random-access memories], then that will be AMS' approach."

IBM's move was "quite a broad one. It countered a lot of competitive pressures to IBM," adds William Jordan, vice president and general manager at Intel Corp.'s Memory Systems division in Santa Clara. He points out, however, that prior to IBM's price reductions, it was selling products at $170,000 per megabyte. That figure is down to $110,000 now, but, says Jordan, Intel's price is still $80,000 per megabyte.

In the view of one semiconductor marketing official, "IBM's price moves are an attempt to go after people using IBM software—so IBM is putting the squeeze on their hardware. We don't see any effect on the peripheral and add-on memory companies." He also sees no effect on semiconductor pricing. □

Consumer electronics

Four a-m stereo techniques compete

1978 approval by FCC could generate $250 million market as special committee sorts systems for upcoming tests

by Ray Connolly, Washington bureau manager

Is everyone ready for a-m stereo?

Probably not the American consumer just yet, since it is an unfamiliar concept even though it has been kicking around for generations. But with some help from the Federal Communications Commission, the National A-M Stereophonic Committee (NAMSC) is ready to change all that. It hopes to iron out the technological glitches during two months of broadcast tests that begin next month using two Washington, D.C., area stations and another in Boston [*Electronics*, March 17, p. 49].

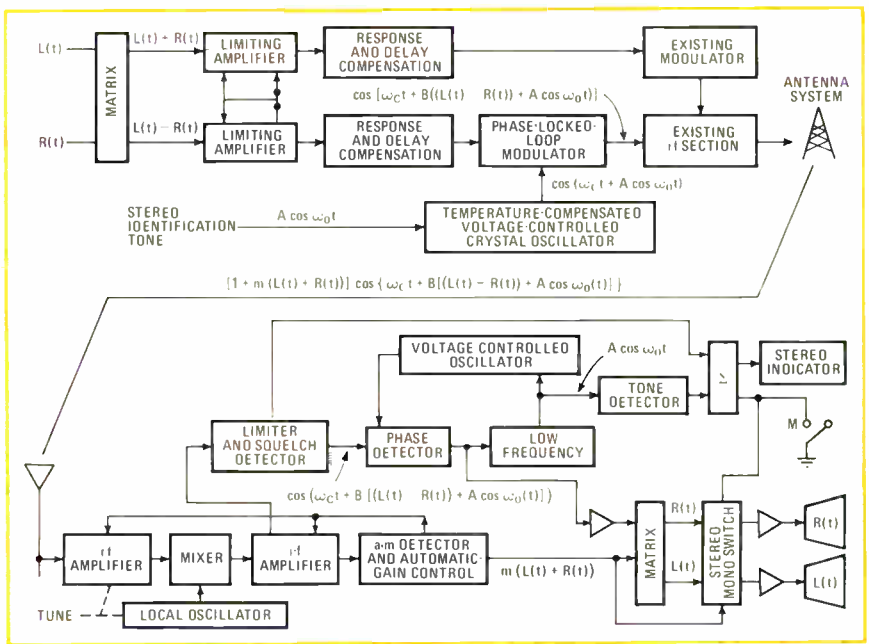
The four organizations comprising the committee—the National Association of Broadcasters, National Radio Broadcasters Association, IEEE, and EIA—are pushing for an FCC ruling by early 1978. Auto makers, which are expected to generate 80% of the a-m stereo market, would then be able to get the new radios into the dashboards of their 1979 models.

Compared to fm, the superior range of a-m is expected to have widespread appeal, and many broadcasters say they are willing to give it a try, if only to counter the growing encroachment of fm stereo on the faltering a-m market. Receiver makers like Delco, Magnavox, and Motorola—not to mention such Japanese manufacturers as Sansui and others—also show strong interest in the NAMSC effort with its promise of an annual wholesale market projected at $250 million. Makers of transmission equipment have less to gain since it will only take a one-time investment of about $20,000 by an a-m/fm broadcaster to adapt an existing transmitter with an encoder to a-m stereo. Yet even at that, the conversion market is estimated to be worth some $90 million or more.

But those golden sounds still need a great deal of fine tuning on both the technological and political levels before a-m stereo will be heard. For example, some broadcasters, particularly smaller ones like Washington's WOL, are wary of stereo. They doubt whether existing monophonic receivers will be able to pick up a clear signal from stereo transmissions, and they also feel threatened by a possible reduction in broadcast range—and in audiences—if stereo requires them to cut modulation or "loudness" of a-m transmissions from a 125% positive limit to, say, 90% or less.

As WOL puts it, "we have a tough time covering out to the suburbs now. If we lose 125%, we won't be able to get even to the city limits." But the view of Motorola's Norman Parker, who is heading his company's NAMSC effort, is that a-m broadcast signals with a present range of 150 miles will be reduced by stereo "by 20 to 30 miles at most" with signal-to-noise ratios "the same as at the outer range."

Testing. The committee expects to quell these broadcasters' fears when it submits the results of its broadcast tests to the FCC by summer's end. The tests will consist of three broadcast approaches and hardware developed by Magnavox Corp. of Fort Wayne, Ind. (see diagram); Motorola Inc. of Schaumburg, Ill., which uses a system called C-QUAM for



Magnavox way. System places left plus right channel information on a-m channel and left minus right on linearly phase-modulated channel. Phase deviation: 1 radian peak.

compatible quadrature amplitude modulated signal, and Belar Electronics Laboratory Inc., Devon, Pa., which is submitting an RCA concept dropped by that company when it withdrew from the radio receiver market.

In the committee's field tests—which will be presented to the FCC without a recommendation for its own judgment—results will be measured at Atlantic Research Corp.'s Laboratories in Alexandria, Va. Signals broadcast from Boston's WBX will be used to measure skywave propagation and selective fading, while WGMS and WTOP in Washington will be used to measure frequency response, signal distortion and separation, occupied bandwidth, interference, monophonic compatibility, and mobile receiver measurements employing a van.

Not participating in the NAMSC tests is Kahn Communications Inc. of Freeport, N.Y., whose founder, Leonard Kahn, a longtime a-m stereo proponent, is petitioning the FCC directly for approval of his system. The evident incompatibility of Kahn with the NAMSC came through clearly to broadcasters, who turned out at 8 a.m. in standing-room-only numbers to hear both sides during an a-m stereo panel at the National Association of Broadcasters' annual meeting in Washington at the end of March. Where all of the NAMSC transmission test systems employ variations of angular modulation to achieve stereo with phase or envelope detection of signals, Kahn's approach uses phase shifting of an audio signal by 90° and producing stereo with one channel on the upper and the second on the lower signal sideband.

NAMSC chairman Harold Kassens of Washington's A.D. Ring & Associates, who was with the FCC when Kahn's approach to a-m stereo was originally turned down by the commission, says he doubts that Kahn "has tested his system" adequately to produce quantitative measurements.

Maverick? According to Christopher Payne, assistant to NAB's engineering vice president and coordinator of much of the NAMSC effort, Kahn has refused the committee's offers to test his system. Kahn,

Payne says, "is something of a maverick in the industry." Kahn, for his part, professes astonishment at what he terms the domination of the committee by representatives of receiver makers, like Motorola's Parker. "These tests should be run by broadcasters—the users of any new system—not the manufacturers," he says. As for his nonparticipation in the tests, Kahn says, "These tests are expensive. We are a small company and spent a couple of hundred thousand dollars on 3½ years of tests." These included over-the-air tests using Baltimore's WFBR in an authorized FCC trial and six months on XTRA, a 50-kilowatt station in Tijuana, Mexico, that beams its music and news to San Diego and Los Angeles.

The NAMSC also contends that Kahn's system would require "two i-fs in a receiver, and that is just too expensive." Kahn terms that view "ridiculous," adding that the approach is not overly expensive, and would enable broadcasters to get on the air sooner with stereo. Also, Kahn says he has applied for a patent on a new system using just one i-f.

When the smoke finally clears and the FCC finally rules on a-m stereo—presumably favorably, blessing one of the four engineering approaches—manufacturers will have a new product for which they hope consumers will make a new market. The new stereo receivers clearly will require a wider bandwidth than existing mono systems. Magnavox's Al Kelsch believes "bandwidths out to perhaps ±12 kilohertz will be realistic" for home receivers if the new sound is to truly compete with fm stereo. Not all NAMSC members are in agreement on that point either.

Nevertheless, there is widespread agreement within the audio engineering community on at least one qualitative aspect of a-m stereo: broadcasters will have to offer listeners something more than the all-news and hard-rock formats that so dominate contemporary programming if any of them is going to buy the new dimension. □

Circle 85 on reader service card

Circle 244 on reader service card

Consumer electronics

Calculators count more in class

Makers designing machines for student use as objections from educators and parents are slowly being overcome

by Judith Curtis, San Francisco bureau

A decade ago, educators and electronics marketers were busily passing on the buzz-words of the day: computer-assisted instruction. CAI, as it was called, never did reach the heady pervasiveness predicted for it. But now a younger cousin of the computer, the handheld calculator, seems to be making a much greater, if quieter, impression on educators.

The calculator, a stranger in many classrooms three years ago, is slowly expanding a bridgehead in mathematics curriculums across the country, making it easier to solve advanced problems. Part of its success is attributable to price erosion.

The trend comes none too soon for manufacturers, which must look away from the saturated consumer market into newer, relatively untapped territory. Texas Instruments Inc. and National Semiconductor Corp.'s Consumer division are the most aggressive. Both are offering a wide range of calculators tailored for school use. They range from TI's Little Professor and Novus' Whiz Kid to programmables with printout. TI, in an effort to capture the education market, retained Ruth Hoffman, director of the University of Denver's mathematics laboratory, to design a program for one of its calculator lines and to appear in commercials promoting the use of calculators in elementary schools.

Strategy. But, says Edward G. Morrett, manager of TI's learning center, "While the market is very large and attractive, it's extremely difficult to penetrate." In a TI survey, two strong objections to calculators turned up: fear of theft and concern over who would pay for them. But even more important to overcome is parents' fear that their children will become math idiots and calculator wizards.

Joseph Hoffman, consultant to California's Department of Education, which is about to release its recommendations, says, "We're in no way ready to stick our necks into another [new] math fiasco." If calculators prove to be an aid, rather than a crutch, he says, then he would be "eager" to see them used on a wide scale.

Most educators view calculators as a positive supplement to math learning. Marilyn Suydam, associate professor of mathematics education at Ohio State University, says preliminary test results she has studied indicate "students will achieve as well, if not better, with calculators." In fact, the consensus among teachers is that when used properly—and, most important, once students understand basic math concepts—calculators motivate them to explore problems outside the normal math curriculum.

Experimenting. "I believe the handheld calculator will do to computational skills what the typewriter did to handwriting skills 50 years ago," says Graham Rankin, associate superintendent of schools in Sacramento, Calif., where elementary and high-school students are using calculators in a federally

Figuring it out. In photo at right, first-grader who has learned calculator activity teaches it to another. At far right, another first-grader uses a TI calculator program called "More Bears—Less Bears" based on estimation.

funded experimental program.

About 800 elementary- and secondary-school students in Philadelphia are using calculators in a city-wide study that will be complete by June. To participate, students had to demonstrate a knowledge of computational skills, "so calculators were not used as a substitute for learning," explains Alexander Tobin, director of math education for Philadelphia. Tobin predicts that within five years, "every kid will have a calculator."

That is certainly welcome news to companies like TI and National, which are anxious to get schools to use calculators on a daily basis, rather than for experimental purposes only. Jay V. Hemming, educational marketing manager at National's Consumer Products division, estimates that the education market could reach $350 million.

This may happen if for no other reason than that calculators are a part of life. In a National Science Foundation study, "Electronic Handheld Calculators: the Implications for Pre-college Education," Ohio State's Suydam notes the mere existence of calculators may be their best selling point. " . . . The pragmatic fact that they exist and that they are appearing in the hands of increasing numbers of students is perhaps the most compelling reason to use them," she states. □

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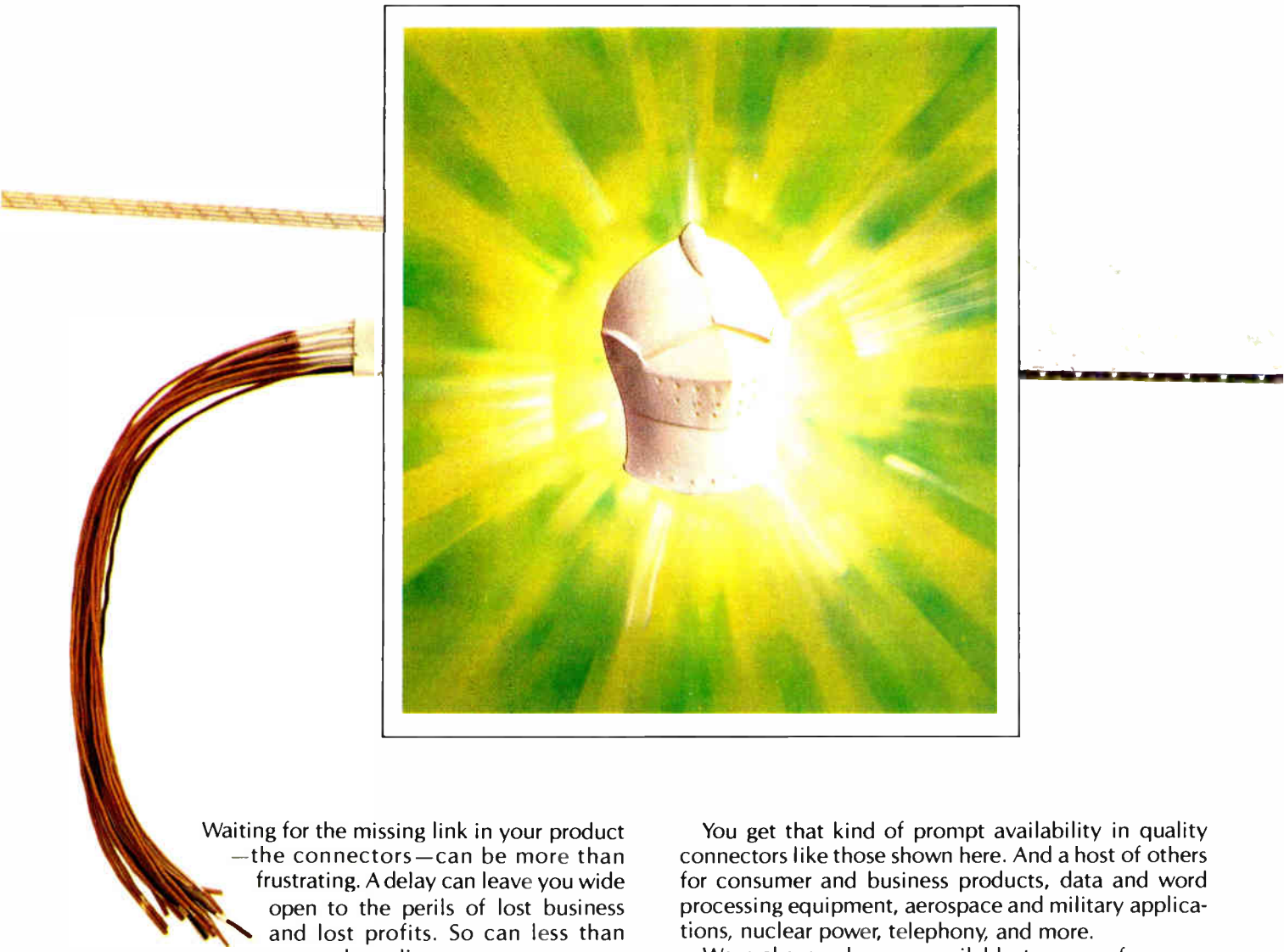

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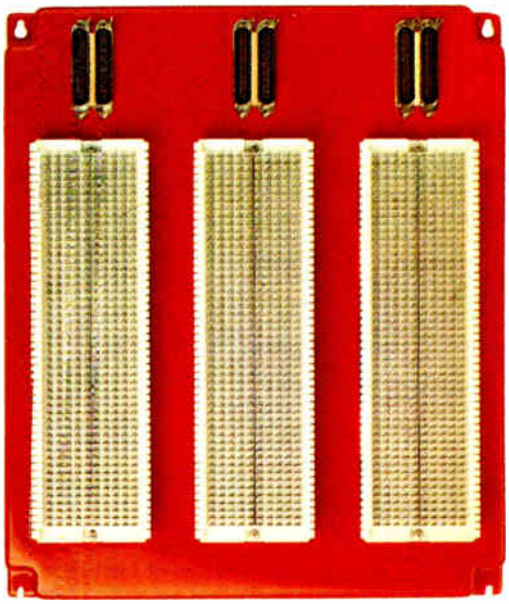

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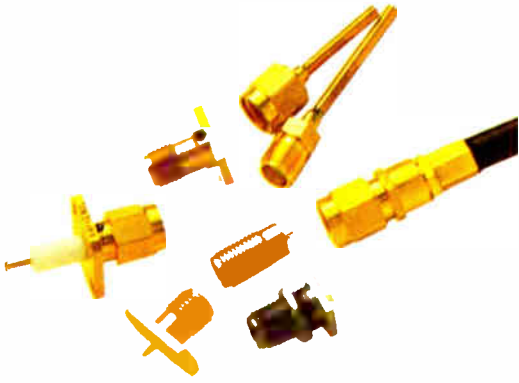

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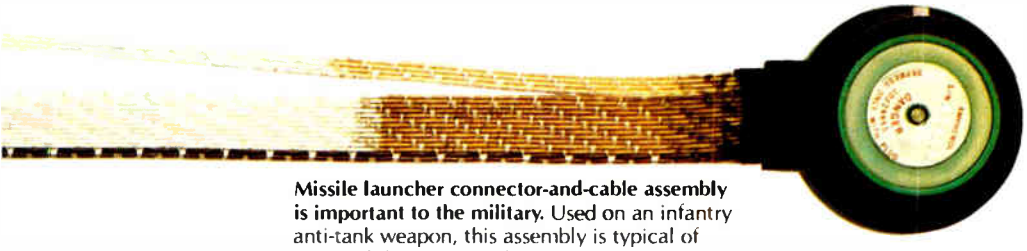

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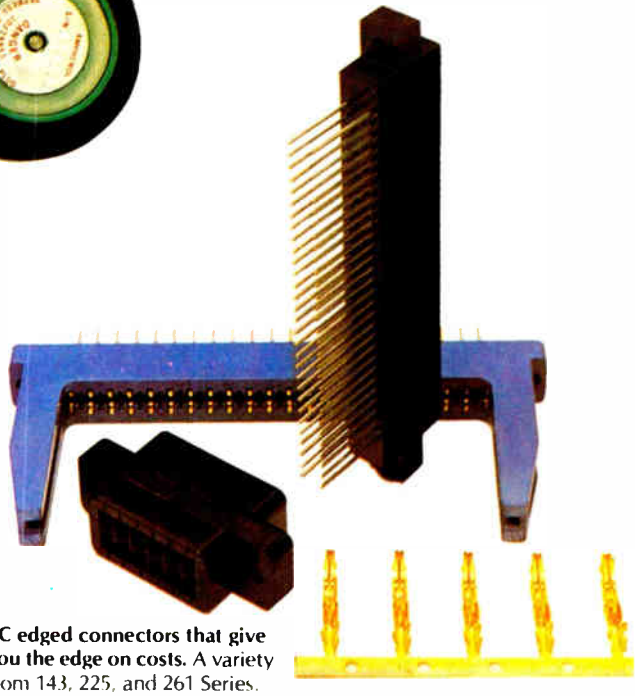

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Ability to produce a desired effect, product, etc., with a minimum of effort, expense, or waste; quality or fact of being efficient.

CREATIVITY (krē′ā tiv′ə tē)

Productive. Having or showing imagination and artistic or intellectual inventiveness. Stimulating the imagination and inventiveness of others.

EMPATHY (em′ pə thē)

The projection of one's own personality into the personality of another in order to understand him better; ability to share in anothers emotions or feelings.

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LSI controls gaining in home appliances

Programmable microwave ovens have paved the way; increased efficiency and reliability are key incentives

by Gerald M. Walker, *Consumer Editor*

☐ Solid-state controls have been slowly edging electromechanical parts out of their well-entrenched position in the appliance industry. But the sudden popularity of programmable microwave ovens is speeding the pace, as well as raising the sophistication to the microcomputer level. Today every major appliance maker is busy planning how to "out-LSI" its competitors.

Some form of large-scale integration has already popped up in standard ranges, clothes dryers, sewing machines, and central air conditioners, with washing machines and refrigerators next to fall in line. Overseas, it is already possible to buy a programmable washer in Japan, and various Common Market companies are beginning to introduce appliances equipped with programmable controls.

Nor are major appliances likely to be the only beneficiaries of LSI. As prices for the new single-chip microprocessors tumble, coffee makers, blenders, bathroom scales, and the like will go solid-state.

Electronics can boost sales

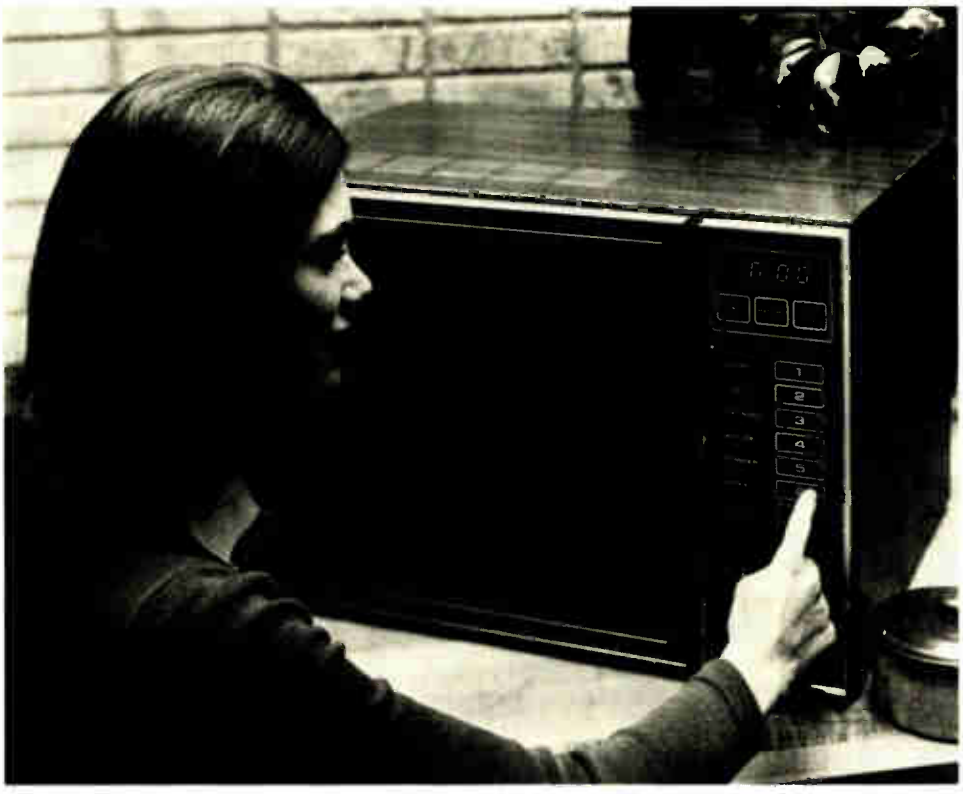
Have the staid appliance makers been grazing on loco weed from Silicon Valley? Hardly; the fact is that they have discovered electronics can improve the sales of their appliances. Programmability, coupled with digital display, has pizzaz (and helps justify a higher price tag). Moreover, electronic controls are more precise than their electromechanical counterparts, and they promise greater reliability. They also can play a role in improving the efficiency of home electrical products—a requirement that may well be state and Federal mandates.

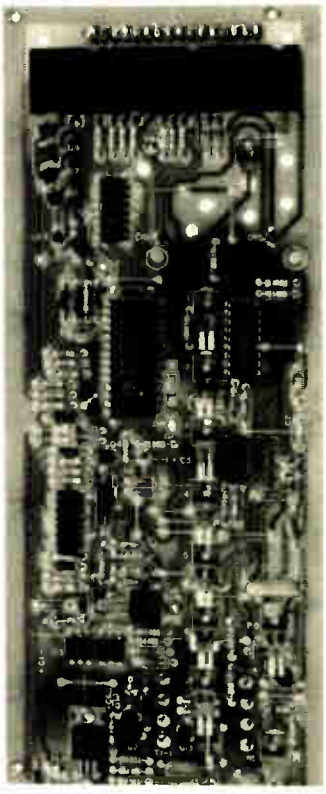
Long term, there is a good chance consumers will demand new labor-saving products capable of being programmed to operate automatically. The technology is here now.

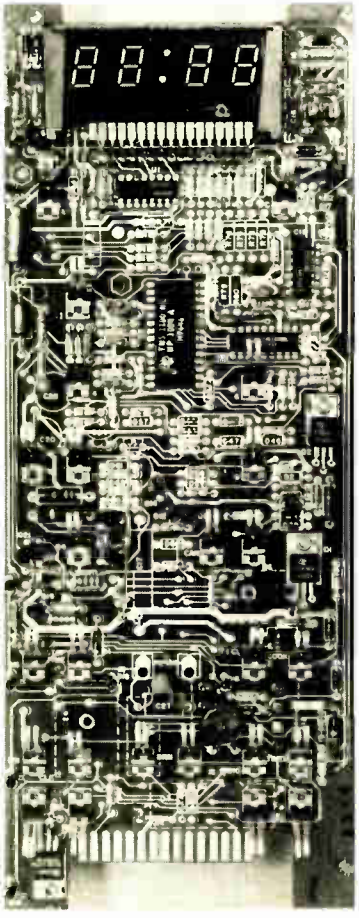
Before anyone begins dreaming about totally automated households, there are design problems to solve in applying the full capabilities of microprocessors to existing home appliances. Development of low-cost and reliable interface components—analog-to-digital converters and sensors or transducers—is a must. Another requirement is simpler interfaces with users, so that they do not need to be computer programmers to fry an egg or wash some clothes. At this point, too, it is not clear whether custom chips or standard microcomputers will establish superiority for the appliance applications. Here price will be a factor.

Reliability is also a crucial problem. Appliance owners expect their ranges, washing machines, and refrigerators to last 15 to 20 years without much maintenance. Can they expect this longevity from electronic controls? If not, the tried-and-true electromechanical components will stay, say appliance-company engineers.

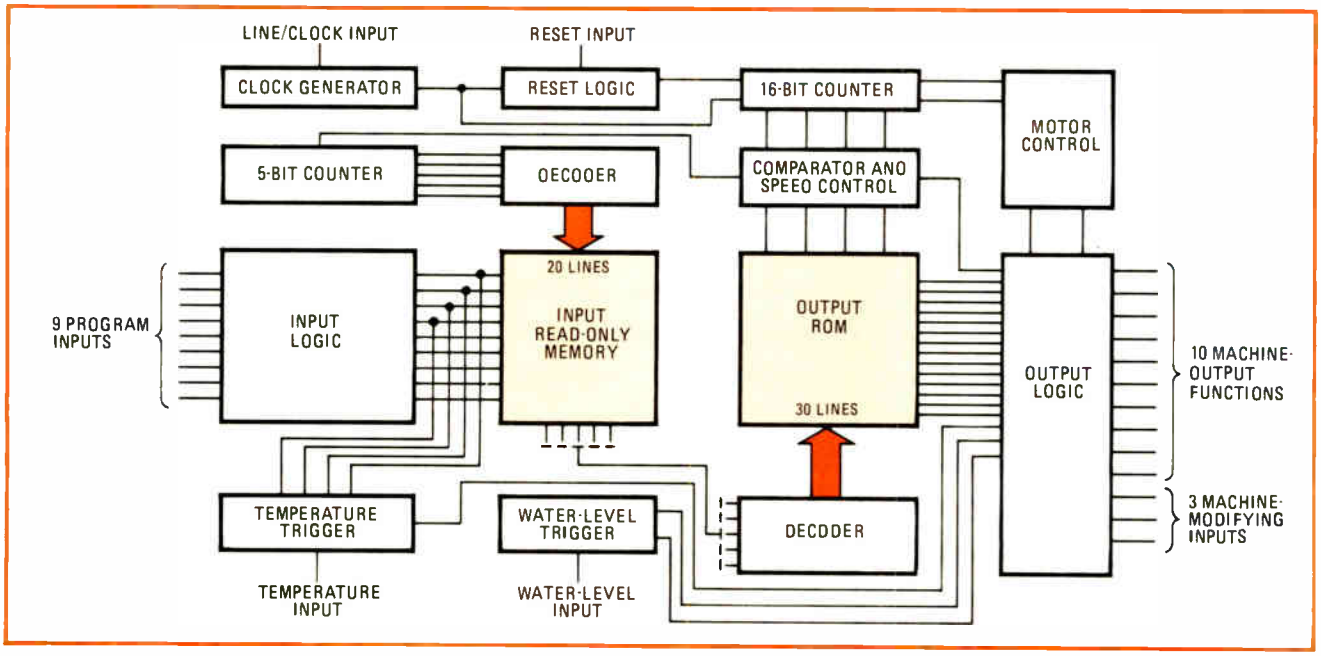
But there is a powerful incentive for going electronic. Consumers are increasingly interested in energy conservation and want to reduce service costs. So appliance manufacturers are seeking better ways of running household equipment. So the ability of large-scale integration to deliver these features will begin to outweigh the long-







1. Processor cookout. Success of microwave ovens with LSI controls and capacitive glass touchpanels has spurred interest in applications in other appliances. Among the programmable ranges using standard microprocessors are Litton's Model 460 Memorymatic, top, with its control the TMS 1000 from Texas Instruments, and Tappan's Tap 'N Touch, bottom, which uses the TMS 1100 from Texas Instruments.



2. Electronic washday. ITT's 7150 dedicated processor for washing machines contains two ROMs. The input ROM is split into nine sections, each of which is controlled by a separate program. The output ROM routes data from first ROM into 18 lines that control operations.

time commitment to electromechanical parts.

Microprocessors' entrée into the kitchen came from an unexpected quarter: microwave ovens. They have been around for some 20 years without making many waves, but a little more than a year ago they suddenly began selling. Biggest surprise of all is that the best-selling model in the United States is the top-of-the-line Touch-Matic programmable oven from Amana Refrigeration Inc., Amana, Iowa, priced close to $600.

The average microwave oven sells for about $400, compared to about $250 to $300 for the average gas or electric range. Industry estimates are that next year the $1.2 billion in total U.S. microwave oven sales will just exceed the combined dollar sales of gas and electric ranges. At least 10% of all American households will have microwave units. Sales last year hit almost 2 million units, compared to 2.5 million electric ranges and 1.6 million gas models.

Programmable cooking catches fire

Microprocessors will begin to move down the product lines of the major manufacturers. By 1980, the majority of units sold will probably be programmable, and they will be in about 26% of all American households. Simultaneously, the industry expects increased popularity for microwave/conventional combinations, with a growth from 100,000 units last year to about 700,000 by 1980.

Further proof of the impact of microwave oven's zooming popularity is the interest of the multi-billion-dollar food-processing industry. General Mills, Pillsbury, and Green Giant, to name just a few of those involved, are working on frozen foods constituted especially for microwave cooking. Another sign: makers of cooking vessels have begun labeling their ovenware if it is suitable for microwave ovens.

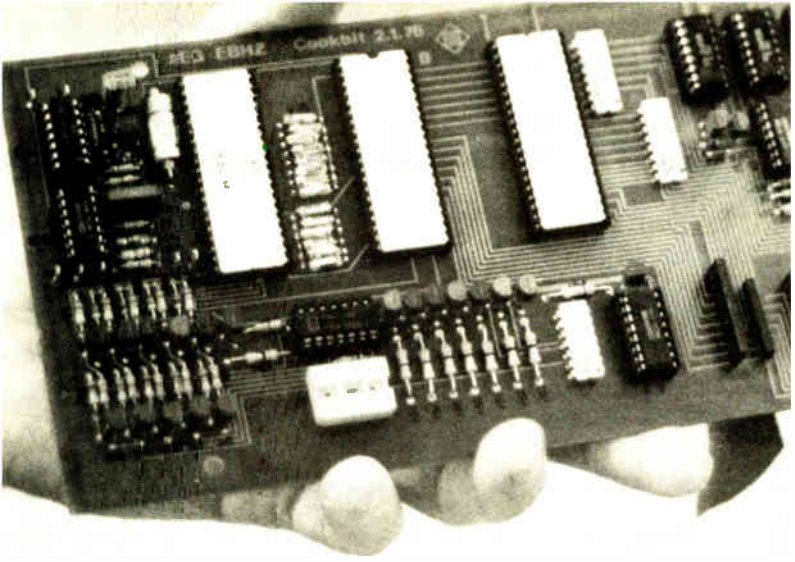
There are a number of explanations for the takeoff of microwave ovens and the success of the programmable controls. Speed of operation, economy, convenience, and prestige are all attractions of microwave operation. The electronic controls make the oven more precise and more flexible. Microwave ovens can do much more than conventional ovens—even scramble eggs or boil water—but they must handle a wide range of exact cooking times, from a second to an hour or more.

"Digital control gave us the precise timing we needed for short and long cooking," says Richard D. Maxwell, senior vice president for engineering at Amana. "If you're restricted to electromechanical devices or even linear devices, you have great difficulty in getting that timing accuracy, short- and long-end. . . . Once you have digital timing, it doesn't cost too much to pick up additional features such as defrost, a variable duty cycle, digital display, and clock."

Another of the major manufacturers of the new ovens, Litton Microwave Cooking, has prepared a comparison of electricity use that strongly favors microwave cooking. The firm claims the energy savings from microwave ovens in 1980 will be about 19 billion kilowatt hours, amounting to $664.6 million less in utility bills. The extrapolation is based on the assumptions that the number of U. S. households remains constant at 70 million and that the average cost of a kilowatt hour stays at an average of 3.5 cents.

Popping LSI into the oven

Since microwave ovens are popularizing programmability, a survey of their use of microprocessors shows how other home-appliance applications are likely to develop. It all began with Amana's introduction of the programmable Radarrange R-6 in June 1975, which marked the culmination of an unusual development effort (see "How Amana started cooking with electronics," p. 99). Essex International's Controls division, Logansport, Ind., built the LSI-based control module to



3. German cooking. The CF3-F microprocessor on the Telefunken Cookbit electric range contains three LSI circuits, a CPU, and two ROMs to control and monitor cooking. The printed-circuit board easily fits behind the keyboard panel used to program cooking.

Amana's specifications, using a custom p-channel metal-oxide-semiconductor chip from General Instrument Corp.'s Microelectronics division, Hicksville, N.Y.

This digital control primarily performs the functions of two electromechanical timers. Besides the MOS chip, there is a decoder-driver plus assorted transistors and resistors as output buffers, an electromechanical switch, and a power supply. The module also includes a capacitive-touch "keyboard" with 10 digits and 5 commands, a light-emitting-diode display, five LED lamps to indicate which command has been programmed, and an acoustical-transducer end-of-cycle indicator.

A conventional relay in the control module is in series with the main power triac, which controls the high-voltage power supply for the magnetron. An electromechanical switch controls the relay's coil. Keeping this control separate from the touchpanel reduces the risk of accidentally energizing the magnetron. The glass touchpanel was selected over other types for its superior resistance to noise and contamination.

The capacitive system also interfaces with the MOS integrated circuit, which can provide the logic needed to detect signals from the touchpanel. The basic configuration is a random-logic array on the order of a watch chip. The RR-6 has recently been replaced by the RR-9, a model which has added features such as variable power settings and two-mode programmability (defrost and then cook, for example).

Standard microcomputers are found in the programmable microwave ovens from Litton Microwave Cooking, Minneapolis, Minn., Texas Instruments Inc., Dallas, supplies one assembly built around its 4-bit TMS 1000 for Litton's Model 460, and Teccor Controls Co., Dallas, supplies another that contains a Mostek microprocessor for the Model 420.

Litton's latest Memorymatic Model 460 (Fig. 1, top), announced in January, combines automatic temperature control with touch-control programming of time. It is possible to program a cooking cycle based on either temperature or time, because a temperature probe, which may be inserted into the food, interfaces with the microprocessor control. The display window shows either a countdown of the time or the increase in temperature.

Programmable temperatures require an automatic cutoff below 90° F to prevent overworking the magnetron and above 195° F to avoid running the temperature beyond the normal cooking level. The microprocessor is programmed to reject any punched-in temperatures that are outside this spread.

The cook may also program 10 variable power modes, which represent power increments from 10% to 100%. The modes cover such familiar operations as simmer, sauté, and bake as well as microwave-inspired choices such as defrost and reheat. Thanks to the microprocessor's memory, it is possible to program two modes at one and the same time.

The generations multiply

Although Tappan Appliance's microcomputer oven followed those from Amana and Litton, the Mansfield, Ohio, firm has benefited from the experience of the others and from the product improvements by its semiconductor supplier, Texas Instruments. If the Amana RR-6 were to be called the first-generation programmable oven, then its RR-9 and the Litton Model 460 would be second generation, and Tappan's Tap 'n Touch (Fig. 1, bottom right) probably would be second-and-a-half generation.

The just-introduced Tap 'N Touch uses a programmable control (Fig. 1, bottom left) built around TI's TMS 1100 [*Electronics*, Dec. 9, p. 105], which provides twice the read-only memory of the TMS 1000. With it, Tappan could match all the features of other programmable ovens, plus offer a stop-time feature for programming the cooking ahead of time and then setting the time for the oven to turn on.

With the additional memory of the TMS 1100, the firm gained an important advantage in testing. The processor is programmed with a test algorithm for incoming and assembly-line inspections. The test sequence permits energization of the microprocessor and cycling through all the functions before installation on the oven. Once in the oven, another test sequence cycles the control IC to check all displays, and yet another runs through checks of the keyboard, the displays, and the clock for input-to-output conditions.

The glass panels that companies put on the ovens have slightly different layouts to give each model its own identity. Both LEDs and gas-discharge displays are being used, Amana sticking to LEDs; Litton using both, one type in each of two models, and Tappan relying on gas-discharge.

Joseph E. Brunk, manager of range engineering for Tappan, explains that appearance is an important factor, because stylists have as much to say about high-priced consumer products as do engineers. And the poor visibility of LEDs in bright light did not please the stylists.

None of the oven makers is ready to touch liquid-crystal displays. But they may change their minds as appearance and reliability of LCDs improve.

Other appliance manufacturers were well along in evaluating LSI designs for their products when the programmable microwave oven began to make its mark. In fact, some products are already available with various

forms of large-scale integration up to and including programmable microcomputers.

What may be the father of them all is the TouchControl electric range, which was introduced in 1973 by the Frigidaire division of General Motors, in Dayton, Ohio. It uses three MOS LSI circuits supplied by American Microsystems Inc., Santa Clara, Calif., and a digital display of flat-envelope gas-discharge tubes from Sperry Information Displays, Scottsdale, Ariz. Frigidaire liked the setup well enough to introduce a companion model a year later.

Whirlpool Corp., Benton Harbor, Mich., makes a clothes dryer with LSI control for Sears, Roebuck and Co. that features a dryness sensor to control operating time. Whirlpool is developing a companion washing machine later this year with complete digital control of operating cycles and functions. The firm also is readying a version of a programmable microwave oven, but has not set an introduction date.

Sewing machines, too

Large-scale integration is also popping up in sewing machines. Singer Consumer Products division, Elizabeth, N.J., introduced the high-priced Athena a few years ago and put the medium-priced Diana on the U. S. market this year, after an earlier introduction in Canada. Both the sewing machines use custom p-channel MOS chips supplied by AMI to control mechanically selected switches.

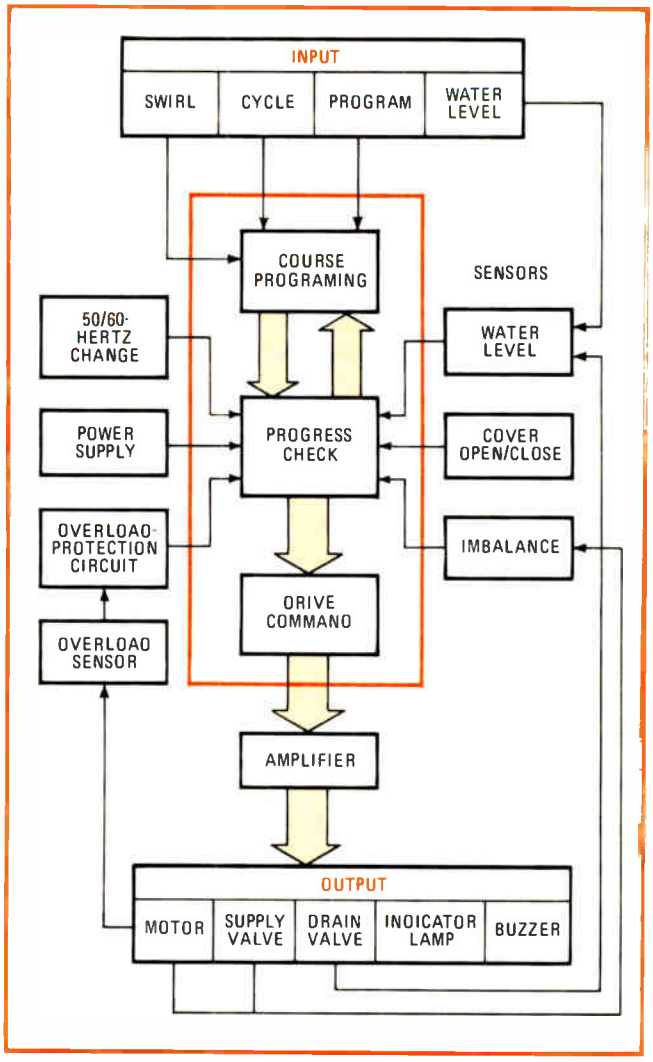
Encouraged by the Athena's reliability record, Singer is close to announcing a microprocessor-based home sewing machine with almost no mechanical controls. There also will be a turn toward programming functions, so that the machine will perform a variety of tasks automatically.

General Electric Co.'s Home Appliance division, Louisville, Ky., is developing LSI applications for its ranges, washers, and dryers, but has not disclosed production plans. The main delay, according to GE, has been lowering the price of peripheral devices, such as displays, sensors, and transducers.

Carrier, York, and Heil-Quaker have been using electronic controls in central air-conditioning systems for some time and have moved with the technology into LSI. The primary function of their LSI circuits is monitoring and protecting the compressor during power outages and other operating conditions that might put a damaging load on the motor.

Needless to say, Amana is well along the development path on LSI controls for its refrigerators and air conditioners. The experience it gained with programmable ovens can be transferred directly to the development of sophisticated controls of the temperature-regulating equipment that use heat pumps. The same type of control used in the microwave ovens can serve to save energy in heating and cooling the entire house—on demand and at very accurate temperature settings.

Microwave ovens are not a big item in Europe, but there is another stimulus there for the development of LSI controls. Europeans have always been more energy-conscious than Americans, largely because their energy costs have been much higher.



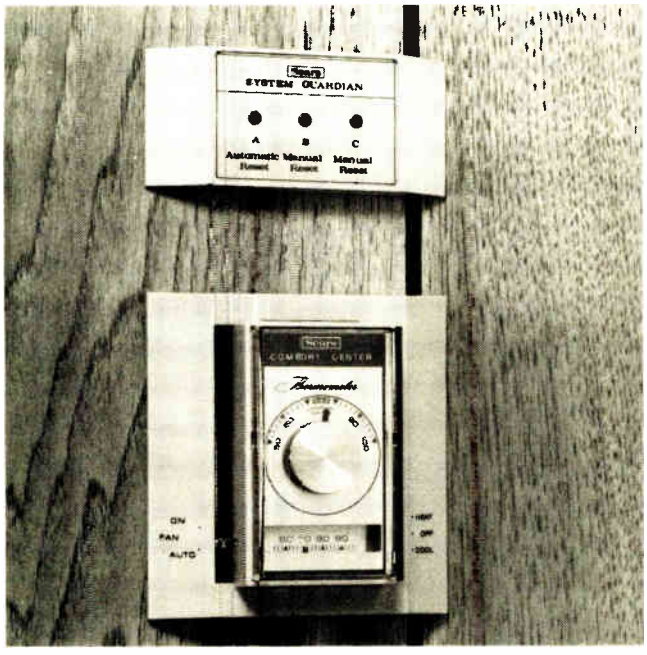
4. Japanese laundry. The control panel on Hitachi's new LSI-programmed washing machine has slide-selector "switches" and three LED status lights. There are nine inputs to the chip to control all the operating functions, including automatic balancing of the load.

Also, European washing machines and dishwashers usually have built-in water heaters, which adds to the controls required. Saving water is important in Europe, so the machines must precisely control wash and rinse cycles. These two factors also contribute to the attractiveness of programmable ICs.

Programmability begins overseas

With these factors in mind, ITT Semiconductors in the United Kingdom has designed a dedicated microprocessor, the 7150, aimed primarily at washing machines and dishwashers [*Electronics*, Sept. 16, p. 138]. The firm claims the 7150 is cost-competitive with electromechanical parts for these appliances (see table). The 4-bit chip is also available in the U. S.

The program information for the washing machines is contained in two read-only memories (Fig. 2). There are 9 program inputs and 10 machine-output functions, which can be controlled by as many as 20 program steps to provide various combinations of fill, wash, heat, spin-dry, etc. A sequence counter, which controls information



5. Air-conditioner monitor. Heil-Quaker's System Guardian designed into a Sears central air-conditioning system has a panel with three LEDs mounted near the thermostat. Triggered by diagnostic routines, the lights tell homeowner when there is a problem.

from the input ROM, steps to its next position on completion of each program step. The input ROM's output is a 5-bit binary word, decoded and entered into the output ROM to produce the commands operating the washer. The high- and low-water-level sensing circuits share one input pin. The levels are detected by two identical triggers.

The temperature trigger is a differential amplifier with a reference potential applied to one input. The reference is progammed by an on-chip resistor chain controlled by the user's wash program. The amp's second input is connected to the incoming temperature's signal. Positive feedback from this temperature sensor obtains a trigger action by reducing the reference voltage. Then the washer will go into its next program step.

A number of European component producers, such as Philips, AEG-Telefunken, and Siemens AG have home appliance divisions. but they are not promoting LSI controls simply to sell semiconductors. One appliance attracting a lot of attention is Telefunken's microprocessor-control Cookbit electric range, just coming on the market after introduction a year ago [*Electronics*, March 4, 1976, p. 33].

Heart of the Cookbit is the CP3-F microcomputer system designed at the firm's Semiconductor division in Heilbronn, West Germany. The system consists of a central processing unit with a 48-by-8-bit random-access memory and two ROMs with a combined capacity of 2,048 by 8 bits. Together with other components, these three p-channel MOS devices are mounted on a printed-circuit board (Fig. 3). Through peripheral channels, they control the range's power states, the line-power-failure buffering stage, and the indicator panel. They also monitor the control panel and the range's temperature levels. The two ROMs store 120 programs, each with a time-temperature profile for the specific dish it represents. The cook prepares the recipe from a special cookbook and punches in the program number listed there, and the microcomputer takes over the timing of the cooking.

The RAM contained in the CPU holds the power levels for specific cooking cycles. The cook also can program a starting time, so the food will cook while no one is home. He or she also can ask the microprocessor for the running time of a particular program.

Japanese are converting too

As in Europe, some of Japan's leading manufacturers make semiconductors and appliances. Here too, the move toward LSI controls has been gradual, but the country's tough energy-conservation program has accelerated the pace. For example, microwave ovens long have been popular, but only just now is programmability being added.

One handicap facing Japanese appliance makers is difficult operating environments that equipment like washing machines must endure. Because homes are small, the washer often ends up in the steamy Japanese bathroom, or, worse, on a balcony or back porch. So while satisfying the growing demand for energy conservation, engineers have also had to meet very demanding reliability requirements.

Nevertheless, large-scale integration has come to the washing machine. Last month, Hitachi Ltd. put the Computer Blue Sky PF 1000 on the market at $255, about $28 more than similar mechanically controlled models. It took the company about five years' work to develop the new model.

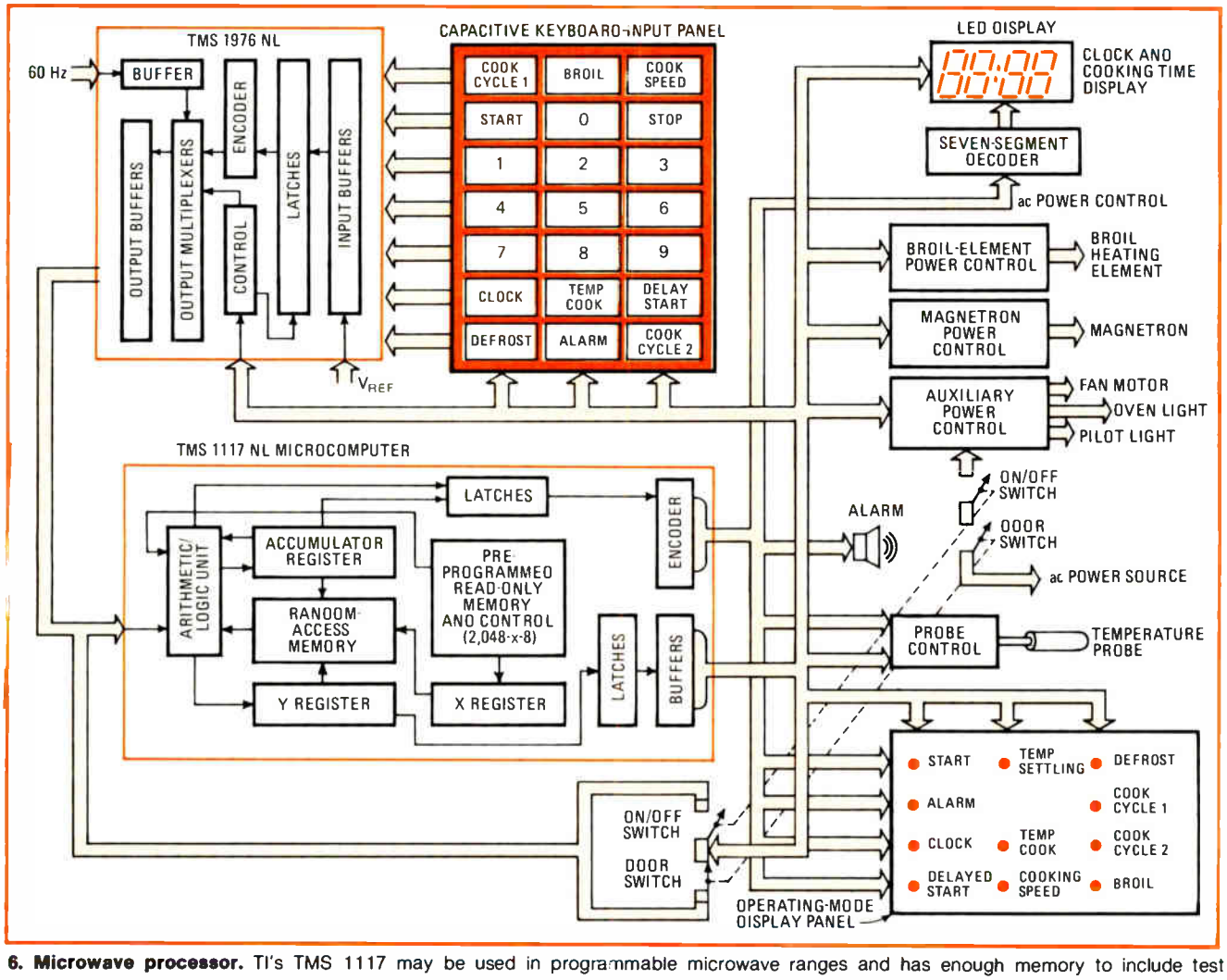
Reliability is the reason Hitachi chose the familiar p-channel MOS technology and a 28-pin ceramic package for the 4.2-by-4.55-millimeter chip. Also included in the control module are 20 discrete transistors, four triacs, and three LEDs.

The control panel of the new washer features three slide switches instead of rotary switches. Each slide carries a small magnet that operates reed switches on the pc board behind the panel. They are used to select soft or strong agitator action, regular or economy cycle, and fully automatic operation or any of the five forms of partial operation.

The three LEDs show whether the machine is in the wash mode, one of the five parts of the rinse mode, or in one of the two parts of the spin-dry mode. Only one diode at a time will be lit, and each minute it will blink the number of minutes that are left in the mode or part of the mode.

The machine operates with sequences stored in a 40-by-40-matrix 1,600-bit ROM. Figure 4 shows the nine possible input signals, including the power supply and overload protection. Time and function are stored in the registers, five for timing and six for functions.

An important function made possible by LSI control is correction of imbalance during spin-dry. Mechanically controlled washers simply shut down when the spin load is unbalanced, and the user has to rearrange the soggy load. The Blue Sky's electronic control can command it to add a small amount of water when there is an imbal-



6. Microwave processor. TI's TMS 1117 may be used in programmable microwave ranges and has enough memory to include test sequences in the 2-k-by-8 ROM. Although programmed for microwave-oven use, this 4-bit microcomputer is an off-the-shelf item.

ance input signal. The agitator spins to redistribute the load, and then the spin cycle starts over. The control will repeat the procedure twice before giving up and shutting the machine down.

One consideration in putting advanced electronics into appliances is maintenance and repair of the new controls. To date, the appliance companies have opted to replace an entire module when something fails. This repair policy avoids the effort of training field-repairmen in making repairs.

Electronic diagnosis appeals

However, it will be possible to program diagnostic routines to aid field repairs of other parts of the appliances. Such use of LSI is already beginning to appear in the central-heating and air-conditioning field, where repairs are expensive. Heil-Quaker Corp., Nashville, Tenn., has developed an unusual electronic diagnostic system for a Sears central air conditioner.

Using a hybrid approach, the company has devised a monitor intended to protect the compressor from the most common problems encountered by air conditioners—voltage cutbacks, indoor or outdoor fan failures, freeze-ups of the evaporator, and loss of pressure. The indicator unit, mounted near the thermostat (Fig. 5), has three LEDs that light, singly or in combination, to alert the homeowner. He or she then consults the troubleshooting section of the user's manual to see what action to take.

When LED A lights, the homeowner does not do anything. The problem is a power interrupt or some sort of low-voltage condition, and the Heil system automatically guards against restarting too soon or operating under abnormal stress.

The lighting of either of the other LEDs or of any combination indicates some sort of action is necessary. Frequently the problem is something the homeowner can fix without calling a repairman—such as when LEDs A and B light. This combination is caused by a falling temperature in the evaporator, indicating liquid refrigerant is returning to the compressor instead of completely evaporating. The compressor could freeze up unless air flow across the evaporator is improved. Usually what is affecting the flow is a dirty filter or failure of an indoor fan. With the help of the manual, the homeowner can troubleshoot the problem—and if it is a dirty filter, he or she can clean or replace it.

All three lights come on when the system detects a

TABLE 1: PARTS COSTS COMPARED

Subsystem components	U.S. dishwasher		European washing machine	
	Electronic	Electro-mechanical	Electronic	Electro-mechanical
Control area	$9.55–11.80	$7.50–9.50	$12.95–14.70	$8.00–10.00
Program-selection indication	1.55	2.00–4.00	1.55	2.50
Program-position indication	1.00–1.30	2.00	1.00–1.20	2.00–3.00
Temperature sensing	0.40	1.00–1.50	0.40	2.00–3.00
Water-level sensing	–	–	1.50	1.50
Power supply	2.50	–	2.50	–
Cable harness	(2.50)	–	(3.00)	–
Total system cost	$12.50–15.05	$12.50–17.00	$16.90–18.85	$16.00–20.00

Source: ITT

clogged condenser coil or failure of the outdoor fan. The two lights A and C go on when the air conditioner takes more than 7 minutes to drop the temperature below 80° F, indicating a serious problem. The Heil system also shuts off the compressor then.

One issue not yet resolved in appliance electronics is the tradeoff between custom LSI chips and standard microcomputers—although the argument seems to engage the semiconductor suppliers more than their customers. Of course, it is the appliance makers who will call the shots eventually, but there is no clear indication of which way they will lean.

Custom vs standard

The economics of custom vs standard are well known by now, and they apply to the appliance industry as much as to any other user. Semiconductor firms have blurred the issue somewhat by offering families of chips covering many specific applications, so that selecting one is almost like getting a custom product without too great a penalty in development cost and time.

On the other hand, even the most specifically oriented standard design will not make as efficient use of the silicon as will a chip designed for a single application. Also, every appliance maker thrives on promoting step-up features from model to model, as well as offering features different from competitors'. Only a custom chip may be able to deliver the electronics for these features.

General Instrument, heavily committed to custom LSI, has gone on from its participation in the development of the Amana Touchmatic ovens to design a second-generation chip for microwave ovens. "Off-the-shelf microprocessors are being fragmented in terms of part numbers," contends Andrew R. Sass, group director of product planning for the firm's Microelectronics division.

"Part numbers are being generated almost daily," he continues. "A microprocessor could have as many as seven different part numbers. Admittedly some of these are only differentiated by memory size, but others are differentiated by dedicated hardware, such as input/output.

"Suddenly the term 'general-purpose microprocessor' starts to blur quite dramatically. All that GI is doing is in its strategy of offering a tailored microprocessor for a microwave oven is recognizing this blurring very early in the game."

Since appliance makers are going for both custom and standard LSI, keeping a foot in each camp is a good strategy. For example, AMI supplied custom MOS LSI chips to Frigidaire for its 1973 TouchControl electric range. The firm also produces chips designed for Singer's Athena and Diana sewing machines and the custom MOS chip for the Sears clothes dryer built by Whirlpool. It also produces a custom microprocessor for a Singer industrial machine and more than likely will participate in designing a custom processor for the next generation of Singer's products for the home.

Standard chips join custom output

Despite this commitment to custom users, AMI is bringing out standard devices aimed at appliance applications. For instance, the popularity of glass capacitive keyboards has prompted the firm to design the S926 family of multiplexed TouchControl interface circuits. These p-channel, ion-implanted MOS parts will address switches in a 2-by-7 or a 2-by-16 matrix. Prices range from less than $3 to less than $4.

This summer, the firm is introducing the S2000, a 4-bit microprocessor designed with timing control of appliances in mind. The device is intended to replace dedicated LSI timing chips already in use.

Mostek Corp., Carrollton, Tex., has turned its interest in appliance applications away from custom to general-purpose products. It has brought out the MK 3870, a single-chip microprocessor that is compatible with the software of the three-chip Fairchild F8.

The MK 3870 could have a major impact on the appliance industry in competition with other single-chip products such as the TMS 1000, Intel's 8048, and Fairchild's new F8. Offering a 2,000-by-8-bit mask-programmable ROM at a price less than $10, the chip is intended to handle the next few generations of consumer-product applications. Mostek also is betting that appliance firms might appreciate the ability to add features with software while using some of the ROM for programming test sequences.

Texas Instruments also is committed to encouraging appliance makers to follow the examples of Litton and Tappan in going with standard microcomputers like the TMS 1000 family. The brand-new TMS 1117, for instance, can control four time sequences plus provide a test algorithm, with memory to spare, at a price less than $10 in volume.

This microcomputer (Fig. 6) has a programmed test capability specifically for microwave ovens. It performs a functional test, display burn-in on the production line, and a final checkout, as well as field-service tests in repair shops and home checks by the user.

The tests are broken into two routines, the second for the final assembly-line tests and the field and home tests. This routine has three automatic procedures for checking the control system and one for checking the keyboard, which requires someone to punch the keys on the oven's front panel.

For its part, National Semiconductor Corp., Santa Clara, Calif., is relying on its Calculator-Oriented Processor System (COPS), a mask-programmable chip family, to penetrate the low end of the appliance market.

How Amana started cooking with electronics

Getting the first LSI-controlled microwave oven designed and to the market required a major commitment by two companies willing to take a risk. Amana wanted something more than just a timer and pushed development of programmable features. Essex Controls, the supplier for the control module, was ready for programmability.

"That first step was a real big one," recalls Richard A. Foerstner, Amana's vice president of microwave engineering (left). "We didn't have the market. We didn't have cost-effective microprocessors off the shelf. Therefore, we had to make a full-blown commitment to custom LSI with all the cost implications that entails. So it was not something that we took lightly."

"Usually your supplier is trying to pound your door down to sell you something," adds Richard D. Maxwell, senior vice president for engineering (right). "But we actually had to sell our suppliers on getting into the business. It was a unique change in the usual procedures, because we were asking for something they really didn't have. We had to convince the supplier."

By coincidence, Essex was also looking for a way to apply its electronics know-how to appliances. Both were looking for someone to go along with programmable LSI controls for a range. A third participant was General Instrument, which designed the custom LSI chip for Essex.

The result was the RR-6 Radarange put on the market in June 1975. After becoming Amana's best-selling microwave range, it has been superseded by the RR-9 shown here.

"There are companies today with engineering and sales departments that are afraid of electronic controls—they really don't understand what a control system can do for them," Maxwell says. "And there are companies that are waiting for electronics to come down to a cost equivalent to electromechanical timers. They probably will never make it. When all of their competition is selling electronics, they will be forced to step up into this technology."

The control package consisted of a capacitive glass touchplate, a LED display, and the microprocessor unit mounted on a 21-by-12-by-8-centimeter printed-circuit board along with the interface circuits for the keyboard, power supply, display, and control switches.

An interesting aspect of the cooperation between Amana and Essex and between Essex and GI is the decision to use the clock feature on the range. GI's view was that the clock came free with the controls, so why not use it? Essex considered the clock worth promoting as an extra feature.

But, according to Dan R. McConnell, Amana's vice president of planning (middle), the firm saw the clock as an excellent means of demonstrating the oven's reliability to the buyer. The clock runs 24 hours a day, impressing upon the consumer the idea that the electronics behind the clock has got to be highly reliable.

Perhaps the most telling aspect of Amana's plunge into electronic controls is the planned spread of LSI into other products the company produces such as refrigeration and heating/air-conditioning units. The firm's engineers are convinced that LSI technology will have an impact on energy conservation, a belief not every appliance company shares.

"I think that the people who don't today believe that electronics will be part of saving energy will find themselves in 1979 forced to go through a crash program of new designs to meet government requirements legislating greater efficiency," Foerstner remarks.

The firm thinks its single-chip SC/MP microprocessor will make a dent in the high end. Yet—an indication of the times—the firm will supply a custom chip for Whirlpool's washing machine that will be introduced this year.

One firm's position

Whirlpool's stance on the custom vs standard jousting may indicate the outcome. At this point, the company leans toward dedicated electronics for products such as the washer, which will have complete cycle and selection control. But this washer does not need a microprocessor to perform these functions. If it did, the balance might tip towards standard chips—although Whirlpool can still see reason why it should favor custom designs.

No matter what the level of sophistication, the firm likes custom chips because they permit customized automated testing. "There's still a premium attached to applying electronics in replacing electromechanical controls," says Allan L. Wennerberg, director of electronics research. "But by the same token, we're hoping that our ability to test electronic controls much better should give us more reliability, which will eventually be reflected in our warranties. Even if all the appliance manufacturers were using the same device, we would still need special requirements—mask modification or whatever—to meet our particular specifications." □

Model for high-power SCRs extends range of computer-aided design

Simulation of all important static and dynamic performance characteristics permits CAD models of automotive and industrial circuits

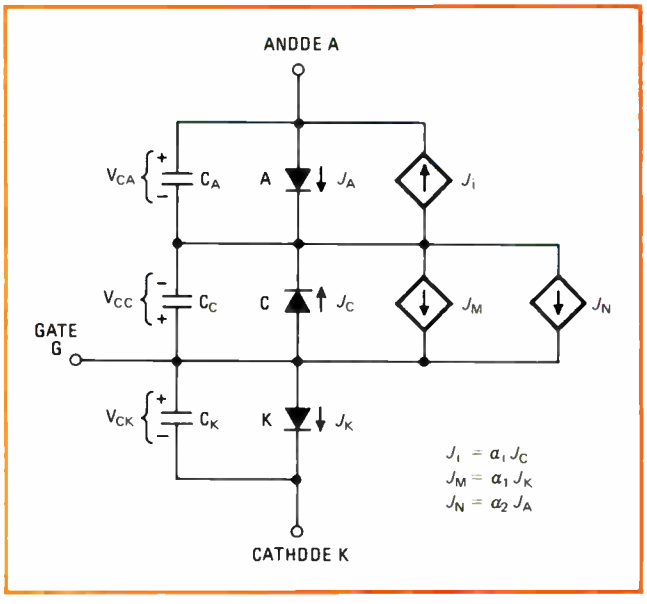
by James C. Bowers and H. E. Nienhaus, *University of South Florida, Tampa, Fla.*

☐ In the congregation of device models for computer-aided circuit design, one gap stands out like the groom who didn't make it to the altar: a comprehensive, universal model for the silicon controlled rectifier. The gap has not always been noticeable, because there has been minimal demand for computer-aided design of circuits using the SCR.

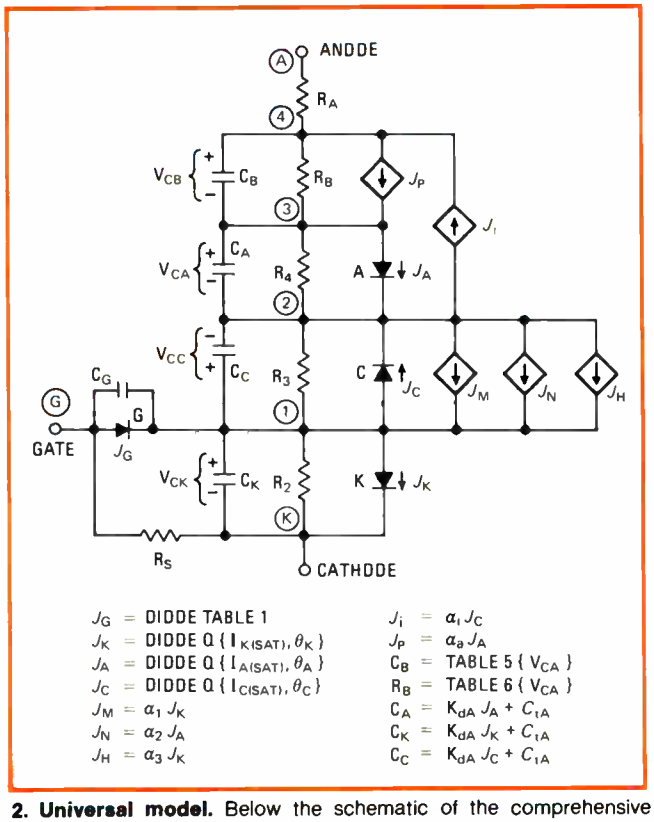
Now high-power SCRs are coming into their own in cycloconverters, automotive applications, and power commutation. So the introduction of an accurate model that simulates all important static and dynamic performance characteristics of any SCR will be welcome news to designers using CAD libraries. The model is characterized in the Super-Sceptre program (see "Meet Super-Sceptre"), but is easily adapted to others.

While a basic equivalent-circuit simulation of an SCR called the intrinsic (or two-transistor) model has been around for a while, it lacks many of the characteristics of high-power devices and has limited use in CAD programs. The new model aims at comprehensiveness by simulating such large-geometry parameters as turn-on spreading time. It also includes turn-on rise and delay time, turn-off time, anode holding and latching current, and gate turn-on voltage and current. Other parameters simulated for the first time include shorted-emitter resistance, nonlinear static and dynamic on characteristics, and gate isolation when the SCR is conducting.

The new model also can lay fair claim to universal applicability. It has been applied to four different high-power devices with surge currents in excess of 1,000 amperes. These SCRs—the Westinghouse T527, the IRC 125PM, and the GE C354A and C358E—all have a shorted-emitter structure, but they differ significantly in



1. Early SCR model. Three junction diodes and their associated junction capacitances represent the pnpn structure of the SCR. Model emulates the SCR only to the extent of turn-on, which is effected by dependent current sources J_i, J_M, and J_N.



2. Universal model. Below the schematic of the comprehensive SCR model are component and current-source values. Diode currents are derived from diode models in subroutines, and values for J_G, C_B, and R_B are obtained from piecewise-linear tables. Resistors R_2, R_3, R_4, and R_A, as well as capacitor C_G, are included for programming convenience and do not directly affect model behavior.

performance, geometries, and construction features. Yet there is excellent correlation between the performance of actual examples of devices and the performance of the CAD model when the specifications of each device are cranked in.

Intrinsic model

The basis for the high-power SCR model is the equivalent-circuit model used in the past to detail simple characteristics of the devices. As shown in Fig. 1, that model depicts the pnpn structure of the SCR as three junction diodes and includes their junction capacitances. Dependent current sources controlled by the junction voltages represent the gains in the diodes' injection currents.

The diodes nearest the anode and cathode of the SCR are labeled A and K respectively, and the center diode, the collector, is labeled C. In accordance with the junction equation, the currents through each of the diodes are:

$$J_A = I_{A(SAT)}(e^{\theta_A V_{cA}} - 1) \quad (1)$$
$$J_C = I_{C(SAT)}(e^{\theta_C V_{cc}} - 1) \quad (2)$$
$$J_K = I_{K(SAT)}(e^{\theta_K V_{cK}} - 1) \quad (3)$$

where the I_{SAT} terms represent the reverse saturation currents, the V_C terms are the voltages across each junction, and the θ terms are the thermally dependent coefficients, q/nkT for $1 < n < 2$.

If the anode-cathode voltage is positive, applying a positive (with respect to the cathode) current in excess of the turn-on value to the gate turns on an SCR. In the model, this is initiated by the forward biasing of diode K. When this diode is forward-biased, a fraction, α_1, of the total injection current J_K diffuses into the collector junction. This diffusion is represented by the dependent current source, $\alpha_1 J_K$, shown as J_M. Similarly, the diffusions from the forward biasing of the diode junction A and collector junction C are represented as J_H and J_i, respectively. (Although another fraction of J_C diffuses to the cathode junction, it is insignificant.)

The three junction capacitances in the model each comprise a diffusion component and a depletion-layer component. The diffusion components are proportional to the injection currents. The depletion-layer components do not significantly affect the performance of the SCR, so they are treated as constants in the model. The capacitance equations are:

$$C_A = K_{dA} J_A + C_{tA} \quad (4)$$
$$C_C = K_{dC} J_C + C_{tC} \quad (5)$$
$$C_K = K_{dK} J_K + C_{tK} \quad (6)$$

where the K_d terms represent the diffusion-capacitance constants of proportionality and the depletion-layer constants appear as C_t terms.

These equations lose much of their physical significance when applied to a device with a large-geometry, shorted-emitter structure. For example, the voltage across the cathode capacitor of such an SCR is impossible to represent with a single lumped element in a model, since it is different at every point along the junction. Of

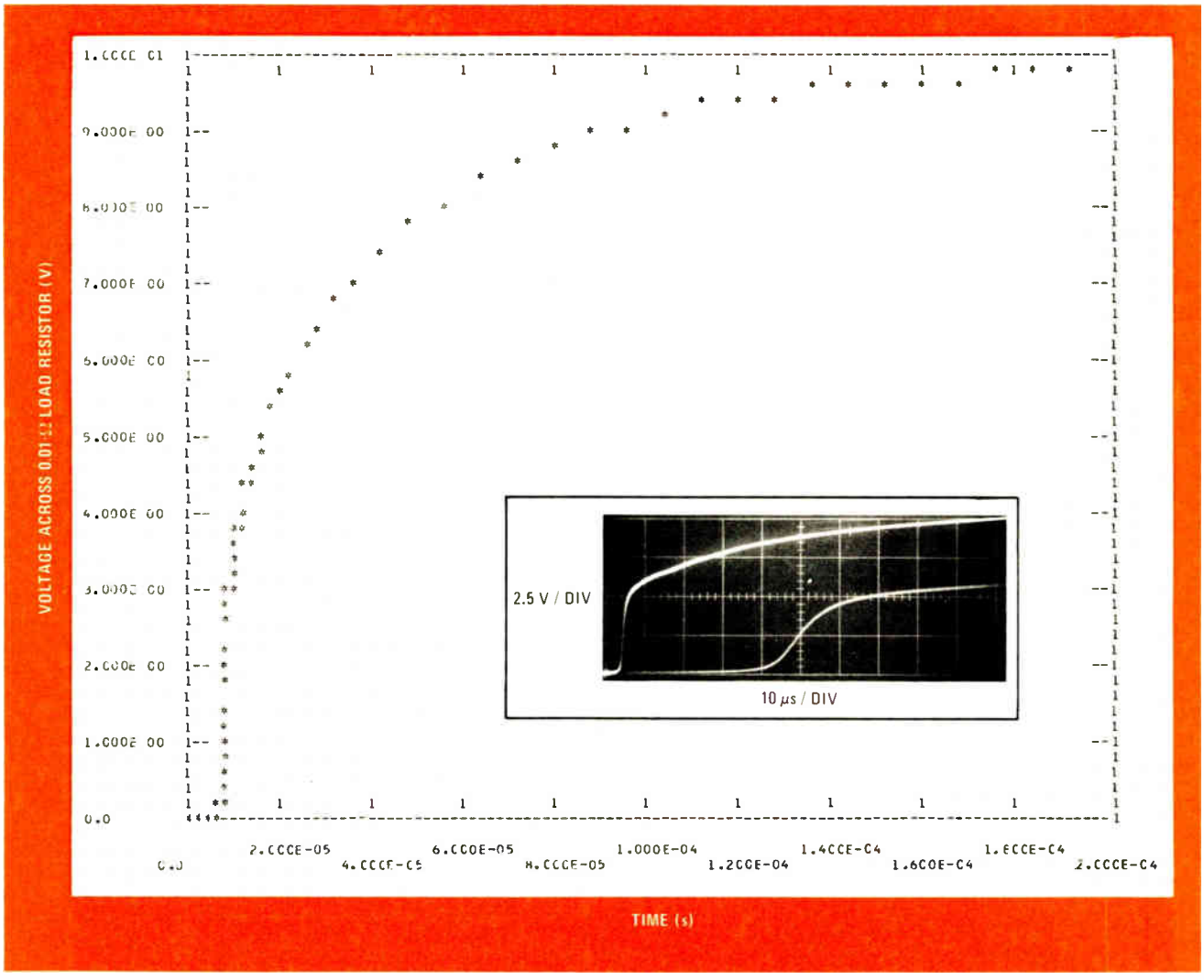
TABLE 1: SCEPTRE PROGRAM FOR SCR MODEL

```
MODEL C358E (G-A-K)

TWO DIMENSIONAL HIGH CURRENT SCR MODEL
UNITS: VOLTS OHMS AMPS FARADS HENRIES SECONDS

ELEMENTS
  JA,3-2=DIODE Q(1E-7,20)
  JC,1-2=DIODE Q(1E-7,20)
  JK,1-K=DIODE Q(1E-11,30)
  JG,G-1=DIODE TABLE 1
  JH,2-1=TABLE 2(JG)*JK
  JI,2-4=TABLE 3(JC)*JC
  JM,2-1=TABLE 4(JK)*JK
  JN,2-1=TABLE 4(JA)*JA
  JP,4-3=.98*JA

  RS,G-K=28.0
  R2,1-K=1E3
  R3,2-1=1E7
  R4,3-2=1E7
  RA,A-4=.0005
  RB,4-3=TABLE 6(VCA)

  CA,3-2=Q1(2.0E-6,JA,1.0E-7,1E-9)
  CB,4-3=TABLE 5(VCA)
  CC,1-2=Q1(5.0E-6,JC,1.0E-7,2.0E-9)
  CK,1-K=Q1(1.0E-7,JK,1E-11,1E-8)
  CG,G-1=1.0E-10

OUTPUTS
  VCC,IRA,PLOT
  VCA,VCK,VRS(VGK),JA,JG,IRS,IRB

FUNCTIONS
  Q1(A,B,C,D)=(A*(B+C)+D)

DIODE TABLE 1
  -10,-.1,-0.8,-.001,0,0, 0.3, .001, .65, .01, 0.9, .04, 1.3, .125,
  1.8, 0.4, 2.5, 0.9
TABLE 2
  -1, .052, 0, .052, .001, 0, 1,0
TABLE 3
  0, .06, 1, .06, 10, 0, 1000,0
TABLE 4
  1E-6,.2, 1E-5,.2, .001,.40, .01,.45, .040,.48, .1,.49, .18,.5, 0.5,.55
  1.0,.60, 10,.60, 100,.55, 500,.52, 1E3,.52
TABLE 5
  0,1E-9, .65,1E-9, 0.8,1.0E-8, 0.85,8E-8, 0.9,6.0E-7, 0.95,4E-6,
  1,3.0E-5, 1.1,1.2E-4, 1.2,1E-3, 1.3,1E-3
TABLE 6
  0,400, 0.65,400, 0.7,200, 0.75,72, 0.8,27, 0.85,9, 0.9,3, 0.95,1,
  1,0.4, 1.05,0.16, 1.1,.12, 1.2,.06, 2,.06
```

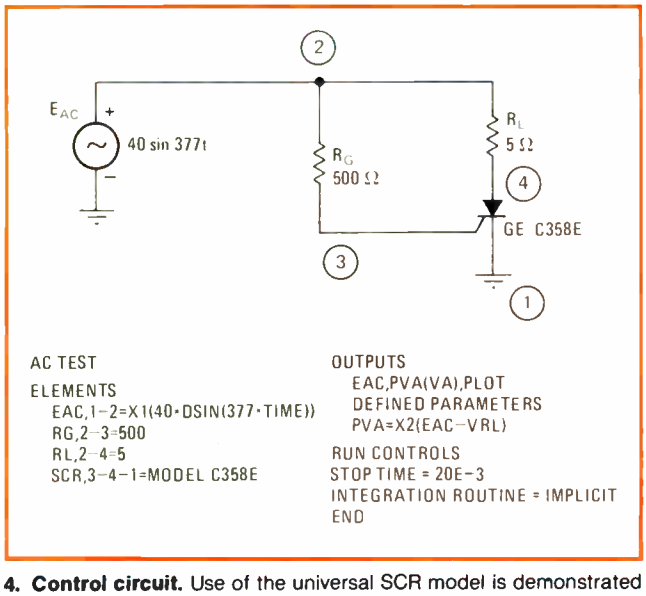
TABLE II — STATIC CHARACTERISTICS OF THE GE C358E SCR

Characteristic	Computer	Measured
Turn-on gate current	48.6 mA	45.5 mA
Turn-on gate voltage	1.25 V	1.22 V
Anode holding current	51 – 54 mA**	52 mA
Anode latching current	174 – 188 mA**	180 mA
100-A on voltage*	1.595 V	1.56 V
10-A on voltage*	1.426 V	1.41 V
1-A on voltage*	1.412 V	1.46 V

*with open-circuited gate
**uncertainty is due to finite resolution of computer simulation



3. Turn-on transient. Computer simulation of current through a Westinghouse T527 SCR is in agreement with the inset oscilloscope photograph. The second image in the photo is the transient at 1 μs/div. The 4-V gate pulse had a 6-μs duration



4. Control circuit. Use of the universal SCR model is demonstrated by a simple control circuit. Circled numbers are nodes corresponding to circuit-element descriptions. The SCR turns on when source voltage provides sufficient gate current through R_G.

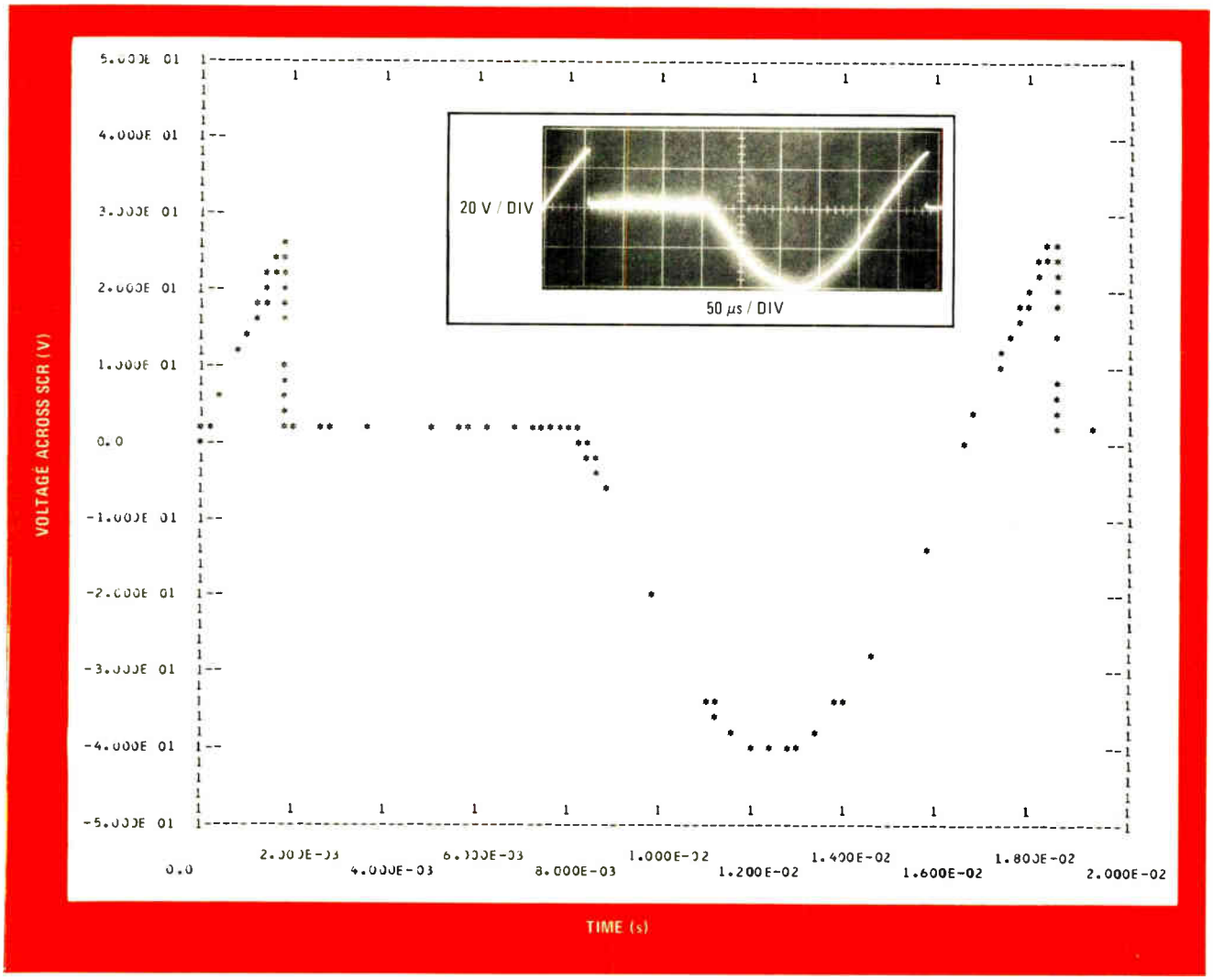
course, the characteristics of the three diodes in the model and the physical significance of the voltages across them are not really important—they are there to simulate the rectifying action of three SCR junctions.

But the basic inadequacy of the equations—and of the intrinsic model—is that they are one-dimensional. The model is a simulation of current going from one point to another with no consideration of the effects of the device's physical dimensions and transverse fields, which are especially significant in SCRs of large geometry.

However, it is possible to modify this model to make it take into account the two-dimensional physical characteristics of large SCRs. While the inclusion of all 2-d effects generates a formidable equation set, a thoroughly adequate model may be obtained by adding only certain of the effects that occur in the high-power devices.

Enter the quasi-2-d model

A comprehensive, accurate model that is accurate even for high-power SCRs is shown in Fig. 2, and the program generating it is listed in Table 1. In this model, the diode injection currents J_A, J_C and J_K correspond to those in the intrinsic model, as do the junction capaci-



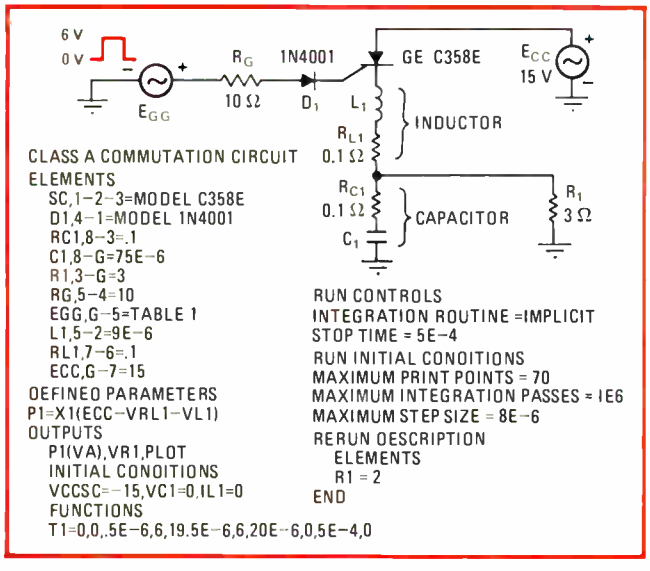
5. Switching waveform. Good correlation is exhibited between measured (photo) and simulated (printout) voltage across the SCR in the control circuit of Fig. 4. The horizontal axis can be expanded about the 2-microsecond instant to detail the turn-on transient of the device.

tances C_A, C_C and C_K. The configuration of dependent current sources now includes J_H, which is a fraction of the injection current J_K, and J_P, which is a fraction of the injection current J_A. J_H varies with the gate current, and J_P is required for simulation of the SCR's nonlinear on resistance. The program uses subroutine models for diodes and piecewise-linear tables for some elements.

There are a number of other components added to make the model accurately simulate all static and dynamic SCR effects. The important additional components in Fig. 2 are worth a closer look.

The effect of spreading (the reduction in SCR on voltage as the conducting area of the current increases from an initially confined cross section near the gate) is accurately simulated by the charging time of capacitor C_B. During turn-on, the current through resistor R_B is equal to the curent required to charge capacitor C_A minus the current in C_B, which produces a larger voltage drop across R_B than in the static case. Therefore, the collector diode C will forward-bias (representing the turn-on of an SCR) at lower values of anode current in the dynamic situation.

Once the SCR turn-on is simulated, the voltage drop



6. Class-A commutation. The SCR is turned on by a 6-V, 20-μs gating pulse and is turned off by LC ringing. Program listing includes initial-conditions specifications and a rerun command that disclosed the SCR's failure to turn off when R_1 was reduced from 3 to 2 ohms.

Meet Super-Sceptre

A nonlinear circuit-analysis program, Super-Sceptre (the second generation of the System for Circuit Evaluation and Prediction of Transient Radiation Effects) performs dc and transient analyses. The Fortran program uses state-variable methods and does transient analysis by any of four user-specified integration routines—including implicit integration, which was not available in the first-generation Sceptre.

Built-in models include logic and mechanical functions, in addition to a library of circuit elements. A rerun description is also featured, which executes multiple runs using specified variations in circuit elements.

The program permits a maximum of 50 outputs and 100 parameters. It is topologically limited to 300 elements. Suitable for batch mode use only, Super-Sceptre is available from the authors at the Department of Electrical Engineering, University of South Florida, Tampa, Fla. 33620. Complete information about the SCR model is in technical report AFAPL-TR-75-106 available from P. C. Herron Jr., AFAPL/TOD-1, Wright-Patterson AFB, Ohio 45433.

across the three forward-biased diodes does not change appreciably. As C_B discharges, the voltage drop across R_B slowly decreases to a steady-state value. The time required for this to occur is the spreading time and is primarily dependent on the values of R_B, gain factor α_a, and C_B. The charge on capacitor C_B is a nonlinear increasing function of injection current J_A.

The anode and cathode diffusion-capacitance constants, K_{dA} and K_{dK}, help simulate the turn-on delay and rise time. In addition, the ratio of K_{dA}/K_{dK} simulates the breakpoint between the rise time and the spreading time. The initial proportion of the turn-on delay is simulated by the constant component of the cathode junction capacitance, C_{tC}. The collector diffusion-capacitance constant, K_{dC}, determines the turn-off time.

To account for the SCR's anode latching current being greater than its holding current, a third dependent current source, $\alpha_3 J_K$, has been included in the model as J_H. The current gain α_3 is zero when the gate injection current J_G is positive, while it has a small finite value for all other values of J_G. The holding current occurs at current levels such that $\alpha_1 + \alpha_2 = 1$. At low current levels, α_1 and α_2 are increasing functions of current, so latching occurs at a higher current level than that of holding.

Simulating turn-on

The turn-on current and voltage characteristics of the SCR's gate are simulated by the resistance R_S, the low-current values of α_1 and α_2, and the nonlinear characteristics of the cathode and gate diodes. Besides their role in modeling the static characteristics of the SCR, the low-current values of α_1 and α_2 help simulate the turn-on delay, while their high current values help simulate the rise time.

The resistance R_S represents the relatively small resistance between the gate and cathode electrodes. This resistance is attributable to the shorted-emitter construction used in the manufacture of most high-power SCRs.

TABLE III – APPROXIMATE INITIAL CONDITIONS FOR SCR PROGRAM

SCR initially on	SCR initially off
$V_{JA} = +0.9$	$V_{JA} = \pm 0.1$
$V_{JC} = +0.9$	$V_{JC} = -V_{aa}$ (anode supply voltage)
$V_{JK} = +0.9$	$V_{JK} = 0.0$

An SCR's nonlinear static on resistance between the anode and cathode terminals is represented by the model's nonlinear resistance R_B in shunt with the linear-dependent current source, $\alpha_a J_B$, shown as J_P in Fig. 2. This resistance decreases as the anode current increases, because a larger portion of the total cross-sectional area of the SCR is conducting.

The spreading effect

In the dynamic case, the spreading effect causes the on voltage to be less than in the static case. This nonlinear behavior is effectively simulated by the interdependence of the current source and the voltage across the anode capacitor. The upshot is a higher on resistance for the dynamic case than for the static case.

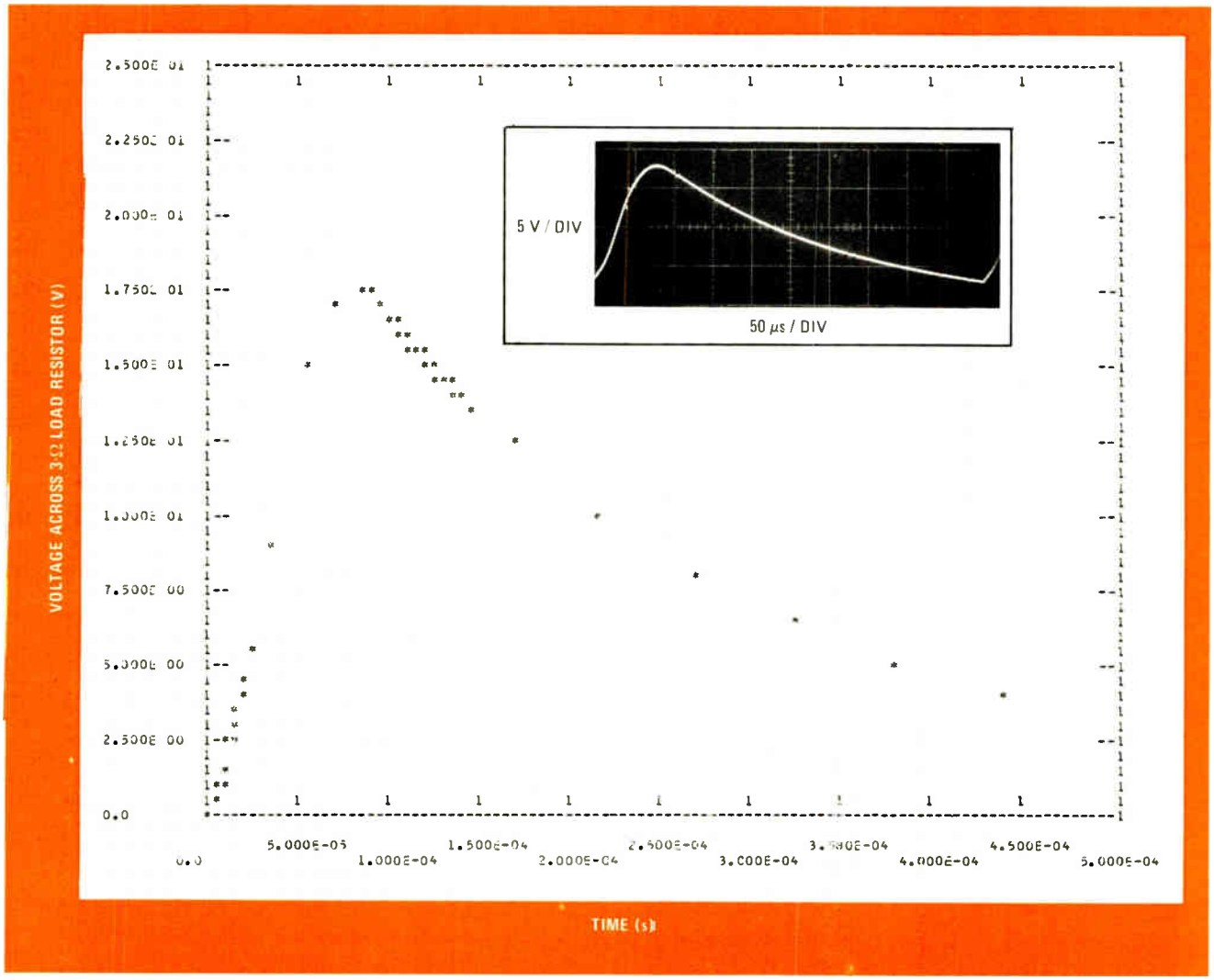
The diode labeled G is not an actual junction. It is a convenient way to represent the nonlinear resistance of an SCR's gate region between the gate electrode and the active portions of the cathode junction. (In a device with an amplifying gate, the pseudo-diode also will take into account the voltage drop across the pilot cathode junction.) The relatively high back resistance of this diode simulates the SCR's invulnerability to turn-off if the gate is reversed-biased.

It can be shown that $\alpha_1 + \alpha_2$ is less than unity for currents below the anode latching level, and $\alpha_1 + \alpha_2$ is greater than unity in the current range from latching to maximum surge-current rating. Once a gate pulse drives the SCR into the region where $\alpha_1 + \alpha_2 > 1$, the device's regenerative behavior will cause it to continue to turn on and stay on, even if the gate pulse is reduced to zero.

The model's accurate simulation of the static characteristics of an actual SCR is illustrated in Table 2. In simulating a GE C358E, the largest deviation from measured characteristics is a 7% error in turn-on gate current. Other deviations are much smaller.

To illustrate the dynamic performance of the SCR model, a computer printout of the simulated 1,000-A turn-on transient for the Westinghouse T527 SCR is shown in Fig. 3 along with an oscilloscope photograph of the response of an actual device. The plots are of the voltage across a 0.01-ohm load resistor connected from the cathode to ground with a 13.5-volt anode supply voltage. To initiate the turn-on response, a 4-V, 6-microsecond rectangular pulse is applied to the gate through a 10-Ω series gate resistance at time $t = 0$.

The transient exhibits three distinct regions: a turn-on delay, a relatively short current rise time, and a rela-



7. Anode-current plot. The rise and decay in anode current of the SCR commutator of Fig. 6 are accurately simulated by the CAD model. Inductors and capacitors, as in the commutating circuit, must include series resistances for accurate prediction of SCR turn-off.

tively long spreading time. In the device, the gate voltage has returned to zero before the load current has become appreciable, but the SCR's regeneration ensures it will still turn on. The model accurately simulates the regenerative behavior of the device.

Similar tests performed over three decades of anode current and with different gate-pulse amplitudes for each of the devices modeled have produced similar correlations between measured and simulated responses. The tests reflect the fact that the turn-on delay is generally a function of the gate-pulse amplitude, whereas the rise and spreading times are functions of the anode current.

Using the model

In using the SCR model in a circuit application where the anode-to-cathode voltage is positive but the gate current is below the turn-on value, there are two possible stable states. If all three junctions in the SCR are forward-biased, it will be on. If the center junction is reverse-biased, it will be off.

The starting values need not be the exact, but a poor estimate may lead to the wrong starting state or to program convergence problems. Suggested values that cover most circuit applications are listed in Table 3.

Two simple circuit models will show how well the SCR model works. In both examples, there is excellent correlation between the actual behavior of SCRs and the computer simulation.

Figure 4 shows a simple alternating-current control circuit and the Sceptre circuit description. Running the program on an IBM 360 computer requires 60.3 central-processing-unit seconds. Figure 5 compares the actual measured voltage across the SCR shown on the scope photograph with the printout of the simulation.

In the waveform, the flat portion indicates the on time of the device. The transient response, shown by vertical lines, is not under consideration in this example, since the excitation is low-frequency 60 hertz.

A Class A commutation circuit is shown in Fig. 6, along with its Sceptre circuit description. Run time on an IBM 360 computer is 113.37/CPU seconds, including one rerun. In this circuit, the SCR is turned on by a narrow gate pulse of 20 μs. The ringing produced by the LC circuit in the cathode leg of the SCR then turns the device off. Figure 7 shows the measured and computer-simulated load-voltage waveforms. □

Frequency-controlled gate makes high-Q filter

by Noel A. Sivertson
Denver, Colo.

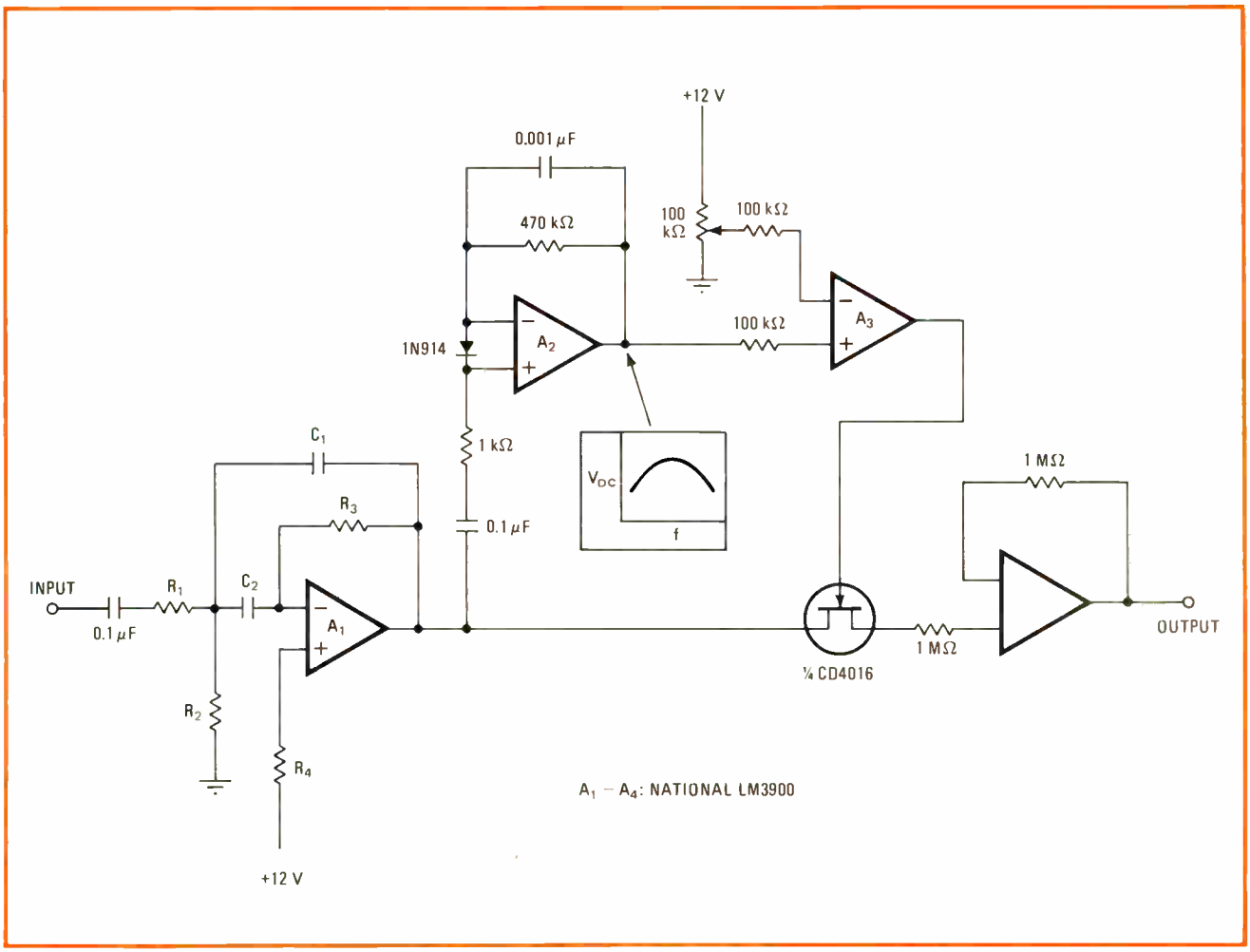
A bandpass filter in conjunction with a frequency-controlled gate provides a highly selective filter at low cost. Its high Q is especially useful for single-frequency discrimination, where conventional filters falter.

The circuit utilizes the response of the bandpass filter itself to pass desired signals, and it absolutely rejects all other frequencies. As indicated by the figure, input signals encounter A_1, a standard bandpass filter. Resistors $R_1 - R_4$ and capacitors C_1 and C_2 determine the filter center frequency and bandwidth, and their values are selected accordingly. The output of A_1 is then presented both to A_2, which serves as a peak-rectifier detector, and to the input of the CD4016 analog transmission gate. The output of A_2 is a dc signal having an amplitude that is proportional to the filter's transmission coefficient—that is, the filter's center frequency produces the largest dc output. This output represents the envelope of the filter response.

A_2's output is compared to a user-determined reference voltage at A_3, and when it exceeds this reference voltage, A_3 signals the transmission gate to transfer its input signal to the output. Thus comparator A_3 is in effect a bandwidth adjustment control.

Depending on the quality of the band-pass filter, the ultimate bandwidth of the circuit could be as sharp as a few cycles. To retain this sharpness, however, it is required that the signal be of a reasonably constant amplitude at the input to the circuit.

This circuit has also been used in an amplifier-squelching device and to control the range of a sweep oscillator. □



Gated filter. Circuit uses pass-band response of ordinary filter in generating voltage reference for gate switching. Transients caused by gate switching in the audio range are not detrimental to circuit performance but may cause concern at higher frequencies.

Decoders drive flip-flops for clean multiphase clock

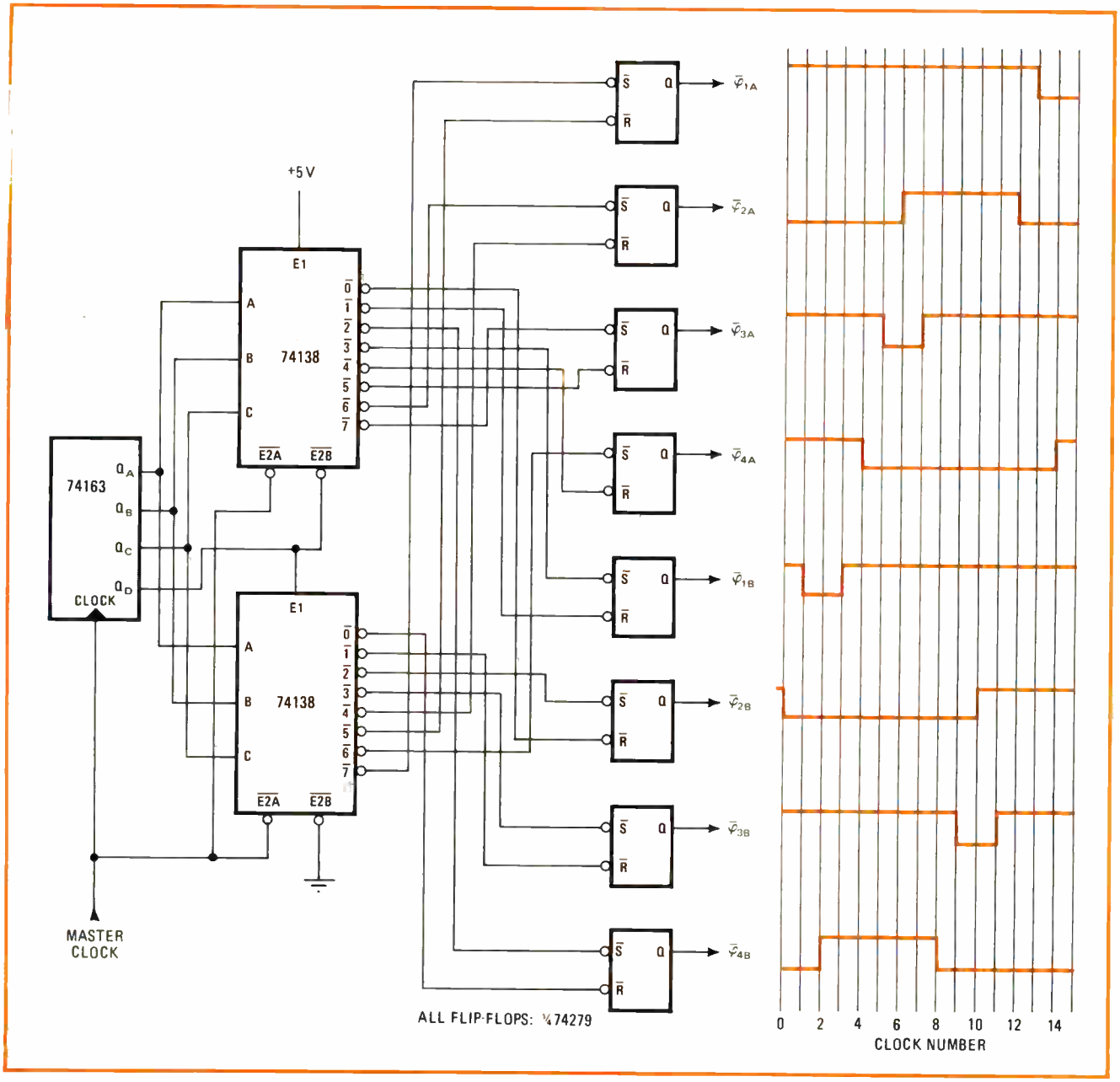
by Craig Bolon
Massachusetts Institute of Technology, Cambridge, Mass.

A multiphase clock suitable for driving circuits with strict timing requirements, such as charge-coupled-device memories, can be built with a counter, decoder, and set/reset flip-flops. This clock can generate any number of outputs at any duty cycle, yet never suffers from the drift and "glitches" encountered in most multiphase designs. Although each signal is phase-locked to a master clock, its timing and duty cycle can be set independently of the others, permitting great flexibility.

The figure shows a typical application—an eight-phase clock designed for driving parallel banks of Intel 2416 CCD memories. A master clock drives the 74163 synchronous 4-bit binary counter. The binary output is then presented to the combinational logic of two 74138 1-of-8 decoders.

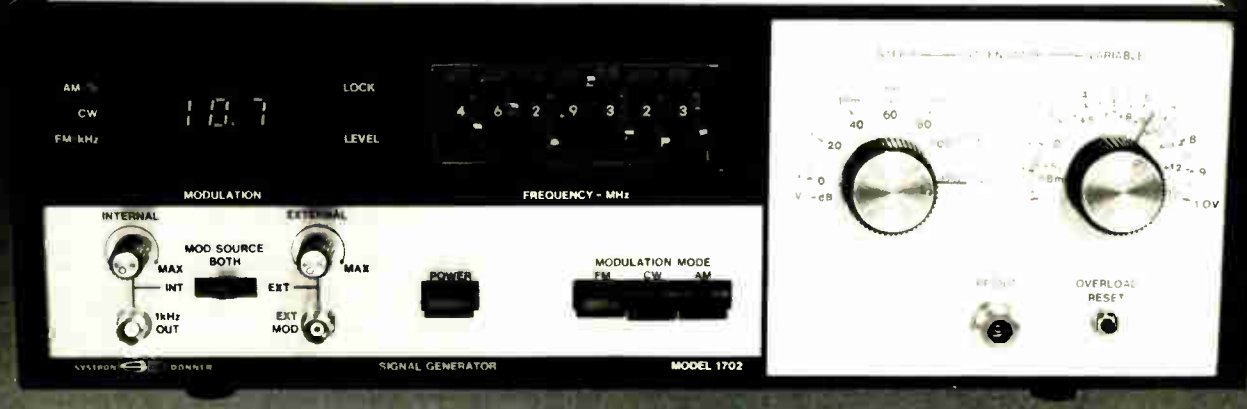
The decoders count one pulse on the rising edge of each clock. The first decoder counts eight pulses (0–7) before its outputs are held high by the Q_D output of the binary counter. The second decoder is then enabled and counts an additional eight pulses, after which the 16-count sequence is repeated.

Each decoder output controls an R/S flip-flop by setting or resetting it at the desired moment. Thus, the



Multiphase clock and waveforms. Master clock can be stopped or started at any point in cycle without affecting the phase relationship at all. Skew in output waveforms can be limited to propagation delay of one gate, provided that edge-triggered flip-flops are used.

100 Hz TO 1000 MHz



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master clock assures synchronous operation, and the strictly sequential nature of the decoder output keeps it glitch-free for all time.

The clock waveforms are shown to the right of the circuit. Phase 2A of the clock, for example, is generated by setting a flip-flop on count 6 of the 16-count cycle ($\overline{6}$ of the first decoder) and resetting it on count 12 of the cycle ($\overline{4}$ of the second decoder). The number of phases can easily be increased by expanding the binary counter and adding decoders and flip-flops. □

Noise-reducing filter switches time constants

by Martin V. Thomas
Boston University Medical Center, Boston, Mass.

To reduce high-frequency noise in a signal waveform without significantly distorting the signal is often beyond the capacity of conventional low-pass filters. For this purpose, a piecewise-linear filter is far more effective, especially for complex waveforms such as square waves and sawtooth signals.

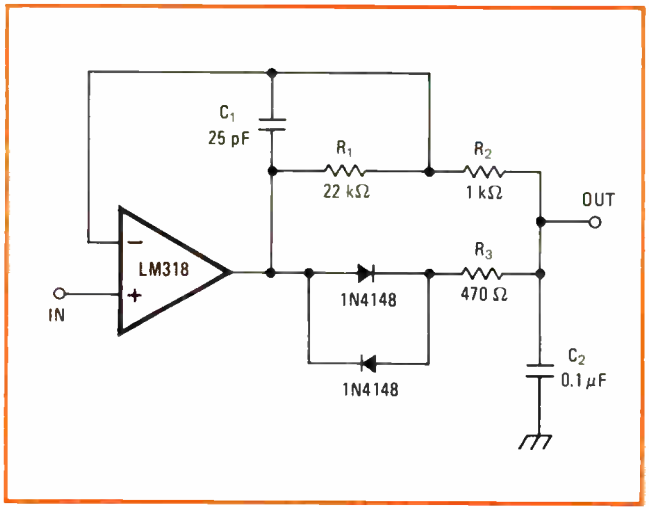
The circuit shown in Fig. 1 achieves this improvement in signal-to-noise performance and has been used for the precise determination of input-signal amplitudes in the presence of noise. It makes use of the fact that although signal amplitude varies significantly with time, the variation of the root-mean-square value of the superimposed noise with time is smaller and relatively constant. The filter normally has a comparatively long time constant, T_1, but switches to a shorter time constant, T_2, whenever the input signal exceeds a certain threshold. Thus, the circuit allows large transients to pass through it relatively unaffected but filters out smaller variations (noise).

Input-signal voltages to the operational amplifier appear immediately at the junction of resistors R_1 and R_2, so that the normal response time of the circuit is $R_2 \cdot C_2$, or 100 microseconds. If the input is constant or slowly changing in amplitude, there is essentially no difference in voltage between the output and the resistor junction. Low frequencies pass to the output, and noise is reduced by the long time constant of the circuit.

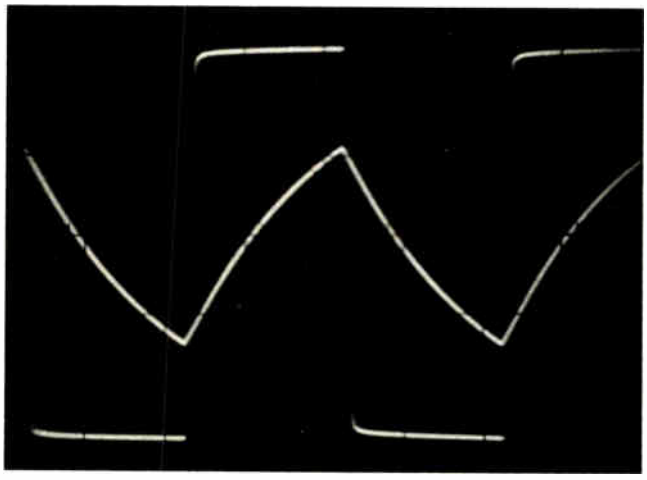
A diode is switched on, however, if the voltage at the junction exceeds the output voltage by $0.7 \cdot R_2/(R_1 + R_2)$ volts, or 30 millivolts in this circuit. Diode switching is possible because of the output voltage lag produced by the RC circuit, and it occurs if a rapidly changing voltage is brought to the op amp's input. An additional current path is established through R_3, and the time constant of the circuit becomes approximately $R_3 \cdot R_2 \cdot C_2/(R_1 + R_2)$, or 2 microseconds, assuming R_3 is much less than $R_1 + R_2$. This allows the high-frequency transient to pass through to the output, virtually undistorted. Although any noise superimposed on the signal at this time passes through also, the circuit's average signal-to-noise ratio for the entire band of frequencies is much higher than can be expected with conventional circuits.

Outputs of the filter with a 1-volt, 5-kilohertz square wave input are shown in Fig. 2. The square wave is undistorted since both time constants are utilized. The superimposed triangle wave shows the resulting distortion if the long time constant alone is used.

The filter's time constant and diode switching threshold can be varied within a reasonable range. Under some conditions it may be desirable to limit the input signal bandwidth to the inverse value of the short time constant, in order to minimize distortion caused by overshoot. □



1. Dual-value response-time filter. For best performance, C_2 is made relatively large. R_3 maintains stability by limiting charge current, C_1 prevents oscillation in feedback loop.



2. Square-wave response. Square-wave output is result of circuit's use of a short as well as a long time constant. If filter uses only long time constant, overfiltered triangular waveform results. Full square-wave output yields higher signal-to-noise ratio.

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High-speed wire-and-solder technique tests connections as it makes them

Automatic method also minimizes production costs and keeps printed-circuit card profiles low for high-density packing

by Bob Whitehead, *United Wiring & Manufacturing Co., Garland, Texas*

☐ A new and different high-speed automatic wiring technique is beginning to challenge existing methods. It produces boards with an extremely low profile and high wiring and packaging densities, and it is the first to make an in-progress check of wiring. A small group of manufacturers is already using it to cut the cost of wiring circuit cards for computers, minicomputers, peripheral equipment, and digital controllers.

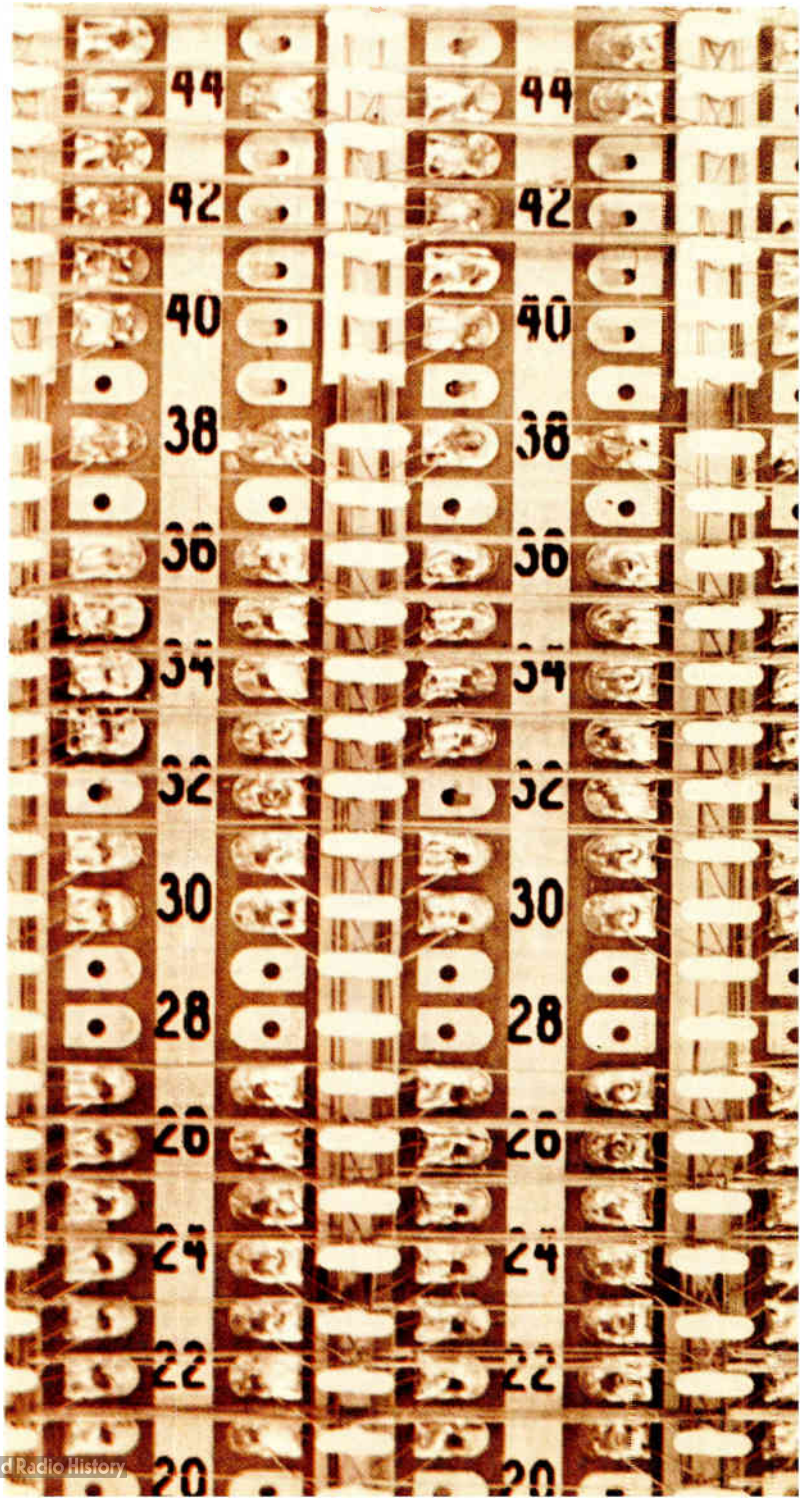
Solder-Wrap (the trademark of the new technique) keeps card profiles low because short solder tails replace the long protruding pins used in other wiring methods. Its end products, though, like theirs, are competitive with two-sided and multilayer printed-circuit boards.

Like the earlier methods, too, it uses stock pc cards with standard conductive patterns for multiple rows of dual in-line packages plus plated ground and power buses (Fig. 1). The three older systems are Wire-Wrap from Gardner-Denver Corp., Grand Haven, Mich., Multiwire from Photocircuits division of Kollmorgen Corp., Glen Cove, N. Y., and stitch-welding, originally developed by Jet Propulsion Laboratories, Pasadena, Calif., and now produced by other companies.

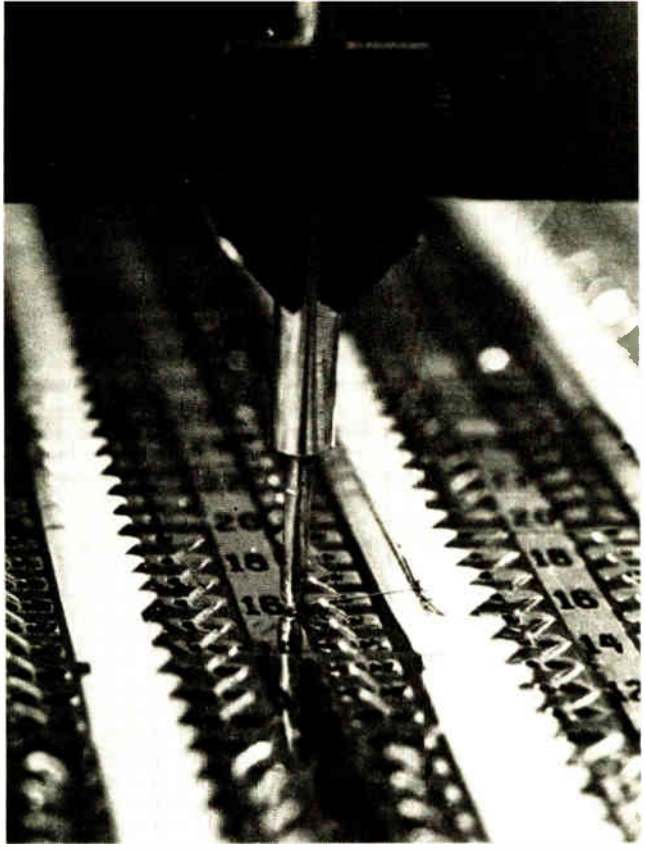
All four automatic systems have several advantages over plating techniques for producing pc boards. The main ones are higher interconnection density, which is frequently comparable to that of multilayer boards; elimination of custom artwork, which is particularly expensive for multilayer pc boards; lower overall costs; shorter turnaround time for design changes, and higher reliability.

Solder-Wrap, in turn, is superior in many respects to the older automatic methods. Most important, it tests its results at every step in the wiring routine; the others cannot check operation until after a board is completely wired. Moreover, the new technique wires boards faster, provides higher wiring and packaging density, costs less, produces better high-speed-logic circuitry, and offers the option of hand-wiring. The manual option, also offered by Wire-Wrap, is useful for breadboarding, low-volume production, and field-engineering changes.

In fact, United Wiring & Manufacturing developed the new system in 1973 as a manual wiring process with



1. All wrapped up. A finished Solder-Wrap board shows No. 38-gauge wire either soldered to socket leads that have been bent over at a 60° angle or wrapped around plastic wire-guide posts.



2. Wiring stylus. This special Solder-Wrap tool wraps a continuous wire around solder tails and wiring guides of a special board as directed by a point-to-point computer program.

3. Stripping for action. At speeds as high as 4,800 connections an hour, solder tool thermally strips polyurethane insulation from the wrapped wire and feeds solder to complete the connection.

a view to developing it into an automated system that would overcome most of the disadvantages of the older techniques. By late 1976, the company had developed automatic wiring machines, special hardware, and software for the Solder-Wrap.

Basically, Solder-Wrapping consists of stringing a fine insulated wire to the solder tails or leads of sockets or pins previously inserted into a specially patterned pc board having wiring guides between the rows of leads.

Soldering and stripping

The wires are soldered to the solder tails by a probe that thermally strips away the wire insulation at the soldering point while the sockets or pins are soldered in place. The resulting loop of connections is cut at the proper places.

Machines for the automatic solder-wrapping processes are programmed by paper tapes produced by a computerized data base generated from information from the customer's schematic. Data from this source document is key-punched into three card decks—one each for parameters, device locator, and signals—which the computer checks for errors before they are loaded into memory.

The parameter cards define the physical characteristics of each device used on the board. For instance, a typical IC could be identified as a 7400 with 14 pins—7 on a side—with 100-mil centers. These cards define X-Y coordinates for the locator cards.

The locator coding defines the row/column address of pin No. 1 of each IC located on the board. The signal cards contain logic-element coding for every pin of every IC called out on the schematic.

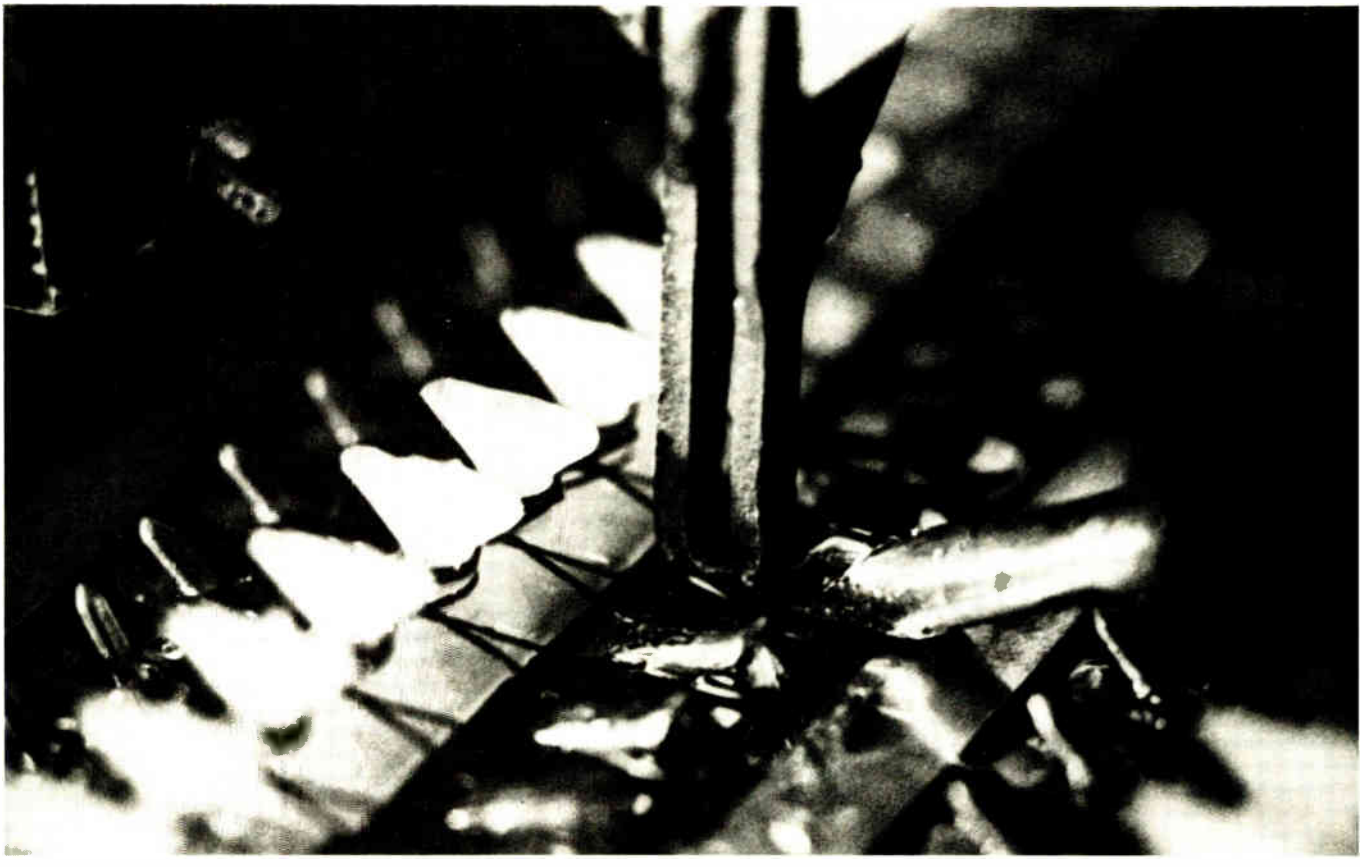


TABLE 1: SOLDER-WRAP AUTOMATIC MACHINES					
Model	Stringing (connections/hour)	Solder (connections/hour)	Cutting (connections/hour)	Average completed connections/hour	Average wires/hour
100	1,000	1,000	2,500	500	300
200	2,400	2,400	5,000	1,000	666
300	3,600	3,600	7,500	1,600	1,066
400	4,800	4,800	10,000	2,000	1,333

The older computer-controlled systems have fairly high design costs. Except for Multiwire, they do not lend themselves to production of high-speed logic circuitry, especially because wires are not placed near enough to the ground plane. Wire-wrap and stitch-welding produce high pin profiles that limit the number of cards that can be stacked in a given space.

A Wire-Wrap machine inserts a matrix of square metal pins spaced on 100-mil centers on the card. Then, under computer control, a special tool wraps several turns of insulated wire around the pins so tightly that the connection is gas-tight.

In the multiwire system, an automatic wiring head lays down a network of magnet wire, insulated with polyimide, on an adhesive-coated epoxy-glass board. Terminations are formed by drilling through the wire and board, then electroplating the sides of the holes.

Stitch-welding employs a semiautomatic tool to cold-weld Teflon-insulated nickel wire to a board with a matrix of either stainless-steel pins or stainless-steel circuit lands. Like Solder-Wrap, it can provide a low profile by eliminating the pins.

Running the Solder-Wrap routine

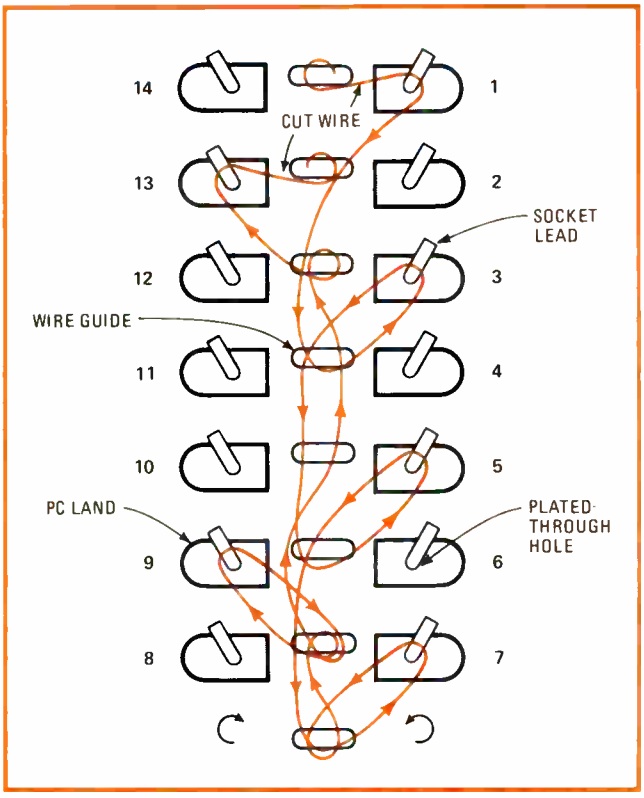
With Solder-Wrap, the wiring stylus shown in Fig. 2 can string No. 30, 34, and 38 gauge polyurethane magnet wires. After routing the wires, the machine steps into a solder cycle using the tool shown in Fig. 3. The solder head has three different timing cycles—strip, preheat, and post-heat. During the 400-millisecond strip cycle, the resistance solder head is heated to 800°F to strip the polyurethane from the magnet wire directly under it. After preheating the electrical pins or component leads, the solder-feed mechanism is activated.

The post-heat cycle starts after a predetermined metered amount of solder has been fed to the electrical land. Completing the solder-feed cycle starts the post-heat cycle, which continues as the solder is retracted from the electrical land. The component or socket lead is soldered into the plated-through hole in the land at the same time the polyurethane-coated magnet wire is soldered to the lead.

Last, the tool shown in Fig. 4 begins cutting into separate networks the single continuous wire running throughout the board. Figure 5 illustrates the cuts made in a typical wire network. In this example, a 14-pin device has been wired into a network that ties pins 1, 3, 5, 7, 9, and 13 together. The routing of wires to pins 1 and 13 differs from that for pins 3, 5, 7, and 9. The automatic cutters separate the networks where slashes are shown.

The four automatic Solder-Wrap machines—models 100, 200, 300 and 400—operate under tape control at different rates. Table 1 indicates their stringing, soldering, and cutting speeds. Connection speeds range from 500 to 2,000 per hour and stringing from 1,000 to 4,800

4. Cutting edge. After a network has been strung and soldered, a third tool, controlled by the wiring program, cuts wire along the network at desired points at a rate as high as 10,000 points per hour.



5. Wire routing. Routing pattern is designed to string a 14-pin socket. Wiring guides channel some wires either in a clockwise or counterclockwise direction. This orientation aids in determining whether a lead is going into or coming out of the network.

wires per hour. The model 100, priced at about $35,000, is a new completely automatic single-headed machine aimed at engineering laboratories and small companies. When not being operated in its normal mode, it may be used for semiautomatic wire-wrapping or component insertion.

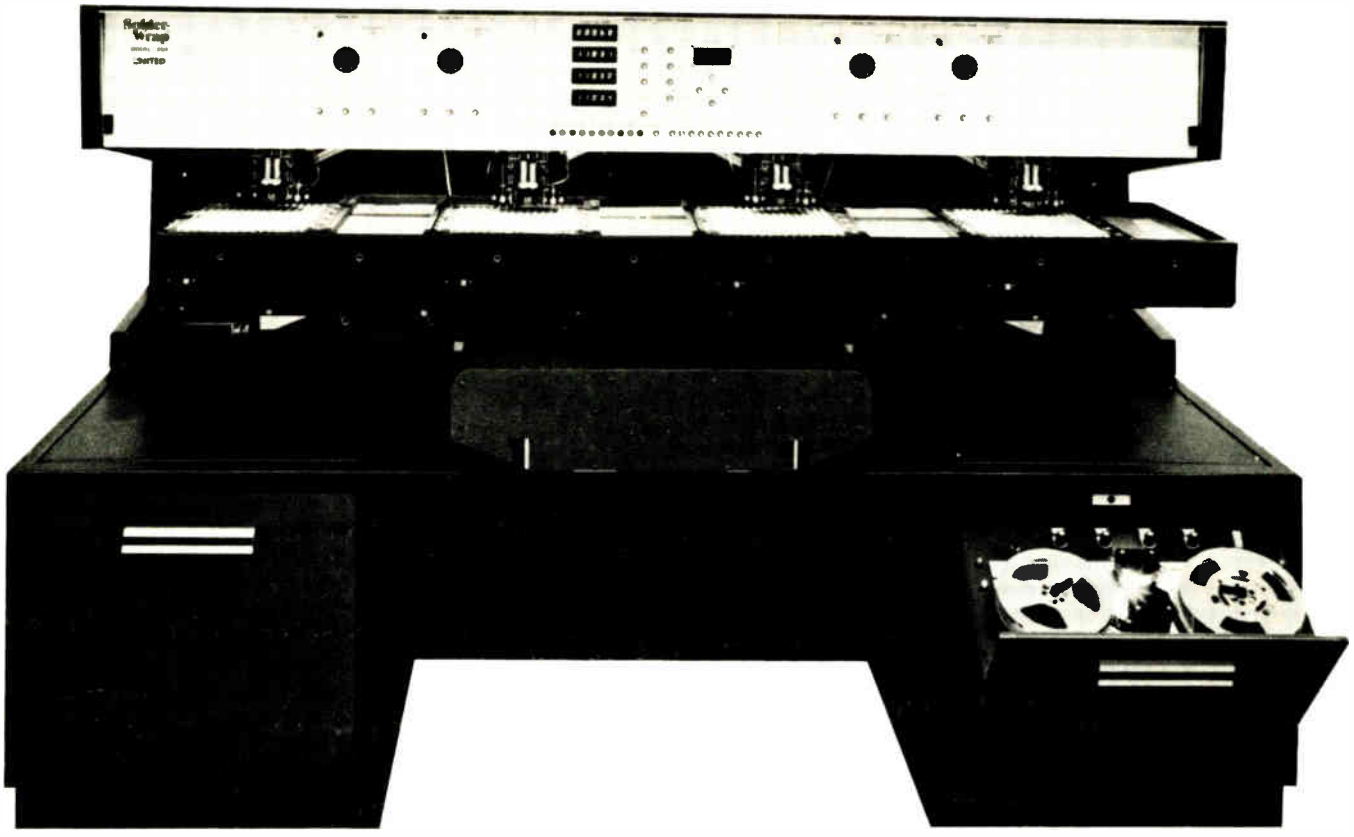
Models 200 through 400 are designed for medium- to high-volume production. The four wiring heads of the model 400 (Fig. 6) can lay down more than 400,000 wires a month.

Wiring the cards

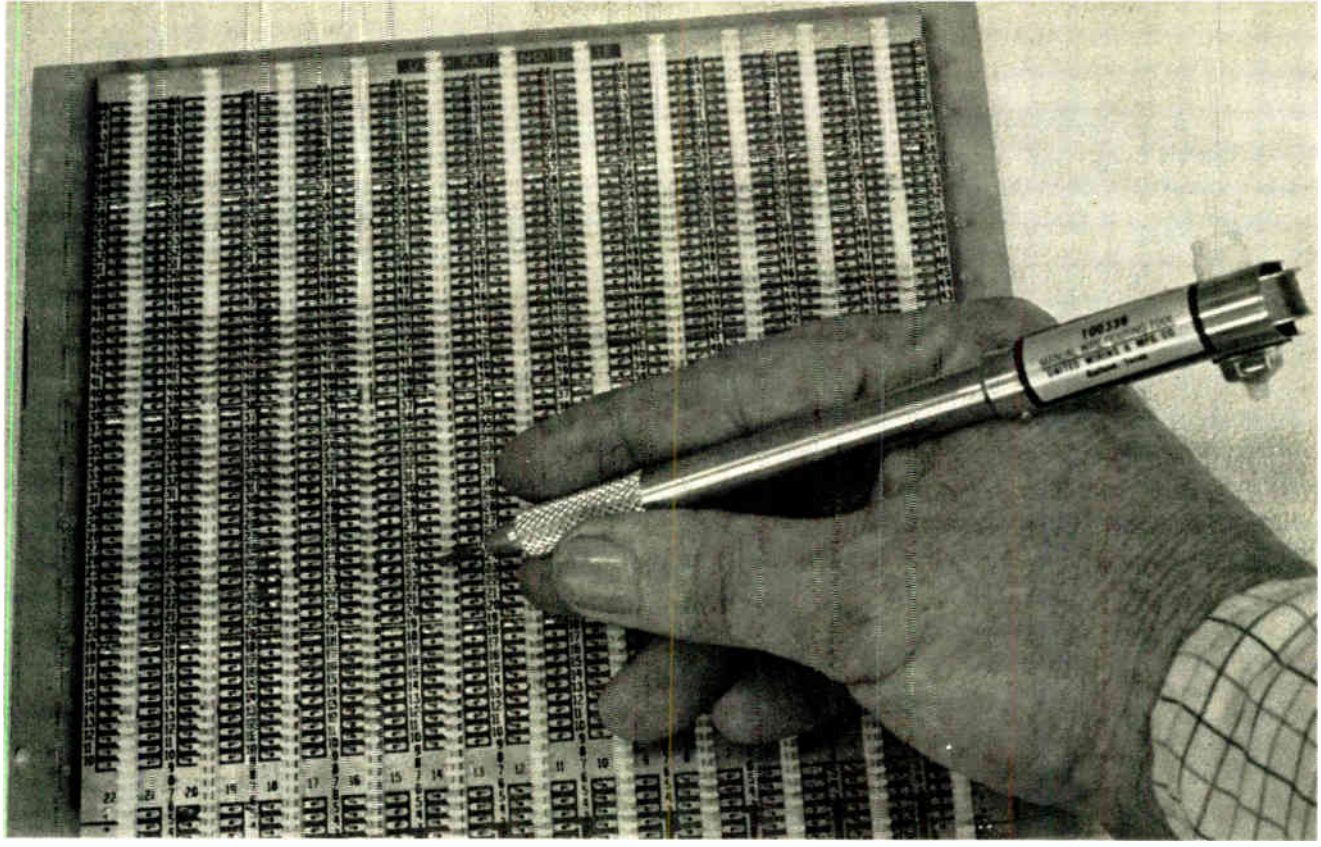
Like the other three automatic-wiring methods, a Solder-Wrap machine lays wires in the desired configuration on a specially modified and patterned pc card. As do Wire-Wrap and Multiwire cards, the epoxy-glass blanks have plated rows of dual-in-line-package patterns spaced on 0.1-in. centers. Ground and power buses on the component side are connected via plated-through holes to similar conductive patterns on the wiring side. On the component side are mounted IC sockets with solder-tail leads, special socket pins with solder tails, or the components themselves. The solder leads are inserted in the plated-through holes to the wiring side, where they are bent at opposing 60° angles in alternating columns, lowering the wiring profile even further.

Finally, rows of plastic wiring guides are attached between the rows of plated-through holes on the wiring side of the board. These guides, which have oblong posts, are used in the wiring process depicted in Fig 5.

However, the user can adapt manual Solder-Wrap



6. Automated wiring. United Wiring and Manufacturing's Solder Wrap model 400 is a fully automatic quadruple-head wiring machine. The wiring pattern is controlled by a paper tape generated from an off-line data base derived from the customer's schematics.



7. Wiring pencil. A pencil-like tool is used to wire manually a Solder-Wrap board at a rate of 200 to 300 wires per hour. Standard hand-soldering and -cutting tools are used to finish the wiring. A special wire cartridge loads the tool with the wire type required.

tools to breadboarding, low-volume production, or field-engineering changes. The manual wiring tool in Fig. 7 can lay down 200 to 300 wires per hour, a rate 3 to 4 times higher than is possible with a comparable hand wire-wrapping tool. In the course of breadboarding, an engineer would load the wiring tool with a special wire cartridge, wire a string, strip away the insulation, and solder the pin connections with a low-wattage soldering iron and then cut the string with diagonal pliers at the proper points.

Mounting circuit cards

Solder-Wrap cards made either with pin-in-board construction or no sockets at all can be spaced on 500-mil centers in a card cage, and the boards with sockets can be spaced on 600-mil centers in the same applications. The only suppliers of boards for its process, United Manufacturing & Wiring offers a library of card designs that includes units for Schottky, transistor-transistor, and emitter-coupled logic. For companies that want to design their own boards, Robinson/Nugent Co., Albany, Ind., has developed both low-profile and high-reliability IC sockets that can be wired with Solder-Wrap equipment. With the high-reliability type, 34 solder-wrapped boards on 0.500-mil centers can be packaged in a 19-in. card cage.

The big advantage of the Solder-Wrap back-panel system is its high cubic density on the wiring side of the backplane. The wiring cost is also lower than previous Wire-Wrap back-panel systems. A Solder-Wrap backplane system would be equivalent to an 8- to 10-layer board.

For applying back-panel wiring, the Milton Ross Co., Southampton, Pa., has designed a special Solder-Wrap edge-board connector that has a solder-tail-lead design on centers of 100 by 300 mils. This connector will be available in several pin configurations for use with present back-panel connector systems. Winchester Electronics division of Litton in Oakville, Conn., is also developing a complete line of Solder-Wrap back-panel edge-board connectors to compete with present available Wire-Wrap back-panel systems.

Automatic Solder-Wrap is the only automatic wiring process available with a complete in-line test of wiring interconnections. All Solder-Wrap machines have four lights on each wiring head that indicate failures of the parameters checked by the self-test circuitry. These lights indicate, respectively, missing pin, broken wires, stripped wires, and solder errors. Since every failure halts a head's tool where an error occurs, a glance at the indicator lights and the position of the tool is enough to identify and locate the error.

Self-testing

While stringing is in process, the wire network being put down is checked for missing pins, strip-wire errors, and broken wires. Missing pins are detected by monitoring for a slack wire. A system to monitor wire-tension errors stops the machine and lights the missing-pin indicator when it detects a slack wire.

The circuit of Fig. 8 checks for strip errors and breaks. Strip errors occur when insulation is missing on the magnet wire, a fault that could short two networks together. In the circuit of Fig. 8, the insulated wire normally tied to V_{cc} passes through the stringing tool, which has its case grounded. If the insulation is broken, terminal A of the circuit will pick up a ground, lighting the strip-error indicator, and the machine stops. Also,

if a wire breaks during stringing, V_{cc} is removed from point A. This causes the machine to halt and lights the broken indicator-wire on the appropriate head.

The solder-error-detection circuit of Fig. 9 checks if the ground tied to the heating tool is carried through to point B. If there is no ground, the solder-error indicator lights, and the machine stops soldering. Possible causes of failure that will open up the ground to point B could be a defective solder head, lack of solder, and a missing broken wire. If the solder cycle does not end before a predetermined period set by the operator, a solder-time-out error indicator lights up on the center console, and the machine stops.

Assessing capabilities

Among the advantages Solder-Wrap boasts over the industry leader, Wire-Wrap, are double the packaging volume, lower production costs, self-testing, and lack of cold-flow short circuits (shorts caused when the insulation flows away from wires bearing against pins under pressure). With the newer process, 34 boards can be packaged in a 19-inch rack, which can accept only 13 to 17 Wire-Wrap boards.

A solder-wrapped board costs only 30% to 50% as much as a wire-wrapped board, depending on the type of socket used with the latter. The wire used in the older process is 40 to 120 times more expensive than the magnet wire used in solder-wrapping. The 30-gauge Kynar is $4 per 1,000 feet, and 30-gauge Milene is $12 per 1,000 feet; in contrast, the magnet wire is only 9 cents per 1,000 feet.

For low-to-medium-scale runs, solder-wrapped boards are much cheaper to produce than two-sided boards (Table 2). Since solder-wrapped boards are equivalent to 8- to 10-layer boards, their advantages over two-sided boards are applicable also to multilayer boards. Solder-Wrap costs 72% for front-end tooling, and the new board designs can be turned around in two weeks—only a third as long as the older method requires.

For engineering changes, the newer system does not require artwork, and existing boards can be reworked in the field with manual Solder-Wrap tools. In addition, Solder-Wrap provides twice as much surface density as two-sided boards, and the shortness of leads brings about better operating characteristics in high-speed-logic applications.

The capital investment required for Multiwire is higher than Solder-Wrap requires, and the latter has lower production costs. However, the surface and volume packing densities of the two techniques are comparable. The biggest advantage Solder-Wrap has over Multiwire is the capability to make changes either in production or for prototyping. The only way to make a single board with the Multiwire process is to make it on the automatic equipment.

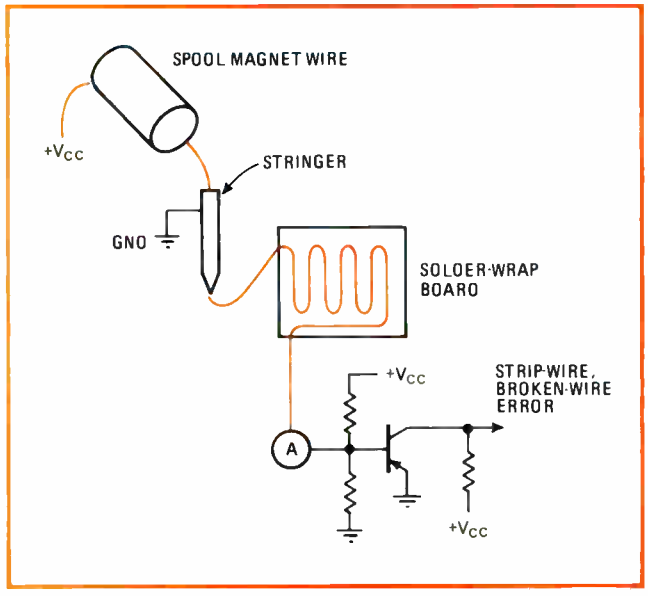
Solder-Wrap is 30% to 50% more cost-effective than stitch-welding, and packing volume is higher because of the lower profile. What's more, stitch-welding machines are semiautomatic—not fully automatic.

Economizing with Solder-Wrap

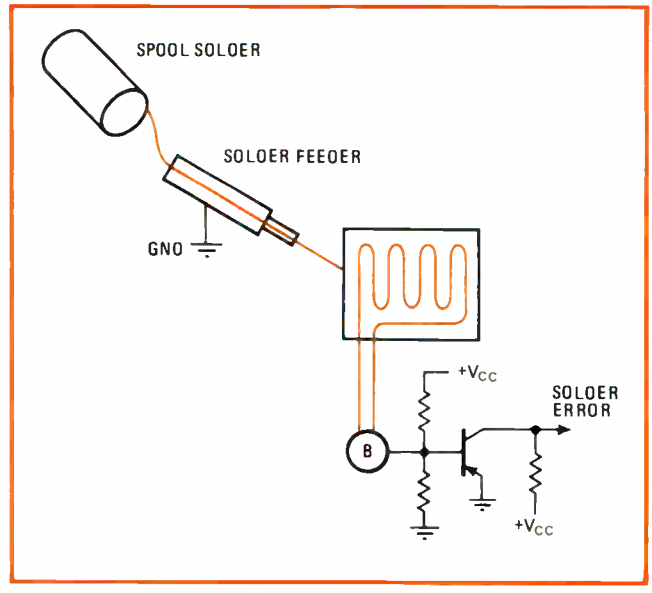
It is instructive to calculate the cost of 25 circuit boards to be manually solder-wrapped using a total of 100 16-pin sockets. Typically, the cost for a set of boards without sockets would be $77, cost for the boards with profile sockets would be $112, and cost for boards using P/B (pin-in board) sockets would be $170.

The average cost to manually Solder-Wrap the set of boards would be about 10 cents per wire, or $100 for 1,000 wires. To this must be added the comparative total costs of the system, which would thus be: socketless boards, a total of $177, low-profile sockets, $212, and P/B sockets, $270.

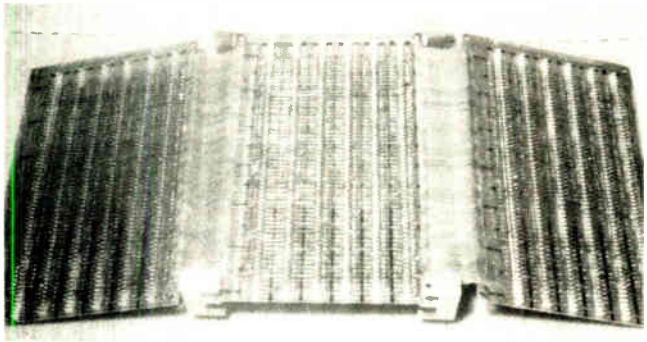
Service costs for automatic wiring of one to four



8. Wiring check. During the wire-stringing cycle, this circuit can detect and indicate either a stripped or broken wire. If terminal A picks up a ground from the stringer, the stripped-wire indicator lights. If the terminal senses loss of V_{cc}, the broken-wire indicator lights.



9. Solder error. Malfunctions such as solder-head failure, lack of solder, and missing or broken wires are sensed by this circuit. Any of these errors disconnects terminal A from ground, activating the circuit. This, in turn, lights up an indicator and stops the machine.



10. Fan-Fold. In the Fan-Fold configuration, the three solder-wrapped boards are fastened side by side by sheets of Mylar, and all card-to-card connections are automatically wired together. The flexible sheets and boards can be folded into a compact packet that does not have either backplane or printed-circuit connectors.

TABLE 2: COMPARATIVE SYSTEM COST

Number of systems	Cost per system (Solder-Wrap)	Cost per system (two-sided)
5	$ 1,626	$ 8,131
10	813	4,065
25	325	1,626
50	163	813
100	81	406
200	41	203
500	16	81
1,000	8	40

boards, on the other hand, vary from 4 to 8 cents a wire, depending on the number of boards. For 100,000 to 10 million wires, prices vary from 7 to 3 cents per wire.

To compare the packaging cost of Solder-Wrap with two-sided pc boards, consider a system with a 48-square-inch backplane that holds multiple circuit cards mating with connectors on the backplane. To handle the 900 16-pin ICs, Solder-Wrap requires 12 circuit boards, while the two-sided-pc-board approach requires 23 units. In addition, the Solder-Wrap backplane requires 975 wires, whereas the backplane for the conventional boards requires 1,863 wires.

Nonrecurring engineering costs for both approaches over a range of system quantities are listed in Table 2. The total nonrecurring engineering cost for one system, consisting of software plus engineering changes, for the automatic wiring approach, comes to $8,130 compared with $40,656 for the pc-board method. Recurring costs for this system would be $507 for two-sided boards and $493 for Solder-Wrap. For even 1,000 systems, total Solder-Wrap system costs are lower than they are for two-sided boards, but the biggest savings are at five systems. At the 200 level, system costs for the two-sided packaging start to close in on Solder-Wrap.

Applying Solder-Wrap

United uses its model 400s in its three contract-wiring centers in Dallas and Longview, Texas, and Santa Ana, Calif. The company plans to open more of these centers. United also plans to develop an automatic machine to handle twisted pairs.

A large computer system made by Scientific Machines Corp., Dallas, is completely wired by the new process. The system uses TTL/Schottky logic. SMC has developed software that contains the board's wire list and generates the logic diagram, timing diagram, board artwork, and parts layout, and wire routing for the automatic solder-wrapping system.

Corporation 1171, Dallas, and United Manufacturing have developed a Solder-Wrap Fan-Fold process on a microprocessor system for controlling drug-store inventories. This Fan-Fold package can handle more than 600 16-pin ICs in a package of 6 by 6 by 16 in. This packaging method eliminates the need for backplanes and edge-board connectors.

In the Fan-Fold package, solder-wrapped boards are tied together by rectangular sheets of Mylar. Typically, the Mylar sheet would be fastened from the right side of one board to the left side of the adjacent board as shown in Fig. 10. Then, all adjacent card-to-card connections are automatically wired together, with all these new wires lying across the Mylar sheet. These wires are then sealed into the Mylar with an adhesive. The resulting package of boards with alternating Mylar interconnects can be folded (like a map) into an extremely small space.

Corporation 1171's package houses the system's memory, processor, floppy-disk controller, switching power supply, and interfaces for the printer, cathode-ray tube, and keyboard. All of this circuitry is contained on six Solder-Wrap boards connected by the Mylar sheets with wires embedded in them. The Fan-Fold package has a low production cost, there are no limitations on I/O signals from board to board, and elimination of backplane connectors results in high reliability.

Innovated Systems, Dallas, Texas, is using Solder-Wrap in traffic-control systems; IBM, Austin, Texas, on typewriter-production test equipment; Texas Instruments, Dallas, in communications systems, and National Computer Systems, Houston, in a high-speed computer system. Also making use of the system are Motorola Semiconductor, Phoenix, Ariz., and Western Geophysical, Houston.

Solder-Wrap need not be limited to making circuit boards. Wiring of electrostatic printer heads looks like an attractive possibility. Right now, all terminations of the printer heads are being wired manually. More than 4,000 No. 30 and 37 gauge wires are being connected manually, thereby incurring high labor costs for each head. A Solder-Wrap machine could cut costs by automating the manufacturing process, since it routinely handles wires of this size.

Another special application involves automatically applying solder in tight packages such as digital watches or heart pacemakers. Some companies have tried solder preforms and infrared heating, but leaves an excess amount of touch-up and repair. A Solder-Wrap machine could solve the problem by being programmed to automatically add solder to selected locations. □

IEEE officials looking for 25,000 to see New York edition of annual show and convention after 1976's successful inaugural of alternating-sites policy

Electro77 in New York means business! That, complete with exclamation point, is the theme of the Institute of Electrical and Electronic Engineers' show and convention this year. It is also the hope.

There is solid foundation for such hope. For example, while attendance at Electro76 in Boston—the first of the shows to be held under the new format of alternating locations between Boston and New York—fell well short of the expected 25,000, it was still better than 1975's total of 20,471. Officials are again predicting 25,000 will push through the turnstiles at the New York Coliseum during the three days of the show, April 19 through 21, if weather and other factors cooperate. That would be the highest attendance figure for a major IEEE electronics convention in New York in five years.

Perhaps more important, exhibit space on two floors of the Coliseum looks to be sold out. With 511 booths available—10% more than in Boston—that would mean about 300 exhibitors eager to make their pitches.

But the silver lining does have a cloud. While there were some notable returnees to the exhibitors' list in Boston, some are unwilling to come to New York because of distaste for the city, because the show attracts the wrong audience, or because Electro is too regional.

Two firms in the New York area, for instance, react quite differently to Electro's site. At RCA Corp.'s Solid State division in Somerville, N. J., the attitude is positive. Absent from the annual IEEE get-together for several years, RCA is returning in 1977 to show its microprocessor wares. "There's a need for us to reach the broadest possible audience," maintains Richard A. Santilli, division vice president for sales and international operations, "and Electro is the place to do it."

But the return to America's largest city "has a considerable bearing" on the withdrawal from Electro by Weston Instruments Inc. of Newark, N. J. Robert Bilby, marketing services manager, says, "The attendant problems of a show in New York, the problems of moving in and out, and the

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general climate are reasons for our not being there." Weston skipped the former Intercon for several years but returned last year.

But the major reasons why companies attend or stay away from Electro still have to do with business. Take MOS Technology Inc. of Norristown, Pa. It was at Boston last year with calculators and microprocessors for industrial markets. But the firm's "thrust this year and for the foreseeable future is taking us deeper into the consumer field," says marketing vice president Julius Hertsch, "and the IEEE is more of an industrial electronics show." Exit MOS Technology.

A similar decision was made at Litton Industries' Monroe Calculator Co. in Morris Plains, N. J., where William O'Neill, special promotions manager, explains that "our products [business calculators] just don't fit in with the category of products that IEEE features." But Mostek Corp. of Carrollton, Texas, which felt "crunched up" last year, has built and is taking its own booth to New York to give it more space.

The regional nature of Electro is the reason Hewlett-Packard Co. of Palo Alto, Calif., is cutting down from Boston's 10 booths to four. "More and more, we have seen that attendance at U. S. electronics trade shows is mainly from the immediate region," says Alfred P. Oliverio, marketing vice president. Even a New York area firm concurs. At the Dumont Electronics Corp. in Clifton, N.J., William Aidkes, marketing manager for the tube divisions at the Thomson-CSF subsidiary, explains his firm's absence by saying, "It's too local a show."

Overall, Electro officials say that components makers still dominate the exhibit booths, continuing the strong comeback they began in 1975.

Program: products and people. If the rows of booths at the Coliseum are Electro77's body, then the technical sessions at the Hotel Americana are its mind. And Electro this year is broad-minded, with the professional program covering a wide and exciting range of subjects concerning products, markets, and engineers as people trying to survive.

Microprocessors again are the favorite subject of the program organizers, with no fewer than a half-dozen sessions at least touching on them. There is also a raft of sessions ranging across the design engineer's spectrum, from power supplies to bubble memories.

The ubiquitous microcomputer. Designers who are confused by the proliferation of low-end microprocessor systems will want to check out session 17 on single-chip microcomputers. The stress here is on choosing the appropriate low-end system for cost-sensitive high-volume controller and consumer applications. The session, notes chairman Alan Weissberger of Signetics Corp. in Sunnyvale, Calif., will address both facets of these systems—their use as stand-alone controllers or with other processors in a distributed configuration.

The speakers Weissberger has lined up are noteworthy: Don Phillips from Intel Corp., Santa Clara, Calif.; Van Lewing from Fairchild Micro Systems, San Jose, Calif.; John Bryant from Texas Instruments Inc., Houston, Texas; and Bruce Kinney from Rockwell Microelectronics, Anaheim, Calif. After delivering their talks, these speakers will be joined by other industry spokesmen, including Bob Schweitzer of Mostek Corp. in Carrollton, Texas, for a panel session in which the audience will be encouraged to participate. With inputs from both the audience and the panel members, Weissberger hopes to get a fix on the optimum direction for microprocessor development—toward special-purpose architecture or towards replicas of existing popular minicomputers on a chip.

The other side of the coin—high-end microprocessor systems—will get an airing in session 38, "Applications of Bit-sliced Microprocessors." "A bit-sliced microprocessor," explains chairman Peter Jessell of the Massachusetts Institute of Technology in Cambridge, "is a component for building a computer, rather than a complete computer on a chip." It is only one member of a

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Microprocessors are very much on everyone's mind, so Electro77 will devote six sessions to covering everything from low-end, single-chip affairs to the high-end, bit-sliced versions

family of chips that is put together, along with appropriate control software, to implement a customized special-purpose computer. The advantages over simple single-chip microcomputers, points out Jessell, are high speed and a wide instruction set that is geared specifically to a particular application.

Besides a talk from Jessell that will cover present chips and future trends, the session offers speakers who are themselves computer designers, as opposed to microprocessor vendors. The design examples will include: a high-speed logic analyzer made by Western Electric Engineering Research Center, Princeton, N.J.; a communications processor for digital data from GTE Sylvania Co., Needham, Mass.; a speech analyzer and synthesizer built by MIT; and a 16-bit computer for military applications from Raytheon Co.'s Electromagnetic Systems division in Goleta, Calif.

Taking a good, soft look. But what about microcomputer software? That is covered in session 16, "Software Strategies for Successful Microcomputer Programming," which proceeds from discussion of a time-sharing system (when not to use a microprocessor) through device selection, support, and prototyping, and finally to the latest trends in software.

Chairman L. A. Solomon of RCA's Solid State division says the session should be significant in that the time is right for refinement—the anxious overengineering of the microprocessor is giving way to an era of sophisticated yet practical design. Though most of the session is aimed at the microprocessor design engineer, it devotes enough time to what to use and when, efficiency of programming, and software development to attract the interest of project people and management in the companies manufacturing microprocessors or just using them in house.

The cost of servicing multitudes of microprocessor-based products is worrying manufacturers. Session 11, led by Steve Swerling of Tektronix Inc., Beaverton, Ore., addresses the problem with three papers, including one on computer-based techniques for predicting the service costs.

Leading off the session is "Designing Microcomputer-Based Systems for Reliability, Serviceability and Maintainability," by Charles A. Christy and Jane G. Morse of Arthur D. Little Inc., Cambridge, Mass. The paper centers on designing software components in read-only memories that can be easily replaced piecemeal in the field. Christy points out that present microprocessor development systems, with in-circuit emulation capabilities, could be used to identify such failed software components.

Roy Pierce of Xerox Inc. in Dallas will report on a method for estimating life-cycle costs for a system. He will present a computerized model of the economic factors involved, in the form of 34 equations that can be programmed into a computer. The set of equations takes account of such factors as parts costs, mean service-call duration, inventory spares in the distribution pipeline, and even taxes.

Hans Nadig will discuss Hewlett-Packard's new HP 5004A signature analyzer [*Electronics*, March 3, p. 89]. Although microprocessor-based equipment must be specially designed to be serviced by the signature analyzer, the benefits are easier servicing right down to the component level.

By design. As for circuit design in general, session 20, "Update on Computer-Aided Circuit Design," offers a useful software overview. It covers such aspects as network theory (esoteric math), selection of a CAD program, and marketing considerations. While most of these discussions are aimed at either the design engineers or the project managers who decide on how to use CAD, the most burning issue may be the marketing ones—a dispute has arisen on whether to develop in house, or go time-shared and play off what is learned from the experience of others.

Session 37, "A/d and d/a Converter Applications," also has to do with design. Data converters are quickly becoming as integral a part of analog signal processing as operational amplifiers. However, not all analog-circuit designers know how to use them to their best advantage, particularly in the newer monolithic versions. To those who do not, session 37 will lend a welcome helping hand.

According to the session organizer, Michael Trimko of Analog Devices Inc. in Wilmington, Mass., the papers concentrate on the latest devices and the newest circuit techniques,

For circuit designers, there is a discussion of computer-aided design in a software overview, as well as a session offering tips on how to use the newer monolithic data converters

emphasizing "cookbook applications that someone can just take and use."

Talking through glass. With fiber-optic communications capturing much of the spotlight recently, it seemed appropriate to Electro's organizers to include a session on the progress in the field. Tingye Li, head of the transmission and circuits research department at Bell Laboratories, believes session 29 will for the first time supply a general audience with talks on recent and ongoing field trials.

Two papers will be given by members of the Bell Labs team who were involved with the lab's recent field experiments. Joseph Mullins will discuss the ongoing field trials within the Bell System, emphasizing the progress made toward producing practical systems for handling transmission in the telephone plant. Morton Schwartz from Norcross, Ga., the site of the trials, will focus on the cables and connectors that were used.

G. Holma and T. Meador of the Naval Electronics Laboratory Center, San Diego, will discuss the design of a fiber-optic system initiated by the Navy for the purpose of evaluating fiber optics for internal aircraft communications. Their paper will also present data gathered from testing, installing, and operating the system.

A fourth paper, by S.M. Stone and G.J. Meslener of GTE Laboratories, Waltham, Mass., will touch on the systems aspects of an experimental pulse-code-modulation fiber-optic communication system that operates at 100 megabits per second with standard NTSC color TV signals over a 1-kilometer link.

Other communications papers. For those interested in antennas, Electro77 has two sessions.

For session 2, Lewis G. McCoy of the American Radio Relay League Inc., Newington, Conn., has assembled four papers on the trends in hf, vhf, and uhf antenna design. They deal with optimizing ground radial systems for vertical antennas, the design of a circularly polarized quadrifilar antenna that produces a hemispheric radiation pattern, a vertical four-element square array with a 97° beamwidth that can be switched to provide 360° coverage, and some insight into the "Quagi" antenna.

Chairman McCoy thinks the "Quagi" (quad plus Yagi) is perhaps the first new, really simple antenna to come along in some time. The hybrid design substitutes full-wave (quad) elements for the conventional Yagi antenna and results in improved impedance matching and higher gain.

Session 26 concentrates on the design and field testing of circularly polarized transmitting antennas that improve the quality of received TV pictures. Until now TV transmitting antennas have either been horizontally polarized, as in the U. S., or vertically polarized, as in most of the rest of the world. The session is timely since an order from the Federal Communications Commission authorizing installation of circularly polarized antennas by broadcast stations is expected within several weeks of the session.

Bubbles and couplings. System designers interested in the prospects of charge-coupled devices and magnetic bubbles for serial memory design should not miss sessions 12 (on bubbles) and 19 (on CCDs).

For small mass-storage systems, J. Egil Juliussen of Texas Instruments compares bubbles with CCDs, floppy disks, and semiconductor memories. Juliussen's conclusion: "Bubbles will be a major storage-memory technology by 1980." While he sees increasing competition in price and performance among these approaches for many large-computer applications, his analysis shows that the growth of the microprocessor will create a need for a companion small mass-storage system that can best be built by employing bubble technology.

The bubble session also includes an update by Wright-Patterson specialists Buvinger and Cummins on bubble technology for the military. Two major programs are discussed—the TI bubble memory being built for the Air Force at Wright-Patterson, and the Rockwell bubble memory for NASA at Langley.

TI is building 128,000-bit bubble chips into 2-megabit modules that will have a data input/output rate of 2 megahertz. From these modules TI will construct prototypes of a 16-megabit disk drum system and two 100-Mb recorder systems.

Rockwell's 50-Mb data recorder is based on

The impact of CCDs and magnetic bubbles on serial-memory design will be assessed, along with the need for more and different testing of printed-circuit boards

4-micrometer bubble technology that was developed in 1975. The paper describes how its 100-kilobit bubble chips have a long continuous loop design as well as a nonvolatility that is achieved by data replication.

A good systems analysis of CCDs for computer memory is to be given by A. V. Pohm of Iowa State University. He treats the impact of the technology on both large and small computer systems. For the large computing systems, where throughput is limited by memory speed, Pohm sees the faster CCDs replacing disk and drum paging formats, despite the drawback of some additional expense and the undoubted inconvenience of volatility.

Board sessions. Sessions 18, 25, and 32 should be of vital interest to engineers involved in the design, manufacture, and test of complex digital printed-circuit boards.

Says Raymond P. Oberly of IBM Corp., Kingston, N. Y., who will lead session 18, "Too much or too little testing can significantly impact any product. This session emphasizes users' experience with the prediction and/or measurement of pc performance using testing approaches."

In "More Board Test Coverage, Please," Oberly and J. Strenk of IBM Kingston point out that increasing the logic-test coverage of LSI circuit boards does not by itself reduce fallout from manufacturing. Other parameters—among them component count, logic-circuit count, module test, and what percentage of the circuit logic is based on field-effect transistors—must also be accounted for.

A second paper, "In-Circuit Test" by David Fucci and H. Whittemore of Data General Corp., describes how this firm cut its overall digital-board testing costs radically by starting an in-circuit testing step.

Of session 25, chairman Don Allen of Fluke Trendar, Mountain View, Calif., says, "What we're trying to do in these five papers is clear up some of the confusion between microprocessor-device and board-testing criteria, talk about what can or should be done at each of these levels, and what the costs and tradeoffs are."

Session 32, according to chairman James Skilling of GenRad Inc., Concord, Mass., will concentrate on how to test and diagnose faults effectively on complex digital assemblies, particularly those that include LSI components. E. I. Muehldorf of IBM in Manassas, Va., compares the cost benefit of a board designed to be tested by a particular test pattern to that of a board of the same function and components without this design discipline. For instance, for a circuit board with 6,000 gates, relative processing costs differ by about 20%. This increases radically as the number of circuit gates increases.

Government as systems house. The Government's role in developing large and sophisticated electronics systems comes in for attention in session 8, "Government Systems: Awacs, Aegis, Navstar," organized by Leo Young, staff consultant at the Naval Research Laboratories' Electronics division.

The reviews of the Aegis shipboard anti-air-warfare system and the Awacs surveillance, command, and control radar "show what can be achieved in a strictly military environment," says Young. While the Navstar global positioning system is being developed solely with military funds, he adds, "it will have broad appeal because of the large number of commercial spin-off possibilities."

The Navstar paper, to be delivered by Edward Martin of Magnavox Research Laboratories in Torrance, Calif., will detail how "it will be possible for civilian users from any nation to use the system to fix their position three-dimensionally to within an accuracy of 30 feet," says Young. The Aegis paper, which Young says "will be the highlight of the convention," will be given by Rear Adm. Wayne E. Meyer, Aegis project officer at the Naval Sea Systems Command in Washington.

A computer in the house. Finally, Electro is taking appropriate notice of a relatively new phenomenon in the world of electronics—or, more specifically, the world of digital computers. That phenomenon is the hobby or home computer, and the IEEE has devoted two of the 42 sessions at its show to the trend. Session 3 is called "Microcomputers for Fun and Profit" and ranges from the history of the hobby-computer market to the retail possibilities. Speakers include

How hard will EEs be hit by social and political changes? Professional program explores the answers and also offers new tools for managing budgets, colleagues, and subordinates

Robert Wickham of Vantage Research Corp.; Carl Helmers, editor of BYTE magazine, which covers the hobby-computer field; and Paul Terrell, president of Byte Inc., a chain of retail shops unrelated to the magazine.

Session 10, "Home and Hobby Computers," is concerned with the differences and similarities between the two categories. Speakers include Sol Libes, president of the Amateur Computer Group of New Jersey; Michael Lipschutz of Byte Inc.; and Steven Jobs, product manager of Apple Computer Inc. of Palo Alto, Calif. Lipschutz will discuss the need for standards for hardware and software in small computers, while Job expects this year to see the start of the transition from hobby to home computer.

How to get your act together. Just three of the forty-two technical sessions this year will touch on engineering professional development. But their provocativeness should make up for their lack in numbers.

The first of the professional development (Pro-D) sessions, "Future Shock for Engineers," should be better than its title suggests. The main topic is not so much future shock as the impact today's social and political changes on the electrical engineer's performance.

But the truly heady topics in engineering management will be found in session 14, "Tools for Managing Your Career." Well beyond the rah-rah inspirational pap that often parades as career improvement, this session will deal with practical managerial concepts.

For instance, Walter D. Storey, GE Co., Croton-on-Hudson, N.Y., will argue that managers should help plan the careers of their subordinates, not just their own. Peter Argyris, Interdata, Tinton Falls, N. J., will describe how the transactional-analysis (TA) workshops that he conducts at a community college in New Jersey can help engineers learn from each other. Robert W. Blanning of the University of Pennsylvania's Wharton Business School will delve into the mysteries of zero-based budgeting, how it compares to other budgeting techniques, and what its advantages are. Finally, recent techniques on generating new ideas, actually managing creativity, will be reviewed by Richard J. Marsh of Innotech, Norwalk, Conn.

After just one year, it seems that no Electro or Wescon program would be complete without "The Engineer Over 40," led by Harold S. Goldberg, president of Data Precision Corp., Wakefield, Mass. But this year's panel session 42 will be different. "Having convinced the EE that he can get his hand held when he's past 40, now is the time to show him what he can do by himself," Goldberg reports.

Putting one's mind to it. The fact that IEEE is sponsoring an evening session at Electro77 on "The State of the Art in Psychic Research" represents a "coming of age" of the subject to the panel's organizer and chairman, Russell Targ, senior research physicist at Stanford Research Institute. The Wednesday night session, to be keynoted by astronaut Edgar Mitchell, will cover recent successes in "remote viewing" (known to occultists as astral projection), electroencephalograph measurement of paranormal brainwaves, an ESP machine for teaching extra-sensory perception, and Soviet ESP research that focuses on a subject's use of ESP to control others' activities.

Perhaps the most controversial topic is remote viewing. Subjects at SRI and Langley Porter described in words and pictures scenes staged in some cases thousands of miles away. Targ and SRI colleague H.E. Puthoff, who have written a book on psychic research called "Mind Reach," believe all subjects are capable of remote viewing. In fact, he says, "people get better and are able to use it in ordinary ways," for instance, to perceive a car collision farther along the road.

E. C. May, Targ, and Puthoff also will discuss EEG indications of extra-sensory perception of which subjects were not aware. Subjects were connected to the EEG and told a battery-operated light would flash in the eyes of someone in another room. At the time of each flash, their brain activity showed significant changes in the alpha range of 9 to 11 hertz.

Besides giving people a useful tool, says Targ, the ESP research should lead to reassessment of current physics. "There's obviously some kind of activity in the space we live in that the old physics doesn't predict," the Stanford physicist observes.

Four quad op amps diagnose automobile voltage regulator

by John Cyril Hanisko and William Wiseman
Bendix Corp., Engine Control System Group, Troy, Mich.

A quad operational amplifier such as the National LM3900 can serve as the major building block in a tester for automobile voltage regulators. The instrument gives a quick go/no-go indication of regulator operation by determining whether the field coil of the car's alternator is being allowed to conduct at the proper times. Though designed for General Motors regulators, the unit can also test other manufacturers' devices.

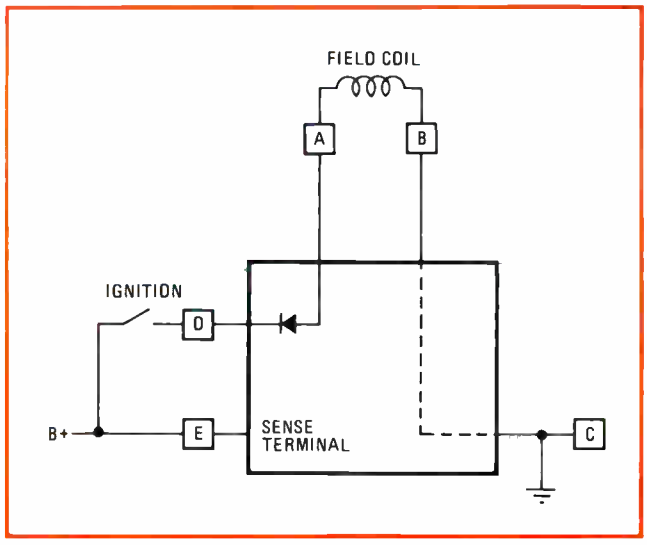
As shown in Fig. 1, the GM regulator module is a five-terminal device. In the car, terminals A and B connect to the alternator field coil, terminal C connects to ground, while terminals D and E connect to the positive side of the battery, D through the ignition switch and E directly.

The tester, which uses four quad op amps, attempts to simulate the conditions the regulator would encounter in actual operation. It is made up of the seven subcircuits shown in Fig. 2. They are:

- A well-regulated 16.5-volt, 4-ampere power supply that drives the regulator as well as the tester circuitry.
- A sense-voltage generator that provides a 16-v/second ramp signal to sense-terminal E of the regulator.
- A sense-voltage comparator that detects when the ramp signal reaches 5 v.
- A field-voltage comparator that meanwhile has checked that current is flowing between terminal A and terminal B.
- A heating circuit that initiates the two tests of regulator operation, at normal and elevated temperatures.
- A window comparator that checks current flow across terminals A and B at one set of ramp-voltage limits during a normal-temperature check and within another set of limits during the elevated-temperature check.
- Finally, logic circuitry that produces the yes/no decision of each test.

Before testing the voltage-regulator module, a 5-ohm piece of Minco thermofoil must be placed across its A and B terminals to simulate the field coil's resistance and also to serve as a module heater during the high-temperature test. Terminal C is grounded, terminal D is directly connected to the power supply, and terminal E is connected to the output of the sense-voltage generator, which produces a 0 – 16.5-v ramp signal.

To check out the device at room temperature, switch S_2 is placed in the "cold test" position, and switch S_3 is depressed and held to trigger the ramp generator. When the ramp voltage is 5 v, op amp A_5 attains the high state (see Fig. 2) and then examines the state of field-voltage comparator A_{16} to determine if the field coil is conducting, as it should be. If it is not, there will be an output at A_{16} that will cause the op amp in the logic circuit, A_{12}, to assume a high state, subsequently latching op amp A_{13} also in a high state that in turn will elicit a fail indication from the red light-emitting diode. A pass indication, if any, will not be given until after the ramp voltage reaches its upper voltage limit of 16.5 v.



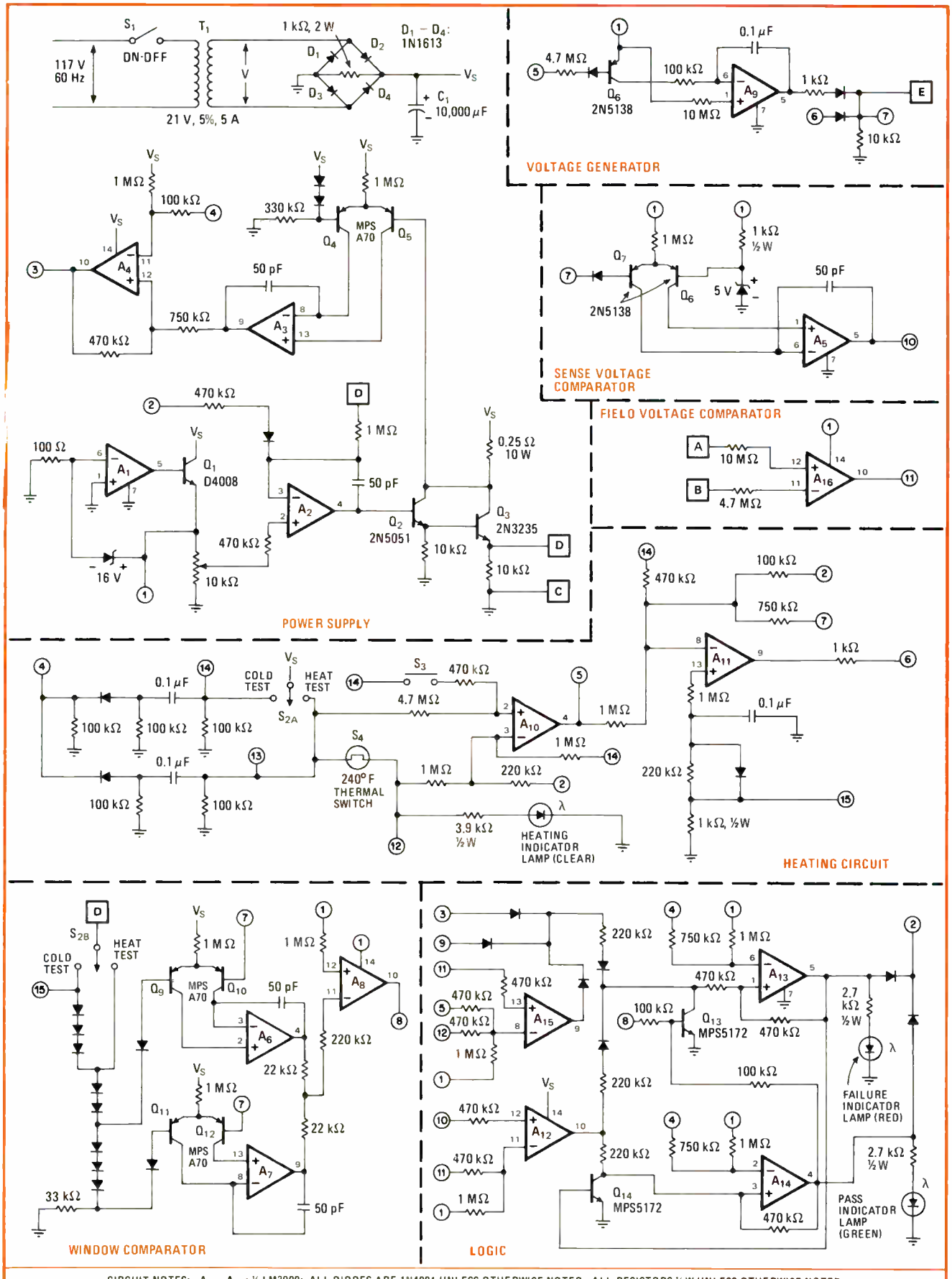
1. Unit under test. General Motors vehicles use five-terminal regulator. Internal diode between terminals A and D prevents battery discharge through field-coil. Terminals D and E have reverse function in circuit that tests module operation (shown in Fig. 2).

Conduction from terminals B to C must, however, be made to cease when the ramp voltage is between 14.0 and 15.5 v since otherwise, in actual operation, the battery would be overcharging. If the module has passed the conditional test where the ramp voltage is 5 v, op amp A_{12} will now be in the low state. Then, when the ramp voltage reaches 14.0 v, op amp A_7 in the window comparator will go low because of the cutoff of Q_{12}. This will cause A_8 to go high, enabling Q_{13} in the logic to enable the + input of A_{14} and also disabling A_{13}. A_{14}'s input stays enabled until the ramp's output exceeds 15.5 v, when Q_{10} is cut off.

If coil conduction ceases, as it should in this voltage window, the resulting low of the A_{16} field-voltage comparator will cause a high A_{12}, and this signal will pass through A_{14}. The green indicator light will show that the test has been passed. A fail indication will occur if the coil continues to conduct, because a rising A_6 will latch the A_{13} op amp.

To perform the heat test, switch S_2 is placed in the "heat test" position. This allows A_{11} to go high and puts its dc voltage on the E terminal of the module. The heat

2. Tester circuit. Circles with common numbers interconnect, as do squares with common letters. Circuit uses 4 quad op amps, 14 transistors, 32 diodes to perform *in situ* testing. Apart from diodes in window comparator, component values are not critical.



CIRCUIT NOTES: $A_1 - A_{16}$: ¼ LM3900; ALL DIODES ARE 1N4001 UNLESS OTHERWISE NOTED; ALL RESISTORS ¼ W UNLESS OTHERWISE NOTED; Q_3 MUST BE ON HEAT SINK

thereupon produced by the thermofoil pushes the module's temperature up to 240°F. At this point, thermal switch S_4 opens, enabling the ramp-voltage generator. The test then proceeds just like the cold test, except that the voltage window is now 12.5 to 14.0 v. Module heating takes approximately 5 minutes and, as in the cold test, power to the module is removed on completion of the test. □

Measure photovoltaic-diode resistance at zero bias

by James A. Kuzdrall
Electronic and Optical Engineering, Candia, N.H.

Now that recent improvements in manufacturing techniques have made nonbiased or photovoltaic photodiodes competitive with externally biased photodiodes, it is worth finding a simple way of determining their quality—and that means finding a simple way of measuring their equivalent noise resistance. To do this, it is necessary to measure the photodiode noise contribution at zero bias because ohmmeters cannot be used.

This circuit determines the resistance accurately—a feat beyond conventional ohmmeters. For, unlike the dominant shot-noise of the biased devices, a nonbiased diode's thermal or Johnson noise is determined by its resistance at zero bias, and an ohmmeter would apply a finite voltage to the diode if it measured the resistance directly.

Shown in the figure, the circuit compares the noise from the photodiode with the noise of a known resistance, so that the device's equivalent noise resistance can be determined from the equation below. Two operational amplifiers are required in a circuit requiring minimal layout consideration.

Operational amplifier A_1, the CA3130, is used as a virtually noiseless preamplifier for input signals. With switch S_1 open, the noise source is that produced by current through feedback resistor R_1. Resistor R_1 is chosen to be equal to the highest diode resistance expected. When the switch is closed, the root-mean-square value of the noise increases because the diode noise adds to the noise already present. The following stage amplifies this signal by a factor of 1,000, and output voltage is approximately 70 millivolts.

The equivalent noise resistance of the diode is:

$$R_x = R_1 \cdot V_o^2/(V_c^2 - V_o^2)$$

where V_o is the output voltage with S_1 open and V_c is the output voltage with S_1 closed. An average-responding voltmeter can be used to make the voltage measurements in place of an rms voltmeter, because, in either case, the ratio of two voltages yields the same number.

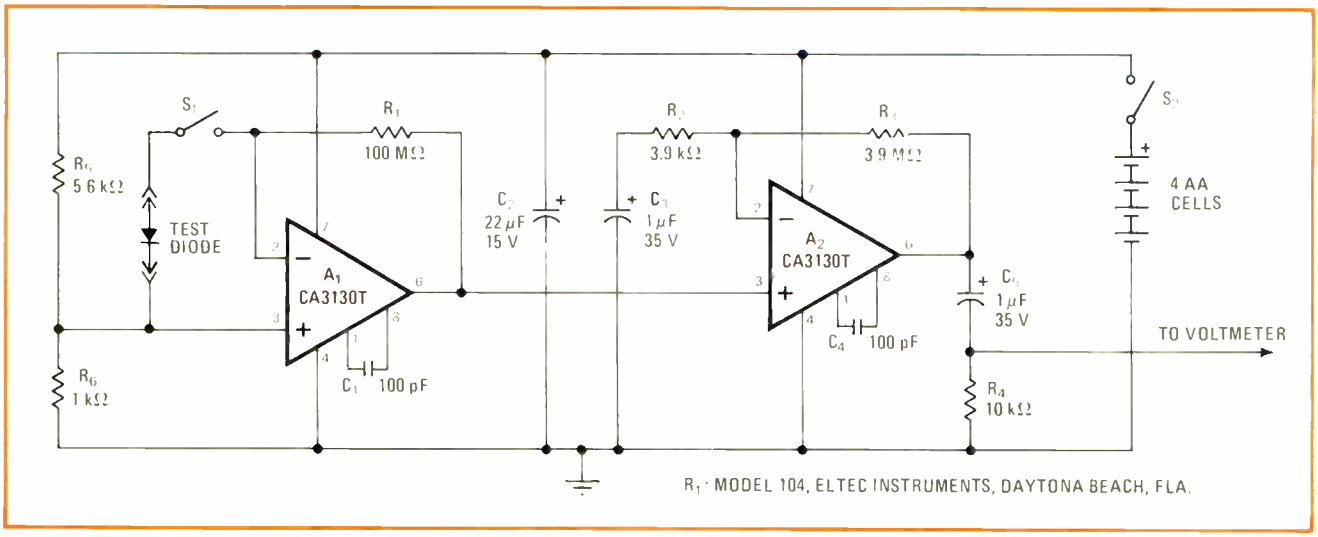
Completed circuits can be checked for proper operation by measuring the output noise levels. A known resistance of 10 or 20 megohms should replace the photodiode for this check. The output noise to be expected is:

$$V_{rms} = (4KTB/R_1 + 4KTB/R_x)^{1/2} \cdot R_1 \cdot G_2$$

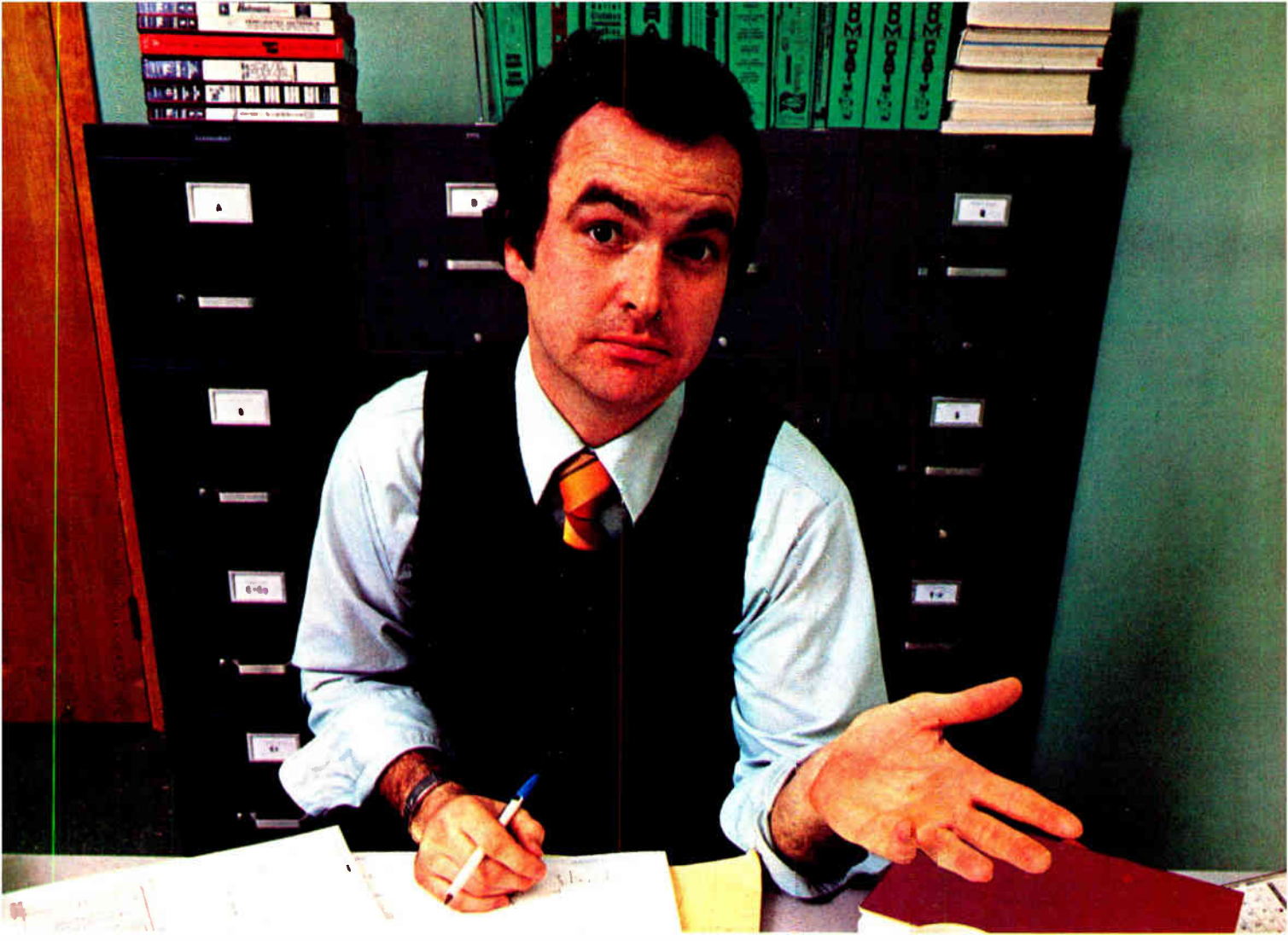
where K is Boltzmann's constant, T is temperature in degrees Kelvin, and B is the bandwidth (approximately 3 kilohertz with a limiting stage gain of 1,000 for G_2). The actual bandwidth can be found by exposing the photodiode to a very small optical signal from a modulated light-emitting diode.

It should be noted that the CA3130 generates noise internally when supply voltages are in the 8-to-11-volt range. That range should therefore be avoided by power sources if the circuit is to operate properly. □

Engineer's notebook is a regular feature in *Electronics*. We invite readers to submit original design shortcuts, calculation aids, measurement and test techniques, and other ideas for saving engineering time or cost. We'll pay $50 for each item published.



Photodiode noise-measurement circuit. Resistor R_1, isolated from metal surfaces to reduce shunt capacitance, has short leads. For very high resistances, inverting node of A_1 is wired on small Teflon standoffs, and S_1 is a permanent-magnet-actuated reed relay.



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Engineer's newsletter

Plug-in modules for Tek TM-500 do special jobs

Upwards of a dozen firms are offering special-purpose plug-in instruments that fit right into the Tektronix TM-500 main frame. Introduced a few years ago, the TM-500 system comprises a group of plug-in instrument modules that slide into the main frame, **enabling users to mix and match modules to come up with an optimum set.** The basic module measures about 2.5 inches wide by 5 in. high by about 12 in. deep.

Among the new plug-ins are: a WWV radio receiver from Spectracom Corp., Penfield, N.Y., ultrasound imagers from Holosonics, Richland, Wash., pulse and word generators from Pulse Instruments Co., San Pedro, Calif., and logic analyzers with hard-copy recording from Scanoptik Inc., Rockville, Md. Other manufacturers are making such specialized units as seismographic equipment, magnetometers, and even equipment for balancing blades in sawmills.

Stop waiting for hard-to-get hi-rel parts

Delivery time for high-reliability semiconductors can be a year or more, because they tend to require extensive special processing and because most orders are for relatively small quantities. It may even take a couple of months just to get a quote from the manufacturer. **To circumvent these delays, you might consider going to a firm that specializes in purchasing hi-rel parts** directly from the semiconductor manufacturers for a large number of various low-volume customers.

Such a central parts contractor, as it's called, winds up dealing in fairly large quantities—large enough to get good service from the semiconductor houses. One of the largest contractors of this sort is DCA Reliability Laboratory, which has headquarters in Sunnyvale, Calif., and local offices throughout the country. Another possibility is Continental Testing Laboratories Inc., Fern Park, Fla.

GI's Minipaks can be a snap to desolder

Soldering General Instruments' Minipak, with solder bumps under all four sides, is easy—but it's not always so easy to desolder this leadless plastic package into which the company puts its chips for electronic games and calculators. Desoldering can especially be a problem if the pc board contains light-emitting-diode displays, which generally have plastic lenses that might be damaged. **The solution is a small hand desoldering tool** made for Minipaks by Nu-Concept Computer Systems Inc., Kollmar, Pa. In use at GI, the tool will be available shortly at a price yet to be set.

Now is the time to brush up on charge transfer

If you're involved in signal processing for sonar or radar systems at frequencies below about 25 megahertz, better start to brush up on your knowledge of charge-transfer devices. **At these frequencies, charge-coupled and bucket-brigade devices look like winners over surface-acoustic-wave filters.** To help you brush up, American University's physics department is offering a three-day course, from August 2 to 4, with an impressive list of lecturers.

The university also is offering three-day courses on infrared focal-plane imaging-array technology and an update of one given last year on CCD solid-state imaging. **Cost of each course is $495, with housing available on campus.** Write Jennifer Murphy at AU's Office of Summer Sessions, Massachusetts and Nebraska Avenues N.W., Washington, D.C., 20016.

Lucinda Mattera

Developed specifically to meet the increasingly stringent safety standards and regulations for electrical and electronic products, General Electric's LEXAN 940 resin provides a new level of performance in flame-retardant materials.

Based on a technological breakthrough, LEXAN 940 resin, both opaque or transparent, offers a UL 94 V-O* rating, an oxygen index of 35 and lower smoke emission. Yet, unlike ordinary flame-retardant plastics, it doesn't sacrifice processability. Melt strength, mold shrinkage and surface appearance are excellent. Forget streaked molded part surfaces.

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You'll find it running Times Square's latest attraction – the new Spectacolor animated sign on the Allied Chemical Building.

The system was developed for Spectacolor by American Sign and Indicator Corporation, using their new Mark 400 Message Center, powered by the LSI-11.

For AS&I's Software Development Group Leader Gary Berg, anything less than the LSI-11 simply wouldn't have been enough.

"In the Mark 400 we wanted a new top-of-the-line controller for our dynamic visual display systems," says Gary. "The computer that runs it had to be powerful enough to handle all our display services – scoreboards, flip discs, LEDs, lamp banks, multiple signs, and our new UNEX displays. But since the Mark 400 also had to be a standard off-the-shelf product, its computer had to come in at a reasonable cost."

For Gary Berg, the LSI-11 was the only answer: "There is simply no other computer that can touch it in terms of the amount of computing power you get for the money."

Another thing that attracted Gary was the LSI-11's ease of programming. "We use assembly-level language for its greater speed and to conserve core. And, for this application, we found the LSI-11's assembler as easy to use as high-level languages."

Gary Berg, Software Development Group Leader at AS&I, Spokane, Washington.

AS&I has had experience with our large PDP-11's for their own data processing and in custom scoreboard applications at Tampa Bay, Florida, and Pontiac, Michigan. And according to Gary Berg, "Being able to use the same software on this full range of computers makes the LSI-11 the clear favorite for us."

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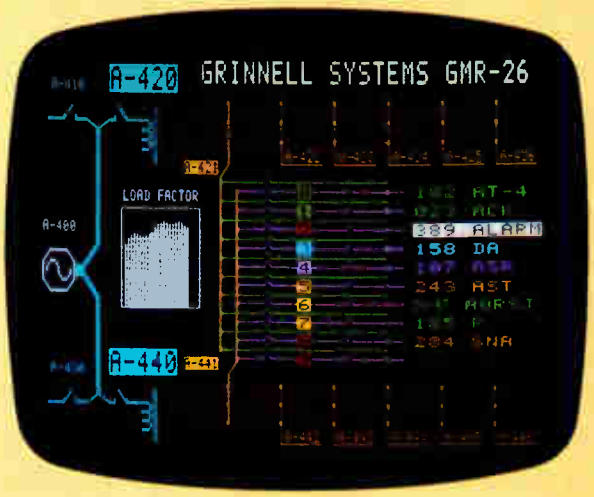

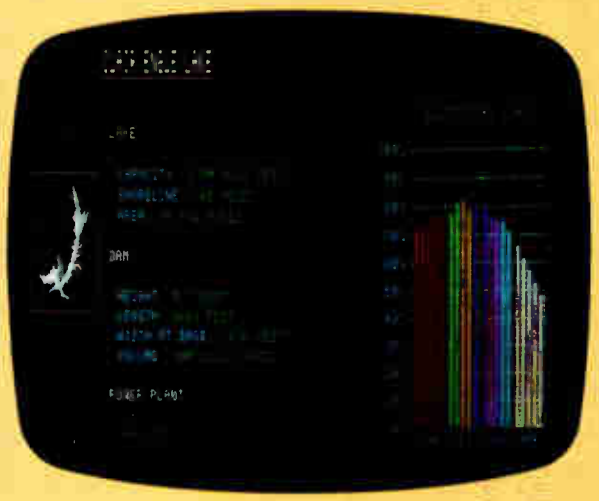

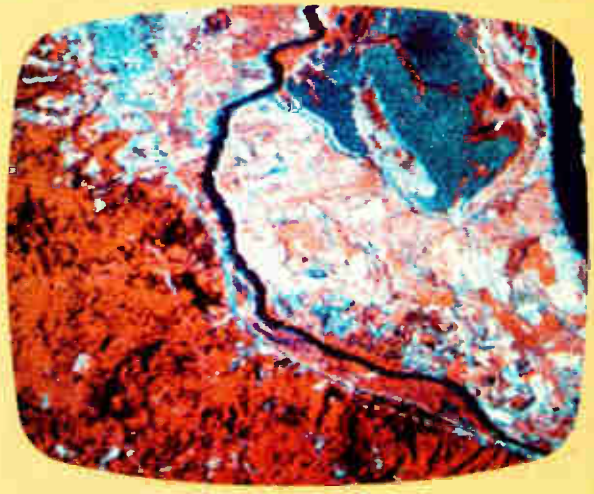

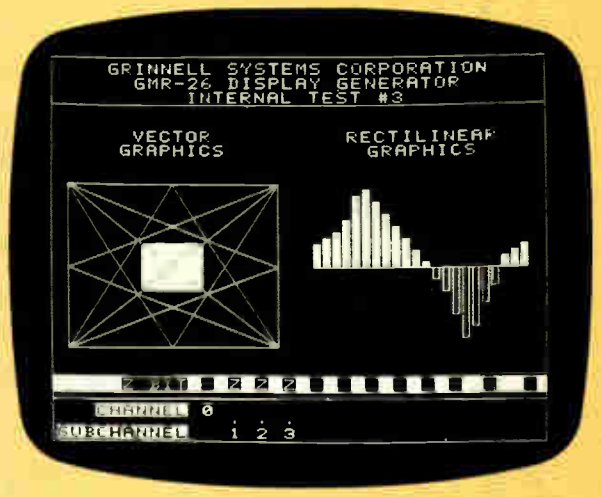

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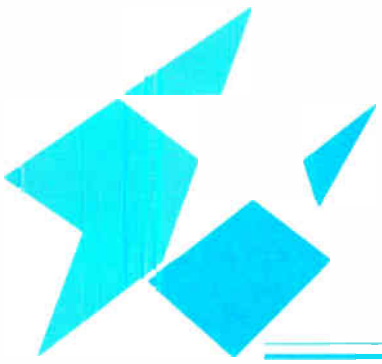


Electro77

On April 19, when the IEEE's annual show opens again in New York after starting its every-other-year alternation with Boston last year, visitors to the New York Coliseum will have their first view of a host of technologically significant innovations.

Programmable exerciser/tester checks IEEE interface and compatible instruments

The growing acceptance of the IEEE 488-1975 standard interface among instrument makers has created a need for one-package programmable testers to replace hardwired, manual, or breadboard setups. In response, Interface Technology has introduced the programmable RS-432-1B exerciser/tester that not only checks out IEEE-interface circuitry, but adds another useful function—control of interface-compatible instruments.

Explains Stanley P. Kubota, manager of sales and marketing: "It allows a user to control and exercise any IEEE-compatible instrument or subsystem, in addition to the interface circuitry." Other IEEE-compatible testers serve as passive bus monitors for checking only the interface-bus function itself, but, Kubota says, "getting out to the device itself in real time" opens up applications in testing and inspection.

Called the microprocessor-controlled data and timing generator, the RS-432-1B stimulates bus-compatible interfaces with required IEEE signal sequences. Visual monitoring is possible in a single-step mode, or the test rate can be specified up to the full dynamic bus speed of about 1 megahertz. Other capabilities include generating repetitive test patterns of loops and setting up the transfer of variable data parameters to the interface and instruments, all of which may be selected by the operator.

Memory is provided in the tester to store and transmit up to 512 bytes of data relating to performance of the device being tested. The microprocessor part of the RS-432-1B executes complete instructions at a 200-nanosecond rate.

Along with the basic IEEE exerciser program, the tester lets a user vary his instructions without changing an entire high-level-language message subroutine. Kubota says this ability to control interface and end-device testing with individual bus signals is the key to an "engineer-oriented" tester. "He is therefore dealing in his own language, in a form normally employed in testing, and does not have to learn the intricacies of a computer language."

In its basic configuration, the RS-432-1B includes: enclosure, microprocessor section, 256-word program memory, 256-word-by-16-bit word generator, standard IEEE-exerciser program and output register, and all associated documentation. A light-emitting-diode readout displays bus control and data, along with program and word memory and contents of address registers.

The basic price is $7,995, with a delivery time of eight to 10 weeks. Available options are a larger memory, card reader, and an interface allowing peripheral loading.

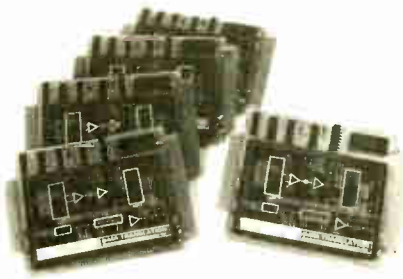
Interface Technology, 852 North Commings Rd., Covina, Calif. 91724. Phone (213) 966-1718 [361]

Data system acquires 12 bits

Broadening its line of microcomputer data-acquisition systems and analog interface products still further, Data Translation Inc. is introducing its DT1723, a plug-compatible data-acquisition system for the National Semiconductor PACE microcomputer application-card series. The company also offers data-acquisition systems or analog-interface products for National's IMP and PACE development systems, Intel's SBC series, Process Control Systems' Superpak, Computer Automation's LSI 2 and 3, Zilog's MCB systems, and Digital Equipment Corp.'s LSI-11

Paul Severino, Data Translation's

New products



director of computer products, says that the DT1723 offers 16 single-ended or eight differential channels. The complete front end contains a multiplexer that is protected from overvoltages, a high-input-impedance instrumentation amplifier, fast sample-and-hold, and an analog-to-digital converter with 12-bit resolution.

The 1723, priced at $225 in OEM quantities, offers a 35-kilohertz throughput rate as standard, and 100-kHz throughput is available as a $75 option in those quantities. Shielding from electromagnetic and radio-frequency interference in the precision analog circuitry is provided by a steel case that is resistant to noise.

Besides the full 12-bit resolution, the 1723 has an accuracy to ±0.03%, linearity of ½ least significant bit, and temperature stability of ±25 parts per million per °C. The common analog input-signal range of 4 to 20 milliamperes is translated by internal circuitry included on the interface board, which also supplies the standard voltage ranges of ±5 and ±10 volts, and 0 to 100 v.

The unit price is $395, and delivery is from stock.

Data Translation Inc., Booth 1925, 23 Strathmore Rd., Natick, Mass. 01760. Phone (617) 655-3300. [362]

A-d converter runs at 11 MHz

Aimed primarily at color-television applications, the MATV-0811 is an 8-bit 11-megahertz analog-to-digital converter system that includes an input amplifier, a sample-and-hold unit, the encoder itself, and a parallel output latch and driver. The unit has an internal voltage reference and clock. Edward L. Graves, Computer Labs product-line manager for modular products, says the MATV-0811 is the least expensive device in its performance category: it sells for $1,150 in singles and less than $1,000 in hundreds.

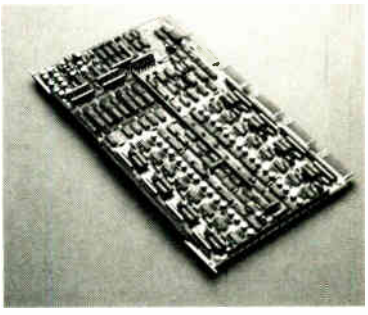
While he sees applications for the new converter in radar-signal processing, medical equipment, and other video systems, Graves is counting on the unit's low cost to greatly expand the already burgeoning commercial-TV market. Video a-d converters are well accepted as components in equipment that performs time-base correction for portable video-tape recorders. Among the new areas he has his eye on, Graves cites frame-store applications in which a disk memory and some digital components (including a-d and d-a converters) would replace a TV camera, a slide projector, and a slide library.

The MATV-0811 is not only inexpensive, it takes up little space and power as well. Its metal case measures only 5.5 by 4.38 by 0.85 inches, and its power consumption is only 8 watts. It weighs less than 10 ounces.

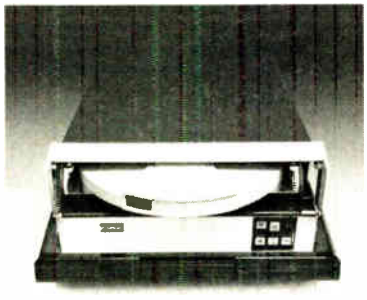
With its aperture uncertainty time of 30 picoseconds and its conversion rate of 11 megahertz, the converter can digitize color-TV signals faster than three times the NTSC standard color subcarrier frequency of 3.58 MHz. For less demanding applications, a similar but slower unit—the MATV-0808—is available. Priced at only $995 in singles, the 0808 is identical to the 0811, except that its upper encode frequency is limited to 8 MHz.

Both units have TTL-compatible digital inputs and outputs and industry-standard analog inputs: 0 to +1 volt at 75 ohms. Dc nonlinearity is less than half a least-significant bit

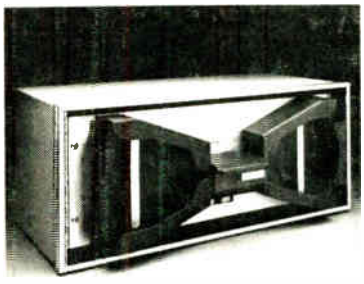
SOMETHING NEW IN MINIPERIPHERALS:



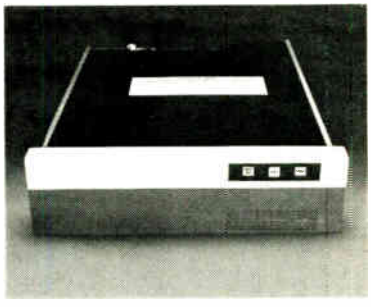
Plessey 8k and 16k plug-in memory modules are fully compatible with your PDP-8, PDP-11, NOVA 2 and NOVA 1200 mini's.



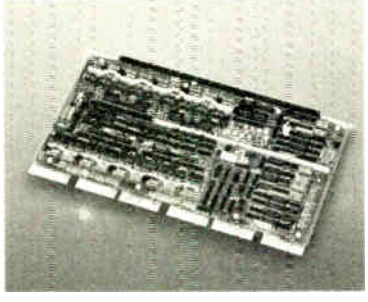
For your PDP-11 and NOVA Series mini's, Plessey can provide plug-in compatible disc systems storing up to 327 megabytes, and 2.5, 5, 10 and 40 megabyte drives.



Try a Plessey reader or reader/perforator as a low cost I/O device with your DEC and Data General mini's, or any of the popular microcomputers.



Plessey 3.23, 6.5 and 13 megabyte disc drive systems are plug-in compatible with your PDP-8/A, E, F and M.



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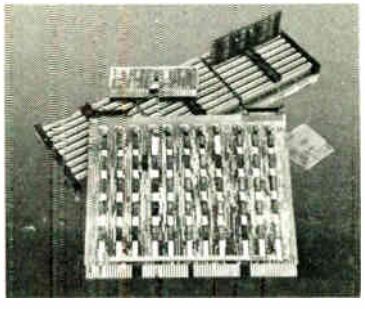

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(0.2%). Ac linearity is specified in terms of the spurious in-band signals generated at an encode rate of 11 MHz. For inputs from dc to 2.5 MHz, the spurs are 50 dB below full scale. For inputs from 2.5 to 5.5 MHz, they are 45 dB down.

Computer Labs Inc., 505 Edwardia Dr., Greensboro, N.C. 27409. Phone Ed Graves at (919) 292-6427 [363]

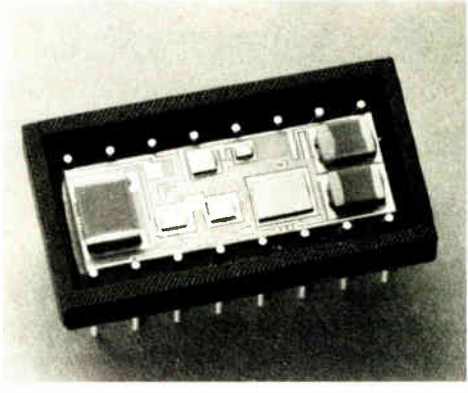
Demodulator is phase sensitive

Likely to lighten the labor of designing military or industrial synchro- or resolver-to-digital converter systems is a hybrid phase-sensitive demodulator being introduced by Micro Networks Corp. Because of its hybrid form, the MN2120 will keep the parts count much lower than in the conventional discrete approach to such systems.

In its 16-pin dual in-line package, the demodulator should find its way into avionics and ship electronics systems, as well as into machine-tool controls to indicate shaft angles and joystick positions, says John Munn, a marketing engineer for the Worcester, Mass., company. Arthur Berg, also a marketing engineer, who participated in the MN2120's design, explains that two of the units are used to demodulate the sine and cosine input signals from a resolver or synchro and convert them into dc voltages. Those voltages are proportional in amplitude to the amplitude of the sine and cosine inputs, and their polarity depends on the relationship between the phase of the sine and cosine and a reference signal. If the sine and reference are in phase, a positive dc output results; if they are 180° out of phase, the dc output is negative.

The MN2120 will convert 400-hertz ac input signals of up to 11.8 volts rms to a proportional dc output of up to ±10 v, with typically less than 6 millivolts of ripple. In a synchro or resolver system, those signals are then sent, Berg says, "to a conventional garden-variety analog-to-digital converter and ultimately to a microprocessor for further processing."

The MN2120 simplifies the process, compared to more conventional discrete implementations, according to Micro Networks. In the latter, the three-phase synchro signals are usually converted to two-phase resolver signals with either a Scott-T transformer or op amps. Then comes signal processing that involves an ac-dc converter, an octant or quadrant-selection network, an up/down counter, a multiplying digital-to-analog converter for each of the sine and cosine signals, another op amp, and a voltage-controlled oscillator to pulse the up/down counter to the correct digital angle. The MN2120 eliminates the need for the expensive multiplying d-a converters, VCO, and



up/down counter.

The unit contains two low-pass filters, an analog switch, and an amplifier. The input signal is rectified by switching. Then the 400-Hz portion of the sine and cosine signals is filtered out, leaving the dc voltages. In a system using the MN2120, the dc voltages would be multiplexed to the a-d converter, digitized, and fed to the microprocessor, which would ultimately supply the angle of the resolver in binary format.

In quantities of 1 to 24, the MN2120, rated at 0° to 70°C, sells for $59. The MN2120H is priced at

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SERIES DC-DC	OUTPUT POWER Watts	OUTPUT VOLTAGE VDC	INPUT VOLTAGE VOC	PRICE RANGE 1 to 9
3150-48	150	5-48	48	595
3100-48	100	5-48	48	495
3100-28	100	5-48	28	495
3050-48	50	5-48	48	425
3050-28	50	5-48	28	425
3025-48	25	5-48	48	395
3025-28	25	5-48	28	395
9525-48	25	5-24	48	250,295,365
9525-28	25	5-24	28	250,295,365
9584	10	5V-5KV	28	210-310
9589	6	5V-5KV	28	190-280
9567	3	5V-5KV	28	180-270
9583	1	5V-3KV	28	200-280
1205	25	5-28	12,24,28,48	198
1000	10	5-24	5,6,12,24,28,48	115,125,140
1600	6	5-24	5,6,12,24,28,48	89,99,109
1300	3	5-24	5,6,12,24,28,48	79,89,99
1100	1	5-24	5,6 12,24,28,48	59,65
HC	max. 3	5-300	5,12,20	49,59,69
HCH, N, E	max. 3	5-300	6,5,12,15,20,24,28	49,59,69
AC-DC				
4200	200	5-48	115	845
4100	100	5-48	115	450
4050	50	5-48	115	425
4025	25	5-48	115	395
4100-3	100	5-48	115	450
4050-3	50	5-48	115	425
4025-3	25	5-48	115	395

Whether you are designing military hardware, space vehicles, communication equipment or other high technology products, the components you select can mean the difference between success or failure in the final product. That's why more and more design engineers are finding the power converters they need in the Tecnetics catalog.

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Circle 137 on reader service card 137

$118 for the full −55° to +125°C range. Delivery is one to four weeks.
Micro Networks Corp., Booth 2511, 324 Clark St., Worcester, Mass. 01606. [364]

Ceramic capacitors get cheaper

Axial-lead monolithic multilayer ceramic capacitors were first put into a molded plastic package by Sprague Electric Co. some 10 years ago, but not much demand for them developed. Now, though, Sprague is getting back into the market with its 292C line at Electro77, says Jack Driscoll, marketing manager for monolithic ceramic capacitors.

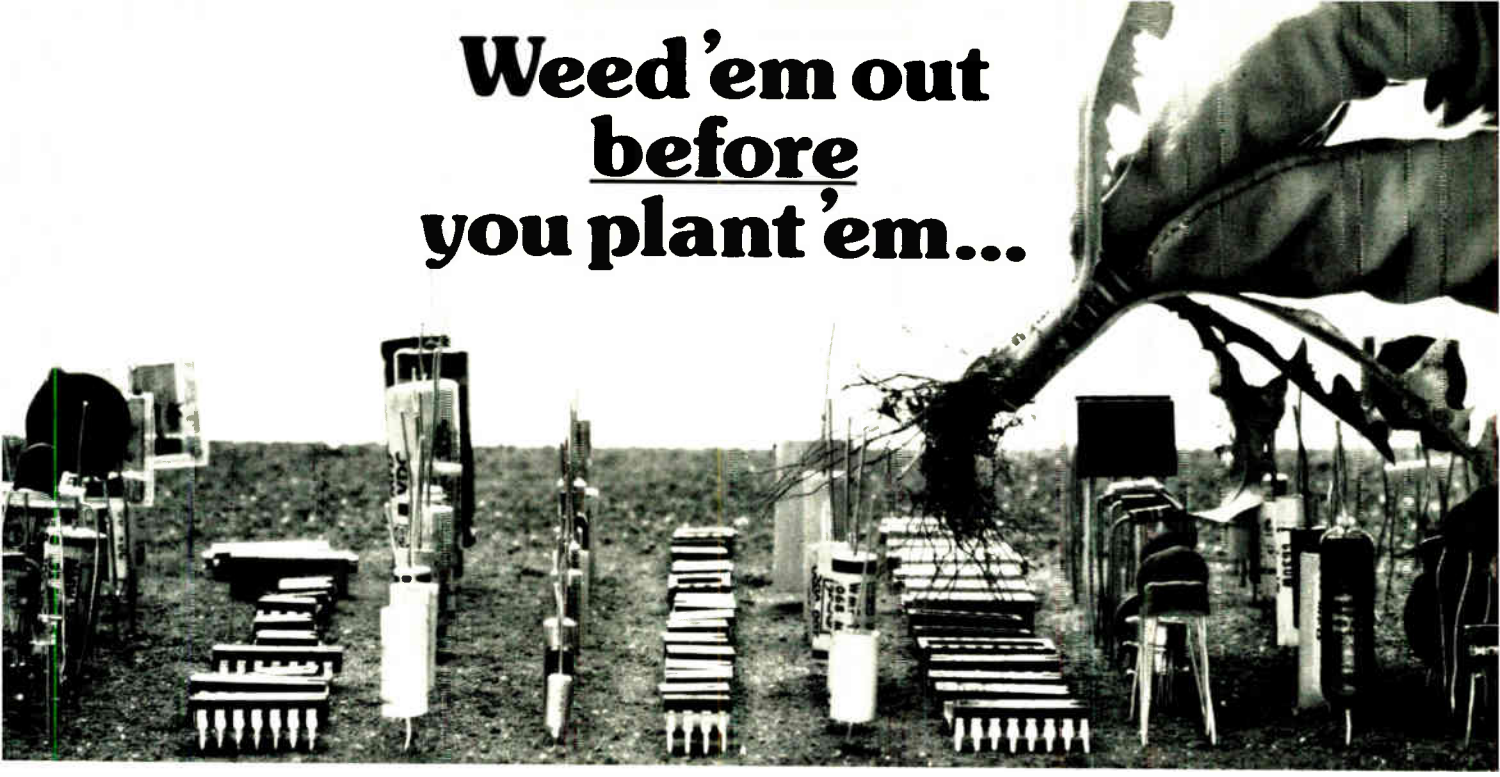
Driscoll says the line will meet recognized industry standards in voltage ratings and capacitance tolerances in three sizes: 0.160 inch long by 0.090 in. in diameter, 0.250 by 0.090 in., and 0.390 by 0.140 in. They are all designed to be packaged on a reel for automatic insertion.

There are three basic temperature

coefficient types in the 292C line. The COG entry has a maximum capacitance change of 0 ±30 parts per million per °C over a −55° to +125°C range. The X7R units have a maximum change of 15% over that same range, and the Z5U parts in the line show a maximum change of −56% to +22% over the range from +10° to +85°C.

Driscoll expects the new line to compete well with axial-lead glass-encapsulated capacitors for two reasons: lower cost, because of the high degree of mechanization at the plant in Wichita Falls, Texas, where

Weed 'em out before you plant 'em...



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New Microprocessor R, L, C Meter with D, Q and ESR
Everything you could want in programmable impedance testing—the Model 296 starting at $4700. Dual 4½-digit displays of C/L and D/Q; dual frequencies of 1 kHz and 120 Hz; wide ranges (C to 200,000 microfarads); 0.1% basic accuracy; autoranging; selectable test voltages; measurement speed as low as 100 milli-seconds; many low cost options such as GPIB interface.

mu'tiple limits and % deviation. Select function, range, voltage, frequency on 24-button panel, or program it remotely.

Linear IC Tester
Model 1234. Devices tested: Monolithic or Hybrid Operational amplifiers. Tests performed: E_{os}, I_{B-}, I_{B+}, DC open loop gain, DC CMRR, oscillation detection. Remarks: 3-digit direct reading digital display which enables GO-NO GO testing. Price: $1265.

Digital IC Tester
Model 1248. Devices tested: 14 and 16 pins. TTL, DTL and CMOS @ 5V. Tests performed: Fixed pattern, dynamic functional test. Performs 2^{20} inspections per test in from 1 to 5 seconds. No comparison with a "good" IC is necessary. 4-digit display gives absolute test results. Can also be used to check continuity of resistor network. Price: $725.

Digital IC Tester
Model 1249. Devices tested: TTL, DTL @ 5V, HTL @ 15V, CMOS @ 5V, 10V, 15V. Tests performed: Same as 1248. Interfaces with manual and automatic handlers. Multiple voltages for CMOS. Price: $1325.

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Circle 139 on reader service card

they're produced, and their proprietary formulation. Sprague calls it MFT, for modified formulation technology, and it is known to contain less palladium-silver than competitive units, allowing additional cost reduction.

All Driscoll will say about MFT is that it is a glass-reactive ceramic "that enhances reliability while allowing the molded package to be competitively priced with other axial-lead capacitors, such as glass." Prices will range from 7 cents to about $1, depending on the characteristics required. Delivery is 8 to 10 weeks, with some of the more popular ratings available from stock.
Sprague Electric Co., Booths 2524–2531 or 87 Marshall St., North Adams, Mass. 01247. Phone Edward Geissler at (413) 664-4411. [365]

Delay lines are set digitally

Besides being digitally programmable, a new family of miniature delay lines interfaces directly with emitter-coupled-logic circuitry. By selecting the appropriate 3-bit binary code, the user can increase or decrease the delay of these series PDU-108 devices in equal increments.

In all, the family consists of eight models, each providing a different

total delay change and minimum delay increment. Excluding the reference or inherent delay of the units themselves, the total delay time may be 7, 14, 21, 35, 70, 140, 280, or 350 nanoseconds, while the delay incre-

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IRIG tape recording/reproduction was never like this. But then, that's the whole point of SABRE X: pushing back the horizons of *our* technology to help you push back yours. We know your needs. So we've given you still more features, including serial and/or parallel high density electronics, vacuum tape tensioning and modular design. We've made it easy to customize the unit with options ranging from coded computer control, data monitoring and a voice/time code to a tape servo and remote control. We've freed you for virtually unlimited applications, including data reduction, deep space, satellite and space networks, mass data storage and security. We've got your number: SABRE X.

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Springfield, Illinois 62714
TEL (217) 544-6411

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Circle 141 on reader service card

ment may be 1, 2, 3, 5, 10, 20, 40, or 50 ns, respectively.

On the input side, the devices respond to a voltage of −0.980 volt at 0.22 milliampere for a logic 1, and a voltage of −1.65 v at −0.5 microampere for a logic 0. At the output, the units develop a voltage of −0.96 v for logic 1, −1.65 v for logic 0.

These commercial devices have an operating-temperature range of 0°C to 70°C, but may be stored at temperatures from −55°C to +125°C. With a no-load condition, power dissipation is typically 290 milliwatts. The miniature devices measure 0.7 inch long by 0.3 in. wide, so they fit into standard 16-pin dual in-line sockets. Their seated height is 0.3 in.

In quantities of 100, these PDU-108 models are priced at $14 each. Delay increments other than the standard values are available on request.

Data Delay Devices, 253 Crooks Ave., Clifton, N.J. 07011 Phone: (201) 772-1106 [366]

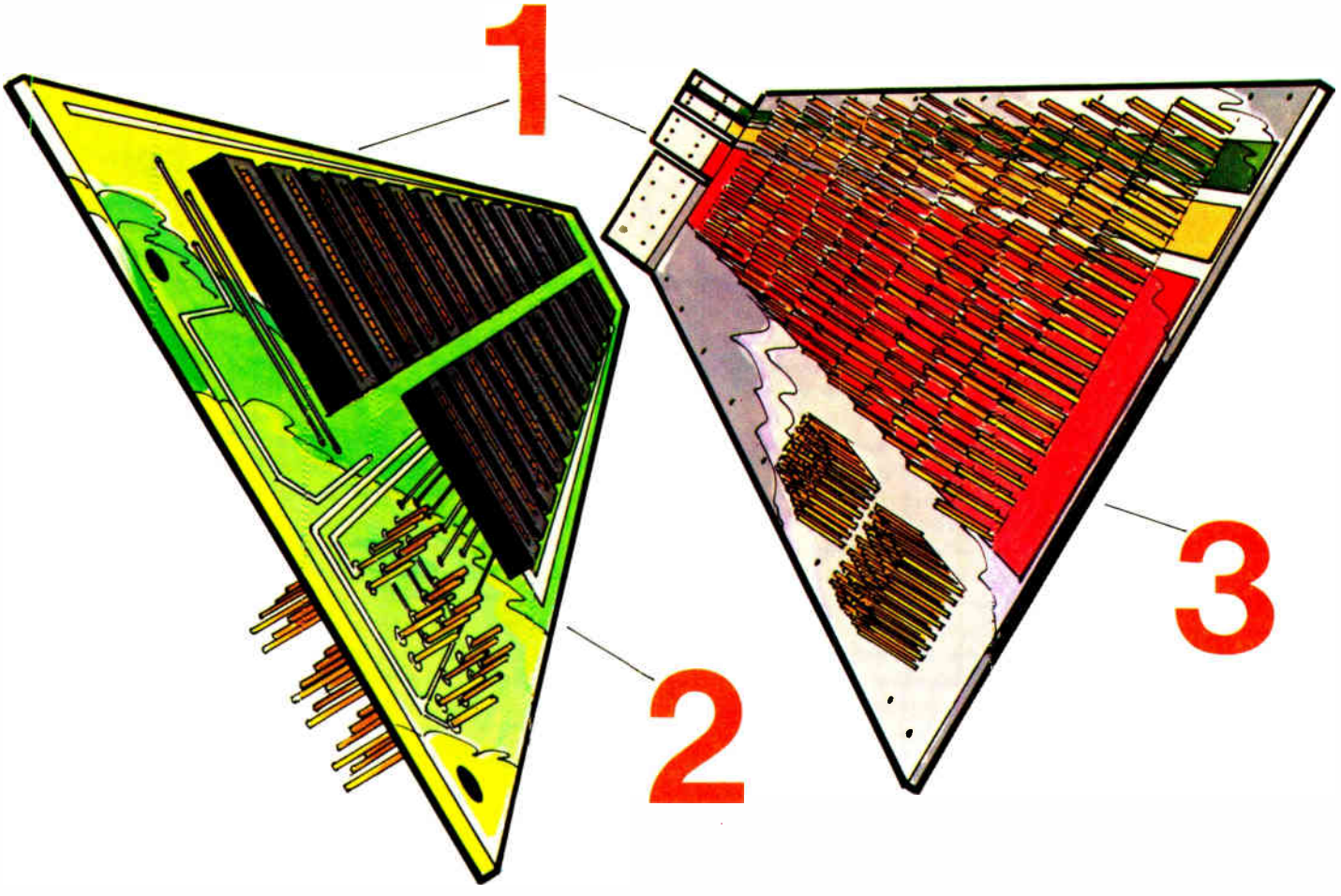
10-turn pot is modular

New from the Trimpot Products division of Bourns Inc. is a modular precision potentiometer, the 10-turn wirewound model 83/84, which achieves an independent linearity of ±0.25%, according to product manager Ken Leebelt. Having a 0.3-to-2.0-oz-in. torque in single- or multiple-cup assemblies, it may readily be combined with other members of the model 80 family in dual-concentric shaft configurations.

The 83/84 is available in resistances ranging from 200 to 50,000 ohms. Rotational life is 1 million shaft revolutions. The compact ⅝-inch-square package allows close spacing in panels. It offers either printed-circuit pins for direct board installation, or, as an alternative, standard solder lugs.

Price is $3.94 in 1,000 quantities, and delivery takes 10 days from the

the nitty gritty



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2 PC press-fit backpanels with .025" or .045" square, solid or compliant pins and contact spacings of .100", .125", .150", .156", .200" and .250" with or without card guides designed to meet your specific requirements.

3 Metal plate backpanels with multiple voltage planes attached to individual contacts are the ideal way to go for those short production runs or high strength requirements.

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GW **Elco Corporation**
a Gulf + Western manufacturing company

Circle 143 on reader service card 143

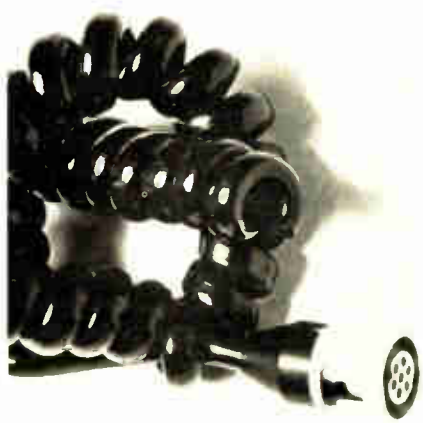
time the company receives the order. Bourns Inc., Trimpot Products Division, 1200 Columbia Ave., Riverside, Calif. 92507. Phone (714) 684-1700 [367]

Cables now come custom-molded

As an alternative to customers having to fabricate their own assemblies for its Thorkom miniature circular connectors, Viking Industries Inc. is introducing a line of custom-molded cable assemblies. The new Vikrom assemblies incorporate either straight or coiled cables that mate with the thermoplastic-shelled Thorkom connectors, which come with 7, 12 or 24 contacts.

Vikord assemblies feature a built-in strain-relief system to protect the connector in case of unusual stress. The molded backshell comes in a previously unavailable right-angle configuration, as well as the straight model. This backshell is highly resistant to moisture and is suitable for applications in dirty environments. Vikord assemblies can be fabricated to a wide range of customer specifications, and custom colors may be selected in high-volume orders.

Because of the safety factor afforded by construction with flame-retardant materials, first sales of the Vikord are aimed at medical-diagnostic, patient-monitoring, and therapeutic applications. The high dielectric strength of the assemblies also protects against possible shocks, the



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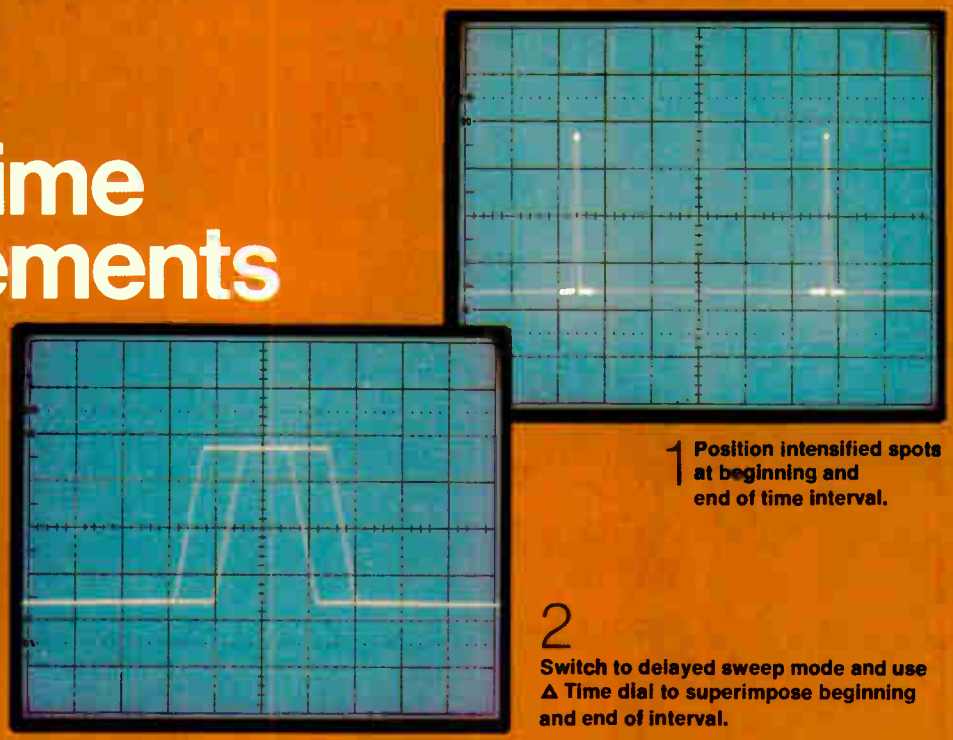

1 **Position intensified spots at beginning and end of time interval.**

2 **Switch to delayed sweep mode and use Δ Time dial to superimpose beginning and end of interval.**

3 **Read time interval directly.**

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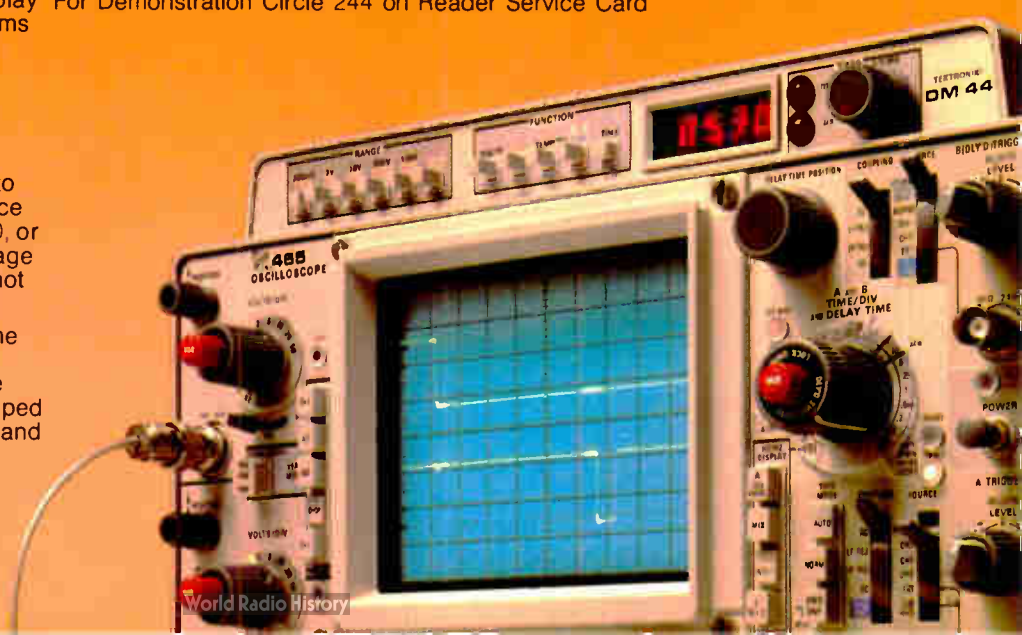

company says. Other initial applications include: equipment for automotive ignition, fuel control, and engine analysis; alarm systems; communications systems; data terminals, and marine depth finders and fish locaters.

Viking Industries, Inc., 21001 Nordhoff St., Chatsworth, Calif. 91311. Phone (213) 341-4330 [368]

Enclosure line is versatile

A line of enclosures developed by Vector Electronic Co. comes in 170 varieties—17 sizes and 10 colors—with a choice of card guides, brackets, and straps that permit installation from front, top, or rear, with either horizontal or vertical orientation.

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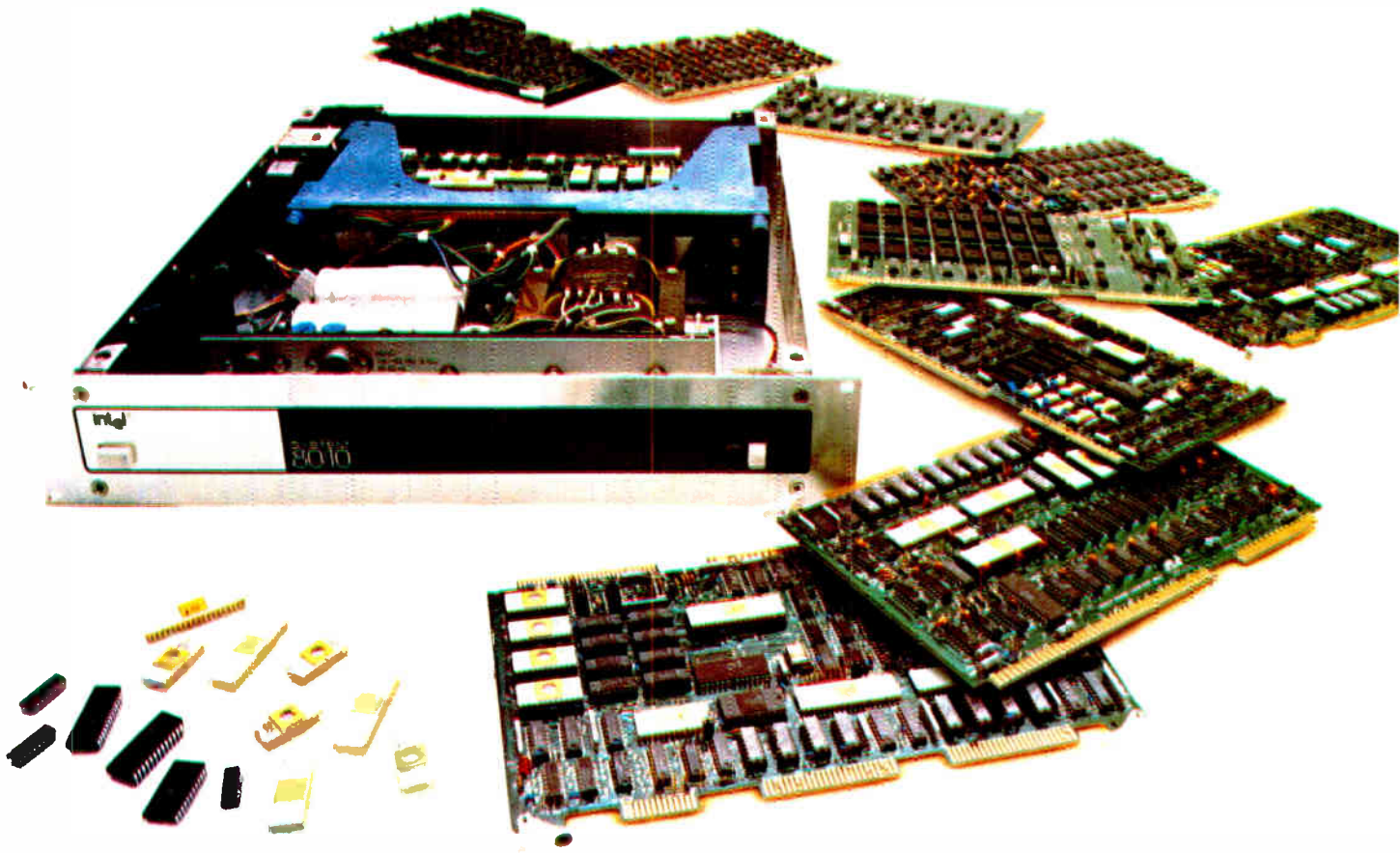
Vector Electronic Co., 1246 Gladstone Ave., Sylmar, Calif. 91342. Phone (213) 365-9661 [369]



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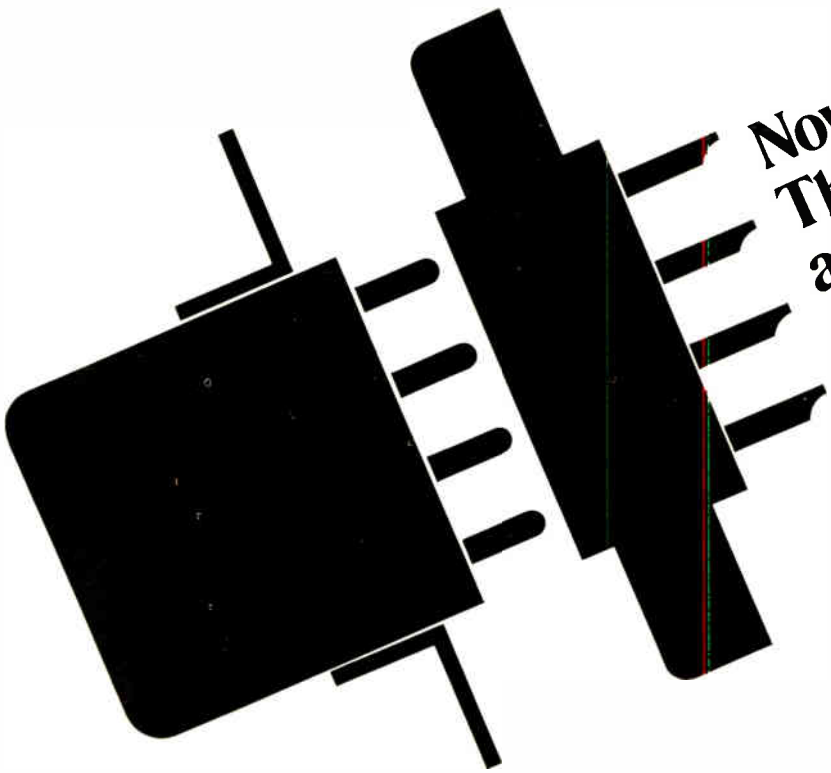

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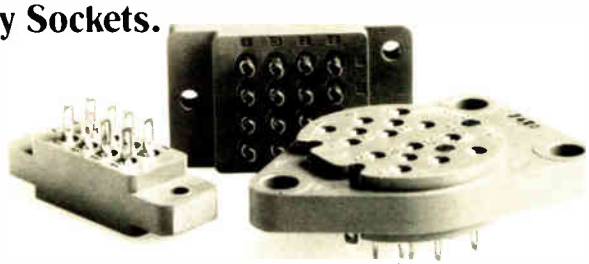

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Synthesizer designed for bench use

With dial-in frequency setting, digital unit takes on jobs that are usually performed by analog instruments

by Bruce LeBoss, New York bureau manager

Although they usually have front-panel controls, most frequency synthesizers are better suited for computer-controlled operation. These digit-by-digit or keyboard-controlled signal sources are fine when a device under test is being examined at specific frequencies. However, they are not a good choice when testing the device to determine at what frequency a specific response occurs.

Then, the engineer, after using a synthesizer under manual digital control for a while, may be tempted to drag out an old dial-tuned instrument. Analog-controlled signal sources, though, have not had the accuracy, stability, or low phase noise of a synthesizer. But they provide easy tuning for such tasks as finding a 3-dB point, searching for spurious responses, or checking a filter's passband and stopband.

Bench instrument. Now, Comstron-Seg of Freeport, N.Y., has decided to provide the best of both worlds in a new $1,595 synthesizer designed specifically for the bench user. Its model 1010, which covers 1 hertz to 10 megahertz in 1-Hz steps, is controlled by a single front-panel knob. The instrument "has been designed for the engineer who wants the frequency accuracy and purity of a synthesizer, combined with the convenience of continuous tuning," says Philip Basse, president. The 1010's front panel, he adds, "works like a standard dial-tuned signal source, but the insides work like a frequency synthesizer."

Direct frequency readout is provided by a five-digit 0.43-inch-high light-emitting-diode display on the 1010's front panel. Fast tuning is accomplished through range switching and a choice of fine- and coarse-tuning modes. The ranges are 1 Hz to 100 kilohertz and 100 kHz to 10 MHz; resolution over the ranges is 1 Hz and 100 Hz, respectively. The coarse-tuning mode permits rapid searching and tuning with three-digit resolution, while switching over to the fine-tuning mode provides full five-digit resolution.

For setting the desired frequency,

New products

the model 1010 uses a digital control technique that is "elegantly simple," says Basse, and less expensive than was used in the firm's original model 1013, a systems-oriented synthesizer. A clear plastic disk with black lines is rotated past two photodetectors, and a simple logic circuit produces a pulse each time a bar passes the detectors. The circuitry also indicates whether the disk is rotating clockwise or counterclockwise, thus converting analog rotational data into enough digital information to control the synthesizer.

The disk and decoders provide only incremental information; so, to store the frequency information, the synthesizer's digit switches were replaced by an up-down counter. "The change reduces cost because digital chips are less expensive than rotary switches," says Basse. The counter's contents are indicated on LED display and also program the synthesizer circuitry.

The model 1010 has a metered output leveled to within 0.25 dB over the full range and drives up to 3 volts rms across 50 ohms. It has a precision output attenuator adjustable over a 60-dB range in 10-dB steps and, in addition to its sine-wave output, has a square-wave output that can drive transistor-transistor-logic levels across 50 ohms.

The synthesizer uses Comstron's patented direct-programming differential-synthesis technique, first introduced in the model 1013. The 1010's phase noise is more than 40 dB down in a 30-kHz band for the top frequency band and more than 60 dB down for the lower range. Harmonic distortion is better than 50 dB down from 1 Hz to 100 kHz and better than 40 dB down in the higher range. Spurious responses are more than 60 dB down on both ranges. Long-term frequency drift is no more than 1 part in 10^5 per year, with a 1 part in 10^6 per year time base available as an option, as is an external-reference lock. Initial deliveries are scheduled this month and from stock to 30 days thereafter.

Comstron-Seg, 200 East Sunrise Highway, Freeport, N.Y. 11520. Phone (516) 546-9700. [338]

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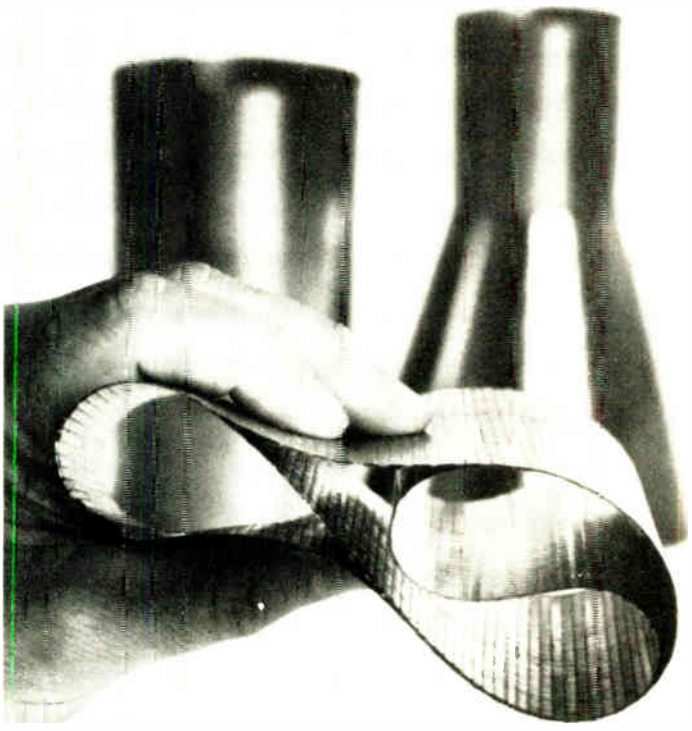

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These Darlingtons are already in high volume production and are available on distributor shelves. For prices, applications literature and data sheets, visit your nearest Delco sales office or Delco distributor, or mail in the coupon on the right.

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DTS-4067	10	150	350V	2.0V	0.25mA
DTS-4074	5	75	350V	3.5V	0.25mA
DTS-4075	10	150	350V	2.0V	0.25mA

TYPICAL SWITCHING

	DTS-4066 DTS-4067	DTS-4074 DTS-4075
t_r	0.5 μs	0.5 μs
t_s	5.0 μs	3.2 μs
t_f	4.5 μs	1.0 μs

NPN triple diffused silicon Darlingtons are packaged in solid copper cases conforming to JEDEC TO-3 outline dimensions.

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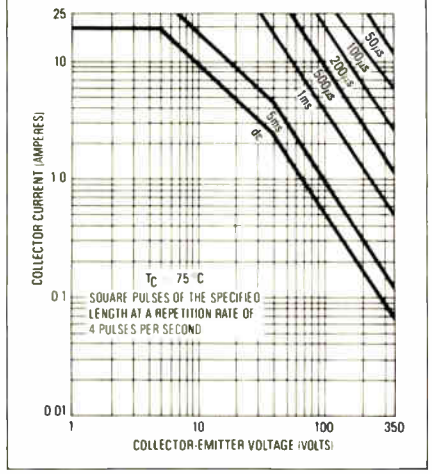

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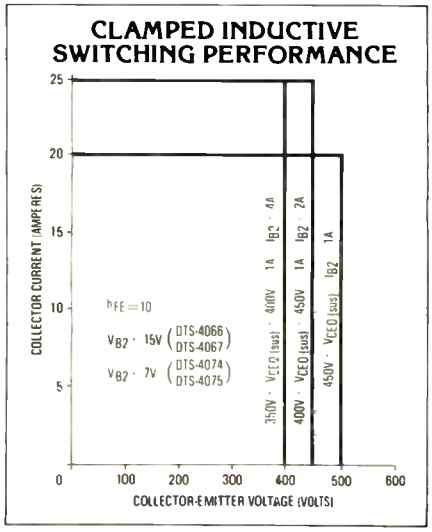

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Solid-state relays need less room

Putting these optically coupled devices into single in-line packages cuts required board space to 0.5 square inch

by Larry Armstrong, Midwest bureau manager

A **single in-line** package for solid-state relays has been developed by Hamlin Inc., and next month samples will be available. They will contain optically isolated solid-state relays that combine thick-film hybrid techniques with tested discrete components.

Most solid-state relays designed for printed-circuit boards have copied the familiar, boxy Crydom package, though a few manufacturers have recently managed to squeeze the necessary circuitry into a dual in-line format. "But the SIP frees up more real estate," says W. Forbes Barton, solid-state-relay product manager for the Lake Mills, Wis., firm. "It's less than a half cubic inch in volume, but more importantly, it takes up only a half square inch of board space."

The epoxy-coated package of the series 7850 relays measures 1.6 inch long by 0.75 in. tall, and is only 0.35 in. thick. Its four pins are spaced so they can fit in existing dual in-line sockets, or users can match existing relay footprints by using a small phenolic header board, Barton points out. The leads also can be bent so that the relay can be used on pc boards spaced on 0.5-in. centers.

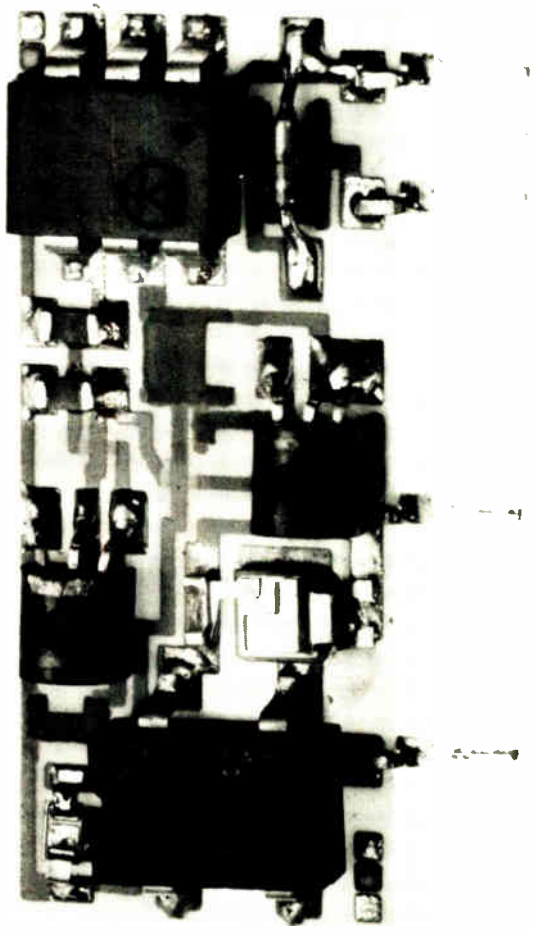
Hamlin, best known as the leading supplier of reed switches to builders of electromagnetic relays, starts building its SIP relays by screening conductive and resistive patterns onto an alumina substrate. The resistors are laser-trimmed, and the substrate is covered with a glass layer for insulation. Tested discrete components are then assembled on the substrate, and the hybrid circuit is reflow-soldered, tested, epoxy-dip-coated, and marked.

"We chose to use plastic-packaged discretes instead of raw chips because we can buy tested packages," Barton says. "The alternative is to build the assembly with chips and wire bonds. Using packaged devices, however, we see virtually no yield loss during assembly." The relay's output triac is simply a chip mounted to a small lead frame, and Hamlin is working to replace the opto-coupler package with a similar lead-frame-mounted device.

The new series will go into production in June. All three relays in it are general-purpose control relays, rated at 2 amperes and used as input/output devices between logic-level circuits and ac-line power in such equipment as computer peripherals, machine-tool controls, and telecommunications gear. The relays all feature zero-voltage switching, 1,500 volts rms isolation, and input polarity protection.

To keep the price down to $4.95 in 1,000-piece lots, Hamlin has eliminated the snubber network. It must be added externally across the output triac when the relay is working into inductive loads. The 7851 is designed for ac-line voltages up to 140 volts, the 7852 up to 280 V, and the 7853 to 280 V with 600-V blocking voltage.

The new relay package is designed for nearly automatic assembly, and Barton notes its price could fall to as low as $3 in very large quantities. The firm is also considering building a version without an output-power semiconductor. "The front end can be coupled to anyone's output triac or SCR and will drive up to 100 A," he says. Also in the works is a second series rated at 3 to 4 A, using the same package with a small heat sink added to the back of the substrate.



Hamlin Inc., Lake & Grove Streets, Lake Mills, Wis. 53551 [339]

New products

Minicomputer offers more for the money

Mid-range machine has features formerly found only in high-price models

by Pamela Leven, Boston bureau

With the introduction of its newest Eclipse computer, Data General Corp. aims at bringing a variety of "super-mini" capabilities to high-speed, high-performance applications while keeping the price within reach of OEM's and end users accustomed to mid-range machines.

With a price tag of $42,150 for a typical configuration with 120 kilobytes of semiconductor memory, battery back-up, 10 megabytes of disk storage, a real-time clock, a terminal, a 48-channel analog I/O subsystem, a floating-point instruction set, and memory allocation and protection, the Eclipse S/130 is a "sign to the industry that capabilities traditionally available only in the super-mini class have migrated downward to mid-range computers," says John Scanlon, processor marketing manager. The new model squares Data General off against Digital Equipment Corp.'s latest entry into the high-performance, mid-range market, the PDP-11/60.

The S/130 offers features ranging from microprogramming to multiprogramming. A microprogrammable control processor is geared to the high-speed requirements of dedicated applications, and Data General's advanced operating system runs time-sharing, batch, and real-time operations. For traditional applications in communications and business, the S/130 features the standard floating-point and character-handling instruction sets of the larger Eclipse computers.

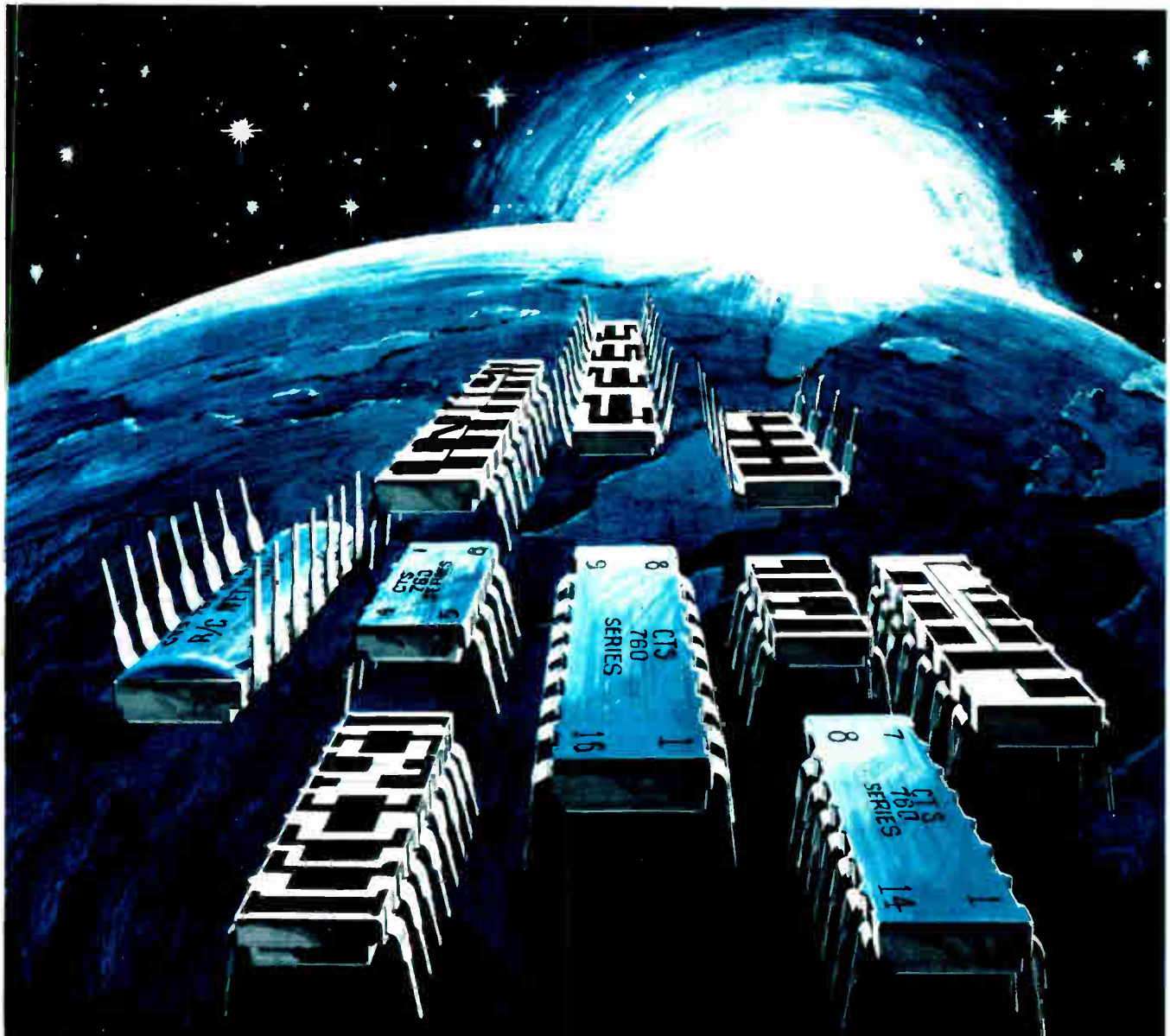
The S/130 is housed in a 12-slot chassis and offers the option of an additional 12 boards. It handles up to 256 kilobytes of memory, and its semiconductor memory modules feature error correction and optional battery back-up. A memory allocation and protection unit provides program and data protection when more than one user has access to the machine.

System software includes Data General's multifunction operating systems, the advanced operating system and the real-time disk operating system. They provide for concurrent and secure batch and real-time operations. The S/130 can use Fortran 5, Fortran IV, single- and multi-user Basic, and Algol. Application-support software includes utilities for remote job entry, sort/merge and business requirements, and communications access and sensor access management.

Data General offers customers its own magnetic peripherals, from 315-kilobyte diskettes to 190-megabyte disk files, as well as a family of tape drives and cartridge disks. Comprehensive sensor I/O and communication subsystems, character printers, and video display terminals are also available.

For specialized applications, the S/130 features custom instruction-set capability through user-microcode storage in random-access memory or programmable read-only memory. The RAM control store offers 1,024 56-bit words to allow scientific or educational users to alter their custom instructions. The PROM control store provides 2,048 56-bit words of non-volatile microcode storage for security-minded users. Deliveries will begin in 90 days, with volume shipments scheduled for early fall.

Data General Corp. Southboro, Mass. 01772. Phone (617) 485-9100. [340]



Down to earth economy from CTS

Overall cermet resistor network economy is what CTS has been putting into modern systems for well over a decade. For example, Series 760 DIP cermet networks, purchased in quantity, can cost less tham 30¢ each.

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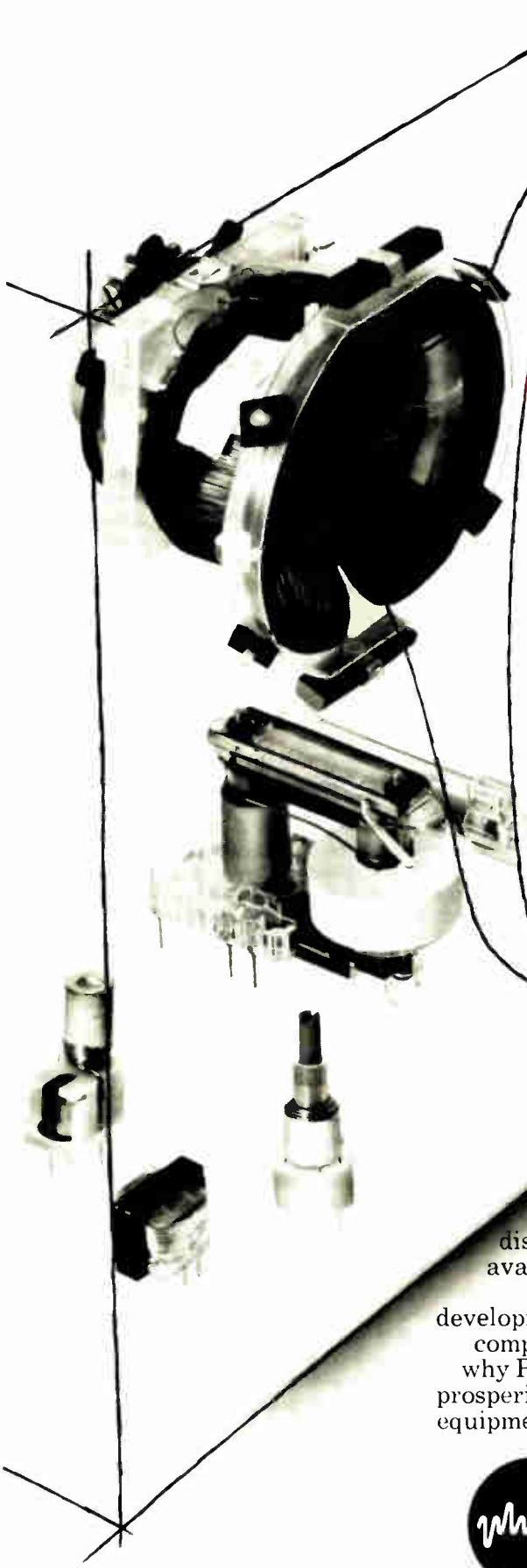

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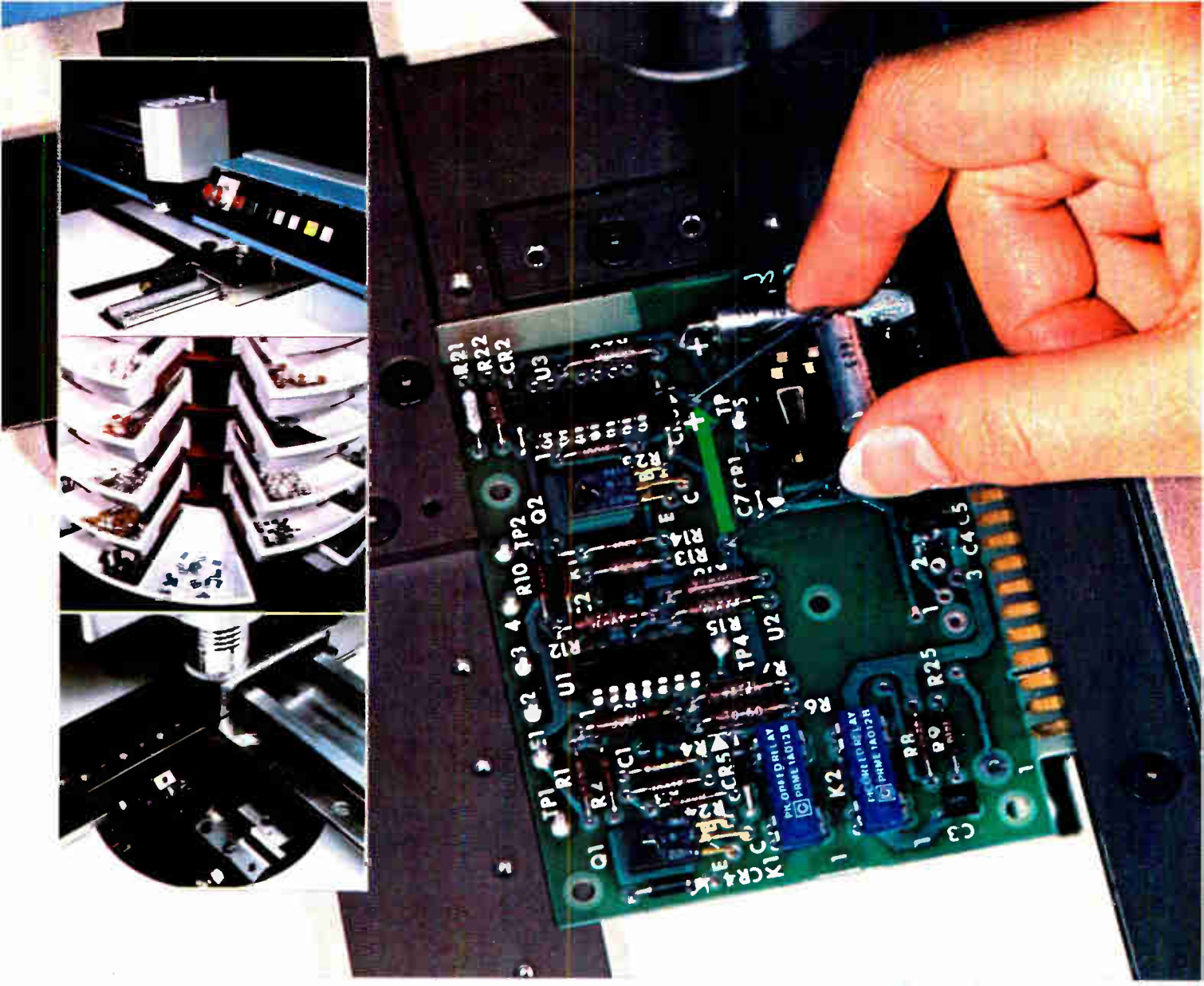

This easy-to-program hand assembly machine thinks for the operator and can cut and clinch leads.

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Semiconductors

1-k RAM has 30-ns access time

Static device has 16 pins, aims at high-speed cache memory jobs in computers

Pushing its n-channel metal-oxide-semiconductor memory-processing technology to the very limits, Intel Corp. is introducing a high-speed version of its 1,024-bit static random-access memory, the 2115/2125A, which is capable of access times down to 30 nanoseconds.

Just as the 70-ns 2115/2125 was designed as a pin-for-pin replacement for the bipolar static 93415 made by Fairchild Camera and Instrument Corp., the new 2115/2125A is aimed at the same sockets as the higher-speed 30- to 45-ns 93415A bipolar RAM.

Designed to meet the requirements of high-speed computer cache memories, the 16-pin device is specified for a maximum access time of no more than 45 ns. But the basic chip can achieve much higher speeds, and units will be available down to about 30 ns, according to Bill Regitz, manager of memory components marketing and applications. All pins are TTL-compatible, and the RAM operates from a single 5-volt power supply with a maximum power dissipation of 525 milliwatts. A lower-power version with a 325-mW power dissipation and about the same speed range will also be available.

High performance and density of the MOS memory were achieved by combining MOS-device scaling with on-chip substrate-bias generation, Regitz says. Reducing the physical parameters of the MOS device by a fixed scaling factor also decreased the active circuit power.

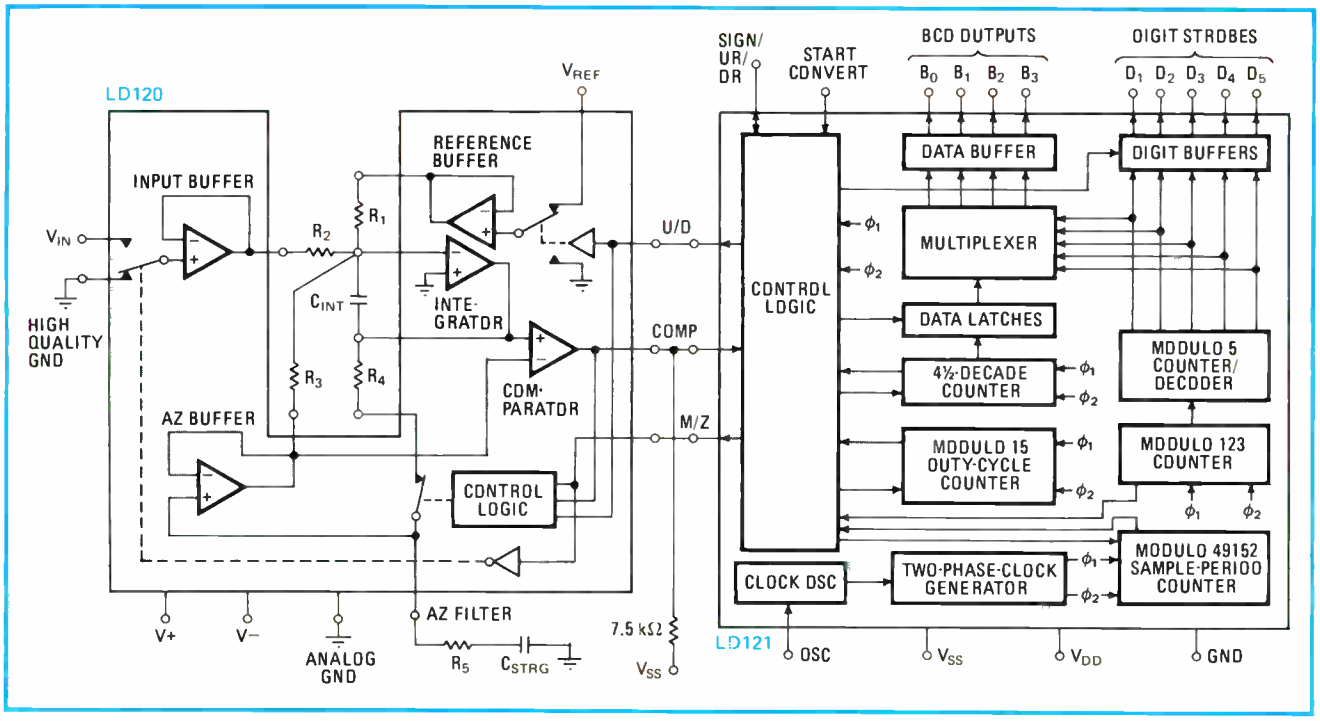
The advanced technology used to fabricate the 30- to 45-ns parts employs polysilicon lengths shorter than 4 micrometers and a gate-oxide thickness of less than 1,000 angstroms. Junctions shallower than 1 μm are obtained by using arsenic as the source-drain diffusant. In addition, oxide isolation and depletion-load processing further improve circuit performance and density. Substrate-bias generation was used to reduce body effects and parasitic junction capacitance. Generating the back-bias voltage on the chip also eliminates a pin and power supply.

The speed-power product of the new device is about 1 picojoule, compared to that of the previous 2115/2125, which was about 4 pJ, using conventional 6-μm n-MOS processing. Like its forerunners, the new MOS RAM uses the basic six-transistor cross-coupled flip-flop as its memory element. Cell size is about 3.75 square mils. Internally, the cell uses depletion-load transistors to obtain full supply voltage while maintaining a typical cell current of 1 microampere.

The low diffusion capacitance allows the memory cell to drive the output-sense amplifier directly, without a column sense amplifier. The output-sense circuit is a simple differential amplifier with dc feedback to provide compensation.

The memory is fully static and requires no clocks or internal referencing, says Regitz, which means a multiple-read operation can occur during a single chip-enable cycle. As a result of using simple circuitry in the periphery, more than 60% of the chip area is memory array.

On parts with a 45-ns access time,



chip-select and read-cycle access time is also 45 ns. Write cycle time is 30 ns, and width of a write pulse is 7 ns. In addition, the output can sink a minimum of 25 milliamperes at 0.45 volt.

Using the same technology and achieving roughly the same performance, Intel is also developing a larger 4,096-bit static RAM, the 2147, which is not yet in production. Available now, however, are the 1-k 2115A and 2125A at prices of about $10 each.

Intel Corp., 3065 Bowers Ave., Santa Clara, Calif. 95051. [411]

V-MOS transistor family drives computer peripherals

The S55V/S75V family of vertical MOS field-effect transistors includes 12 devices with power dissipation ratings of 4 and 25 watts, standoff voltage ratings up to 90 v, and continuous-current ratings up to 2 amperes. Digital versions of the recently introduced VMP family of general-purpose power FETs [*Electronics*, Nov. 11, 1976, p. 144], the new devices are intended for peripheral interface applications such as driving lamps, displays, alarms, relays, solenoids, stepper motors, and printers. The devices are available in versions for either the military or

Configurability at a price you didn't figure on

Here's a really multi-functioned digital multimeter: Six functions—dc and ac voltage, dc and ac current, resistance and dB (both dBV and dBm)—in one compact, 3½-digit DMM for just $250*. It's called the DM 502 (Option 2) and it has the configurability to interface with a full range of test and measurement instruments in the TEKTRONIX TM 500 line.

If you need to measure temperature—perhaps you're aware how quickly you can isolate faulty semiconductors with a digital thermometer—the DM 502 (with temperature measurements from −67°F to +200°F, or −55°C to +150 C) costs just $375*, complete with temperature probe.

Combine either DMM with compatible TM 500 plug-in instruments and you can create unique performance configurations within a single mainframe. Select a packaging configuration to fit your job site: TM 500 mainframes come in benchtop, rackmount, rollabout and portable models, with spaces for one to six plug-ins.

One typical configuration, the Audio Travel Lab**, combines the DM 502 (or the DM 502, Option 2) with an SG 502 Audio Oscillator, a DC 504 five-digit Counter/Timer, and an SC 502 15-MHz Dual-Trace Oscilloscope within a TM 515 Traveler Mainframe. This lab-quality instrument configuration looks like carry-on luggage and provides comprehensive audio measurement capability which you can take anywhere.

So the next time you're looking for a 3½-digit DMM with all the functions you need and with the configurability to work with the rest of your test equipment, select the DMM that is also priced right for you: DM 502. Or, for similar functions and 4½-digits, look into the configurable DM 501; you'll be pleased with its price, too.

For more information on configurable instruments, call your local Tektronix Field Engineer or write Tektronix, Inc., P.O. Box 500, Beaverton, OR 97077. In Europe, Tektronix Limited, P.O. Box 36, St. Peter Port, Guernsey, Channel Islands.

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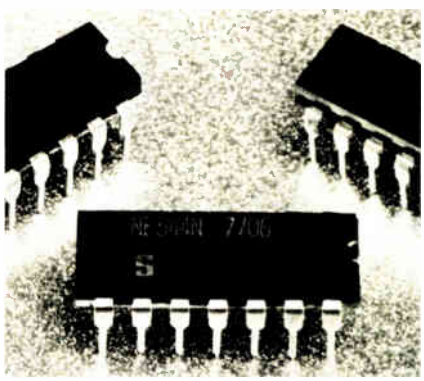
Siliconix Inc., 2201 Laurelwood Rd., Santa Clara, Calif. 95054. Phone Jim Graham at (408) 246-8000 [416]

Servo amplifier IC includes motor drive

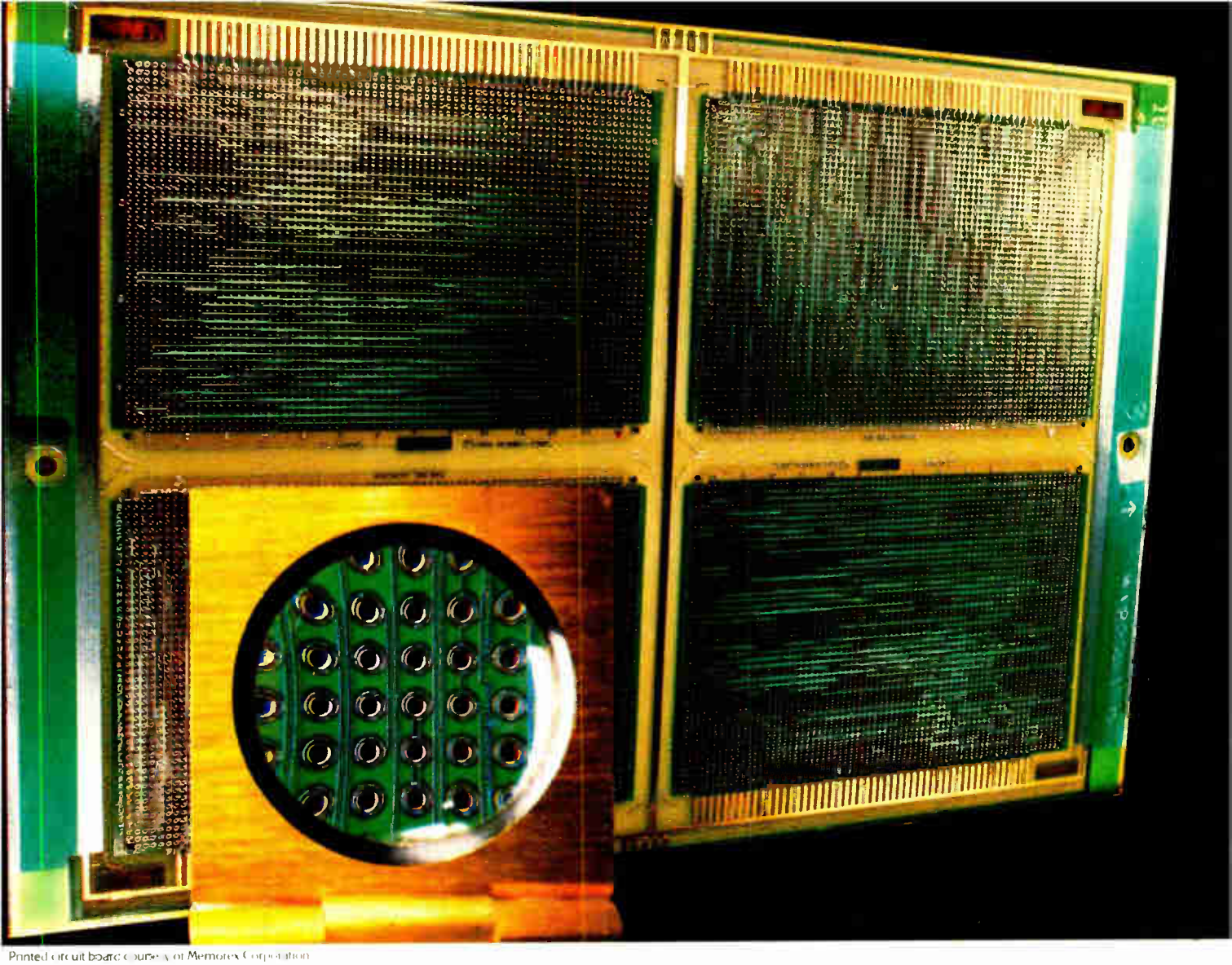
A linear integrated circuit for servo control systems includes not only a servo amplifier, pulse-width demodulator, a precision monostable multivibrator, and a voltage regulator, but also output motor-drive transistors capable of delivering 500 milliamperes at 6 volts. Designated the NE544, the IC is intended for remote control applications, particularly radio-control systems. The unit's highly stable one-shot gives it enhanced positional accuracy, while its voltage regulator makes it tolerant of wide supply-voltage variations. Housed in a 14-pin plastic DIP, the NE544N sells for $2.05 each in hundreds. Other available packaging options include 16-pin plastic ($2.15) and 16-pin miniature ceramic ($2.60).



Signetics, 811 East Arques Ave., Sunnyvale, Calif. 94086. Phone (408) 739-7700 [413]

Block-addressable CCD memory holds 65,536 bits

Intended to compete with such mass memory devices as drums and disks, the CCD464 is a 65,536-bit block-addressable memory with an average latency time (retrieval time for an



Printed circuit board courtesy of Memotex Corporation

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All of these features of the dry film process with RISTON Solder Mask add up to wide flexibility for the designer. What's more, it comes in a variety of film types which enable masked boards to pass UL flame-retardant standards. RISTON Dry Film Solder Mask adheres to all common metals and performs consistently under a variety of soldering conditions as well as solder flux cleaning. The result for you is a tough, permanent, well-designed board.

Find out how the benefits of RISTON Dry Film Solder Mask fit your needs. Call your Du Pont RISTON Technical Representative, or write Du Pont Company, Room 35619, Wilmington, DE 19898.

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Electronics

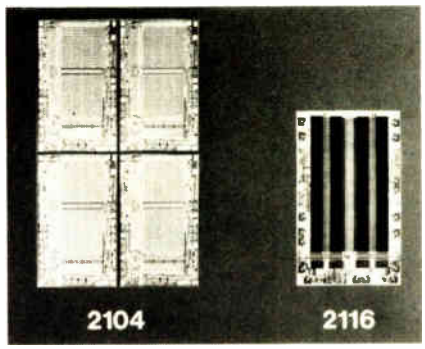
Circle 165 on reader service card

average bit) of 400 microseconds. The charge-coupled device is internally configured as 16 blocks of 4,096 bits each. Its typical data rate is 5 megahertz, and its typical power dissipation is less than 5 microwatts per bit when active, dropping to less than 1 μW/bit in standby. The memory is housed in a standard 16-pin dual in-line package.

MOS/CCD Division, Fairchild Camera and Instrument Corp., 464 Ellis St., Mountain View, Calif. 94042 [414]

4-k and 16-k dynamic RAMs are interchangeable

The 4,096-bit model 2104A and 16,384-bit model 2116 dynamic random-access memories are electrically and logically compatible with each other and with the industry standard 16-pin 4-kilobit RAMs now used in many production memory systems. They thus allow 4-kilobit and 16-kilobit RAMs to be easily combined in memory systems that are being tailored for specific applications.



The 2104A types are available with access times down to 150 nanoseconds, while 2116 types go down to 200 ns. Active/standby power consumption is 240/8 milliwatts for the 2104A and 588/14 mw for the 2116. Pricing on the 4-kilobit memory ranges from $9.95 to $14.20 each in quantities of 100 units and up, depending upon speed. For the 16-kilobit memory the range extends from $47 to $62.50.

Intel Corp., 3065 Bowers Ave., Santa Clara, Calif. 95051. Phone Bill Regitz at (408) 246-7501 [417]

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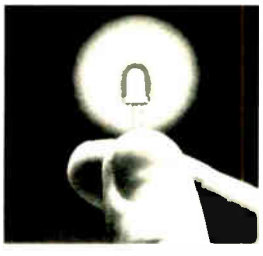

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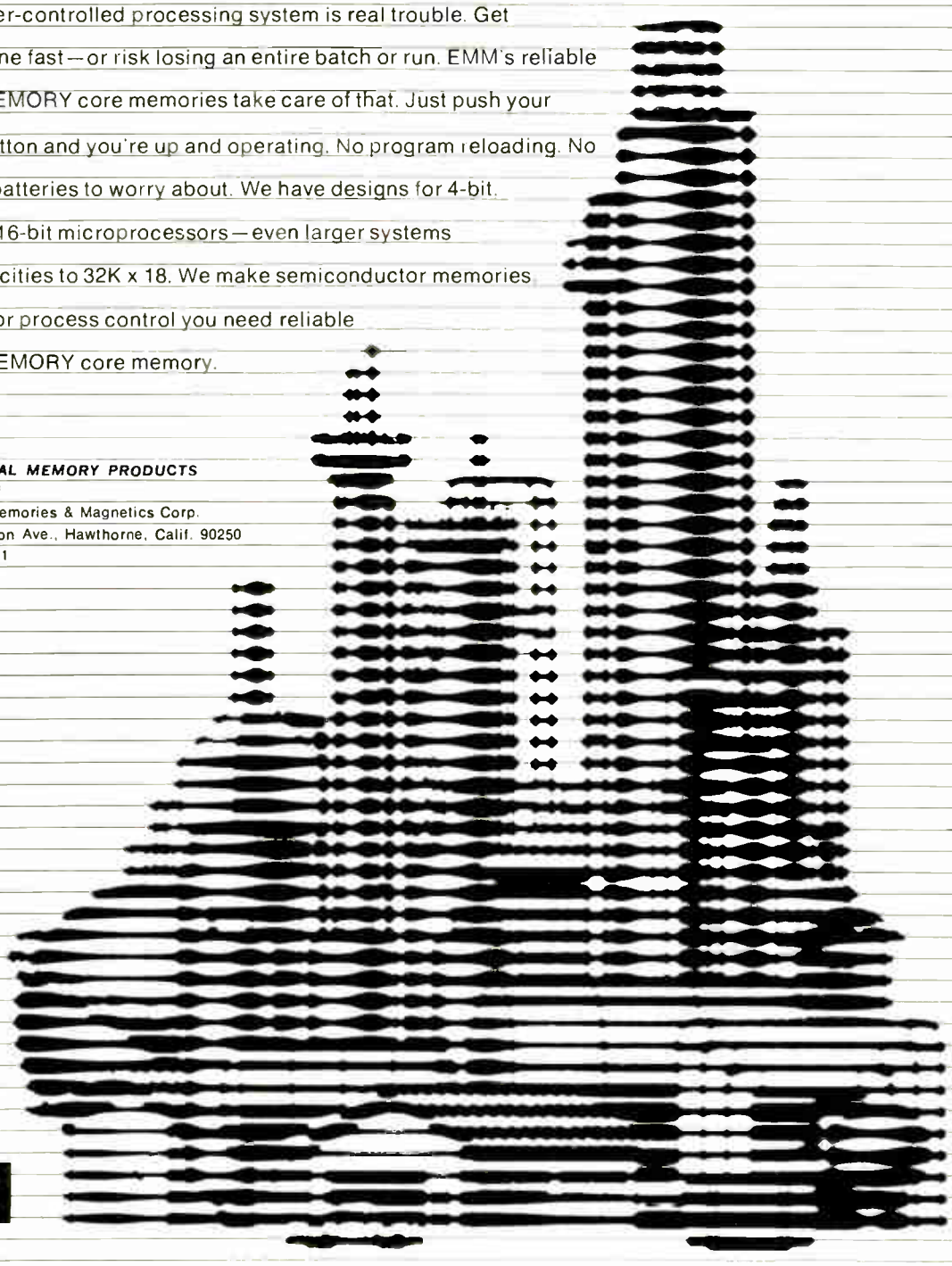

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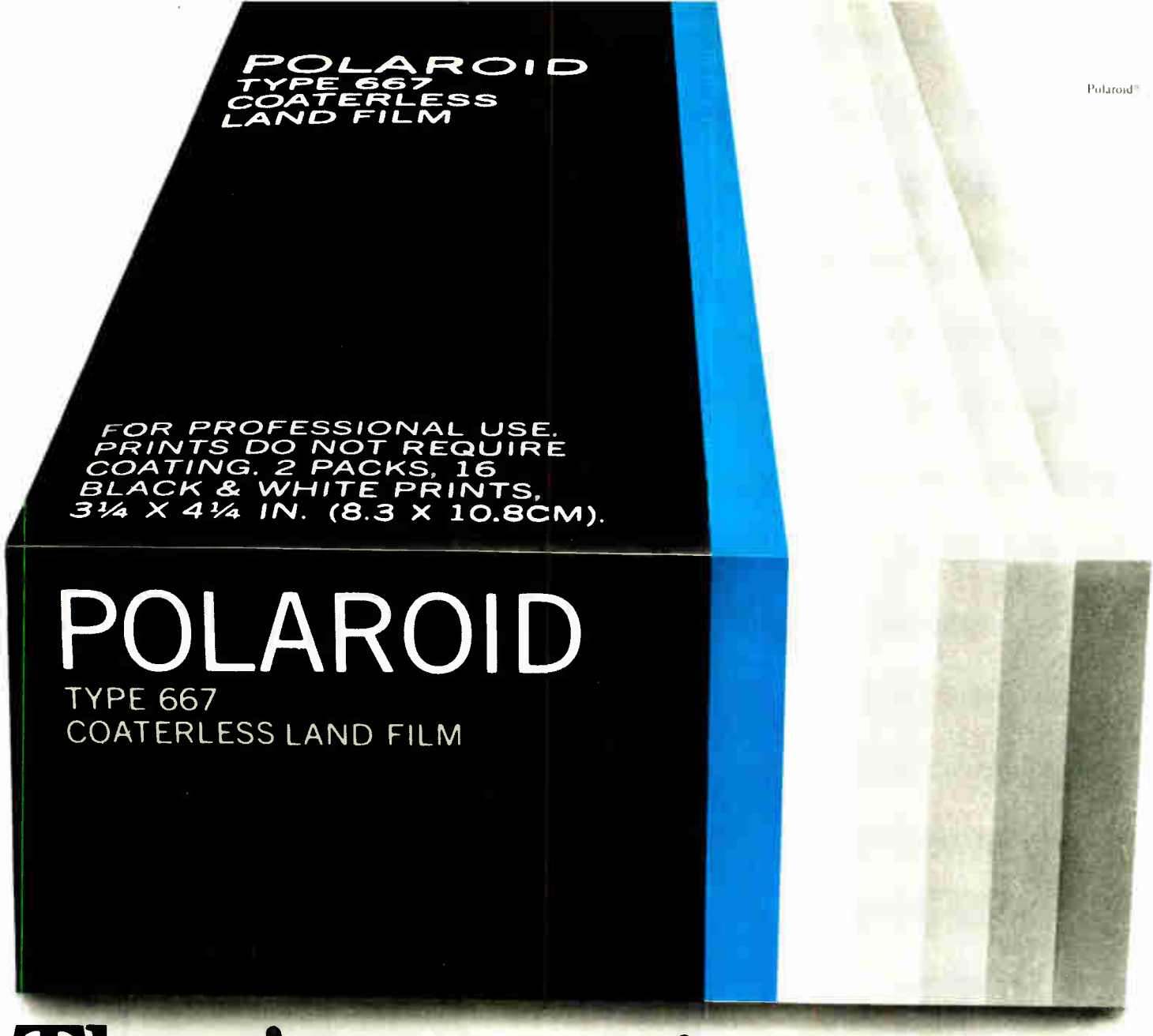

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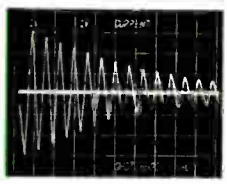

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Instruments

Analyzer eases operator's job

Operator controls on HP's 8565A are coupled, ensuring that proper values are shown

Ordinarily, the operator of a microwave spectrum analyzer must pay careful attention to interactions among various settings, including frequency span, resolution, bandwidth, video filtering, and sweep time. If all conditions are not harmonious, the operator could be unaware that measurements may be inaccurate.

However, the model 8565A spectrum analyzer from Hewlett-Packard Co. eliminates these hazards, claims Irv Hawley, engineering section manager for spectrum analyzers at HP. These various controls are now coupled in such a manner that resolution, video filtering, and sweep time are automatically set to the proper values for the chosen frequency span.

Similarly, the amplitude controls (radio-frequency input attenuator, and intermediate-frequency gain control) are coupled so that the operator can always maintain absolute amplitude calibration while also ensuring conditions that generate minimum distortion. The operator can readily override the control coupling, however, for those measurements where different relationships are needed, says Hawley. Examples are measuring pulsed signals and radio-frequency-interference testing.

Wide range. The 8565A covers the spectrum from 10 megahertz to 22 gigahertz (extendable to 40 GHz), provides fully calibrated performance, and permits unambiguous measurements with wide dynamic range, because of its internal preselection.

The instrument also has new operating features that HP claims make it the easiest-to-use microwave analyzer on the market. Among them are light-emitting-diode readouts around the cathode-ray tube that indicate control settings and operating conditions, plus coupling of controls to reduce most measurements to a simple three-knob sequence.

Throughout the spectrum analyzer's coverage, it can measure absolute power levels from a high of +30 dBm (1 watt) down to the analyzer's average noise level, which is −110 dBm to 1.8 GHz, −106 dBm to 4.1 GHz, and −72 dBm at 22 GHz. Total uncertainty of absolute power measurements is 2.5 dB to 1.8 GHz, and from 3 dB at 4 GHz to 5.8 dB at 22 GHz.

For relative measurements, fre-

quency-response variations are typically 1.3 dB lower than absolute power-measurement uncertainty. These accuracy and flatness figures, which are referred to the 100-MHz internal calibrator and therefore include all input circuitry (rf attenuator, preselector, and mixer) as well as passband gain variations, are all lower than those for any other manufacturer's preselected microwave analyzer. All internal distortion products are greater than 70 dB down from 10 MHz to 18 GHz and 60 dB down from 18 to 22 GHz.

Frequency ranges include a 1.7-to-22-GHz span in one sweep, selected full spans that cover 10 MHz to 1.8 GHz or slightly more than octave ranges, starting at 1.7 GHz, and adjustable spans from 1 kilohertz per division to 500 megahertz per divisions in a 1, 2, 5 sequence that can be used throughout the range even to 40 GHz. There is also a zero-span mode where the analyzer becomes a fixed-tuned receiver. For all spans of 100 kHz per division and smaller, automatic frequency stabilization facilitates narrowband measurements.

Resolution bandwidths from 1 kHz to 3 MHz in a 1, 3, 10 sequence are provided. The resolution filters are synchronously tuned (approximately gaussian) to prevent undesirable ringing at fast sweeps. The 60-dB/3-dB selectivity ratio for all filters is less than 15:1.

When measuring the amplitude of signals, vertical-scale factors of 10, 5, 2, and 1 dB per division can be selected, and the power reference is maintained when changing the scale factor. Linear amplitude display is also provided, with power reference maintained. The internal preselector, which operates from 1.7 to 22 GHz, provides more than 70-dB rejection to 18 GHz or 60 dB to 22 GHz, and the instrument can measure distortion products that are as much as 100 dB down.

To give the operator the "complete picture" about the signals being measured, LED displays in the CRT bezel indicate all pertinent control settings and operating conditions. When an oscilloscope camera is used to permanently record the

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For only $1995 your Datalogger 1000 comes complete, ready-to-monitor 10 data points and is easily expandable to 100. Unattended, it watches your test, experiment or process, logs all pertinent information and warns you of potential problems.

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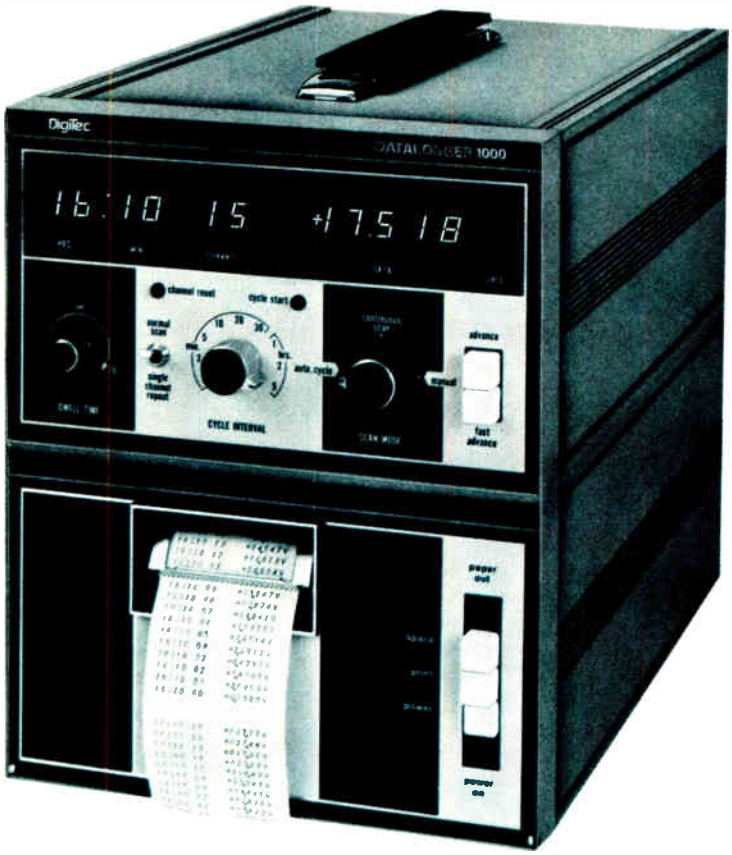
Compact and portable, the Datalogger 1000 can be used by Research, Engineering or Manufacturing, in the plant or in the field, to provide a quick return on investment.

At $1995, there is nothing comparable.

For additional information contact your United Systems Representative or call the factory (513) 254-6251.



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"Demonstration only" Circle 173

New products

spectral display, the LED data also is recorded in the photograph.

In the U.S. the 8565A is priced at $17,850. Customer deliveries will begin in May.

Inquiries Manager, Hewlett-Packard Co., 1501 Page Mill Rd., Palo Alto, Calif. 94304 [351]

Sweeper covers 1 MHz to 1 GHz in one continuous band

Because its output is derived from the beat frequency between two microwave oscillators, the model 9062 sweep generator can cover the range from 1 megahertz to 1 gigahertz in a single glitch-free band. One of the microwave oscillators is fixed in frequency; the other one is varactor-tuned, allowing the 9062 to be swept at high rates—up to 5 kilohertz—before its sweep width begins to decrease.

The instrument uses a 10-turn potentiometer to set its center frequency to three significant figures. The output is leveled and is adjustable over an 80-decibel range. Leveling is within 0.5 dB across the full frequency range, and within 0.25 dB across any 200-MHz segment. All spurious and harmonic signals are down more than 30 dB at full output and even more when the output level is decreased.

Priced at $1,350, the sweeper provides for six birdie markers of either the single-frequency or harmonic type. It can handle a variety of functions such as external frequency modulation, manual sweep, continuous-wave operation, and line-locked sweeping. Delivery time is three to four weeks. The 9062 will be

You could be paying extra for rechargeable battery dimensions that aren't critical!

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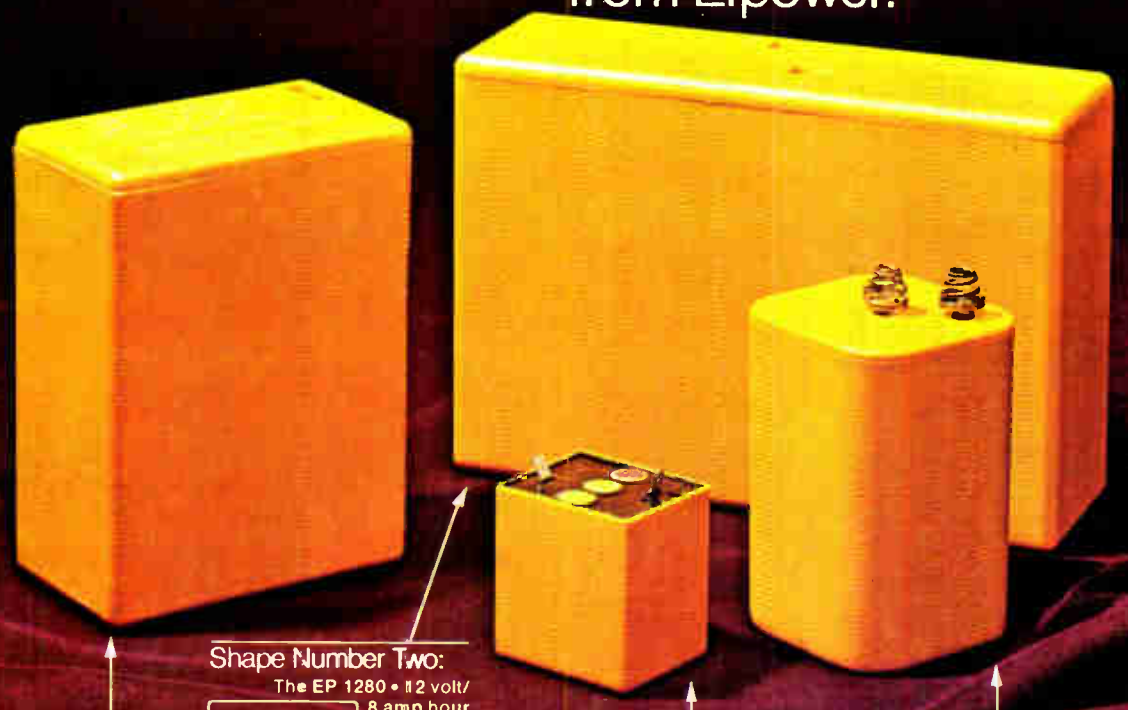
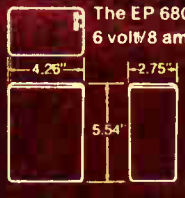
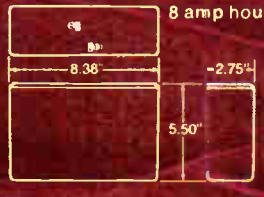


Shape Number One:
The EP 680
6 volt/8 amp hour



Shape Number Two:
The EP 1280 • 12 volt/
8 amp hour



Shape Number Three:
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6 volt/1 amp hour

Shape Number Four:
The EP 640
(Lantern Battery)
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These four sizes are unique:

Elpower has designed an exclusive high-speed production system around them. This means that you buy famous Elpower hand-made quality at machine-made prices.

Gain a competitive edge with more powerful batteries for less money. If size is critical, look into the standard Elpower line of over two dozen size and capacity combinations.

Discover why experienced buyers buy our experience . . . and save money!
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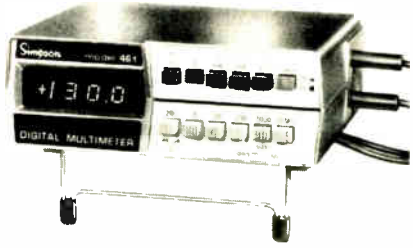
In Canada: Eldon Industries of Canada Inc. | 50 Prince Andrew Place, Don Mills, Ontario | Tele. 449-2866

New products

on display at Electro77 next week.
Kay Elemetrics Corp., 12 Maple Ave., Pine Brook, N.J. 07058. Phone (201) 227-2000 [353]

3½-digit multimeter sells for $130

Priced at only $130 with four nickel-cadmium cells and an ac charger/adapter, the model 461 digital multimeter is a 3½-digit instrument with a basic dc-voltage accuracy of 0.5% of reading ±1 count. Automatic polarity determination and display and automatic zeroing are standard. The meter measures dc voltages from 200 millivolts full scale to 1 kilovolt, ac voltages from 200 mv full scale to 600 v, ac and dc current from 200 microamperes full scale to 2 amperes, and resistance from 200 ohms full scale to 20 megohms. It measures 2 by 5.6 by 4.6 inches and weighs 1.5 pounds.



Simpson Electric Co., 853 Dundee Ave., Elgin, Ill. 60120. Phone (312) 697-2260 [354]

Digital voltmeter includes printer

Put together a timer, a printer, and a digital panel meter, and the resulting digital voltmeter can record readings taken at periodic intervals. The printing DVM can be set by means of a pair of front-panel thumbwheel switches to make readings as often as once a minute or as far apart as once every 99 minutes. The data is

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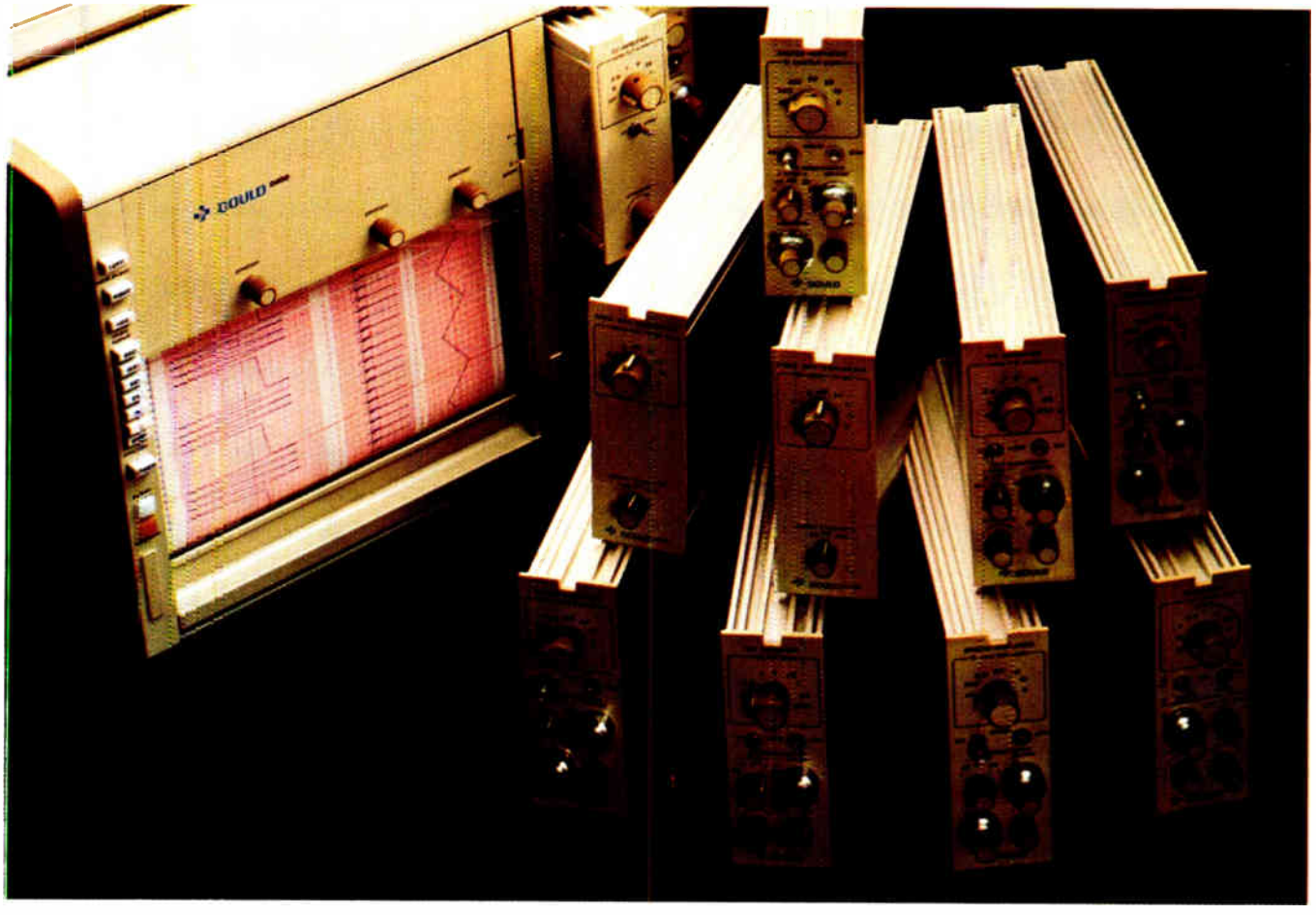

You can: amplify, convert, attenuate, suppress, reject, filter, expand, add, linearize, subtract, display, multiply, invert, square, divide, integrate, isolate, detect, alarm, control, demodulate...

Its modular design and interchangeable signal conditioners mean you get a recorder system "customized" to your needs with the ability to change input parameters at will through the addition of appropriate plug-in conditioners. Let us tell you more. Write Gould Inc., Instrument Systems Division, 3631 Perkins Ave., Cleveland, Ohio 44114. Or Gould Allco S.A., 57 rue St. Sauveur, 91160 Ballainvilliers, France.

For brochure, call Gould toll-free at (800) 325-6400, Ext. 77.
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The product development company

Circle 177 on reader service card 177

New products

displayed on a readout made of 0.6-inch light-emitting-diode digits and recorded on ordinary office-machine paper. In its standard form, the 3½-digit instrument has a full-scale range of 1.99 volts and an input impedance of 100 megohms. It sells for $990.

Columbus Instruments International Corp., 950 North Hague Ave., Columbus, Ohio 43204. Phone Jan Czekajewski at (614) 488-6176 [355]

Miniature units generate and measure low dc levels

Two small calibrator/potentiometers—one with a five-digit LED readout and the other with a null-balance detector—both generate and measure low-current and low-voltage dc signals. Input/output ranges for both units are identical: 0 to 110 millivolts, 0 to 11 volts, 0 to 22 milliamperes, and 0 to 52 mA. The compact, portable units can be used to calibrate thermocouple-type thermometers, pH meters, chart recorders, and similar equipment.

The digital model 1040 is powered by a built-in rechargeable-battery pack and contains its own charger. The null-balance model 1030, which uses a pair of LEDs to indicate the null point, uses five 9-V batteries. A rechargeable battery pack is optional. A special intrinsically safe version for use where explosive gases may be present is also available.

Transmation Inc., 977 Mount Read Blvd., Rochester, N.Y. 14606. [356]

Creeping up on daylight

We've just brought the integrated dc-to-daylight frequency synthesizer a couple of steps closer to reality.

The new Plessey IC's offer a quick and easy way to lower synthesizer costs while increasing loop response and channel spacing all the way from dc through the HF, VHF, UHF and TACAN bands.

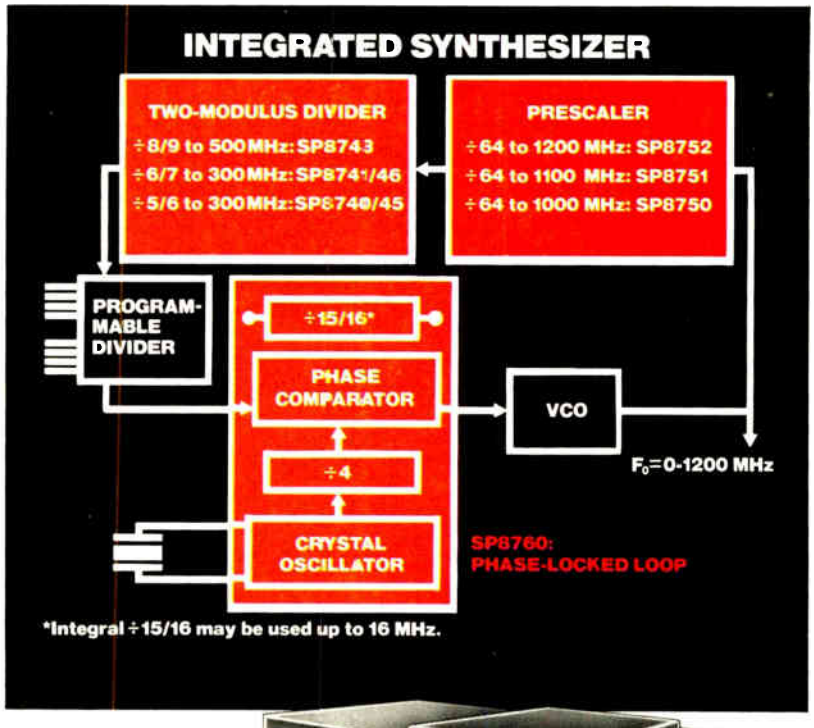
Start with one of our IC prescalers. They feature input ports for VHF and UHF, self-biasing clock inputs, TTL/MOS-compatibility and variable input hysteresis for wideband operation.

Then add one of our two-modulus dividers. All of them provide low power consumption, low propagation delay and ECL-compatibility, and most of them are available in commercial and MIL-temp versions.

Finally, to make things even simpler, add the Plessey SP8760 control chip and phase lock your synthesizer to any crystal up to 10 MHz. All the stability you need with none of the usual headaches and hassle.

If it all sounds too good to be true, contact us today for details and application notes.

Once you've seen the data, you'll see the light.



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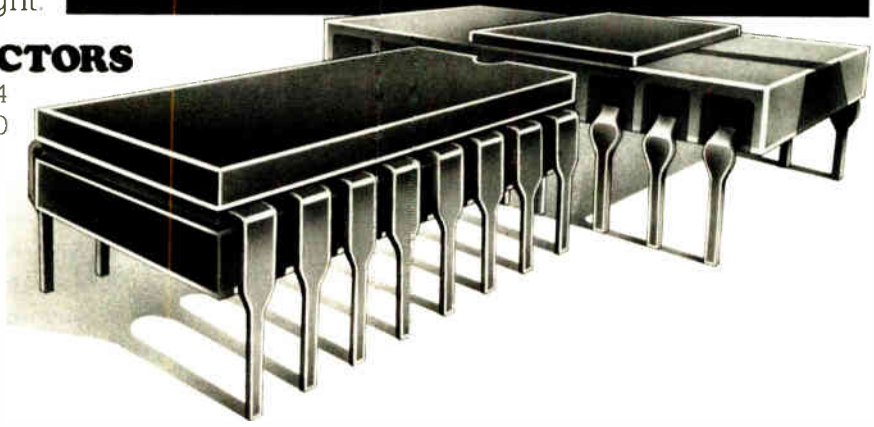

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Fixed and programmable dividers ☐ Linear and digital communications circuits

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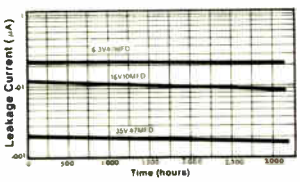


Matsuo developed the world's first resin dipped tantalum capacitor in 1960. Today, Matsuo delivers a broad range of capacitors to meet your needs. 5 types, 22 case sizes, 348 ratings. **And one standard of excellence.**

That's why Matsuo capacitors perform better. We build them better.

And because we do, we can talk about things like failure rates and leakage current when no other manufacturer does. Here are some highlights.

DIPPED TANTALUM WITH LEAD FRAMES.

Type 221. 7 case sizes, 188 standard ratings. We not only build them better, we pretest longer—48 hours at full voltage. That's why we offer the lowest failure rate—less than 2% per 1,000 hours—60% confidence level. Selected units at 1% FR. Better DC leakage control—.01XCV. Selected units at .001XCV. Fixed lead spacing. Square leads that "bite" corners so Dip stands upright even during soldering.

NEW! MICRODIPS®

Shown actual size

Type 203. 3 subminiature case sizes for high component density. From .110" to .126" diameter; .177" to .236" high. 31 standard ratings. Color coded. Solid tantalum, wire leads. Matsuo μ Dips exhibit superior electrical characteristics. Better DC leakage control—.01XCV.

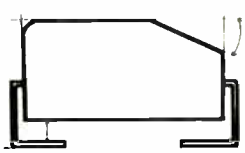
NEW! DIPPED TANTALUM WITH WIRE LEADS.

Type 202. 7 case sizes, 55 standard ratings. Flexible wire leads for point to point wiring. High reliability. Better DC leakage control—.01XCV. Designed for superior performance where minimum cost is required.

NEW! MOLDED TANTALUM.

Type 242. 1 case size, 38 standard ratings. Pretested for 48 hours at full voltage. Lowest failure rate—less than 1% per 1,000 hours. Better DC leakage control—.01XCV. Uniform lead location.

TANCHIPS. THE CHIPS ON STILTS.



Type 262. Now, 4 case sizes instead of 3. Each size now available in 3 lead styles. 36 standard ratings. Stilt-like leads keep capacitor away from hot solder, preventing heat transfer. Also, facilitates cleaning of solder flux, allows visual check of connection, eliminates moisture entrapment. Pretested 48 hours at full voltage. Lowest failure rate and better DC leakage control (.01XCV).

You should also know: Most orders are filled from stock. And Matsuo prices are competitive and then some. For more information, engineering samples, prices, just write or call.

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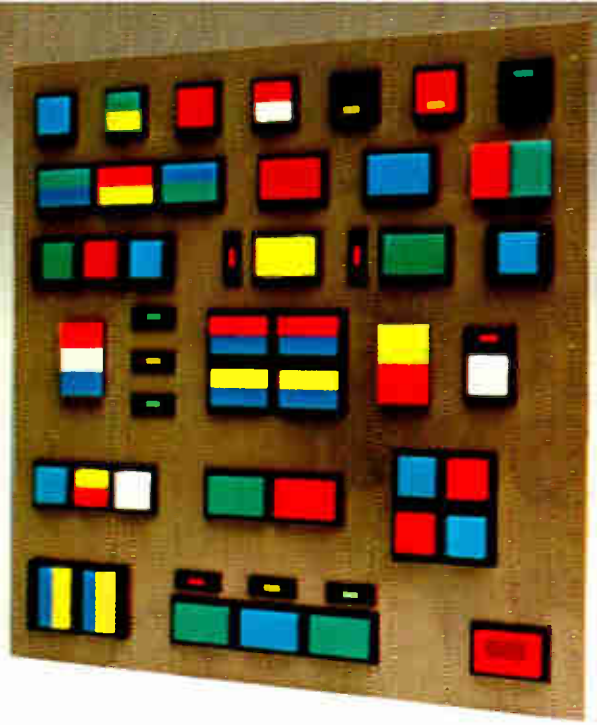

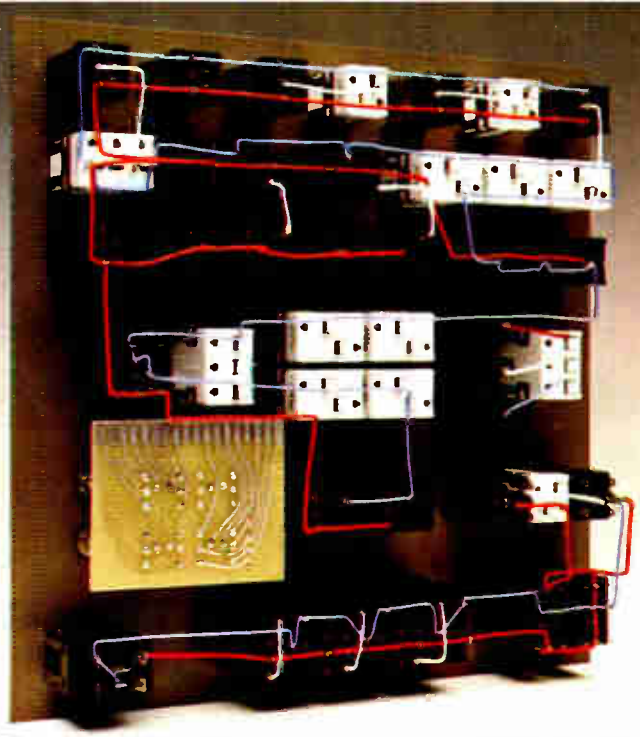

The only pushbutton that gives flexibility to designers...

...without giving fits to the people who wire it.

Until now, you wouldn't have counted on good-looking pushbuttons to look nearly as good when it's time to wire them.

But the AML (Advanced Manual Line) from MICRO SWITCH has changed all that.

AML devices combine button height, bezel size and compatibility of square and rectangular shapes to harmonize your panel. And the line is so broad, you won't need different-looking units to perform different functions.

Displays range from split screen and hidden color to a unique, three-segment lens cap indicator, all with transmitted or projected illumination, and a choice of lamps, including a T-1¾ wedge base lamp, neon and LED.

AML units also offer electrical flexibility, with features like three different electrically rated switches in the same size housing. Solid state pushbuttons that operate at 5V or 6-16V with a built-in regulator, sink (TTL) and source (CMOS). Electronic control from logic switching to 3 amps, 120 VAC. And power control up to 10 amps at 120 VAC.

All AML pushbuttons offer the same shallow depth for unique, single-level termination and easy wiring. You either snap them in place from the front, or subpanel mount them, using individual, strip or matrix mounting hardware.

And every AML device is designed to meet IEC, CEE24, UL and CSA standards.

Write for our "Control Panel Layout Design Guide." Contact your nearest MICRO SWITCH Branch Office or Authorized Distributor. Or call 815/235-6600.

Either way, you'll end up with a pushbutton that works as well as it looks.

MICRO SWITCH

FREEPORT, ILLINOIS 61032

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Circle 184 for data

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We've made it easy for you to experience the unique design, production, pricing and customer service benefits other Licon switch users have enjoyed for years. Free of charge . . . without any strings of any kind!

Here's all you need to do. Ask your nearby Licon distributor (he's listed below) for a copy of the New Licon Switch Selection Guide. Pick out the model you'd like from the list of Licon lighted and non-lighted pushbutton switches and single and double break basic switches. Fill out the postage-paid card that's enclosed . . . and we'll take it from there!

We'll rush you the Licon switch you choose.

You can weigh it, measure it, plug it into your product or prototype, bite it, kick it, sniff it, life test it . . . do whatever you want. It's yours.

You've nothing to lose. So call or write for a test drive today. Offer good in the U.S.A. only. Licon, A Division of Illinois Tool Works Inc., 6615 West Irving Park Road, Chicago, Illinois 60634. Phone: (312) 282-4040. TWX 910-221-0275.

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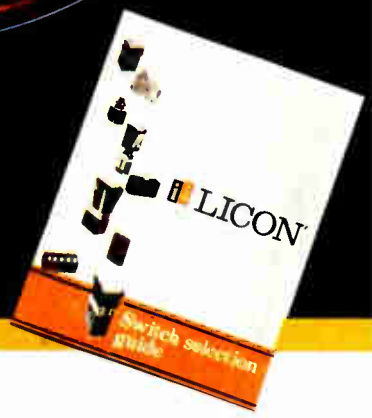

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Circle #182 For Full Details

Circle #257 To Have Salesman Call

Microprocessors

Computer boards are compatible

National Semiconductor aims microcomputer and memory boards at SBC 80/10 market

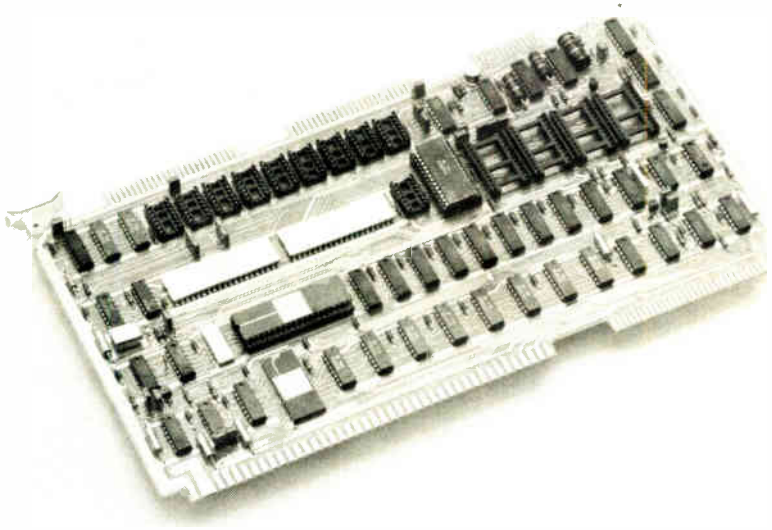
Look for action in the 8-bit microcomputer marketplace to heat up considerably now that National Semiconductor Corp. has decided to introduce a new line of board-level microcomputers and memory boards compatible with the Intel 80/10. The move comes less than a year after National introduced the INS8080, its version of Intel Corp.'s, MSC-80.

The National microcomputer board, the BIC 80/10, is priced at $265 when purchased in quantities of 100 or more. The memory boards, designated the BLC 016 and BLC 406, are priced at $527 and $189 each in 100-up quantities. According to Donald J. Schare, business manager of the Series/80 systems, these prices are 10% lower than those for competitive units in similar OEM quantities.

The BLC80/10 contains the INS808 microprocessor central processing unit, 1 kilobyte of on-board random-access memory, sockets for 4 kilobytes of on-board read-only memory or programmable read-only memory, complete serial input/output capability and six 8-bit programmable ports that allow true software control of peripheral I/O. The BLC 80/10 fits on a single 6.75-by-12-inch board.

The 1-kilobyte RAM is made up of National's low-power static MM2111 devices. Extra ROM or programmable ROM may be added in 1-kilobyte increments, using the MM2708 or the equivalent masked ROM, up to a maximum of 4 kilobytes. Synchronous/asynchronous serial communications ports are provided for either 20-milliampere current loop for teletypewriter or for RS-232-C-compatible peripherals.

The INS8080 has a basic instruction time of 1.95 microseconds. Data words are 8 bits, while instruction size may be 8-bit, 16-bit, or 24-bit. The six general-purpose registers may be addressed singly or in pairs for single or double precision. The maximum power supply, exclusive of PROM, I/O drivers, and terminators, is 5 volts dc at 2.9 amperes, +12 V dc at 150 mA; −5 V dc at 2 mA, and



Circle 183 on reader service card 183

New products

−12 v dc at 150 mA. The board weighs 14 ounces.

The BLC 016 contains 16-k by 8 bits of RAM, implemented with 32 MM5271 dynamic memory devices. On-board circuitry refreshes by 64 bit positions in all 32 devices every 29 milliseconds if read or write cycles are not active. When R/W cycles are in progress, refresh cycles are inhibited until the operation is complete.

The BLC 406 has 24 sockets for up to 6-k-by-8 bits of ultraviolet-erasable PROM or masked PROM in 256-byte increments. The sockets improve modularity and reduce inventory costs.

The BLC 016 and the BLC 406 provide direct memory expansion to 64 kilobytes via the system's buses. Fully buffered, all address, data, and command signals are compatible with transistor-transistor logic. In unit evaluation quantities, the BLC 80/10 is priced at $445, the BLC 016 is $878 and the BLC 406 is $315. Delivery is stock to three weeks from National and its authorized distributors.

National Semiconductor Corp., 2900 Semiconductor Dr., Santa Clara, Calif. 95051 [401]

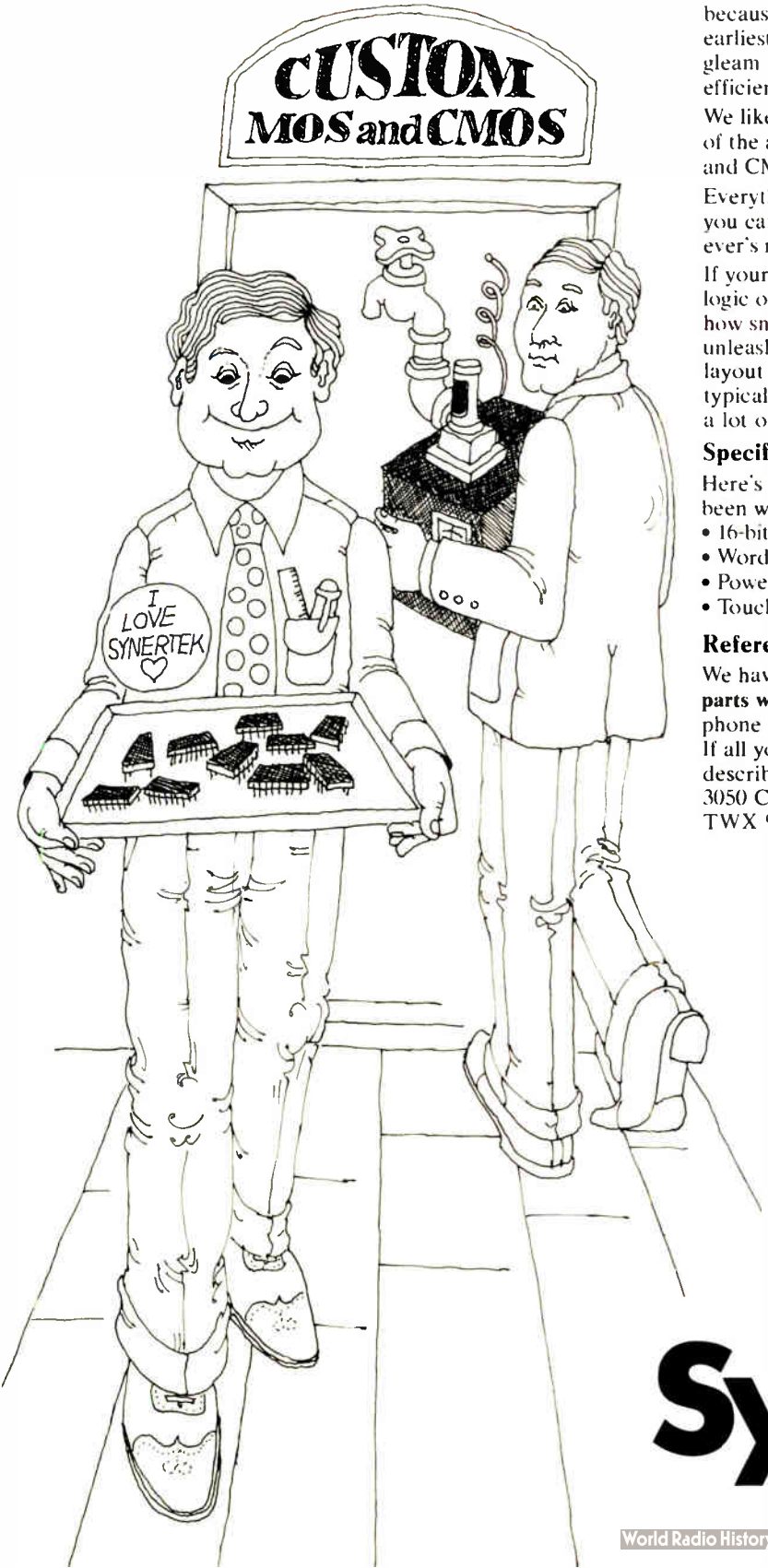
Rockwell adds six one-chip computers

Rockwell's MM77 one-chip microcomputer is being joined by six new members of the PPS-4/1 family. Three of the new devices are almost identical to the MM77 except for different amounts of on-chip random-access memory and read-only memory. The MM76 has 640 bytes of ROM and 48 4-bit words of RAM; the MM76E also has a 48-by-4 RAM, but its ROM is expanded to 1,024 bytes. The MM78 has 2,048 bytes of ROM and 128 4-bit words of RAM. For the record, the earlier MM77 has 1,344 bytes of ROM and 96 4-bit words of RAM. While they have some minor differences in instruction sets, all four of these microcomputers have 31 input/output ports.

The fourth new microcomputer is

Big enough to do your custom jobs.

Small enough to care.



Let us help you put your design into an LSI chip in the most efficient and cost-effective manner. We're good at it!

We do custom MOS and CMOS design and fab. And because we're set up to work on your project at the earliest possible stage (even when the black box is just a gleam in your eye), we can guide you into the most efficient design.

We like to go **one-on-one** with you. Your understanding of the application coupled with our experience in MOS and CMOS circuit design makes us an unbeatable team.

Everything we do is depletion mode Silicon Gate, and you can choose P-Channel, N-Channel or CMOS, whichever's right for your application.

If your next project is going to require a lot of random logic on one chip, we're the guys to see. Let us show you how small your big, complex LSI circuit can get when we unleash our experts on it. We do the toughest part—the layout design—by hand. This results in chips that are typically 30% smaller. Takes a little extra effort, saves a lot of bottom-line money.

Specifically . . .

Here's a sampling of the types of custom projects we've been working on recently.

- 16-bit μP
- Word processor control logic
- Power demand control circuits
- Touch-Tone* decoders
- Automatic phone dialers
- CMOS timing circuits
- CMOS paging systems

References?

We have a lot of happy customers. Because **their custom parts work.** If you want to get happy, just pick up the phone and give Bob Cushman a call at (408) 984-8900. If all you need is our short form catalog which also describes our standard product line, contact us at 3050 Coronado Drive, Santa Clara, CA 95051. TWX 910-338-0135.

*Touch-Tone is a trademark of the Bell System.

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Circle 185 on reader service card

New products

a minimum-cost device. Called the MM75, the single-chip computer has 22 I/O lines, 640 bytes of ROM and 48 4-bit words of RAM. Unlike the others, which are housed in large 42- or 52-pin dual in-line packages, the MM75 comes in a 28-pin DIP.

The remaining two units are the MM76C and MM76D, both of which are identical to the MM76, but with an added feature. The 76C includes a high-speed up/down counter, while the 76D offers a 12-bit analog-to-digital converter and six additional I/O lines. Actually, the 76C offers two 8-bit counters.

The MM76, 77, and 78 are available from stock now. The 75 and 76C will be available in production quantities during the second quarter of 1977. The 76D is planned for the third quarter, and the 76E has a 16-week delivery time.

Rockwell International, Microelectronic Device Division, 3310 Miraloma Ave., P.O. Box 3669, Anaheim, Calif. 92803. [403]

Analog I/O devices added to Motorola line

Oriented toward the original-equipment manufacturer, two data-acquisition modules and an analog-output module from Motorola are bus-compatible with the company's Exorcisor and Micromodule systems. The MM5A is an eight-channel differential-input data-acquisition unit that contains an input multiplexer, a high-gain instrumentation amplifier, a sample-and-hold circuit, a 12-bit analog-to-digital converter, logic for interfacing with the system bus, and a dc-dc converter. It can handle input voltage ranges from ±10 millivolts to ±10 volts and input currents of either 4 to 20 milliamperes or 10 to 50 mA. The gain of the instrumentation amplifier is programmable between 1 and 1,000. The MM5B is similar to the MM5A except that it has 16 single-ended inputs.

The MM5C is a four-channel analog-output module. It contains four 12-bit digital-to-analog converters, a 12-bit latch, control logic, and

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Guildline's radical 7-1/2 digit precision digital voltmeter, Model 9577 features standards laboratory accuracy and stability. The 9577 is equally at home on the work bench or in a system application via programmable BCD or IEEE Standard 488.

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Circle 188 on reader service card.

New products

a dc-to-dc converter. Strap-selectable outputs of 0 to 10 v, 0 to 5 v, ±10 v, ±5 v, and ±2.5 v are provided.

All three modules operate over the temperature range from 0 to 70°C, and all of them have a one-piece price of $725.

Technical Information Center, Motorola Semiconductor Products Inc., P.O. Box 20294, Phoenix, Ariz. 85036. Or phone Motorola Microsystems at (602) 244-6815 [404]

National unveils one-chip computers

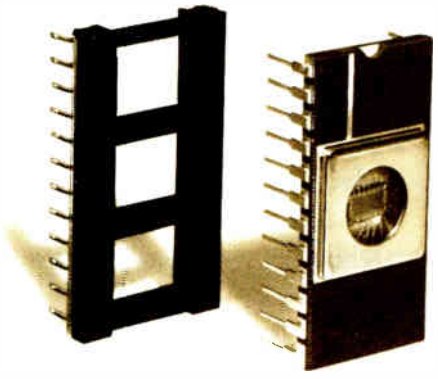
A line of calculator-oriented processors (COPS) from National Semiconductor is designed to fill the gap between powerful general-purpose microprocessors and dedicated custom circuits. According to Orville Baker, marketing manager for microcontroller products at National, general-purpose microprocessors are too expensive for many applications because of the large number of pieces that must be added to them to form a working system. Custom circuits, on the other hand, often take too long to develop, and they are not economical unless they are used in very large volume.

The COPS units each contain a 4-bit microprocessor, a clock generator, some control read-only memory, some random-access memory, parallel inputs, programmable outputs, and several single-bit programmable input/output ports. The units differ in the amount of ROM and RAM they provide, and in the number and type of I/O ports.

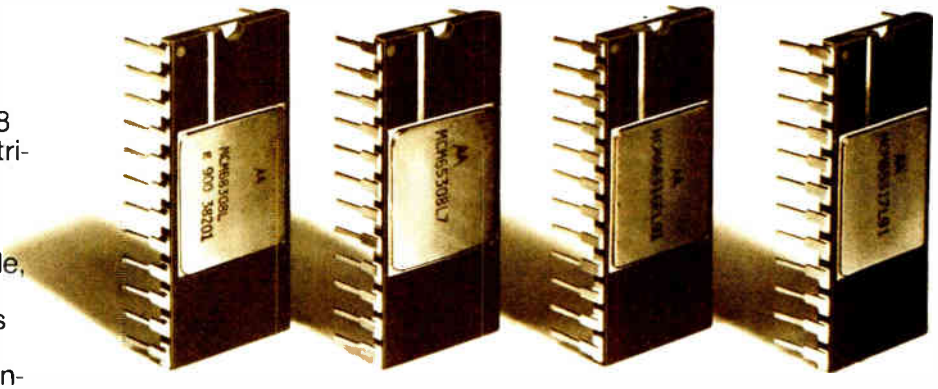
The MM57140, which has a cycle time of 14 microseconds, contains 630 bytes of ROM and 55 4-bit words of RAM. The faster (10-μs) MM5799 offers 1.5 kilobytes of ROM and 96 words of RAM. The most powerful of the new computers is really a two-chip set: the MM5781/82. It has 2 kilobytes of ROM and 160 words of RAM.

All three computers are expected to find wide application as dedicated controllers in equipment ranging from vending machines and elec-

For EPROM sockets,



the EPROM... and four low-cost alternatives.



Motorola's new MCM68708 is an 8192-bit erasable and electrically reprogrammable pin-for-pin equivalent of the 2708 type EPROM so popular for system debugging and other non-volatile, reprogrammable ROM applications. The 68708 is organized as 1024 bytes of 8 bits, has a max. access time of 500 ns, uses standard +12 V, +5 V, and −5 V power supplies, and is TTL compatible. It's pin-for-pin compatible with popular 8Ks and upward compatible with 16K ROMs. For pricing and delivery, please contact your authorized Motorola distributor or Motorola sales office.

Mask programmable ROMs are the low-cost alternative.

When you really need that reprogrammable EPROM, there's no better choice than our MCM68708. However, there are plenty of applications where mask-programmable ROMs will do as well, and they're much easier on the budget. We supply four of these low-cost, mask-programmable alternatives, two 8Ks with 68708/2708 pin-outs, and two 16Ks with nearly identical pin-outs.

The MCM65308 is a metal-gate 8K ROM with an access time of 350 ns, for systems that require three power supplies. The other is the silicon-gate, depletion-load MCM68308. This high performance 8K ROM has an access time much faster than the 500 ns printed on the data sheet, and it requires only a single +5 V supply.

You can put 16K of ROM in those sockets where only 8K fit before with our metal-gate MCM65317 to achieve lowest costs in three-supply systems. The MCM68316E is the silicon-gate 16K for single-supply, extended temperature range applications.

Turnaround on these mask-programmable types is super. Contact your authorized Motorola distributor or Motorola sales office for your next requirements.

Data sheets are available from Motorola Semiconductor Products Inc., P.O. Box 20912, Phoenix, AZ 85036.

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New products

tronic scales to specialty calculators and computing instruments.

National Semiconductor Corp., 2900 Semiconductor Dr., Santa Clara, Calif. 95051 [405]

Triple-output bench supplies can power microprocessors

Most triple-output supplies consist of a fairly high-current 5-volt supply and a pair of tracking bipolar outputs. The model 6236B and 6237B can perform this function, but they also have a continuously adjustable tracking-ratio control that allows the user to adjust the relationship between the tracking outputs. Specifically, the negative output can be set to any negative voltage between 5% and 95% of the positive output.

The bipolar outputs, each of which is rated at 0.5 ampere, can be connected in series to provide 40 v at 0.5 A. Regulation is within 0.01% plus 2 millivolts, and ripple and noise are rated at 1.5 mV peak to peak.

The third output is what distinguishes the two supplies. The 6236B

provides 0 to 6 v at up to 2.5 A, while the 6237B puts out up to 1 A from 0 to 18 v. Both units sell for $345, and both have a delivery time of two weeks.

Hewlett-Packard Co., 1501 Page Mill Rd., Palo Alto, Calif. 94304 [407]

Video terminal works with TI 990 computer family

The model 911 video display terminal is a relatively inexpensive unit that was designed to work with the 990 computer family from

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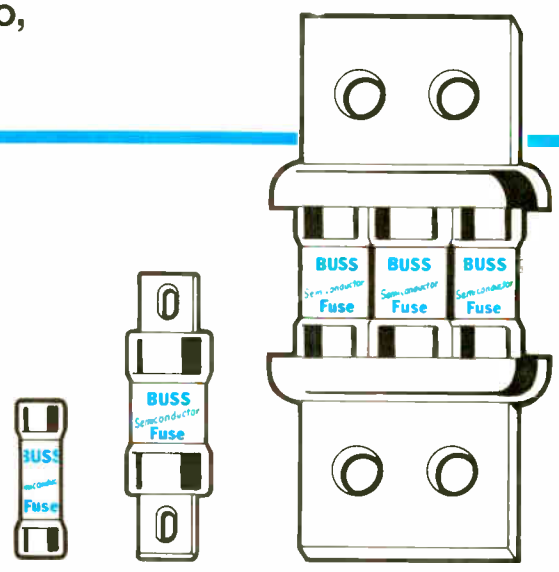

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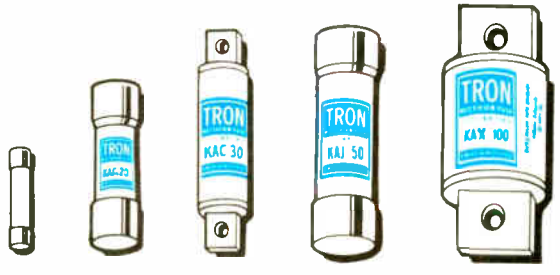

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Circle 191 on reader service card 191

New products

Texas Instruments. It consists of a display unit, a separate keyboard, and a controller. The controller is contained on a circuit board that plugs into a 990 computer chassis.

The display uses an 8.5-by-5.5-inch monitor with 5-by-7-dot-matrix characters. It comes in two versions: the 960-character unit uses 12 lines of 80 characters each and the 1,920-character model is organized as 24 80-character lines. Display features include dual intensity and a blinking underline cursor.

The keyboard is connected to the display by a five-foot cable.

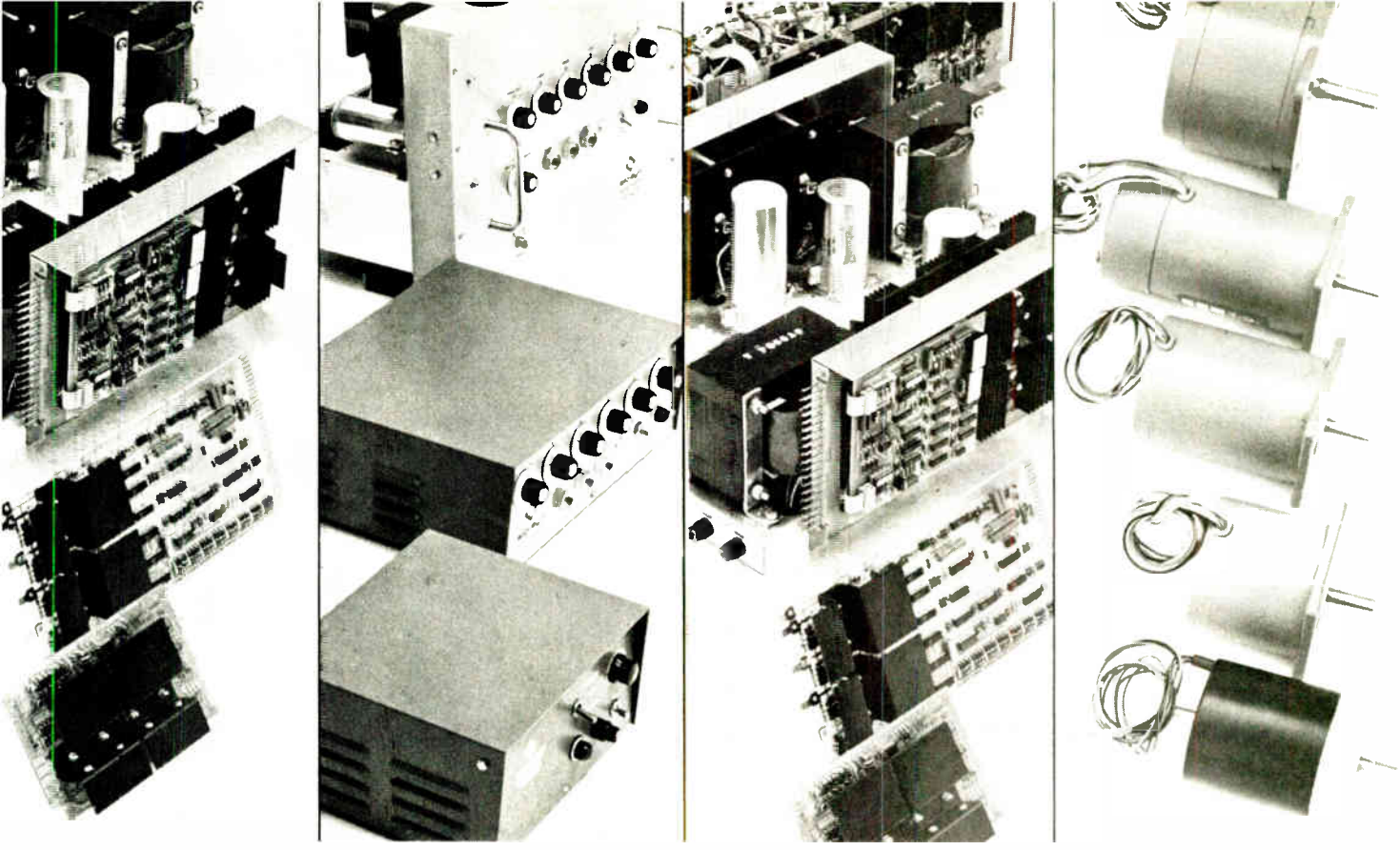
The 1,920-character version of the 911 sells for $1,700 each, dropping to $1,088 in lots of 50. Deliveries will begin in July.

Texas Instruments Inc., Digital Systems Division, P.O. Box 1444, M/S 784, Houston, Texas 77001. Phone Computer Systems Marketing at (512) 258-5121 [408]

Microcomputer is built around TMS-9900 processor

The TEC-9900-SS is a single-board microcomputer built around the Texas Instruments TMS-9900 16-bit microprocessor. The basic unit includes RS-232 and 20-mA current-loop interface capabilities along with an erasable programmable read-only memory programmer. The board has room for 2 kilobytes each of ROM, erasable PROM, and random-access memory. Additional memory boards can be added to expand the total memory to 65 kilobytes. The system sells for $399 and a kit form is also available at $299.

Technico Inc., 9130 Red Branch Rd., Columbia, Md., 21045. Phone (800) 638-2893 [409]



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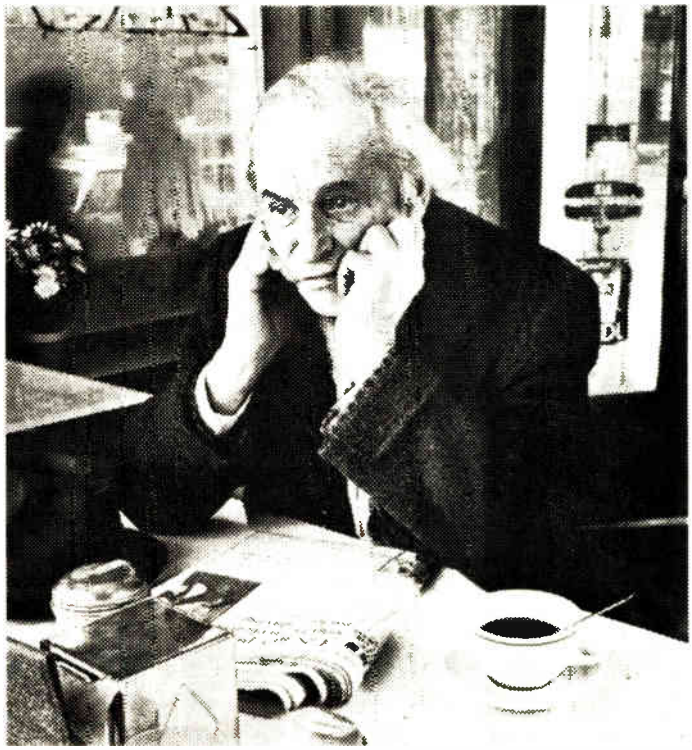

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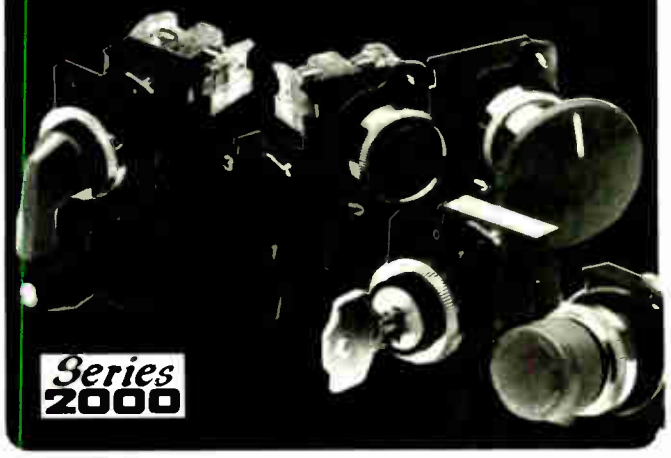

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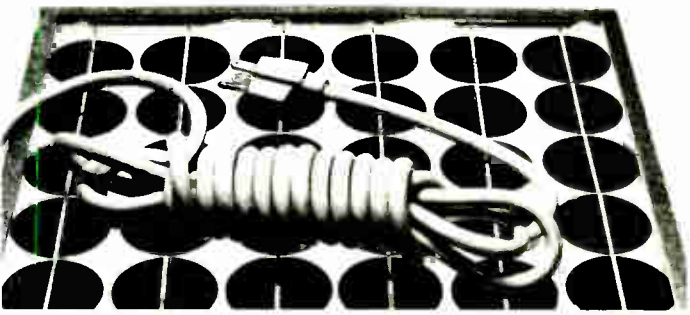

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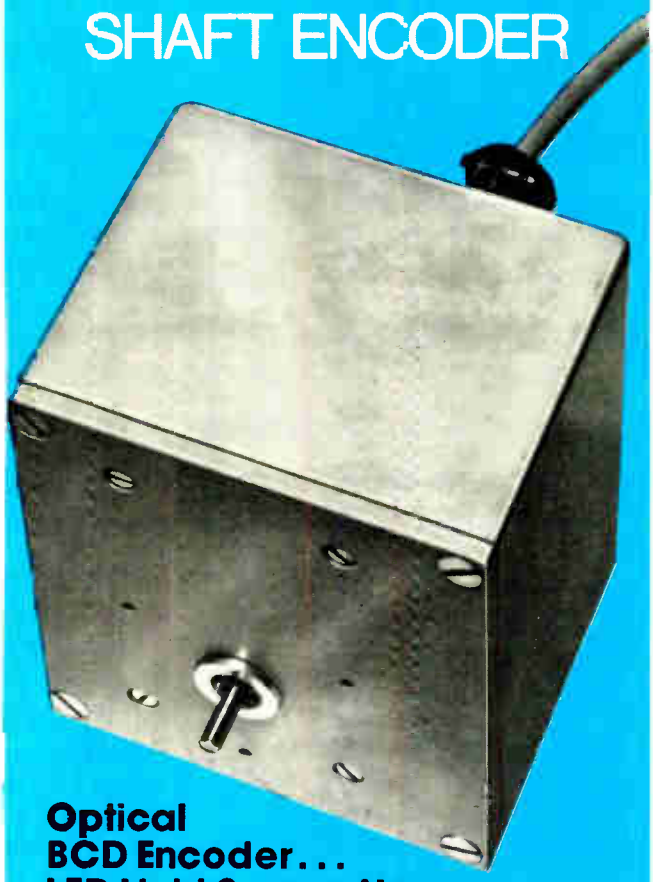

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Circle 263 on reader service card

Packaging & Production

Prototyping kit is solderless

Interconnection system uses insulation-piercing contacts and special hand tool

A kit for wiring prototype circuit boards borrows from a reliable solderless technique often used for connectors for mass-terminating tape cable. The designer mounts U-shaped insulation-piercing contacts on a prototyping circuit card and uses a special tool (not part of the kit) to push AWG 30 Kynar-insulated wire onto the sharp contacts. Kit-maker 3M Co. uses the same approach in its Scotchflex connectors, and the technique also resembles Quick-Connect, used for some time in manual and automated form at Bell Laboratories [*Electronics*, Feb. 19, 1976, p. 104].

The 3383 breadboard kit contains a prototype printed-circuit card and 36 eight-terminal breadboard strips. The 4½-by-6⅜-inch card has printed busses and floating multiple connections with a grid of holes on 100-mil centers. The contact strips have a thermoplastic body and beryllium-copper insulation-piercing contacts with gold-over-nickel plating.

Circuit cards are designed to mate with either the Scotchflex 40-position edge connector with 100-mil pad spacing or a 44-position card-edge connector with 156-mil pad spacing. As an added option, a Scotchflex 40 position header can be soldered to the board for interconnection to a socket connector-cable jumper.

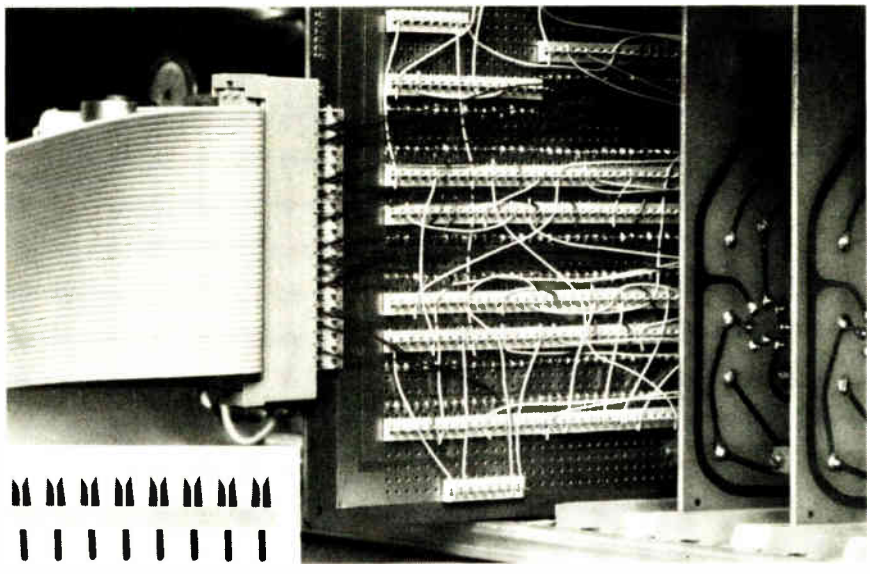
The company has further developments on this system in the works. To come out soon is a more advanced strip that will allow a user to plug a dual in-line package directly into the contact strip rather than soldering the DIP to the board. In addition, 3M and a large manufacturer of automatic machinery are looking into automating the process.

Price of the breadboard kit is $34.94 in single units. Additional contact strips cost 60 cents each in 100-per-carton quantities. The hand tool costs $3.28.

3M Co., Department EP7-9, Box 33600, St. Paul, Minn. 55133 [391]

Bare board tester has built-in test fixture

The cost of continuity testing of bare pc boards could tumble with a new test system, the CV50 Circuit Verifier. In the case of relatively short runs and a multiplicity of board



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patterns, each new board usually requires a new fixture. But the new system avoids this requirement.

Packaged as a single, portable bench-top unit, the CV50 combines a microprocessor-controlled, all-solid-state tester with novel vacuum-actuated fixturing. This combination substantially cuts system and interchangeable-test-head cost. A basic system with 2,048-point switching and interface capacity sells for $13,250. The interchangeable test heads, which accept boards up to 10 by 14 inches, are priced at $275 plus $1.15 per test point.

The system provides go/no-go circuit verification with a capability for board-fault analysis. System test time is 250 microseconds per point. Combined cycle time, including fixture actuation is 1.5 seconds maximum, so throughput is essentially limited by operator speed. A self-test mode indicates faults in the instrument's switching network and test head.

The system is initially programmed from a known-good board. Nominal programming time is 2½ minutes. An optional cassette tape recorder may be used to permanently store the program.

Everett/Charles, 2806 Metropolitan Place, Pomona, Calif. 91767 [392]

Connector holds LCDs perpendicular to pc boards

A connector for liquid-crystal displays is designed to hold the displays at right angles to a printed-circuit board. The heart of the assembly is a

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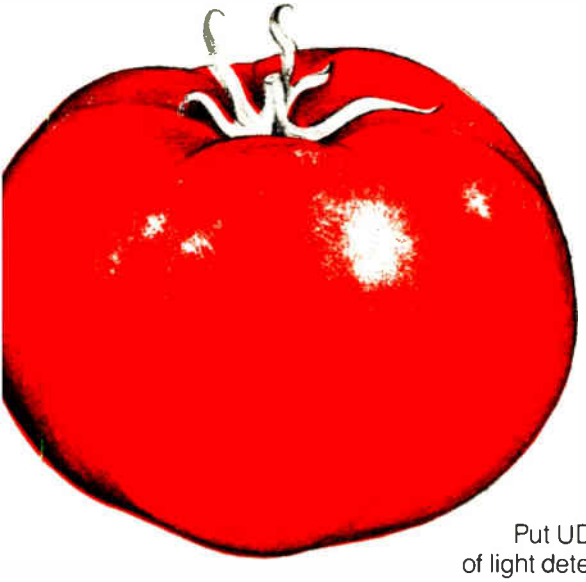

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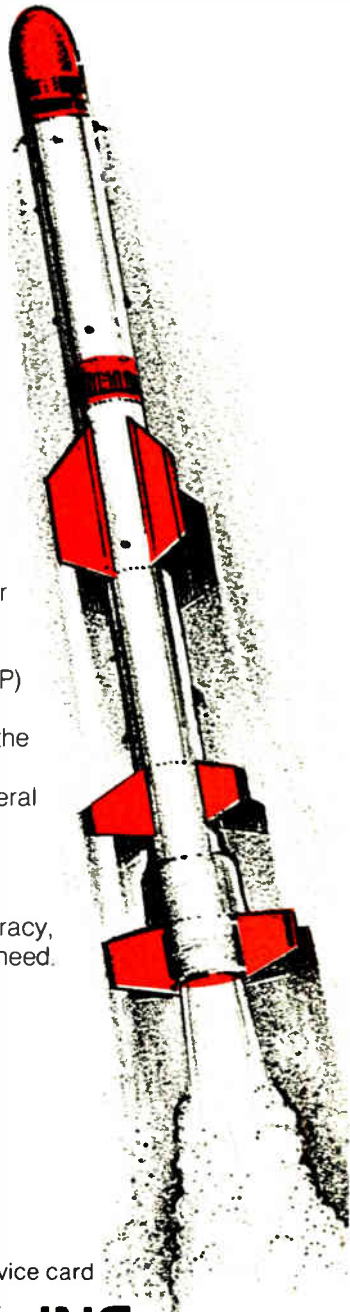

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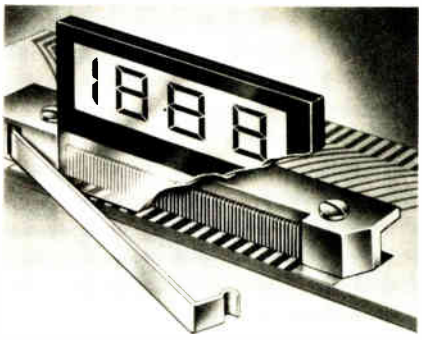

Zebra 1010 elastomeric connector—a flexible plastic element made up of alternating conductive and nonconductive layers. The Zebra connector is positioned in a dielectric holder with zero insertion force, and an LCD of any design up to 2.760 inches long is then placed in the holder and secured with a metal clip. The entire assembly is then mounted on a pc board with two pairs of nuts and bolts. Assembly and disassembly are rapid and require no soldering.

Technical Wire Products Inc., 129 Dermody St., Cranford, N.J. 07016. Phone (201) 272-5500 [393]

Automatic probing system handles 5-inch wafers

An automatic wafer-probing system that combines microprocessor control with air-track handling can accommodate wafers with diameters as large as 5 inches. The model 1038X prober can be programmed to operate in both English and metric units on 2-, 3-, 4-, and 5-inch wafers. Faster than its predecessor, the

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1034X, the 1038X can be made even faster by the addition of an automatic alignment option. Provision is made for six inker positions, including two for in-place inking. The base price of the prober is $30,500; adding the automatic-alignment option increases the price by $10,000.

Electroglas Inc., 2901 Coronado Dr., Santa Clara, Calif. 95051. Phone Al Harmon at (408) 246-6500 [394]

Inserter accommodates 48 component values

An automatic machine that inserts axial-lead components into circuit boards is fed by up to 48 cartridges (or a total of 48 reels and cartridges in any combination) so that up to 48 values of, say, resistors can be handled with no need for presequencing. The machine sequences and inserts in one operation. Sequence operation is numerically controlled by punched paper tape. As one component is inserted, the next is selected, its leads are formed, and the operator positions the board to receive it.

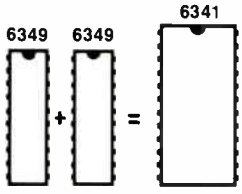
Amistar Corp., 2675 Skypark Dr., Unit 203, Torrance, Calif. 90505. Phone Ed Booth at (213) 538-1303 [395]

Ultrasonic soldering unit works without flux

Sonosolder is an ultrasonic production tool for soldering or coating a variety of nonferrous metals without a flux. The technique not only eliminates flux and its attendant post-soldering cleaning operations, but it also permits soldering to materials

Even if you have room for the state of Texas...

You'll want this space saving 20-pin 4k PROM



Now you can put two 4K bipolar memories into less space than that required for one 24 pin package.

This is a space savings of 54%.

Monolithic Memories' 5/6308 and 5/6348 series is a solid second source to the TI SN54/74 series of 20 pin 2K and 4K bipolar memories. And . . . we can deliver!

It takes tenacity to run with the "big guy," but that's what we've got—and you get the *price* and *availability* you want when you deal with Monolithic Memories.

Introducing Monolithic Memories "TENACITY DEVIL"

Features

- 54% reduction in space over 24 pin 4K
- Available in volume now (25K from stock)
- Fastest guaranteed access time (70 nsec max on 4K)
- Lowest cost per bit
- Cerdip product at plastic prices
- Direct drop in replacement for TI devices

Monolithic Memories Part #	Replaces TI Part #	Size	Organization	Output	Temperature	t_{AA} MMI	t_{AA} TI
5308-1	SN54S470	2K	256 x 8	OC	Military	80	80
5309-1	SN54S471	2K	256 x 8	TS	Military	80	80
6308-1	SN74S470	2K	256 x 8	OC	Commercial	70	70
6309-1	SN74S471	2K	256 x 8	TS	Commercial	70	70
5348-1	SN54S473	4K	512 x 8	OC	Military	80	85
5349-1	SN54S472	4K	512 x 8	TS	Military	80	85
6348-1	SN74S473	4K	512 x 8	OC	Commercial	70	75
6349-1	SN74S472	4K	512 x 8	TS	Commercial	70	75

Unites States
Monolithic Memories, Inc.
1165 East Arques Avenue
Sunnyvale, CA 94086
Tel: (408) 739-3535
TWX: 910-339-9229

Europe
Monolithic Memories, GmbH
8000 Munich 80
Mauerkircherstr. 4
West Germany
Tel: (089) 982601, 02, 03, 04
Telex: (841) 524385

Far East
MMI Japan KK
Parkside-Flat Bldg.
4-2-2, Sendagaya Shibuya-Ku
Tokyo 151, Japan
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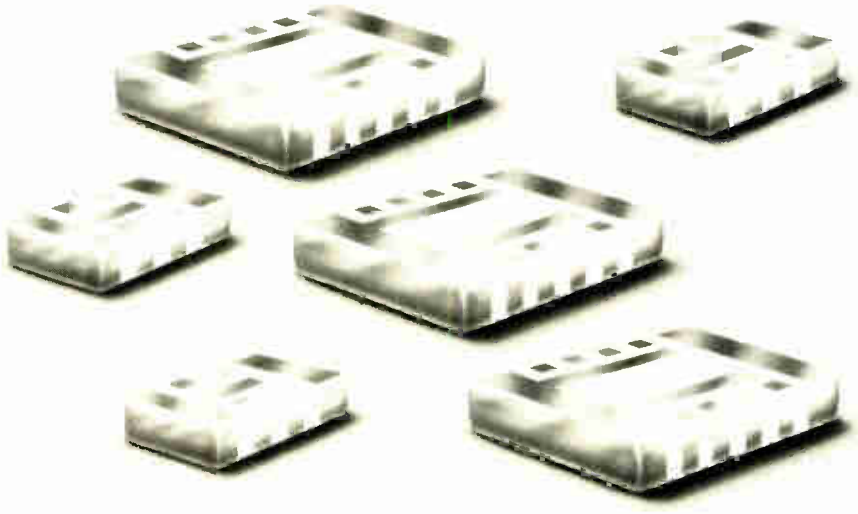
Monolithic Memories

Circle 203 on reader service card 203

Monolithic capacitors have been our business for nearly three decades.

We build them better.



Now we're offering Adjustable-Fixed Chip Capacitors in two sizes

Your interest in our first planar 'VEE CAL' Adjustable Fixed Chip has led us to develop an additional body size — the popular .08" x .05" (2.03 x 1.27mm) package.

Now you can obtain the original VC2A (.12" x .10"/3.05 x 2.55mm) in values 3 to 47 pF — and adjust it within ±.25 pF of any value.

Or you can select the new VC3A and adjust it within 2-3 pF of any value in its 15 to 32 pF range.

You can adjust (add or subtract) capacitance in or out of circuit on both NPO parts — and arrive at a fixed value each time.

We've also developed a probe card system that allows you to adjust the VC2A to within ±.25 pF of any value in 30-45 seconds.

Thinking of making some adjustments in your chip capacitor usage? Then think of our 'VEE CAL' Adjustable-Fixed Chip Capacitors. In fact, call us at (203) 268-6261 and ask for your free sample.

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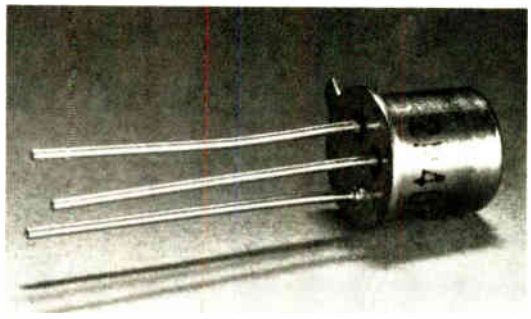
Circle 206 on reader service card

Good ones might cost you 12¢ ...bad ones $2000.



It can be one of the real frustrations of manufacturing electronic products: a simple 12¢ IC fails and shuts down an expensive piece of equipment you have in the field under warranty. To make it right you send a service engineer out at a cost of anywhere from several hundred to several thousands of dollars. All for a 12¢ part.

How does a bad IC get through both your supplier's tests and your own in-house screening? And what can you do about it?

First, a simple GO/NO GO test does only part of the job. It spots the *dead-on-arrivals*, but not those doomed for *infant mortality*.

All ICs, from the most simple to the most complex, need to be *preconditioned* before testing. We can take one of your ICs and put it through a series of preconditioning steps that packs a year's worth of living into less than a week.

That's a lot of stress, but semiconductors don't wear out merely through normal use. They die from some kind of congenital defect.

Our preconditioning—tailored to your specific devices and the environment in which they're used—turns up those defects, and in a hurry, before you invest time and labor into them.

We've been doing this longer than just about anybody else—since the mid-sixties. We have 3 labs for quick nationwide service. And last year over 40,000,000 ICs of all kinds went through those labs.

There are two steps to our service. Step 1: we calculate the optimum, most economical preconditioning and testing procedures for your devices. And step 2: we do the work.

We're successful because we've saved our clients hundreds of thousands of dollars, yet that first step costs even less than our hypothetical 12¢; it's free. Call us.

Free. Basic Handbook of Preconditioning and Testing Semiconductors

Here's your quick guide to some of the important ins and outs. It won't replace your need for experts—but it will certainly help you get the most out of them. Included: "Testing—how much, how little?" "The cost of testing vs. not testing." "How to test the test labs." And more.

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Send for our "Timex Believes in LCDs" brochure. Timex Components, Inc. 115 Belmont Dr., Somerset, N.J. 08873.

TIMEX COMPONENTS, INC.

Today, Tomorrow, Beyond

Subassemblies

Dc converter controls flashes

Eight-pin DIP combines monolithic IC and a power transistor

A hybrid control unit that acts as a dc-to-dc converter for xenon flash lamps promises tighter control and higher efficiency than comparable discrete units. Designed by Micro Components Inc., the MCC 139 consists of a monolithic integrated circuit and power transistor in an eight-pin dual in-line package. It is expected to find use in strobe units for commercial and consumer cameras, as well as in battery-operated instruments, beacon lights, and switching regulators.

Built into the IC are a free-running oscillator, a temperature-compensated voltage-reference regulator, and two comparators. The oscillator, with a frequency programmed by an external resistor, drives the power transistor. The transistor operates as an efficient switching amplifier and can directly drive a transformer at peak currents of 4 amperes, or an average of 1.4 A. In typical strobe applications, the transformer charges a capacitor to several hundred volts through a diode. The capacitor is discharged when the strobe is triggered and then recharged.

The comparators use a resistive voltage divider to monitor the capacitor voltage. The reference regulator establishes a reference for the comparators. One of them provides a current to illuminate a LED indicator that shows less-than-desirable voltage levels that would result in a weak flash. The other turns the oscillator off at a set input level.

Once the oscillator is turned off, the capacitor loses charge slowly. The IC turns the oscillator back on to charge the capacitor when the voltage drops to the set level. "This way, we hold the energy level tighter than can be done with discretes, and the oscillator is turning on and off," says Robert Maigret, product engineer. "With discretes, the capacitor is being charged all the time. They require idling current of about 200 milliamperes, compared to 20 mA for the MCC 139."

The MCC 139-1, optimized for 3-V systems, is priced at $1.68 in quantities of 100. The MCC 139-2, intended for 6-V systems and with a typical on voltage of 0.3 V at 3 A, sells for $1.61. The MCC 139-3, for 6-V systems, has a typical on voltage of 0.4 V at 4 A and costs $1.26.

Micro Components Corp., 99 Bald Hill Rd., Cranston, R.I. 02920 Phone (401) 463-6000. [382]

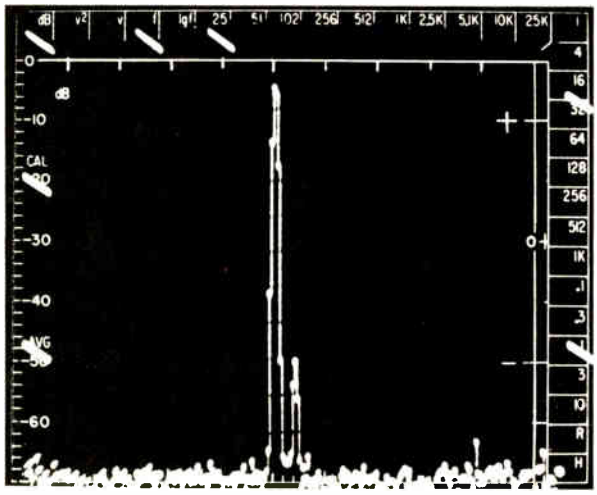
Switcher delivers 120 amperes at 5 volts

Although it measures only 3.5 by 8 by 13 inches, the model 712 power supply can deliver up to 120 amperes at 5 volts. The 20-kilohertz switcher is able to produce 1.6 watts per cubic inch because of its high (75%) efficiency. For maximum reliability it produces 600 watts without using parallel-connected power transistors.

For users who need more than 120 A, two or more 712s can be

combined by simply connecting their outputs in parallel. No master/slave connection is required. The power supply is protected against both short circuits and overvoltage. In addition, a thermostat monitors the case temperature and allows full output until the case reaches 80°C. For quantities up to 99 units, the 712 sells for $650. Small quantities are

How do you resolve two signals spaced 1 Hz apart at 2 MHz?



With an EMR Model 1510 Digital Real-Time Spectrum Analyzer and EMR Model 1520 Digital Spectrum Translator. Simply add the optional EMR Model 1521 Range Extension Module to the 1520 Translator, and you have real-time spectrum analysis at frequencies up to 2 MHz!

The CRT photograph illustrates the result. The input signal consisted of two discrete frequencies spaced 1.0 Hz apart, with a 50 dB difference in amplitude. The frequency range covered is 25.6 Hz centered about 1.990000 MHz, and the frequency resolution is 0.1 Hz!

Only EMR offers that much resolution at frequencies up to 2 MHz in real time.

So if you have an analysis problem requiring high-resolution/high-frequency real-time spectrum analysis, contact EMR . . . we will arrange for a demonstration or detailed information.

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813-371-0811

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210 Circle 210 on reader service card

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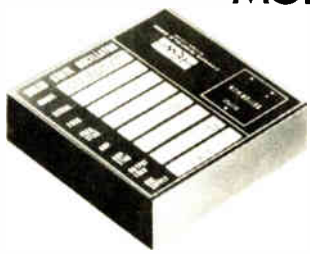

DIMENSIONS:
Height – 0.5" (1.27 cm)
Width – 1.5" (3.81 cm)
Length – 1.5" (3.81 cm)

FREQUENCIES AVAILABLE:
24.4Hz to 250kHz

STOCK FREQUENCIES:
Binary Countdown from 400kHz or 500kHz

FREQUENCY STABILITY:
±.1%

TEMPERATURE RANGE:
+ 0 C to + 50 C

OUTPUT WAVEFORM:
Squarewave, duty cycle 50%
Standard CMOS Output

SUPPLY VOLTAGE:
Any fixed voltage from + 5Vdc to + 15Vdc ± 5%

SUPPLY CURRENT:
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DELIVERY:
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Circle 265 on reader service card

$10 Thermopile Detector is here

Its initially high cost limited the thermopile to defense and space applications. Sensors patented production process lowered the price of the thermopile, permitting its use in gas analyzers, non-contact temperature monitors and fire detection systems. Our latest price milestone places the Sensors thermopile in a new realm of applications.

The thin film thermopile detector has long been the choice infrared detector in many instruments and systems. It is rugged, stable, and is especially suited for DC measurements. It is a low noise, low impedance device that has a flat response from the UV to 40 microns.

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Telephone: 313/973-1400

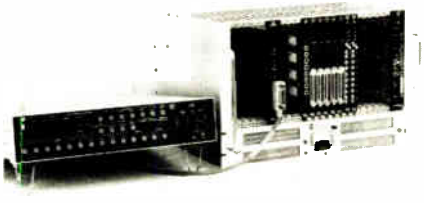
Circle 266 on reader service card

available immediately from stock. RC Associates Inc., 3705 Haven Ave., P.O. Box 2163, Menlo Park, Calif. 94025. Phone R. D. Okada at (415) 322-5321 [386]

Module links CAMAC system with IEEE interface bus

To allow the easy interconnection of standard CAMAC modules (IEEE standard 583) with instruments that incorporate the general-purpose interface (IEEE standard 1975-488), KineticSystems has added the model 3388 GPIB Interface to its line of CAMAC modules. The double-width module allows up to 14 instruments to be connected via standard GPIB cables.

The unit can function as a controller, talker, and listener. For systems containing another controller, the 3388 also has a controller-idle state.



The unit is supplied with either the 24-contact connector specified by IEEE 488 or with the 25-contact D-connector specified in Europe by the IEC. In small quantities, the model 3388 sells for $850.

KineticSystems Corp., 11 Maryknoll Dr., Lockport, Ill. 60441. [387]

10-watt, 5-kilovolt supply occupies only 6.4 in.^{3}

Capable of delivering up to 2 milliamperes at 5,000 volts, the model RVF5-10 is an adjustable power supply housed in a module measuring 2 by 4 by 0.8 inches. A built-in 10-turn potentiometer allows adjustment of the output voltage from 2 to 5 kilovolts, or an auxiliary 5-kilohm pot can be employed for

New products

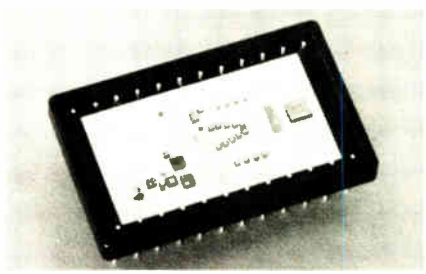
remote setting of the voltage. The unit's output terminals are both floating, so either or neither can be grounded depending upon system requirements.

The RVF5-10 operates from −55°C to 100°C. It requires an input voltage of 25 to 31 v dc at a current of no more than 650 mA. Load regulation is within 2%; line regulation within 0.1%. The device is compliant with the requirements of MIL-E-5400. It sells for $295 and has a delivery time of 10 weeks.

Spellman High Voltage Electronics Corp., 7 Fairchild Ave., Plainview, N.Y. 11803. Phone Dom Galluzzo at (516) 822-2203 [384]

A-d unit in DIP converts 8 bits in 900 nanoseconds

With a total conversion time (including start command) of only 900 nanoseconds, the model MN5101 is believed to be the fastest 8-bit analog-to-digital converter available in a dual in-line package. The unit, which will be shown at Electro77 next week in New York, can run even faster if its resolution is reduced. It performs 6-bit conversions in 650 ns, and 4-bit conversions in 400 ns. Linearity is within half a least significant bit over the full operating temperature range, while accuracy is within 1 LSB at 25°C and 2 LSBs over temperature.



Two versions are offered. The MN5101 operates from 0 to 70°C and sells for $234 in unit quantities. The MN5101H works from −55 to 85°C and is priced at $354 in the same quantities.

Micro Networks Corp., 324 Clark St., Worcester, Mass. 01606. Phone John F. Munn at (617) 852-5400 [385]

New literature

Measuring forward voltage drop. A three-page article from Westinghouse explains how to measure the forward voltage drop of power diodes and thyristors. Tech Tips 4-6, "Forward Voltage Drop Measurements," includes a simplified diagram of a test circuit that is essential for correlating such measurements with those of the device manufacturer. It is useful both for incoming inspection and as a matching criterion for selecting devices to be operated in parallel. Copies are offered by the Semiconductor Division, Westinghouse Electric Corp., Youngwood, Pa. 15697. (In Europe write to S. Zambelli, CDS Westinghouse, BP107, 72003 LeMans Cedex, France.) Or circle reader service number 421.

Using a vector voltmeter. Application Note 22, "Vector Voltmeter Measurement Techniques," is a 12-page paper that tells how to use a vector voltmeter to measure such quantities as group delay, scattering parameters, gain, phase, amplitude, attenuation, and power over the frequency range from 1.5 megahertz to 2.4 gigahertz. Copies are available from Harris Corp., PRD Electronics Division, 6801 Jericho Turnpike, Syosset, N.Y. 11791 [422]

Everything electronic. A 64-page catalog from Mouser Electronics, 11511 Woodside Ave., Lakeside, Calif. 92040, includes data and prices on a wide variety of passive and active components, transformers, tools, hardware, switches, and test equipment. [426]

Power supplies. The line of ac-to-dc power supplies and dc-to-ac power inverters made by Abbott Transistor Laboratories Inc., is described in the company's "Industrial Power

Supply Catalog." Copies may be obtained from the company at 5200 West Jefferson Blvd., Los Angeles, Calif. 90016 [423]

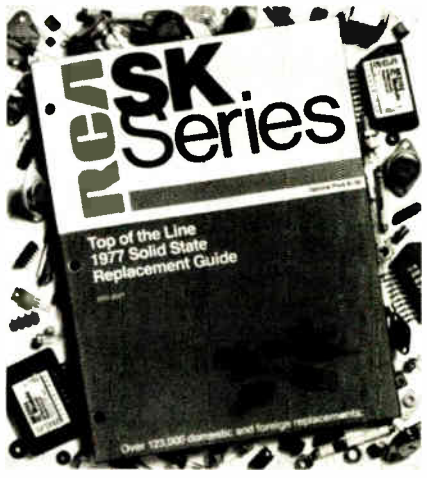
Electrical test equipment. Instruments and systems for measuring high and low resistance, insulation

integrity, earth gradient, earth resistance, etc., are covered in a 12-page catalog put out by James G. Biddle Co., Plymouth Meeting, Pa. 19462. The catalog also includes data on cable-fault-locating equipment, transformer turns-ratio test sets, power-factor test sets, frequency meters, and stroboscopes, as well as tachometers. [424]

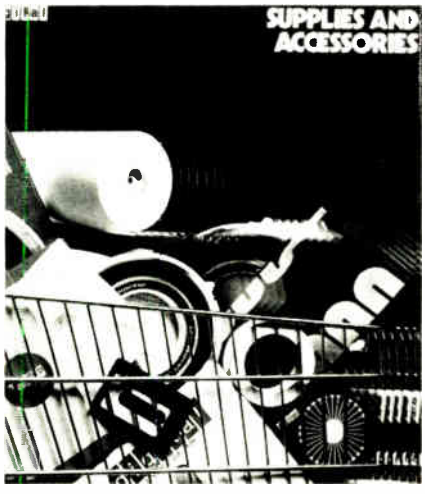
Wire and cable. An electronic-engineering data package includes wire and cable samples as well as technical data, applications information, and a product-selection guide. The material in the package is specifically aimed at designers of computers and computer peripherals. It is offered by Essex Electronic Wire Products, 1601 Wall St., Fort Wayne, Ind. 46804 [425]

Solderless terminals. Many types of insulated and noninsulated solderless terminals, butt splices, snap terminals, and quick-disconnect terminals are described in detail in a selection guide to solderless terminals that is available from Zierick Manufacturing Corp., Radio Circle, Mount Kisco, N.Y. 10549. The guide also gives details on four types of hand-operated attaching tools. [427]

Finding a device. For engineers who work with solid-state devices, the 1977 "RCA Solid State Replacement Guide" cross-references more than 123,000 devices made in the U.S. and abroad that can be replaced with RCA's SK-Series parts. The series consists of transistors, rectifiers, thyristors, and integrated circuits. The 195-page book also carries an index of SK-Series semiconductors and accessories, significant characteristic and application information, line drawings of dimensional outlines and terminal arrangements, and a list of mounting hardware. The suggested optional list price of the guide is $1.50. It is available from distributors or from RCA Distributor and Special Products division, Box 85, Runnemede, N.J. 08078 [428]



Peripherals from DEC. "Supplies and Accessories," a new 56-page color catalog from Digital Equipment Corp., includes pictures and descriptions of 200 replacement and enhancement items for use with DEC peripheral equipment. Listed are



media for disk and magnetic tape drives; paper supplies, baskets, and ribbons for printers, plotters, paper tape, and card readers; terminal stands, chairs, tables, and other convenience accessories. The book includes order blanks and is available from Digital Equipment Corp., Communications Services, 444 Whitney St., Northboro, Mass. 01732 [429]

First edition. The "Temperature Measurement Handbook," 176 pages of information on products as well as data on thermocouple, thermistor, and RTD data, is now available. Grouped in a 38-page data section are the latest complete temperature-millivolt tables for all practical thermocouple calibrations prepared by the National Bureau of Standards. The free book is available from Omega Engineering Inc., Box 4047, Stamford, Conn. 06907 [403]

Digital systems study. A 72-report from the U.S. Department of Commerce's Office of Telecommunications compares actual modem performance measurements with modem performances predicted theoretically. The study was prompted by the fact that although the increased interest in digital communications systems has inspired a number of theoretical studies based on ideal modems and filters, experimental verification is either rare or nonexistent. The report is entitled "Measurements of Digital Systems in Gaussian Additive Noise and Interference." It describes how the performance of five different digital modems was measured with respect to Gaussian noise and interference. Designated OT Report 76-104, the report is available at $4.50 per copy from the National Technical Information Service, Springfield, Va. 22191 [431]

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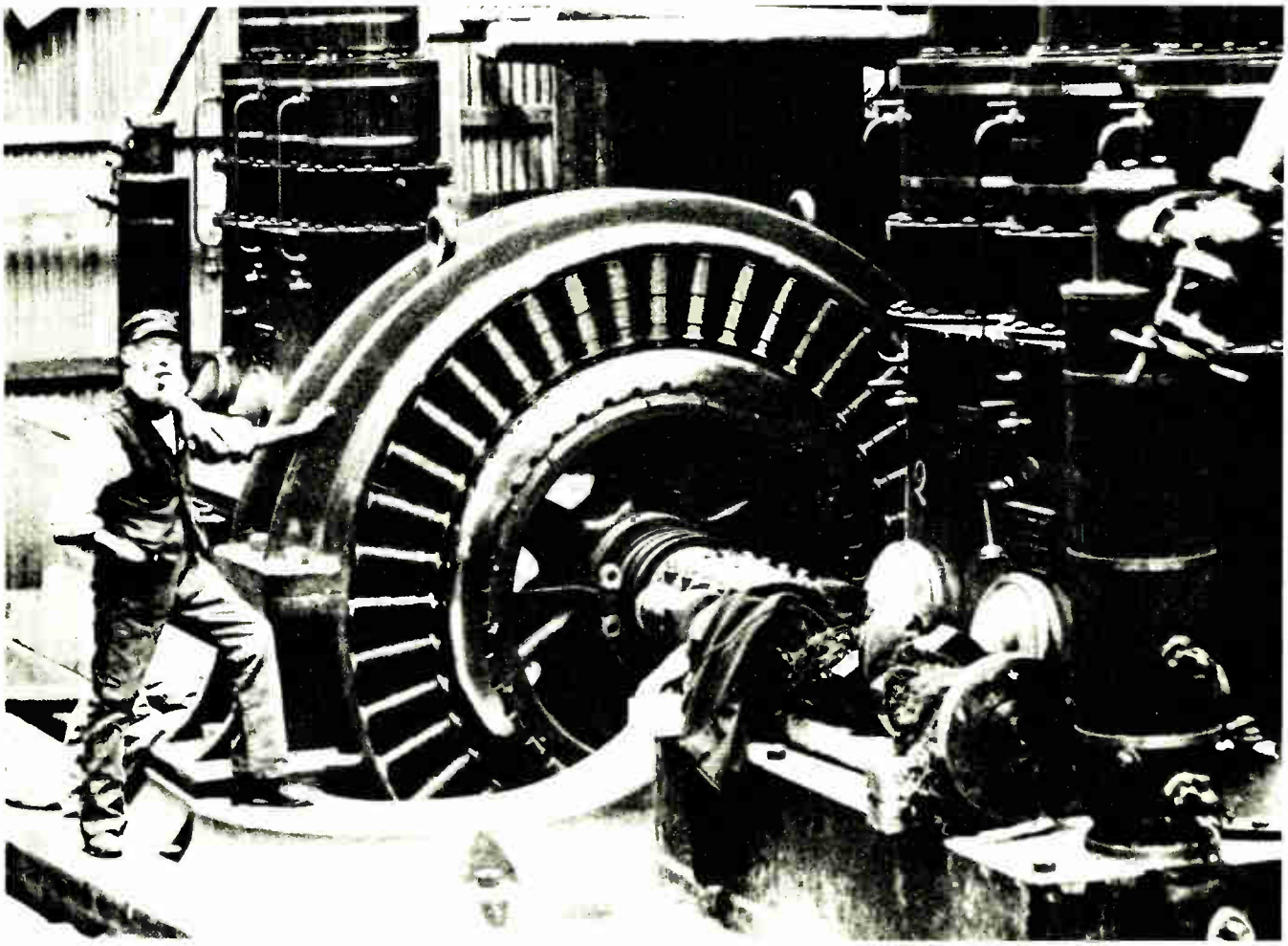

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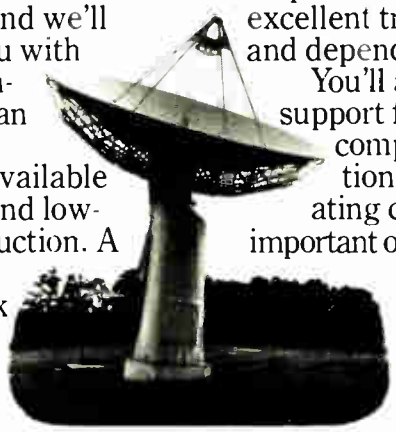

For more information contact Milt Folds, Commissioner, Georgia Bureau of Industry & Trade, P.O. Box 1776, Atlanta, Georgia 30301, Dept. EL-776.

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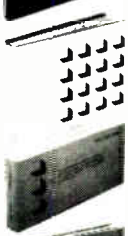

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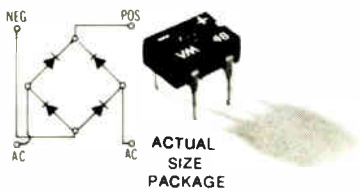

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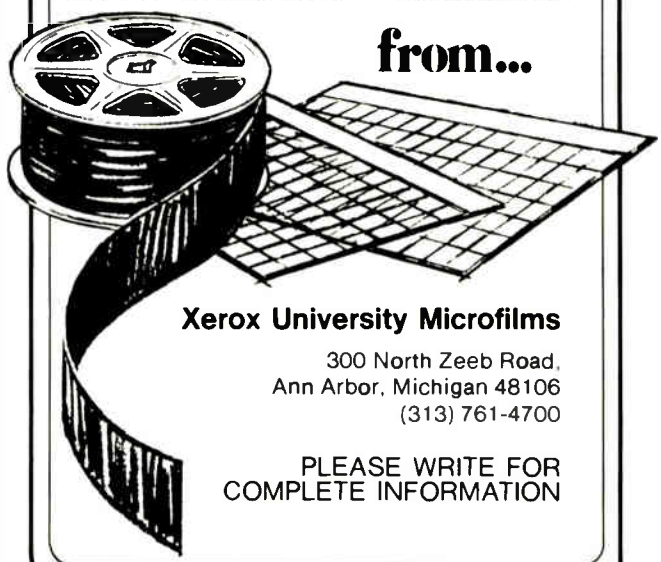

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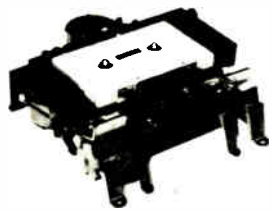

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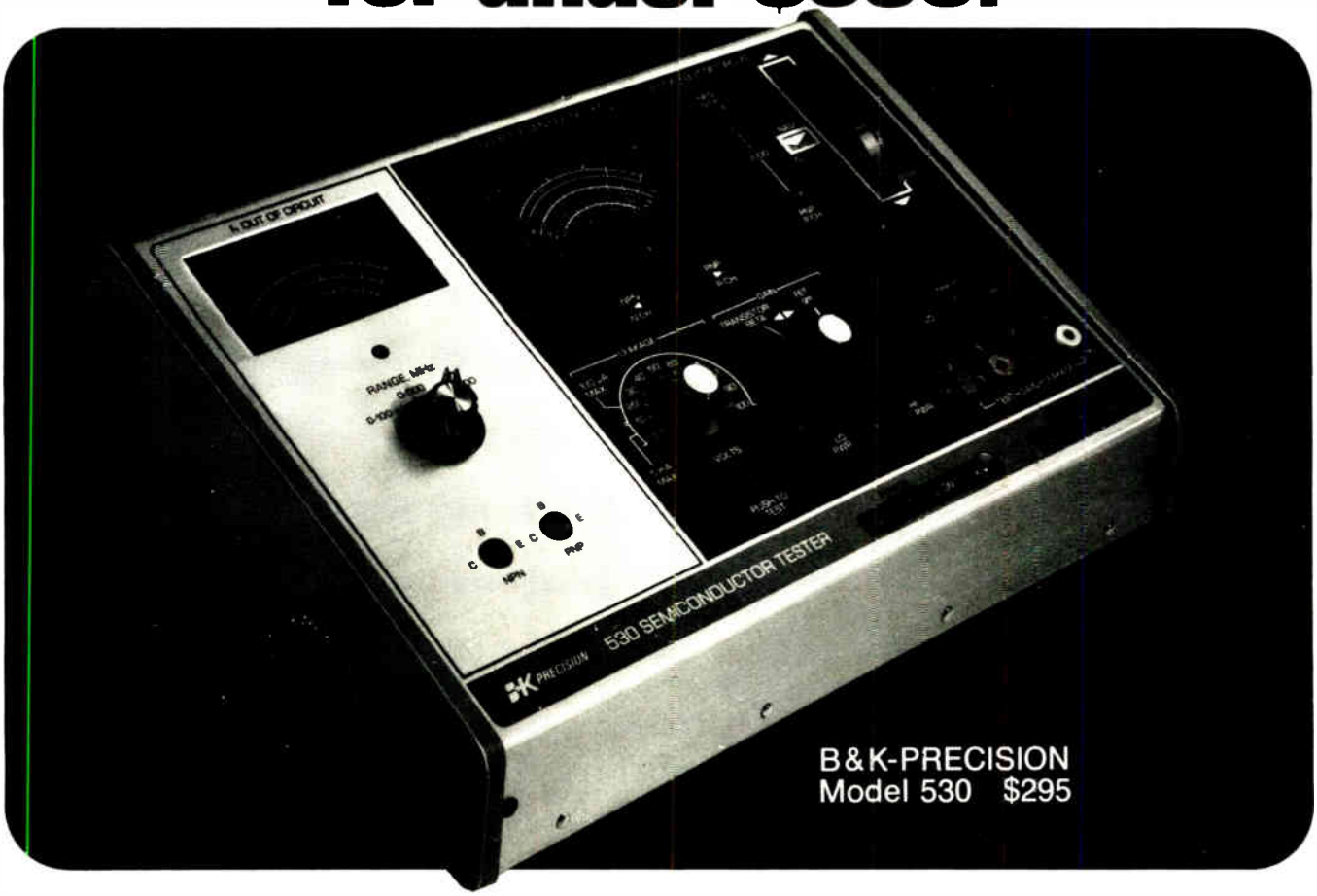

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Emerson & Cuming Inc., Canton, Mass. 02021 [476]

An emulsion hardener for emulsion screens used in circuit printing, Chroma-Set is said to more than double the life of any direct/indirect or direct emulsion screen. Its use is particularly recommended when high image resolution is critical, especially on long runs or when high humidity is a factor. The biodegradable material is easy to use—just spray it on after image washout and then wash it off.
Chromaline Inc., 4832 Grand Ave., Duluth, Minn. 55807 [477]

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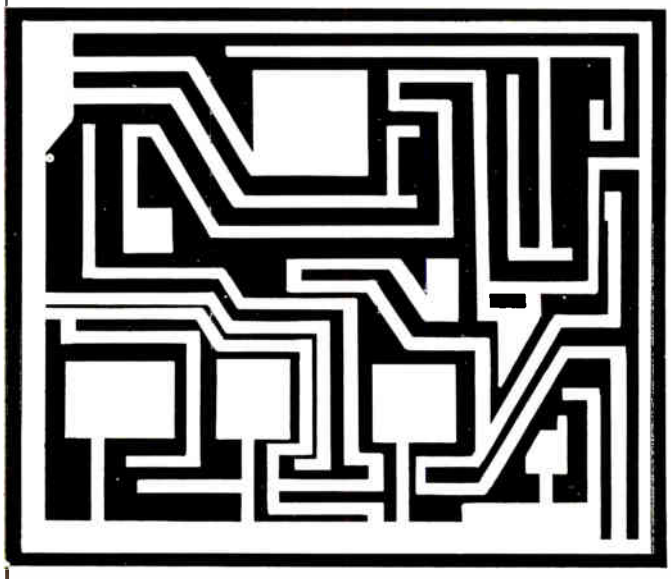

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The inks can be used with most existing screening machines after a fairly simple modification, involving insulating the screen frame and supplying a source of low-voltage current across the screen itself. Alternatively, an automatic screening unit for Electro-Therm inks has been developed by Cladan Inc. of San Diego, Calif. Besides electrode inks, the line of Electro-Therm inks will eventually include other conductors, resistors, dielectrics, and passivity glasses.

Ferro Corp., 4150 East 56 St., Cleveland, Ohio 44105. Phone Raymond B. Jones or Sean D. McKinley at (216) 641-8580 [478]

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J.B. Cooper Division, Sterndent Corp., 320 Washington St., Mount Vernon, N.Y. 10553 [479]

A ferrite U core for applications involving high flux densities is intended for use in power transformers and chokes. Made of 3C8 material (a manganese-zinc ferrite), the U64 core offers medium permeability, high magnetic-induction saturation, and a high Curie temperature.

Ferroxcube, Saugerties, N.Y. 12477 [480]

A water-soluble soldering flux known as Alpha 850 is recommended for use in automatic soldering machines, especially in high-speed applications. It has yielded bright clean solder joints, free of icicles and webbing, at wave-soldering speeds up to 20 feet per minute. The flux, which is as highly activated as most organic-acid fluxes, does not require the neutralizers or other rinse aids normally used with other water-washable fluxes. After being washed in plain hot water, Alpha 850 leaves

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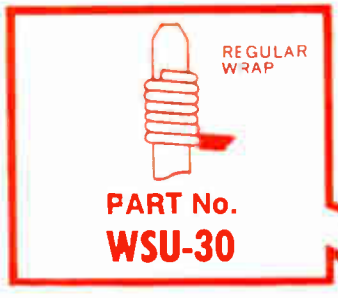

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Cermalloy, Cermet Division of Bala Electronics Corp., Union Hill Industrial Park, West Conshohocken, Pa. 19428 [372]

Conformal coating PC 54 is a two-part epoxy resin system that may be applied by dip, spray, or brush to printed-circuit boards and components to preserve the integrity of

their surfaces. It forms a thin, tough coating that provides protection against moisture, most chemicals, and the rigors of handling. Pot life is more than eight hours after mixing at a temperature of 20°C. Included in the coating material is a fluorescent compound that aids in the detection and identificaton of irregularities such as bubbles, pin holes, and dry spots when the coated part is inspected under ultraviolet light.
Multicore Solders, Westbury, N.Y. 11590 [373]

New books

Designing with Operational Amplifiers, Jerald G. Graeme, McGraw-Hill (Burr-Brown Electronics Series), 269 pp., $17.50.

Advanced Electronic Troubleshooting, Derek Cameron, Reston Publishing, 325 pp., $16.95.

Electronic Drafting and Design, 3rd ed., Nicholas M. Raskhodoff, Prentice-Hall, 555 pp., $16.95.

An Introduction to Operational Amplifiers, Luces M. Faulkenberry, Wiley, 257 pp., $14.95.

Operational Amplifiers and Linear Integrated Circuits, Robert F. Coughlin and Frederick F. Driscoll, Prentice-Hall, 312 pp., $15.95.

The 1977 Radio Amateur's Handbook, Headquarters Staff, American Radio Relay League (Newington, Conn.), 704 pp., $7.50 (paper).

Electronic Power Control and Digital Techniques, Bryan Norris, ed., McGraw-Hill (Texas Instruments Electronics Series), 216 pp., $16.50.

Switchgear and Control Handbook, Robert W. Smeaton, ed., McGraw-Hill, 980 pp., $32.50.

Digital Computer Electronics, Albert Paul Malvino, McGraw-Hill, 404 pp., $13.95.

AC Motor Design with Conventional and Converter Supplies, H.C.J. De Jong, Oxford University Press, 106 pp., $10.50.

Semiconducting Devices: A Bibliography of Fabrication Technology, Properties and Applications, A.H. Agajanian, Plenum Publishing, 944 pp., $57.50.

Function Circuits: Design and Applications, Y.J. Wong and W.E. Ott, McGraw-Hill (Burr-Brown Electronics Series), 291 pp., $18.50.

Manual of Solid State Circuit Design and Troubleshooting, Vester Robinson, Reston, 413 pp., $18.95.

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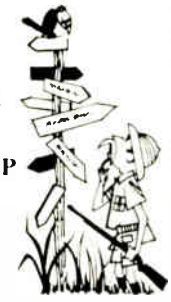

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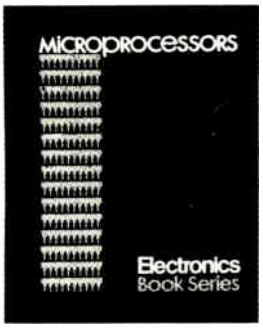

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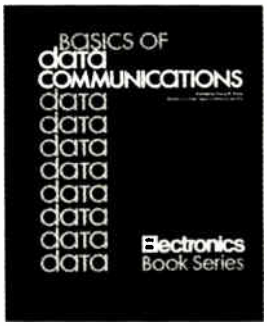

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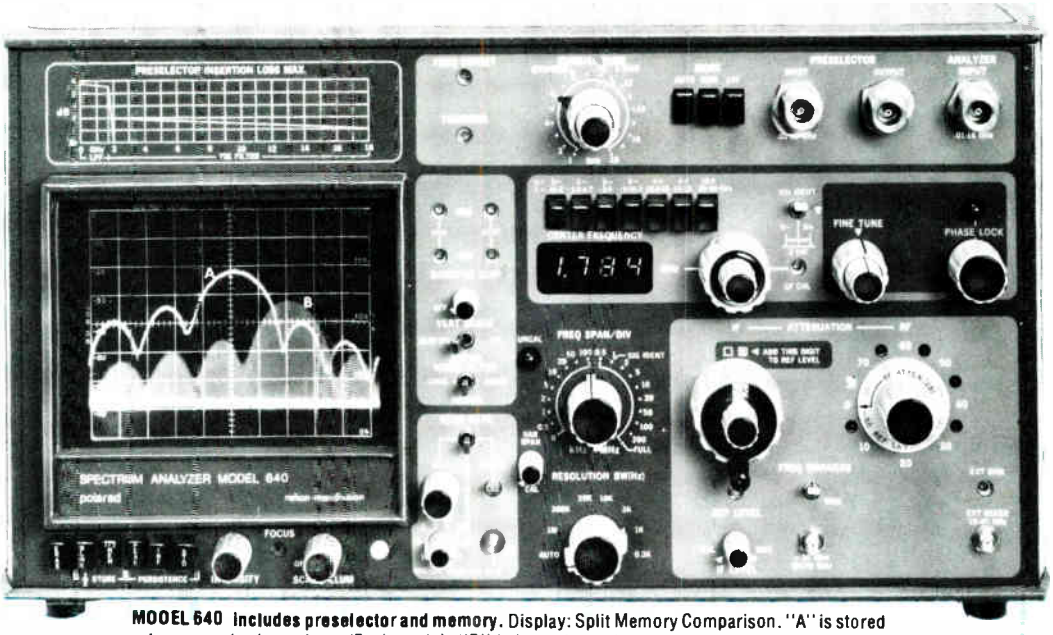
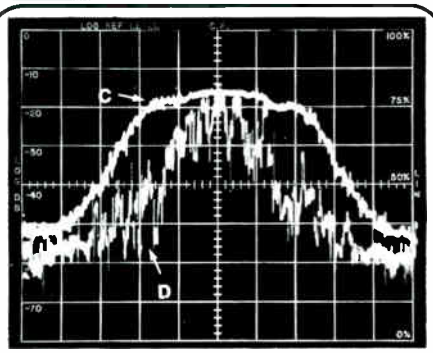


MODEL 640 includes preselector and memory. Display: Split Memory Comparison. "A" is stored reference pulsed spectrum (Peak mode). "B" is incoming pulsed spectrum. Frequency and level differences are easily measured.



SPLIT MEMORY. Comparison of maximum vs. instantaneous levels of FM broadcast. 20kHz/Div Span. 10 dB/Div. "C" is stored max. level vs. frequency. "D" is incoming level, using flicker-free updated memory mode.

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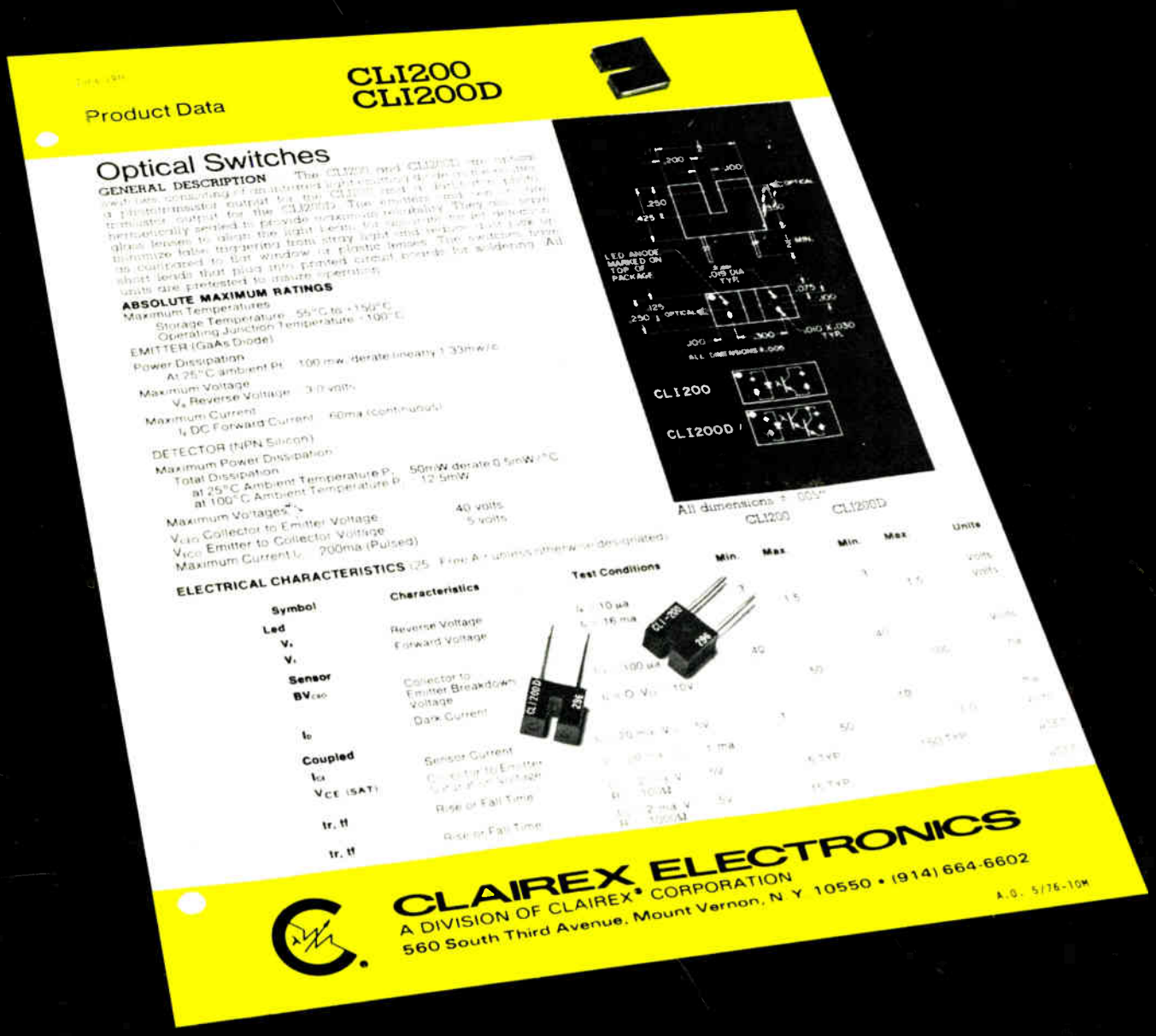

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