SEPTEMBER 15, 1977

WESCON PREVIEW: MICROPROCESSORS STILL KING AT SESSIONS/97

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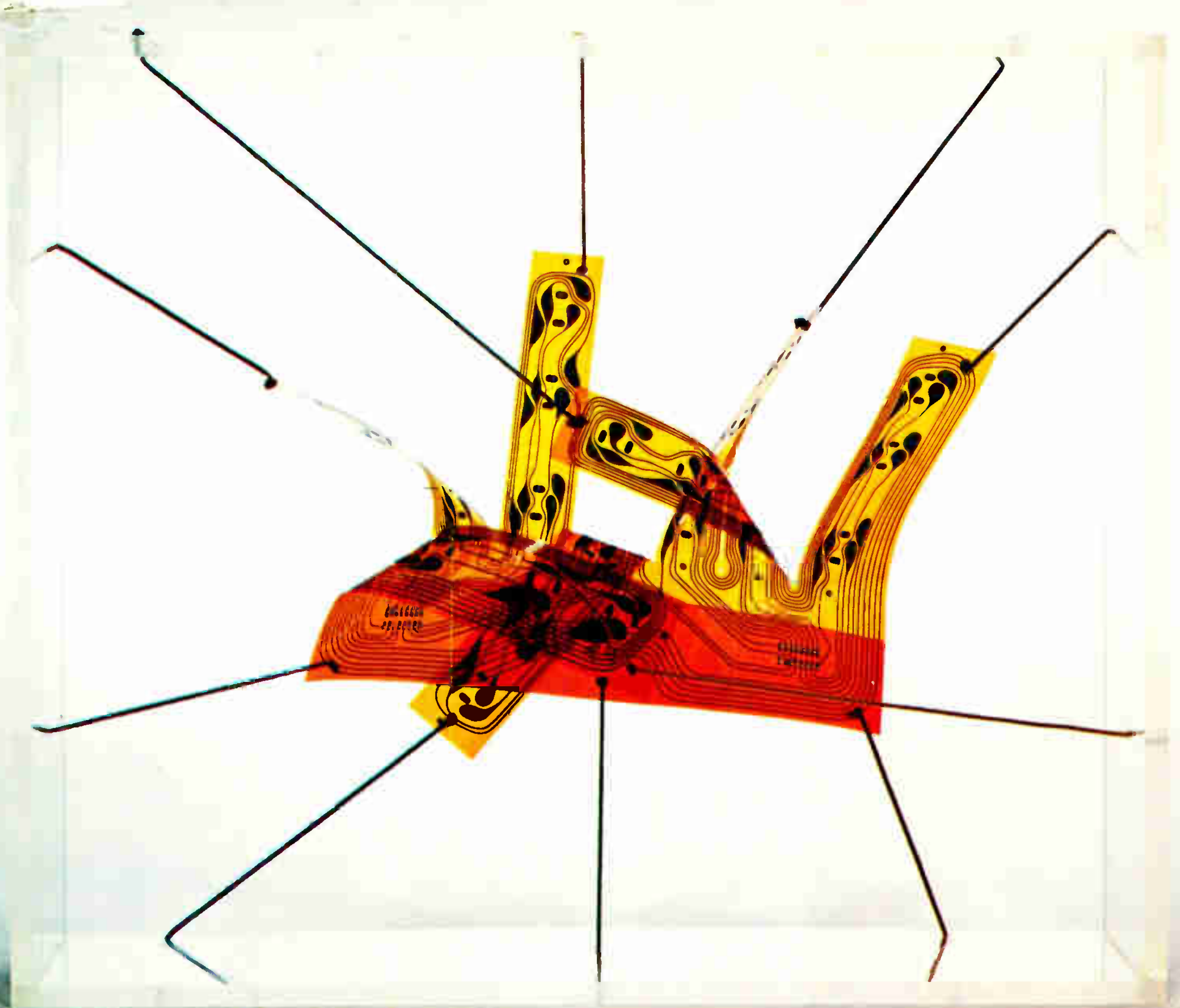
Electronics

FLEXIBLE CIRCUITS

Working in inner space



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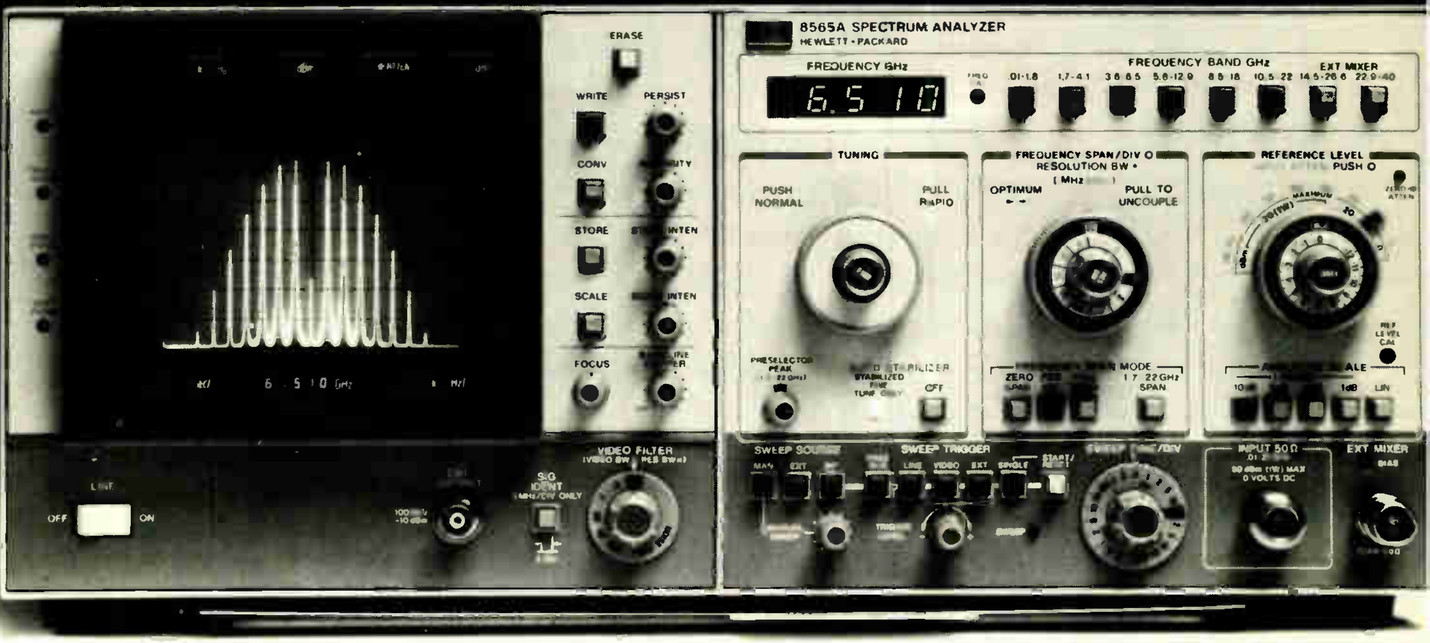

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Here's a combination of fully-calibrated performance, with wide dynamic range from 10 MHz to 22GHz (extendable to 40 GHz), plus operating features that make it extremely easy to use.

Frequency response is within ±1.2 dB to 1.8 GHz, and from ±1.7 dB at 4 GHz to ±4.5 dB at 22 GHz. These figures include all input circuitry effects as well as frequency band gain variations. Internal distortion products are 70 dB down from 10 MHz to 18 GHz; 60 dB, 18 to 22 GHz.

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As for convenience, the 8565A makes most measurements using just three controls: tuning frequency, frequency span and amplitude reference level. Resolution, video filtering and sweep time are automatically set to the proper values. Bright LED's in the CRT bezel give you all pertinent operating conditions right there with the trace being viewed. And a scope camera records these data along with the CRT trace.

The 8565A Spectrum Analyzer gives you the capability you need and the convenience you'll fast appreciate. Domestic U.S. price is $17,850 (add $800 for 100 Hz resolution). Find out more by calling your nearby HP field office, or write.

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Circle 2 on reader service card

Electronics

The International Magazine of Electronics Technology

Vol. 50, No. 19 • September 15, 1977

Highlights

Cover: Ready, set, flex! 97

Bendable printed circuits are coming into their own in all areas of electronics. As this special report details, their flexibility and the savings in weight, unit assembly time, and money are becoming especially important in the computer, industrial, consumer, and automotive areas.

Cover by Robert Strimban.

Bigger ROMs ready to storm the market, 73

As program sizes grow, microprocessor users are showing that they want big volumes of read-only memories with high bit densities, and the semiconductor houses are anxious to oblige. Marketing of the 32,768-bit ROMs is off to a slow start, but device makers are racing ahead with 65,536-bit designs.

Nitride EAROMs get into designs, 107

The electrically alterable read-only memory combines nonvolatility with reprogrammability—characteristics that make the nitride-storage device ideal for TV tuners, phone dialers, and point-of-sale terminals, where its relative slowness is no limitation.

Wescon's 26th gears up, 141

San Francisco is the site of Wescon's 26th annual edition, Sept. 19–21. The exhibits lean strongly toward microprocessor design, while the technical sessions are peppered with advice on what to do and how to do it with the popular little devices, with emphasis on the peripherals. Beginning on page 158 is a preview of products being introduced at the show.

In the next issue . . .

Automotive electronics get the green light . . . a one-chip multiplier with an amazing speed-power product . . . a better way to build prototype boards.

Electronics

Publisher's letter

Chalk one up for the East. Although the Southwest and the Bay Area around San Francisco have become the hotbed of new semiconductor technology, a development effort on the East Coast gets the credit for pioneering nitride technology for read-only memories. The article starting on page 107, by General Instrument's Brian Cayton, gives details on that effort.

While Cayton has day-to-day responsibility for marketing the growing line of electrically alterable ROMs, it is really his boss, Edgar A. Sack, a senior vice president and worldwide operational director for GI's microelectronic and related products, who brought the nitride technology to commercial fruition. It started in the late 1960s, when Sack was running Westinghouse's military electronics division in Baltimore.

"I saw an internal report from our central research laboratories in Pittsburgh describing a hysteresis phenomenon in the thin-oxide-nitride interface under an MOS gate," recalls Sack. A few days later, while driving to attend the ISSCC, Sack realized that the technique might work for nonvolatile storage. "When I got back to Baltimore and called the research team with my opinion," he continues, "they of course had reached the same conclusion. Patents were filed and the technology was born."

Cooperation in the East did not stop there. Dayton-based NCR was also looking at the nitride process as a candidate for providing nonvolatile storage in reprogrammable terminals. "At that time GI was interested in nitride memories for TV tuners," says Sack, "so in 1973 we formed a joint program with NCR for developing nitride storage further." GI has the venture's exclusive rights for marketing the alterable ROMs.

"We'll make a believer out of Silicon Valley yet," Sack says. Apparently he is on his way to that goal. The only other commercial supplier of nitride memories in the world is Nitron Corp., and it is in Cupertino, Calif.

Flexible circuits, the subject of our cover article this issue, are more than just another wiring method. They are the basic elements in a whole approach to circuit design.

Our packaging and production editor, Jerry Lyman, found in his reporting for the article that flexible-circuit manufacturers, unlike their counterparts in the rigid printed-circuit-board business, are really building complete interconnection systems, not just components.

Says Lyman: "I found flex people busy designing complete system packages for customers or converting existing packages to flex circuitry configurations. Often this work involves assembling flex circuitry, rigid boards, component sockets, and connectors. As an added fillip, flex companies can supply two-sided or multilayer rigid pc boards and, in one case, flat cable."

For a roundup, then, on what is happening in flexible circuits, and what they can do for equipment design, turn to the report that starts on page 97.

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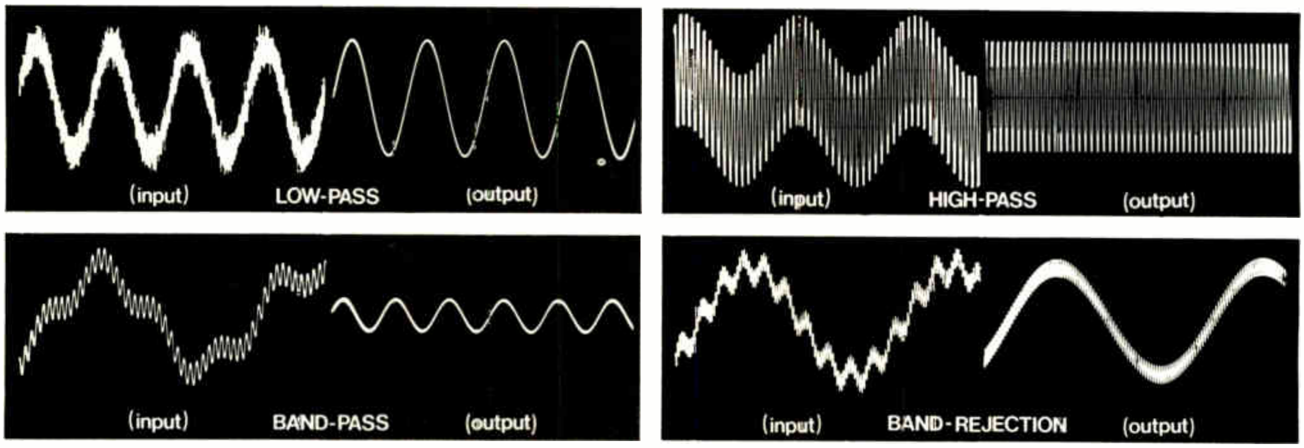

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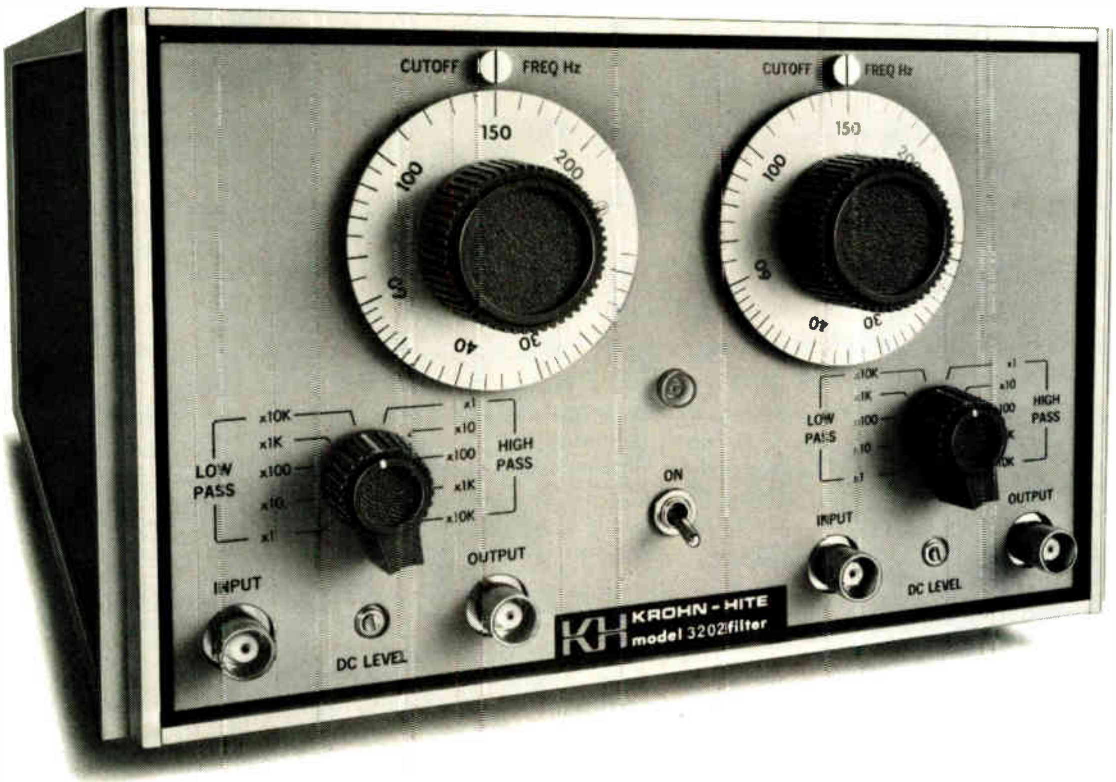

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Circle 4 on reader service card

Readers' comments

More for your money

To the Editor: In part 2 of your career series [July 21, p. 100], you quote Paul Groner, circuit design manager at Varian Data Machines, as accusing the Institute of Electrical and Electronics Engineers of inactivity in promoting the EE's health and welfare: "The American Medical Association and the American Bar Association do a good job, whereas the IEEE doesn't do anything." While it is true that the AMA and the ABA have for many years done quite a bit for their members in exchange for several hundred dollars in annual dues, the IEEE has—since an enabling amendment barely five years ago—done a disproportionate amount of promotion of its members' welfare for the initially $5 and now $10 annual assessment. A special report by the institute's United States Activities Board, "How USAB Helped Members in 1976," is available from the IEEE's Washington office (2029 K Street N. W., Washington, D. C. 20006).

The USAB will ask IEEE members in a September survey (in The Institute) which professional programs they deem important and how much they are willing to pay for them.

Herbert H. Heller
USAB, Surveys
Cleveland Heights, Ohio

In-house concepts

To the Editor: As the inventor of pocket electronic games at Mattel, I would like to correct the implication that Mattel relies on outside sources for creative inputs in this area [Aug. 18, p. 71].

The first game was built by me in November 1975, several months before Rockwell entered the scene. It used C-MOS logic and an array of LEDs to simulate motion.

All our game concepts were and are being created within Mattel's preliminary design department.

George Klose
Mattel Inc.
Hawthorne, Calif.

■ *There was no suggestion that Mattel relies on outside help in conceiving or designing its electronic games—only that it is supplied by Rockwell.*

The Cube widens the gap...

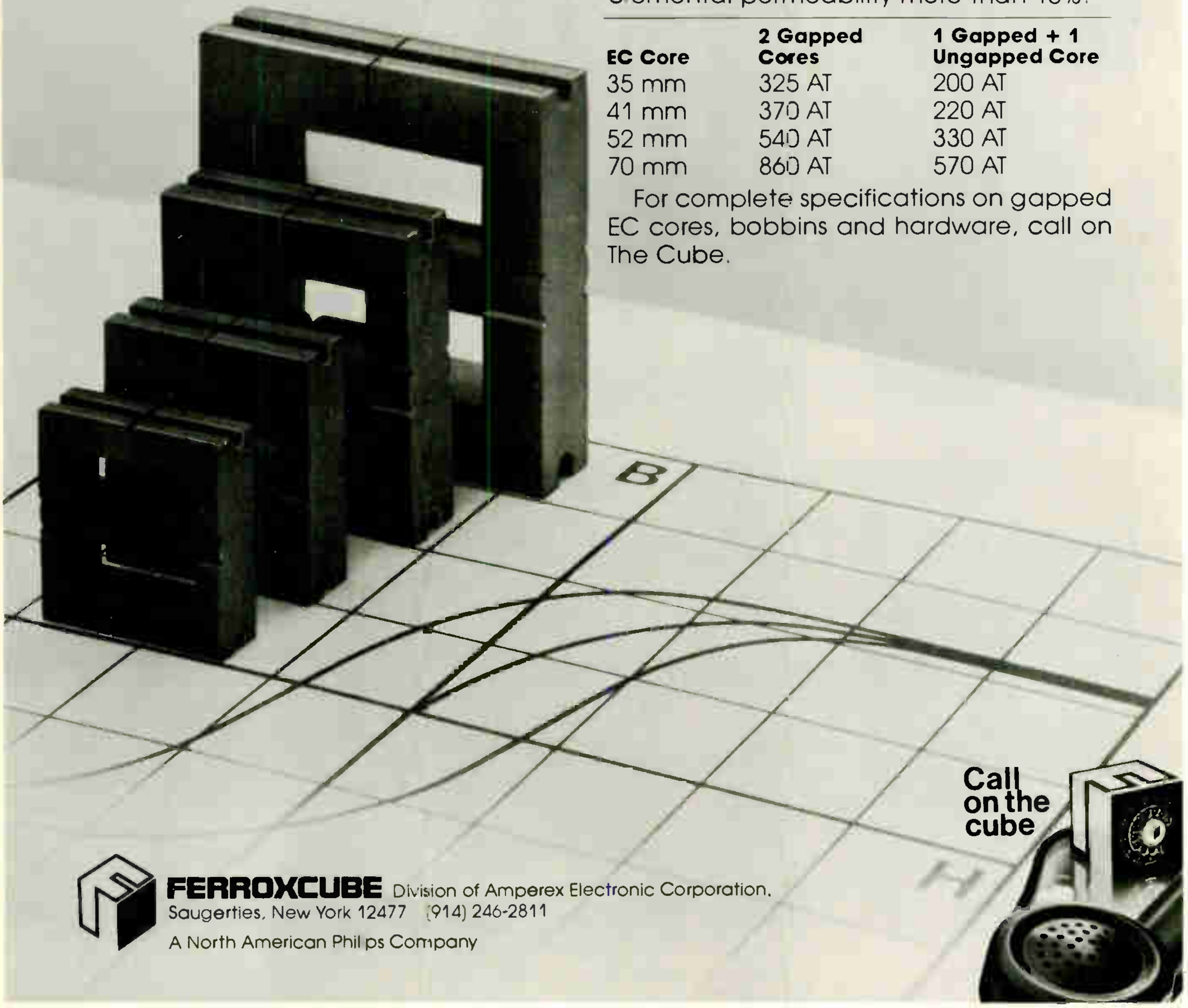
In Power-Ferrite EC cores for switching power supply chokes

Now available from Ferroxcube are standardized gapped EC cores in four sizes: 35, 41, 52 and 70 mm. The gap lengths have been optimized to prevent saturation of the core due to a high DC field while simultaneously providing maximum impedance to the AC ripple current.

For worst case DC bias, two gapped cores should be used. Under less stringent conditions, one gapped and one ungapped core in combination may be used. The chart below shows the DC ampere-turns which can be supported for both 2-gapped and gapped/ungapped combinations that will not decrease incremental permeability more than 10%.

EC Core	2 Gapped Cores	1 Gapped + 1 Ungapped Core
35 mm	325 AT	200 AT
41 mm	370 AT	220 AT
52 mm	540 AT	330 AT
70 mm	860 AT	570 AT

For complete specifications on gapped EC cores, bobbins and hardware, call on The Cube.



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News update

■ The U. S. Navy's hopes of eventually replacing heavy copper wiring on ships with lighter, interference-free cables are riding high after recent tests at sea of a fiber-optic sonar link. Designated FOSL-1, the 52-channel analog link used plastic-fiber cable from E. I. du Pont de Nemours & Co. of Wilmington, Del.

The Naval Underwater Systems Center in New London, Conn., is believed to have installed FOSL-1 aboard a nuclear submarine [*Electronics*, May 27, 1976, p. 39]. The Navy hoped the tests would demonstrate fiber optics' ability to transmit wideband, low-level signals with very little distortion. Thus, FOSL-1 had to have a system capability of 100 decibels of dynamic range and harmonic distortion of less than 1%. Short-term reliability and maintainability, as well as low cost, were other musts.

"We built a breadboard to establish credibility for the fiber-optics technology, and we did that in spades," states Fred Allard, head of the fiber-optics systems branch at the New London center's Submarine Electro-Optical Systems division. The FOSL-1 link was built with off-the-shelf commercial components, and after 25,000 hours of operation all of its channels were still operative, showing no signs of deterioration, says Allard.

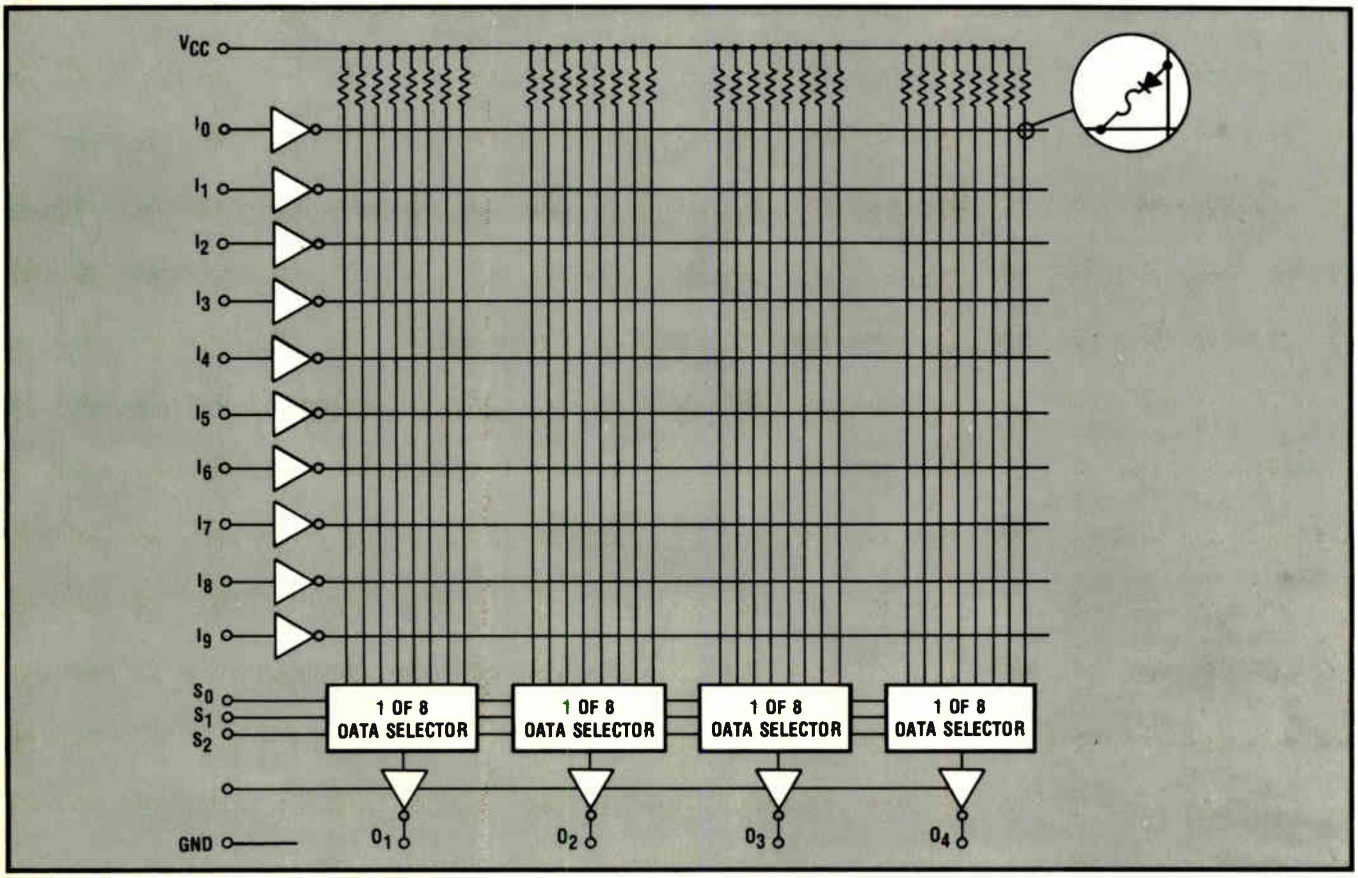
He estimates it would cost about $91 per channel to purchase the electro-optical components and another $40 a channel for the fiber-optic parts, so that per-channel costs for a 50-channel system should be on the order of $130 to $150. This is much less expensive than other high-quality systems, he claims.

The Navy has made no commitment as yet to an operational system. Nevertheless, "we at the laboratory feel we're onto something that will play a part in our future systems," Allard concludes.

Meanwhile, Du Pont has been doing some environmental testing in support of possible use by the Navy of its PFX plastic cables, says senior marketing specialist C. Ronald Ferguson. The tests include two years of accelerated aging at 90°F and 99%

Introducing the PMUX

The world's first programmable multiplexer



humidity; 25 weeks at 122°F, cable immersed in water; one year ambient environment in a lab at estimated conditions of 60°F to 90°F and humidity of 30% to 85%; and 40 days and nights of salt water immersion at 25°C, both for the fiber and the cable. "In all cases, there were no adverse effects on the transmission characteristics of the plastic cable," Ferguson says.

■ Solid State Scientific Inc. of Montgomeryville, Pa., is delivering samples of its first second-source devices for the CDP 1800 family of C-MOS microprocessor products. The action comes less than six months after the company signed an alternate source agreement with RCA Corp.'s Solid State division, which is in Somerville, N. J. [*Electronics*, July 21, p. 8].

Earlier this month, Solid State Scientific began shipping samples of its 1852, an input/output port that acts as a buffer interface to adapt peripheral devices to RCA's 1802 central processing unit. It is "well into initial production" on its 1802 CPU and will begin sampling that 8-bit part next month, says Jeff Krawitz, manager of microprocessor marketing.

Krawitz, who recently joned the Pennsylvania firm from RCA's microprocessor marketing group, says it expects to have an initial group of six 1800 series products "in volume production by the end of this year. All will be available in samples by late November or early December," he adds. In addition to the 1802 and 1852, the initial devices include the 1824 random-access memory organized as 32 registers of 8-bit words, the 1831 and 1832 mask-programmable 4,096-bit static read-only memories, and the 5101, an equivalent to RCA's 1822 1,024-bit RAM.

"We'll be in volume production by the end of the first quarter of 1978 on virtually all CDP 1800 parts that RCA currently is marketing," Krawitz says. As for his company's option to make a silicon-on-sapphire version of the 1802 CPU, he says, "The decision has not been made."

Bruce LeBoss

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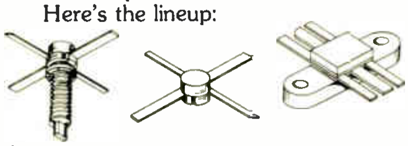
More 900 MHz stuff . . .
Rugged radio message here.

Characterized at 870 MHz for the 806-907 FM mobile band, the new MRF840/842 units are 100% tested for load mismatch stress at all phase angles with 20:1 VSWR at 16 V supply and 50% RF overdrive.

We *publish* that on the data sheet! Not just infer it in private.

Min power gain specs for the 12.5 V units range from 6.5 dB for the 1 W MRF838 common-emitter studless and 838A stud unit to 8 dB for the 20 W CQ-packaged MRF842 . . . pretty super for this frequency. Both the MRF840 and 842 are internally matched for broadband operation.

Here's the lineup:



A

Speaking of Linear Price/Performance . . .

Here's the only transistor spec'd for 100 to 500 MHz with mounting ease and increased P_D through emitter-grounding.

The MRF525 TO-39 offers impressive specs for linear aircraft radio/instruments and cable communications. Third order intercept is +35 dB, minimizing those nasty IMD problems in AM and multi-channel.

It's fully characterized for S parameters at 13.6 and 26 V, 10-100 mA, has min gain of 13 dB and max noise figure of just 4 dB at 225-400 MHz, 26 V.

If you can go $2.30 each for a hundred or more, contact your authorized distributor. If not, dicker with your OEM man for larger quantity savings. A bargain either way. **B**

Now back to rugged VHF

Here's a bunch of splendid 28 V devices complementing a UHF lineup we intro'd a while back, the MRF321-327.

Gold-reliable and thermally-engineered using IR scan techniques for guaranteed ruggedness at 30:1 VSWR, all phase angles, the new MRF314-317s have super wide-band characteristics and are ideal for hi-rel designs. They employ SOE and Controlled Q* technology, offering up to 10 dB min G_{PE} at 150 MHz.

You get stud and studless in 0.380 SOE and 0.5 CQ. P_{out} ranges from 30 to 100 W.

Input impedances remain consistent through programmed, computer-controlled wire bonding. You'll surely use them in MIL radio, class A, AB, B and C for AM, FM or FSK application. They're good as gold. **C**

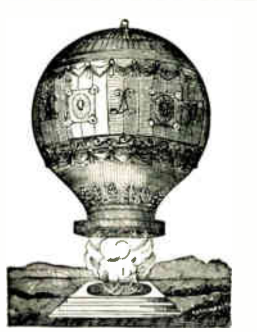
HF RF at LF $$ = TO-220

There's a lot of RF in TO-220 around. But none with the low lists of ours—prices approaching that of our also-new but well-accepted LF TO-220. Take the new MRF476. At $1.09, 500-up. A comparable ceramic SOE stud would run about $8.50.

Whattaya get for that? The same performance for SSB and CB others offer at higher prices. The 12.5-V '476, for instance, provides 3 W PEP, 15 dB min G_{PE} and 40% SSB efficiency at 30 MHz. IMD is typically -35.

The '475 muscles out 12 W at 13.6 V, 10 dB min G_{PE} and 50% efficiency (CW) at 30 MHz. IMD is -30 min. It's just $2.30.

Plus we offer gold-plated headers, gold-tin pre-forms for die attach and high-volume production taken for granted by everyone using plastic devices. Now it's your turn. **D**



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1500 V horizontal deflection MJ12005

The story's simple—25 times more SOA than the BU208. Correct. 25 *Times* more.

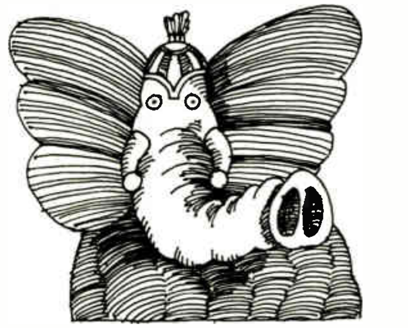
At 400 V, the new MJ12005 offers 20 amps of SOA, 50 μs single pulse. The BU208 provides just 0.8 amps.

Where Darlingtons aren't needed, the new unit's ideal. And besides super SOA, you get higher gain, too—all the way out to 5 at 8 A.

The MJ12005 is triple-diffused to attain its high-voltage rating and photo-glass-passivated at collector-base junction for reliability and stability. Operating and storage junction temperature is spec'd from -65°C to +150°C.

Price is only $3.50, 100-up, or about 35¢ less than the '208.

Super SOA. Super gain. Super price. From the SuperPower, of course. Motorola.
E



Bigger and Bigger static ROMs.

This one's 32K.

The MCM68332 is a 32K static ROM with 4096-word by 8-bit organization that makes it prime for high-density fixed memory applications like microprogramming in MPU-based systems. It's a second source for TMS4732 and MK32000.

All inputs and outputs are TTL-compatible. Inputs are directly driven by TTL without external pull-up resistors, and outputs drive TTL without external resistors. Outputs are three-state.

Silicon gate NMOS technology gives this large ROM excellent speed. Max access time is 450 ns, and min cycle time the same. Active P_D is 450 mW (typ). It operates with a single 5 V supply.

Pin-compatibility with MCM2708, MCM65308 and MCM68316E is another important feature of the MCM6832, available in both plastic and ceramic 24-pin. **F**

CMOS ICs

reduce smoke detector costs, simplify circuitry.

Two new Motorola CMOS ICs clear away the fog of some 30-odd components while reducing costs and improving reliability in battery-operated ionization chamber smoke detectors. Because the units are designed for use with less expensive 9-volt alkaline batteries, the consumer nets additional savings in operating costs.

It's the combination of economical circuitry, battery operation, and ease of wire-free installation that's generating the consumer popularity of this type detector.

The MC14462P incorporates an on-board FET for direct operation with the ion chamber, whereas with the MC14461P the FET is separate. Another key feature of the MC14462 is the active guard on the input, which achieves vast reductions in circuit and package leakage currents. Both units provide the choice of operating the low battery warning circuit in either the static-test or pulse-test mode. On-off pulsing of the horn and protection from pulse-caused transients are exclusive features.

Additional system cost-savings in the smoke detector are realized because both use minimal external capacitance and require a low value of timing capacitance. The circuits also feature on-chip predrivers, voltage reference, and voltage regulator.

Large volume supplies of these smoke detector ICs are assured. They're produced with low-power linear and digital CMOS on the chip using the same process and lines on which we produce the industry's largest volume of CMOS gates, flip-flops, and MSI.

Call us and compare the cost savings obtained by using our smoke detector ICs. **G**

Sleuthing around for cost-saving?

Try L14H1/MRD160 Photo Detectors

Plastic is what they're packaged in and tight places are where these new miniature photo transistors go.

Sensitive throughout the visible and near IR spectral range, the TO-92 and Mini-T* units are ideal for punched card and tape reading, pattern/character recognition, industrial inspection, processing and control, sorters, switching and logic circuits, shaft encoders or any design requiring radiation sensitivity, stable characteristics and high-density mounting. (Whew!)

Easiest to understand is price—just 33¢ for the L14H1 and 50¢ for the MRD160. And that's in published quantities.

The L14H family has a range of sensitivity and voltage for your exact needs. You have a choice of either 30 or 60 V min C_{EO} and either 0.5 or 2.0 mA collector light current. Dark current is just 100 nA, max. It makes a great companion to the MLED92 IR emitter and, of course, derives from Motorola's "billions-made" TO-92 capability.

The MRD160 complements Motorola's MLED60/90 IREDs. It specs out at 0.20 mA light current sensitivity and 0.10 μ A max dark current. C_{EO} is 40 V.

Both offer Annular† passivation for reliability and stability.

Both offer the solution to cost problems. Try 'em and you'll like 'em. **H**

†Annular is a patented Motorola process.

Big IF for FM Scanners

Big is right. Not in size, for this littl linear gem's in standard 16-pin plastic DI

What we're talking about in the MC335 is just about the whole bag of function needed for the IF stage in FM scanners. T wit: oscillator, mixer, limiting amp, quadra ture discriminator, active filter, squelch, sca control and mute switch. Not many exter nals to add here.

This Mr. Complete uses a dual conver sion system including second crystal oscilla tor circuit with demodulator for max signa to noise ratio.

You can convert the input frequenc (i.e., 10.7 MHz) down to 455 kHz where after external bandpass filtering, most of th amplification is done. Audio is recovere using the quadrature and absence of inpu signal is indicated by presence of noise abov desired frequency. "Noise band" is mon tored by the filter and detector and th squelch trigger indicates presence of nois (or tone) by an output which can contro scanning. Plus, an internal switch is operate which can be used to mute audio.

At 6 V_{CC}, squelch-on draws a measl 3 mA typ. (others run high as 10 to 20) for lo power drain. Sensitivity's excellent—inpu limiting voltage: (-3 dB) = 5.0 μ V typ. Re covered audio is 350 mVrms typ, mute off i 0.5 V max and mute on is 5 V min.

What may turn you on most is the lov low $1.75, 100-up. And it's available throug authorized distributor or OEM order.

No ifs, ands, or buts. **K**

Big push

on Small SCR nets 600 V technology

All of the people have some of the stuff none of the people have all the stuff... excep Motorola... leader in 0.5 A to 40 A thyristors We're talking about the capital and the equip ment to do what we've done—come up wit the one and only 600 V TO-92 SCR in th industry.

Right. The good ol' MCR100 TO-9 SCR is rated to 600 V, something nobod else but we plastic SCR pioneers seem t have the nuts, bolts, screws, gears, buck and commitment to build.

You'll be pleased because it offers all th traditional advantages: 200 μ A max gat triggering, 100 μ A max reverse and forwar blocking, 5 mA max holding current, etc. No to mention glass passivation that (at las count) has provided second-to-none relia bility in TO-220 SCRs of 43 million cycle of 30°C to 125°C T_J power cycling with jus 15 failures!

Use it for bigger jobs in line-power appli cations like relay and lamp drivers, smal motor controls, gate drives for larger thyris tors, sensing and detection circuits. An have your P.A. check our pricing. He'll fin it's the most aggressive since the beads-fo Manhattan deal... and less than half TO-18 and TO-5s! **L**

Movin' On with M10800

Motorola in Mountain View?

Could be, for Fairchild's announced intentions of second-sourcing the M10800 prove what we've been telling you all along ... the M10800 high-performance processor family will be the standard for next generation, performance-oriented systems.

Motorola and Fairchild. Partners in progress. What more can you ask?

Well, how about our MC10802 timing function for starters. Fast starters. Currently being sampled, the part is designed to provide timing signals for a processor in one LSI circuit. It contains logic to generate 4 clock pulses, simplify system start and stop commands and provide some diagnostic capability. It is not restricted to use in '10800 systems, but can simplify timing requirements in *any* MECL 10K designs because (how could you forget!?) it's fully compatible with the industry standard 10K family!

Other new sample members are the MC10804 and '10805 bidirectional transceivers that interface MECL logic levels with T^2L logic levels. Data can be transferred in either direction—MECL to T^2L or T^2L to MECL—and an optional gated latch is also provided.

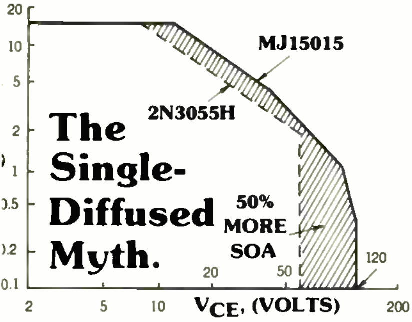
The '10804 is a 4-bit version in 16-pin CERDIP and the '10805 is a 5-bit device in a 20-pin CERDIP.

For MOS memory freaks, the MC10805 is designed to interface MECL systems to MOS main memories. And if you haven't been able to remember all our Fast Freddies on the MECL track, one more time—

MC10800	4-Bit ALU -30°C to +85°C
MC10800M	4-Bit ALU -55°C T_A to +150°C T_J
MC10801	Microprogram Control
MC10802	4-Phase Timing
MC10803	Memory Interface
MC10804	4-Bit Bidirectional Translator w/Latch
MC10805	5-Bit Bidirectional Translator w/Latch
MC10806	32 x 9 Dual Access Stack
MC10807	5-Bit MECL Transceiver w/Latch
MC10808	16-Bit Programmable Shifter

Keep on movin' with MECL. **J**

Motorola PowerBase
Silicon Power Breaks



The Single-Diffused Myth.

Everybody thinks single-diffused is lways better. Everybody thinks single-iffused dice make for increased SOA urves. Everybody's wrong.

Motorola's new PowerBase* is a high-nergy breakthrough in power transistor echnology and here's what it does:

. Provides rugged SOA previously obtained only with conventional single-diffused.
. Allows economy previously possible only with conventional EpiBase* products.
. Closely approximates f_T characteristics of single-diffused transistors (there's hardly any difference).
. Offers complementary structures eliminating the single-diffused, single-polarity bugaboo.

Take a look at the curve and you'll find)% more SOA capability with our '15015 ian a single-diffused 2N3055H.

We use a patented process on our optiized PowerBase die to achieve superior OA with greatly improved uniformity and eproducibility over S.D. By improving deice thermal efficiency so significantly less licon is required, we offer you lower cost. imple, right?

What it all comes down to is if you're sing a single-diffused RCA 2N3055H, you an obtain 50% more SOA for 19% less bucks ith the MJ15015! If you're using a 2N3443 nit you get 10% more SOA for 49% less $. And so on, according to latest available ricing.

Flawless performance at far less cost!

Make your own comparisons today. our authorized distributor's got off-the-ielf units. Coupon response brings you ew PowerBase product data sheets.

Motorola PowerBase is a hit and that n't no myth. **M**

*Trademark of Motorola Inc.

RAMs multiply like rabbits

MCM2114 4K static RAM

Static operation means no clocks and no refreshing required for Motorola's new MCM2114, a 1024-word by 4-bit organized silicon-gate plug-in equivalent for the Intel NMOS RAM.

It's fast, with access time as low as 200 ns and cycle times to match. Power dissipation is typically a low 400 mW, and the 2114 operates from a single 5 V power supply. It's directly compatible with TTL and DTL, and has three-state outputs. **N**

MCM4116 makes the 16K RAM derby a real race.

Those hard to get 16K RAMs will be a lot easier to find now that Motorola has introduced the MCM4116. It's in the industry standard 16-pin package and compatible with common automated test and insertion equipment. It's an easy upgrade from 16-pin 4Ks, and is pin-compatible with other 16Ks now on the RAM market.

Three different speed options are available with access times from 200 ns to 300 ns. All inputs are TTL-compatible as are the three-state outputs. **P**

New source for the 4096 dynamic 4K.

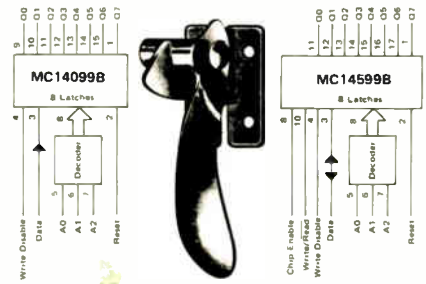
Maybe you've noticed. Availability of the 4096-type 4K has tightened up. Well, we're loosening things up again with the MCM4096. It's compatible with the other popular 4K standards like the 2104, MK4096, and MCM6604A.

Eight-Bit Latches

added to CMOS B Series

The new MC14099B and MC14599B are the first in a series of 8-bit addressable latches being added to Motorola's industry-leading standard CMOS line. These latches are designed to meet JEDEC B-Series specifications. They are excellent in demultiplexing and serial-to-parallel conversion applications, but they have yet another claim to fame. Use MC14599B or MC14099B to provide outputs for our unique new MC14500B single-bit processor called the Industrial Control Unit.

The MC14099B is an alternate source part for the CD4099B. The MC14099B and the MC14599B are similar, with but one significant difference. The MC14599B has a bidirectional input port, which allows data to be placed in a latch, then retrieved through the single port or from the 8 parallel outputs. It's in 18-pin plastic and ceramic packages, and the MC14099B uses 16-pin packages. The two extra pins in the MC14599B are assigned to Chip Enable and Write/Read.



Three additional 8-bit latches are being prepared for introduction. The MC14598B is similar to the MC14099B, but its outputs are three-state, with the capability to drive a bus line and sink one TTL load or four LSTTL loads over temperature. The MC14597B differs from the MC14598B by virtue of an on-board counter at the input, rather than direct address. The third future 8-bit latch is the MC14094B, alternate sourcing the CD4094B. It also has three-state output, with a drive capability of one LSTTL load. The MC14094B has a shift register input contrasted to the decoder input of the MC14598B or the counter input for the MC14597B. Pricing, 100–up, for the introduced parts is $2.21 for the MC14099B and $2.81 for the MC14599B. **R**

All Aboard! Motorola Omnibus • Rollin' along the routes to right design.

(Coupon Missing?) Send inquiries to: Department LDC, Motorola Semiconductor Products Inc., P.O. Box 20912 Phoenix, AZ 85036

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C ☐ **VHF MRF314-317**	**H** ☐ **Photodetectors**	**N** ☐ **4K Static RAM**
D ☐ **TO-220 RF**	**J** ☐ **M10800 MPU**	**P** ☐ **16K RAM**
E ☐ **MJ12005 Power**	**K** ☐ **Linear IF**	**R** ☐ **8-bit latches**

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People

Hinkelman sees SIA as free-trade vehicle

With the appointment of Thomas Hinkelman, a 30-year veteran of the semiconductor industry, as its first executive director, the newly formed Semiconductor Industry Association has picked a firm believer in the importance of semiconductor technology in today's—and tomorrow's—society.

"Just as steam and steel were the motivating forces that made the industrial society happen," says the 52-year-old executive, "semiconductor technology and the manipulation of the flow of electrons is what motivates our present age." As executive director of the SIA, which was established to provide a public platform for the flourishing $6 billion U. S. semiconductor industry, he sees one of his jobs as convincing governments and the public of its importance and another as promoting open competition.

"The SIA is really an association of free traders," says Hinkelman, "for it is free trade that has contributed to the spectacular growth of the semiconductor and electronics industries. If it is to continue to grow, free trade must continue."

He is a veteran of the semiconductor industry in every sense of the word. His first job after graduating from Renssalaer Polytechnic Institute in 1947, was with Eckert-Mauchley Computer Corp., the company formed during World War II to build vacuum-tube computers. In 1955 he joined General Electric Co. as product planner for transistors, working on germanium-alloy and grown-junction germanium transistors. He was active at this time in developing the first Jedec specifications on transistors.

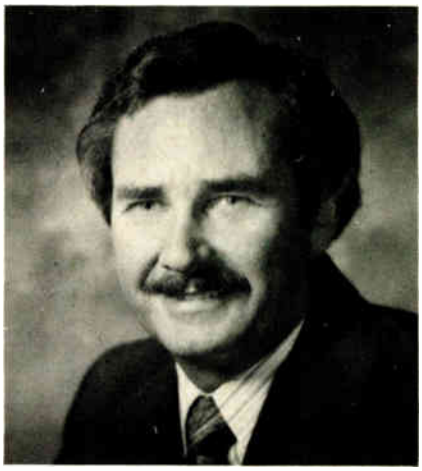
He was at Motorola Inc. from 1958 to 1968, serving finally as director of planning. Then he moved to Fairchild Camera and Instrument Corp. with then president Lester Hogan. Since 1973 he has been at Monsanto Co.'s electronics division as director of product planning. Always, he was active in the semiconductor group of the Electronics Industries Association, serving as its chairman from 1971 to 1972 and also heading its trade policy committee.

Reflecting on his experience, Hinkelman points out that "the semiconductor industry grew up in a freely competitive environment." However, those conditions are changing. "There is a rise of Government regulation in the U. S. and an increase in competition from other countries with the positive support of their governments," he says. "The U. S. semiconductor industry does not expect to be nurtured, as it is in other countries, notably Japan. But, at the very least, it should not be handicapped."

For Hybrid Systems' Peacock, reorganizing is key

The problems that Wayne Peacock faced when he became president of Hybrid Systems Corp. in April were the kind you would only wish on your worst enemy. The company, now in Bedford, Mass., makes discrete modules and hybrid thin-film microcircuits used in data-conversion, signal-processing, and measurement products, among other things.

The problems included the move of the thin-film facility from Worchester, its location before the com-



Taut. Cutting back, on payroll and business, was Wayne Peacock's move.

Precision quad op amps. *Precision.*

PMI's new OP-09 and OP-11 are pin-compatible with the un-precision quads now on the market.

The quad op amp has finally come of age. With the introduction of the OP-09 and OP-11, PMI has made it a truly workable reality. Consider:

Low V_{OS} and other goodies.

Since quads can't be nulled—there aren't enough pins available—the user is at the mercy of whatever input offset voltage (V_{OS}) he happens to get. PMI refined the manufacturing process to get V_{OS} under control. We came up with the lowest V_{OS} of any quad op amp made today.

At the same time, we gave the OP-09 and OP-11 the highest gain and the lowest drift of any quad op amp. We expanded bandwidth, reduced offset and supply current, and increased the slew rate. Here it is in black and white:

OP-09/OP-11 Features

	TYP.	MIN./MAX.
• Low V_{OS}	0.30 mV	0.5 mV MAX.
• Low offset current	8.0 nA	20 nA MAX.
• Low supply current (Total for all 4)	3.5 mA	6 mA MAX.
• Voltage gain	250K	100K MIN.
• Slew rate	1.0 V/µS	0.7 V/µS MIN.
• Matched positive and negative slew rate for low distortion.		
• Bandwidth	2.0 MHz MIN.	

We make them match.

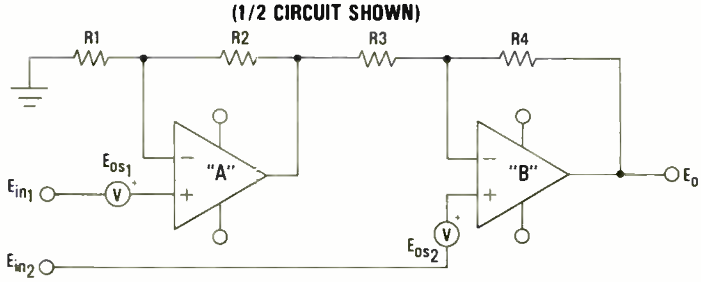
Another important advantage: we guarantee that all four op amps will match in terms of V_{OS} and CMRR. Here's how we specify them:

Matching Characteristics

		OP-09A/E OP-11A/E			OP-09B/F OP-11B/F			
Parameter	Symbol	Min	Typ	Max	Min	Typ	Max	Units
Input Offset Voltage Match	ΔV_{OS}	–	0.5	0.75	–	0.8	2.0	mV
Common Mode Rejection	ΔCMRR	–	1.0	20	–	1.0	20	µV/V
Ratio Match		94	120	–	94	120	–	dB

(Match exists between all four amplifiers)

DUAL INSTRUMENTATION AMPLIFIER 2 OP AMP DESIGN
(1/2 CIRCUIT SHOWN)



These matching dc characteristics should interest you. They reduce distortion, improve system performance, and simplify your design. But that's not all.

We've given all four op amps symmetrical positive and negative slew rates—an important thing to keep in mind for audio system design.

It's fair to say that the OP-09 and OP-11 are the most accurate, most advanced and the only **precision** quad op amps on the market. And they **are** on the market—available now, today.

Like to check one out? Be our guest. Just drop us a line on your company's stationery, telling us if you'd prefer an OP-09 (4136 pinout) or an OP-11 (148/4741 pinout). We'll be glad to send literature and a sample.

Precision Monolithics Incorporated
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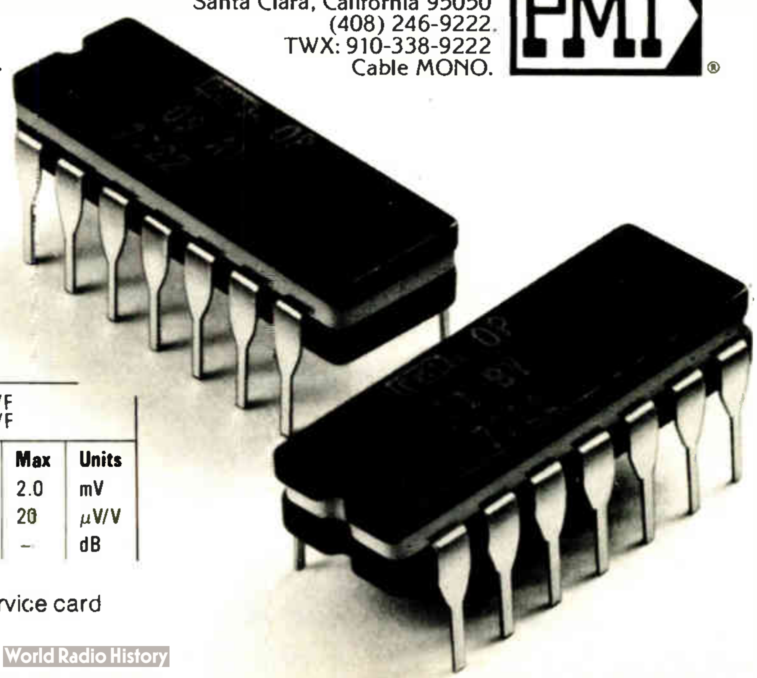


Circle 15 on reader service card

People

pany bought it from Sprague Electric Co. in October 1973, to Bedford. That move, in late 1975 and early 1976, caused disruptions in production and the loss of experienced assembly workers. There was also a flood that caused a "very large dollar loss," of work in progress and resistor-chip inventory in Worcester, Peacock says. Add to that a cash drain of some $500,000 to support the mercurial growth of stereo-component subsidiary, Audio Pulse Inc., and the picture begins to fill in.

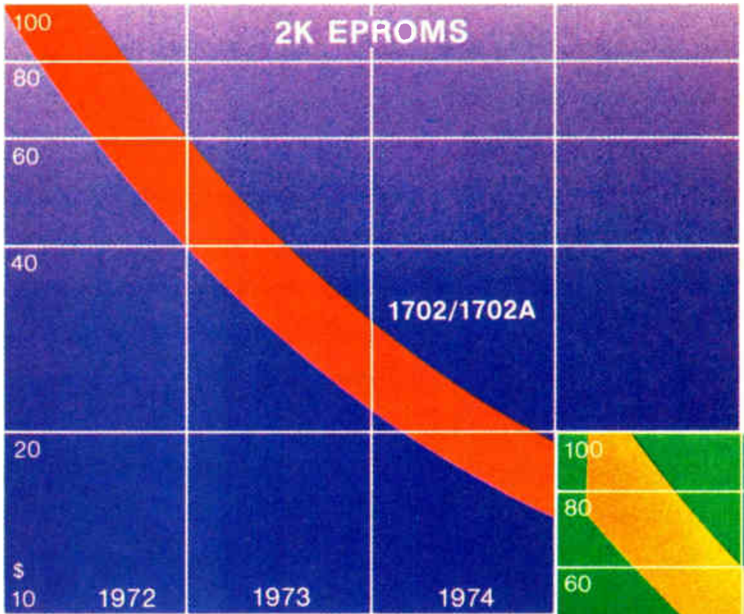
"What with financing Audio Pulse, the move, and the flood," says the ebullient Peacock, "we didn't even notice the recession that was going on." The 42-year-old president says, however, that he has stopped the down trend. The company's most recently concluded quarter, ending June 25, set records for sales and profits, and he projects sales of $10 million by fiscal 1980, up from between $5.5 million and $6 million last year, which included Audio Pulse's sales.

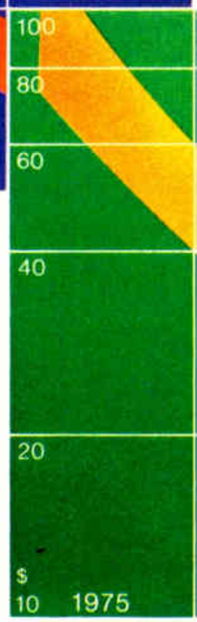
To start the recovery, Peacock sold most of Audio Pulse's assets and the right to market its products to Hoffman Electronics Corp. in return for royalty income. That cut the payroll by 22. Then, he lopped off another 77 Hybrid Systems employees—a move that reduced the average yearly salary by 20%. The cuts hit management-level people hard, but Peacock felt the company was too top heavy.

On the plus side, training programs for new employees have begun to show results in good thin-film product yields. What's more, Peacock has reorganized the company into three business centers—modules, resistors, and hybrids.

Peacock left Zeltex Inc., Concord, Calif., late last year and spent two months evaluating job opportunities. Despite its recent history, he joined Hybrid Systems as vice president for sales and marketing in January. "When I saw how good the thin-film technology was," he relates, "and the caliber of the technical people, I realized what a nugget this was." He plans to polish that nugget back to a high gloss soon.

Intel delivers the best for today





Industry standards, volume support and cost efficiency are what you've learned to expect from Intel, the company that invented EPROMs and delivers more of them than all other manufacturers combined.

In 1972 we introduced the world's first EPROM, the 2K 1702. Then in 1975 it was the 8K 2708 which quickly became the industry standard. Now we're delivering the 5 volt 2716 EPROM with the performance and economic advantages it takes to be the industry standard 16K EPROM— for today's system upgrades from 8K to 16K and for tomorrow's systems designed with 5 volt microprocessors.

For economy, the 2716 offers a die size 20% smaller than any other 16K EPROM and a price-volume learning curve that will descend even more rapidly than our 1702 and 2708 EPROMs. And the 2716 is the only 16K EPROM with a pin for pin interchangeable 16K ROM, the 2316E.

For performance, the 2716 consumes a maximum of 525 mW in the read mode. That's 50% less power than our 2708 and 25% less than any other 16K EPROM. Intel's unique power-down feature reduces the standby current to 25mA maximum, a 75% savings over active power. And at 450ns there's no penalty in access time.

Programming the 2716 is simpler and twice as fast as any other 16K EPROM. Single-pulse, single-location

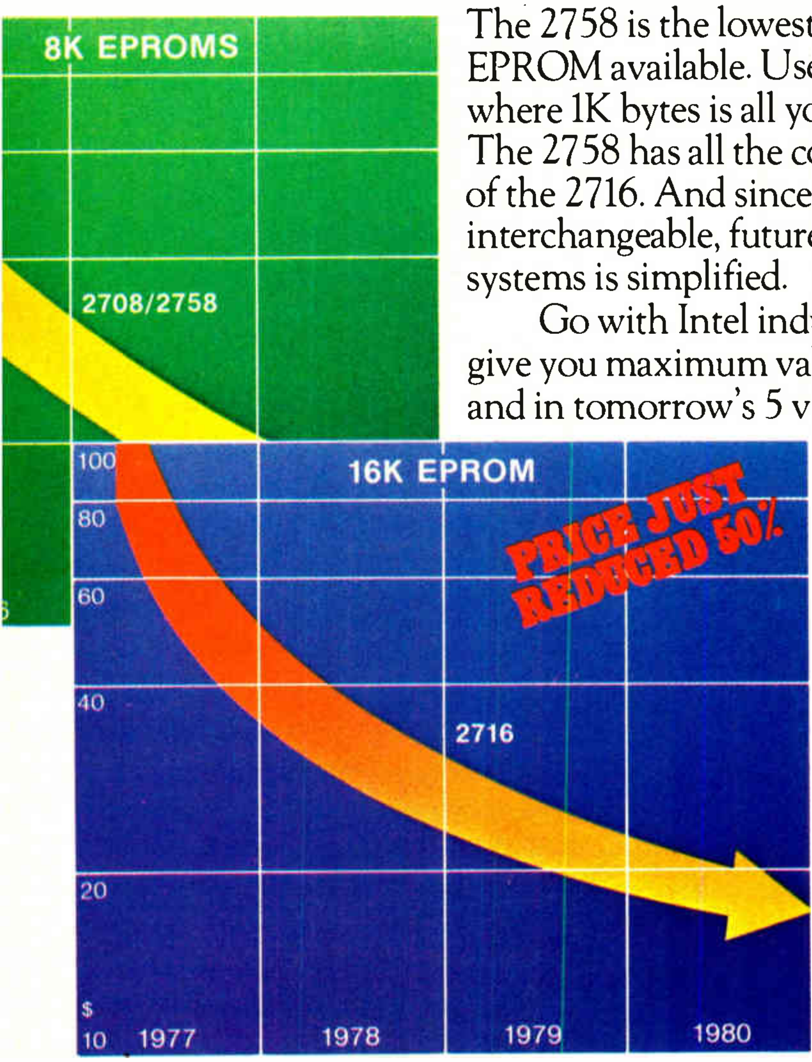
PART NUMBER	SIZE	POWER SUPPLY	MAXIMUM CURRENT		ACCESS TIME (MAX)	COMPATIBLE ROM
			ACTIVE	STANDBY		
1702A	256 x 8	+5V −9V	65 mA	65 mA	1 μs	1302
2708	1K x 8	+5V −5V +12V	10 mA 45 mA 65 mA	10 mA 45 mA 65 mA	450 ns	2308
2758	1K x 8	+5V only	100 mA	25 mA	450 ns	2316E
2716	2K x 8	+5V only	100 mA	25 mA	450 ns	2316E

8K and 16K EPROMs and tomorrow.

programming and TTL-levels allow programming on-board, even in the field. Use the Intel Universal PROM Programmer or any other commercially available programmer to program any 2716 word location, either individually, sequentially or randomly.

Intel's 2716, along with the compatible 2316E ROM, is your best choice for upgrading from 8K to 16K.

For new designs using 5 volt microprocessors, the 2716 and new 5 volt 2758 8K EPROM are the obvious choices. The 2758 is the lowest power 8K EPROM available. Use it for small systems where 1K bytes is all you need, or for 1K byte modularity. The 2758 has all the cost savings and performance benefits of the 2716. And since the 2758 and 2716 are completely interchangeable, future upgrading from 8K to 16K in 5 volt systems is simplified.



Go with Intel industry standard EPROMs because they give you maximum value in today's system upgrades to 16K and in tomorrow's 5 volt designs. Order the 2716, 2758 and compatible 2316E ROM from your Intel distributor.

For technical information and a copy of "The new 16K EPROM" article reprint (AR-42) write Intel Corporation, 3065 Bowers Avenue, Santa Clara, California 95051. In Europe contact Intel International Brussels, Belgium. Telex 24814. In Japan contact Intel Japan, K. K. Tokyo Telex, 28426.

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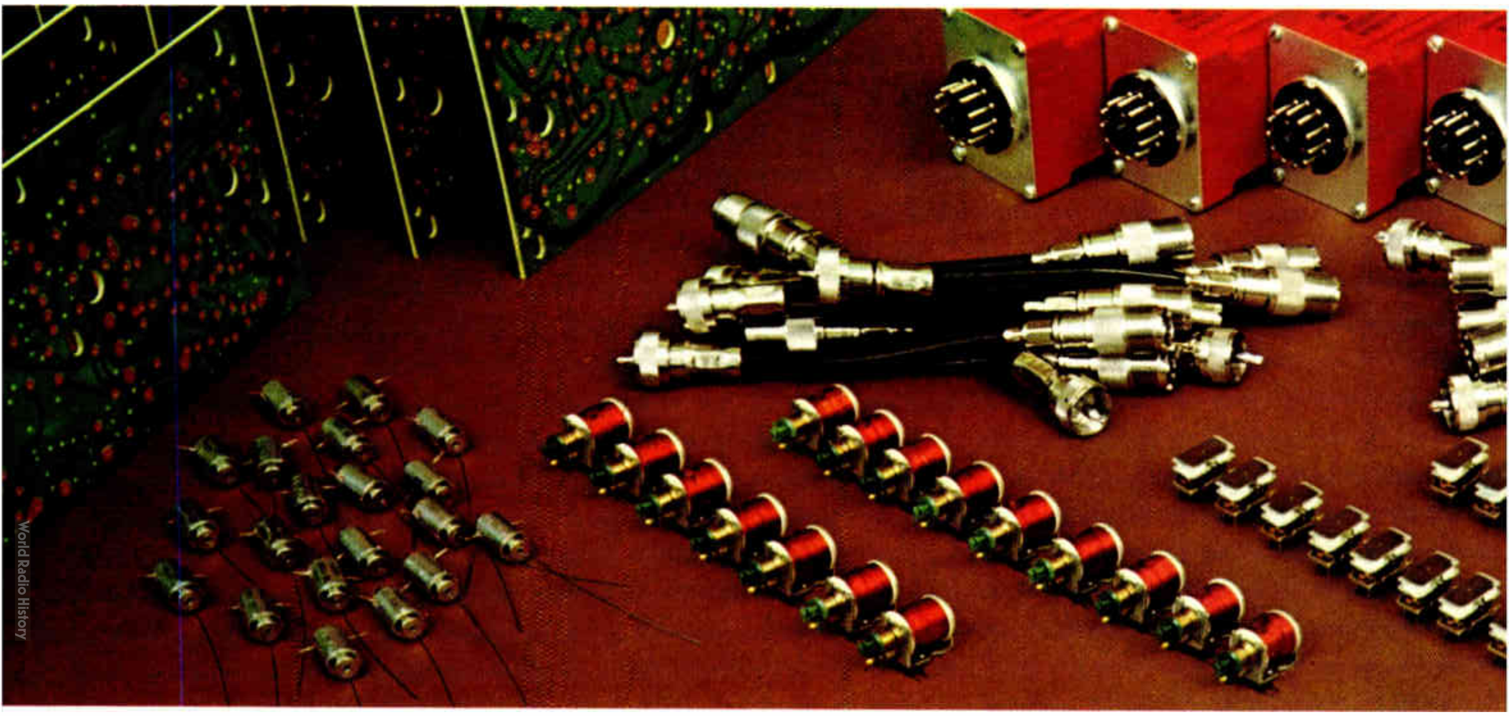
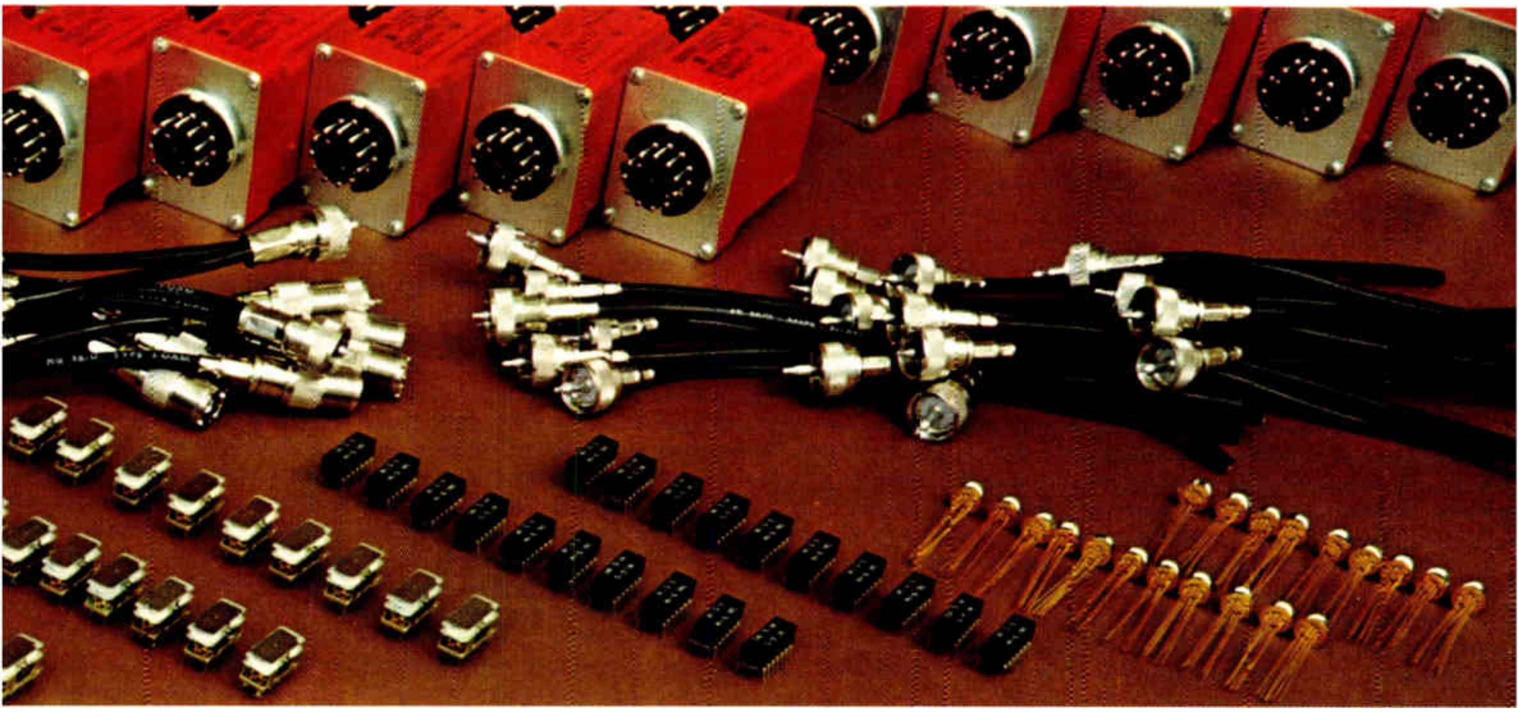


Major manufacturers forget them all the time. Polaroid. DEC. Honeywell. Tandy. Foxboro. Ford. Bendix.

Our products are *easy* to forget. Because, once installed, all of Hi-G's quality products (transformers, solenoids, timers, printed circuit boards and others) do what they are meant to do. Keep right on working.



That's why Polaroid selected a Hi-G Magnetec solenoid to actuate the shutter on the SX-70 and the Pronto Land Cameras. Why Raytheon relies on the quality and performance of our Defiance printed circuit boards, counts on our prompt delivery at competitive prices. And why Hi-G commercial relays are on the job in scores of Foxboro control systems.

Our products work. And keep working. So it's fine with us if you forget them. Just remember our name. Hi-G Incorporated, 580 Spring Street, Windsor Locks, CT 06096.

Hi G

Remember our name.

Circle 21 on reader service card

Editorial

A new sense of time for Wescon

As a showplace of the highly innovative electronics industries, Wescon should feel comfortable with innovations. Indeed, the original decision to alternate the annual show between Los Angeles and San Francisco reflects that openness to trying new things. And over the years it has responded to the changing needs of both its exhibitors and its attendees. The success of that response can be measured by the fact that this year's attendance may even exceed the 31,000 people who attended the last San Francisco edition in 1975.

It is heartening, then, that the Wescon management continues to try new ways of making the show a valuable working tool to the engineer, as well as a worthwhile vehicle for electronics companies. This year's show marks the first time that it will span three days instead of the traditional four. The move was based on the results of an exhibitor survey that was in favor of trying the shorter show as an experiment, and it was natural to make the experiment this year to avoid Yom Kippur, which falls on what would have been the fourth day.

Since the majority of showgoers do not stay the full four days, the three-day run should not prove a great hardship. In fact, with all the activities crammed into a shorter time, most attendees might even get more benefit out of their limited visits. What is more, exhibitors will not have to tie up quite as much time and talent for the same show exposure. Indeed, if even the same number of people come to the show this year, that averages out to some 10,000 a day, up from 7,500 or so in 1975. All in all, going to three days is a sensible idea. It will be interesting to see how it works in practice.

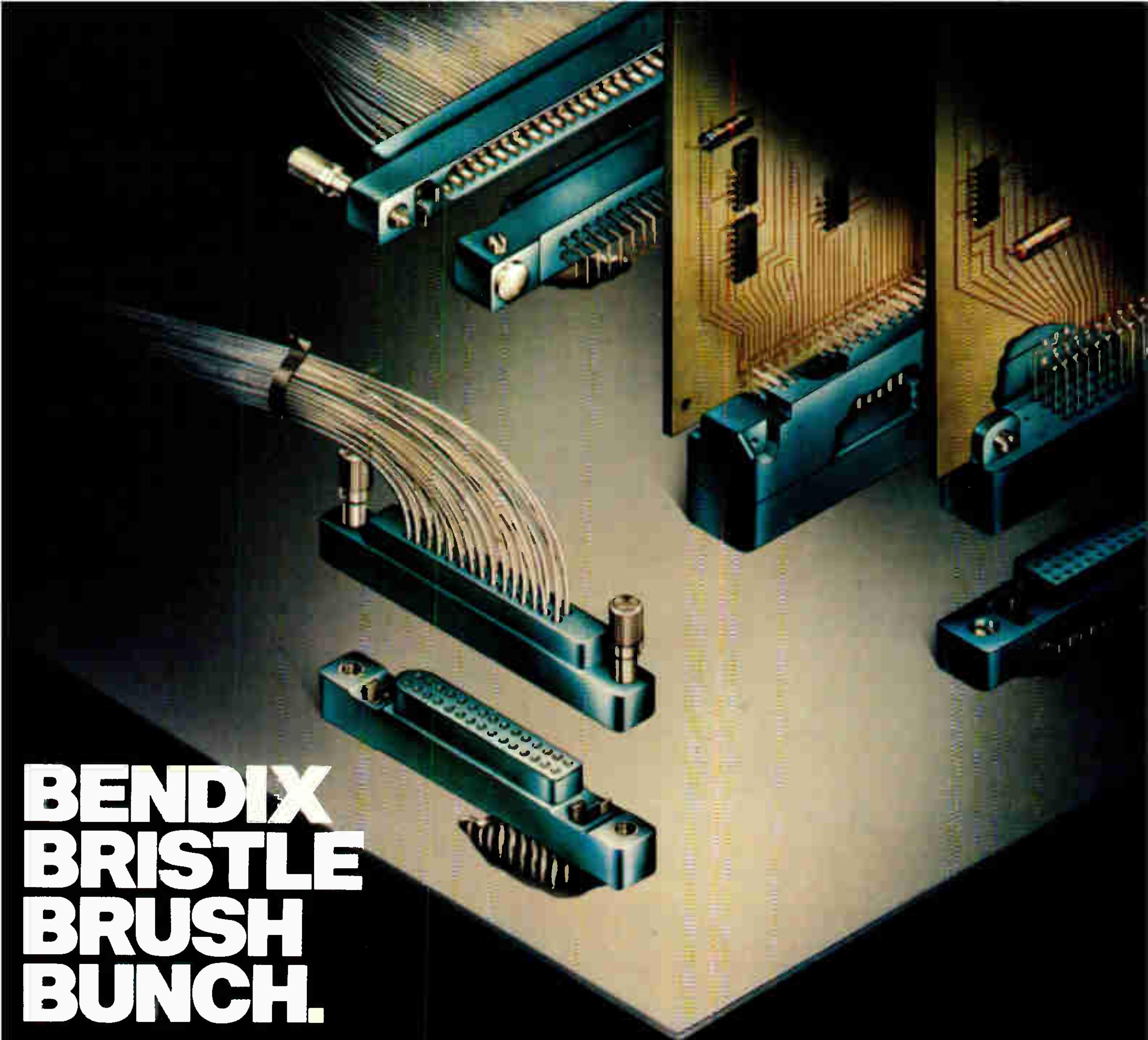
IEEE: perils of an active campaign

The IEEE election campaign is really heating up. The latest major campaign move is the organization of a membership committee that opposes the Good Government Group, which was itself only recently formed by a number of industry officials, former IEEE leaders, and engineering educators. The new committee, called the Electrical and Electronics Engineers' Committee for a Member-Oriented Institute, characterizes itself as a grass-roots response to an "elitist" point of view.

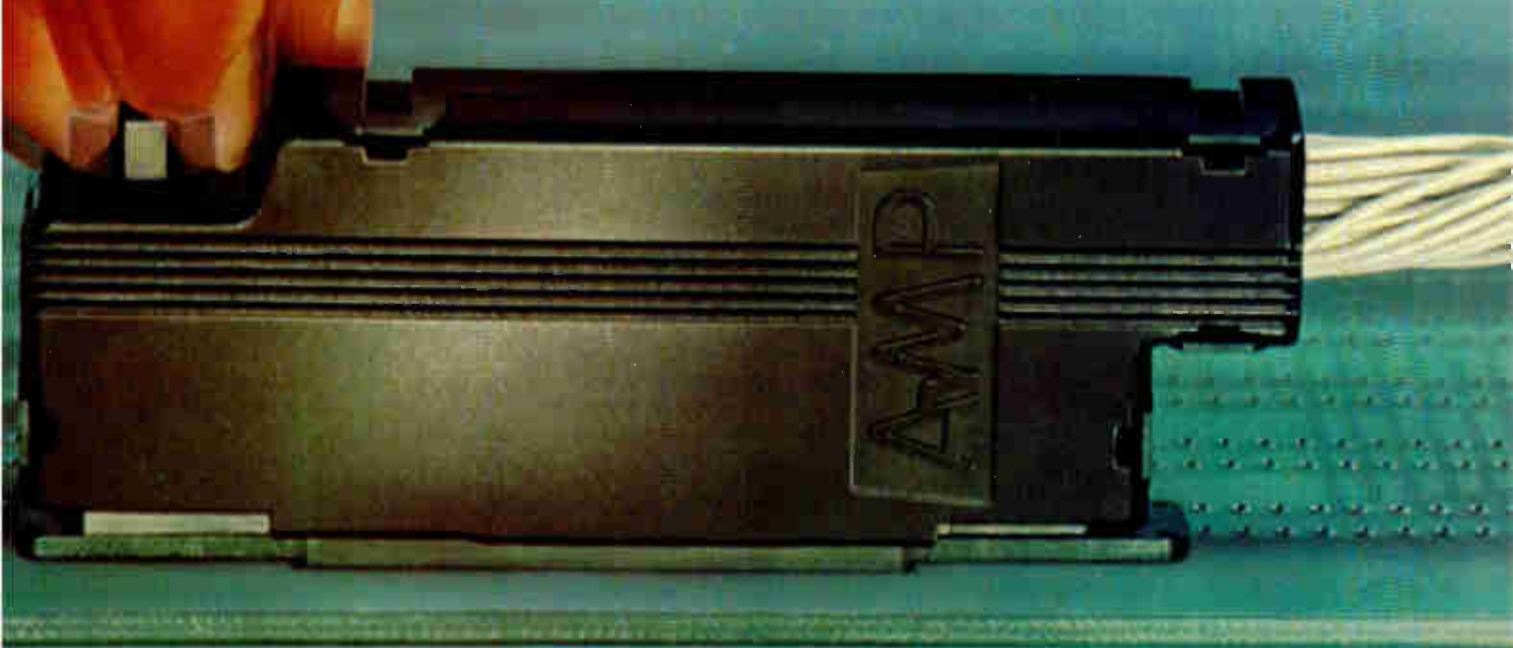
Such groups are the sign of an active campaign, which we are all for, because that is the sure way to generate interest among the apathetic members. The trouble is, in the flurry of public statements, newsletter articles, and mailing pieces, a lot of charges and countercharges are being made. There is, then, the danger of a damaging polarization of the institute between extremist groups, and the interests of the membership at large may become obscured.

The members' attention should be attracted with serious and constructive debates over the issues—from the professional directions the institute should take to career problems—not by personal attacks, rumor spreading, and other questionable tactics.

Certainly apathy hurts, but, in its way, unstatesmanlike campaigning can do even more damage to a professional organization like the IEEE. It is to be expected, of course, that the campaigners' emotions should run high. But they must take a longer view and make sure that the campaign is based solidly on the issues—not on side issues.



AMP's CR connectors prevent damage to pc board traces. They mate with Zero Insertion Force.



AMP 40 position CR connectors assure excellent connections. Because they apply over 150 grams of force to each contact with just a turn of the cam. The wipe backwipe motion of the contacts precleans the surfaces for full electrical continuity. And contact wear is virtually nonexistent for well over 5,000 insertion cycles.

The 40 position CR connector is designed specifically for input/output functions in today's high density pc board applications such as those used in microprocessors. Its modular design means extra economy because it can be loaded with as few or as many contacts as you'll actually use. And it will accept either crimp snap-in or insulation displation modules.

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For more information on CR Series connectors, call Customer Service at (717) 564-0100. Or write AMP Incorporated, Harrisburg, PA 17105.

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Circle 24 on reader service card

Meetings

Industry Applications Society Annual Meeting, IEEE, Marriott Hotel, Los Angeles, Oct. 2–4.

Euromicro—Third Symposium on Microprocessing and Microprogramming, IEEE *et al.*, Free University, Amsterdam, the Netherlands, Oct. 3–6.

Nepcon 77 Central, Industrial & Scientific Conference Management Inc. (Chicago), O'Hare International Trade and Exposition Center, Chicago, Oct. 4–6.

Gidep—Government-Industry Data Exchange Program Conference, Gidep (c/o Dennis Starling, Datagraphix Inc., San Diego, Calif.), South Coast Plaza Hotel, Costa Mesa, Calif., Oct. 5–7.

Interkama 77—International Congress and Exhibition for Instrumentation and Automation, NOWEA (Düsseldorf, West Germany), Fairgrounds, Düsseldorf, Oct. 6–12.

Info/Expo 77—International Data Processing Conference and Business Exposition, Data Processing Management Association (Park Ridge, Ill.), Washington Hilton Hotel, Washington, D. C., Oct. 9–12.

Electrochemical Society, Electronics Division Symposium, The Electrochemical Society (Princeton, N. J.), Hyatt Regency Hotel, Atlanta, Ga., Oct. 9–14.

National Electronics Conference and National Communications Forum, NEC (Oak Brook, Ill.), O'Hare Hyatt Regency Hotel, Chicago, Oct. 10–12.

Tenth Convention of Electrical and Electronic Engineers in Israel, (c/o Daphna Knassim Ltd., New York), Tel Aviv, Oct. 10–13.

International Symposium on Information Theory, IEEE, Cornell University, Ithaca, N. Y., Oct. 10–14.

IntelCom 77—International Telecommunication Exposition, Horizon House International (Dedham, Mass.), Georgia World Congress Center, Atlanta, Oct. 10–15.

Loran-C Comes to the West Coast—Sixth Annual Wild Goose Association Convention, WGA (c/o Samuel H. Goldstein, Great Neck, N. Y.), Edgewater Inn, Seattle, Wash., Oct. 12–14.

Minicomputer Applications Conference, American Institute of Industrial Engineers (Santa Monica, Calif.), Twin Bridges Marriott Hotel, Washington, D. C., Oct. 12–14.

1977 Canadian Reliability Symposium, Society of Reliability Engineers, Ottawa Chapter, Talisman Motor Hotel, Ottawa, Ontario, Oct. 13–14.

ISA-77: Fall Industry-Oriented Conference and Exhibit, Instrument Society of America (Pittsburgh, Pa.), National Convention Center, Niagara Falls, N. Y., Oct. 16–20.

Noise-Con 77—National Conference on Noise Control Engineering, NASA Langley Research Center and Institute of Noise Control Engineering, Sheraton Inn, Hampton, Va., Oct. 17–19.

Oceans 77, IEEE, Los Angeles Bonaventure Hotel, Los Angeles, Oct. 17–19.

Seminar on Time and Frequency Calibration, National Bureau of Standards, Boulder, Colo., Oct. 17–19.

Info 77—Information Management Exposition & Conference, (c/o Banner & Grief Ltd., New York), New York Coliseum, New York, Oct. 17–20.

Data Management Symposium, NASA Marshall Space Flight Center and University of Alabama in Huntsville, MSFC, Huntsville, Ala., Oct. 18–19.

International Telemetering Conference, International Foundation for Telemetering and Instrument Society of America, Airport Hyatt House

Meetings

Hotel, Los Angeles, Calif., Oct. 18–20.

Eighth Korea Electronics Show, Korea Fine Instruments Center (Seoul), Korea Machinery Permanent Exhibition Hall, Oct. 18–25.

Tenth Annual Connector Symposium, Electronic Connector Study Group Inc. (Camden, N. J.), Hyatt House, Cherry Hill, N. J., Oct. 19–20.

Third Workshop on Reliability Technology for Cardiac Pacemakers, National Bureau of Standards, Gaithersburg, Md., Oct. 19–20.

1977 Design Automation Workshop, IEEE, Michigan State University, East Lansing, Mich., Oct. 19–21.

Nuclear Science and Nuclear Power Systems Symposia, IEEE, Sheraton Palace Hotel, San Francisco, Oct. 19–21.

ISHM 77, International Society for Hybrid Microelectronics (Montgomery, Ala.), Baltimore Hilton Hotel and Civic Center, Baltimore, Oct. 24–26.

International Conference on Energy Use Management, University of Arizona (Tucson), Marriott Hotel, Tucson, Ariz., Oct. 24–28.

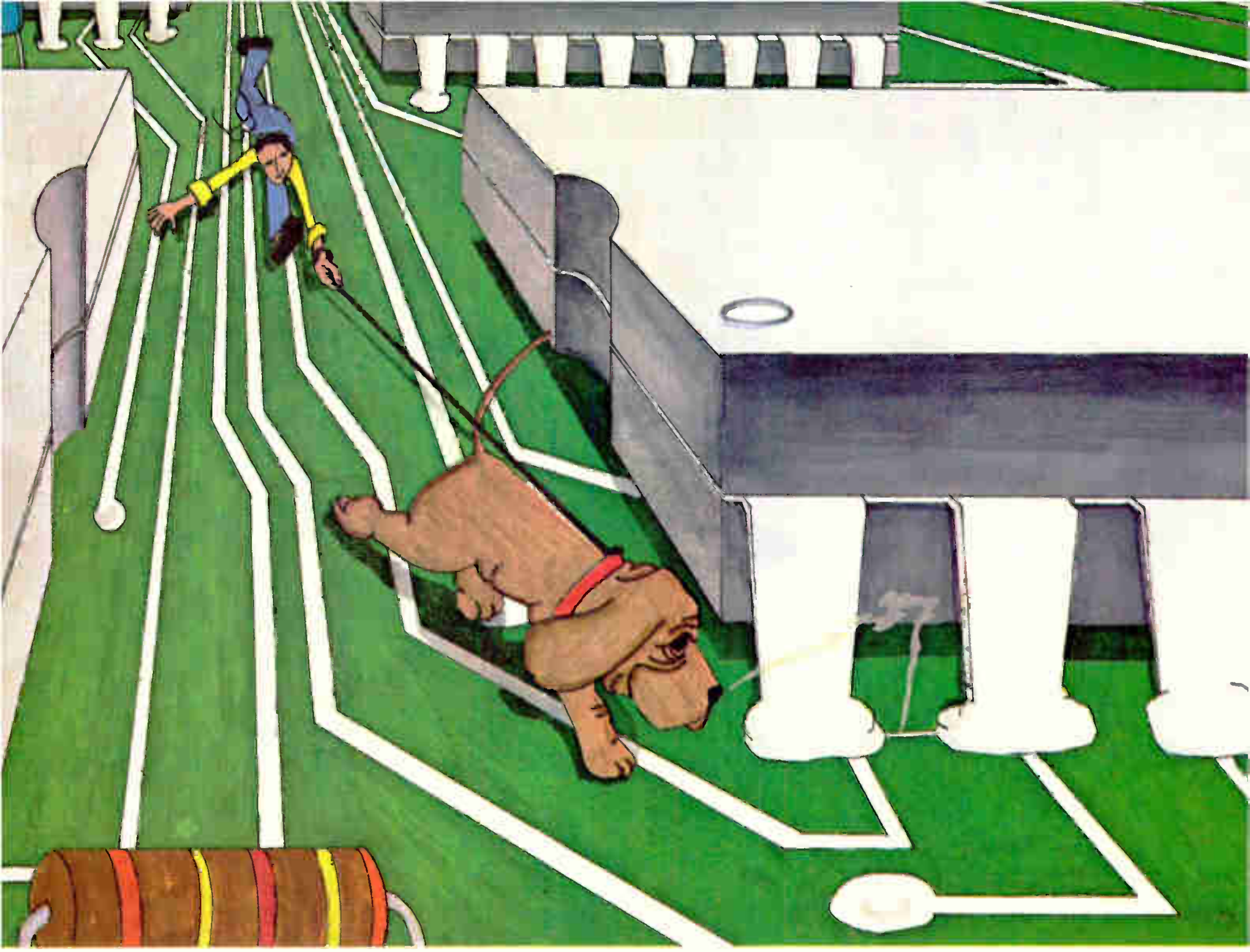
1977 Fall Symposium—PC Boards for the 80s, California Circuits Association (Palo Alto, Calif.), Airporter Inn, Irvine, Calif., Oct. 25–26.

Electro-Optics/Laser 77, Industrial & Scientific Conference Management Inc. (Chicago), Anaheim Convention Center, Anaheim, Calif., Oct. 25–27.

Machine Tools Industry Technical Conference, IEEE, Marriott Inn, Cleveland, Oct. 25–27.

Semiconductor Test Symposium, IEEE, Hyatt House, Cherry Hill, N. J., Oct. 25–27.

Radar 77—International Radar Conference, IEEE *et al.*, London, England, Oct. 25–28.

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Circle 29 on reader service card

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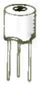
Type A: ¼" diameter, single turn, 10 ohms to 2 megs ±10%, 0.5W at 85°C, immersion sealed, 3 terminal options, Publication 5238. **1000 piece price $1.12 to 1.68.**



Type S: ⅜" dia., single turn, 50 ohms to 1 meg ±10%, 0.5W at 85°C, immersion sealed, top or side adjust, Publication 5208. **1000 piece price $1.15 or 1.40.**

Type E: ⅜" square, single turn, 10 ohms to 2 megs ±10%, 0.5W at 70°C, immersion sealed, 13 terminal options, Publication 5219. **1000 piece price $0.49.**

Type D: ⅜" diameter, single turn, 10 ohms to 2 megs ±20%, 0.5W at 70°C, dust cover, 6 terminal options, Publication 5240. **1000 piece price $0.42.**

Type 90: Approx. 7/16" square, single turn, 100 ohms to 2 megs ±20%, 0.5W at 70°C, open frame, 2 terminal options, Publication 5242. **1000 piece price $0.55.**

Type MT: ⅜" square, 20 turn, 10 ohms to 2 megs ±10%, 0.5W at 70°C, immersion sealed, 3 terminal options, Publication 5241. **1000 piece price $1.18.**

Type RT: ¾" long, 20 turn, 10 ohms to 2 megs ±10%, 0.75W at 70°C, immersion sealed, 3 terminal options, Publication 5237. **1000 piece price $0.65 or 0.93.**

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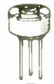
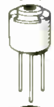
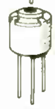


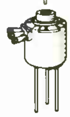
Type Y: ½" dia., single turn, 100 ohms to 5 megs ±10% or 20%, 0.25W at 50°C, dust/splash resistant, 5 styles, non-linear tapers, Pub. 5209. **1000 piece price $0.90 to 1.59.**



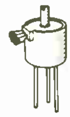
Type F: ½" dia., single turn, 100 ohms to 5 megs ±10% or 20%, 0.25W at 70°C, immersion sealed, 6 styles, non-linear tapers, Pub. 5234. **1000 piece price $1.00 to 1.62.**



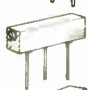
Type O: ½" dia., single turn, 100 ohms to 5 megs ±10% or 20%, 0.40W at 70°C, immersion sealed, 4 styles, non-linear tapers, Pub. 5235. **1000 piece price $1.20 to 1.58.**



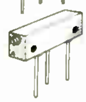
Type FD: ½" dia., 2 sec., 1 turn, 100 ohms to 5 megs ±10% or 20%, 0.25W at 70°C, immersion sealed, 4 styles, 5 tapers, 2 atten. Pub. 5231. **1000 piece price $2.65 to 4.10.**



Type BT: ½" dia., 2 section, 1 turn, for 75 ohm Bridged-T pad applications, dust/splash resistant, side and top adjust versions. Pub. 5236. **1000 piece price $2.49.**



Type N: 1¼" long, 25 turn, 100 ohms to 2.5 megs ±10% or 20%, 0 33W at 50°C, immersion sealed, Publication 5206. **1000 piece price $2.50 or 2.65.**



Type R: 1¼" long, 25 turn, 100 ohms to 2.5 megs ±10% or 20%, 0.25W at 70°C, immersion sealed, bushing mount option, Pub. 5205. **1000 piece price $2.87 to 3.73.**

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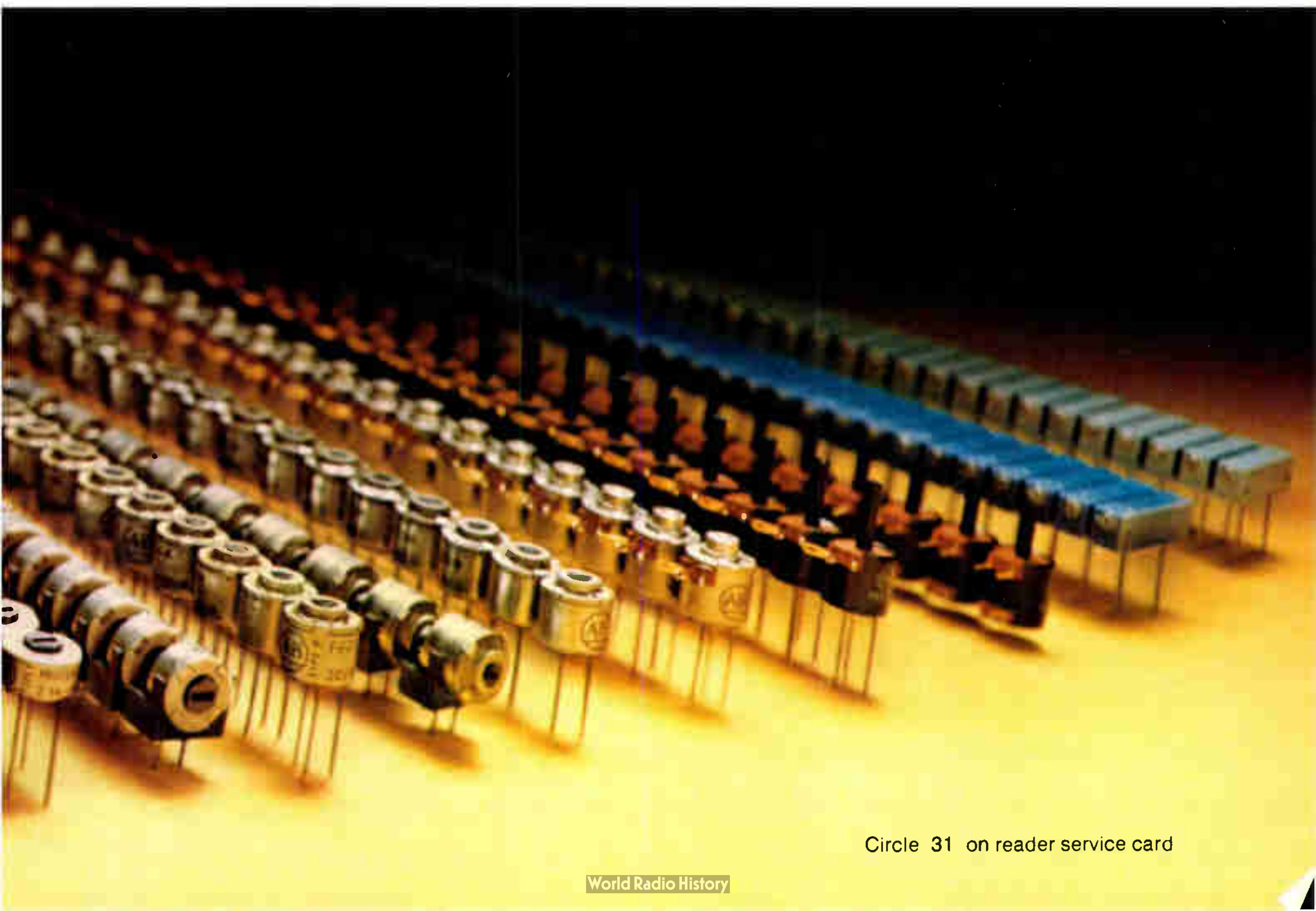

Circle 31 on reader service card

Why does a little GE Press-Pak SCR handle more current than a big one?

More pellet power.

The larger the pellet, the greater the current. The basics behind General Electric's new ½-inch Press-Pak SCR package are just that simple.

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New GE ½-inch Press-Pak SCR's are interchangeable with standard ½-inch Press Paks. Thus, you can use them to upgrade equipment without redesign. And higher surge current in the ½-inch packages means you're buying a higher margin of safety.

Models include C430 (1200v, 1000A) and C431 (1800v, 1000A) phase controllers; and C435 (800v, 1000A) and C438 (1200v, 850A) inverters.

High current performance in a small SCR package is the kind of innovation you expect from the world's leading manufacturer of power semiconductors. For more information, call your nearby GE electronic components sales engineer, or write General Electric Co., Electronics Park 7-49, Syracuse, NY 13201. 222-03

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GENERAL ELECTRIC

Electronics newsletter

Nonimpact printers drawing attention and R&D dollars

Look for some big changes in the high-end printer market **as money is diverted from impact-printer work to research on nonimpact models.** According to industry sources, the yawning gap between the fastest line-impact printers (2,000 lines per minute for under $20,000) and the nonimpact types (about 20,000 lines per minute for a few hundred thousand dollars) is begging to be filled, and companies like Dataproducts Corp. and Computer Peripherals Inc. are after the market.

Although electrographic printers like the IBM 3800, Xerox 9700, Honeywell's page-printing system, and others dominate the market, most of the action will be in ink-jet printing, once the technology is worked out. The process has the advantage of printing on any material, and four-color picture-quality prints are not inconceivable.

Germans find way to put op amps on LSI chips

Two researchers at the University of Dortmund in West Germany think they have found a way **to put operational amplifiers in otherwise digital large-scale integrated circuits.** The technique, which will be discussed at the third European Solid State Circuits Conference in Ulm, West Germany, Sept. 20–22, uses an n-channel enhancement-depletion mode tailored to analog circuit needs. It results in an op amp with a gain of 90 dB, power dissipation of 4 mW, and a unity gain bandwidth greater than 1 MHz. Each op amp occupies only 2.5 square millimeters of the chip.

Emulation, signature analysis to be used in service instrument

Millenium Information Systems, Inc., Cupertino, Calif., the supplier of the Tektronix 8000 series of microcomputer development systems, is about to move into service instruments for microprocessor-based equipment. Millenium is combining the techniques of signature analysis [*Electronics*, March 3, p. 89] and in-circuit emulation to produce an instrument that, it says, **can be used by technicians with low skill levels.**

Evaluation kit is Augat's entry into fiber-optics

Augat Inc., the large electronic-interconnection firm, has taken the plunge into the fiber-optics field. Its first product, a low-cost kit **for engineering evaluation of fiber-optic interconnections,** will be shown at Wescon.

The kit comes in two versions. One at $190 has an infrared emitter assembly with an 880-nanometer spectral peak; a 5-meter-long fiber-optic assembly; a temperature-referenced photodetector assembly matched to the emitter; and preamplifier and emitter driver modules compatible with TTL. A $99.50 version is available without the two modules.

Analog Devices lists nine I/O interfaces for microcomputers

It has been a while in coming, but Analog Devices Inc. has greatly broadened its plan for going after the burgeoning microcomputer analog input/output interface market. The Norwood, Mass., company **will introduce nine new products** between October and February to go with microcomputers from Intel, Pro-Log, Motorola, National, and Texas Instruments. The company's first such product was an analog I/O board for Intel SBC-80/10, which bowed last fall [*Electronics*, Nov. 25, 1976, p. 141]. The new round of introductions indicates that Analog Devices will have a broad-based analog I/O board line, with prices ranging from $235 to approximately $500.

The lowest-priced unit will be the four-channel output board, with 8-bit accuracy, designed to go with the Pro-Log 4- and 8-bit microcomputers. It and a 16-channel data-acquisition board for the same machines will be available next month, as will similar boards for the Intel SBC-80 and MDS, and the National BLC-80. Three I/O boards for the Motorola 6800 will reach the market in November and December, with two more for TI's TMS-990/1000 being prepared for next February.

Potentiometer line gets two options from Allen-Bradley

Allen-Bradley Co. has started sending out samples of two new options for its distributor-assembled MOD POT line, **and is preparing the devices for production this month.** New to the series of interchangeable panel potentiometer modules is a switch for signal-level circuits, tested for currents as low as 15 mA and rated at 5 V. The dry-current switch is designed for such applications as function switching in oscilloscopes. The Milwaukee, Wis., firm is also adding low-torque conductive plastic resistive elements to get the easier-turning pots often needed for miniature equipment. They will be available from 100 Ω to 1 MΩ in tolerances of ±10% and ±20%, and power ratings of 0.25 and 0.50 W.

Intel gets out of watch business, closes Microma

The anticipated departure of Intel Corp. from the digital watch business [*Electronics*, Aug. 18, p. 74] has been made official **with the closing of its Microma subsidiary.** Microma will continue to manufacture watch products only until it "fills shipments of products already committed," says Gordon Moore, Intel's president. Intel is charging the $1.4 million after-tax loss to its earnings in the current quarter. The decision does not affect the parent firm's commercial production of C-MOS watch chips.

Motorola, Fairchild to bring out V-MOS power parts

It looks as though power V-MOS, a young technology for fabricating power MOSFETs, is starting to catch on. Two major semiconductor houses, Fairchild and Motorola, will shortly have devices out in the marketplace, **and other traditional leaders in bipolar power now have evaluation programs under way** (see "will V-MOS make it in power market," p. 84).

Next month, Fairchild is introducing a pair of power FETs, types 2N6557 and 2N6660, and is now circulating samples of a p-channel device. Additionally, besides second-sourcing the entire line of power MOSFETs now made by Siliconix, which pioneered power V-MOS, Fairchild plans to develop its own rf and high-voltage high-current parts. The latter should be available in the first quarter of next year. In particular, the firm is working toward a general-purpose complementary pair of 140-V, 10-A devices.

Meanwhile, Motorola has been shipping samples of a low-power V-MOS part since the beginning of the year. Intended for vhf applications, the unit develops 1 W at 175 MHz. It is slated for introduction later this year.

Leeds & Northrup seeks acquisitions

Look for Leeds & Northrup Co. of North Wales, Pa., to acquire companies or product lines that complement its own catalogue of process controls and instrumentation. The firm, **in various stages of discussions with about a half dozen companies,** is most interested in adding test and measuring equipment, such as digital voltmeters, multimeters, counters, and signal sources, to its line of laboratory instruments.

microNOVA keeps on trackin'.

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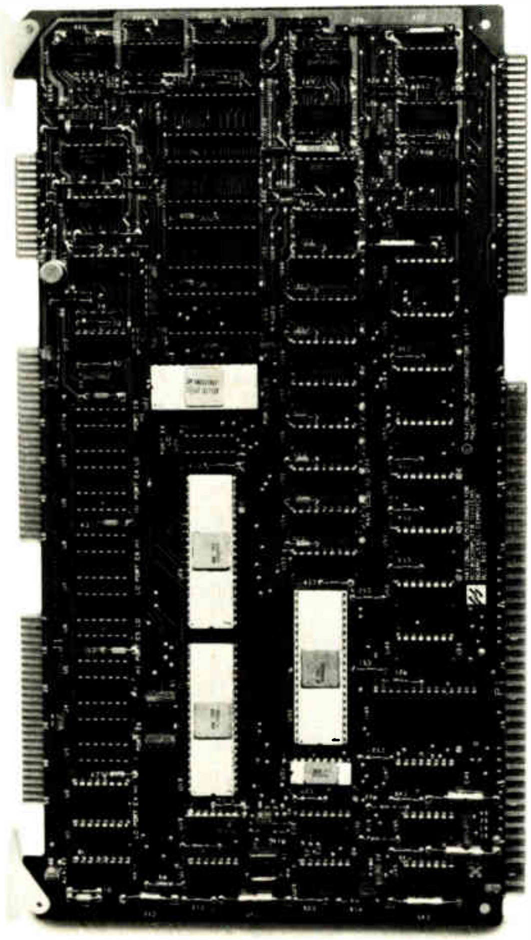

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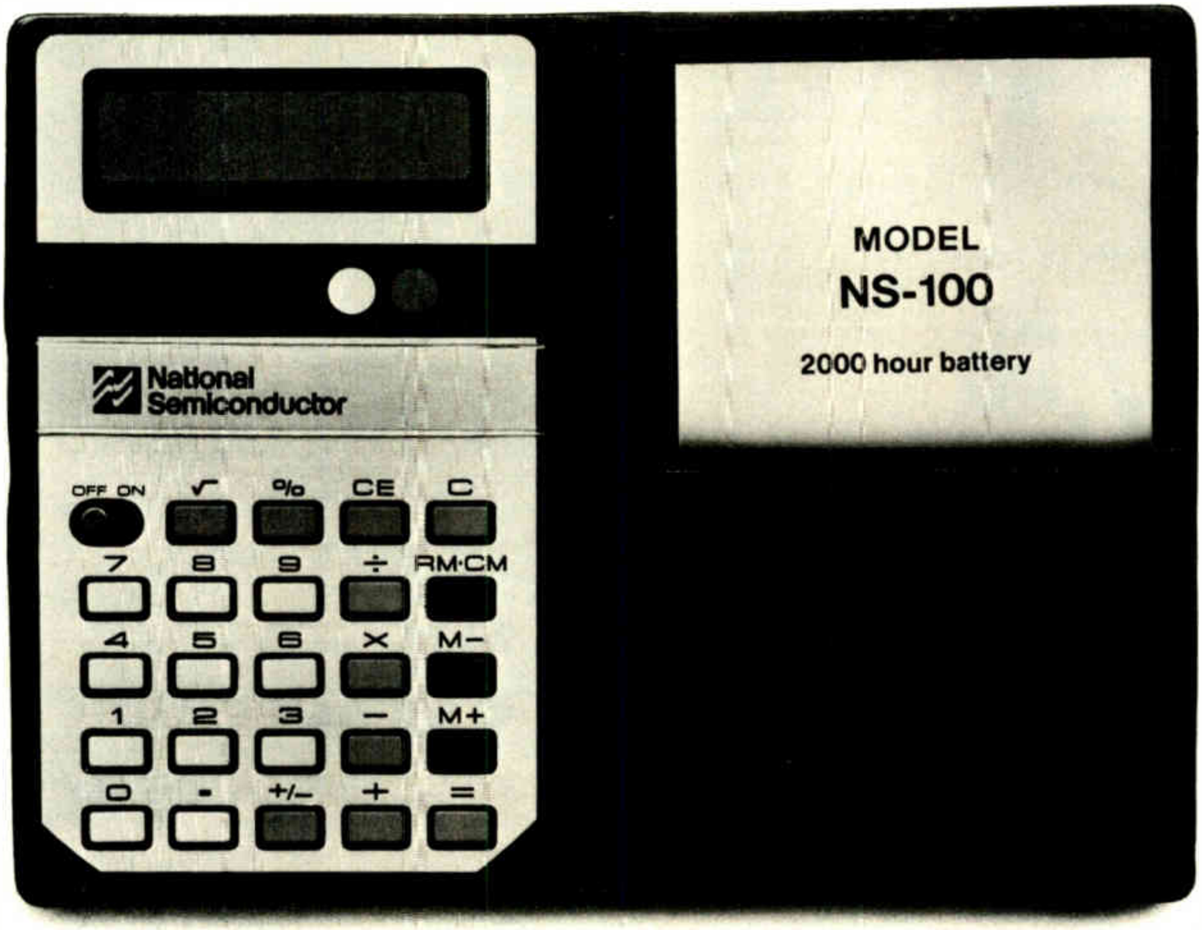

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Offer expires October 15.

Japanese 4-k RAM challenges U.S. devices

Fallout from Japanese government's subsidized project, double-diffused static unit can copy many parts

Using a double-diffused MOS process, Nippon Electric Co., under Japanese government sponsorship, has developed a 4,096-bit static random-access memory that rivals the performance of the most advanced static RAMS now in the works at U. S. suppliers. This development supports the American industry fear that Japanese government-sponsored electronic programs will spawn advanced semiconductor components, which when exported will quickly penetrate the American and European digital markets.

The device is a 57-nanosecond 1,024-word-by-4-bit fully static RAM built with a 4-micrometer double-diffused metal-oxide-semiconductor process, which is called diffusion self-aligned MOS in Japan. It was developed as a cache or buffer memory for a high-speed microcomputer in the $100 million 10-year national project on pattern-information processing. The project, started in 1971, is financed by the Ministry of International Trade and Industry. To export a version of the device, NEC, which manufactures the part for MITI, will apply to the government for a commercial license.

NEC has not disclosed which of the American static memory types it will copy. For new mainframe applications, it could copy the pin-out and power-down configuration of Intel's new 2147 4-k static RAM built with the 4-micrometer high-performance MOS process, or it could copy the 4-k versions from American Microsystems Inc., built with the double-diffused V-groove MOS process. For cache applications, it could supply the part in 4-k-by-1-bit configurations identical with the industry-standard 95415 bipolar package. For high-speed microprocessor and peripheral static RAMS, it could copy the 1,024-word-by-4-bit or 4-k-by-1-bit MOS configurations of Mostek Corp., Intel Corp., or Semi Inc.

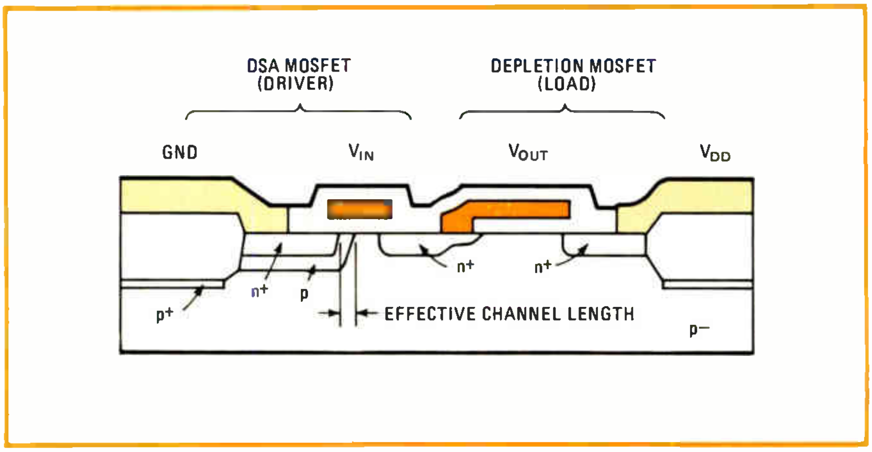
In any case, industry sources close to the development estimate that NEC's part will turn up as samples in some form in the U. S. within six months. In that time frame, only Intel and AMI are expected to have 50-ns 4-k single-5-volt MOS static RAMS on the market.

The current NEC device has a typical access time of 57 ns, typical cycle time of 100 ns, active power dissipation of 520 milliwatts, and standby power dissipation of 375 mw. Cell size is 52 by 64.5 μm, and chip size 4.6 by 6.09 millimeters. It operates off a supply voltage of 5 v, $\pm$ 1 v, and dissipates power in a backup mode of 4.4 mw at 1.1 v.

For commercial export NEC designers will either optimize the specifications on the D-MOS part or switch to a short-channel silicon-gate approach (similar to Intel's) which is also under development. Within six months, the company expects to see samples of 4-k RAMS built with either process, so that NEC may be the only other semiconductor manufacturer in a position to provide an alternate source to Intel for a power-down 2147-type static RAM for sub-100-ns mainframe use.

How it's built. The basic configuration of the NEC approach is six transistors per cell. A special configuration of silicon-gate enhancement-depletion inverter including double-diffusion and advanced local-oxidation techniques gives the high speed. The basic mask dimension is about 4

Inside view. Basic structure of Nippon Electric Co.'s static random-access memory uses diffusion self-aligned, or D-MOS, driver and conventional n-MOS load.



μm, giving source-to-drain separation of less than 2 μm and source and drain depths of about 1 μm. The gate oxide is 800 angstrom units thick.

Despite the small dimensions, the double-diffused configuration eliminates punch-through, shifts in threshold voltage, and other short-channel effects. It also allows use of thicker oxide, plus deeper source and drain diffusions than is possible in standard n-channel transistors of similar dimensions.

Two measures were taken to decrease junction capacitance and thus increase operating speed. The p^+ diffused channel stopper under the local oxidation was fabricated by an advanced technique so that it is vertically separated from the source and drain n^+ regions, and a substrate with the high resistivity of 100 ohm-centimeters was used.

Ion implantation is used for deposition of the boron in the p-diffusion layer of the transistors to precisely set the threshold at 1 v, ±0.1 v. Thresholds of the depletion-load transistors are also adjusted by ion implantation—to two different threshold voltages—to meet high-speed–low-power requirements. Threshold voltages for the write driver and decoder and for the decoder buffer and load cell are −3 v and 0 v. □

Displays

Package combines optical fibers, lasers for liquid-crystal display

The package may be the key to making gallium-aluminum-arsenide laser arrays practical in display, printing, and communications applications. Researchers at IBM Corp.'s Yorktown Heights, N. Y., research center have developed a novel fiber-optic laser array package that goes a long way toward solving the many optical and physical problems associated with such devices.

John D. Crow, one of the developers, says that such a fiber-optic laser array combination, with each laser providing 50 milliwatts in continuous-wave operation, can write characters into a liquid-crystal display by heating sections of it. The feasibility of this approach has already been demonstrated at IBM's San Jose Research Center, he says.

Crow sees other applications as well. Printing hard copy using the laser array to heat volatile dye on a ribbon, similar to a typewriter ribbon, literally blows the ink off the ribbon and onto the paper. "And of course with such an array, parallel data can be sent over fibers in a byte-wide format instead of in bit-serial fashion, when only a single fiber is used," he adds.

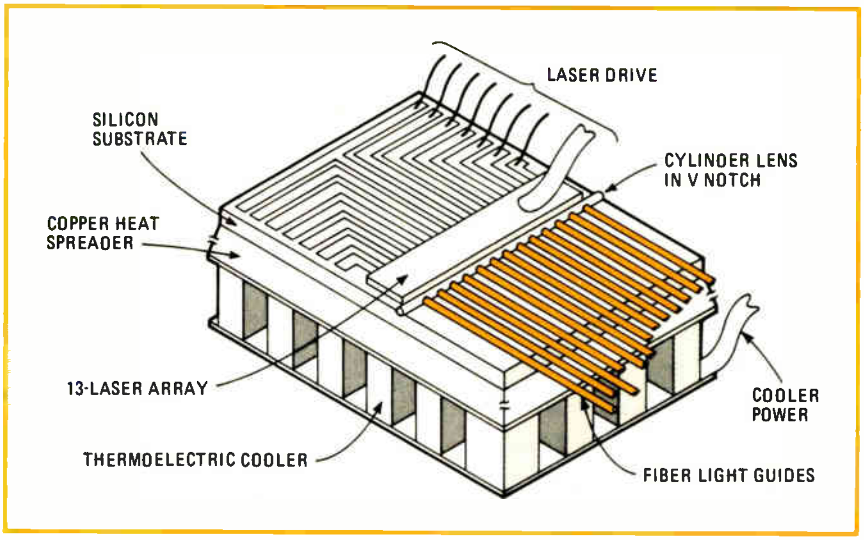
The package designed by the group of IBM researchers from different disciplines contains 13 gallium-aluminum-arsenide double-heterostructure lasers bonded to an inexpensive silicon substrate. The substrate is soldered to a copper heat-spreader, which is attached to a thermoelectric cooler to ensure that the lasers' operating characteristics remain constant for full-array operation. An optical fiber is used as a cylindrical lens to efficiently couple as much as some three quarters of the light from the lasers into the larger fiber light guides.

The group realized early on that a silicon substrate was the key to solving all the problems that faced them. Using the same technology as is employed in making V-MOS transistors, they preferentially etched the silicon wafer along the (111) planes to form V grooves with a shape and depth precisely controlled by the crystalline planes. When the (111) faces meet at the bottom of the groove, the etching process is essentially terminated; thus grooves of different depths can be etched into the same substrate in a single fabrication step.

Silicon benefits. Precise optical alignment in an inexpensive material with an easily fabricated process was a key consideration, says Eric G. Lean, an IBM researcher who helped formulate the package concept and guided its progress, but the silicon substrate offered other benefits as well.

"It's easy to diffuse an n layer into the p-type silicon substrate to form a diode that is reverse-biased and thus electrically isolates one electrode from all the others," he says. "And these junctions do not affect the heat flow from the laser to the copper heat-spreader." What is more, the

In the groove. Glass fiber, placed in etched V groove, acts as lens to concentrate light from semiconductor lasers into output fibers, giving 70% transfer efficiency.

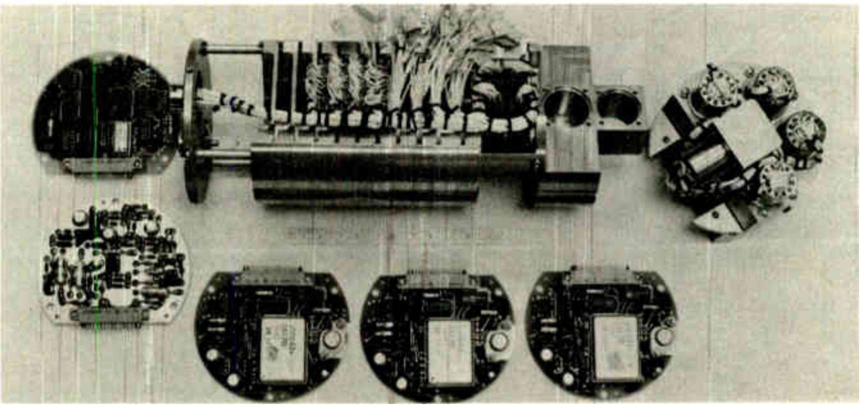


thermal coefficient of expansion of silicon is a better match to GaAs than is copper, putting less stress on the laser and greatly reducing laser degradation.

Lean and Crow agree that future packages will integrate active driver- and control-circuit chips directly onto the same silicon carrier that contains the laser array and the optical components. Then, too, easily fabricated pn junctions used for electrically isolating electrodes for individual addressing can also be used as temperature sensors. Looking ahead, they see no reason why fibers from a number of source packages could not be combined into larger arrays to allow rapid printout of full pages of information onto a liquid crystal display, or carry more data on parallel paths. □

Navigation

Microprocessor ups missile capabilities



Inertial guidance. Advanced version of Northrop Corp.'s attitude-reference assembly, part of midcourse guidance system for Harpoon anti-ship missile, uses microprocessor.

Microprocessor technology promises to pack more punch into future U. S. Air Force and Navy tactical missiles. Not only will more computing power go into their midcourse inertial guidance systems, but their terminal seeker electronics will be simplified and will be better integrated with the midcourse unit. That is the conviction of engineers at the Precision Products department of Northrop Corp.

Probably the first weapon to benefit from this integration will be the advanced medium-range air-to-air missile, for which requests for proposals are expected to be issued next month by an Air Force–Navy program office at Eglin Air Force Base, Valparaiso, Fla.

Joseph Yamron, vice president and general manager of the Northrop department in Norwood, Mass., says his organization has a good chance to win the midcourse guidance system subcontract because it builds the attitude-reference assembly for the system in the Navy's Harpoon antiship missile. That unit was the first all-digital strapped-down inertial unit to go into production for a missile [*Electronics*, Dec. 23, 1976, p. 26]. An advanced version of the Harpoon attitude-reference assembly has undergone successful bench and sled tests at the Navy's China Lake, Calif., Weapons Testing Center.

For the advanced medium-range air-to-air missile, the Precision Products department will probably propose an even newer generation of midcourse inertial unit than the one tested at China Lake. John McNeil, systems development section manager at the department, says the newest-generation strapped-down unit can use microprocessors such as the Motorola 6800, Texas Instruments 9900 or Advanced Micro Devices 2901 bit-slice device.

Operation. The Northrop design incorporates three of the department's rate-integrating gyros and three of its accelerometers. Before launch, the midcourse guidance system would store the coordinates of its launch position and the target coordinates derived by the fire-control system of the launching ship or aircraft.

After launch, the guidance unit puts out error signals indicating how far off course the missile is in relation to the target and in relation to the launch reference coordinates, starting, according to Christopher Reynolds, systems design branch manager, with angular information from the gyros.

The microprocessor, McNeil says, computes the attitude of the midcourse guidance unit in reference to the missile airframe to which it is strapped. It then takes digital signals from the accelerometers to compute changes in the missile's velocity. Finally, the microprocessor translates the missile coordinate data into the reference coordinates and generates commands to steer the missile.

The digital data is ultimately converted to analog signals that will drive actuators to change the missile's course. The Northrop unit can also provide commands that will aim a terminal seeker that is capable of being steered. In this manner, the time the terminal seeker takes to acquire the target can be shortened, lessening the chance that its radar may be jammed. Then, too, duplication of inertial components in the terminal seeker, midcourse guidance, and autopilot units can be reduced or eliminated. □

Microprocessors

National produces 16-bit, 40-pin chip

With their third-generation 8-bit medium-range microcomputers on the market, semiconductor makers are taking aim on the 16-bit marketplace as well. Major microprocessor firms—among them Intel Corp., Zilog Inc. and Motorola—have announced plans to introduce high-throughput 16-bit n-channel metal-oxide-semiconductor microcomputers during 1978, with speeds as much as 10 times that of present 8-bit machines.

Hoping to blunt the impact of both the advanced 8-bit machines on the market and to steal a march on the projected 16-bit devices, National Semiconductor Corp. has gone into production on a high throughput n-MOS 16-bit microprocessor that it says outperforms most present 8-bit designs. Designated the INS8900, the three-power-supply, 40-pin device is the newest member of the Santa Clara, Calif., firm's Pace family of microprocessors.

Timing. Execution times for the most commonly used instructions are equivalent to those on advanced 8-bit designs such as the 8085 and 10% to 30% faster than on older designs, such as the 2-microsecond 8080, according to Howard Raphael, director of microprocessor marketing at National. Most significant is the price in volume on the 8900: only $10 each in volume.

"Our strategy from here on out is to leapfrog the competition," says Raphael. In the works are single-supply, +5-volt, scaled n-MOS versions of the 8900 with even greater throughput, as well as minimum three-chip systems in which the 8900 or some more advanced version will be coupled with two input/output timer chips, one for read-only and one for random-access memories.

Even in its present configuration, the new microcomputer is impressive. Fabricated with an advanced depletion-load n-MOS process and operating with only a 2-megahertz clock, it has a microinstruction cycle time for most internal operations—even 16-bit-wide ones—of 2 μs. At the macroinstruction level, the 8900 really shines, says Raphael. A bit transpose takes 110 μs, a memory-to-memory add about 16 μs, and an interrupt I/O about 54 μs. Comparable speeds on a 2-μs 8080 are 164, 27, and 44 μs, respectively.

The 8900 makes use of both 16-bit instruction words and data words and features a powerful and flexible set of 45 instruction types with 337 individual instructions. All instructions use a single 16-bit word, thus reducing memory-access and program-storage requirements.

Novel. The device has the ability to operate on both 8- and 16-bit data words. This extends the inherent efficiency and power of a 16-bit processor to 8-bit applications, Raphael says. In addition, the 8900 can add four-digit-per-word binary-coded-decimal data as well as straight data. "This capability eliminates the program storage and execution time usually required for BCD-to-binary conversions in 8-bit designs," Raphael says.

Like other advanced microprocessor designs, the 8900 has an on-chip I/O capability. It has flag output and jump commands that, in addition to giving it flexibility in controlling peripherals, can be used together as a serial I/O port, "eliminating the hardware that would otherwise be required to interface to the data bus and to decode the device address," Raphael says. The device also has a six-level, priority-interrupt structure on the chip, while most 8-bit systems require a separate large-scale integrated device. □

Packaging & production

Philips says yes to resistless, etchless printed-circuit boards

A two-year-old process for delineating printed-circuit board patterns without using resist may be getting a shot in the arm from Philips' Elcoma division. The Dutch group is considering switching much of its subtractively etched board production to its own version of the American-devised photographic process. Philips intends to license the process, which it calls PD-R.

"The prestige of a giant like Philips is going to do a lot to legitimize the process in the eyes of potential users," asserts John Dennis-Browne, manager of technology sales and licensing for the Kollmorgen Corp.'s Photocircuits division, Glen Cove, N.Y. His unit introduced the resistless process, called Photoforming, in 1975.

Several companies in the United States and abroad have secured licenses but, according to Dennis-Browne, additional development time was required to adapt the procedure to a manufacturing environment. Photocircuits and its licensees are now at the prototype stage of their operations.

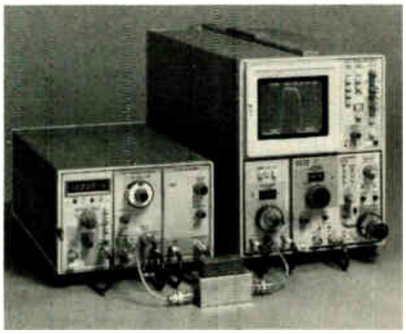
The Philips and Photocircuits processes are very similar. Both use ultraviolet light to project an image onto a printed-circuit board with a chemically treated surface. The surface reacts with the light and the image is then developed using photographic techniques.

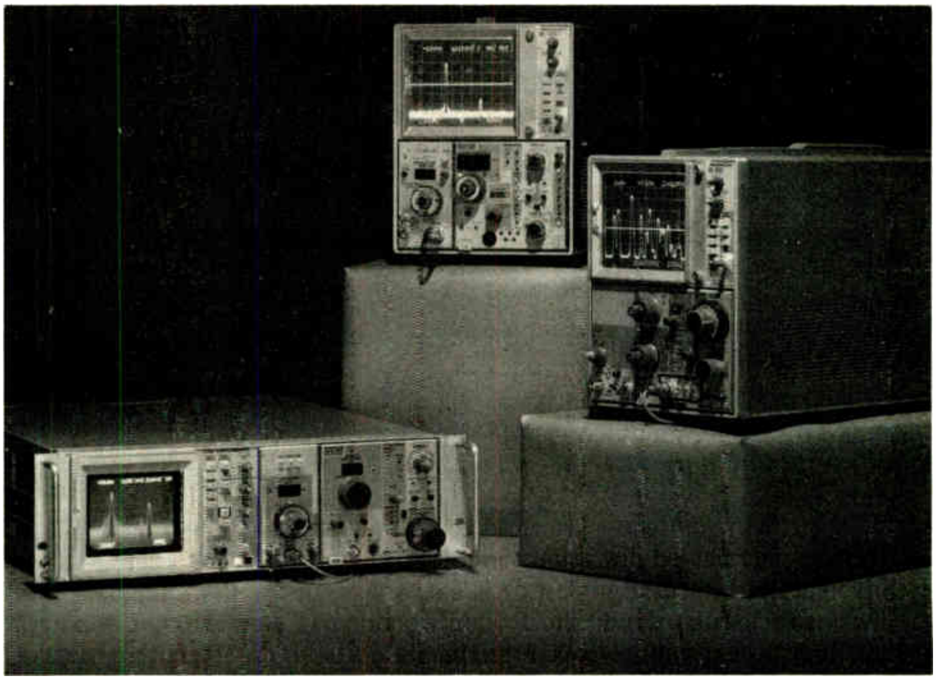
What results is a metallic pattern that can be built up to circuit-board thickness using electrolessly plated copper. Gone are the screened-on or film resists used in the conventional additive and subtractive processes and the masks through which the pattern is screened on. Gone, too, is the stripping operation in which the unwanted resist is removed chemically. Unlike the subtractive process, there is no etching away of copper in the resistless method.

Savings. All of this adds up to a 30% reduction in cost over Philip's standard subtractive etching of pc boards, according to a company spokesman in Eindhoven. Also, it is also possible to plate conductors and spaces as narrow as 6 mils, compared to 13-mil conductors and 16-mil spaces possible with subtractive etching. Additive-process limits are conductors and spaces about 10 mils wide.

The Elcoma division in Eindhoven is using the PD-R process for prototype telecommunications boards. In its process, Philips first coats a standard FR-4 glass-epoxy board with a layer of titanium oxide. After holes are drilled, the board goes through a swell-and-etch step to ensure a firm

A high performance spectrum analyzer family?





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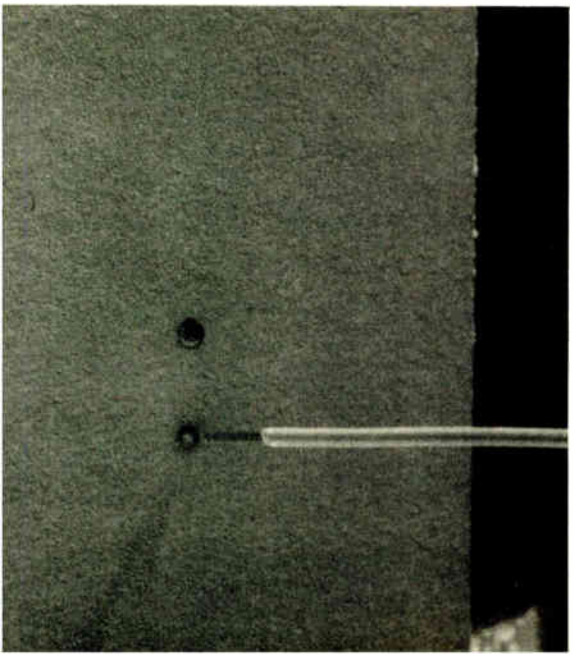
While PD-R works solely with FR-4 laminate, Photocircuits' Photoforming can be used on a variety of glass-epoxy boards and other materials like paper and phenolics. Moreover, Photoforming does not need a catalytic coating like titanium oxide but relies on an adhesive coating to hold the copper. Finally, Photoforming's light-sensitive material is based on non-noble copper salts rather than palladium. □

Fiber optics

Hughes fiber shows 0.01 dB/km loss in IR

Although fiber-optic technology based on silica materials works in transmitting signals at visible frequencies, there are basic optical limits to its use in infrared ranges. Yet, the IR range offers some promising applications for short-range image relay, power transmission, and long-distance communications.



Burn in. Showing only a 0.01-decibel loss per kilometer, polymer-clad fiber handles infrared energy hefty enough to burn holes.

Now, a team at the Hughes Aircraft Co. Research Laboratories, Malibu, Calif., has demonstrated a polycrystalline core technique that permits fabricating IR fiber-optic waveguides. "We have achieved optical transparency of these fibers extending from approximately 0.6 micrometer in the visible to approximately 35 μm in the infrared," reports Douglas A. Pinnow, assistant manager of the chemical physics department. "Conventional oxidic glass fibers have infrared cutoffs in the range of 3 to 4 μm."

Hughes produces polycrystalline cores with a prototype extrusion process, using thallium bromide and thallium bromoiodide materials. For a waveguide, the cores are inserted into a loose-fitting polymer cladding, which serves as optical confinement as well as mechanical protection, Pinnow explains. Developed for a sensing requirement in a classified military project, the cores are manufactured in low volume in diameters in the range of 100 to 500 μm.

In tests, the new fibers have exhibited low losses in comparison with the best glass materials, Pinnow says. At 4 to 5 μm, for example, the fibers have a 0.01-decibel-per-kilometer loss, against 0.5 dB/km, "probably at the fundamental limits of silica," he observes. Moreover, the polycrystalline fibers have a pliable quality that allows bending them more easily without damage.

Medical uses. While this performance shows what is possible with further development in improving low-loss communications links, applications in medicine are imminent, according to Anthony L. Gentile, head of the semiconductor optical materials section. "The best transparencies we've been able to observe is 10% attenuation at 10.6 μm by transmitting a 2-watt continuous carbon-dioxide laser beam," he says.

Its significance to physicians is as a highly selective cauterization instrument, which is particularly useful for internal surgery. Now, such lasers are in the visible light range and deeply saturate tissue, he says, whereas the 10.6-μm laser can excise such growths as shallow tumors of one-cell thickness.

While Hughes fibers have the potential of being perhaps three orders of magnitude more transparent than silica, Pinnow concedes the need for a lot more research in two areas. Materials of much higher purity are basic, he says, and production processes must be improved from the "now feeble rate of a few centimeters per minute" in the Hughes laboratory. □

Radar

Highway radar eludes detectors

Police departments now have another weapon to help in enforcing—and motorists another obstacle to beating—the speed limits. The device is a small traffic radar that uses a microprocessor to help in camouflaging itself from the barrage of radar detectors now on the roads.

The radar, which Kustom Signals Inc. started shipping last month, is programmed with a hold feature that suppresses the microwave transmission until a target vehicle is within sight. That way, it is invisible to radar detectors until it is fired, and by the time it is seen, the radar has recorded the target's speed. "It's the same idea as hand-held point-and-shoot radars, but we've applied it to a moving radar," says William D. Goodson, chief engineer for the Chanute, Kansas, firm that supplies most police radars. Kustom has shipped more than 100 units, 85 to state police in Kansas and Minnesota.

Short bursts. Moving radars not only look at the Doppler shifts of signals returned from the target vehicle, but also must keep track of patrol car speed by scanning the roadway. Instead of simply turning off the radar, Kustom's KR-11 sends out bursts of pulses shorter than the integration time most radar detec-

tors use to minimize false triggering.

"We use a pseudorandom pulse, period- and frequency-randomized by the microprocessor," Goodson explains. "If a detector manufacturer figures out how to detect our radar signature, we can change it by simply changing the software."

The $300 premium that Kustom is asking for its $3,000 radar may be justified by its antidetector aspect alone, but the firm is using the microprocessor to load the unit with other features as well. "We had reached a size limit using standard logic," Goodson says, and the microprocessor not only meant a smaller device, but "also allowed us more features at a lower cost than if we had used standard transistor-transistor logic."

Those features include improved range and accuracy and faster target acquisition than earlier radar units. Range, for example, has been roughly doubled to an average of 4,000 feet, and the new radar has spotted cars three miles away under extremely favorable conditions. "With the Motorola MC6800 microprocessor, we can use a more sophisticated algorithm for digging signals out of noise," Goodson explains.

Kustom units previously looked for five additional consecutive readings before locking onto a target. "Now we look not only at the frequency of the signal, but at what it's doing—whether it's increasing or decreasing and by how much." Goodson will not specify what criteria are used, but, he says, "we can now make intelligent decisions based on what the signal is doing, and we can make them in about a fifth the time, or about 14 milliseconds." In addition, the radar can speed through its calibration sequence so fast that it checks its accuracy with a pair of crystal oscillators each time it locks onto a target.

Conversion factors for kilometers and knots are also written into the device's 2,650 bytes of programmable read-only memory, and Kustom has equipped the radar with connections for future peripherals. "By changing the PROMS and adding a peripheral interface adapter, we can give the customer whatever he wants," Goodson says. The first accessory, due next month, is a plug-in camera that captures speeders on film along with time, date, and speed readings. "We can also bring out analog information for a strip-chart recorder, or data for some sort of remote display or for a data-gathering statistical package."

The unit is the first moving radar to operate in the K band, at 25.15 gigahertz, the upper end of the microwave spectrum allocated by the Federal Communications Commission for police radar. Doubling the frequency of the earlier X-band—10.525-GHz—radars means that the antenna's waveguide and microwave assembly can be half the size. Kustom launched K-band hand-held units two years ago, "and there's yet to be a detector developed that works very well against K-band radars," he says. □

Testing

With LSI outdistancing tester makers, chip insides must be guessed at

Even with full cooperation of chip makers, manufacturers of automatic logic test equipment would find it a knotty problem to prepare the software simulation packages necessary to check out computer and memory boards. "But it is even tougher when a definitive internal description of the part is not supplied by the vendor, which is usually the case," says Ray Turner, senior systems analyst for the industrial products division of Computer Automation Inc., Irvine, Calif., which builds test equipment. Turner discusses this problem, and his solution, at the September 19 Wescon technical session on automatic test techniques for complex digital assemblies.

Such descriptive data was available in the past, when the Computer Automation division devised logic test packages for simpler small-scale and medium-scale integrated components, in the form of vendor-supplied "gate equivalents"—internal input/output characteristics of such devices as NAND gates, flip-flops, or decoders. Engineers and programmers employed this information to construct mathematical software models that were put together into simulation packages for testing entire boards.

An Intel Corp. official confirms that it does not normally supply internal device specifications to outsiders, but says this decision is dictated largely by economics. "It's not that we don't want to be open," explains James Coe, international marketing manager for microprocessors. Developments are moving so rapidly, and advanced LSI chips becoming so complex, "that we don't have the manpower to do this and our own manufacturing, too."

Although it is in the interests of semiconductor companies to encourage independent test equipment makers, in his view "the burden of keeping up is on the testers."

Emulation. In the meantime, faced with customers needing to test more complex logic and memory boards, Turner's division had to find a solution. Their answer is a shortcut technique, called functional emulation. To get around the lack of internal component data, division engineers treat each complex device as a single element, writing a functional mathematical description based on inputs, outputs, and a transfer function relating the two. Put into a high-level computer language, combinations of these descriptions, reflecting specific board configurations, become simulation packages that generate automatic test programs.

The packages generate test programs four times faster than manual methods, Turner says, and are particularly useful in manufacturing environments, where many different circuit boards are used.

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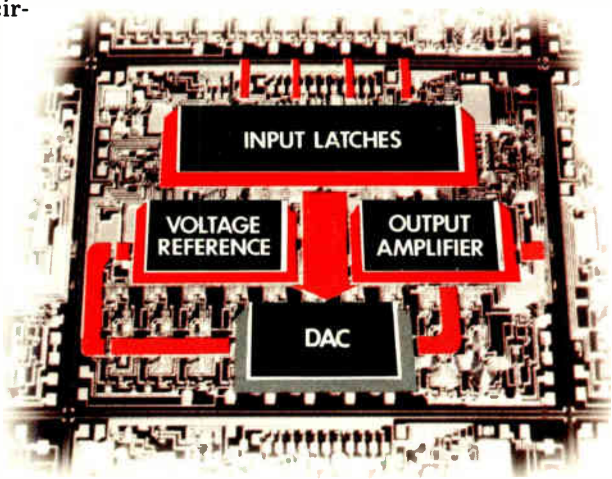

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Circle 47 on reader service card

point internal device faults, he admits. But since many LSI failures "are related to timing, noise, and threshold problems," it still works.

Other tester makers agree that economics blocks needed information transfer. GenRad Inc., Concord, Mass., for example, gets around that by taking a functional-model approach, too. Says Robert Szpila, marketing manager for the Electronic Manufacturing Test division: "You don't care what's inside, but you do need conductivity information—what inputs affect what outputs—so that you can track down faults with a guided probe."

Fred McDonald, product manager for functional card testing at Teradyne Inc., Boston, however, says his company has not had any real problems getting NAND-gate models from vendors. "Because we do it with gate descriptions, we can generate test patterns as if these [LSI devices] were SSI or MSI." □

News briefs

TI 40-channel CB delayed till next year

Texas Instruments has had to put off application for FCC-type acceptance of its 40-channel combination a-m and single-sideband citizens' band radios. The reason they give: the need to make minor redesign changes to improve the sets' manufacturability. According to a TI spokesman, the firm expects to have sets on the market the first part of next year.

Amdahl taps Xerox, IBM computer execs

In an apparent bid to deepen its penetration into the mainframe computer market, Amdahl Corp. of Sunnyvale, Calif., has appointed two executives from International Business Machines Corp. and Xerox Corp. to key management and marketing posts. John C. Lewis, former president of Xerox' Data Systems division and most recently president of Xerox' Business Systems group, has been named Amdahl's president and chief operating officer. Lewis succeeds Eugene R. White who becomes deputy chairman for the producer of IBM-compatible mainframe computers. William F. O'Connell also has joined Amdahl as senior vice president, marketing, a new post. He was large systems marketing manager for IBM World Trade Europe/Middle East/Africa Corp.

Sikorsky tops Boeing Vertol for $750 million Navy helicopter pact

United Technologies Corp.'s Sikorsky Aircraft division in Stratford, Conn., has been awarded a Naval Air Systems Command contract to produce the Light Airborne Multi-Purpose System, or Lamps, as the anti-submarine warfare helicopter is called. In winning the approximate $750 million award, Sikorsky beat out the Boeing Co.'s Vertol division in Philadelphia. IBM Corp.'s Federal Systems division in Owego, N. Y., is prime contractor for the Mark-3 avionics system for detecting and tracking submarines. Major electronics subcontractors include Texas Instruments, Sperry Univac, Raytheon, Interstate Electronics, Itek, and Fairchild Space & Electronics Co.

Communications

Secure voice link to use CCDs

With digital data communications spreading rapidly, related techniques, like digital voice transmission look ever more attactive. Compared with analog methods, going digital allows voice signals to be easily encoded for security and privacy, noise and interference to be lessened, and economical time-division multiplexing to be used.

One bottleneck, of course, is that voice-processing techniques are complex enough to need a large computing capacity and much equipment. However, developers at TRW's Defense and Systems Group, Redondo Beach, Calif., believe they have a solution to this processing problem. "The only way to get a low parts count and high power appears to be charge-coupled devices,' says Thomas A. Zimmerman, charge-transfer department manager.

Building on unique digital processing research [*Electronics*, June 10, 1976, p. 41], the TRW workers are planning fabrication of chips to go into a voice processor. Their program, partially supported by the Navy, will have the CCD devices ready by the second quarter of next year, Zimmerman predicts. The next step is building the voice-processing breadboard module, which could be completed by the end of 1978 if expected funding is obtained.

Three chips. As now configured, the processor would require only three CCD chips, one arithmetic unit, and two control units, although these two controllers stand a good chance of being combined into one, Zimmerman notes. All functions, analog-to-digital and d-a converters, amplifiers, and memory, go into only 43 16-pin components, attached to a 5-by-7-inch board, which will fit under a telephone set.

Concerning chip architecture, "there is very little novel or original," he explains, "It is simply a way of connecting two or three CCD chip types to form a processor." Main elements on the arithmetic chip are a 16-by-16-bit multiplier, already completed, and a nearly developed 32-bit adder/subtracter with multiplexed gates to route data in the desired order. The control chips provide both data and read-only memory shift registers, also with multiplexers to route inputs and outputs.

The Navy program is directed toward providing an advanced secure communications terminal, and one measure of the complexity of voice processing is the 7.4 million operations per second required to implement linear predictive coding. The technique, which achieves good bandwidth compression and best reproduces individual voice nuances, was developed some years ago. "CCD processors should have no problem performing at this speed," Zimmerman notes, based on proved 5-mega-

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Military

Cost savings eyed in modular testing

The U.S. Air Force thinks it has found a way to stop the proliferation of the extremely costly automatic test equipment used to maintain avionics systems. If the service is right—and it is willing to risk from $50 million to $100 million to prove it is—the test-equipment industry could be in line for an estimated $1 billion-plus in new business.

The solution is to develop a modular automatic test equipment, (MATE) system for use with not one but all Air Force aircraft avionics systems at all maintenance levels, says Lt. Col. Kenneth D. Wilkinson, MATE program manager in the Aeronautical Systems division at Wright-Patterson Air Force Base in Ohio. He says it marks the first time the Air Force has sought development of automated test equipment independent of a specific aircraft. Early this month, over 130 companies received the service's request for proposals for MATE hardware development.

Saving. He expects the system to save the Air Force in excess of $100 million a year by the mid-1980s. To date, the service has developed and purchased separate test equipment, from a variety of contractors, for each aircraft at each level of maintenance—field, organizational, and depot. "We spend about $700 million a year purchasing, maintaining, and operating this equipment," he notes. But under the MATE program, the Air Force would purchase interchangeable, or modular, hardware and software to a single system, he says. The systems would be assembled from the hardware and software modules appropriate to the aircraft and avionics to be tested.

Unlike the Navy's Versatile Avionics Shop Test (VAST) system and other military automatic-test systems that are procurable from one source and built around specially developed functional building blocks or standard hardware, MATE will be defined by hardware standards, says Wilkinson. Any available hardware that meets the performance and interface standards is a candidate for use in a MATE configuration.

Bus structure. Through interface adapters, the various stimuli and measurement modules will be linked to a central data bus, as will be the unit under test, the control module, and any input/output modules, such as a display. Software will be modularized, too, and a hardware module will have an associated software module. "The biggest cost savings will be in software, as well as in test program sets and interface adapters," notes Wilkinson.

The proposals from industry are due back to the Air Force by Oct. 31, with cost data to follow by Nov. 15. Wilkinson expects "about 12 to 20 responses made up of teams from some 70 companies." After considering these proposals, at least two contractors will be chosen for the first and largest phase of the four-step MATE program.

Initial awards, to be made around April of next year, will call for each contractor to build at least four feasibility development models of MATE configurations and to conduct studies on applying the system to future weapons systems. Later phases of the program involve: the development of programming aids, software verification and validation, and technical-services support.

Overall, the advanced development of MATE will take five to six years. Halfway along, notes Wilkinson, one contractor will be selected to continue advanced development and build a first prototype, and "engineering development could start before fiscal 1983."

Thus far, $53.4 million has been approved for advanced development of MATE, "but I've asked for substantially more, in excess of $90 million," states Wilkinson. The program's total business potential for industry, though, could be many times larger. "If MATE is used to

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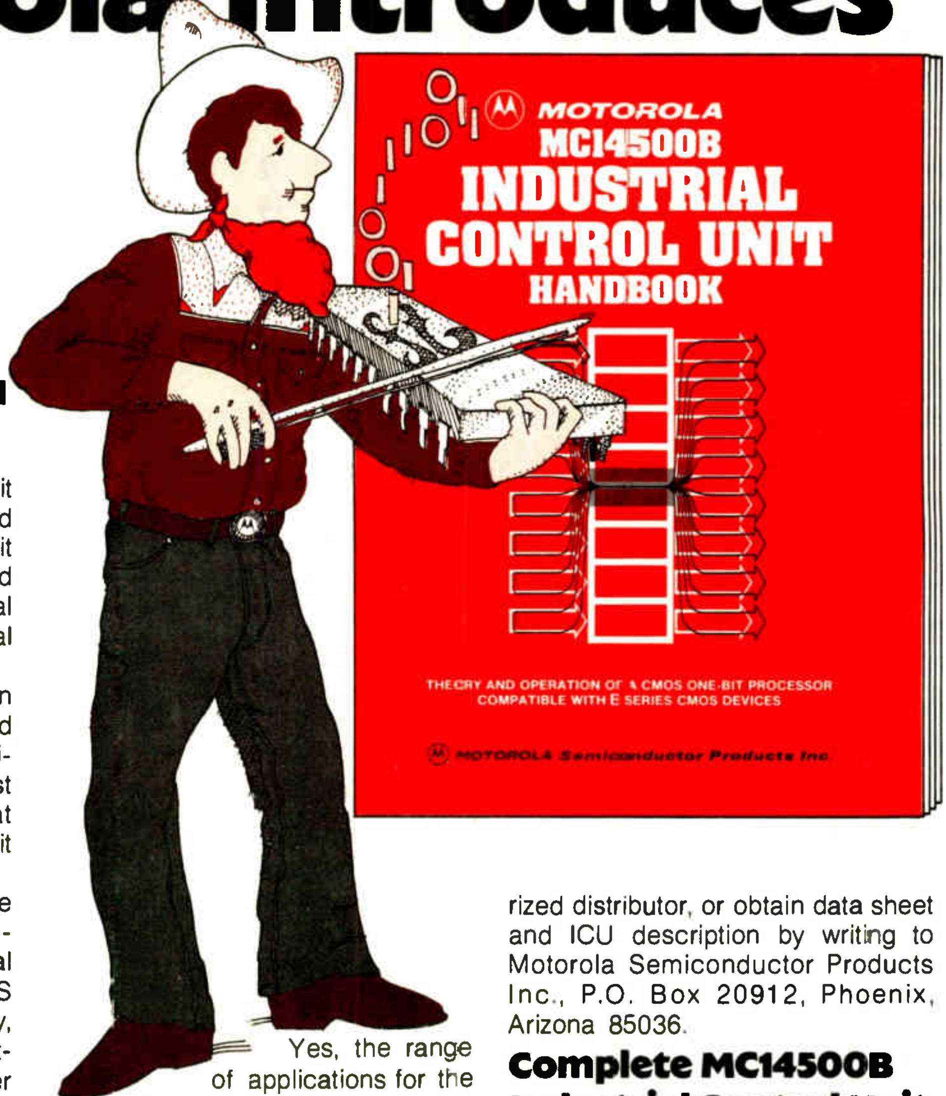

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support just two weapons systems at all maintenance levels, then $1 billion is a conservative estimate of the program's value," he says.

Will it be worth the expense? Wilkinson answers, "If we can make it work on only one aircraft, at all levels of maintenance, we will be making money on it." □

Consumer

Communications chip aids home security

A device borrowed from the data communications industry may go a long way toward achieving the "foolproof" status that is the goal of security systems for the home. At least so thinks Joseph E. Pascente, who is putting a UART in the basement of every house in an expensive subdivision in Oak Brook, Ill.

The plan is for each of 95 homes—selling for $200,000 and up—to have a home security monitor built around a universal asynchronous receiver/transmitter and tied to a central microcomputer in the subdivision's guard station, explains Pascente, president of Electronic Relays Inc. and Sadeto Inc., the Oak Brook subsidiary he has set up to handle his security business. With the communications chip, "we're monitoring a digital bit stream, instead of looking for the presence or absence of a tone or electrical signal," he says. "That makes the system very difficult to defeat." It also makes the lack of a valid signal an alarm condition.

Batteries. The UART, which converts parallel data into a serial bit stream, is a complementary-metal-oxide-semiconductor chip from Intersil Inc. By using C-MOS, the entire network can be powered through leased phone lines by the central computer or its battery backup. Earlier p-channel MOS devices, with their multivoltage and higher power requirements, would have made the system more expensive.

As in most home security systems, more money is spent on installation—distributing standard sensors throughout the house and wiring them to a central monitor—than on the hardware itself. "A basic system guarding front and back doors, with a smoke detector and emergency button, costs about $1,000," Pascente says, "but most are going for roughly $3,000 to $3,500 per house, and then about $4 a month to lease the phone lines." The higher price includes a unit that uses reed switches to monitor all windows and doors for break-ins and accepts inputs from fire, smoke, flood, freeze, power-loss, and medical-emergency sensors, and an alarm button. The UART-based system translates the sensors' contact closures into logic levels and is the least expensive way to put the signals into a time-multiplexed format, according to Pascente.

Most other home security systems sound an alarm in the home, alerting only the resident and his neighbors. Residences that are connected to a central station, such as a guard house or local police station, usually rely on automatic telephone dialers to relay taped or digital messages—a technique that can be defeated simply by cutting the telephone lines.

Scanning. The guard station computer is a Mike 3 microcomputer—built around Intel Corp.'s 8080 microprocessor—from Martin Research Inc., a Northbrook, Ill., firm that also wrote the multitasking software program that allows the computer to scan houses even as it goes about its other security chores. Those include running the system's keyboard, printer, and video display. The program is stored in 6,144 bytes of 8-bit erasable programmable read-only memory; 98,304 bits of random-access memory contain information about the homes such as owner, address, and phone number.

This information is printed out each time an alarm condition is sensed or removed, along with date, time, and type of alarm. Using the computer's keyboard, the guard must acknowledge the alarm within one minute to forestall a second alarm that automatically alerts the city's police and fire department. □

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Analog Inputs	16 channels	●	●	●	●	●	●	●	●	●	●	●				●	●	●	●	●	●	●	●	●	●	●	●
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Analog Outputs	2 channels	●		●		●	●			●		●	●				●		●			●		●			●
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	8 channels													●	●												
	0 to 10V, ±10V, ±5V ranges	●		●		●	●			●		●	●	●	●		●		●			●		●			●
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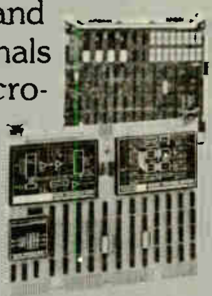

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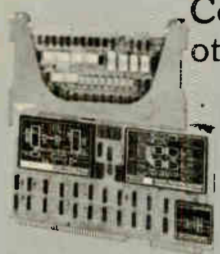

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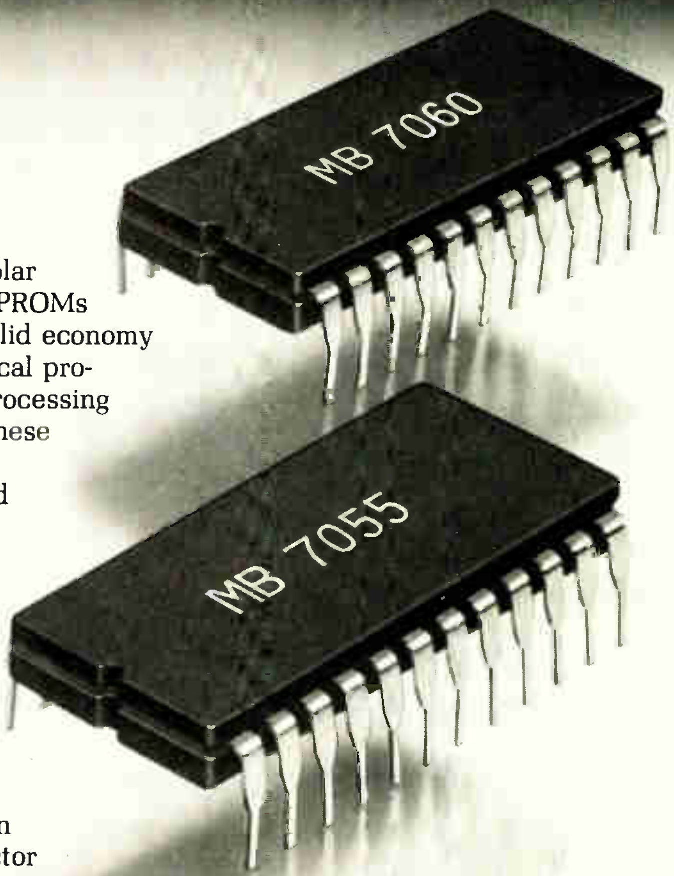

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Washington newsletter

Commercial birds board early shuttle flight

The first commercial use of the space shuttle as a satellite delivery system will be a July 1980 joint mission for Satellite Business Systems and Western Union International. The first SBS satellite, designed for domestic satellite communications on the 12-to-14-GHz frequency, will be launched with the first of a series of data-relay satellites to be owned and operated by Western Union for NASA's deep space missions. **NASA says that it has signed up eight Space Shuttle payloads** from three firms, including WUI, SBS and the Communications Satellite Corp. In addition, several NASA missions and Defense Department projects also are among the 17 shuttle flights currently scheduled.

Meanwhile, SBS says that Hughes, General Electric, and RCA submitted bids on building three satellites, and a contract award will be made by the end of the year [*Electronics*, June 9, p. 49].

Ferris to replace Wiley as head of the FCC

Federal Communications Commission Chairman **Richard E. Wiley will soon submit his resignation to the White House.** Wiley says he wants to be out by very early October. Charles Ferris, general counsel to House Speaker Thomas P. "Tip" O'Neill Jr., will replace Wiley, with the White House expected to send his name to Congress for confirmation any day. Wiley will remain in Washington to practice law upon leaving the FCC.

Navy expects approval to put Seafarer in Michigan

Navy brasshats privately express optimism that the service will get its multimillion-dollar submarine communications facility, Seafarer, located in Michigan. The National Academy of Sciences' final report on the biological and ecological effects of the extremely-low-frequency communications facility states: "A number of concerns raised over the years that Seafarer e-l-f fields might constitute a source of dangerous—even catastrophic—environmental contamination **have been examined and found invalid and unwarranted."**

The Navy is using the report to squelch objections to the facility. It plans to issue a final environmental impact statement by late November and to make a formal site selection recommendation to the Secretary of Defense by year's end. The admirals hope to get President Carter's official approval early next year to build the facility, possibly over the objections of Michigan officials.

No action expected against imports of microwave oven

The microwave-oven manufacturers' appeal to President Carter for an agreement with Japan to voluntarily restrict exports of ovens to the U. S. will be politely rebuffed. Because of the healthy growth in production and employment in the microwave-oven industry, **U. S. officials are skeptical that the industry can prove injury.** Without such proof, the International Trade Commission cannot propose import restrictions, which would be the foundation for the "orderly marketing agreement" sought by the manufacturers in a Sept. 6 letter to the President. Alternative anti-import strategies also would fail, the officials say, because of the lack of injury to the industry.

Ironically, the microwave-oven industry's Association of House Appliance Manufacturers concedes its healthy growth, declaring, "The industry is one of the fastest-growing in the United States today. Sales in 1976 were estimated at 1.6 million units and are expected to grow to 2.2 million units in 1977."

The arms export control numbers game

A wide-ranging Treasury Department analysis of the policy and economic impact of U. S. arms export controls proposed by President Carter has been delivered to Congress and is now being assessed by the aerospace and military electronics industries. Since it is designed to support the White House plan, the numbers are far less terrifying than those advanced last month by the Electronic Industries Association [*Electronics*, Aug. 4, p. 50]. Which merely proves once more that a competent statistical analyst can make any point he wishes, depending on his initial assumptions and data selection and weighting. Even so, the Treasury report is the more extensively researched and better-reasoned of the two and is worth reading for insights into the Administration's thinking. Analysts for many corporations—including some EIA members—are now doing just that.

The Treasury's study of arms export economics is based on six assumptions, the first of which is that the existing \$32.8 billion order backlog will not be affected. The hardware portion of that is \$20.4 billion—nearly \$10.4 billion and \$3.8 billion for aircraft and missiles, respectively, \$2.6 billion for ships, \$1.7 billion for vehicles and weapons, \$1 billion for ammunition, and \$849 million in communications. The remainder is for construction, maintenance, supplies, training, and technical assistance.

Other assumptions include: an annual ceiling on new orders of \$8.5 billion, equal to the fiscal 1976 level; achieving a 40% reduction by gradually cutting new commitments 10% each year from the previous year's level or, less probably, invoking the total reduction immediately. The study also assumes that 30% of arms money unspent by the Organization of the Petroleum Exporting Countries would be invested by the Government in the economy, or, alternatively, there would be no such investment and the dollar would be allowed to depreciate.

Job losses

On this basis, Treasury concludes that 29,000 American jobs would be lost by a 10% annual reduction in new orders from the \$8.5 billion base spread over four years, while 52,000 jobs would be lost by an immediate 40% cutback. The aircraft, communications, and ordnance industries would be most affected, and 25% of the jobs would involve professional, technical, and management posts. However unsettling the figures may be, they are less frightening than EIA's estimate of 100,000 jobs lost.

The Treasury also considered tax losses to the national economy that the EIA did not. For example, corporate and personal income tax revenues lost in and by fiscal 1983 would be \$300 million. Total revenue lost by that year would be \$1.4 billion if the dollar depreciates. If not, it would be \$2.9 billion. And that does not include the unmeasurable costs of higher unemployment compensation, increased public assistance, or the loss in social security taxes.

The impact of a graduated reduction on the Defense Department budget would also be considerable. Smaller procurements would boost military hardware costs by \$604 million, recoupment of R&D investments made possible by longer production runs for overseas sales would be cut \$192 million, while DOD's overhead savings from foreign sales income would be reduced by \$32 million.

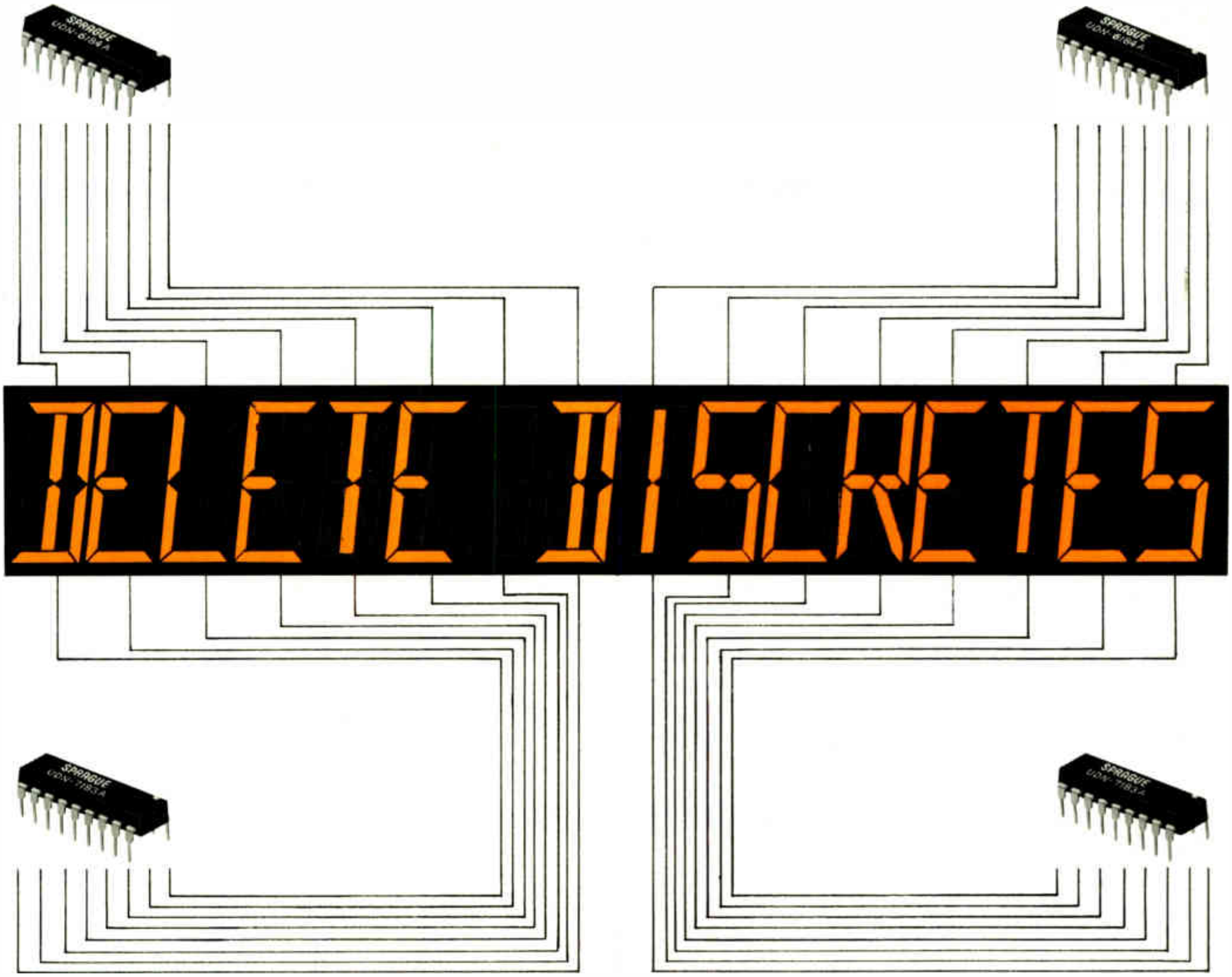
One military electronics company analyst believes the Treasury report "tends to minimize the economic impact" of the Carter proposals. For example, he points out that Treasury failed to consider other elements, however unmeasurable, that could lead to even higher defense costs. These include possible added outlays to maintain the U. S. industrial mobilization base at an effective level and to increase U. S. troop deployments in areas abroad where an ally's capabilities are cut by export restrictions, as well as the possible loss of bases, porting privileges and intelligence-gathering facilities.

Discounting EIA

Nevertheless, the same analyst discounts the EIA data in a report to his management. "It's hard to work your way through the EIA report because they use all exports, not just defense exports—foreign military sales and commercial defense sales." Indeed, the EIA did use the U. S. Standard Industrial Classification for communications electronics (SIC-36) and transportation equipment (SIC-37) and then estimate their electronics content. "It's not clear," the analyst's report points out, "how defense exports get backed out [of these categories]."

Of the EIA study's state-by-state breakout of the economic impact of reduced arms exports, he concludes it is "rather tortured" in view of its extrapolation of 1972 figures out to 1985. The EIA goal, he believes, is "to stir up state congressional delegations to fight the Administration's new restrictive policy." The assessment is valid. For a frightened Congressman can be a vicious opponent, especially when he remembers that a voter out of work is a voter he has probably lost.

Ray Connolly



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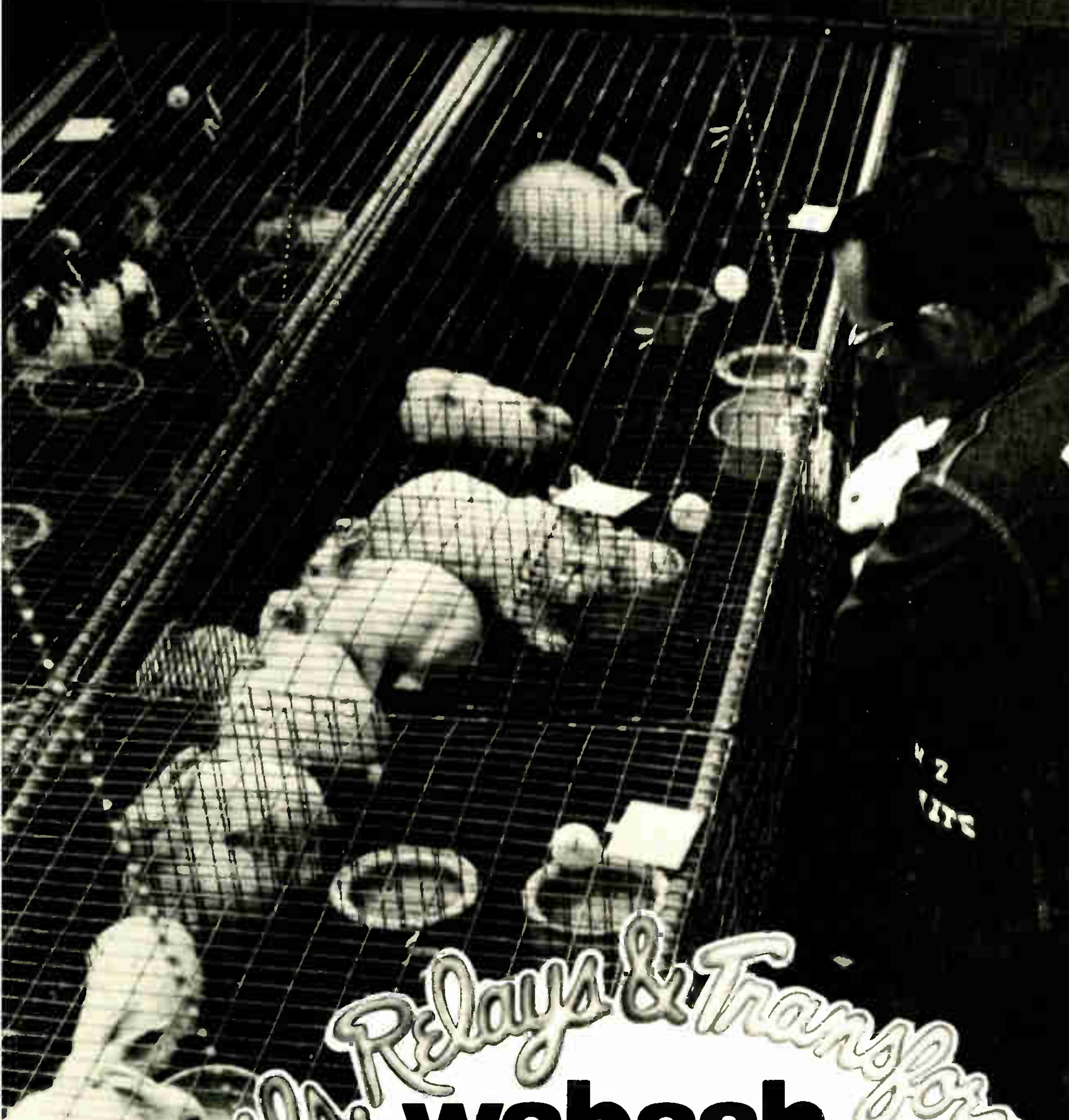
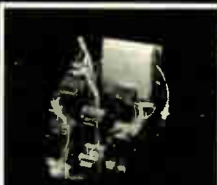
Knee's Rabbitry is one. Wabash Transformers is the other. And it's a generally held local opinion that Wabash has got the edge. Not just in sheer numbers—but in variety. While Knee's Rabbitry can produce only two genders of rabbits, Wabash produces literally thousands of different types of transformers.

Not only that—Wabash custom designs their product to precisely suit the application—any type of transformer or high voltage power supply application. A few where Wabash is a leader are air cleaners, photocopying and VRT equipment.

With their engineering expertise, sophisticated products, automated winding and high volume production capability, Wabash is a standout among the hundreds of transformer manufacturers. But, in turning out sheer numbers, Knee's Rabbitry is pretty stiff competition.





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International newsletter

48-fiber optical cable will be linking four Tokyo exchanges

Within a year, 20 kilometers of fiber-optic cables will be carrying customers' voices and data along a route in Tokyo linking four exchanges of the Nippon Telegraph and Telephone Public Corp. Each pair of fibers will transmit pulse-code-modulation signals at 100 megabits per second: the equivalent of 1,440 telephone channels. **Thus the 48 fibers in the cable will be able to transmit 34,560 telephone channels (24 for each direction in a conversation).** For data, the system will transmit the required bit rate, so there is no true comparison with telephone channels.

There will be eight repeaters along the route, even though experiments show satisfactory transmission for distances of at least 8 km. NNT feels laser communications are practical because lasers operating at a wavelength of 850 nanometers with an extrapolated lifetime of 1 million hours and low-loss multifiber cables are available. Individual graded fibers in the cable will measure 140 micrometers in diameter, and the 48-fiber cable measures 17 millimeters in diameter.

IC for cars drives clock and controls warning circuitry

Intermetall GmbH, the German member of the ITT Semiconductor group, has readied a complementary-MOS integrated circuit that can control a variety of functions in automobile electric systems. Besides supplying the drive signals for dashboard-mounted crystal-controlled clocks, **the device generates the control pulses for the car's directional indicators, for its external warning lights, and for the alarm circuitry** that indicates conditions like abnormal oil and water temperature, excessive vehicle speed, unfastened seat belts, and other hazards. Designated the SAF1055, the 18-pin plastic-encapsulated IC will be introduced at the Sept. 15 – 25 international automobile show in Frankfurt. It will be available in quantity towards the end of this year.

UK doppler system lands plane automatically

Britain has demonstrated automatic airplane landing using a microwave landing system. The demonstration is an attempt to bolster its doppler candidate against the U. S. time-reference scanning-beam system for selection as the international microwave-landing-system standard. **A twin-engine transport made five consecutive landings at Gatwick International Airport using a doppler system** colocated with an existing conventional instrument landing system for comparison. Britain is trying to amass enough operational experience with its doppler system to overcome an apparent U. S. lead with the International Civil Aviation Organization, which will choose a standard system. At stake besides national prestige is influence over a vast worldwide market.

TV-game market in Europe to grow 400% this year

The European market for TV games will leap to 1.4 million units this year, forecasts Videomaster Ltd., a dominant British maker of the products. The projected total is four times greater than last year's and will equal 15% of the projected 1977 U. S. market. The company sees a total market of 500,000 units in West Germany, 400,000 in the United Kingdom, and 500,000 for the rest of Europe. **By 1980, it estimates, total European sales will reach 3.5 million, nearly 25% of the projected U. S. market.** West Germany will lead with 1.25 million, the UK will follow with 1 million, and the rest of Europe will total 1.25 million.

To keep pace, the fast-growing company is introducing a three-game color unit based on National Semiconductor's SK 1121 decoder and game chip set, to which it has exclusive European rights. It also is mounting a substantial export drive to the Middle East and next year plans to introduce cartridge-based games and to invade the vast U. S. market.

User can vary playback speed in new VTR

Several playback speeds are featured in a new video tape recorder from the Victor Co. of Japan. The tape can be played back at twice the normal speed, with the audio processed to restore normal pitch so that it is intelligible—albeit with low fidelity. It can also be played back silently in slow motion or stopped on a single frame. **The HR-3600 is a deluxe version of the company's video-home-system VTR, with provision for speed selection added.** It has the usual two-hour recording and playback capability in a real-time mode. It will go on sale in Japan in December for about $1,200, or about $110 more than the standard model. Victor says that about a fifth of its production will be time-selection models. Exports are contemplated, but no schedule has been set.

Mideast sales of air-traffic-control gear mount for SEL

For West Germany's Standard Elektrik Lorenz AG, the Middle East region is turning into a sizable market for its solid-state air-traffic-control and navigational systems—this after SEL is already firmly established on the North African market for such gear. **The latest Middle East orders for the ITT affiliate call for the delivery of a number of systems to both Turkey and Saudi Arabia.** The deal with Turkey involves five very-high-frequency omnidirectional range (VOR) systems, while that with Saudi Arabia is for 16 such systems, plus 6 doppler VORs and 13 instrument landing systems. Oil-rich Saudi Arabia has embarked on a major equipment modernization program that, according to SEL, will make the country the operator of one of the world's most advanced air-traffic-control setups.

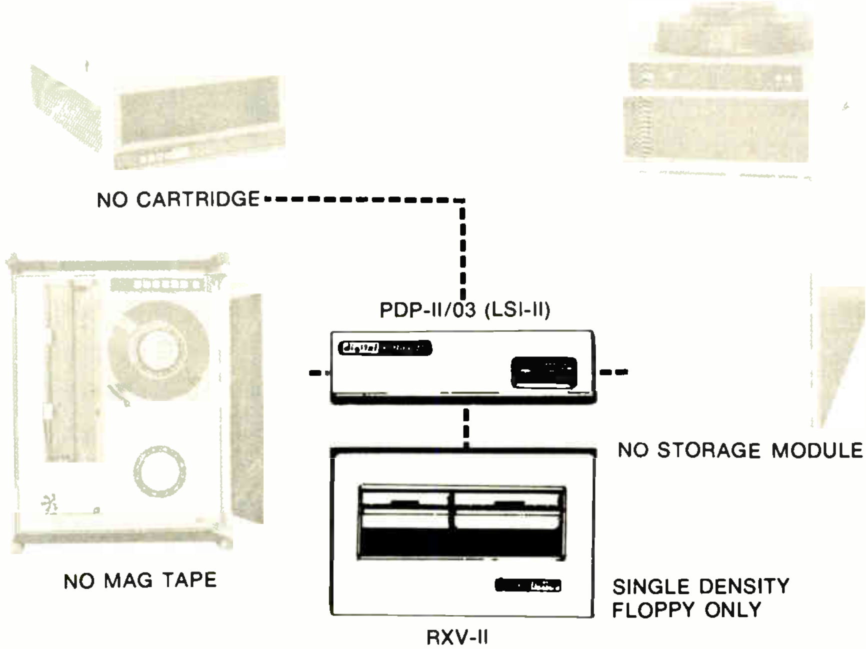
All-channel alarm lets CB operator get help faster

A new signaling scheme from Blaupunkt-Werke GmbH will increase the effectiveness of citizens' band radio communications in emergencies. In the West German firm's scheme, implemented with signal-generating circuitry in the transceiver, **an operator in need of help triggers the transmission of beep tones on all CB channels.** This alarm tells others on the air to switch to channel 9—the one set aside for emergency purposes. With many people aware of the call, aid can be given much faster than previously. Blaupunkt plans to introduce CB radios incorporating the beep-producing circuitry some time next year, after it has obtained government approval.

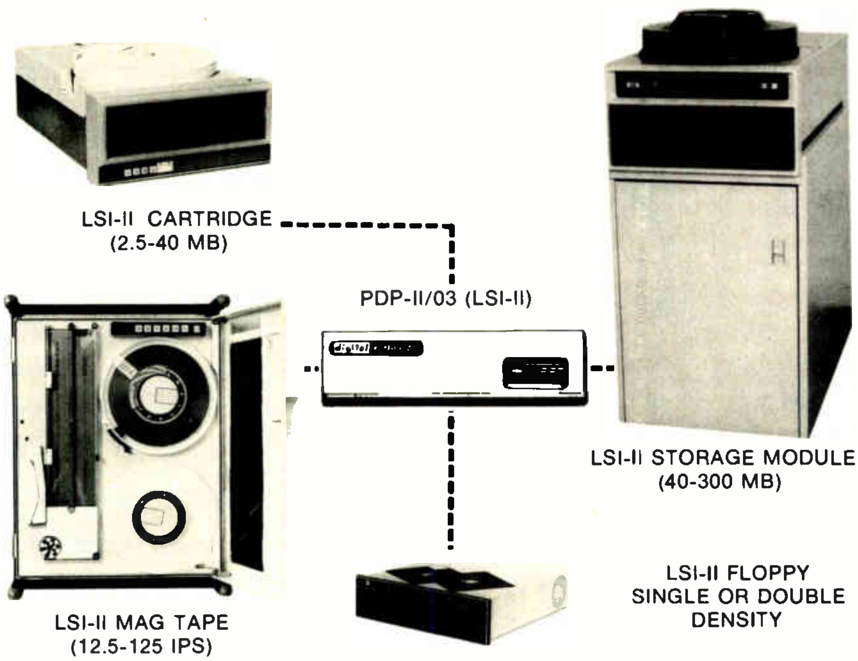
Sony PCM unit converts Betamax to stereo recorder

Bowing Sept. 21 is Sony's pulse-code-modulation adapter that converts the video channel of the Betamax video tape recorder into an ultra-high-fidelity stereo tape recorder. An analog-to-digital converter and coder turn the incoming audio into a 1.762-Mb/s PCM stream, while a decoder and d-a converter turn the code back into the original audio. **At the same time, Matsashita is unveiling a similar prototype.** The Sony unit operates with the new two-hour VTRs—an improvement on the prototype units shown last year. The adapter costs $1,800 in Japan, with U. S. sales probably starting next year. It features a frequency response flat within 1 dB from 2 Hz to 20 kHz, harmonic distortion of less than 0.03% at all frequencies and levels within its range, and a dynamic range of more than 85 dB.

CONSIDERING
DEC'S LSI-II?



CONSIDER IT AGAIN WITH A FULL LINE OF PERIPHERALS.



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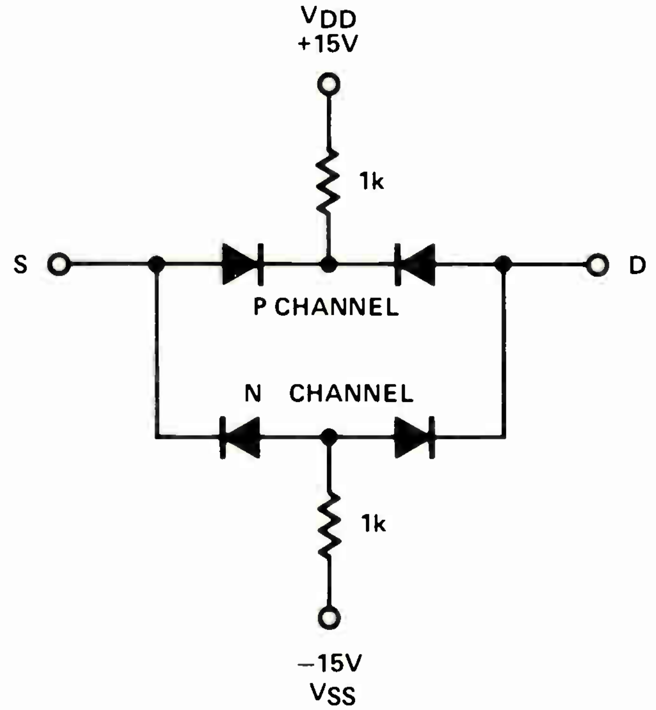

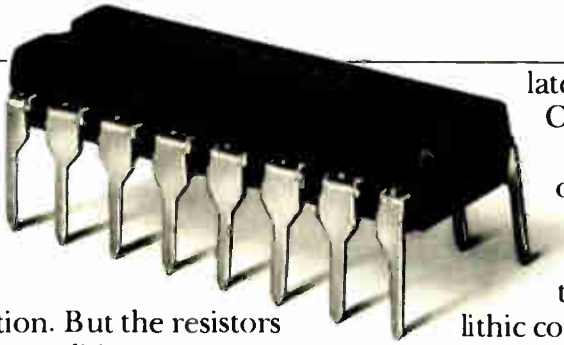

But not Analog Devices' AD7510 family of DI CMOS analog switches. They belong to a whole new generation. With positive overvoltage protection, but without any inhibition on performance.

We accomplished it through a unique design, utilizing "on-chip" resistors in series with the power supply. It provides as much as ±25V overvoltage protection. But the resistors only switch in when an overvoltage condition occurs. So normal performance never suffers. And you get both the main assets of an analog switch: a low "ON" resistance of 75Ω and a low leakage current of 400pA.

The equivalent circuit of the output switch element shows that, indeed, the 1 kΩ limiting resistors are in series with the back-gates of the P- and N-channel output devices — not in series with the signal path between the S and D terminals.

This design, combined with our dielectrically-isolated CMOS fabrication process, prevents latch-up. And allows TTL/CMOS direct interfacing.

We also included two other measures of security. Silicon nitride passivation to ensure long term stability and monolithic construction for reliability.

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Minicomputer network to serve Swedish city's entire administration

The Swedish city of Malmö is not alone in discovering more virtues in the minicomputer than the mainframe. But it is unusual in putting all its administrative systems onto a network of minicomputers. The comprehensiveness of this network is uncommon—perhaps unprecedented—since it encompasses so many different types of data.

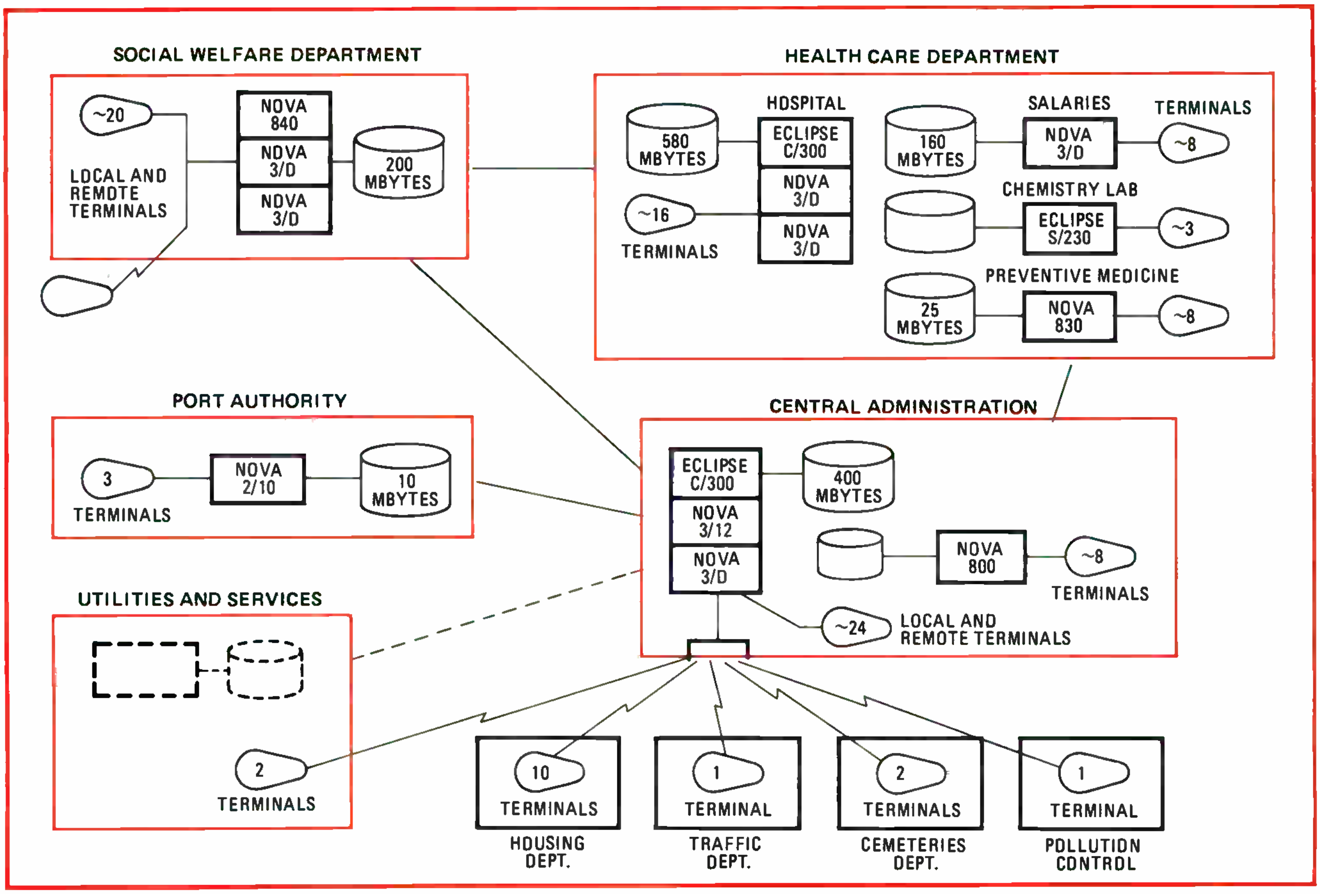
Until next spring, the network approach is limited to local clusters of minis, typically three, linked by high-capacity channels capable of handling around 1.2 million kilobytes per second. The approach is for each central processing unit to handle a specific function—for example, disk storage or the teletype-compatible display units.

The decision to go for the mini solution rather than to continue with the mainframe approach was mainly economic. The city's data-processing manager, Nils Dahlberg, says his department calculated that a system handling 130 transactions a second would be required to implement all the planned interactive applications. Such a transaction rate would require 13 IBM 370/148s with 2 megabytes of storage costing about $1.1 million each. Alternatively, 32 Data General Eclipse S/130s with 250,000 bytes of memory would meet the transaction rate and would cost only $44,500 each. This gives a hardware outlay of about $1.45 million for the minicomputers, compared with an IBM cost 10 times that.

Configuration. Apart from two 10-year-old Saab large systems with programs that are being rewritten to run interactively on the minicomputers, Malmö's current configuration is 14 Data General machines, with about 80 terminals on line, and disk storage totaling 1,900 megabytes. Ten different user groups are running about 25 different applications.

The central administration systems for the city of 250,000 include financial long-range planning, a population register, taxi administration, and program-development systems. Other systems include one for billing and bookkeeping for the port and several for health care and the social welfare department. Many more are under development.

Testing is already under way to connect the different centers to each



other and to the central administration system. The system will be installed over 9,600-bit-per-s telephone lines, over distances not greater than 3 or 4 kilometers.

Swedish data-protection laws will require extensive security safeguards in the software and protection against unauthorized access to files. One novel safeguard comes in delegating the choice of a key word for an individual data record to the clerk responsible for operating the system. This scheme guards against the hazard of commonly accessible identifiers, which could facilitate easy access to an unlimited number of files. The cross-reference list of these key words and personal identifiers is safeguarded.

The program development has undoubtedly proved less of a stumbling block than is commonly supposed with minis. Dahlberg says that the software for interactive program development is fully comparable with that on bigger machines and is simpler to use. System manager Hans Hallden agrees that large systems are often unwieldy and provide more facilities than can be used. "In addition, there is a big advantage in having the machines close to the programmer," he says. "You can work on one program until it is finished, instead of running several and getting involved in long turnaround times."

Software. The Malmö data processing team is using standard Data General real-time disk operating system software. Network protocol is designed along industry standard lines—that is to say, it is similar to IBM's synchronous-data-link-control and the international high-level-data-link-control standards.

For the data-base handling and telecommunications protocol, the Malmö team had to develop extensive routines of their own. One reason is that the city is using more than one type of Data General minicomputer, and the interfaces between the systems are not supplied with the standard software.

The file-handling software, incorporating six access methods, access control, file security, transaction logging, and a variety of other features, has been in existence for around three years. Called Z, this software sits above the Data General operating-system software and is written so as to interface with any improved version that the Southboro, Mass., firm may bring out. □

Japan

Static-induction-transistor cell may up RAM performance tenfold

With a device called the static induction transistor—developed as a junction-type vertical field-effect-transistor configuration for high-power applications—a team of researchers at Tohoku University is developing a random-access-memory cell that may offer a very high packing density of 10-micrometer-square cells, operate at subnanosecond switching speeds, and dissipate merely a few femtojoules of power. This performance is easily 10 times better than that contemplated by even the most optimistic metal-oxide-semiconductor and bipolar technologists.

The work, under the direction of Professor Jun-ichi Nishizawa, who jointly holds a basic patent on the SIT configuration, combines the one-transistor double-level configuration of today's 16,384-bit n-channel MOS RAMS with a configuration that, like integrated injection logic, operates with the current flow perpendicular rather than parallel to the surface of the device. This three-dimensional property is responsible for the cell's small size. The high speed comes both from the higher mobility obtainable in the SIT's perpendicular-flow configuration, where carriers travel in the bulk silicon rather than on the surface as in standard MOS devices, and from the faster drift velocity of this bulk-flow operation, compared to the slower diffusion carrier-flow of surface MOS devices.

The RAM array being built at the university is a partially populated device consisting of 10 rows by 3 columns. It contains no peripheral circuitry such as decoding and sense amplifiers. According to Nishizawa, larger arrays and peripheral circuit development will be undertaken commercially.

The prototype is fabricated in an n^- or intrinsic epitaxial layer on an n^+ wafer. A shallow n^+ diffusion for the source is sandwiched laterally between two deeper p^+ diffusions that act as the gate. The substrate serves as the drain. The configuration and doping are such that the field from the gate—the natural depletion region—either pinches off the channel or nearly pinches it off with no applied bias.

Changes. For memory operation, a silicon-dioxide passivation film is applied directly over the source, and metal word lines that do not connect to the source are run over the oxide. The source forms one plate of the capacitor that stores the state of the cell; the word line forms the other plate. Actually, source diffusion is not required, but it forms a unipotential region and allows storage of a larger charge than if it were omitted.

In the experimental RAM, the source diffusion is rectangular and is surrounded by the rectangular inner periphery of the gate diffusion. The outer periphery of the gate diffusion is also rectangular, and gate diffusions of individual cells are joined to form bit lines perpendicular to the word lines.

In the experimental memories, 1 is written by applying a -5-v pulse to the word line and holding the bit line at 0 v. Electrons are forced out of the storage cell and flow to the bit plane. The positive charge in the form of holes is stored in the cell maintained by a bit voltage of -3 v and word voltage of 0 v.

For readout, the bit line is raised to 0 v. Electrons flow from the bit plane to the storage cell. □

Four very small ways to improve on your PC design.

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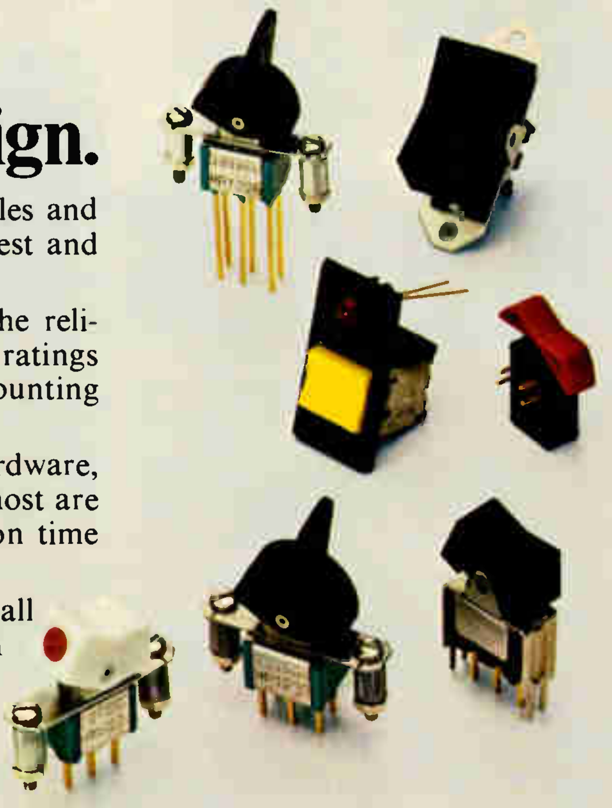

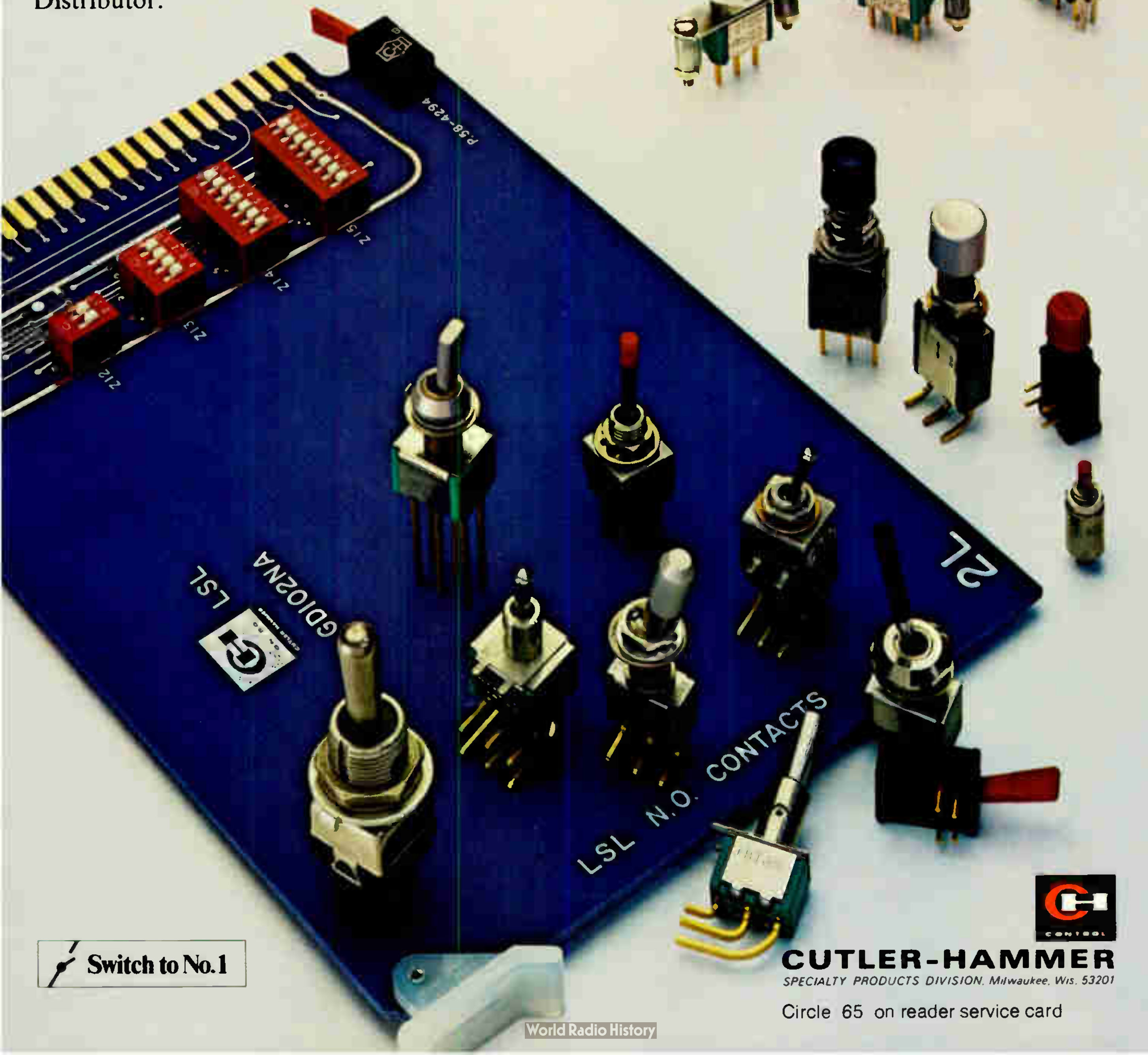

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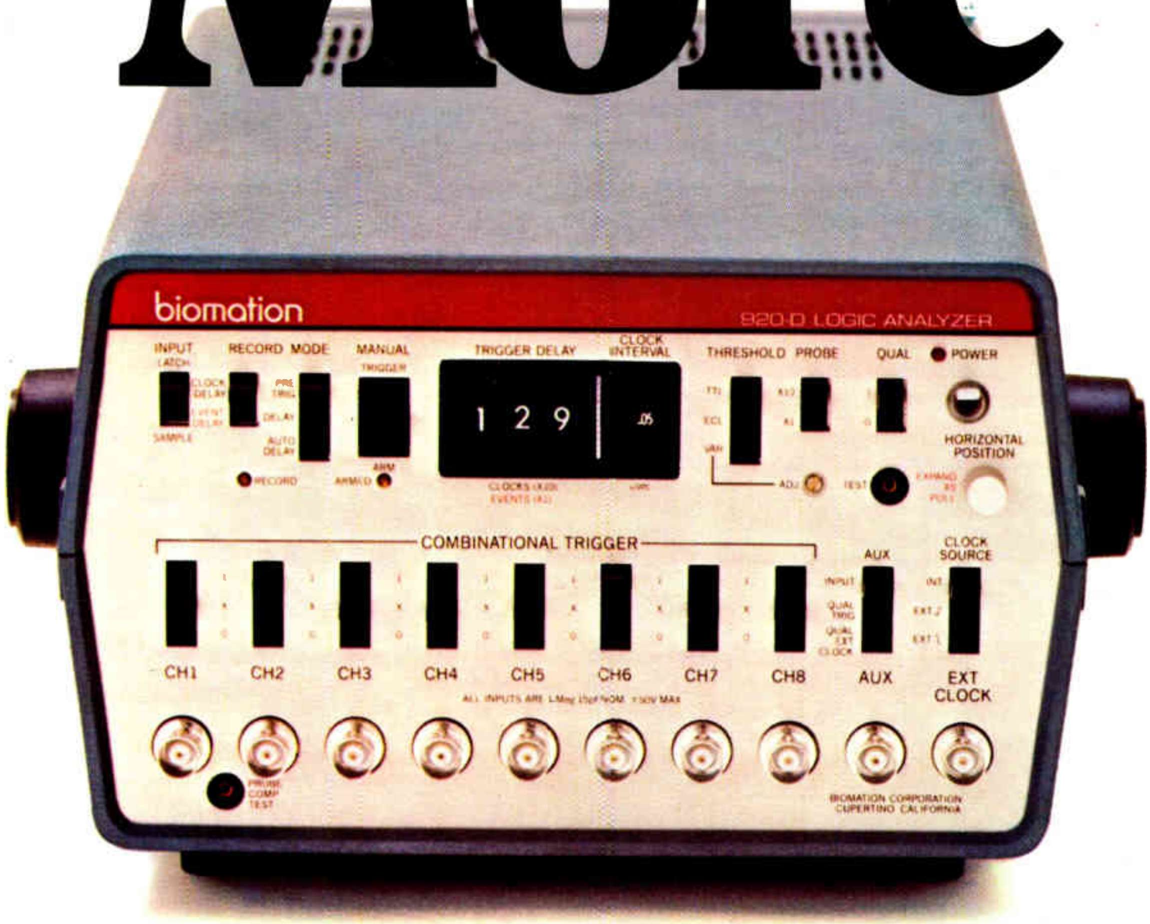

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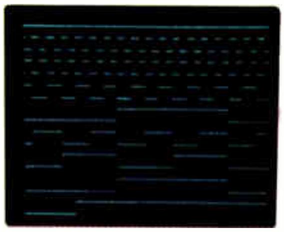
The 920-D enables you to set a precise interval between the actual trigger and the start of recording, using either clock periods or number of trigger events. Or the pre-trigger recording mode can be selected to capture data from before the actual trigger. The logic threshold level is selectable — TTL, ECL or variable. And you can record at rates from DC to 20 MHz.

Captured data, at 256 bits per channel, can then be displayed on any single channel scope or CRT display in timing diagram format.

Compare the 920-D with other logic analyzers, for both price and performance. Then ask yourself if you can afford to settle for less.

Don't let the 920-D's many features and high performance mislead you. It's priced less — far less — than any comparable logic analyzer.



In fact, the 920-D's $1295* price tag makes it practical to put its extensive capabilities to work wherever you design, debug or troubleshoot TTL logic.

The 920-D is a cost-effective first logic analyzer for most applications. Years of experience providing

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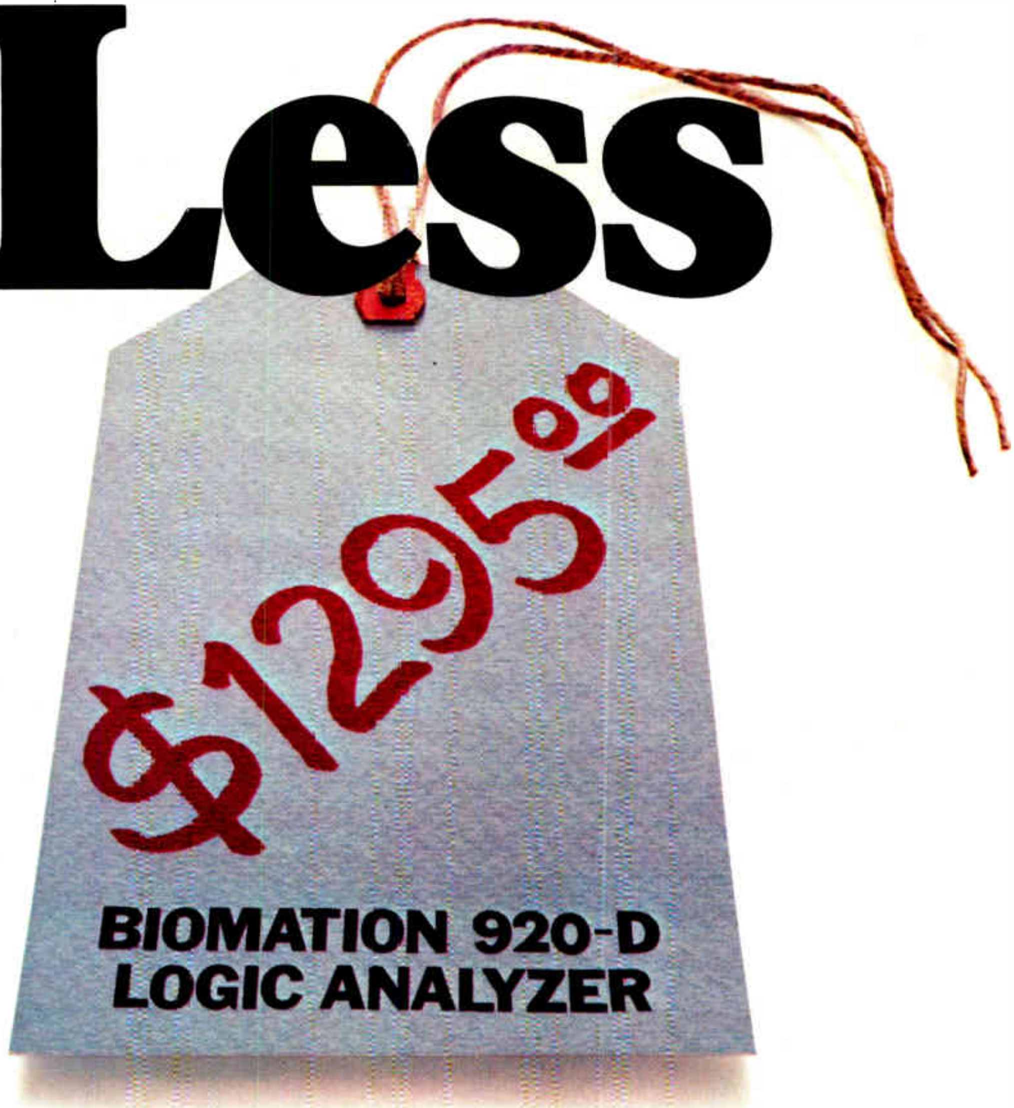

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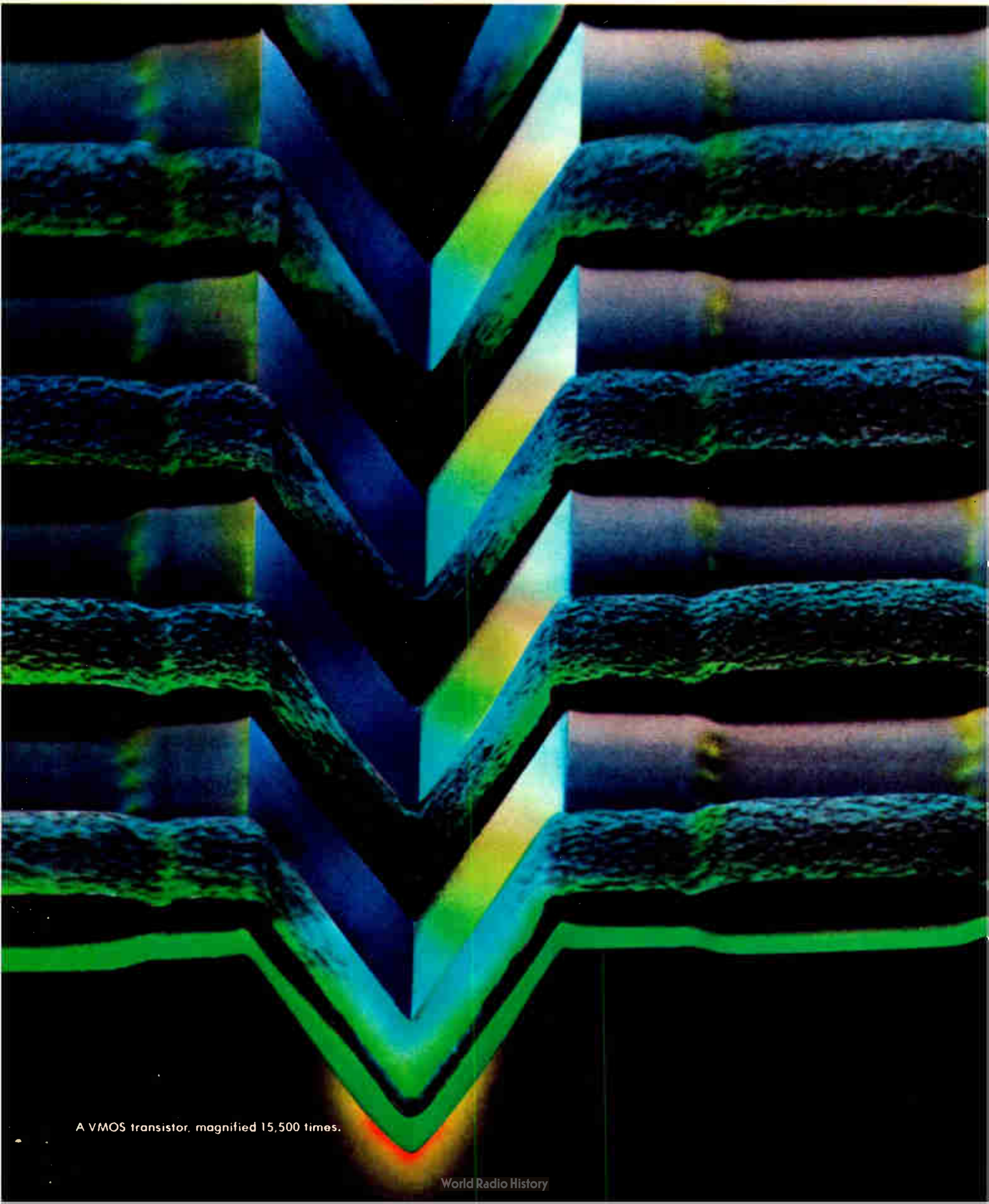
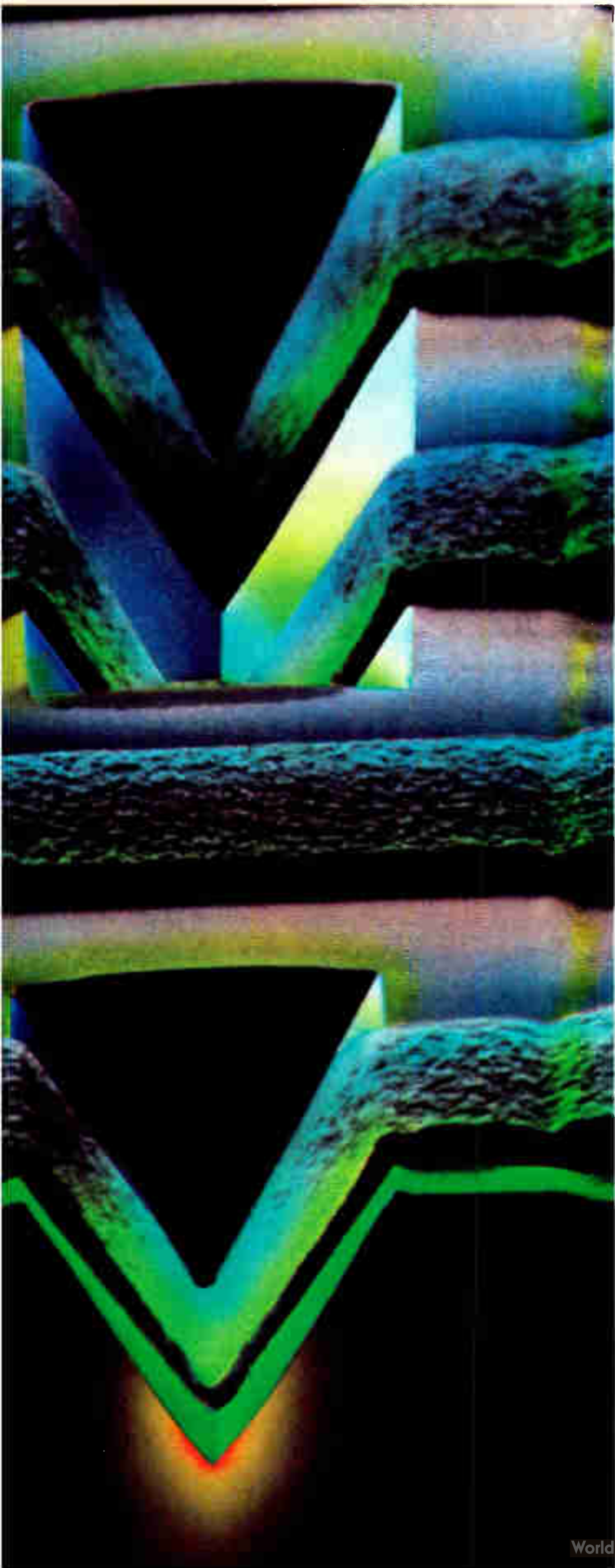
The MOS world



A VMOS transistor, magnified 15,500 times.

is no longer flat.



AMI creates VMOS. This revolutionary idea revolves around a three-dimensional transistor, etched into the silicon substrate.

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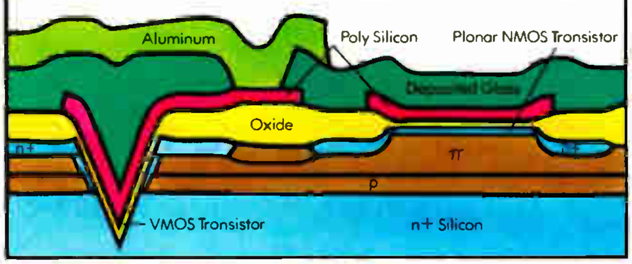
4K fully static RAM	(1K x 4)	80 ns
4K fully static RAM	(4K x 1)	80 ns
4K fully static low power RAM	(4K x 1)	45 ns
8K fully static RAM	(1K x 8)	125 ns
16K ROM	(2K x 8)	100 ns
64K ROM	(8K x 8)	250 ns
16K EPROM	(2K x 8)	200 ns

The density permitted by vertical short-channel FETs produces VMOS circuits that are much smaller than competitive chips, increasing the speed and lowering the cost. For example, the latest bipolar 1K size is 61% larger, and the new fast NMOS 1K is 87% larger than AMI's S4015-3. And VMOS densities are achieved without stretching feature dimensions at the sacrifice of yields, as is necessary with bipolar and NMOS technologies.

"VMOS" refers to a short channel NMOS structure fabricated in "V" shaped grooves which penetrate the silicon surface and are combined with planar NMOS devices



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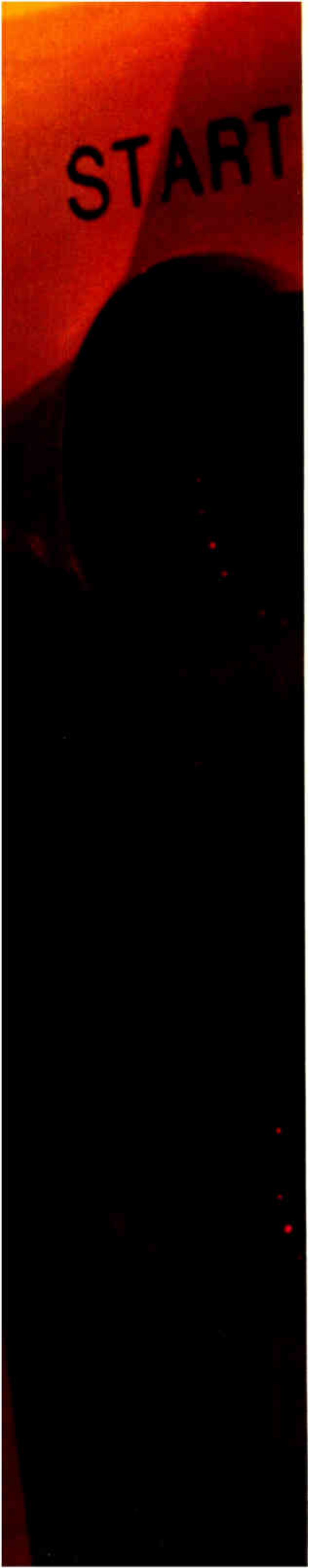

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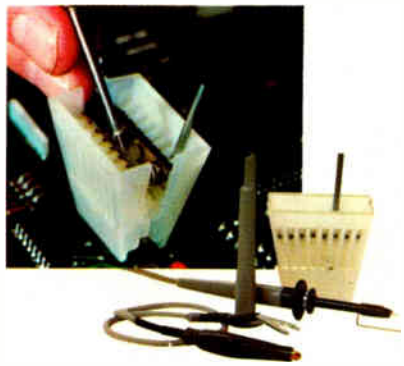
And there's much more. Your local HP field engineer has the details.



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Big ROMs begin to make waves

32-k and 65-k devices coming to market in response to need for more storage and use of higher level languages

by Larry Armstrong, Midwest bureau manager

The big ROMS are coming, and they should win untroubled acceptance by users. The new 32,768-bit and 65,536-bit read-only memories are designed to be pin-compatible with their smaller counterparts, easing the expansion of already designed systems. With their increased densities and performance and decreased power and per-bit cost, there is no sacrifice when a user moves up.

The fastest-growing ROM application is program storage for microprocessors, and as the performance of microprocessors and the sophistication of their users increase, so will the amount of program storage. Also driving up ROM sizes is the trend toward higher-level languages for microcomputers. Although less efficient than assembly languages, they are being used to pare the cost of software. Programmers can capitalize on the ROM's falling per-bit price to store extra code.

Nevertheless, the 32-k ROM market got off to a slow start earlier this year: General Instrument Corp. never got beyond the sampling stage with its 850-nanosecond RO-3-9332A. "We decided to pull it back for a redesign so as to come out with a faster part that will be competitive with what the rest of the industry will be offering," explains Robert A. McDonald, memory products general manager for the Hicksville, N. Y., Microelectronics division. Also, Electronics Arrays Inc., Mountain View, Calif., is not yet in full production on the three-supply EA3200 it introduced in May, Mostek Corp. circulated preliminary data sheets on a part that is different from the one it is taking orders on now, and Texas Instruments Inc. has not met with resounding success on its version.

However, a newcomer to the 32-k market may be the first in volume production. Rockwell International's R2332, a fully static 250-ns part, is intended for program storage in the firm's 6500 microcomputer family. The $20 silicon-gate unit also could find considerable demand elsewhere.

Front-runner. But now, Mostek and American Microsystems Inc. are neck and neck in a race to get the first 65-k parts out next month. Both firms are showing ROMS compatible with the newest generation of microprocessors.

An innovative V-groove metal-oxide-semiconductor process is the key to AMI's extremely fast 65-k ROM [*Electronics*, Aug. 4, p. 40], an effort funded in part by Tektronix Inc., Beaverton, Ore. It is a process that AMI, in Santa Clara, Calif., is counting on to bridge the gap between its reputation as a custom house and its desire to sell standard circuits. The result is a 30,000-square-mil chip, denser than some of

THE BIG MOS READ-ONLY MEMORIES

Vendor	American Microsystems	Electronic Arrays	General Instrument	Mostek	Mostek	Motorola	National Semiconductor	Texas Instruments
Part	S4264	EA3200	RC-3-9332C	MK32000	MK36000	MCM68332	MM5235	TMS4732
Size (kilobits)	65	32	32	32	65	32	65	32
N-channel process	V-groove	metal-gate	metal-gate	silicon-gate	silicon-gate	silicon-gate	metal-gate	silicon-gate
Number of pins	24	28	24	24	24	24	24	24
Chip size (mil^2)	29,929	41,500	36,000	22,875	34,770	?	?	?
Maximum access time (ns)	350	350	350	300	300	450	800	450
Maximum active power (mW)	725	500	500	200	200	788	1,000	788
Maximum standby power (mW)	*	50	*	50	50	*	*	*
Power supplies (V, tolerance)	+5 (10%)	+12, ±5 (5%)	+5 (10%)	+5 (10%)	+5 (10%)	+5 (5%)	+5 (5%)	+5 (5%)
Input levels (V)	2.0, 0.8	2.4, 0.8	2.4, 0.8	2.0, 0.8	2.0, 0.8	2.0, 0.8	2.2, 0.6	2.0, 0.65
Output levels (V)	2.4, 0.4	4.0, 0.45	2.4, 0.4	2.4, 0.4	2.4, 0.4	2.4, 0.4	2.4, 0.4	2.4, 0.4
Availability	Oct.	now	Jan.	Oct.	Oct.	Oct.	Oct.	now

*Part is fully static (no clocks), and input/output levels are important for determining TTL compatibility.

the 32-k devices on the market. Access time is typically in the 225- to 300-ns range.

In addition, Mostek has eschewed the fully static designs of its competitors in favor of what it calls edge activation. Though the technique requires a pulse at the chip-enable input to turn the part on and off, it yields a high-performing device that needs very little power. Worst-case access time for the 32-k and 65-k parts is 300 ns; maximum power is less than 200 milliwatts. Clocking the part gives an automatic standby that dissipates less than 50 mW.

National Semiconductor Corp. will start offering samples of its 65-k ROM to outside customers next month also. But it will be next year before other vendors—Electronic Arrays, Intel, GI, Motorola, TI—will have their versions ready.

Intel, at least, plans to deviate from the 24-pin package that AMI and Mostek are using, preferring instead a 28-pin configuration that allows another chip-select input. "We feel that the user needs an output enable on the 65-k devices, as he's had on earlier ROMS, to get the minimum package count in a microprocessor system," says William Regitz, strategic marketing manager for Intel's Components division, Santa Clara, Calif. Others may follow Intel's lead away from the 24-pin package, but in the Mostek design, its clock does it.

Erasable encroachment. Microprocessors may be driving ROM sizes up, but they are also nibbling at the lower end of the ROM line: the new one-chip microcomputers—with an on-board ROM—can be expected to start taking over the market for 2,048, 4,096, and 8,192-bit sizes. More dramatic, however, is the competition small ROMS will see from their ultraviolet-erasable and, eventually, electrically alterable brethren, the programmable EPROMS and EAROMS. "In small volumes, our 16-k erasable PROM is already having an impact on masked ROMS," says John Hewkin, strategic marketing manager for MOS memories at TI, Houston. "In 10,000-piece lots, the device costs more, but we find the customer is willing to pay to get instant delivery and the ability to make a change in the program."

The erosion is even more apparent at Motorola, which sells the cheapest erasable PROM on the market, a plastic-packaged version that can be programmed only once. "The majority of industrial accounts will soon be using erasable PROMS instead of masked ROMS because of their flexibility," argues Lyle P. Arends, memory marketing manager.

Leveling off. The result is a masked-ROM market that many people think is beginning to level off. "The total dollar volume of the ROM market is going to grow less than 5% a year over the next several years," suggests Thomas L. Humphrey, strategy manager for EDP products at AMI—who pegs this year's market at $75 million. "But the distribution is going to change dramatically in favor of the larger ROMS, in the 16-k to 65-k range." Further, the distribution may stay concentrated in that range: "There's a risk beginning with the 65-k, and certainly with the 131-k and 262-k, which are within the range of technical feasibility within the next couple of years," he continues. "The bigger the ROM, the more chance there is of making a mistake in its programming, either in the coding or in the design or the final product. And that mitigates against getting large." Humphrey believes that users prefer to write programs in modules instead.

In a report to be published this month, Dataquest Inc., Menlo Park, Calif., estimates that this year's market for masked ROMS will reach $103 million, and will grow about 14% per year for the next several years. It feels that the ROMS will average 40 millicents/bit this year, a number that will drop to 9 millicents/bit by 1981. □

Taking a hard look at software

Makers of read-only memories are keeping an eye on another potentially big market: manufacturer-preprogrammed read-only memories.

Mostek Corp., for one, figures that the cost of generating enough fully debugged software to fill a 65,536-bit ROM is $48,000—a calculation that assumes that software costs $10 per line of code, debugged, and that a Z-80 programmer using assembly language averages 1.7 bytes per line of code. "That makes it obvious to us that users are not going to start from scratch on every application program for 65-k ROMS," says Derrell C. Coker, marketing and applications manager for the Carrollton, Texas, firm's memory products department.

An early example of this new software product is the Lawrence Livermore Laboratory version of Basic that Electronic Arrays Inc. has been offering since May. The company packaged it in a pair of 32,768-bit ROMs and used it for samples of the part. "But we've sold a lot of them into the personal computer market, as well," says Michael McCoy, director of memory product development. National Semiconductor Inc. will have an 8080-oriented version of the same Basic on a single chip, along with a hex debugger, when it starts sampling its 65-k ROM next month. A second device will use NIBL, for national industrial basic language, and a third will use two 65-k chips to implement an expanded Basic for the firm's 16-bit Pace microcomputer. Eventually, this will be put on a single 131,072-bit ROM that's now in development at National.

Electronic Arrays' McCoy agrees that the big ROMs are an ideal vehicle for carrying the higher-level languages. "And I think that applications software, such as a small accounting system, will also be sold in ROM. The big advantage for the user is that loading a program in ROM form doesn't take up valuable RAM [random-access memory] space," he says. "Within five years, I believe that just about every terminal will have fixed programs that have been purchased in ROM form."

The microprocessor manufacturer, or software consultant, might also develop libraries of software routines that customers could sift through, selecting several to be put together on a single ROM. "If the manufacturer can guarantee the software, the customer will be more comfortable using ROMs instead of erasable programmable ROMs or random-access memories," says Mostek's Coker.

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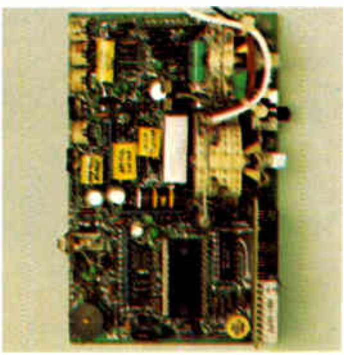

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Electronics abroad

For Czechs, production gear is first

Tesla, the $2 billion state company, has neglected consumer goods, but current five-year plan calls for change in that attitude

by John Gosch, Frankfurt bureau manager

Mention Czechoslovakia, and what springs to mind is a land in central Europe known for its fine beer, the "golden city" of Prague, and, possibly, a long industrial tradition.

It is that tradition that has set the course for Czechoslovakia's efforts in electronics: the accent is clearly on systems and devices for industrial applications, especially automated production. So strong is the emphasis that, in the view of many Western observers, the consumer sector has been neglected. Czech officials agree, but they are quick to point out that things are about to change.

A second mainstay is communications. Starting out as a fledgling producer of simple broadcast equipment in the late 1950s, "we now rank among the world's top manufacturers of radio and television transmitters," says one industry official. To support his contention he points to the delivery last year of the 500th transmitter to the Soviet Union. He adds that a large number also have been sold elsewhere, particularly to other Comecon nations and to developing countries in Latin America and the Middle East.

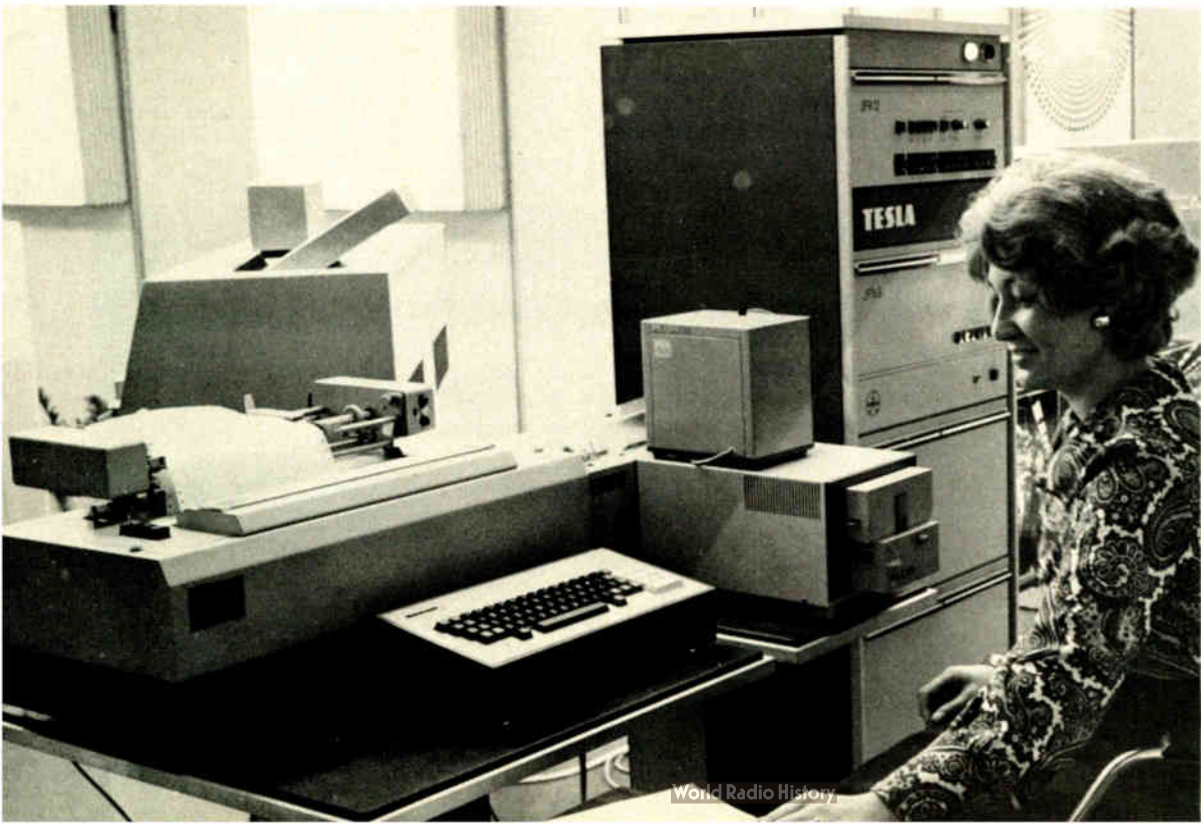
Credit for these achievements goes to Tesla, a state holding company that accounts for 90% to 95% of Czechoslovakia's electronics production (excluding computers), according to Milos Krejci, director of international business relations. A conglomerate of 21 enterprises, Prague-based Tesla runs some 53 highly specialized manufacturing facilities, with five research centers.

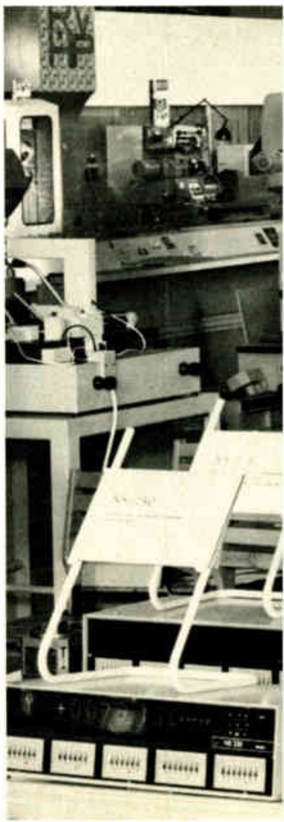
Selling. A Tesla-administered business organization with nationwide outlets handles domestic sales. Exports and imports, however, come under the wings of KOVO, a foreign trade organization, also based in Prague. Of Tesla's 90,000 employees, 13,000 work in R&D.

Tesla's production in 1975 came to about $2.1 billion. That volume, Krejci says, is nearly twice what it was in 1970.

Except for computers, Tesla pro-

This article is the fifth in a series that examines the electronics industries of the Eastern European Bloc, or Comecon.





Homegrown. Illustrating Czech expertise in industrial electronics is this JPR12 EDP system from Tesla, with 90,000 employees the country's leading electronics combine.

duces just about everything in electronics—from simple passive components and active solid-state devices to consumer goods, studio equipment, industrial control systems, and so on, up to high-powered radio transmitters. The lineup also includes some computer peripherals and automation equipment.

Computers. Computers are the domain of ZPA. Employing 35,000 to 40,000 persons, the conglomerate turns out peripherals like tape-punching and -reading equipment, process-control systems, and small to medium-size computers. ZPA's production increases between 15% and 20% a year on average, says Tibor Vasko, who is the director of the computer and automation department in Prague's Ministry for Technology and Investments.

As in other Comecon Bloc countries, economic development in Czechoslovakia proceeds according to five-year plans. The current one, the sixth such plan and running from 1976 through 1980, again gives top priority to electronics. During the five-year period, output of components and equipment in all fields except computers, is to rise 80%—to $3.5 billion by the end of this decade. Production of computers during the five-year span is to total nearly $2 billion, which means doubling production by 1980.

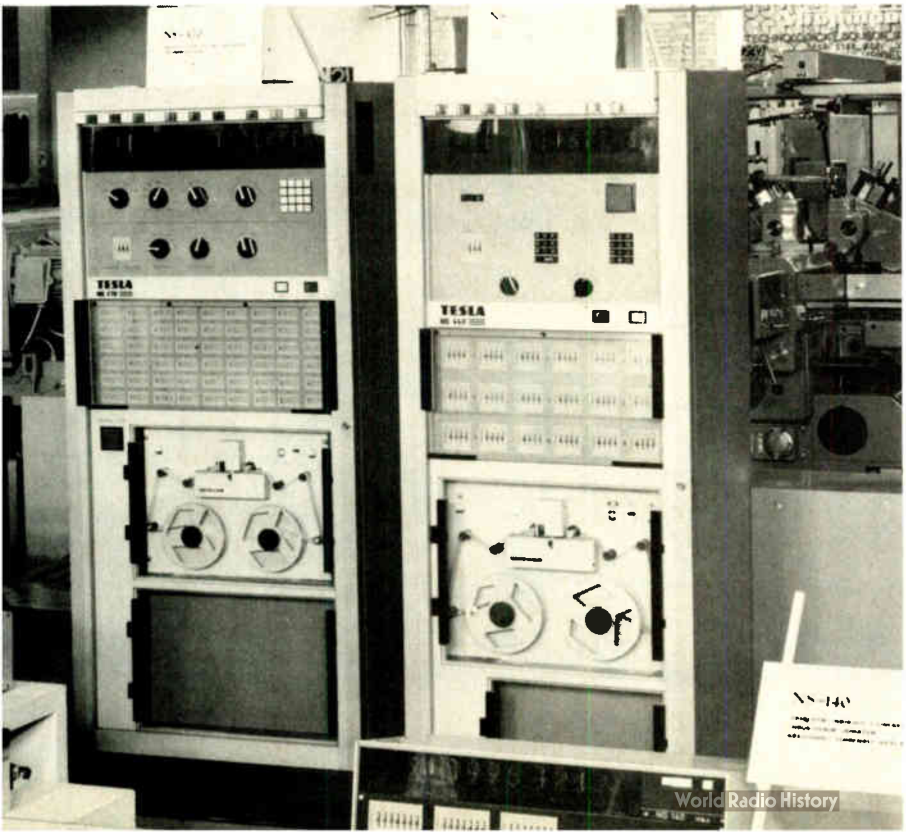
On the qualitative side, the Czechs aim to step up their efforts in readying electronic components for the RJAD line of mutually compatible computer and peripheral systems produced by the Soviet Union, Poland, East Germany, Bulgaria, Hungary, and Czechoslovakia.

Home-grown capability certainly exists in broadcasting equipment, Tesla says. The firm prides itself in being able to produce its own high-power tubes and whatever solid-state components are needed for the radio and TV transmitters it builds, and still have enough for exports.

Such capability also applies to industrial controls, especially to numerical-control systems for machine tools. "While at one time we were dependent on imports from the West, we now produce our own systems," says Jaroslav Hrouda, a Tesla engineering official. The main reason for building up a strong NC capability, Hrouda says, is to keep Czechoslovakia in the forefront of machine-tool technology and exports.

Also commanding considerable attention in Czechoslovakia's electronics efforts is automation. "Putting production lines under computer control is getting top priority," Hrouda says, and the reason is obvious—a shortage of labor. The effort works: Tesla's output doubled during the 1970-to-1975 period with only 6% more employees.

By the numbers. Numerical-control system from Tesla is typical of Czech-produced industrial equipment. This system, the NS440, is used to control cutting and forming machines.



Solid-state activity. As for semiconductors, Tesla says it has microprocessors in development, but concedes it lacks the technology and equipment to get them into production soon. So, as one official points out, "it is more economical at present to import the microprocessors we need." They presumably come from the West and are intended for use by Czech research institutes.

When it comes to integrated circuits, though, Tesla clearly has solid know-how, especially in bipolar devices. There is also activity in metal-oxide semiconductors, and much work is said to be going on in research and development of ceramics, plastics, and materials.

Industrialized as Czechoslovakia is, it is only natural for the country to stress computers. R&D in the field, says the technology ministry's Vasko, started in the early 1950s, with first-generation machines coming off Czech production lines during the latter half of that decade. Second-generation versions followed soon thereafter. Typical for this class is the Tesla 200.

More color TV sets. For the consumer, production of color TV sets is to be stepped up considerably in an effort to get prices down. Color set production is running at about 50,000 units per year. This is to be doubled by 1980.

Color broadcasting started in Czechoslovakia in 1973. What has hampered its spread is the rather limited color signal coverage of the country, plus the relatively high receiver prices. Black-and-white and color installations total 3.7 million units in the New York State-size country with about 14 million persons. In 1975, about 450,000 receivers of both types came off Czech production lines. Of the monochrome versions, substantial numbers are being exported, including some that are going to West European countries. □

Commercial electronics

L.A. buses to get monitoring system

Hoffman Information wins $2.7 million Federal contract to install signpost transmitters and vehicle electronics for 200 units

by Lawrence Curran, Senior Editor

A minicomputer-based monitor promises bus passengers on seven routes in the Los Angeles area better service in the not-too-distant future. The progress of 200 buses of the Southern California Rapid Transit District will be checked by an automatic vehicle-monitoring system to be installed by 1979 by Hoffman Information Identification Inc., Fort Worth, Texas.

The wholly owned subsidiary of Hoffman Electronics Corp. late last month won a $2.7 million contract from the Department of Transportation's Urban Mass Transit Administration to design, build, and install its signpost system—winning out over three other bidders [*Electronics*, July 21, p. 26].

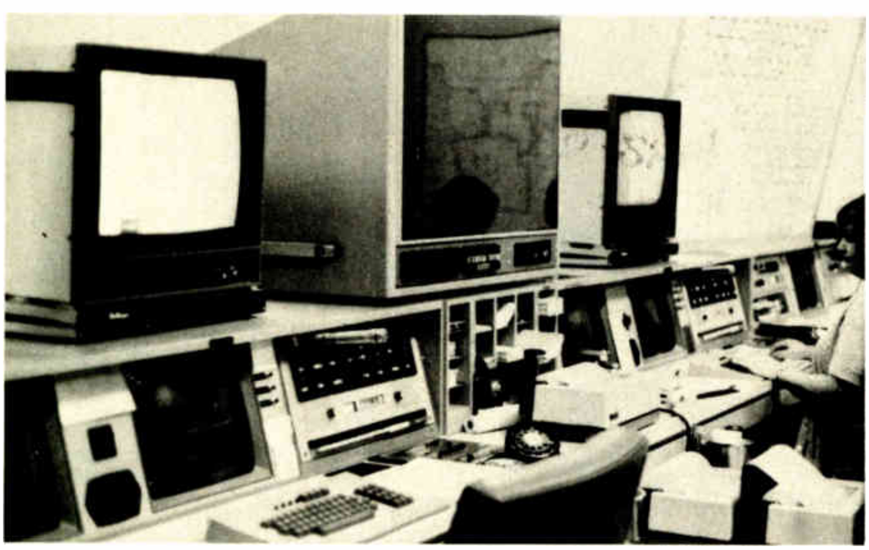
The system will be able to pinpoint bus locations to within 300 feet or better and log their time to within ±15 seconds. Hoffman beat those specifications in tests conducted in Philadelphia during the winter of 1967–77. Those tests were conducted for UMTA by the Federal Transportation Systems Center, Cambridge, Mass.

With the data derived from the system, dispatchers will be able to observe and correct such conditions as buses bunching on a given route. For example, if a crowded bus is closely followed by one carrying far fewer passengers (as determined by an onboard counter), the dispatcher may radio the driver of the crowded bus to skip a stop, or direct the emptier bus to pass the crowded one. In this manner, the transit district plans to maintain schedules as closely as possible, keep uniform headway between buses on the covered routes, and achieve uniform loading of passengers.

Hoffman chose a signpost system similar to one it has installed for the Huntington Beach, Calif., police department, which monitors 44 police cruisers over their random routes. That system ties into an existing computer-aided dispatch station.

Signposts. In the Los Angeles scheme, the signals from two adjacent signposts will be received by the bus simultaneously. The unique digital code from each signpost indicates the bus's direction, and by calculating the signal strength of the two, the minicomputer determines its distance from each of the signposts and hence its location.

The overlapping technique permits use of fewer signposts. Hoffman expects they will be two to three blocks apart in the Los Angeles area, and there will probably be one time-checkpoint signpost every mile. Part of the 16-bit code at those signposts identifies them as time checkpoints, and the data is time-tagged by



Forerunner. Hoffman bus-monitoring system uses dispatch center similar to this one at Huntington Beach, Calif., police station.

Posted. In Philadelphia test, Hoffman put its signpost-type transmitters on light poles: the black box just below the pole's arm.

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Police package. Vehicle unit for monitoring system is shown in police car's trunk.

means of a real-time clock signal from the base station.

One competitor in the Philadelphia tests also employed a sign-post-based system. Fairchild Space and Electronics Co. of Germantown, Md., used microwave signposts operating at 2.5 gigahertz. Hazeltine Corp. of Greenlawn, N. Y., competed as well, using a pulse-trilateration system at 1,000 megahertz and a network of receivers. Signals received at three of them were used to generate intersecting hyperbolic lines to determine bus location. The final competitor, Teledyne Systems Co. of Northridge, Calif., went with a Loran-C system that converted Loran coordinates into map positions to locate the vehicle.

Black box. For the bus system, Hoffman will provide the signpost transmitters; a black box aboard the bus linked to an ultra-high-frequency radio to receive, decode, store, and transmit the coded signpost signals; plus base-station equipment consisting of a fairly large minicomputer and interactive cathode-ray-tube displays to process and present the data to dispatchers.

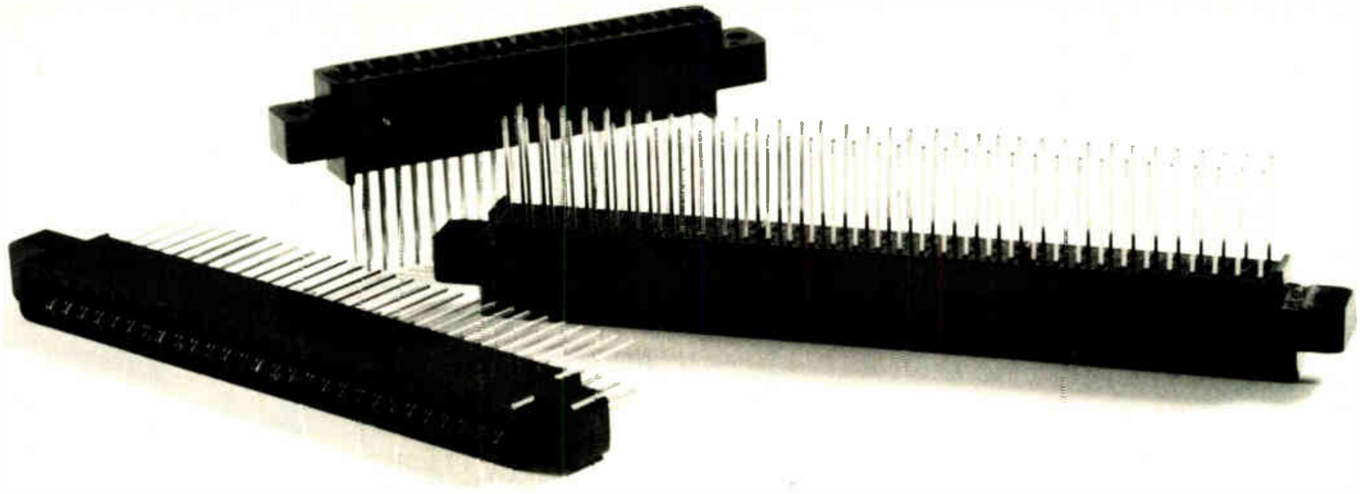
In addition, George Gruver, program manager for automatic vehicle monitoring systems, says his company will supply some kind of display at four selected bus stops to inform passengers of the schedule status on that route. Finally, Hoffman will also provide a small display in the bus to let the driver know if he is ahead of or behind schedule. Gruver says that could use a light-emitting-diode display.

On the basis of the Philadelphia experience, the signpost transmitters will be powered by lithium batteries with an expected life of seven years and will operate at 49.5 MHZ. Charles Freeney, president of Hoffman Information Identification, says each transmitter is turned on about once a second and broadcasts its 16-bit digital code. A receiver that is in the bus's unit picks up the signal, which is decoded there with the aid of a microprocessor.

The vehicle unit stores the time and location data, then transmits it digitally to the base station over a conventional uhf voice radio operating in a band from 465 to 475 MHZ. For the Southern California bus system, the base-station computer will poll all 200 buses every 20 seconds, look up the signpost codes in a table, and display each vehicle's location on one of the two CRT displays—which may be color units—for action by the system's dispatchers.

Gruver says the class of minicomputer has not been determined, but its disk-contained data base will be able to store the required signpost codes and other information necessary to cover the 150 miles of Los Angeles County roadways covered by the system.

Cheap. Hoffman picked the signpost approach essentially because the company believes it is more economical than other systems. "Most people have known for some time that signposts work," he says, "but it's often thought that so many signposts would be needed that a system would be uneconomical." He maintains, though, that the Hoffman type of signpost transmitter is cheaper than a street light. Combined with the low power and narrow bandwidth required, this means that vehicle electronics can be inexpensive. □



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Companies

ITT Semiconductors stakes U. S. claim

Miller has a three-year plan for his division based on reinforcement of its role as 'very rapid follower'

by Lawrence Curran, Senior Editor

After a little more than a year as president of the U. S. division of ITT Semiconductors, Norman J. Miller acknowledges the strengths and weaknesses of his organization. He believes the division has established its reputation in certain computer components areas but must do better at penetrating the U. S. semiconductor market, is not a technology leader, and will not be a price leader.

So Miller has taken steps to improve things. He feels he has the right management team in place and has the financial backing of the parent corporation to pursue technology and second-source agreements that are already paying off. He will stake his and the division's reputation on delivering quality parts on time.

"We recognize where we are in the market," Miller says. "We're a follower, and we'll remain a follower for the next three years—but we'll be a very rapid follower" because of alternate-source agreements in the memory and microprocessor lines. Those agreements, combined with the purchase from Standard Microsystems Corp., Hauppauge, N. Y., of its coplanar metal-oxide-semiconductor process [*Electronics*, Aug. 4, p. 72], will allow the division to trade on its reputation as a supplier of transistor-transistor-logic circuits and discrete diodes and rectifiers to the computer market.

Based in Woburn, Mass., the U. S. division bought the SMC coplanar process rights last fall, engineered an exact copy of the Mostek 4027 4,096-bit random-access memory (the ITT 4027), and is offering samples to customers. Using the same process, the division will begin offering samples of the Mostek 4116 16,384-bit RAM (ITT 4116) to selected customers this month.

Miller says the three-year plan is to expand the division's base in the U. S. data-processing market with those RAMs and microprocessors, then take aim at the market for consumer integrated circuits, particularly for television sets, with the proven technology and reputations of ITT Semiconductors in Great Britain and Intermetall GmbH in Germany.

A dissenting voice. One Wall Street analyst questions that strategy. Sal Accardo, vice president and electronics analyst at Kidder, Peabody & Co., thinks it would be wiser for the U. S. division to quickly take advantage of the established positions of its British and European counterparts by tackling the consumer and telecommunications circuits business and to avoid the high-risk route of second sourcing in memories and microprocessors. "ITT Semiconductors does such an outstanding job in the consumer market and secondly the telecommunications equipment market in Europe, they should pursue the same strategy in the U. S.," says Accardo.

"But to be in the 4-k and 16-k RAM business is a very high risk as a second source. That will be a commodity business like TTL, where the U. S. division has had only limited success. There are only three or four companies that can do that job. The rest will lie down and die."

Miller recognizes the commodity nature of the computer market for semiconductors and believes the U. S. division has demonstrated it can take the pressure. He points out that the discrete facility in Lawrence, Mass., has been supplying commodity diodes and rectifiers to the computer market very profitably for years. Gerald Bellis, director of discrete operations in Lawrence, is also getting the facility tooled up to move into the power market—in triacs, transistors, Schottky rectifiers, and power zeners.

The division produces ICs in West

Talking it over. Norman J. Miller, left, president of ITT Semiconductors' U. S. division, and Daniel del Frate, vice president and director of marketing, confer at Woburn, Mass., offices.

Palm Beach, Fla., where Miller instituted a yield-improvement program shortly after taking over as president. To date, that effort has led to a 16% improvement in yield, he says. Miller credits that success to Eric Burlefinger, recently named director of IC operations, who retains the title of technical director of U. S. semiconductor operations.

Rounding out the management team responsible for operations and marketing is Daniel del Frate, vice president and director of marketing for the U. S. division. Miller chose del Frate because of his solid experience in semiconductor sales and marketing, especially in the American market, "and especially his understanding of sales representative and distributor organizations," on which his division relies heavily, Miller says.

Filling some holes. Over the near term—the next several months—Miller wants to fill out both the discrete and IC product lines. That means continuing the push into power discretes, building volume in 4-k and 16-k RAMS, and implementing a second-source microprocessor agreement reached in July with Monolithic Memories Inc. That agreement covers the MMI 6701 bipolar 4-bit slice and related large-scale integrated parts. It could lead to ITT's second-sourcing the 2901A bipolar microprocessor and provides for a monthly information exchange.

Miller also expects to have a second-source agreement giving ITT an MOS microprocessor family by year's end and by then will have fleshed out the low-power Schottky IC line from 68 circuits in production in July to 108.

Beyond those moves, his goal is to make the division recognized as one that meets its delivery commitments.

His prime goal is to reduce returns and "deliver a minimum of 85% of all line items on the first factory commitment date. We've done that in Lawrence, where the cycle time is inherently less for ICs." Front-end wafer cycle time—production time at that stage—has been cut at West Palm Beach, as well. Now a major program is under way to do the same in assembly. "We'll stake our reputation on service and delivery of commodity products," says Miller. □

Components

Will V-MOS make it in power market?

Siliconix expects technology to win price and performance honors against bipolar competitors in $200 million arena

by Lawrence Altman, Solid State Editor, and Lucinda Mattera, Components Editor

The $200-million-plus power-transistor market is under attack by an intruder with a new technology. The intruder is Siliconix, a relatively small ($30 million) California-based specialty manufacturer of field-effect transistors, data converters, and digital stopwatches. The new technology is V-MOS.

How far this Santa Clara firm can take its V-groove metal-oxide-semiconductor power technology in a market dominated by bipolar devices manufactured mostly by large electronics firms is anybody's guess. Art Fury, vice president and marketing manager, makes the case for V-MOS: "We think V-MOS could grab as big a piece of the power market as n-channel MOS is grabbing in the digital market. We'll beat them on performance and we'll beat them on price. We're practically betting our company on it."

$1 apiece. And Siliconix is beginning to deliver, recently introducing three V-MOS 12.5-watt, 2-ampere power transistors in plastic packages for logic-interface applications that will sell for about $1 in 100-up quantities. That is about the same price as comparable bipolar transistors.

Moreover, the company is readying new, formidable products aimed at the high-voltage, high-current area and the radio-frequency market. Coming in the first quarter of next year are 10-W MOS field-effect transistors for continuous-wave operation at 400 megahertz and 80-W CW devices operating at 100 MHz. For high-power applications, Siliconix is preparing samples of 100-V, 15-A devices, 200-V, 7-to-10-A devices, and 400-V, 4-to-5-A devices.

Thus, Siliconix will challenge bipolars in all major areas of the power market. "With this line in full swing," says Fury, "we'll be in a position to range across the whole field. We think we can fill a lot of bipolar sockets, and create a lot of new ones as well."

COMPARING V-MOS AND BIPOLAR POWER TRANSISTORS

Description / use	Bipolar	V-MOS power field-effect transistor
Control mechanism	current	voltage
Bias requirements	normally requires reverse bias	normally off with no bias
Charge carrier technology	minority-carrier injection	controlled by majority-carrier field
Switching speed	100 ns or so	10 ns or so
Rf input impedance	low, limits bandwidth	high, easily matched, permits broadband designs
VSWR range	varies, depending on device	unlimited from short circuit to infinite
Saturation on-resistance	negative temperature coefficient	positive temperature coefficient
Input drive required	< 2 volts, milliampere currents	10 volts, nanoampere currents

SOURCE: SILICONIX INC.

The reaction. But that will not happen if bipolar power-device manufacturers can help it. While many firms are looking into V-MOS technology for power applications, there is considerable skepticism about its virtues and many more reservations about its reach than at Siliconix. In fact, most traditional suppliers see V-MOS FETS as potentially interesting mainly for the high-frequency area.

"Because of its low driving current, V-MOS seems to lend itself to high-frequency applications," notes Donald Watson, director of marketing for power devices at RCA Corp's Solid State division, Somerville, N. J. "On the other hand, the direct cost of manufacturing is high compared to bipolar devices because the process is more complex." RCA is currently evaluating the viability of V-MOS and expects to conclude its investigation in 3 to 6 months.

Further along in its V-MOS effort is Motorola Semiconductor Products Inc., Phoenix, Ariz. Since the beginning of the year, the firm has been sampling a 1-W, 175-MHz V-MOS power FET, which it expects to introduce officially by year's end. For next year, the company plans to ready a full line of V-MOS FETS for rf applications, says Harry Kosci, product marketing manager for FETS.

"We don't see power FETS as competition to present-day bipolar devices," asserts John Hey, manager of power components at General Electric Co.'s Semiconductor Products department, Auburn, N. Y. The company is presently evaluating the power-FET technology.

No panacea. Also looking into various techniques for doing power FETS is National Semiconductor Corp., Santa Clara, Calif. "V-MOS is really not a panacea, and I do not see it as a major competitor of bipolar technology in the next five years," says Mike Turner, product marketing manager for FETS. "It's going to take a major power house and a good second source to make it go." □

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Series 440, Circle Reader Service No. 271
Series 481, Circle Reader Service No. 272
Series 600, Circle Reader Service No. 273
Series 800, Circle Reader Service No. 274
Series 925, Circle Reader Service No. 275

Switch

Modern electronics demands switches of all types. Switches capable of withstanding the most rugged working conditions. And giving reliable service that continues throughout the life of the systems they serve.

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Take a look at the variety:

Series 10 — This rugged, versatile four lamp push-button switch has become the standard of the industry with many diverse applications in control panels for ships, oil fields and power generating plants, just to name a few. This switch has UL approval, is QPL (MIL-S-22885/9/10) listed and features positive indexing and front panel relamping without tools. RFI protection, solid state switching, and "high shock" modifications are available as options.

Series 90 — This two lamp pushbutton switch is cased in stainless steel and is resistant to most environmental extremes. A favorite of designers everywhere because of its overall versatility and the wide variety of terminations available for low cost assembly. Standard features include: UL approval, QPL (MIL-S-22885/58), relamping and legend change from front panel without tools, and a wide choice of switch actions.

Series 440 — This switch series provides the electronic designer with a microprocessor compatible, touch activated solid state switch. The 440 switch becomes part of the electronic circuitry without the need for interface. Because it is a capacity transducer, the reliability of the switch equals that of any transistor. The compact design eliminates the need for deep panel clearance. The touch face incorporates an optional LED as a visual activation indicator.

Series 481 — A true solid state electronic "thumbwheel" switch with the same design advantages as the Series 440. Incorporating two series 440 switching functions with an encoder/decoder/driver IC which makes an all solid state lighted thumbwheel switch with true BCD output. The seven segment LED display occupies the center section of the switch plate. The bottom plate advances the count and the top plate resets the switch to zero.

Series 600 — The Series 600 computer-grade switch is the most versatile switch in its class; unmatched performance is provided by the wiping action contact design unavailable in any other line of low-cost, computer-grade lighted push button switches. Available in many different mounting configurations, sizes, styles and colors, the 600 also offers a wide choice of switch actions.

Series 800 — Ideal for matrix mount applications, this four lamp pushbutton switch is available in two display face sizes. A standard 3/4" square and a 3/4" by 1" provide the flexibility needed in panel design. Standard features include positive indexing and front panel relamping without tools. Optional solid state models and electrical interlock holding coils are available. The 800-H has received MIL-S-22885/74/30 approval.

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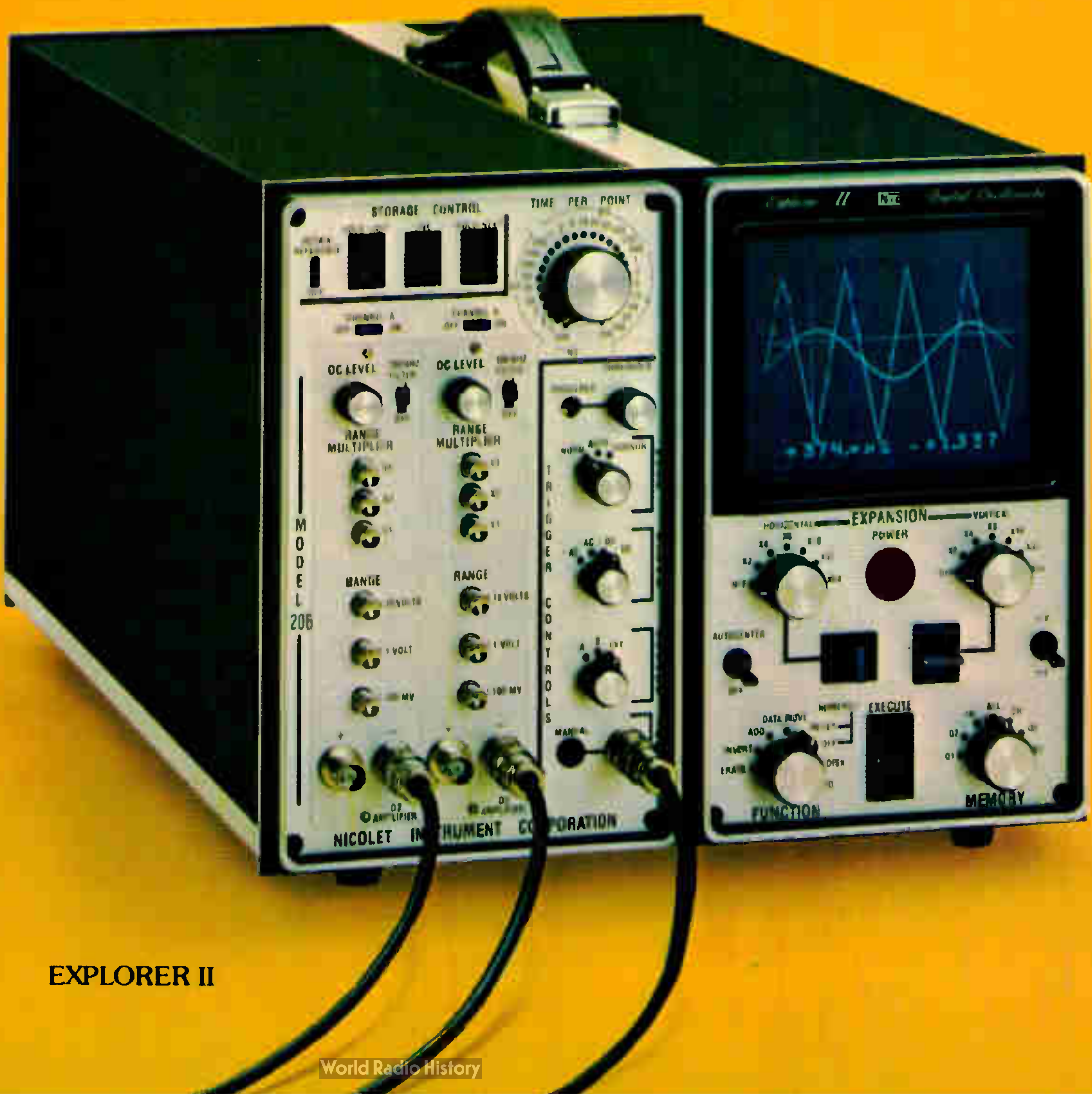
Imagine, for example, being able to touch a button to "freeze" the waveform on the screen. If you wish, the live waveforms continue, superimposed, so you can see changes while they are occurring. Then you can zoom-in on any detail of interest, with high magnification, to see changes as small as 0.025%. The stored waveform has almost unbelievable detail. It would take an analog storage 'scope with a screen area 400 times greater than usual to capture the same detail.

It has some long-needed conveniences such as automatic trace centering, with simultaneous numerical display of the voltage and time corresponding to screen center, so you know where you are. It has non-fading storage, which doesn't require adjustments, manual erasure, mode switching or sweep arming. It has automatic perfect persistence. Waveforms stay until replaced by the next to occur, when you wish. It has a numerical display of the true voltage and time corresponding to any selected point — with respect to zero or with respect to any other point.



EXPLORER II

There's a lot more to EXPLORER II. But a simple listing of features doesn't tell the story very well. You really have to see it in action, or better yet, use it. Then, we think you'll agree — It's some 'scope.

Plug-in units include model 204, which has 50 ns rise time: model 205, a single input, 500 ns rise time, high precision unit; model 206, a two channel unit similar to model 205; and model 201, a one millisecond rise-time, 10 μv, ultra-stable unit for measuring slowly changing variables. Price $4400 with model 205 plug-in unit. **EXPLORER III** is an EXPLORER II with an added module. This module provides two more features; an internal magnetic disk memory, and a digital input/output port to allow interfacing to computers and the fine HP 9825 calculator. The combination of an outstanding digital oscilloscope, the recorder, and the interface to processors or calculator make it possible to handle a wide range of signal acquisition and analysis problems conveniently, and less expensively. These EXPLORERS are new versions of EXPLORER I, now in use in hundreds of laboratories all over the world.

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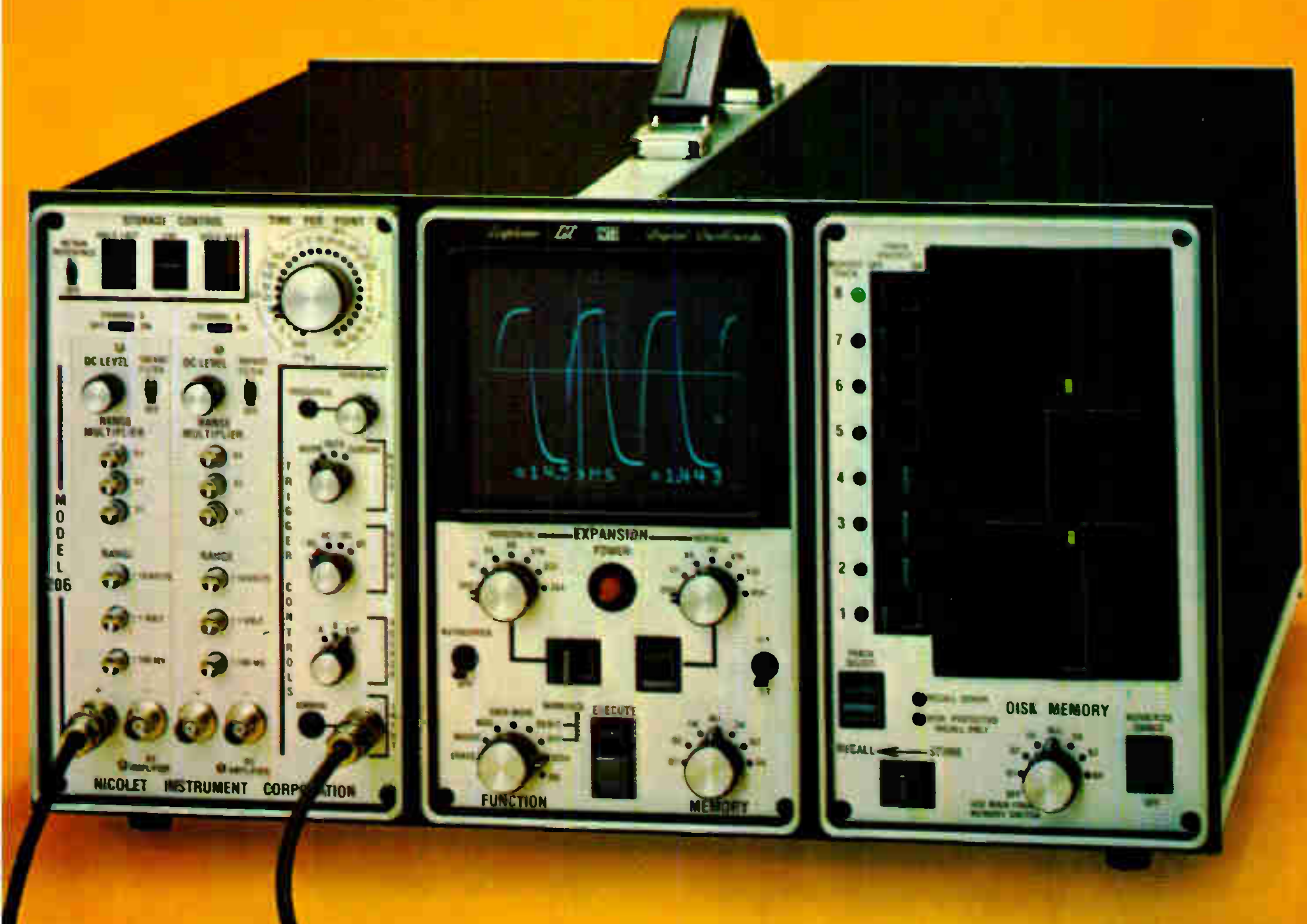

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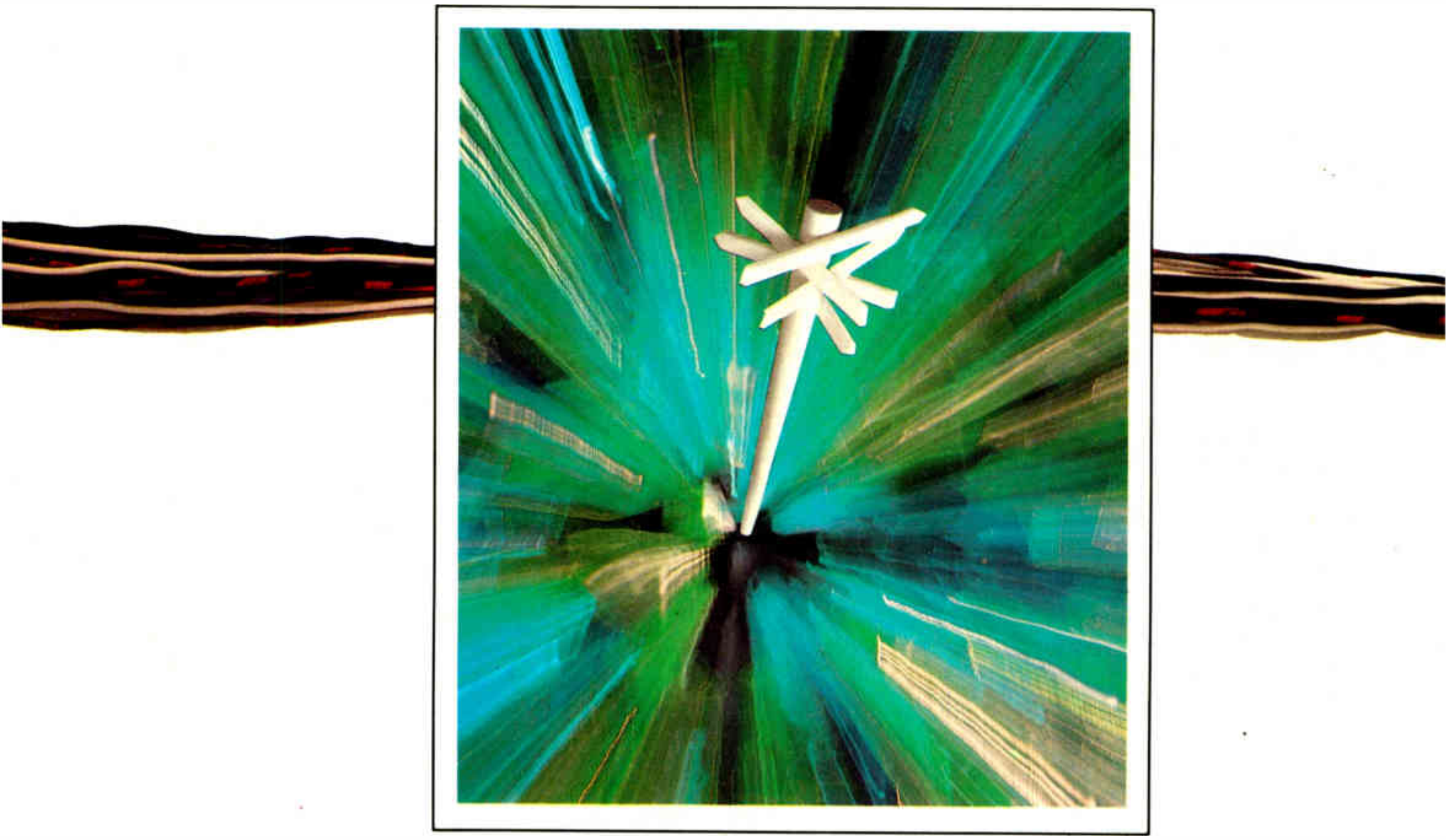

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But we promise you more than an expanding product line. We'll provide proper means of terminating too. There's also our extraordinary quality. Our prompt delivery from our close-to-you distributors. Our personalized technical help. Perhaps what you need now in connectors is shown here. If it isn't, just ask.

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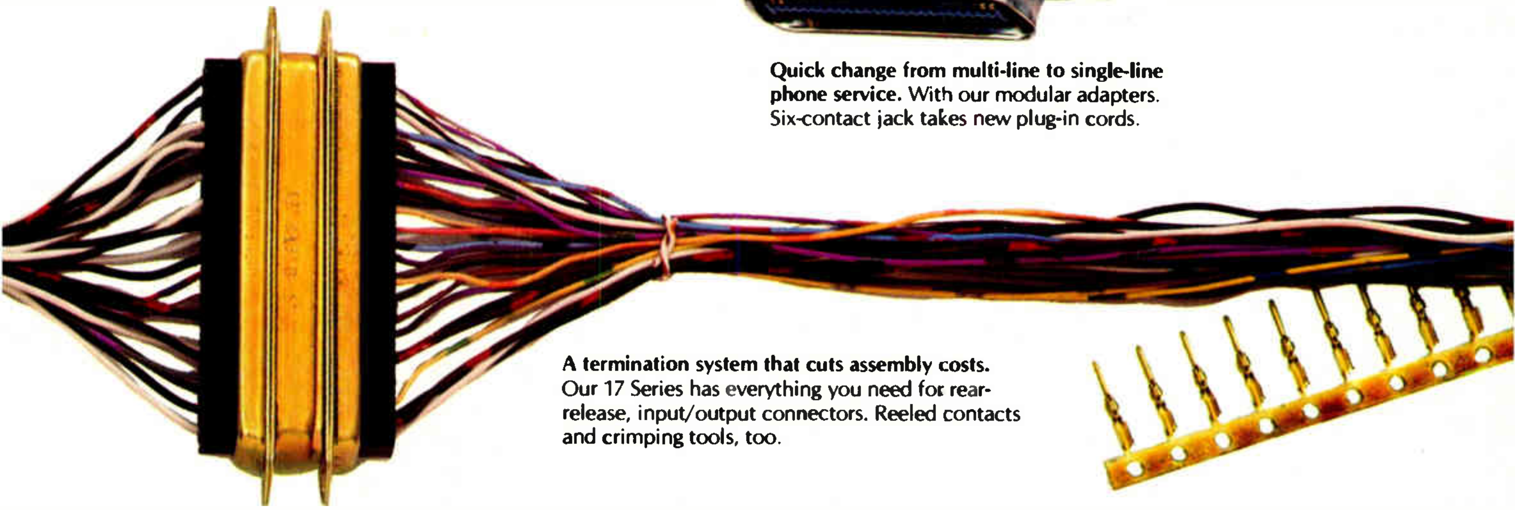

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SINGLE CONTACT design
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4 TIMES BETTER
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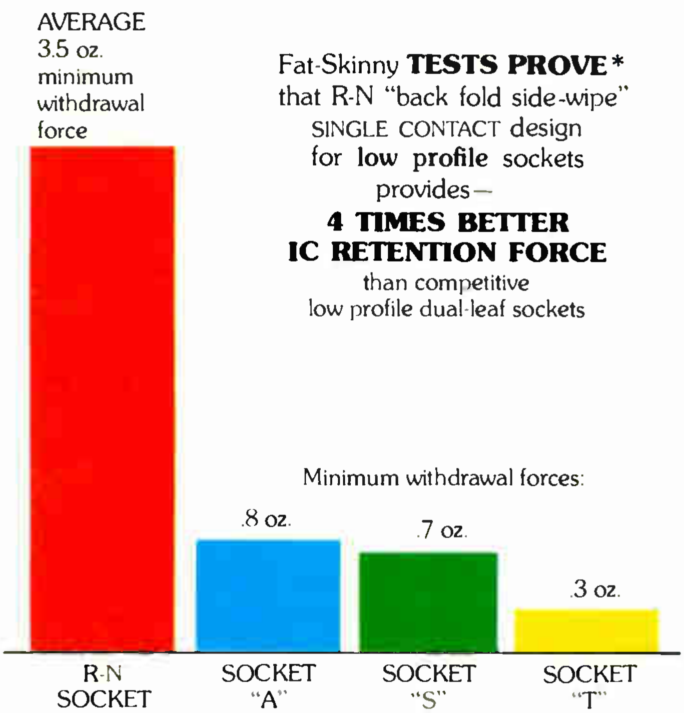

* In "Fat-Skinny test," withdrawal forces are measured using the smallest size (.008") lead **after** insertion of **largest** size (.012") lead.

Representative NORMAL FORCE Test Scores for 10 R-N ICL low profile sockets

TEST SOCKET	NORMAL FORCE *
1	410 grams
2	465 grams
3	480 grams
4	465 grams
5	395 grams
6	425 grams
7	465 grams
8	395 grams
9	410 grams
10	425 grams

AVERAGE—430 grams

This force is 4 to 5 times greater than average dual contact socket NORMAL FORCE

* NORMAL FORCE means force perpendicular or at right angles to IC lead. The single ICL contact exerts this kind of force against the IC lead when inserted into the socket.

"...TWO contacts are not more reliable than ONE!"

Surprisingly, a **low profile** (.150" high) DIP socket is a different breed of cat when it comes to engineering in contact reliability. Most standard DIP sockets have dual contacts. (R-N's dual "side-wipe" contacts are among the most reliable in the industry.) But, when you **shorten the contact length** to achieve the "low profile" you lose a great deal of contact force and IC retention strength. So, to achieve effective low profile socket reliability you must **redesign the contacts** and make them out of the **strongest contact material available.**

Low .150" profile of ICL socket reduces board density by 26%.

DEBUNKS
DIP socket MYTH

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In a tough, 50-G shock test of 25 ICL sockets—not a single IC package came loose from the socket! More convincing proof that vibration problems are ended with R-N's new low profile ICL sockets. Socket density in multi-layer board can now be increased **without** sacrificing reliability.

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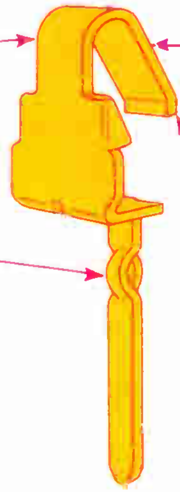

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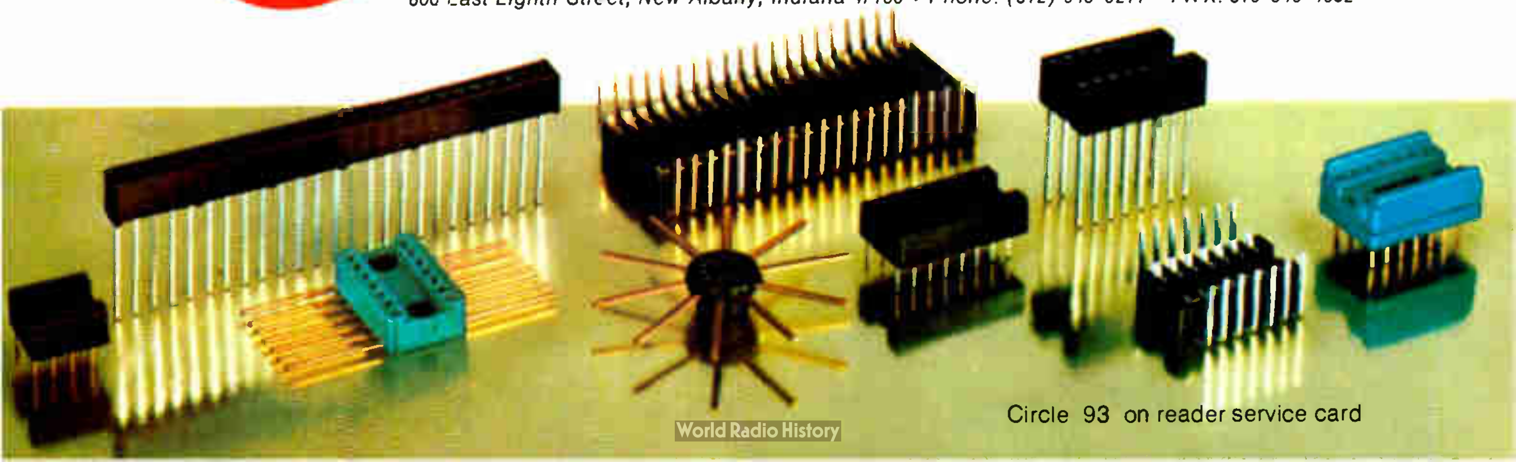
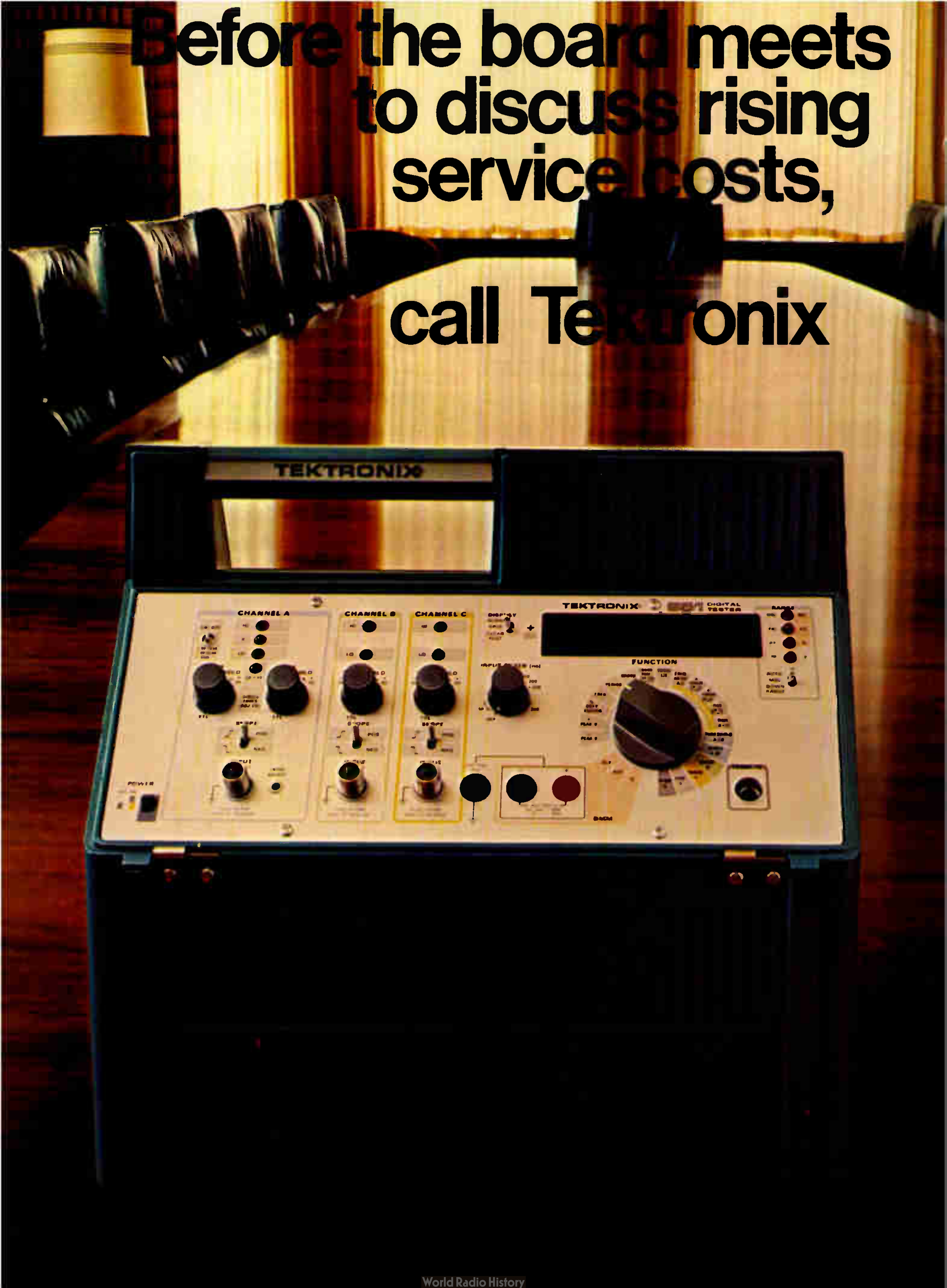


Circle 93 on reader service card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service costs,
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Our new 851 Digital Tester can give you the leverage to control those costs.

Managing a service organization is no bed of roses. It's big business. And it's continually getting more costly. Customer engineers, spare parts inventories, training, designing for serviceability, documentation, and instrumentation all contribute to these spiraling costs. Because service is so important to the success of a company, you need to indentify those elements which have the greatest leverage for your service organization.

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That's why we built the new 851 Digital Tester. It's a synergistic, new service instrument that combines the functions of many instruments in one portable package.

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A new concept in service instruments.

Your inventory of service instruments probably includes oscilloscopes, DMM's, counters, timers, logic probes, thermometers, and some special purpose test equipment.

A bench full of test equipment is a great resource for your customer engineer to rely on...as long as he doesn't have to travel much.

But imagine a self-contained service instrument that weighs only 13 pounds and makes most of those same measurements. That's our new 851 Digital Tester.

The power of the 851 lies in the fact that even though this one instrument makes the measurements of a variety of test gear, it is also easy to use.

With just one turn of the knob you can dial 22 different functions to make a wide range of system measurements and tests.

851 Functions

MEASUREMENTS		SIGNAL ANALYSIS	SELF TEST
VOLTAGE PEAK (25 ns to 25 ms) AC DC POWER LINE INPUT LOGIC THRESHOLDS RESISTANCE (0.1Ω to 50 MΩ)	TEMPERATURE TIME (20 ns to 10 s) PERIOD FRECUENCY PULSE WIDTH INTERVAL COINCIDENCE TRANSITION	LOGIC STATE INDICATORS HI, LO, INVALID, ACTIVE % DUTY FACTOR COUNTING FREQUENCY RATIO EVENTS BETWEEN START AND STOP PULSES TRANSITIONS BETWEEN START AND STOP PULSES TOTALIZE	TEST SIGNAL EXERCISE FUNCTIONS ADJUST PROBE READOUT TEST

It's easy. Just dial a function, probe the circuit being examined, and read the results directly from the autoranging LED display.

And what about product support? With Tektronix, it's worldwide.

Wherever in the world your service organization goes, Tektronix is with you all the way. Service personnel at 46 Tektronix Service Centers in the U.S. as well as service personnel in 50 other countries back our products.

Put the 851 to work in your digital service environment.

The measurement capabilities of the 851 make it particularly useful for sevicing computer peripherals, small business systems, and industrial control equipment.

We had you in mind when we designed the 851 Digital Tester.

For a demonstration, visit the TEKTRONIX booth at WESCON. Detailed specifications, application notes and a color brochure are also available for your information. Please contact your Tektronix Field Engineer. Or write Tektronix, Inc., P.O. Box 500, Beaverton, OR 97077. In Europe, write Tektronix Limited, P.O. Box 36, St. Peter Port, Guernsey, Channel Islands.

New concepts in digital service

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For Technical Data circle 94 on Reader Service Card
For Demonstration circle 95 on Reader Service Card

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First of all, the 3001's base price is just $2,750. That buys you full frequency programmability, 0.001% accuracy, 1 to 520 MHz frequency range, stability of 0.2 ppm per hour, built-in AM-FM capability, and a front panel that was actually designed for the user.

Now let's talk options. One lets you lock the 3001 to either an external frequency standard via rear panel BNC input or an internal reference frequency standard with 5 x 10 per day stability. And there are others like reverse power protection and auxiliary RF output. But even if you took all these options, you couldn't spend more than $3,650. Simple arithmetic says that it's still a lot cheaper to buy two loaded Wavetek 3001s than one Brand X.

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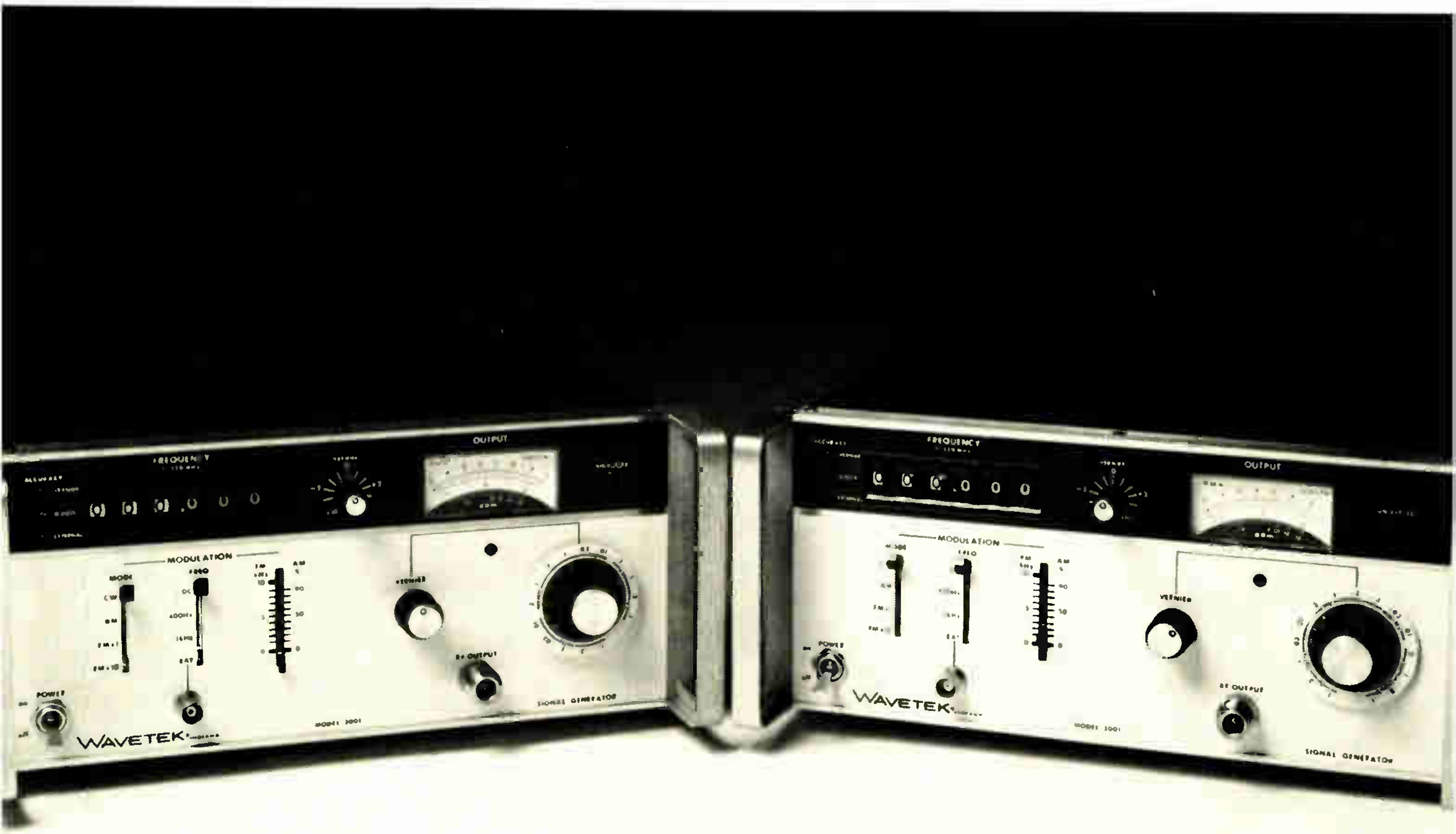


Get two Waveteks for the price of one Brand X.

Circle 96 on reader service card

Flexible circuits bend to designers' will

Now competing with rigid boards, flexible printed circuits can form connections in several planes, as well as saving weight, unit assembly time, and money

by Jerry Lyman, *Packaging & Production Editor*

☐ After being overshadowed for years by rigid circuitry, flexible printed circuits are moving out of their niche in the military and aerospace industries and into all areas of electronics, especially computer, industrial, consumer goods, and automotive systems. In fact, because of their cost effectiveness as an interconnect technique, it is now mandatory at many firms to try a flexible design first.

The most common manufacturing method starts with a substrate composed of sheets of thin copper, adhesive, and flexible insulating film laminated together. After lamination, circuit patterns are etched on the copper side of the substrate. The resulting device can be used as a harness, a pc board, or a combination of the two. Sanders Associates Inc., Manchester, N. H., originated flexible circuitry in 1952, when it developed this technique for a military application in which space and weight were at a premium.

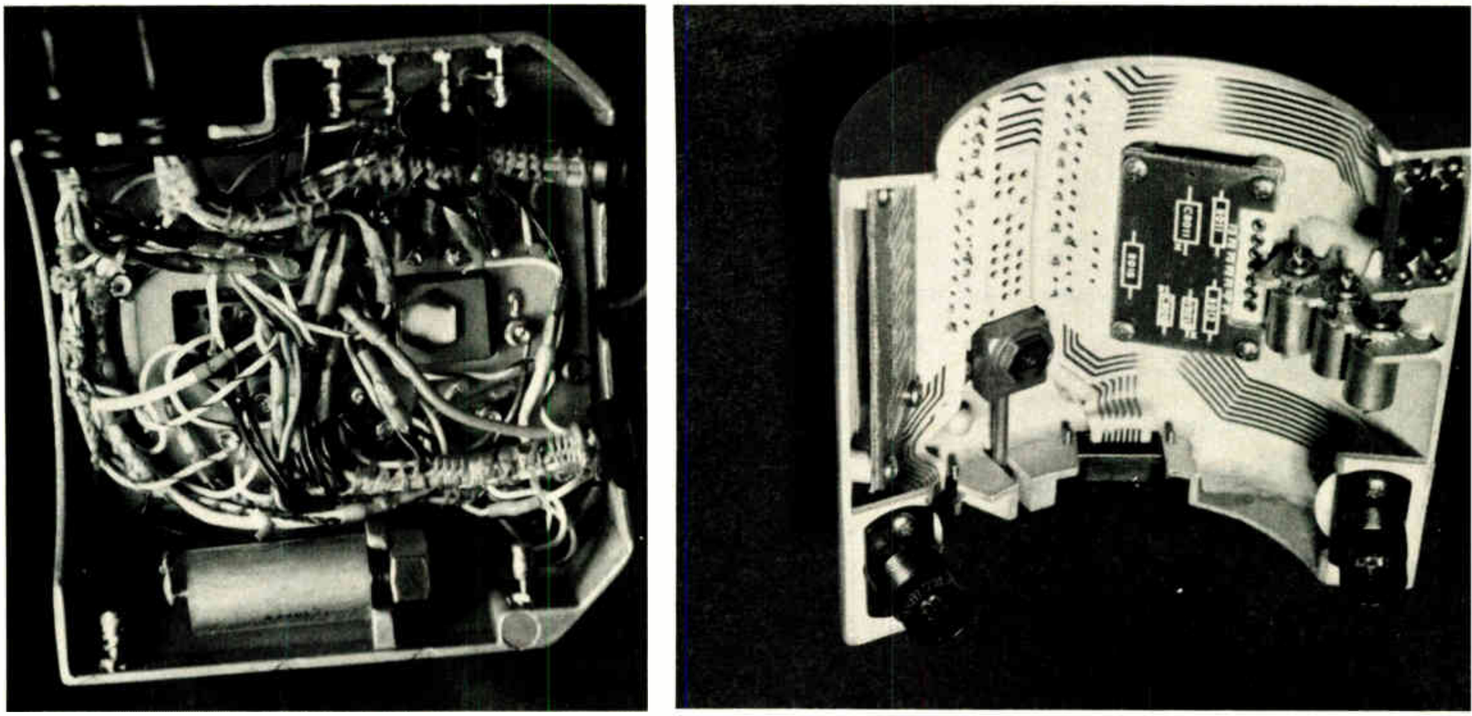
For example, Fig. 1 shows a military system that has been converted from rigid boards plus wiring harnesses to a flexible circuit. These photographs illustrate one of the main advantages of flexible circuitry—its ability to be shaped into more than one plane or to conform to an irregular package. Such circuits can also be folded up to save space—say, in a small module—and can branch off in many directions, as shown in Fig 2.

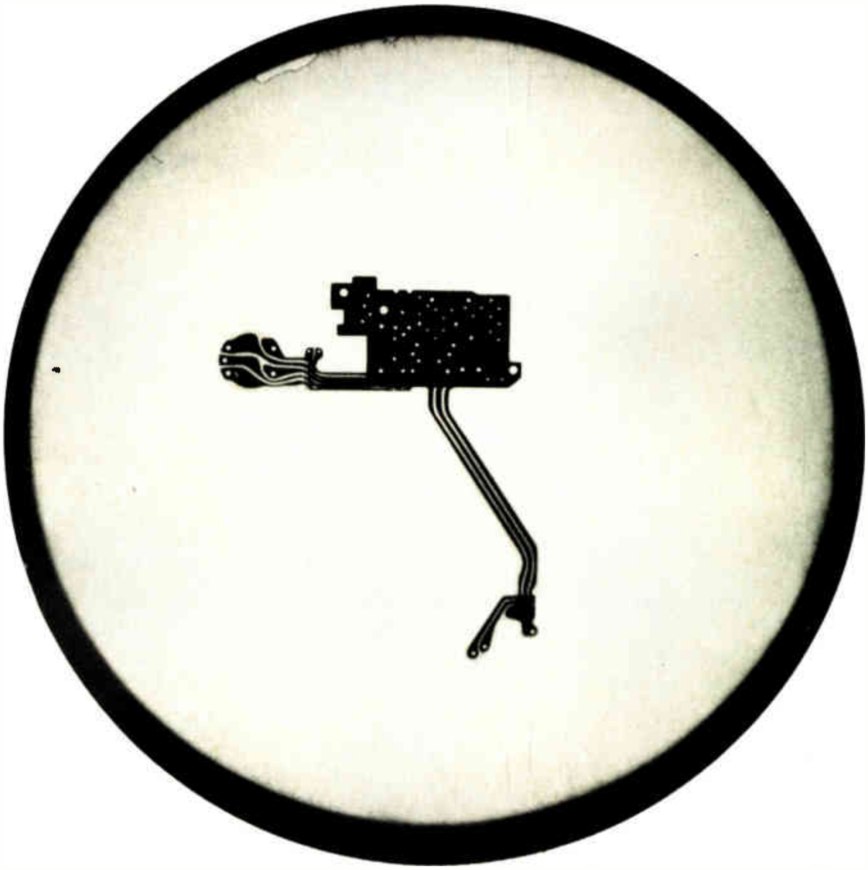
Flexing the circuit

Another advantage of this kind of circuitry is its ability to be continually flexed from a small folded or rolled-up configuration to its full length. This ability accounts for the popularity of flexible-circuit harnesses in the moving members of plotting boards and magnetic disks.

Flexible circuits are also extremely thin. Their thickness runs from 4 to 11 mils on average, whereas a typical two-sided rigid board is 62 mils thick. And such thinness,

1. Flexible vs rigid. A control box from a military system is shown in both its rigid (left) and flexible circuit versions. Note the clean, uncluttered package of the flexible-circuit system. Converting a system of this type to flexible circuitry cuts size, weight, and assembly time.





2. Multiplanar. Flexible printed circuits can be shoehorned into spaces where rigid circuitry could not possibly fit. This flexible printed circuit is bent into four planes and has two 180° fold-over sections to provide circuit reversal. End use of the board is in a portable movie camera.

plus the lightness of the insulating film, automatically brings with it a drastic reduction in weight.

Nowadays, most flexible circuits are replacing complete interconnection systems rather than individual hardboards. In these cases, in addition to saving space and weight, they eliminate wiring errors and cut testing time, rework, and assembly costs. Vic St. Amand, marketing director of Teledyne Electro-Mechanisms, Nashua, N. H., gives these examples: an avionics black box redesigned by his company's engineers with flexible circuits saved 129 hours per box in assembly time and cut weight 29%. A similar conversion of another military system cut 140 hours off unit assembly time and reduced weight by 50%.

If pins, wires, or plated-through holes are placed at its terminations, flexible circuitry can also eliminate the need for a connector. Still another advantage is shock-resistance. Vibrations and shock that would crack a rigid board have little or no effect on flexible circuits. That is why they appear in such diverse equipment as missile electronics and watch modules.

Drawbacks

Of course, flexible circuitry does have its disadvantages. One is that for high-frequency work it is difficult to control the characteristic impedance of transmission lines formed by the laminated system used in flexible designs, because of the many variations in the thickness of the layers of copper, adhesive, and film. Also, many users of flexible circuitry claim that it is difficult to use with automatic component-insertion equipment without the addition of hardboard stiffeners. However, Teledyne Electro-Mechanisms routinely inserts components automatically on unsupported flexible circuits.

What held back the growth of flexible circuitry in spite of its obvious advantages over the rigid-board-plus-harness technique? One factor was problems with materials. Early insulating films were unstable during processing, causing poor yields, a limited capability to hold tight dimensions, and poor solderability. Another problem was a lack of connectors and termination methods to interface flexible printed circuits with other parts of a system.

The introduction of polyimide laminates in 1965 provided the industry with a high-temperature, solderable film that solved the materials problem. Now there are four satisfactory flexible laminates that are available. In addition, many interconnection schemes have been designed for interfacing with flexible circuitry.

Today, the biggest problem flexible-circuit manufacturers face is the resistance of packaging engineers accustomed to designing with hardboards. As Steve Gurley, director of sales and marketing at Sheldahl Inc.'s Electrical Products division, Northfield, Minn., says, "Our biggest problem is educating people to use flexible circuitry. Many companies are just not willing to take a chance on a technique unproven to them."

In spite of the resistance, total sales of flexible-circuit boards will be \$128 million in 1977 and will grow to \$177 million in 1980, according to Steve Grossman, director of interconnection studies for Gnostic Concepts Inc., Menlo Park, Calif. The breakdown of available and captive flexible-circuit production is shown in Fig. 3.

Flexible insulating base materials are literally and figuratively the backbone of flexible circuitry. In the early years, materials like Vinyl, Kel-F, Teflon, and glass-reinforced Teflon were tried and found lacking. Today, four insulation materials —Kapton, Dacron-epoxy, Nomex, and Mylar—dominate the field (see table). (Kapton, Dacron, Nomex, and Mylar are registered trademarks of E. I. du Pont de Nemours & Co., Wilmington, Del.)

Base materials

Kapton, a polyimide-based film, is perhaps the most widely used, particularly in military and space projects. It has good dimensional stability, electrical characteristics, and high-temperature properties, and it withstands temperatures produced by wave soldering. However, it is the most costly material of the four.

Dacron-epoxy, used extensively by Western Electric and ITT, consists of nonwoven polyester fibers embedded in an epoxy resin. It has excellent dimensional stability, high moisture and tear resistance, and good electrical characteristics. Wave-solderable and flame-resistant, it has a cost close to that of Kapton.

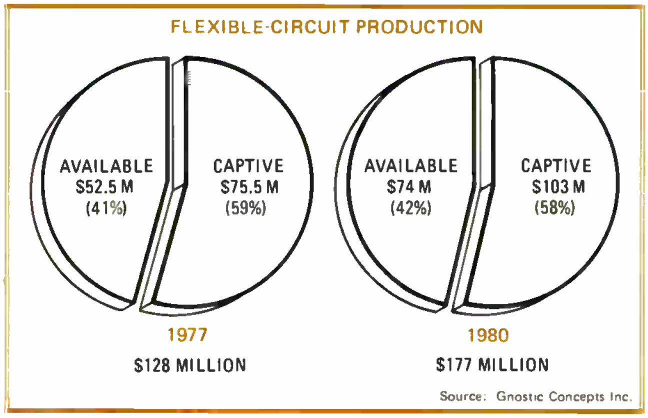
Nomex, a low-priced nylon-and-paper insulator, is wave-solderable but extremely moisture-absorbent. It is used in commercial applications—especially in cameras and cars—where humidity is not critical.

A low-cost polyester-based film with good electrical properties and good dimensional stability at room temperature, Mylar has poor high-temperature characteristics and limited solderability. It is heavily used for the flexible circuitry of automotive dashboards (mainly as a harness), where soldering is often eliminated.

In addition, a lower-cost insulating film with properties similar to Kapton may soon appear. Exxon Chemical Co. USA, Houston, Texas, has been developing a film made with polyparabonic acid (PPA) for some time [*Electronics*, Dec. 25, 1975, p. 63]. Called Tradlon, it has properties approaching that of Kapton at about 65% to 75% of the price. Tradlon is being evaluated by several manufacturers. However, Exxon is manufacturing it so far only on a pilot basis.

Manufacturing

Flexible printed circuits, like rigid ones, can be made by either the additive or the subtractive process. In the additive process, electroless copper is selectively plated onto a substrate. The subtractive process selectively removes copper by etching a copper-covered substrate. Practically all flexible circuitry is made by the subtractive process, which is shown in Fig. 4a for a simple single-sided board and in Fig. 4b for a two-sided board with plated-through holes.



3. A growing market. According to Gnostic Concepts, the flexible-printed-circuit market will increase 38.2% by 1980. Captive production will retain the major share of this growing field, particularly in automotive and telecommunications systems.

As the flow chart of Fig. 4a shows, resist (a material that resists etching) can be either screened on through a fine mesh (similar to the process used in thick films) or photographically exposed and developed. Normally, for lines and spaces 10 mils wide or less, most flexible-circuit manufacturers shift from screened-on to photographic resists.

Fine lines

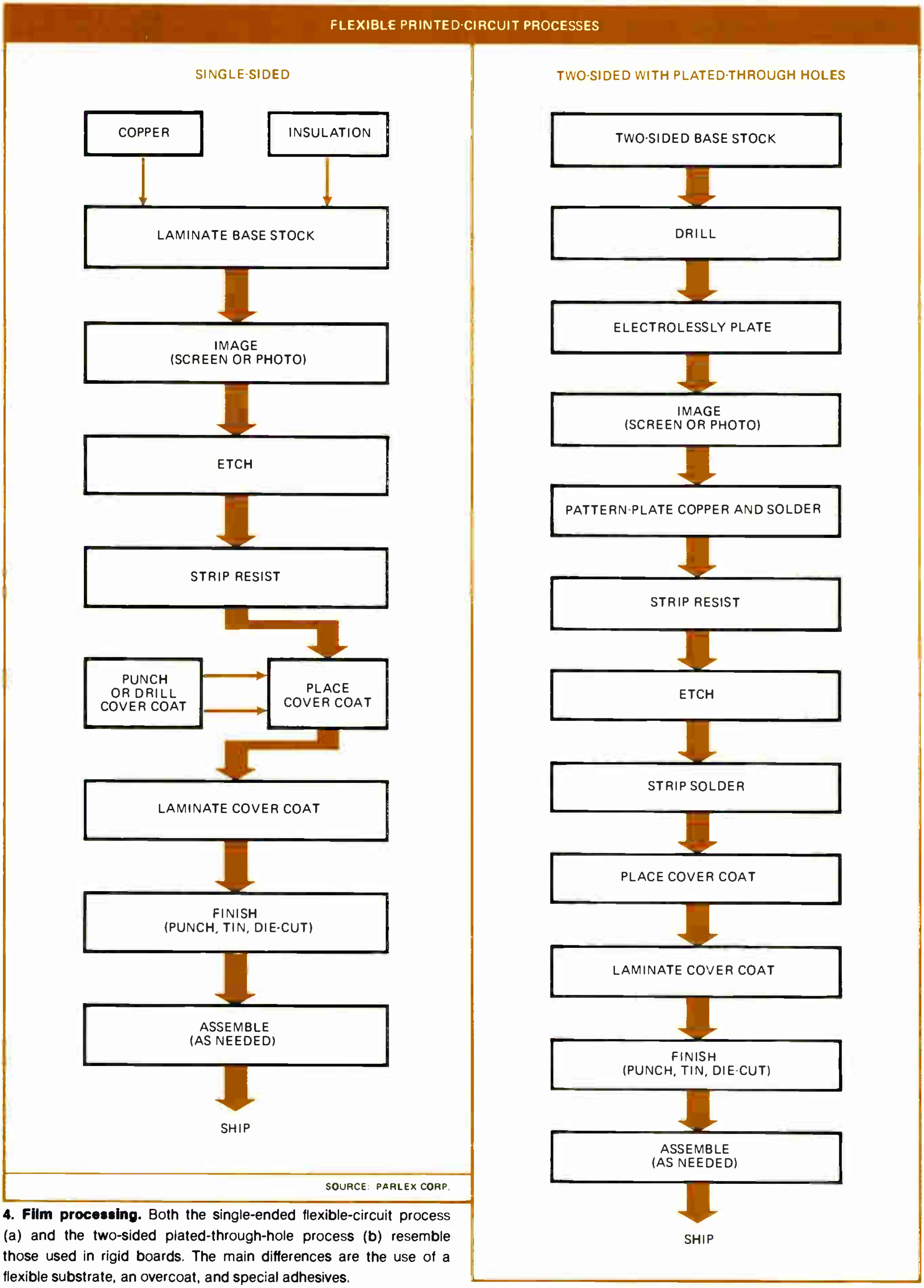
As with rigid pc boards, the great majority of flexible circuitry is based on 10- to 20-mil lines. However, almost all flexible-circuit manufacturers can supply circuits with 3-mil conductors and spaces; moreover, in an engineering model, Sanders Associates has now achieved 1-mil conductors with subtractive etching. Fine-line (3 mils or less) circuits are of course much more expensive than ones with the normal line work, because processing is more complicated and yields are lower. They are being used to connect to magnetic recording heads or directly to integrated-circuit chips.

At this point, most flexible-circuit manufacturers are just beginning to investigate the use of additive plating. Only Buckbee Mears Co., Nashua, N. H., and Pactel

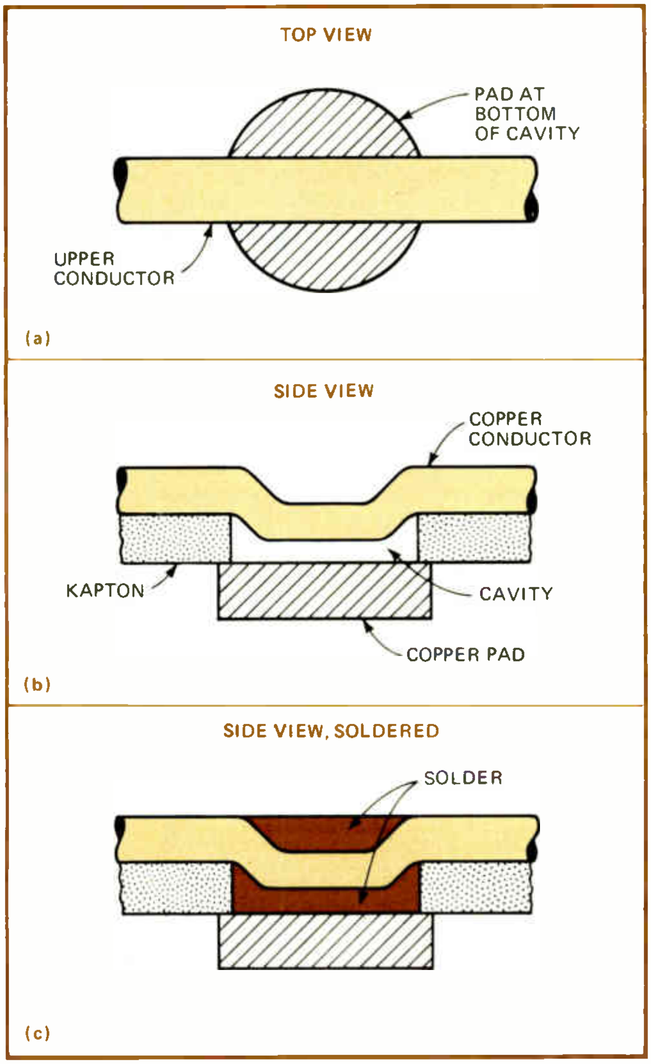
FLEXIBLE INSULATION MATERIAL PARAMETERS

	Sample thickness (in.)	Tensile strength (psi)	Tear strength (gm/mil)	Folding endurance (cycles)	Ultimate elongation (%)	Moisture absorption (%)	Dielectric constant (1 kHz)	Dielectric strength (V)	Dissipation factor (1 kHz)	Flammability	Service temperature (°C)
Kapton	0.001	23,000	8	10,000	70	3	3.5	7,000	0.003	94V-0	−250 to +250
R/2400 Dacron-epoxy	0.004	5,500	40	50,000	15	1	3.2	3,100	0.015	94V-0	−60 to +150
Nomex	0.002	11,000	49	5,000	10	5	2.0	600	0.007	94V-0	−60 to +120
Mylar	0.001	23,000	15	14,000	100	0.01	3.2	7,000	0.005	burns	−60 to +95

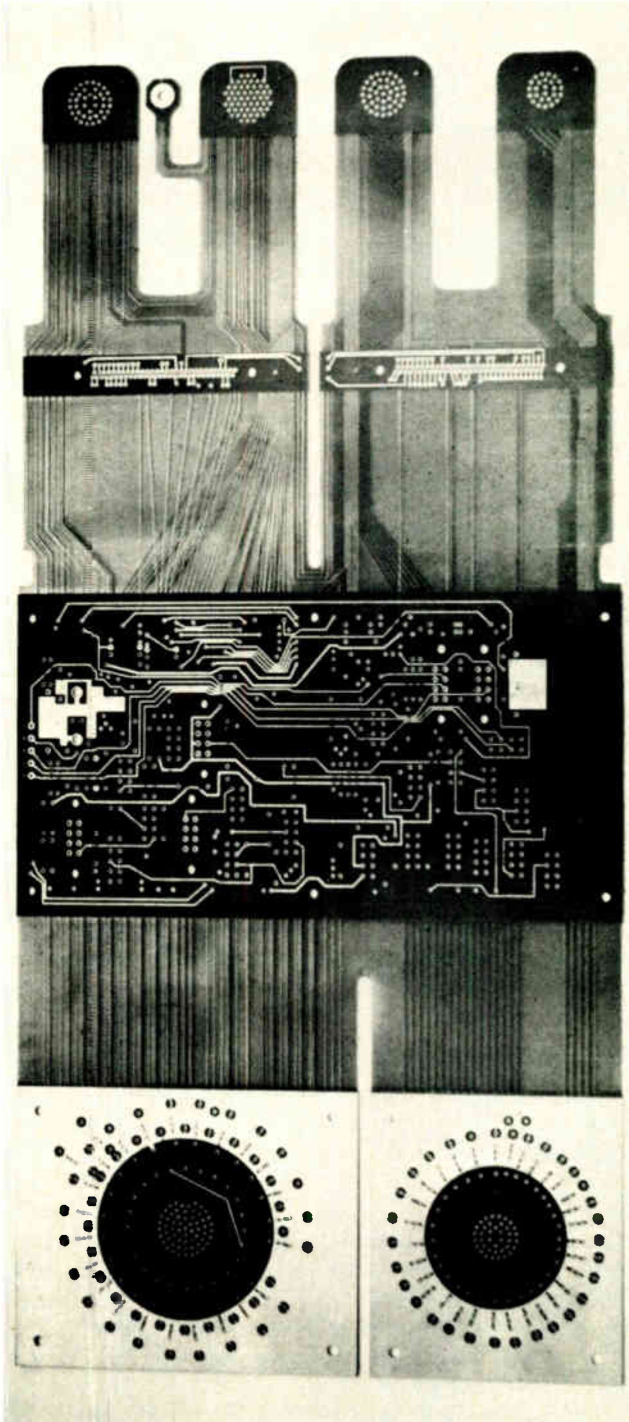
SOURCE: ROGERS CORP.



4. Film processing. Both the single-ended flexible-circuit process (a) and the two-sided plated-through-hole process (b) resemble those used in rigid boards. The main differences are the use of a flexible substrate, an overcoat, and special adhesives.



5. Solder-through. Teledyne Electro-Mechanisms uses this method as a low-cost alternative to plated-through holes. A cavity (a and b) is created between an upper conductor and a lower pad. During wave soldering, solder fills the cavity (c) making a through connection.



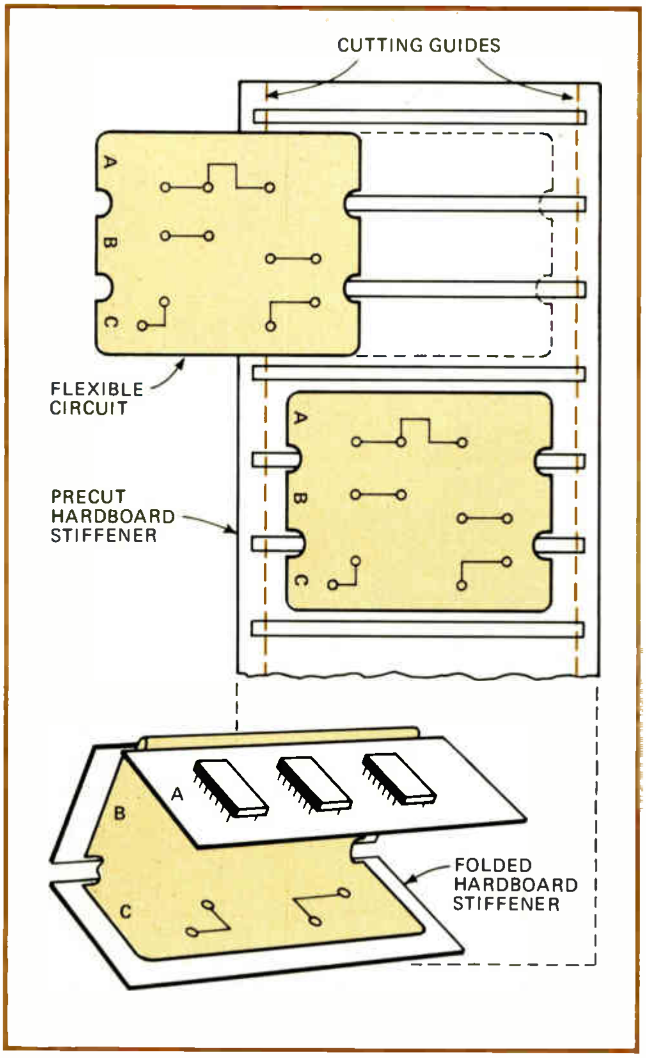
6. Rigid plus flexible. The flexible circuit shown has a dual purpose. It ties the nine rigid multilayer printed circuits together and at the same time serves as two conductive layers of interconnect in each multilayer board. Plated holes extend through all the layers.

Corp., Westlake Village, Calif., have additive programs, while Flexible Circuits Inc., Warrington, Pa., combines subtractive and additive plating for some special circuits.

Buckbee Mears has a proprietary additive process for putting copper conductors on Kapton that has been used in missile work. Pactel additively plates copper conductors on thin sheets of polyimide [*Electronics*, July 22, 1976, p. 101] and has supplied flexible circuitry 6 mils thick with 5-mil lines and 10-mil spaces for various military and space projects. It has also produced flexible circuits with 1-mil lines on 3-mil centers and expects to be able to make 0.5-mil lines on 1-mil centers. In addition, Pactel uses its additive process to manufacture strips of film carriers (a film carrier—really a series of repeated flexible circuits—is a copper IC interconnect or spider plated onto an insulating film).

Usually, one of the last steps in making flexible circuitry is to protectively coat the subtractively etched copper conductors (see Fig. 4a). The cover coat, or coverlay, is a clear film that is removed at the points where the circuitry patterns must be tinned. For some time, Flexible Circuits has been additively plating ground planes or traces onto the normally bare cover coat, to act as a radio-frequency shield for the circuitry underneath. Ground is carried up through an additively plated hole extending through all the flexible circuit board's layers.

Yet another method of creating conductors on a flexible substrate is screening a low-temperature-curable



7. Hardboard center. Multiple identical flexible circuits can be mounted on a hardboard carrier. The assembly is then loaded with components and wave-soldered. After this step, the individual units are punched out of the carrier and folded into modules.

conductive ink onto a Mylar film. This low-cost technique is now being used by Chomerics Inc., Woburn, Mass., on Touch-Tone telephone keyboards, calculator keyboards [*Electronics*, July 7, 1977 p. 42], and other applications that combine keyboards, circuit boards, and interconnects, and it is ideal for single-sided flexible circuitry in consumer products.

It is also possible to screen resistors onto the film. However, the problem of soldering discrete components to the conductive ink has yet to be solved.

No matter what the etching or plating technique, flexible circuits can appear in three forms—single-sided, two-sided with plated-through holes, and multilayer.

Bendable boards

Single-sided flexible printed circuits are generally used for the simplest low-cost jobs. The great majority of flexible circuitry made today is two-sided with plated-through holes connecting the patterns on each side. The holes are usually plated through by an additive (electroless) process after the main circuitry has been subtractively etched (Fig. 4b), although two-sided boards have been made with braised eyelets or pins in the holes.

One company, Teledyne Electro-Mechanisms, has come up with a novel process for electrically connecting layers of a two-sided flexible circuit. Starting point of the proprietary method is a completed two-sided flexible circuit with no connections between the sides. Assume a conductor on one side is to be connected to a circular pad directly underneath it on the other side. A cavity is created under the top conductor and over the bottom pad by removing the insulating film in between (Figs. 5a and 5b). During wave soldering, the cavity is filled with solder connecting the upper conductor to the lower pad (Fig. 5c).

Soldering through costs less than electroless plating of holes. Two other pluses for the process are that the connections are 100% visually inspectable and reparable with standard equipment.

Flexible multilayer circuits

The most complex flexible circuits made today are multilayer types. The process for making them is similar to that used for making rigid multilayer boards, in which a sandwich of layers is laminated together in a large press under heat and pressure. Flexible boards have been made with as many as 23 layers, but the use of too many layers results in a loss of flexibility. Most manufacturers agree that the limit for a truly flexible multilayer circuit is five to six conductive layers. Flexible multilayer boards are confined mostly to military work but are now finding their way into computers also, because of increasing interconnection and component densities in the new machines.

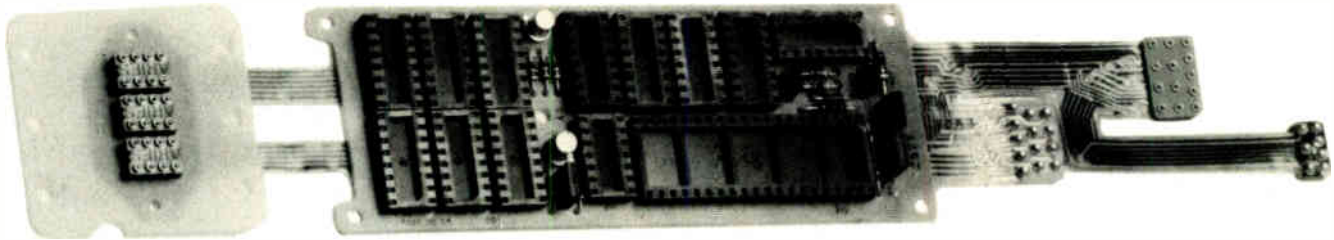
These multilayer circuits are not simply flexible copies of rigid multilayer boards. Each layer can be extended separately to serve as a wiring harness to connect elsewhere in the system, and the extensions can go off in many planes. This allows points in the overall system to be connected to specific points in a particular layer.

Flexible circuits can be laminated between the layers of several rigid multilayer boards, forming Parlex Corp.'s rigid-flexible multilayer board system in Fig. 6. This entails making plated holes extending through both the rigid and the flexible boards. The flexible printed circuit serves as a preformed, prewired harness for connecting individual rigid boards and the rest of the system. In addition, the flexible circuit adds two conductive layers to each rigid multilayer board.

Hardboard carrier

This combination in turn has lead to a cost-saving variation that is especially popular in the production of small instrument modules. A two-sided flexible pc board composed of multiples of a particular electronic circuit is laminated to a large hardboard base of the type shown in Fig. 7. The rigid board has predrilled holes to accept the components of each flexible circuit and punched-out areas corresponding to the spaces between the circuits on the flexible pc boards.

At the customer's plant, parts are automatically inserted into the assembly and then wave-soldered. If any repairs are needed, they are made on the assembly.



8. Socketed. This is a flexible-printed-circuit–hardboard combination used in an airborne fuel gage. To make changing ICs easier, sockets are mounted on the hardboard and soldered to the flexible circuit. The flexible board is both a circuit board and a multitermination harness.

Then the borders of the hardboard are sheared away and the circuits are folded up as at the bottom of Fig. 7 or in any other configuration desired.

In general, components are soldered to flexible circuitry. Soldering can be done with hand tools or by wave, dip, or infrared reflow soldering. In film carrier applications, IC chips have been temperature-compression bonded to copper conductors; however, the conductors require special gold plating.

In general, before soldering it is important to know the temperature limitations of the flexible insulating film and adhesive used. It is also important to keep in mind that a component can be replaced many fewer times on a flexible circuit than on a rigid pc board. For instance, at Gull Airborne Instruments Inc., Smithtown, N. Y., a manufacturer of avionic instruments, a component may only be replaced twice on a flexible circuit as compared with a dozen times on a hardboard. Excessive soldering on a flexible circuit can cause layers to come apart or even cause copper conductors to peel off.

Pluggable circuit

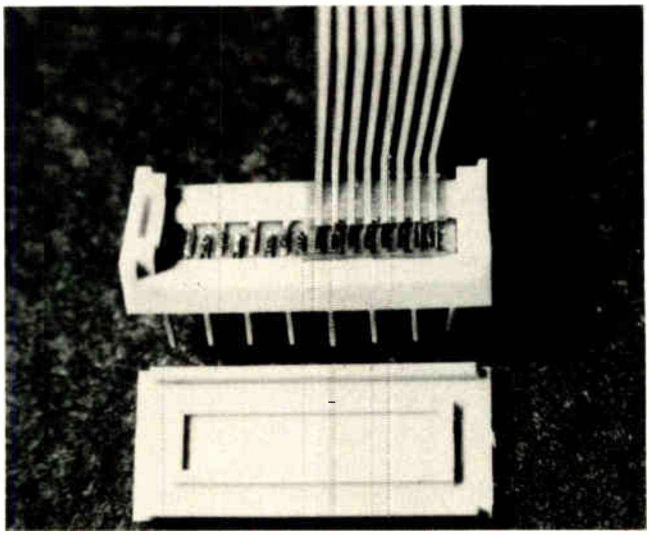
Gull gets around the problem of component replacement simply. The instrument assembly in Fig. 8 is a combination of flexible circuitry and hardboard stiffeners. Sockets for heat-sensitive ICs and light-emitting-diode displays mounted on the hardboard allow the devices' removal without resort to desoldering.

As was noted before, a user now has many ways to connect his flexible circuitry to the rest of his system. There are numerous types of connectors, including rectangular, cylindrical, edge, crimp-on, insulation-piercing, and pressure-contact, designed specifically for flexible circuits. Also, many manufacturers wave-solder, weld, or braise pins onto the circuitry to eliminate a male connector. In some applications, the ends of the circuits are tinned and soldered directly to the next interface points, such as a rigid or another flexible pc board.

A DIP connector

A novel approach used at Teledyne Electro-Mechanisms is built around a lead frame that has its outer leads on 0.1-inch centers. Tinned termination leads from a flexible circuit are soldered to the inner leads of the lead frame. Then the outer leads are bent down and placed in a plastic dual in-line package's cavity. The resulting connector, shown in Fig. 9, can be plugged into a rigid printed circuit, a backplane, or a flexible circuit.

Flexible printed circuits found early applications in guided-missile electronics. As more and more circuits were crammed into smaller spaces, the density and number of electronic interconnections grew rapidly. General Dynamic Corp.'s Pomona division, Pomona, Calif., which has worked on missile programs for the Navy since 1964, quickly turned to flexible circuitry.

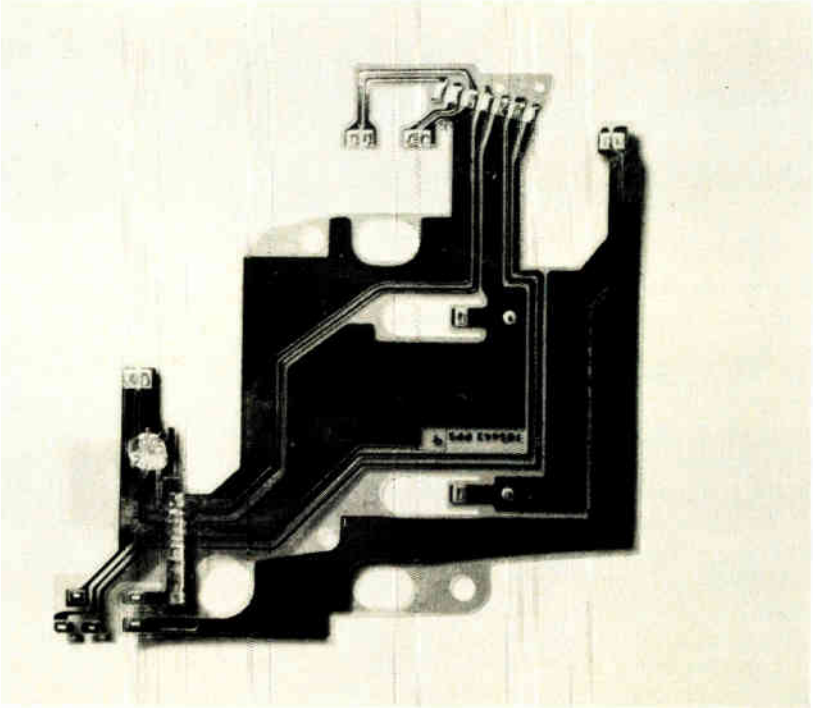


9. DIP connector. In this unit, a flexible circuit's tinned ends are soldered to the inner leads of a leadframe having outer leads on 0.1-in. centers. Placing the assembly in a plastic dual in-line body results in a connector that plugs into other rigid or flexible boards.

"Our driving force was, first, circuit density and then reliability," recalls Marvin Abrams, chief of advanced technology at GD Pomona. To meet a density requirement that grew from 775 conductors per square inch in 1964 to about 10,500 by 1972, the GD division started out in 1965 with designs that provided 825 conductors per square inch with 50-mil lines and spaces. These were two-sided flexible printed circuits on a Kapton film. Overall size of the flexible boards varied from 5 to 100 mils thick, 4 to 8 in. wide, and 6 to 24 in. long.

Today, GD Pomona, where all circuit fabrication is in-house, is making a six-conductive-layer flexible pc board up to 34 in. long, with lines and spaces of 25 to 10 mils. Used in the preproduction Standard Missile 2, it permitted reduction of a subsystem on the Standard Missile 2 to one quarter of the size of a comparable subsystem on the Standard Missile 1.

The advantages of flexible circuits were also quickly recognized in avionics—another area where space is a major concern. At Grumman Aerospace Corp., Bethpage, N. Y., they are now a way of life: a recent directive specifies that new equipment must be designed with



10. **Camera circuit.** An 8-mil-thick flexible circuit, produced by Sheldahl for the Polaroid SX-70 camera, distributes power to electronics, switches, film roller motors, and the shutter solenoid. The part flexes whenever the camera is opened or closed.

flexible circuits if at all possible, and as further evidence of their importance, the company is preparing its own design manual on the subject.

Michael LaTorre, group head of design engineering at Grumman Aerospace, states, "It is obvious to us that this is a superior method of interconnect." As an example, he cites a case in which a system's assembly time was reduced from 45 hours in the hard-wired version to 2 hours with flexible circuits.

Saving space

Telephonics, a division of Instrument Systems Corp., in Huntington, N. Y., has been using flexible circuitry since 1964 on avionic hardware. Telephonics' mechanical designers got their first exposure to these circuits while packaging the multiplexed entertainment system for the Boeing 747 jumbo jet. As a weight-saving measure, flexible pc boards were used instead of discrete harnesses and card-edge connectors to connect system modules. Single-sided Kapton printed circuit were the main substitutes.

As Telephonics' engineers grew more experienced with flexible circuitry, they went to more sophisticated designs, like the electronic packaging for the headset of the Lockheed 1011's cabin galley intercom. Originally, all the electronic circuitry was packed on two rigid pc boards within the set's small volume.

In 1971, new requirements called for many more electronic components and more wiring to be added to the already cramped unit. It was soon evident that more hardboards could not be added to the headset. Therefore, the designers decided to combine all the old and new electronic components and the harness wiring into a two-sided Kapton flexible circuit. The updated version is an example of an electronic package possible only with flexible circuitry.

Now, the firm's engineers are applying the combined hardboard-carrier—flexible method described earlier to assemble a small modular power controller in which the cut-out boards are folded up and placed in a small cubical package.

Another Long Island avionics firm, Gull Airborne Instruments, uses its flexible-hardboard combination in Fig. 8 to act as both a circuit board and an interconnect for digital fuel metering. The combination has resulted in an overall savings in assembly costs of up to 30% over a straight hardboard package.

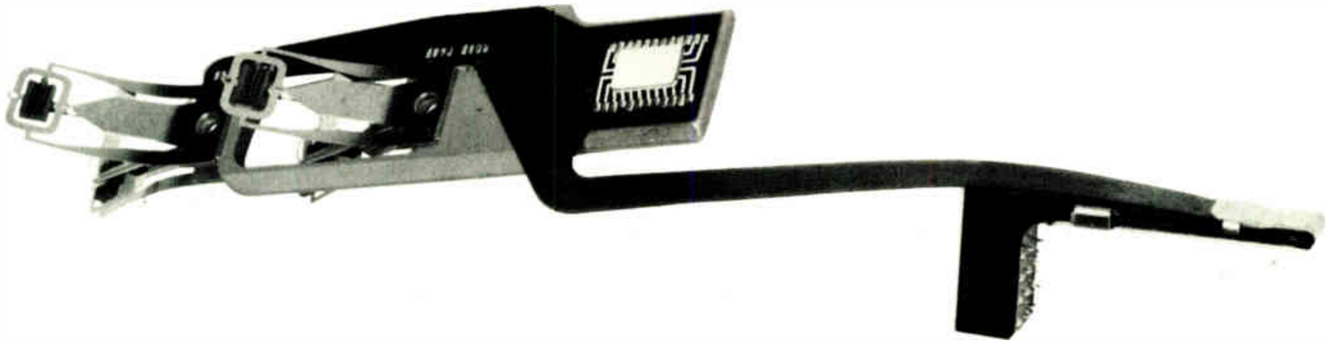
Dick Holtz, manager of manufacturing engineering at Gull, has found it cost-effective to apply flexible circuitry to systems that have a production run as small as 25 units and to harnesses with as few as 10 wires. The company converted many units to flexible circuitry two years ago, and the field failure rate has turned out to be less than ¼%.

Consumer products

The largest area of growth for flexible circuitry in the next few years will be consumer electronics. Already, this interconnect method has found its way into cameras, calculators, watches, citizens' band radios, pocket pagers, video games, and microwave ovens. Within the next few years, it will be found in almost every consumer product that contains electronics.

Polaroid Corp. and Eastman Kodak Co., the two leading U. S. camera makers, both have been using flexible circuitry for some time. Polaroid in particular has applied it to various cameras for two basically different reasons, depending on the camera type.

The Cambridge, Mass., firm's SX-70 is designed to fold up into an extremely compact package. To accomplish this, Polaroid's designers selected a foldable pc board of Kapton to house the electronics in the back of the camera and behind the shutter. The board, which folds and unfolds as the camera opens and closes, is a



11. U-shaped. This circuit interconnects a magnetic head in a disk memory. During normal head motions, the circuit is folded in a U configuration and flexed in excess of 400 million times. Special treatments and processes are used to make this extremely flexible circuit.

single-sided type that is 8 mils thick (Fig. 10).

On Polaroid's Pronto and One-Step instant cameras, which do not fold, flexible circuitry was chosen for its ability to make multiplanar connections. It was used to accomodate camera wiring that turned at right angles and that had to be connected to many different points at different levels.

Multiple flexures

John Burgarella, director of engineering for product electronics at Polaroid, says that flexible circuitry has proved to be about 25% less expensive than the wiring in early SX-70 designs. He adds that it has also proved extremely trouble-free. The only hitches showed up early in the prototype stage when circuits were sometimes bent too sharply and tore. Modifying the bending radius solved this problem.

In most applications of flexible circuits, the board is bent, shaped or folded only initially. However, in the computer peripheral and rotating memory field, flexible circuitry completely lives up to its name. For instance, a circuit designed by Rogers Corp., Chandler, Ariz., connects signal-processing circuitry to a magnetic head for a disk memory (Fig. 11). Over the course of normal head operation, the circuit may be flexed more than 400 million times. Rogers uses rolled, annealed copper, rather than electro-deposited copper, which work-hardens as it is flexed, resulting in broken conductors; in addition, the company employs special treatments and processes to make the circuit truly flexible.

Flexible heater

Copper is not the only metallic material that can be laminated to a flexible base. Sheet nichrome can be also. Using this principle, Parlex Corp., Methuen, Mass., among others, is making flexible heaters by selectively etching on a nichrome-covered Kapton base. Like its circuit-bearing counterpart, the flexible heater can be folded and made in unusual shapes and patterns. In addition, the heat at various portions of the circuit can be controlled by varying the conductor pattern and thickness. To prevent heat from being applied in selected sectors, the nichrome can be plated over with copper. Circular flexible heaters are now being used to control the temperature of missile gyro packages.

Another area that thrives on the space savings and reliability of such circuitry is medical instruments. Flexible circuits have been part of pacemakers for some time—and acceptance of any technique or part in a pacemaker is a testimonial to its reliability.

Flexible Circuits manufactures a flexible pc board that is used in another highly reliable medical instrument—a cardiac event recorder. Fairly heavy hybrid modules are mounted unsupported on the 12-mil thick Kapton substrate, which is not usually done with most flexible boards, and the 38-in.-long circuit and a miniature tape recorder are stuffed into a 5-by-2½-by-3-in. package that is hung on a patient's belt; the recorder has a mean time between failures of three years. Only flexible circuitry can supply the tight packaging and reliability needed for this instrument.

The future

Flexible circuitry is certain to be one of the growth areas in the wiring field. Most of its manufacturers see a 25% growth rate for the next few years. A large part will occur as it spreads into more consumer products areas. In the automotive field, flexible applications will no longer be limited to the present componentless dashboard circuits; instead, new uses will be in the control circuits the industry is developing for ignition control, fully electronic fuel injection, and pollution control—as true flexible pc boards with components soldered on.

In the technology of flexible circuitry, several trends are starting to appear. One, brought on by pressures for even denser circuits and by the use of unhoused IC chips, is a general shift to 3-to-5-mil lines and spaces from the present 10-mil widths.

According to David Cianciulli, marketing manager for Hughes Aircraft Co.'s Connecting Devices division in Irvine, Calif., "There should be a large increase in the use and fabrication of flexible multilayer boards, since manufacturing methods are now fairly well established." Again, demands for increased packaging density can only be met by the density of the multilayer board and the multiplanar feature of the flexible circuit.

Another aspect of flexible circuitry that will increase is the use of combined rigid-flexible boards. The hard-board carrier scheme is becoming more and more popular, while applications that combine a rigid multilayer or two-sided pc board with a layer of flexible circuitry will also become more accepted. □

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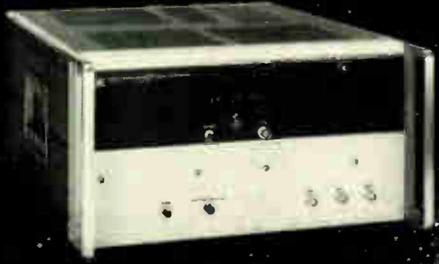

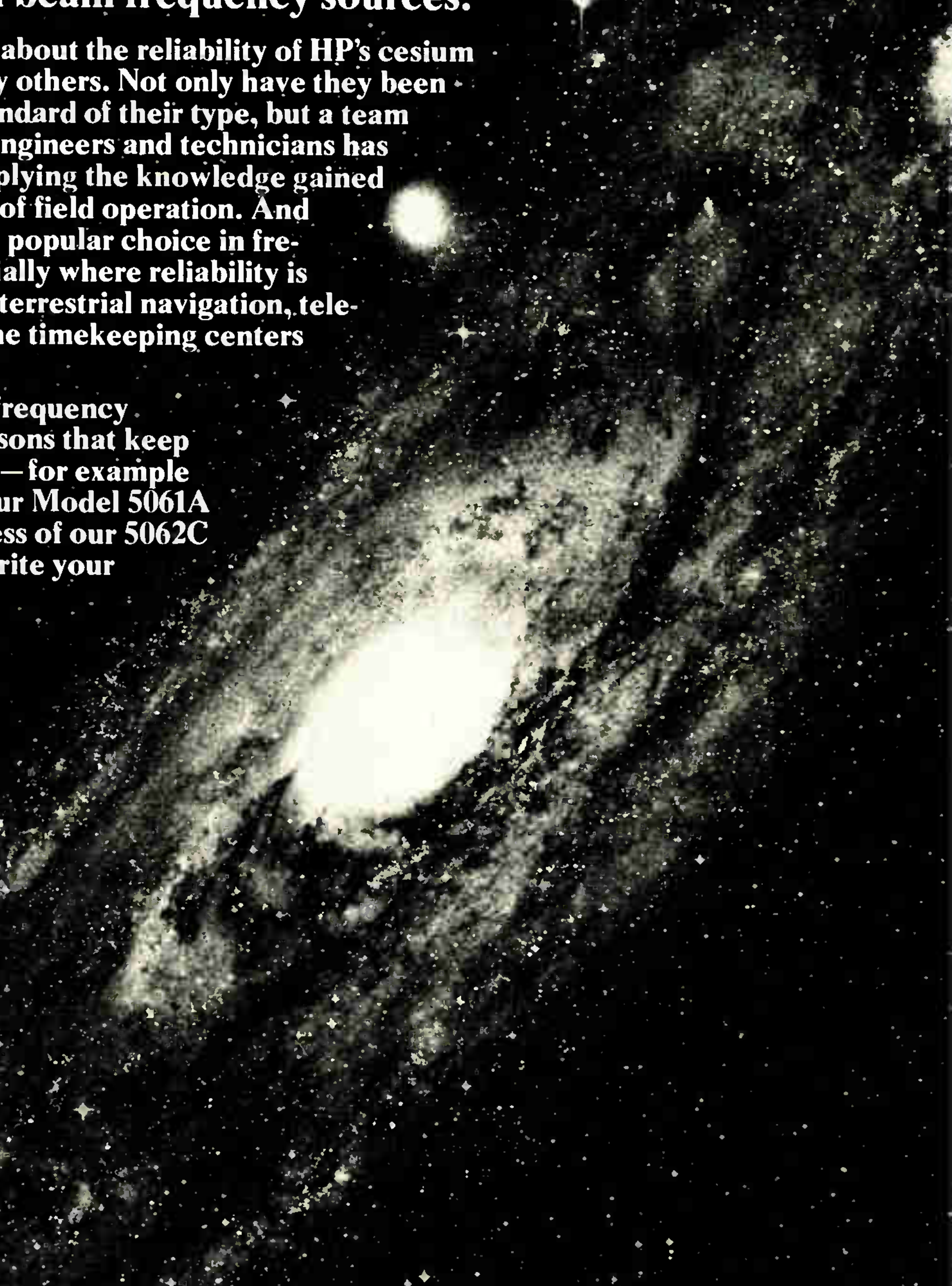

Photograph of Andromeda Galaxy, courtesy of Lick Observatory. Photograph has been reversed for composition.

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Circle 106 on reader service card

Designing with nitride-type EAROMs

Being nonvolatile and reprogrammable, electrically alterable read-only memories fill the needs of such systems as TV tuners, phone dialers, and point-of-sale terminals

by Brian Cayton, *General Instrument Corp., Microelectronics Division, Hicksville, N. Y.*

☐ Attracting the attention of digital-system designers is the electrically alterable read-only memory, or EAROM. First available in volume production about a year ago, the electrically alterable ROM is unique among semiconductor memories in combining nonvolatility with reprogrammability. Like the ordinary ROM, it needs no power to retain data; and like the random-access memory, it is electrically erasable and system-reprogrammable over and over again—in contrast to the 2708-type reprogrammable ROM, which requires ultraviolet light for erasure. In other words, the device operates like an erasable ROM or a nonvolatile RAM.

As such, it fits the needs of a good many electronic systems better than either a RAM or a ROM. For instance, it is perfect for storing channel voltages in inexpensive digital television varactor tuners. In telephone dialing systems, it is the most efficient way of storing and updating phone numbers. It can be designed into point-of-sale terminals for updating inventory and price information or into industrial control equipment for storing process routines or numerical-control data. It can even be built into security systems as part of an electronic lock storing a code the owner can change at will.

Moreover, while not intended for mainframe applications, which require RAMs with access times in the 150-to-300-nanosecond range or for main program storage, which requires ROMs in the 500-ns range, MNOS alterable ROMs are improving dramatically in speed. Access times in new devices are as fast as 750 ns, and erase and write times are in the 10- and 1-millisecond ranges respectively. This makes their performance a perfect fit in systems wherever human input over a keyboard or a dial controls the operation, as in phones, TV sets, or calculators, and where high speed is not critical, as in some microprocessor-based systems, such as point-of-sale terminals and surveillance gear.

The longest-established way of making semiconductor storage nonvolatile is to put a nitride layer beneath the memory's metal-oxide-semiconductor gate electrode. This method is used in the memories listed in the table below. (Electrically alterable ROMs using an alternative approach—a floating-gate structure—have recently become available and are compared to the MNOS types in "An alternative," p. 110.)

A lucky chance

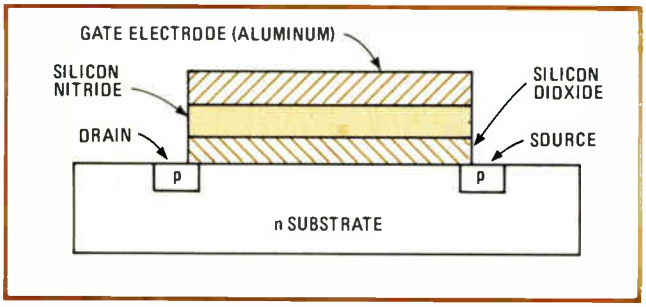
Like so many discoveries in electronics, nitride's value as a changeable yet permanent MOS storage mechanism was stumbled upon by accident. It all started with the standard p-channel MOS transistor, which with a negative bias applied to its gate repels negative charges from the substrate into the region forming the channel between the source and gate. At the same time, positive charges (holes) are attracted to the channel, changing it electrically from n- to p-type material and causing conduction between drain and source.

A simple MOS field-effect transistor of this type has an operating threshold voltage of 3 to 4 volts, too high to be driven by the 2-to-3-v signals of standard transistor-transistor logic. The most likely remedy appeared to be the substitution of silicon nitride for the silicon dioxide of the gate dielectric, because the nitride's higher dielectric constant and greater resistance to ion migration were expected to lower threshold voltage.

But to the surprise of the early experimenters, the silicon-nitride transistor exhibited an unstable threshold,

OPERATING TIME OF ELECTRICALLY ALTERABLE READ-ONLY MEMORIES

Part	Size (bits)	Organization	Alterability	Read access time (μs)	Write time (ms)	Erase time (ms)
ER1105	1,024	256 by 4	block	2	10	100
ER1400	1,400	100 by 14	word	–	10	10
ER2050	512	32 by 16	word	6	100	100
ER2401	4,096	1,024 by 4	chip	2	10	100
ER2800	8,192	2,048 by 4	chip	2.6	10	100
ER3401	4,096	1,024 by 4	word	0.95	1	10



1. The basic transistor. To decrease their operating threshold, MOSFETs use a silicon-dioxide – silicon-nitride sandwich as their gate oxide. Without the dioxide, the nitride would store charge — a characteristic exploited in nonvolatile MOS memory design.

one that varied up and down as the device was switched off and on. It turned out that charges were tunneling from the substrate into the nitride and being held there in "trap sites." So device specialists were quick to abandon this simple nitride structure for one containing a layer of silicon dioxide deposited between the silicon nitride and the silicon substrate (Fig. 1). In this structure, the so-called metal thick-oxide nitride semiconductor device, the oxide was thick enough to prevent charges from tunneling through into the nitride layer, yet thin enough to exploit the superior silicon-nitride characteristics. This MTNS transistor, which was stable and possessed a TTL-compatible threshold, became the basis for today's mainline MOS device technology.

However, in the late 1960s, researchers found that they could harness the hysteresis effect of the older silicon-nitride devices by reducing the thickness of the silicon dioxide from 500 angstroms to approximately 25 angstroms. Being so thin, the silicon dioxide allows charge to tunnel through it when a high enough voltage (25 – 30 v) is applied to the gate. This charge is then trapped in the silicon-dioxide – silicon-nitride interface, and since both the oxide and the nitride are high-quality insulators, it remains trapped for a very long time. (Data retention for General Instrument devices is guaranteed for 10 years.) This nitride structure is basic to today's MNOS memory devices.

A typical MNOS transistor is put (or written) into the low-condition state by the application of –25 to –30 v to the gate. This drives electrons from the interface region through silicon dioxide into the silicon substrate and leaves the interface region with a net positive charge (Fig. 2a). The charge has the same effect as a positive gate bias, opposing the field produced by normal logic-level, negative signals applied to the gate. The result is a very high threshold, typically –12 v, and this condition serves as the off state of the transistor.

How it works

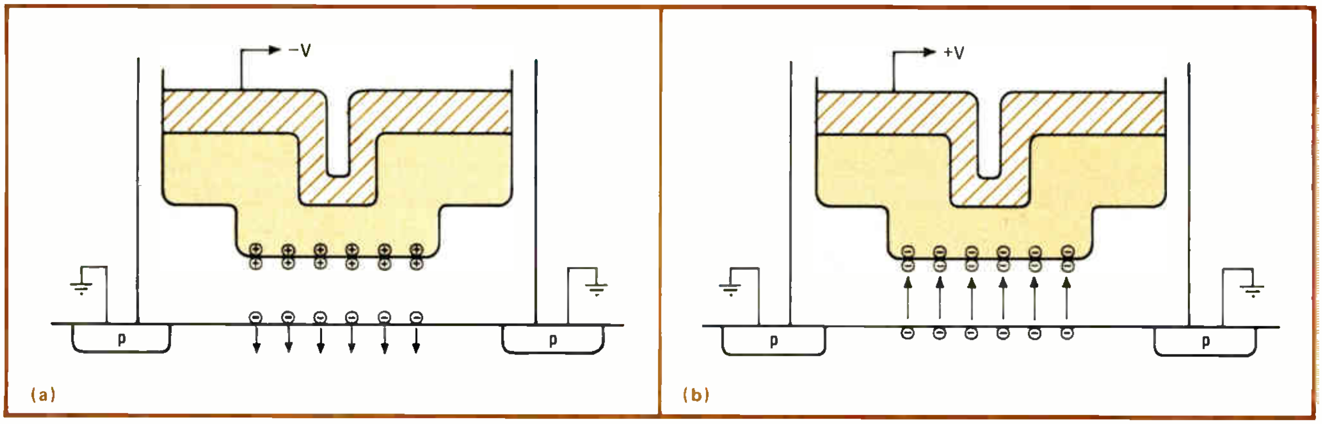
To put the cell into a low-threshold (high-conduction) or on state, a positive voltage is applied to the gate (Fig. 2b). This positive voltage attracts electrons into the interface, producing a negative charge that aids negative logic signals applied to the gate.

The memory transistor illustrated is, unfortunately, not quite practical: in the erased state, the threshold may be so far below the transistor's bias voltage that the device is always on. Additionally, the gate-enhanced source-to-drain junction breakdown is so low as to cause unreliable operation.

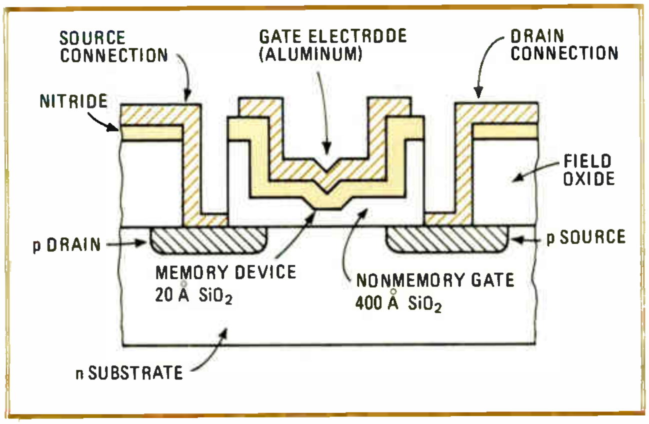
Both of these problems are solved by the three-gate structure shown in Fig. 3. In this structure, the high-threshold state is still approximately –12 v. But because the oxide in the noncritical gate region is now at least 10 times thicker than in the thin storage area — 400 as against 25 angstroms — the low threshold is pegged by this nonmemory region to approximately –2 v.

Moreover, in this three-gate structure, it is possible to tailor the process parameters to fit the best possible tradeoff between data retention and erase/write or switching time. As the thickness of the silicon dioxide is decreased, the shortened charge-injection path decreases switching time. The thinner oxide, however, also allows easier charge leakage and so decreases data retention. On the other hand, increasing the nitride trap density allows faster writing and erasing, but creates dispersion paths through the nitride, shortening data retention. The decision at General Instrument was to adjust these parameters to obtain a minimum data retention of 10 years and then optimize write/erase time. The ER3401, for instance, has a guaranteed write time of 1 ms and an erase time of 10 ms.

The simplest of the circuits that can write and read



2. Writing and erasing. To write into an MNOS memory, a negative voltage is applied to the gate (a), repelling electrons from the nitride trap sites in the silicon-oxide – silicon-nitride interface and setting up a net positive charge. Conversely, erasure of data from the MNOS memory uses a positive voltage (b), which attracts electrons and results in a negative charge at the storage interface.



3. What the three gates do. This three-gate structure allows the MNOS memory designer the optimum tradeoff between storage-gate thinness and nonstorage-gate thickness. Here a 20-angstrom-thick silicon-dioxide layer in the center of the channel allows charge to tunnel from the memory's substrate to the oxide-nitride interface when a high enough voltage is applied to the gate.

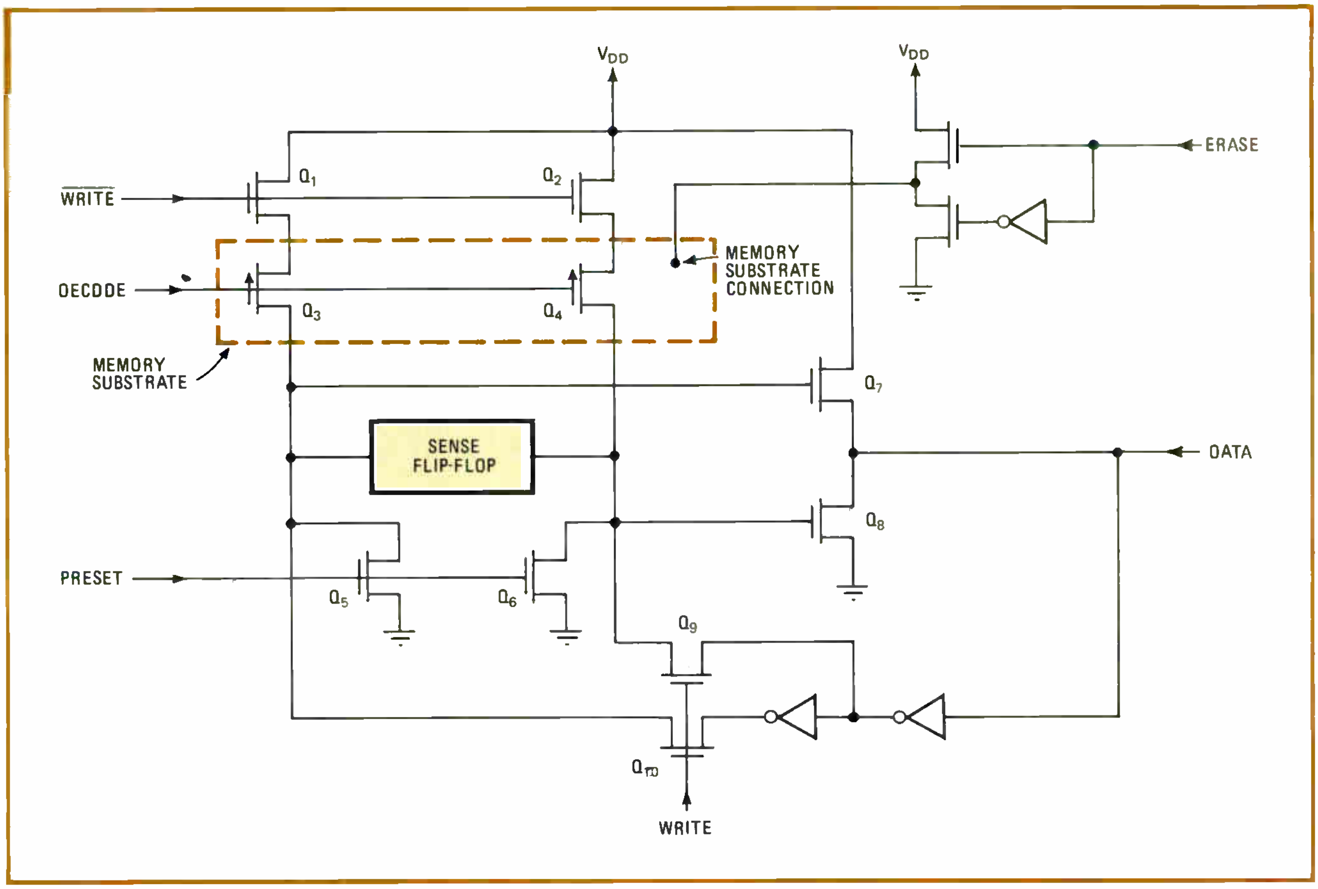
and erase data is the two-transistor structure shown in Fig. 4. (This cell is used in the 512- and 1,024-bit alterable ROMS listed in the table on p. 107.) The flip-flop detects whether an addressed memory location is in the low- or high-threshold state over a range of input voltages. The same circuitry also writes a bit into or erases it from the memory cell.

The cell's operation is unusually simple. Each contains two transistors. Before writing, both transistors are erased by being put into the low-threshold state.

To write, the gates are then biased with a negative signal, and the flip-flop is switched into the desired state. One memory transistor will then have a high gate-voltage threshold, indicating a bit has been written into it; the other, which still is kept at source potential, continues to have a low threshold. Reading is then simply a matter of using the sense flip-flop to detect the high-threshold transistor. In the erase mode, the drains of memory transistors are placed at a negative potential, as is the memory substrate. The decoder circuitry then positively biases the gates of the memory transistors at the selected address, erasing their contents.

Figure 5a is a simplified schematic of the device in the write mode. Q_1 and Q_2 are biased off, leaving the drains of memory transistors Q_3 and Q_4 floating. In this state the memory gates are biased negatively. Pass transistors Q_9 and Q_{10} are on, allowing the data signal and the inverted data signal to pass through to transistors Q_3 and Q_4, respectively. Now, if the data is a logic high (positive), Q_3 will see a negative gate-source potential and will be written. Q_4, which has its gate source at the same potential, will remain in the erased state.

In the read mode (Fig. 5b), Q_1 and Q_2 are on, providing supply voltage to the memory transistor drains. As the first part of the read sequence, an internal clock sends a preset signal to transistors Q_5 and Q_6, momentarily shorting the outputs of the sense flip-flop,



4. Two transistors. The flip-flop of this two-transistor cell detects whether an addressed memory location is in the low-threshold or in the high-threshold state over a range of voltages. The same circuitry also writes bits into the memory cell and erases them.

An alternative

Besides nitride storage, another means of building electrically alterable read-only memories is the floating-gate metal-oxide-semiconductor or Famos technique.

In the Famos process, the need for a thin oxide in the critical gate portion of the device is overcome by the use of two gate layers. One layer is buried in an insulating oxide and kept floating with reference to the substrate's voltage potential, while the other is deposited on top of the oxide and connected to the control circuitry. Data is then stored by charges trapped on the floating gate.

However, no hard connection is made to this floating gate. Also, to isolate it properly from the control gate, the oxide used to separate the two must be at least 1,000 angstroms thick—which is too thick to allow charges to tunnel in and out as in the metal-nitride-oxide-semiconductor structure. Thus writing and erasing are more difficult than with the MNOS device. With Famos cells, the trick is to apply a high enough voltage long enough to break the junction down without destroying it—a definite hazard to reliability, especially as −36 volts and 50 milliamperes are needed to do the job.

This is not the only drawback of the Famos structure. No means of word erasure exists, so the entire device must be erased, and this burns power. For example, erasing a 2,048-bit Famos device requires a supply of 76 V and peak current of 300 mA, or a power rating of over 20 watts. The erase times (60 seconds) are also much longer than for MNOS devices. As for writing, the Famos μPD454, as shown in the accompanying table, needs a supply of 28 V for 100 ms, a lot of power.

COMPARISON OF MNOS AND FAMOS ELECTRICALLY ALTERABLE ROMs

Type	Bits	Write		Read		Erase		Comments
		Voltage (V)	Time	Voltage (V)	Time	Voltage (V)	Time	
μPD454	2,048	−2, +26	100 ms	+5, +12	800 ns	+36, −40	60 s	voltage to pins must be switched
ER3401	4,096	+5, −12, −30*	1 ms	+5, −12, −30*	950 ns	+5, −12, −30*	10 ms	word erase or block erase

*no supply switching necessary

thus sensitizing the flip-flop. Then a reference-level signal is provided to the memory transistors. As the erased or low-threshold transistors will have a lower impedance than the off or written transistor, one side of the flip-flop will see a higher potential; this sets the flip-flop, so that it is ready to drive the output transistors Q_7 and Q_8, which form a totem-pole output driver pair.

Although this circuit is fine for memory devices not requiring high density (1,024 bits and less), its use of two transistors per memory cell is a drawback. For higher-density, 4,096- and 8,192-bit electrically alterable ROMS, a one-transistor cell is better (Fig. 6). In this configuration, as with the two-transistor cell, erasing is necessary to precondition the cell before writing. This is done by biasing the gate with a potential that is positive with respect to the substrate. The memory cell is then in the low-threshold (logic 0) state. To produce a high-threshold (logic 1) transistor, the gate is pulsed with a negative voltage.

For reading these states, the gate of the memory cell is provided with a reference bias voltage. A threshold lower than the reference holds the cell off; a higher threshold turns the transistor on. A constant current-source is used to overcome any leakage that might occur from the charged cell to the substrate.

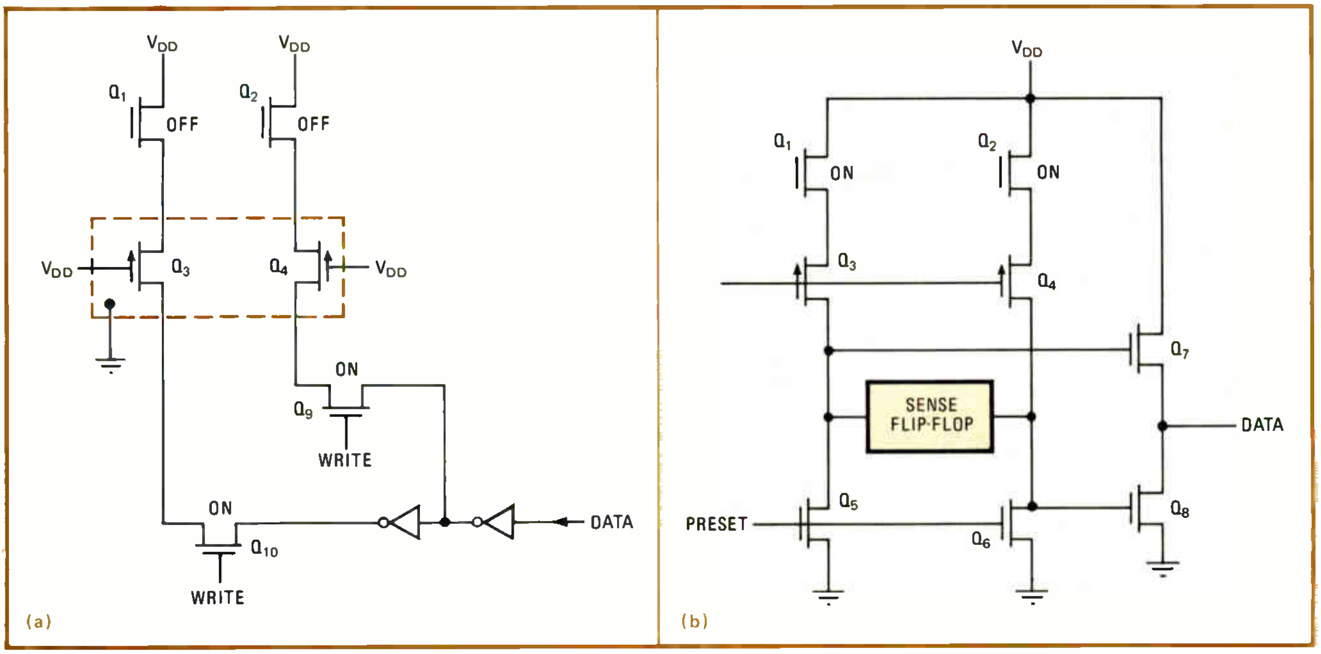
Although not apparent from the circuits shown in Figs. 4 and 5, the ability to put a complete memory on a single MNOS chip required innovative processing as well as clever circuit design. Early alterable ROMS were complicated to use because positive gate voltages were required to erase each cell. Since there was no way of internally switching the high positive voltage required at the memory transistor gates, these gates had to be brought directly out to pins. It then was up to the user to decode the gates with externally generated signals.

Processing helps, too

Epitaxial wafer processing, a technique developed for bipolar transistors, provided a means of on-chip decoding. By separating the MOS gate from the substrate with an epitaxial layer, a boron diffusion can successfully isolate the gate-memory portion of the circuit from the logic and decoding.

Secondly, because the memory substrate is now isolated from the logic circuitry, the memory cell's input voltage can be made independent of the voltage required for the logic circuitry. If the memory transistor gate is held at ground and the epitaxial layer is biased in the negative direction, a positive gate-substrate potential results that erases the device. The epitaxial layer can alternatively be held at ground, while the gate is negatively biased to allow writing. This makes it possible to design parts that are not only chip-alterable, in which an erase command erases the entire chip, but also word-alterable, in which the user can address and erase one word at a time without disturbing the contents of other memory locations.

Thirdly, once the voltage-switching circuitry has been placed outside the memory substrate on the fixed-potential substrate, all control signals can be made TTL-compatible, while on-chip circuitry can buffer and amplify them to switch supply voltages internally. This



5. Writing and reading. In the write mode of an MNOS memory cell (a), Q_1 and Q_2 are biased off, and the drains of memory transistors Q_3 and Q_4 are left floating. With pass transistors Q_9 and Q_{10} on, the data signal and inverted data signal pass through to Q_3 and write a bit onto the storage transistor. In the read mode (b), the flip-flop transistor pair sends a signal to the output totem pole driver Q_7 and Q_8.

makes the alterable ROM as easy to use as a RAM.

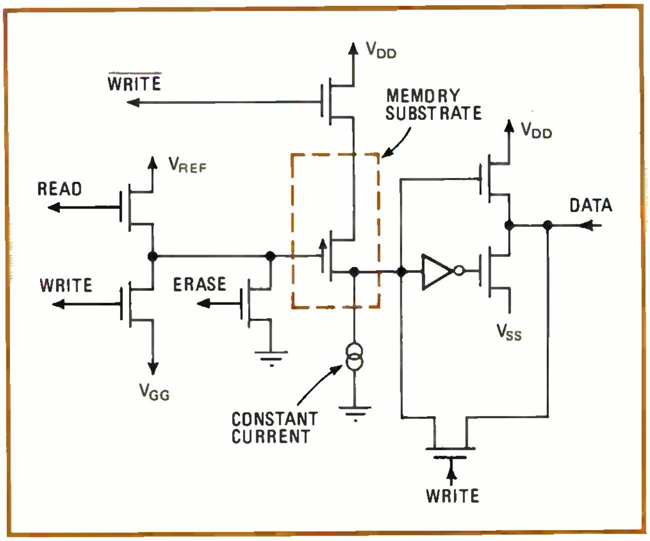
The use of epitaxy grants yet a fourth benefit, for it permits zener diodes to be fabricated with better characteristics than normal MOS processing can give. Accurate-value low-impedance zener diodes provide excellent static protection, besides serving as on-chip regulated voltage supplies.

Testing an alterable ROM

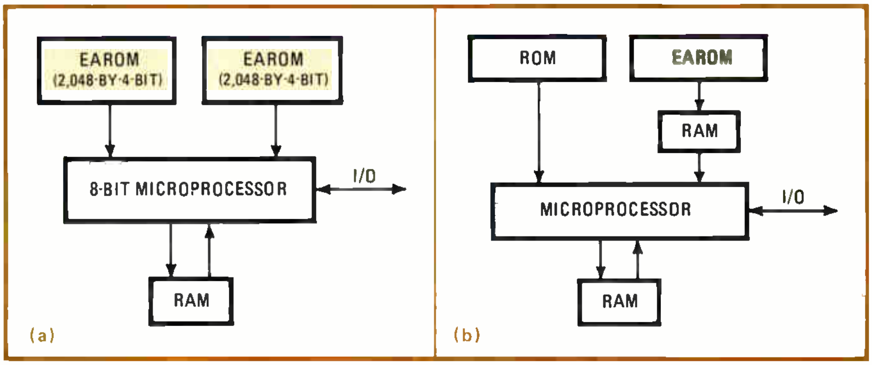
With alterable ROMs, the testing of factory parts is relatively straightforward, consisting of writing and then reversing in checkerboard fashion all 1 and then all 0 test patterns. As is the case with ordinary ROMs, the more sophisticated test patterns used in dynamic RAM are not required, since the relatively static nature of the data storage makes soft failures and pattern sensitivities unlikely.

Tests for data retentivity require plotting the decrease in threshold voltage with time. Fortunately this degradation follows a predictable relationship, requiring just a few points.

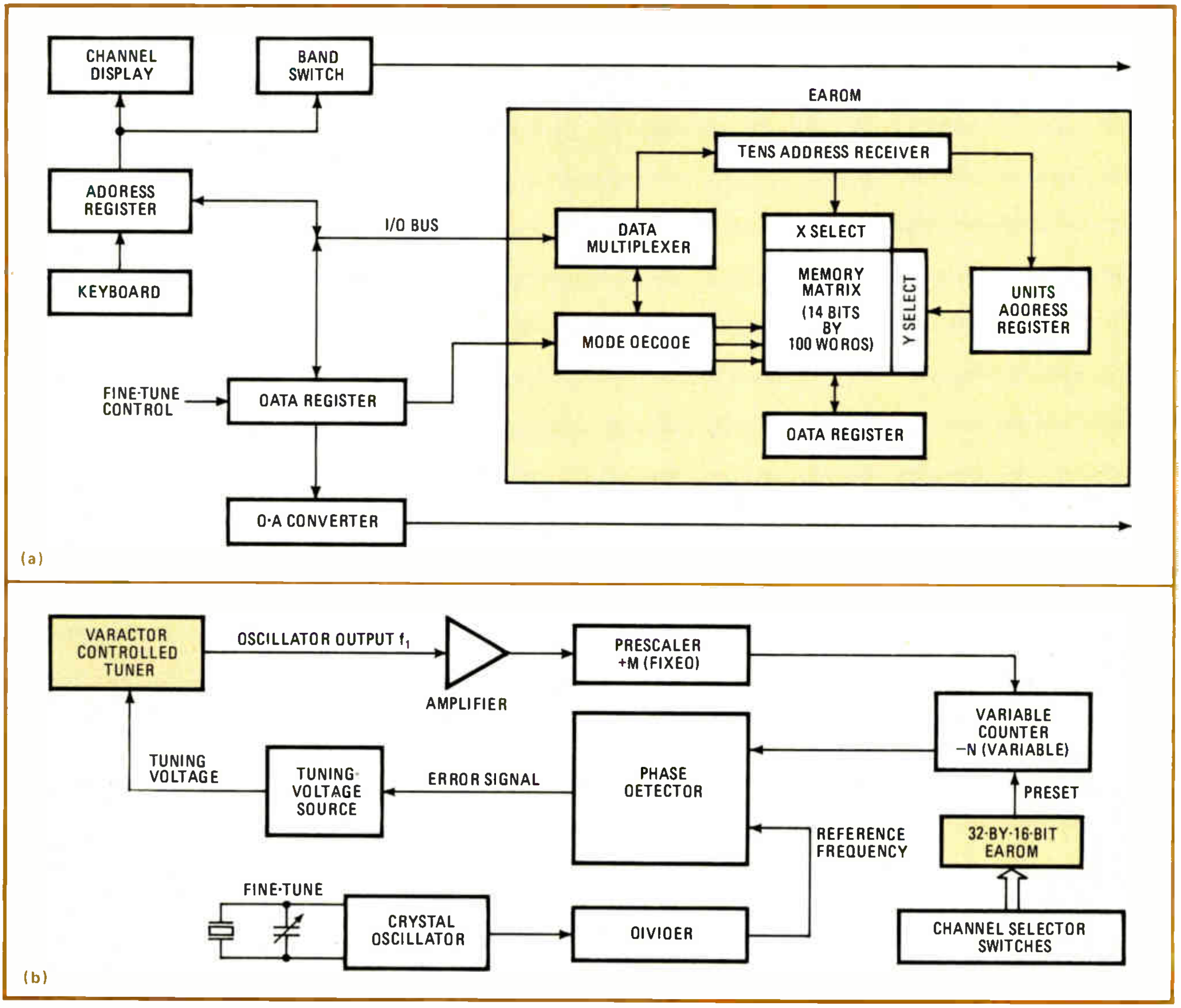
As for testing for threshold voltage, since it could vary with individual part types, each type is tested for its



6. A more compact design. Intended for use in high-density electrically alterable ROMs, this one-transistor cell is erased by having its gate biased positively and read when the threshold is compared to a reference standard. A constant current source overcomes any leakage from the charged cell to the substrate.



7. Up to date. In microcomputer-based systems such as point-of-sale terminals, the electrically alterable ROM can be used as a nonvolatile data store for updating inventory and price information. If the access time is a key factor in the application, a low-cost RAM may be used to receive the alterable ROM's contents on system power-up.



8. Tuning a television set. In varactor tuning (a), the electrically alterable ROM stores digital information that goes to a digital-to-analog converter to provide the proper bias to the varactor. In phase-locked-loop systems (b), the alterable ROM stores the proper division information for the various desired channels by controlling the count ratio of the variable counts.

internally generated voltage reference, and the threshold voltage is maintained at sufficiently reliable levels above this reference. This is done by varying the bias voltage until the point is reached at which the output of the memory cell is switched. This adjustment can be done either as wafer mapping, wafer probe, or final die testing. In addition, all devices are "margin tested," a process that consists of measuring the reference voltage, V_{ref}, and then increasing or decreasing it by an amount determined to be equivalent to the change in threshold over 10 years.

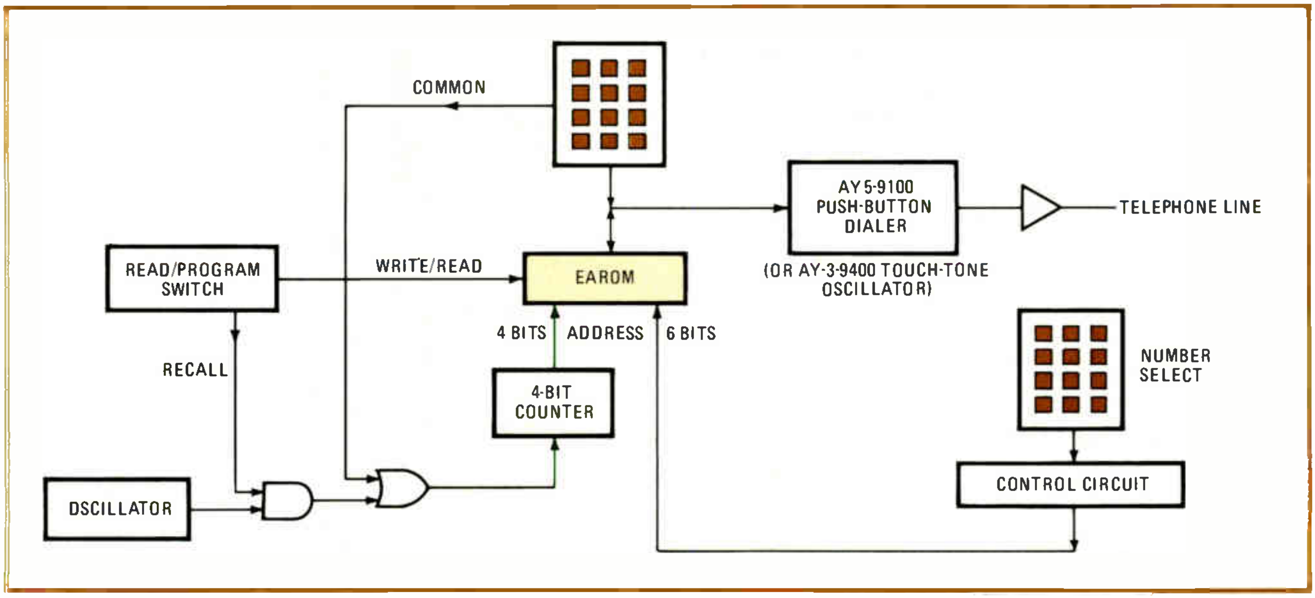
Applying the alterable ROM

Though the electrically alterable ROM is too new to have accumulated a reservoir of general application information, several basic configurations have already emerged to guide a system designer. Figure 7 shows two microprocessor-based systems that use the device.

In systems in which the microprocessor controls cash registers or other peripheral equipment that uses manual input, the electrically alterable ROM provides local nonvolatile data storage that can be frequently updated. This is the configuration of Fig. 7a, where the program information handled by the two 2,048-by-4-bit ER2800 alterable ROMs is extensive enough to cope with the inventory of many supermarkets and department stores. The 2-microsecond read times of these devices satisfy the needs of even the fastest cash-register operator.

Other systems, while still requiring some nonvolatile reprogrammable memory, may need part of their data to be immediately accessible to a computer. A credit-card–cash-register point-of-sale terminal is an example. Any data needing fast access would then be programmed into an ordinary ROM while the inventory data would be coded into the alterable ROM. Since the two kinds of ROM are generally compatible in voltage, power, and pinout configurations, the same printed-circuit board can hold both, with standard interface circuits used in reprogramming the alterable ROM.

Another configuration (Fig. 7b) combines an alterable



9. Dialing. An electrically alterable ROM in a repertory dialing system stores telephone numbers, which are then automatically supplied to the dialing mechanism when requested by the user. This 4,096-bit memory provides enough data to handle 64 16-digit numbers.

ROM with a RAM to handle real-time situations where the system must meet the requirements of many different stores yet also react quickly to an individual store's needs. On these occasions, where faster access times are required than the alterable ROM can provide, the device can automatically dump its contents into an inexpensive RAM on system power-up. The RAM then provides the program information, leaving the alterable ROM free to be updated at leisure. Moreover, although not intended as a scratchpad memory, the alterable ROM can also be used with the RAM to provide data storage off line—a configuration that could be useful for obtaining running totals, say.

Large quantities of alterable ROMs are also being used in digital TV tuners, which exploit both the nonvolatility and the reprogrammability of the devices. In the Omega system developed by General Instrument (Fig. 8a), the alterable ROM stores tuning information needed by the varactor but formerly provided by much more expensive potentiometer banks.

It works like this. The digital tuning information is passed through a digital-to-analog converter to supply the varactor with the proper tuning voltages. But since varactors differ from device to device, these voltages need tweaking, and if this is done with potentiometers during assembly, it is a costly operation. An alterable ROM, however, can be preprogrammed with the digital information that goes to the converter, adjusting for the varactor variations and providing a cheap and very accurate method of obtaining the right voltages (See *Electronics*, April 1, 1976, p. 86, for a full description.)

An alterable ROM can also be used to store the viewer's own fine-tuning settings. Here, after selecting a channel, the viewer fine-tunes the set by incrementing or decrementing the data register with a simple chassis switch. When he or she releases the switch, the data is loaded back into the alterable ROM so that it always contains the most up-to-date information.

Tuning applications are not limited to simple open-loop tuners. A phase-locked-loop tuning configuration controlled by an alterable ROM is shown in Fig. 8b. In typical phase-locked tuners, channels are selected by varying the counter division ratio, which changes the phase-locked loop frequency. In this circuit, the alterable ROM stores the proper division information for the various desired channels, controlling the count ratio of the variable counts.

In operation, the crystal oscillator frequency is divided down to provide a stable reference. The variable counter, in conjunction with the prescaler, divides the local oscillator to a frequency close to the reference. The two signals are then fed to the phase detecter. Any error between the reference and the present frequency is used to adjust the varactor tuning voltage, reducing the error and locking in the desired station.

In locks and dialers

In an electronic door lock (Fig. 9), the alterable ROM stores the key code, which may be periodically changed by the user against unauthorized entry. To drive the latch that opens the lock, data from a keyboard is compared with the data from the ROM and at the same time fed to a counter. Any error in the data will inhibit the unlatch signal. But if the full string of numbers is entered into the counter without error, the counter overruns, the solenoid is powered, and the door latch opens.

Finally, there is the telephone repertory dialer of Fig. 10. This system uses a 4,096-bit alterable ROM to store 64 16-digit numbers. To select a number, the caller uses either a push-button pad or a thumbwheel switch to enter 6 address bits. In the program mode, the keyboard provides binary-coded-decimal digit data as well as a common signal for incrementing the address counter. As each button is pushed, the digit is fed to the memory, and on completion of the phone number, the counter is incremented. To recall a number, the oscillator pulses the 4-bit counter, scanning through each of the digits of the desired telephone number. □

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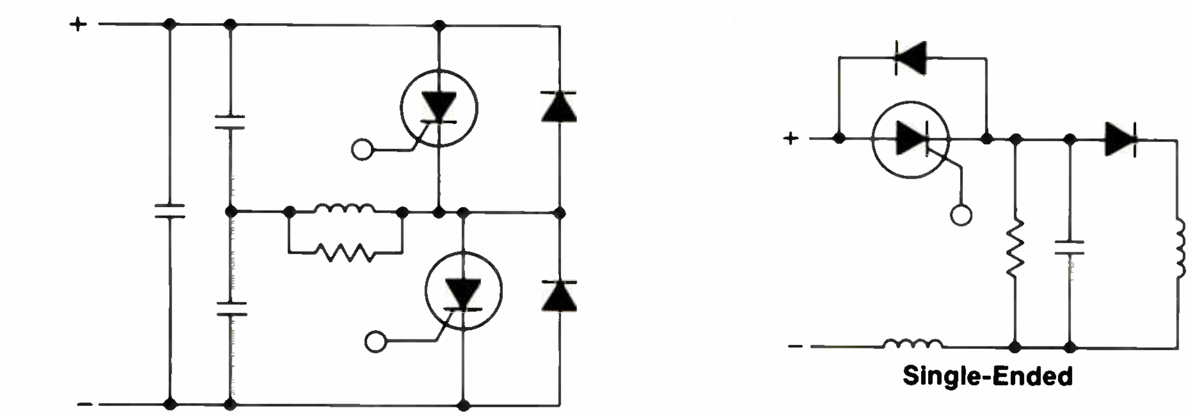

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S5800	100-600	15	25	Fast switching SCR	TO-220
C106	15-600	4.0	0.200	4-amp gen. purp. SCR	TO-202
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555 timer isolates equipment from excessive line voltage

by R. J. Patel
Tata Institute of Fundamental Research, Bombay, India

Instruments and appliances can be easily damaged when the line voltages that power them become excessively high or low, but a voltage-sensing circuit using the 555 timer will disconnect the equipment from the power lines if the set limits are exceeded. This circuit offers a better alternative for protecting instruments than a voltage stabilizer circuit, which is usually effective for detection and compensation of short-term variations only.

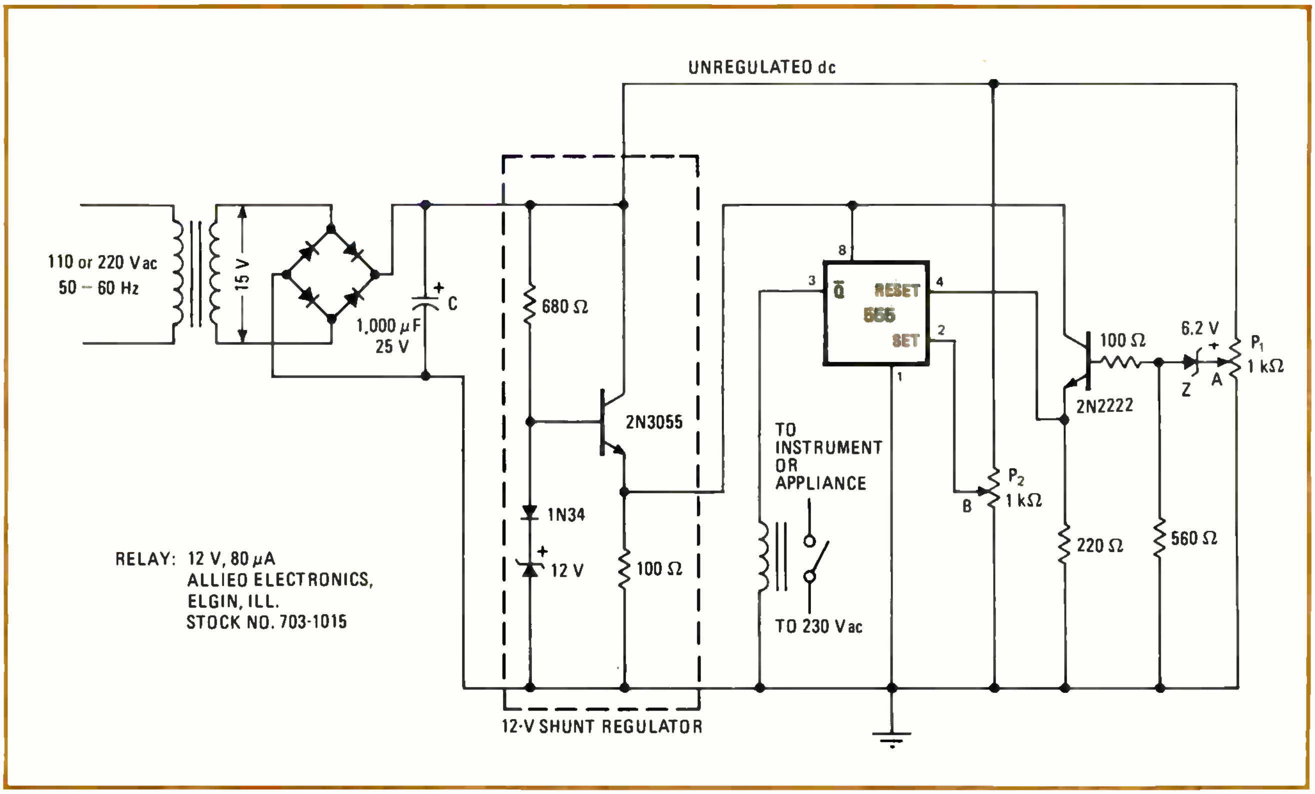
As shown in the figure, the line voltage is converted to approximately 15 volts by the step-down transformer, whose turns ratio is determined by the magnitude of the incoming voltage at the primary winding. This voltage is rectified, then filtered by capacitor C and applied to a 12-v regulator in order to bias the timer and the 2N2222 sense transistor. The magnitude of the unregulated voltage varies proportionally with the line voltage, as is to be expected, and this voltage is continually sampled by potentiometers P_1 and P_2, the upper and lower threshold controls.

The 555 timer is used in the bistable mode, and its state is a direct function of the voltages on its set and reset ports, pins 2 and 4, respectively.

Under normal conditions—that is, when the supply line voltage is within the set limits—the unregulated dc voltage at point A is sufficient to fire zener Z, saturating the transistor. Pin 4 of the timer rises rapidly to 12 v; when this voltage exceeds two thirds of the 12-v bias voltage on the timer, or 8 v, pin 3 moves high and the relay is energized.

If the ac line voltage is below the low set value, the voltage at A is below the value needed to fire the zener, and the relay is de-energized. When the line voltage shoots above the set upper limit and the dc voltage at pin 2 exceeds one third of the 12-v supply voltage, the relay is de-energized as pin 3 moves low.

The upper and lower set limits can be set with an accuracy of ±5 v of the true ac line voltage if precision potentiometers are used. There is no set-point hysteresis, because of the avalanche breakdown characteristics of the zener Z. Any transients generated by the power line are rendered harmless by the large filter capacitor C. □



Line-voltage monitor. 555 timer circuit senses if ac line voltage is above or below set limits, then de-energizes line relay if necessary, removing power from equipment. Simple circuit uses set-control potentiometers P_1 and P_2 to monitor unregulated dc voltage, whose value is directly proportional to the ac line voltage. Timer and 2N2222 transistor require the regulated power source.

Resettable electronic fuse consists of SCR and relay

by Russell Quong
Palos Verdes, Calif.

Most direct-current power supplies rely on a circuit breaker, current-sensing circuit, or fuse for current-overload protection, but this simple resettable-fuse circuit has advantages over all three. Built around a silicon controlled rectifier and a line relay, it is faster than a circuit breaker, less complex than most current-sensing circuits, and never in need of replacement.

How the circuit operates is evident from (a). Momentarily depressing S_1 closes the relay so that current flows from the supply to the load. In normal operation, the voltage across points PQ will be equal to the nominal supply voltage, and the normal operating voltage will appear across the relay winding. The relay and resistor R_2 are selected according to the dc supply voltage used and the relay's rated coil voltage, respectively.

Excessive current to the load causes a voltage drop across R_1 greater than 0.65 volt and switches on the SCR. The anode-to-cathode voltage of the SCR in the conducting region is approximately 2 v. This voltage, also across the relay coil, is far below the relay's holding voltage. Consequently, the relay opens, disconnecting the load from the supply. The relay may be reset by depressing S_1 again.

If a variable threshold point for SCR switching is desired, the SCR's gate can be connected to R_1 through potentiometer R_3. Resistor R_1 is calculated as before. ☐

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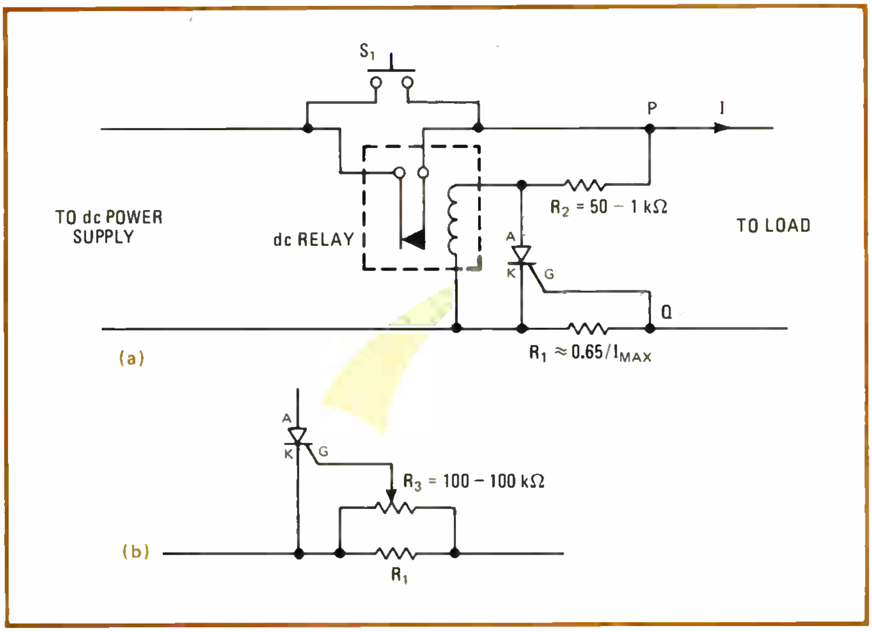


Electronic fuse. SCR and relay form resettable fuse for dc power supplies. When I_{max} is reached, SCR turns on, opening relay and disconnecting power from load. Depressing S_1 reinitializes circuit (a). SCR switching point may be adjusted with R_3 (b).

Versatile phase detector produces unambiguous output

by L. E. S. Amon and B. Lohrey
University of Otago, Department of Physics, Dunedin, New Zealand

A dual monostable multivibrator and integrator network forms a detector that not only measures phase difference between two signals throughout the entire 360° range, but also produces an unambiguous output signal for various phase-advance and -retard conditions by generating a voltage and slope output combination that is unique for every angle.

As shown in (a) of the figure, a positive zero crossing of reference signal A triggers the comparator C_1 and one-shot MS_1 at time t_a, where MS_1 is one half of the 74123 device. This one-shot, in the retriggerable mode and set so that its pulse width τ_1 is greater than T_a, the period of the reference signal, stays on until comparator C_2 and one-shot MS_2 are fired by signal B at time t_b. The narrow pulse produced by MS_2 resets MS_1.

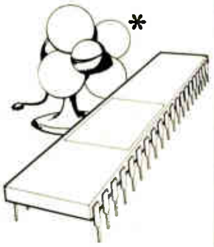
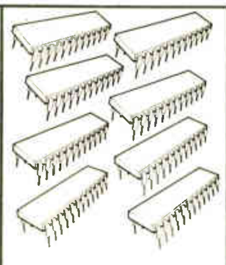
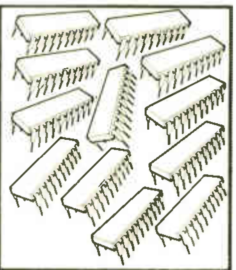
The phase of B with respect to A may be related to the duty cycle of the output signal from MS_1. The duty cycle may be expressed by:

$$W = \frac{t_b - t_a}{T_a}$$

The output signal may be converted to a dc voltage by the integrator network connected to the output of MS_1. Alternatively, the phase may be measured digitally [see *Electronics*, Dec. 20, 1973, p. 119].

As shown in (b), an increase in the dc output of the integrator occurs when the phase angle of B increases

Four ways to do 8x8 Multiplication

		 *		
DEVICE	MMI 67558	TRW MPY-8	AMD 25S05 (FD 93S43)	TI (MSI) 74S274/5
ORGANIZATION	8 X 8	8 x 8	2 X 4	4 X 4
TYPICAL SPEED	100 NS	130 NS	75 NS	75 NS
POWER	1W	1.8 W	5W	5.4W
PACKAGE	40-PIN	40-PIN	24-PIN	20-PIN
NUMBER OF PACKAGES	1	1	8	12
TECHNIQUE	COMBINATORIAL (BOOTH)	COMBINATORIAL	COMBINATORIAL (BOOTH)	COMBINATORIAL (WALLACE)
ROUNDING	YES	YES	NO	NO
MFG. PROCESS	LS/TTL	TRIPLE DIFFUSION	S/TTL	S/TTL
SECOND SOURCE	YES	NO	YES	NO
DATA REP.	SIGNED and UNSIGNED	SIGNED ONLY	SIGNED ONLY	UNSIGNED ONLY
TOTAL $ At 100 UP quantity — **MIL**	110	115	210	≈140
COM	64	70 (Fan not included.)	124	68

*300 fpm cooling required.

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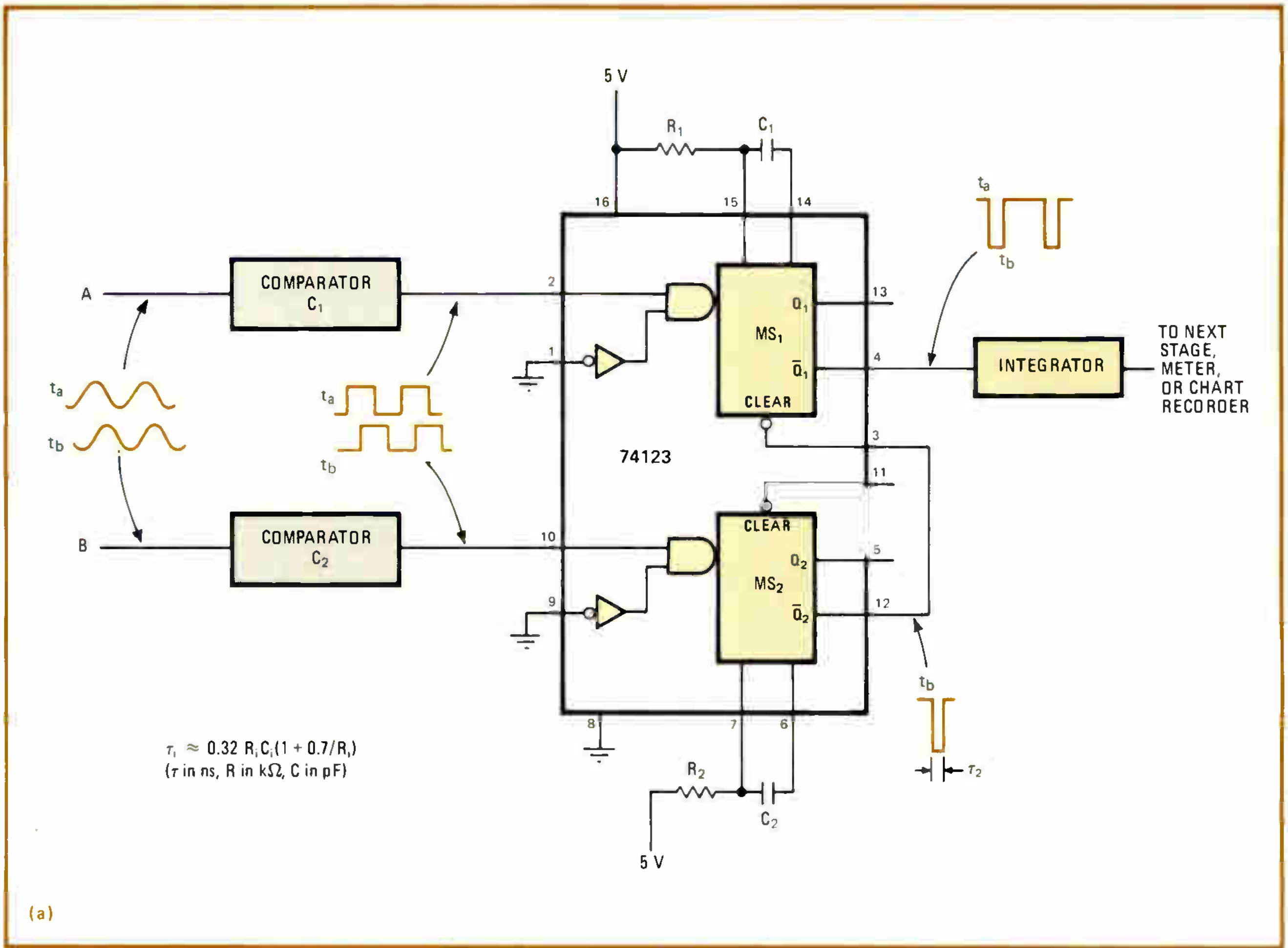
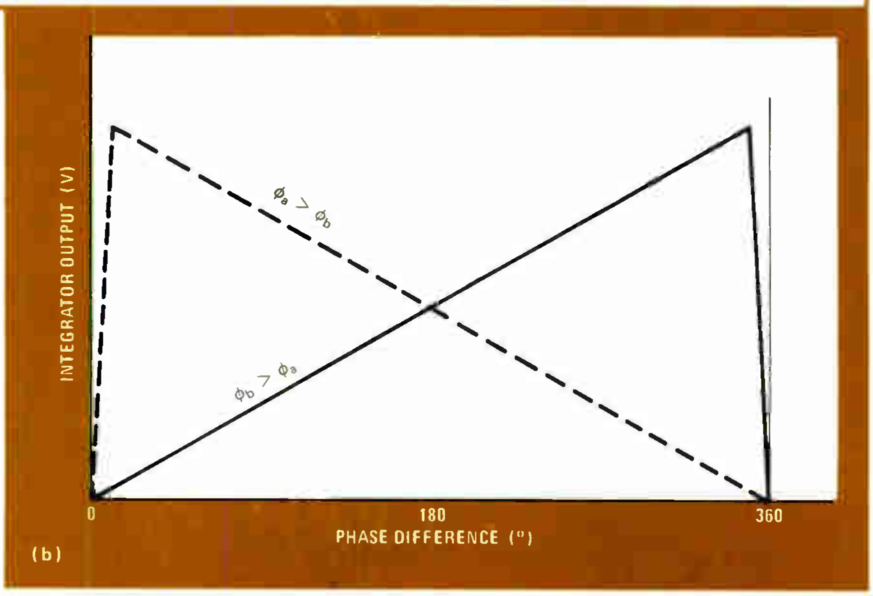


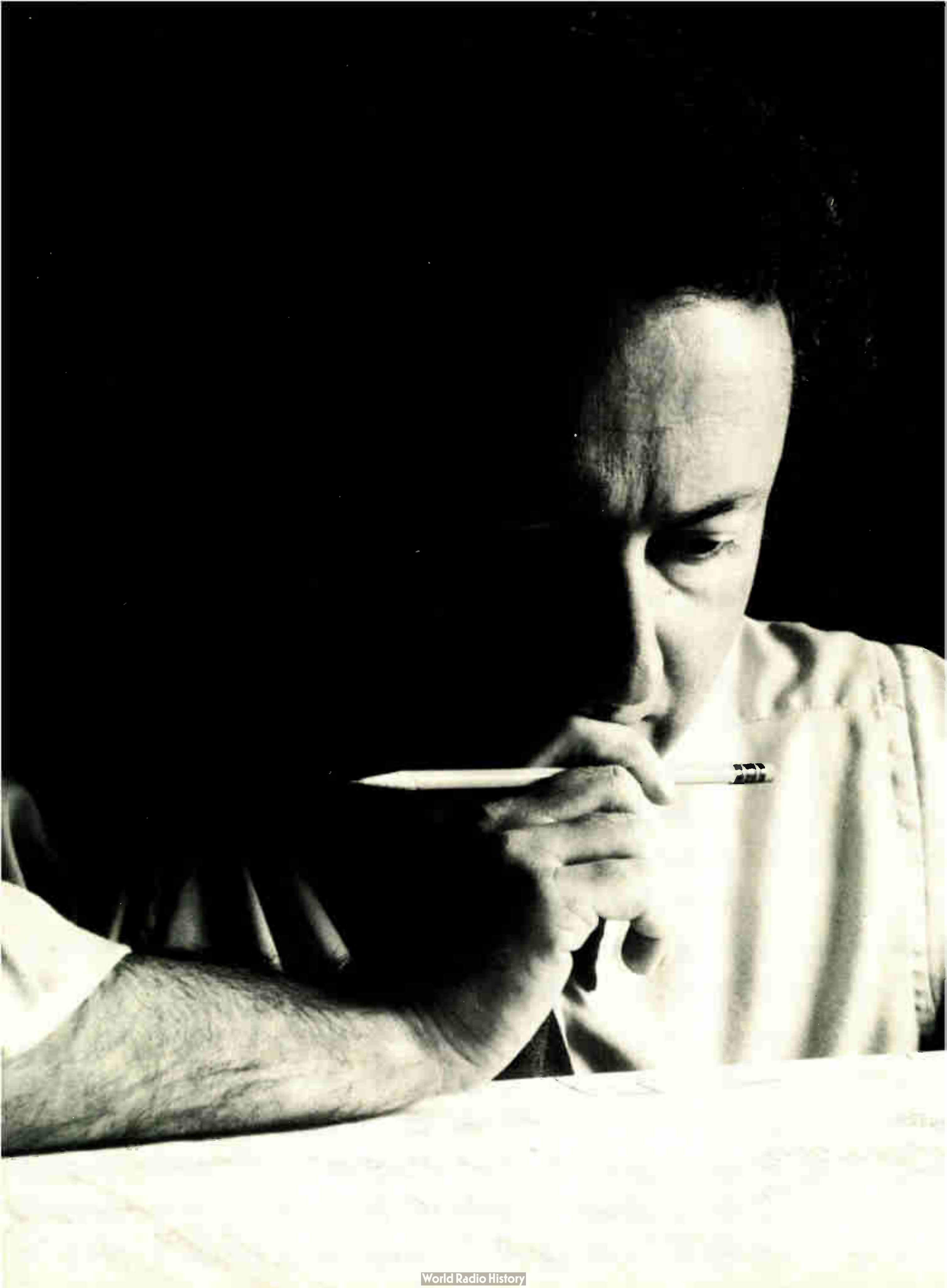
360° phase detector. Dual one-shot and integrator yield unambiguous voltage and slope output combination for changing phase-lead or phase-leg angles (a). Output from integrator is maximum at 360° when A leads B, minimum when B leads A (b).



with respect to A. The output decreases when the phase angle of B decreases with respect to A. Thus the frequency relation of B to A may be determined from the slope of the integrator's output if the two signals are of similar but not identical frequency.

When the two signals are not harmonically related, their phase relationship will change with time. The circuit is therefore useful as a phase-modulation detector for applications in communications receivers.

Further versatility can be achieved by placing frequency dividers at the input ports of the phase detector to achieve a full-scale output at N × 360°. The sensitivity can be increased, on the other hand, if both of the input frequencies are multiplied by N. This reduces the range of phases that yield an identical output voltage to 360°/N. □



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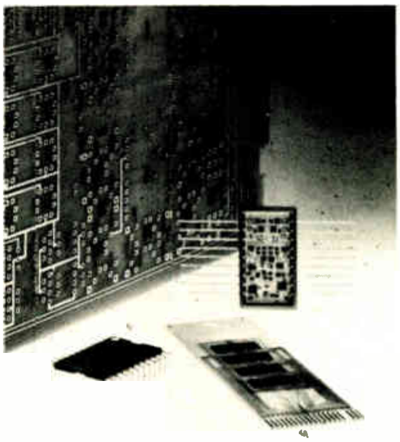

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Reducing system interconnections with multivalued logic

Sending multiple voltage and current levels over a transmission line enhances processing capabilities of otherwise all-binary systems

by Clive W. Ross, *Plessey Marine, Templecombe, Somerset, England*

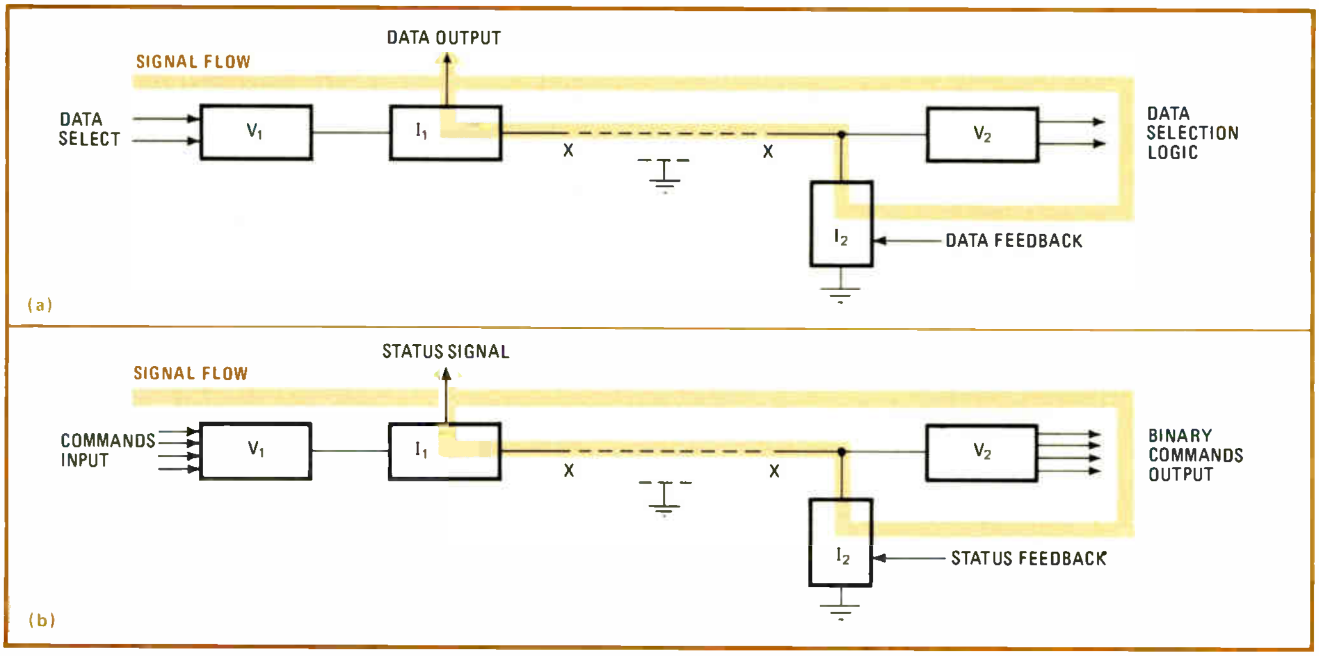
☐ Even though all present digital integrated circuits work with binary data and control signals, binary logic need not monopolize a digital system. The use of logic based on more than two levels of voltage or current—or, better yet, on multiple values of voltage *and* current—is possible in parts of today's systems. It will greatly expand the amount of information they can process and does not even require the development of new multiple-state devices.

Most efforts in multivalued logic circuits have concentrated on what may be termed a "first order" system, which quantizes either the voltage or the current levels. But greater processing capability can be obtained with a "second order" system, in which both voltage and current levels are used.

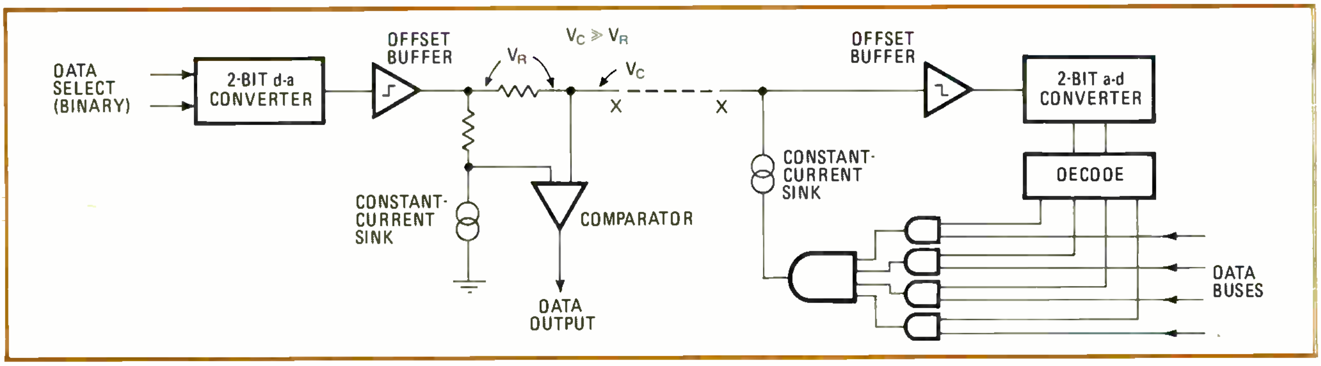
Consider a system in which a transmission path links control circuits to other circuits where data is either processed or acquired. Both ends of such a system may work in a binary mode, but if a second-order nonbinary regime is imposed on the transmission path, significantly fewer interconnection paths are required. It can be done very simply, by using present-day binary devices along with analog-to-digital and digital-to-analog converters to generate the multiple voltage and current levels required. Nor need there be more than, say, three voltage states and two or three current states to gain the promised improvement over strictly binary systems—four to ten times their information processing capability.

The simplest system

To back up a little, a simple device that can be used in a first-order nonbinary system is the familiar tri-state integrated circuit. Although the tri-state device works in the binary mode, it may actually generate more than two output states. Two of the states in a typical tri-state device are the normal 1 and 0 conditions, while the third is a high-impedance or off state, which permits the device to be controlled by some other source by means of a bus. A bias network can be used at the output of the device to assign an arbitrary voltage value to this third



1. Second-order nonbinary system. Multiple voltage and current levels are generated for single-wire multiplexing. V_1 converts the binary input signals into several voltage levels, while I_1 detects current flow in x–x line. V_2 converts the levels back into binary format so logic may pass desired data. I_2 detects data, changing current on line, passing data to output. Digital (a) and process-control systems (b) are similar.



2. Digital-data application. Practical nonbinary system may be easily implemented. Two-bit d-a converter assumes duties of V_1 in Fig. 1; a-d converter is V_2. Logic drives current sink I_2. Comparator is I_1. Offset buffers calibrate current sinks.

state. Thus it is shown to be possible for three voltage levels or, alternatively, three current levels to be generated from binary input signals.

A second-order binary system is a more complicated, but easily understood, network. Generally speaking, binary control signals retrieve data from a data source through a bidirectional transmission line and deposit it at a designated point in the operating system. To do so, they must generate several voltage levels on the transmission line. Returning on the line is a multicurrent feedback signal corresponding to the retrieved data.

The basic idea is the same for both a digital data application (Fig. 1a) and a control application (Fig. 1b). Voltage source V_1 converts the binary input signals into one of several voltage levels, while circuit I_1 detects the resulting current flow in the x – x line. Circuit V_2 detects and translates the voltage levels back into binary format at the receiver end. I_2 detects a data feedback signal, which is a function of the data on the line selected, and changes the line current. Finally the data is transferred to the output.

Some applications

The relationship of this block diagram to various applications can be easily demonstrated. In many cases, only a single wire and ground will be needed for the data multiplexing.

Figure 2 shows a digital data application—a circuit using two converters, a comparator, and two-state current sinking. Obviously there could be multistate current sinking and the use of multiple comparators, but for simplicity's sake only two current states and four voltage states are considered.

As shown, the 2-bit d-a converter generates four voltage levels and sends these control signals through line x – x. The offset buffer applies some low potential to the line to allow calibration of the current sink.

At the receiver, the voltage steps are level-shifted by the buffer and fed to a simple analog-to-digital converter, which in turn feeds a decoder and four gates. The gates are enabled by the binary signals from the a-d converter, permitting the data already on particular gates to pass through to the current sink. The constant-current sink switches on or off, depending on the state of the gate array. The data, either a 1 or a 0, is sent back through the line to appear at the output of the comparator. The comparator detects the current changes in the line by using a reference input voltage derived by a constant-current network. In this case, four lines of data have been interrogated and read out at a remote location, using a single line plus ground.

A control application is also easily implemented. Consider a magnetic-tape recording system having 24 channels and three operating modes (normal playback, playback from record head, record), in which it is desired to detect the magnitude of the bias current flowing through the tape head during a recording period. This information is to be fed to a remote unit containing a number of light-emitting diodes that indicate system status. There are thus five conditions of the system that must be identified: these three voltage states plus two bias-current states. These conditions can be detected with a three-voltage – two-current-state circuit using only a single control line per channel. For example, suppose the system has these voltages and currents:

- Normal playback: 0 volt.
- Playback from head: 10 v.
- Record: 20 v.
- Record bias current, below normal or zero: 0 – 0.5 milliampere.
- Record bias current, normal or above: 5.0 mA.

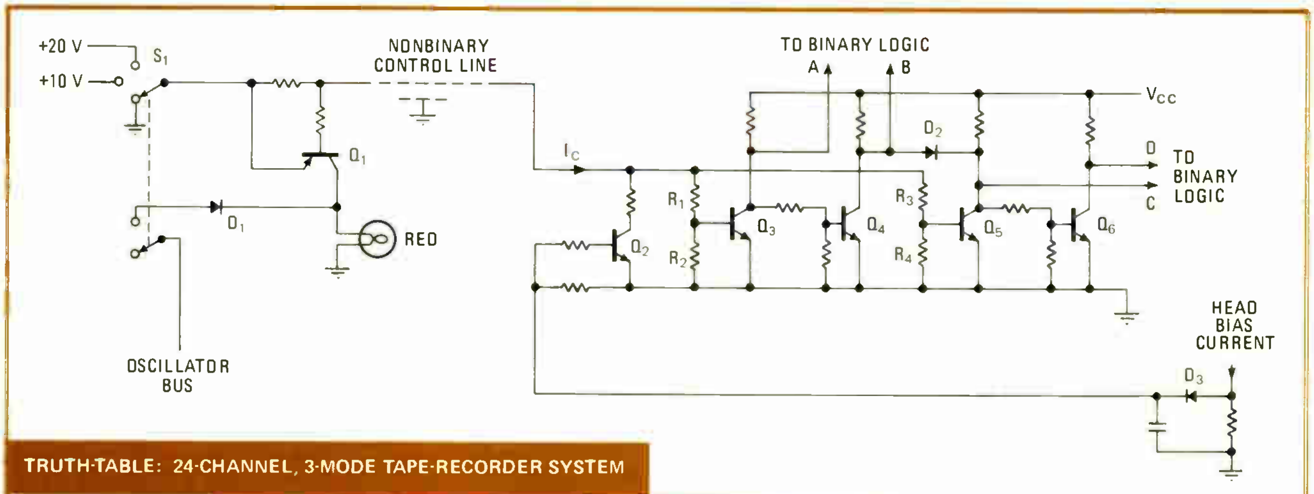
Circuit details

A simple three-voltage – two-current transmitter for this circuit is shown to the left in Fig. 3. A switch selects the mode desired, and a two-level current sensor, Q_1, determines the relative magnitude of the bias current.

When the switch is in the record mode, a 1-hertz oscillator is connected through diode D_1 to the red lamp, the bias-current indicator. Then if a logic decision made at the receive end indicates normal bias current, the command-line current rises, transistor Q_1 saturates, and the lamp will fully be biased on. Otherwise, the lamp will be controlled by the oscillator and will flash a warning indicating low bias current.

A circuit using simple comparators is needed at the receiving end, to translate the quantized voltages back into binary form. Also needed is a means of applying a binary signal to a current sink that is controlled by some final event, to acknowledge that the chain of command is by then complete.

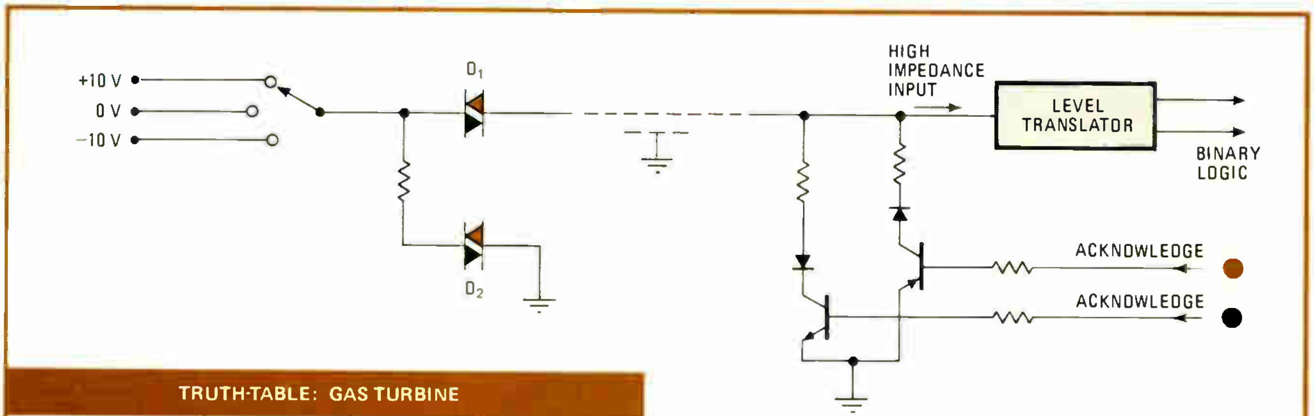
In Fig. 3, the ratios of resistors R_1 to R_2 and R_3 to R_4 are selected so that Q_3 and Q_5 saturate at control-line potentials of 10 and 20 v respectively. Under certain



TRUTH-TABLE: 24-CHANNEL, 3-MODE TAPE-RECORDER SYSTEM

Function	$V_{control}$	I_C	A	B	C	D
Play (normal)	0	0	1	0	1	0
Play (rec head)	10	0	0	1	1	0
Record (?)	20	0	0	0	0	1
Record (OK)	20	1	0	0	0	1

3. Process-control application. Value of head bias current is to be determined during record periods in this magnetic-tape recording system. Receiver detects mode, drives logic circuits so that head current is sampled if system is in required mode. D_3 conducts if current is normal. Q_2 fires, changing current I_C so as to bias red lamp fully on. Otherwise, lamp is fired by 1-Hz oscillator.



TRUTH-TABLE: GAS TURBINE

Command name	Voltage state	Current state	Visual indication D_1	D_2
Standby	0 ±0.5 V	0 ±100 μA	none	none
Forward propulsion on, velocity low	+10 V ±2 V	0 to +500 μA	none	green
Forward propulsion on, velocity normal	+10 V ±2 V	+15 mA ±20%	green	green
Reverse propulsion on, velocity low	−10 V ±2 V	0 to +500 μA	none	red
Reverse propulsion on, velocity normal	−10 V ±2 V	+15 mA ±20%	red	red

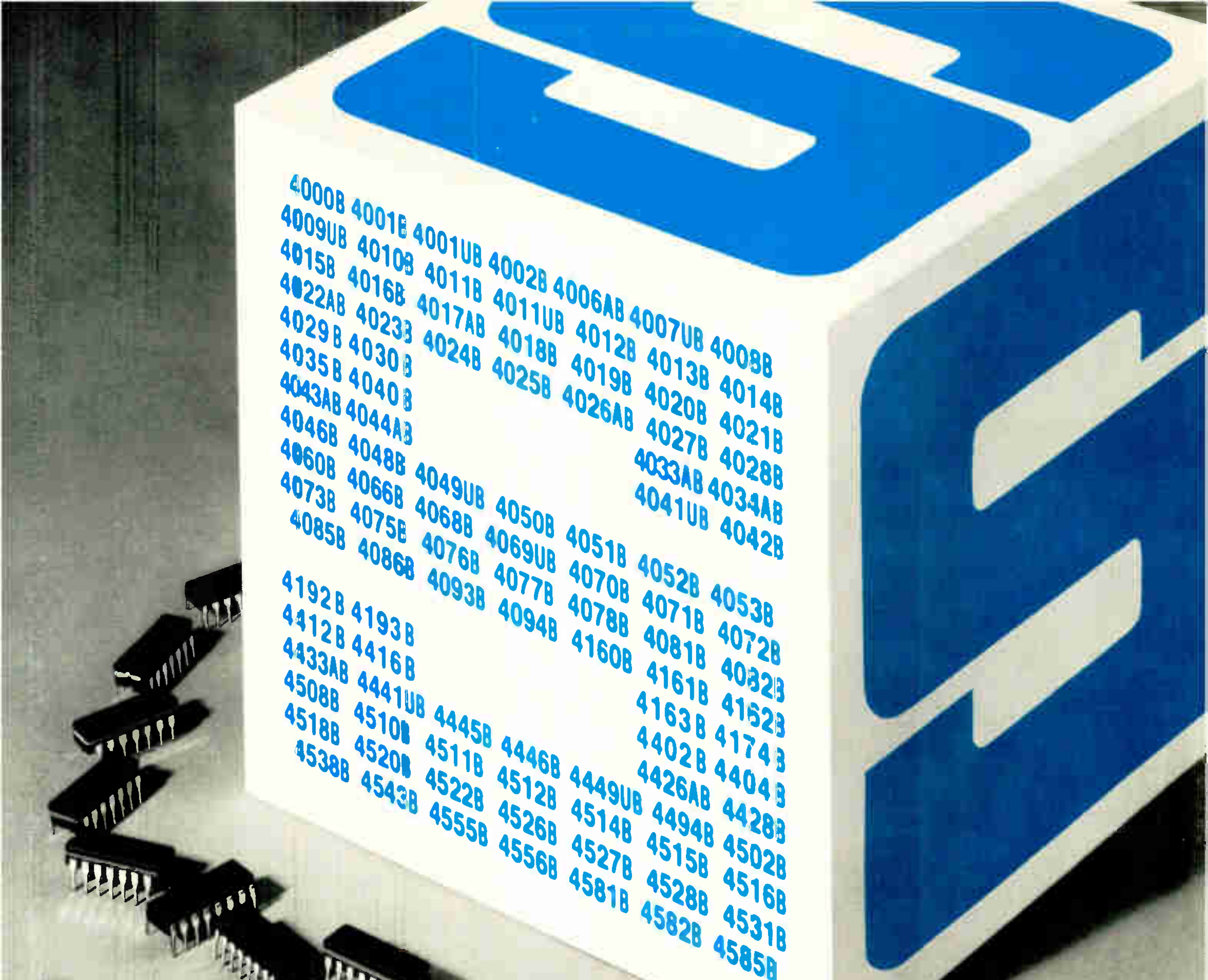
4. Modification. The addition of one current sink and the use of two-color LEDs provide a three-voltage–three current circuit for monitoring a gas turbine system. The output circuit is simplified, because the diodes convert line current changes directly, needing no transistors, comparators, or current sinks.

circumstances Q_4 and Q_5 assume opposite logic states. So diode D_2 has the important function of preventing the condition where they try to force point B to assume two different logic states simultaneously.

When the record command is detected, the logic connected to the binary output points A through D activates the record-head circuits. The bias current is detected by D_3 and turns on Q_2 if the current is greater than 5 mA, and consequently the current on the control line will change.

An interesting transmitter is shown in Fig. 4. Though extremely simple, it produces three voltage states and three current states. Two current sources and red/green LEDs provide more capability than the previous circuit.

Conventional binary-logic circuits are in wide use, and the use of tri-state devices is expanding. It seems certain that nonbinary systems will soon have considerable impact in many areas, particularly as a practical second-order binary system could have 10 times the information capacity of its binary counterpart. □



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4N38	1500	7500
4N25	2500	7500
4N25A**	2500	7500
4N38A**	2500	7500
MOC1005**	5000	7500
MOC1006**	5000	7500

B Darlington Couplers	House/Jedec-Registered Isolation* Voltage (Min.)	Motorola-Tested Isolation* Voltage (Min.)
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4N31	1500	7500
4N33	1500	7500
MOC119	1500	7500
MOC8030	1500	7500
MOC8050	1500	7500
4N29	2500	7500
4N29A**	2500	7500
4N32	2500	7500
4N32A**	2500	7500

* AC peak voltage — for five seconds.
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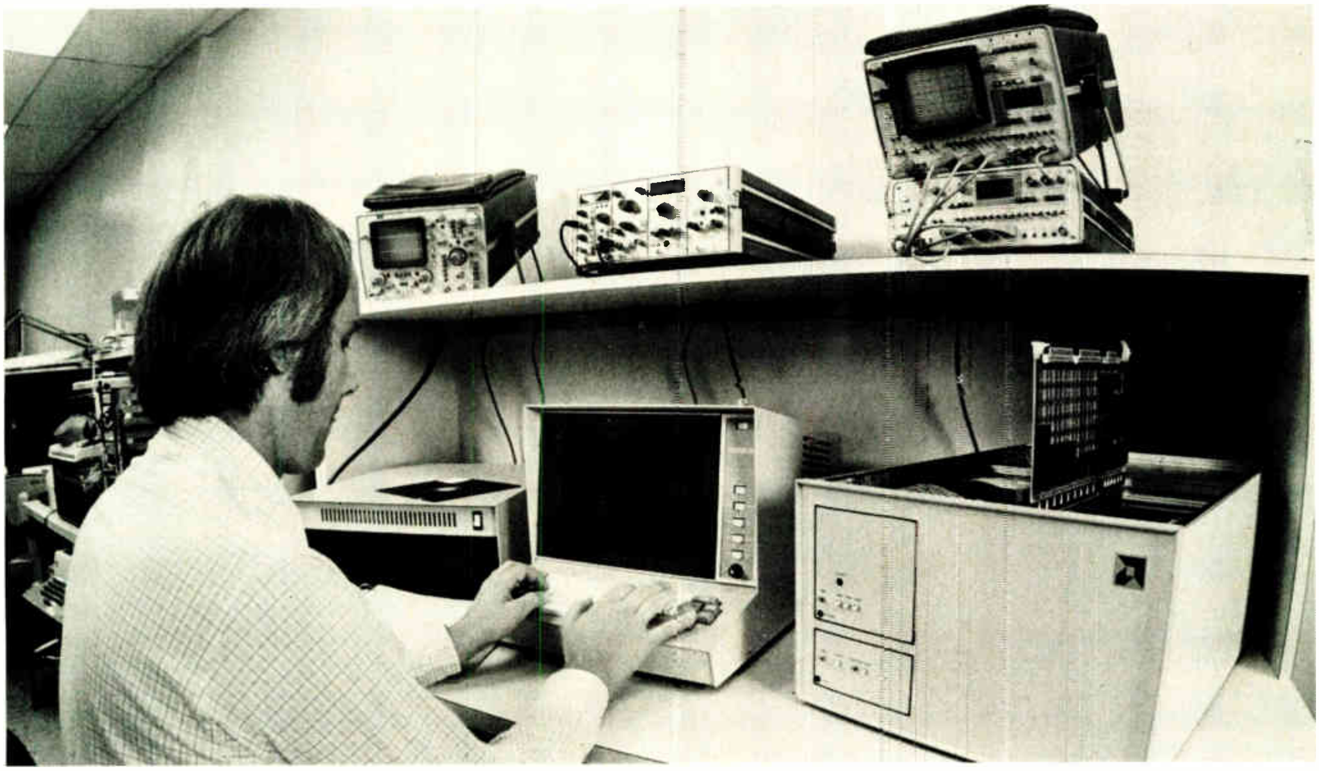
MOS support microprocessor teams with bit-slice prototypes for easier microprogram debugging

by John R. Mick and Robert Schopmeyer,
Advanced Micro Devices Inc., Sunnyvale, Calif.



☐ Because of the variety of architectures and instruction formats possible with microprogrammable components, it takes team work of a high order to design high-speed processors with bit-slice devices and to write and debug the programs. A new member of the team that greatly eases these tasks is itself an example of teamwork: it is a prototyping aid called System 29 built with a metal-oxide-semiconductor microprocessor to help in the debugging of bipolar systems.

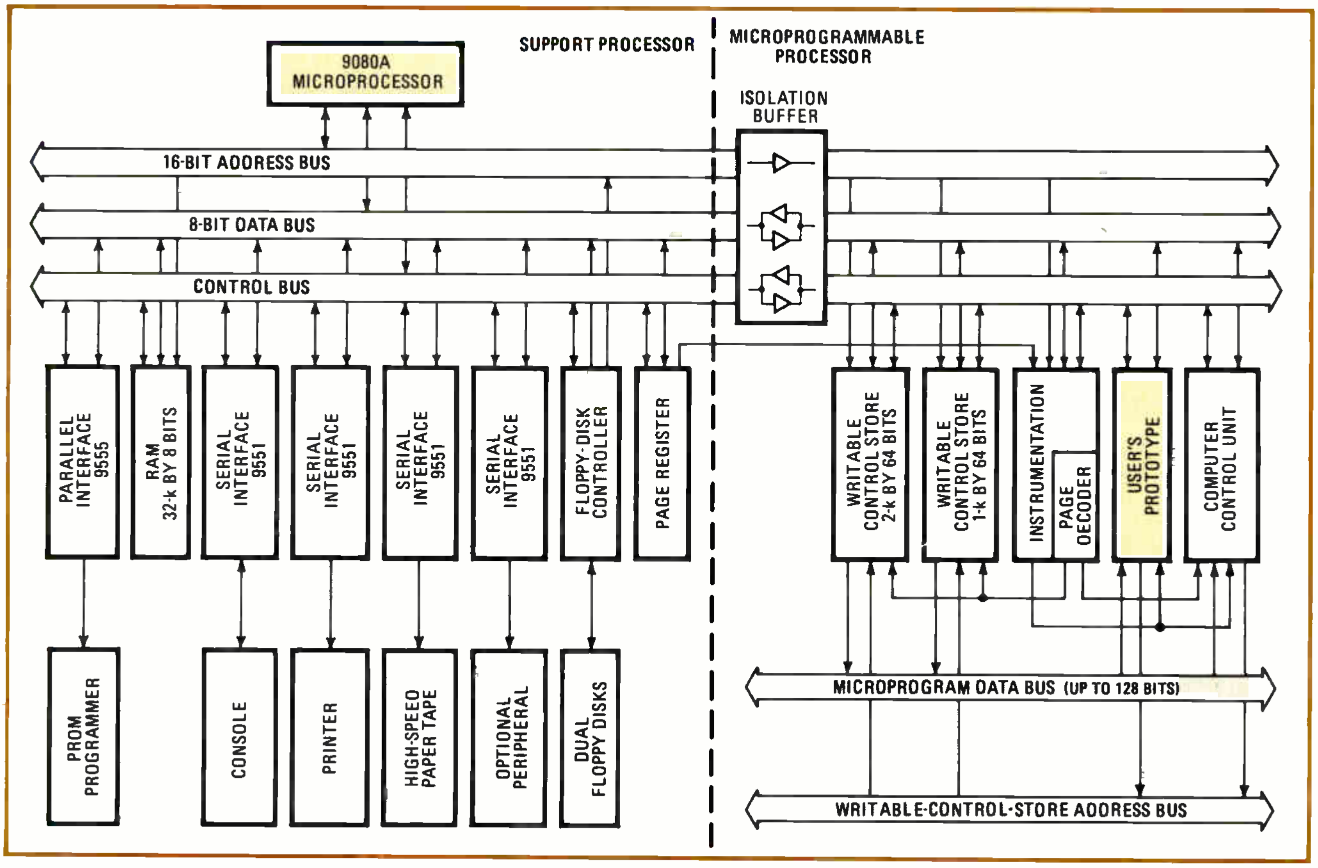
A designer can actually build a prototype of a microprogrammed processor using the Am2900 bipolar building blocks on special universal cards inside the System 29 chassis. To speed the prototyping, there are several optional cards holding control units that may be used in the final version of the system under design or may stand in for control units yet to be designed. Once the prototype has been fabricated, the designer can check out his microprogram as he debugs the various wiring and design errors and component failures that are sure to occur in the initial stages.

Perhaps the most flexible aspect of the system is part of the software: the disk operating system, called AMDOS/29, gives the rapid access to a large number of programs through a comprehensive file-management package. In addition, it provides all operations necessary to access floppy-disk drives and to interface the system to many standard peripheral devices.

Two processors

There are actually two separate processor systems in the single package (Fig. 1). One, called the system support processor, is built around a 9080A MOS microprocessor with a dual floppy disk, which holds all operating software, and 32,768 bytes of static random-access memory, which stores the disk operating software. The SSP serves as the user's interface to the second system—the user's prototype—which is built around an Am2900 bipolar bit-slice processor chip set.

The many options on architectures and instruction formats make developing the microprograms generally



1. The system. Built for microprogrammable bit-slice components such as the Am2900 series, the System 29 is run under the direction of a 9080A MOS microprocessor working with dual floppy disks and several peripherals. The bipolar section includes writable control stores, an instrumentation page useful in debugging, and the prototype system that is under development.

more difficult than programming fixed-instruction microprocessors, such as the 9080A. Designers using such devices also have enjoyed a wealth of design and development aids, but the System 29 is the first one for microprogrammable components. Until now the designer using these components had to write the programs and assemble them himself. The new system has a resident assembler, called the AMDASM/29. Moreover, its many controls and peripheral devices eliminate the need to build special test fixtures with switches and displays to give insight into what was happening in the prototype circuitry.

System hardware

In addition to the 9080A, the floppy disk, and the 32-kilobyte memory board, the support processor has a serial interface for communication to peripheral input and output devices. This interface will provide a current mode or an RS-232C electrical interface. A parallel interface allows communication to a printer and to either a programmer for a read-only memory or a high-speed paper tape producing PROM tapes. Also in the MOS section is the page register that is essential to the memory paging scheme.

Besides the user's prototype microprocessor, the microprogrammable section consists of an instrumentation board, which allows the 9080A to control the bipolar section, and the writable control store, which is a RAM that stands in for the microprogram memory and mapping PROM of the system under design. The system support processor also has access to this RAM. Another important part of the bipolar section is the optional control unit or units.

The basic configuration of the writable control store is two memory boards with low-cost, 4,096-bit static RAMS. It can provide a microprogram memory space of 32 kilobytes that is either 2,048 words wide by 128 bits deep or 4,096 words by 64 bits. This configuration is intended as a design aid for two types of systems: those using a slow PROM and those that will use a fast PROM but with microprograms that need to be debugged at a reduced system speed.

Alternatively, a 1,024-by-64-bit memory that has 50-nanosecond access time can be substituted. Using 30-ns-access bipolar RAMS, the writable control store lets users simulate as closely as possible the operation of fast PROMS.

One unusual feature of System 29 is the way in which it allows the 9080A to control various functions by memory mapping. Since the processor can address 64 kilobytes of RAM, the system maps various functions into the upper 32 kilobytes of address space, while the lower 32 kilobytes is reserved for the RAM that holds the disk operating system. For example, the system is designed to accept 4 kilowords by 128 bits of writable control storage. This program represents two pages of 32 kilobytes each. Each 32-kilobyte block is mapped into the upper 32-kilobyte address space when needed.

Extensive software eases development

The software system for the System 29 has four basic parts: the input/output system, the disk operating system, the console command processor, and the transient program area. The disk operating system, AMDOS/29, allows files to be opened, closed, renamed, read, written onto disk, or searched for by name. The console command processor reads inputs from the console and processes these commands to print listings of the file directory and the contents of various files and to control the operations of various other standard programs supplied with the disk operating system. The transient program area holds programs loaded from the disk for execution by the system.

The software package also can load microcode that has been assembled on the Computer Science Corp. time-sharing service. An acoustic coupler can load these programs directly into microprogram memory without punching paper tape. In addition, source files can also be loaded onto the floppy disk in the same way.

The disk operating system also contains a set of commands to display and modify the contents of microprogram memory. Once the microcode has been assembled, the user will probably want to set breakpoints, set trap bits, set comparison values, and so forth so that he may easily test and debug the microcode and its associated hardware. Examples of these commands are:

- Display—Display the contents of memory on the console.
- Move—Move a block of data to one location from another location in memory.
- Locate—Locate a particular character sequence in memory.
- Store—Store hexadecimal data into memory.
- Verify—Compare two blocks of data in memory.
- Set—Set bipolar format table attributes.
- Jump—Transfer control to any memory location in the writable control store.
- Read—Read hex-format paper tape.
- Write—Write hex-format paper tape.
- Page—Select a particular page as the upper 32,768 bytes of the 9080A address space.

Although there are many programs available for the 9080A, some designers will want to provide their own. A number of programs help set up the software to add various control features:

- Assemble—Loads a 9080A assembler and assembles the specified program from the disk.
- Status—Provides statistical information about particular files on the disk.
- Debugger—Loads a debug package from the disk.
- Peripheral interchange—Allows media conversion operations.
- Editor—Loads and executes a 9080A text editor program.
- Batch—Allows batch processing of various disk operating system commands.

On the bipolar side of System 29, a number of microprogram generation aids are available. These include:

- AMDASM/29—A two-pass microprogram assembler used to convert an established set of formats into machine language.
- AMPROM/29—A postprocessing program that allows the user to put out his binary object code in a form that corresponds to the PROM organization.
- AMSCRM/29—A postprocessing program that allows the user to reorganize the columns of microcode for programming in any PROM.
- AMPARITY/29—A postprocessing program that allows the user to generate one or more parity bits on the defined microcode word.

In addition to the pages available for the microcode, a number of other 32-kilobyte pages can be dedicated to provide other features. One page is the instrumentation board, which gives the designer significant firmware-debugging and hardware-checkout capability. It provides the logic necessary for the 9080A to directly control the microprogrammable section. It includes clock control—stop, single step, run, and trap on breakpoint—as well as control of microprogram address trapping and branching. Stop, single step, and run are under control both from the 9080A software and the front panel, while trap on breakpoint is controlled only by the processor's software. A 12-bit breakpoint address is loaded into a register by the software and is compared against the 12-bit address for the writable control store. When there is a match, the microprogrammable processor clock is stopped and an interrupt request is sent to the processor.

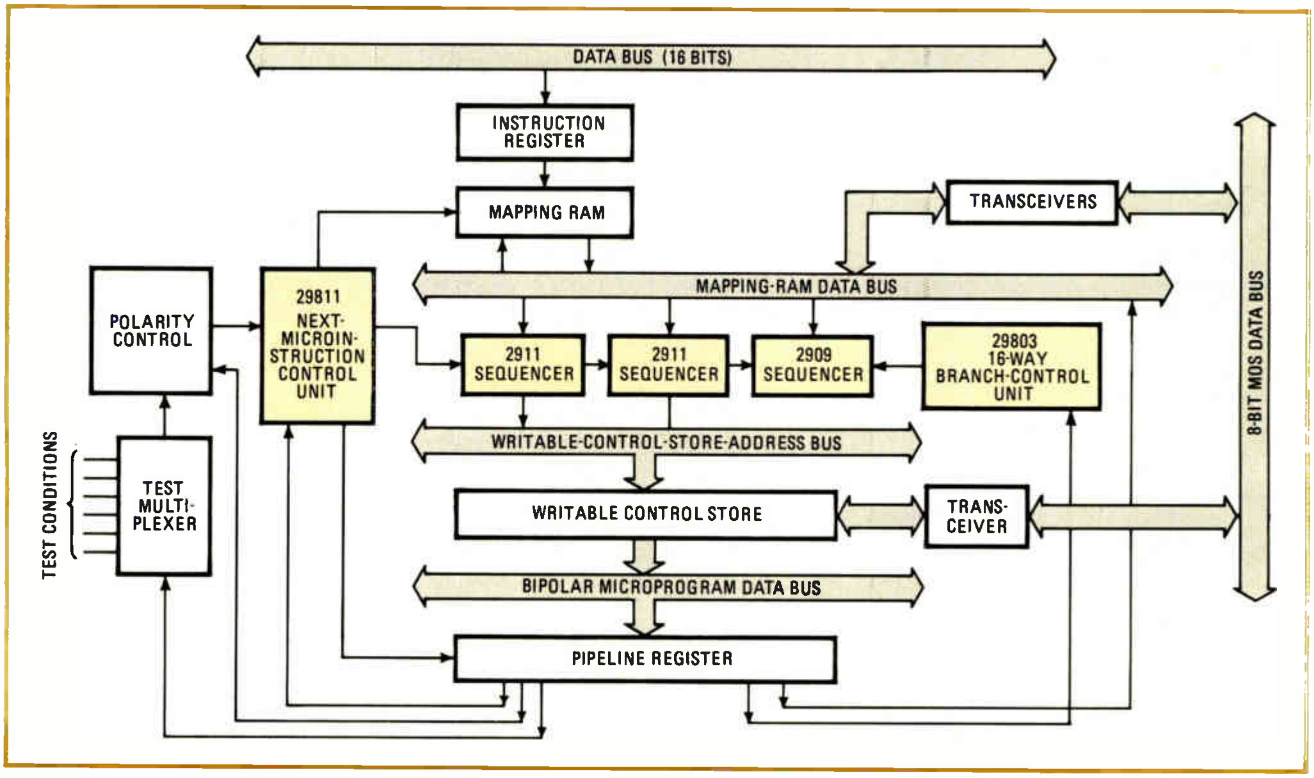
Under software control, a branch address can be forced, causing a bipolar sequencer to start executing microcode from there. This feature can be used to provide a starting address or to jump to a diagnostic microroutine when debugging microcode. The instrumentation page also allows the user to examine various buses in his system and determine the correct operation of the prototype.

The paging scheme provides an estimated throughput improvement of 10:1 compared with a system using I/O controls. It owes the improvement to its use of memory instructions, rather than I/O instructions, for access to the bipolar side. It provides 256 individual pages to perform various development system functions. Since only a minimum number of pages are used in the system, the user may add his own circuitry for maximum utilization when developing his designs.

The system can monitor as many as 100 test points in real time. These test points are saved in an additional RAM at the bipolar clock frequency (or some fraction or multiple of this frequency). When the clock is stopped, as from an address compare, then the last 256 states of these test points can be displayed in a user-defined format on the system CRT.

Using the system

After the basic logic design has been completed, the designer must set up the microcode format, build the microcode source files using the interactive editor, and then assemble the microprogram using the assembler, AMDASM/29 (see "Extensive software eases development"). This assembly produces a binary representation of the microprogram, which can be printed in several



2. Computer control unit. A typical example of a 2900-based auxiliary system is this computer control unit, which provides sequencing of a microprogram for a central processing unit. The 2909 and 2911 sequencers are controlled by the 29811 and the 29803.

Am29811 INSTRUCTIONS AND RESULTANT ADDRESSES

Micro-instruction mnemonic	Micro-instruction bit field	Instruction
JZ	0 0 0 0	jump to address 0.
CJS	0 0 0 1	conditional jump to subroutine with jump address in pipeline register.
JMAP	0 0 1 0	jump to address at mapping-PROM output.
CJP	0 0 1 1	conditional jump to address in pipeline register.
PUSH	0 1 0 0	push stack and conditionally load counter.
JSRP	0 1 0 1	jump to subroutine with starting address conditionally selected from Am2911 R register or pipeline register.
CJV	0 1 1 0	conditional jump to vector address.
JRP	0 1 1 1	jump to address conditionally selected from Am2911 R register or pipeline register.
RFCT	1 0 0 0	repeat loop if counter is not equal to 0.
RPCT	1 0 0 1	repeat pipeline address if counter is not equal to 0.
CRTN	1 0 1 0	conditional return from subroutine.
CJPP	1 0 1 1	conditional jump to pipeline address and pop stack.
LDCT	1 1 0 0	load counter and continue.
LOOP	1 1 0 1	test end of loop.
CONT	1 1 1 0	continue to next address.
JP	1 1 1 1	jump to pipeline register address.

different formats and may also be included in a cross-reference table of symbols.

After assembly, the binary file is routed to floppy-disk storage for further processing. The assembled binary code can be loaded into the writable control store (beginning at a user-defined starting location) for check-out of the microprogram. When microcode check-out has been completed, a utility program, AMPROM/29, is available to punch the microcode on paper tape for use on a given PROM programmer. The output also may be sent to a PROM programmer directly.

Rather than design his own microprogrammed control unit, the user may decide to use the computer control unit (Fig. 2) that is available with System 29. A pipelined microprogram sequencing unit, it will interface directly with the writable control store.

The microprogram sequencing comes from Am2909/11 sequencers, which can select the microprogram address from several sources—the external input, an internal register, the stack, or the microprogram counter register, which holds the last address sent to the microprogram memory incremented by one. The source is determined by the microinstruction, which is fed to the sequencer by the Am29811 next-microinstruction control unit.

The microinstruction can unconditionally select any of these inputs or registers as the address. Or it can select conditionally between two of them for microprogram branches. The table shows the instruction and resultant address as a function of the microinstruction and test condition. The microinstruction also specifies the condition to be tested (which appears as an input through the test multiplexer).

In addition to selecting a particular source for the microprogram address, the sequencer can modify the address using the Am29803 16-way branch-control unit tied to the OR inputs of the Am2909, which is holding the four least significant address bits.

When the external input to the sequencer is selected, the mapping RAM can be selected for the next address. It can change the address bit of an instruction register in order to send it to a new location in the microprogram. The contents of the RAM can be read or written under control of the system software from the support processor. This feature provides a convenient means for users to change the macroinstruction decoding of their design by modifying the contents. □

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Circle 131 on reader service card

One-chip conductivity meter monitors salt concentration

by Michael Ahmon
The Midlands Center for Neurosurgery, Warley, West Midlands, England

Using a single quad operational amplifier, this inexpensive circuit measures the relative change in the concentration of a solution by checking its conductance. It automatically monitors the long-term variations in the electrical conductance of any ionized fluid—or more precisely, any solution of a salt.

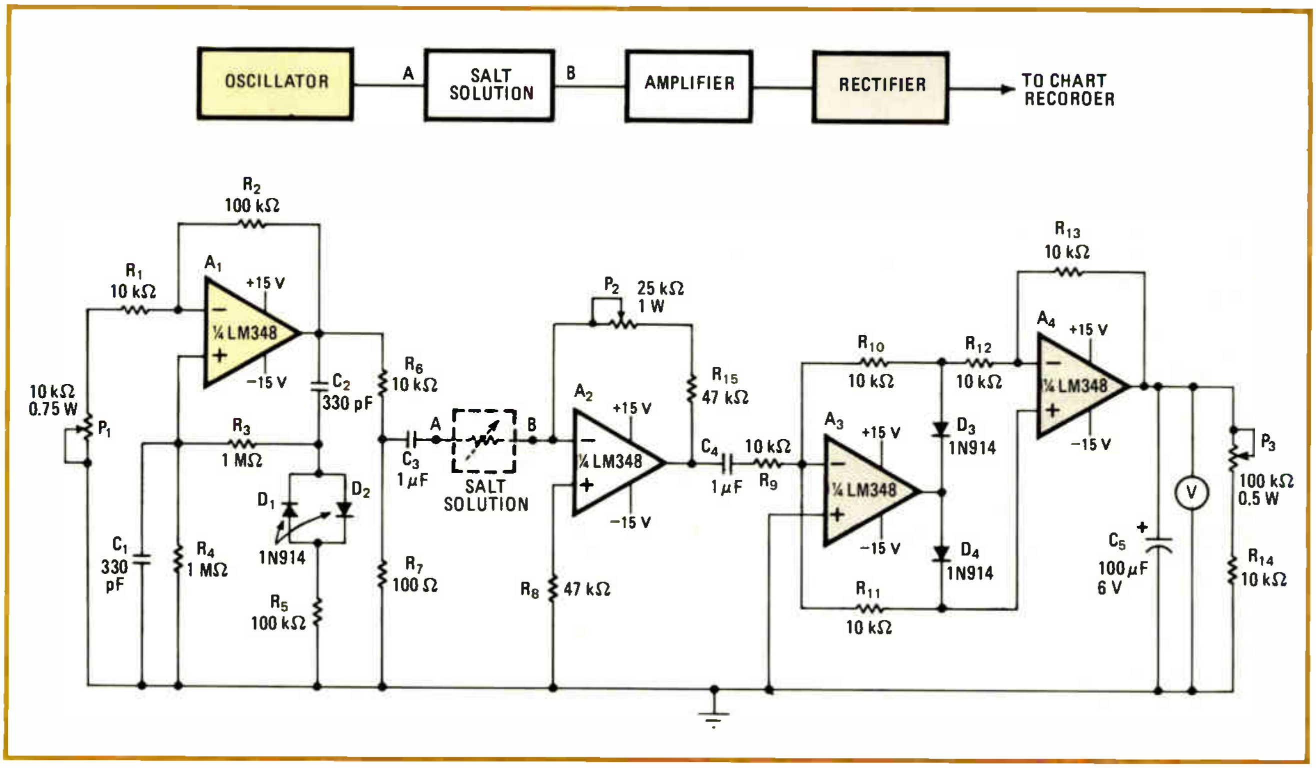
The circuit derives its long-term accuracy by passing an alternating current, rather than a direct current, through the solution, thereby eliminating the electrolysis effect which often causes large errors in measurement. Use of an op amp rather than a bridge circuit eliminates periodic manual adjustments and most nonlinearity. This permits continuous and unattended monitoring at an accuracy acceptable for most industrial applications.

Like metallic conductors, solutions of salts conduct electricity and obey Ohm's law, but a transfer of ions in the fluid, rather than electrons in a solid, takes place between the electrodes. Passing a direct current through the solution causes ions of like charge to cluster around the electrodes (the electrolysis effect), and this often acts to reduce current flow, causing errors when measuring solution concentration. To overcome this, an alternating current is sent through the solution as shown in Fig. 1.

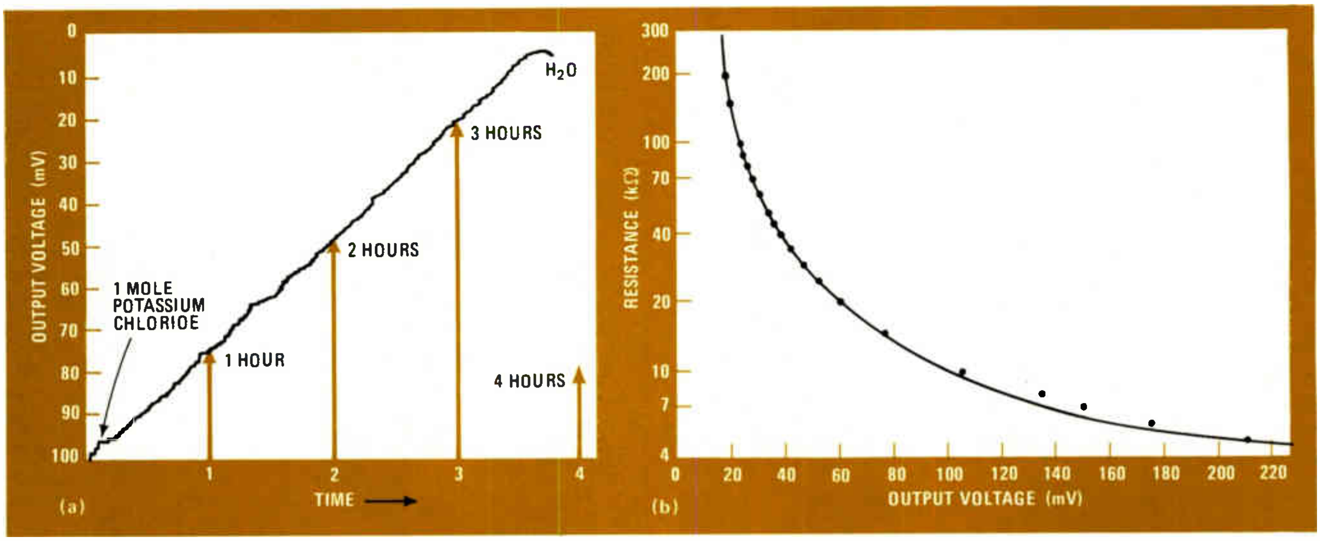
The salt solution may be characterized by a variable resistance. The voltage appearing at point B rises as the salt solution's concentration increases and is amplified and rectified in order to drive a chart recorder or a dc voltmeter.

A Wien bridge oscillator, having R_4C_1 and R_2R_3 as the arms of the bridge, generates a signal of about 1 kilocycle to drive amplifier A_2 through the salt solution. Potentiometer P_1 controls the oscillator's amplitude but has a small effect on oscillator frequency. P_2 adjusts the gain of state A_2 as required.

The output of A_2 drives a precision rectifier composed of A_3 and A_4, producing an output voltage equal to the absolute value of the input voltage. The rectified signal is



1. Conductivity checker. Meter uses one integrated circuit to measure relative change in concentration of salt solution by monitoring its electrical conductivity. It checks solution automatically and has good long-term accuracy, achieved by passing alternating current through solution, in lieu of direct current which causes electrolysis effect and measurement inaccuracies.



2. In action. One mole of potassium chloride is diluted over almost a 4-hour period (a). Output voltage is proportional to the salt concentration; the exact shape of the curve is dependent upon the salt tested. A curve showing relation of output voltage to solution "resistance" may be constructed (b). Alternatively, the ordinate may be calibrated in moles per cubic centimeter.

filtered, or smoothed, by C_5 for the dc instrument. P_3 controls system calibration.

Figure 2a shows a typical test result obtained from the dilution of a solution of 1 mole of potassium chloride over almost a 4-hour period. The output voltage of the circuit is set at 100 millivolts at the start, and the KCl is gradually diluted by water introduced to the solution by gravity feed. The instrument probes are connected to the opposite ends of the beaker holding the salt solution.

Naturally, the shape of the curve depends upon the salt used and the test conditions. It should be noted that it is not unusual to perform tests that may require days to complete.

The instrument is not intended to measure the absolute value of the number of free ions in the solution or even the value of its electrical conductivity. Rather it uses them only as an indicator of the relative change in fluid concentration. The exact number of free ions is difficult to determine accurately. In addition, determining the "conductivity" or "resistance" of a solution is meaningless in most applications.

If necessary, however, a curve of output voltage vs solution resistance or absolute concentration can be made for special applications, providing a quantitative measurement that is reasonably accurate. Simply substitute a resistance decade box for the salt solution and measure output voltage versus resistance as shown in Fig. 2b. Later, correlate the output voltage of the measured salt curve to resistance. Of course, the vertical scale in Fig. 2b can be calibrated in moles per cubic centimeter, which is the concentration, if the initial concentration of the fluid is known. □

Gate and counter check phase-locked loop sensitivity

by Marion J. Dudek
Crookshanks Consultants, Palos Verdes, Calif.

Determining if unwanted feedback from the voltage-controlled oscillator is responsible for poor sensitivity in a phase-locked loop can be difficult, but it can easily be done by measuring the change in system noise that occurs when the feedback is present. Relatively inexpensive instruments are used to make this usually tough measurement—only an exclusive-OR gate and a frequency counter are needed. VCO feedback problems are often responsible for the loop's poor signal-to-noise ratio, so it is best to perform this test immediately after a system is built—it will cut troubleshooting time greatly.

Unwanted feedback may be due to poor shielding between phase-locked-loop stages, inadequate bypassing of power leads, or a host of other reasons. The signal may enter any point in the system by a back-door route, as shown in (a) of the figure and may be out of phase or in phase with the VCO's normal output. This circuit is

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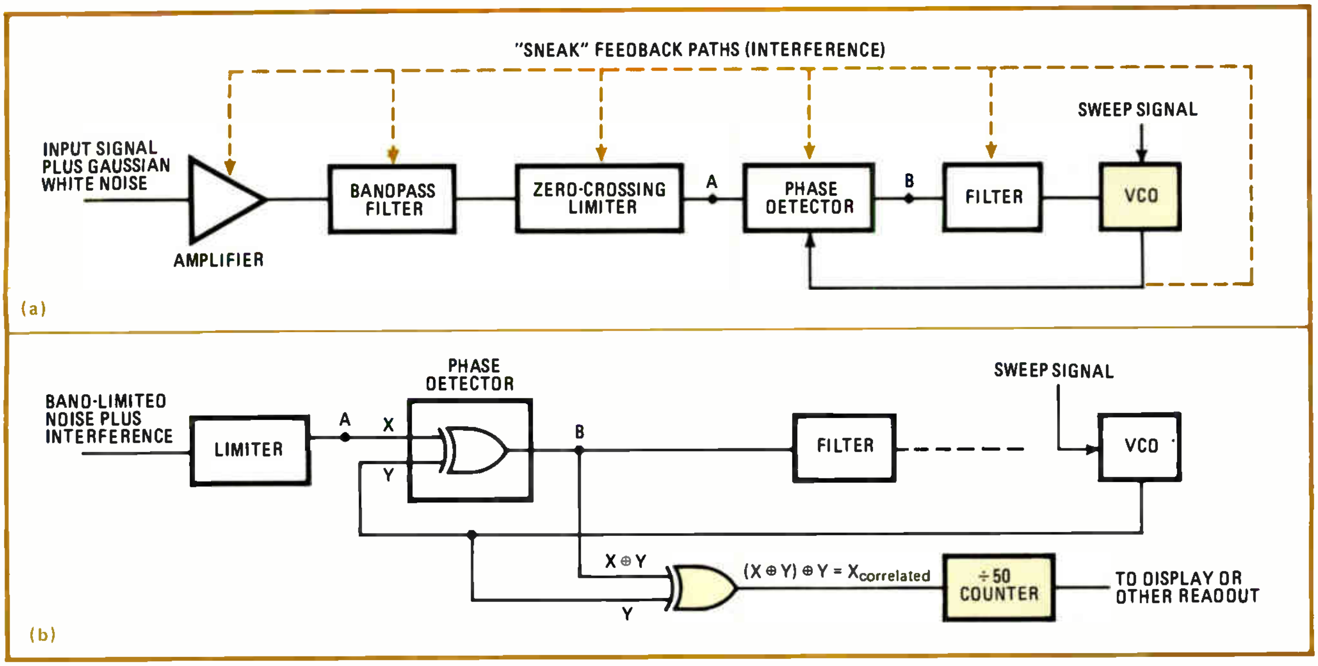
Circle 134 on reader service card



Signal-to-noise check. Back-door feedback voltages from VCO often mask input signals, confuse phase detector, and ultimately desensitize system (a). Addition of exclusive-OR gate and counter will determine whether out-of-phase interfering signals emanate from VCO by correlating system's white noise and interfering signals to the prime VCO signal (b). In-phase interference is checked by monitoring point B.

especially useful in detecting the out-of-phase condition.

The signal appearing at point A may be due to the feedback signal, the input signal (which inherently has a certain amount of Gaussian white noise present on it), or both. Thus the feedback signal is a source of interference that ultimately reduces the loop's ability to lock onto the desired signal. If the phase detector is an exclusive-OR circuit, the presence of out-of-phase interfering signals may be detected by adding the second exclusive-OR gate and the frequency counter to the circuit, as shown in (b).

To perform the interference test, it is only necessary to disconnect the input signal from the system and sweep the VCO as shown. The X input of the phase detector is now driven by band-limited noise and, possibly, an interference signal, both which have been converted to pulses by the limiter stage.

In the absence of interference, the output of the phase detector and exclusive-OR gate will switch on and off randomly, triggered by the system's Gaussian white-noise source, and will pulse the counter. The counter then measures the center frequency of the band-limited noise source. Note that the divide-by-50 counter further band-limits the noise, in effect filtering the signal so that the center frequency is more exactly determined and changes in the frequency are more easily detected. (This point may not be obvious, but may be understood if reviewed in the light of several of the sampled-data axioms that have become the cornerstone of data communications theory.) As the VCO is swept through its range, the output should remain constant, of course, because there is no correlation between the noise and the VCO signal.

But if out-of-phase interference is present, the counter's display will reflect a change in frequency as the VCO is swept, because the output of the phase detector will change state at a different rate. Another way of viewing this is to realize that the exclusive-OR gate has correlated the interfering signal with the VCO driving signal, changing the apparent center frequency of the white-noise source.

In-phase interference can be directly and more easily determined without the need for the additional exclusive-OR gate by monitoring point B. If this test proves negative for either type of feedback signal, but the signal-to-noise ratio of the system is subsequently found to be low, the problem lies either in an overall poor design of the system or with an external noise source—but not with interference from the VCO. □

It's easy to connect dc supplies in parallel

by Shri D. Bhanumurty
Defense Electronics Research Laboratory, Hyderabad, India

Connecting the outputs of two direct-current power supplies in parallel is not as complicated as one might think. Moreover, the supplies may even have different voltage or current capabilities.

The only criterion for parallel operation is that both sources be current-limited. Any such circuit can provide load currents up to the set limits of one supply. The second unit supplies any needed additional current at its rated output voltage, once it determines that the limits of

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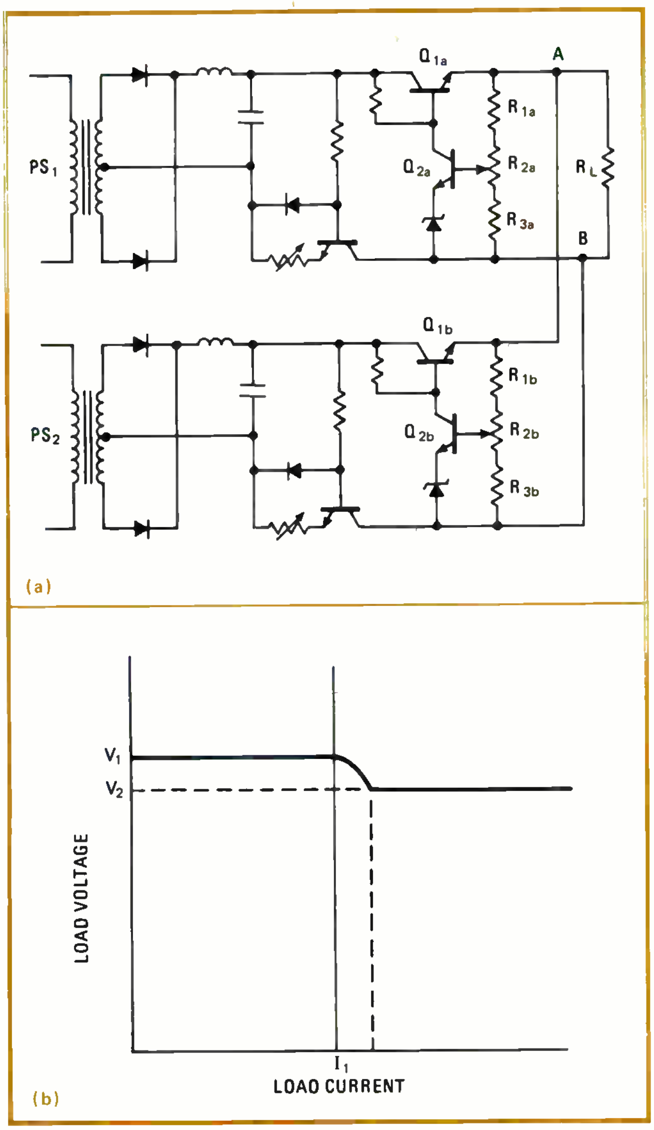
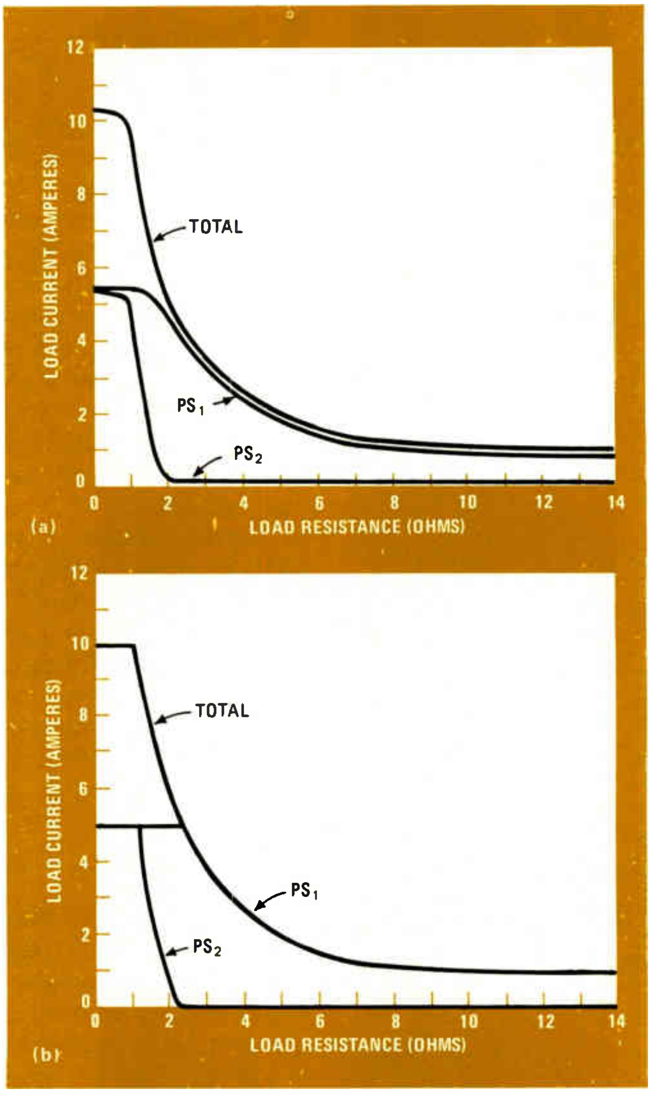


1. Current takeover. Parallel connection of dc supplies for shared current duties is permissible if both have current-limiting networks (a). Current to load is supplied solely by PS_1 until limit I_1 is reached. Then PS_2 supplies additional current needed at voltage V_2(b).



2. Supply characteristic. If two 10-volt, 5-ampere supplies with 0.1% regulation are connected and placed in operation, the curve in (a) results. PS_2 begins heavy turn-on as PS_1 approaches 5 V. Curves of ideal power supplies connected in parallel (b) show that PS_2 turns on at precise moment the current limit of PS_1 has been reached.

the first source have been reached.

The outputs of two power sources PS_1 and PS_2 are connected as shown in Fig. 1a. They are set at voltages V_1 and V_2 and current limits I_1 and I_2, respectively, where V_1 is slightly greater than V_2 at all times.

Under no-load conditions and until the set current limits of PS_1 are reached, the load voltage will be V_1. This is easily explained. Suppose that because of a power-line voltage increase V_2 temporarily increases. The increase in output voltage will be detected by the current-sensing resistors R_{1b} through R_{3b}. Transistor Q_{2b} will be biased more heavily into the conducting region and will bias Q_{1b} into the back-biased region. Thus, a greater voltage drop will appear across Q_{1b} than before. The output voltage will drop slightly, but will still be above V_2, at $V_2 + \delta$. This δ voltage is the result of compensation for the increase in input voltage at PS_2; however, PS_2 will supply very little current to the load.

As long as the current drawn by the load does not exceed I_1, the voltage across the load will be V_1, and PS_1 will supply all the current. If the current demanded by the load should exceed I_1, the voltage will drop to V_2. R_{1b} through R_{3b} will detect this drop, back-biasing Q_{2b} and forward-biasing Q_{1b}. Thus PS_2 will contribute the additional current demanded by the load (Fig. 1b).

When two dc supplies conduct in parallel, the result is a system characteristic of the kind shown in Fig. 2a, which is a plot of load resistance to load current. Both supplies can deliver 10 volts at 5 amperes, and each has a regulation of 0.1%. PS_1 is set at 10 v, PS_2 to 9.99 v.

Compare Fig. 2a and Fig. 2b, where a plot of load resistance to load current has been made for two ideal supplies. As one may deduce from these plots, a nonideal PS_2 will begin to contribute current to the load before the PS_1 limits have been reached. □

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.

Engineer's newsletter

Linear LSI breaks the ice for delta modulation

Although delta modulation is one of the simplest ways of converting analog into digital data, it has been used in only the most demanding communications chores because of its high cost and the restricted performance of early components. But **now low-cost, high-performance delta-modulator chips are available.** Consumer Microcircuits of America, Motorola, and Harris already have inexpensive chips on the market selling for as little as $6 in quantities of 100. These linear large-scale integrated devices contain all the active circuitry required for delta modulation and need in addition only a supply voltage, a clock signal, and external resistors and capacitors.

Besides telephony, many other applications are on the horizon for the delta-modulation technique. Digital filters are one, because delta modulation considerably simplifies the circuitry, doing away with the need for costly multipliers and permitting filter characteristics to be changed easily. Another possibility is controlling motor speed remotely by means of a binary signal transmitted over a cable or radio link. Additionally, delta modulation may be used to **realize simple speech-scrambler circuits, to delay audio signals,** to encode photographic profiles of objects for computer processing, and to encode transient signals for storage and delay.

Big, fast MOS ROMs deserve checking out

Systems designers who are automatically specifying bipolar read-only memories for high-speed storage of program and fixed data like look-up tables, should consider the new MOS ROMs now becoming available. Because some semiconductor manufacturers are using the ROM as a vehicle for developing fast MOS technologies, such as V-MOS and H-MOS, **a spate of really big 32,768- and 65,536-bit MOS ROMs is emerging that sport access times typically under 200 nanoseconds.**

While that's not as fast as the sub-100-ns speeds of standard 4,096- and 8,192-bit Schottky parts, it's fast enough for many minicomputer-based real-time data-processing systems. If you can live with their slower speed, the MOS units are a better buy than Schottky devices, being two to three times cheaper per bit, since they pack eight times more memory into a package. Furthermore, they dissipate about half the power.

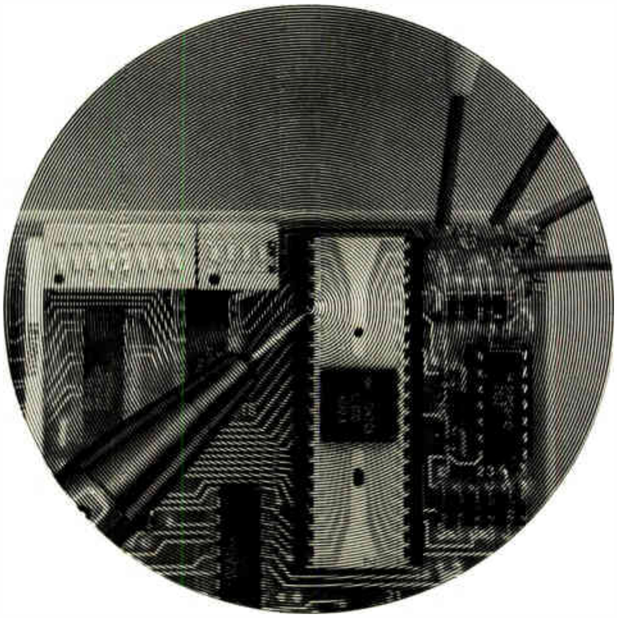
How to make a professional job of prototype pc boards

If you like to design and etch your own printed-circuit boards for prototype purposes, you have probably found that most industrial suppliers don't sell through distributors and have bought your materials from hobby outfits, even though hobbyist materials don't give professional results. But there is one well-known industrial supplier—Kepro Circuit Systems Inc.—that not only offers a full line of complete kits and materials for making prototype boards but also sells through distributors. Besides high-quality photosensitized boards providing a very uniform coating, the firm has **a room-temperature-immersion tin-plating kit that puts a fine finishing touch on etched boards,** depositing a shiny layer over the etched copper to retard oxidation and increase solderability.

The $20 kit, part number ITP-801A, plates up to 25 square feet of copper. Kepro's address is: 3630 Scarlet Oak Blvd., St. Louis, Mo. 63122.

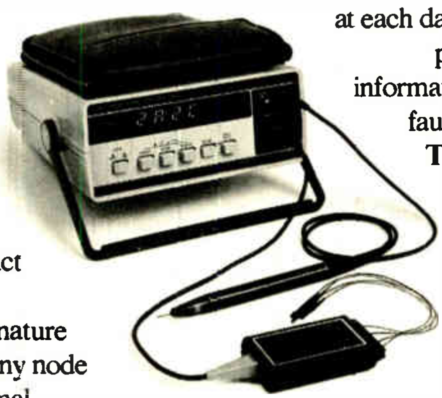
Lucinda Mattera

Troubleshoot microprocessor products fast–



right down to the component level.

Here's HP's new Signature Analyzer. It makes it economical to find the faulty component in a microprocessor-based product both in production and in the field. No longer is it necessary to make a large investment in expensive modules or boards for service. And no longer do you have to troubleshoot by conventional and costly hit-and-miss methods. It could even eliminate the need to partition your product for modular service.



The concept is simple. The 5004A Signature Analyzer converts lengthy bit streams at any node in a circuit into short, four-digit, hexadecimal "signatures." Just activate a digital exercise routine in the circuit under test, and compare the bit stream "signature" at each data node with the known good signatures previously written into your manual. This information lets you backtrace right down to the faulty component. Quickly and confidently.

The price is low. Only $990.* To help you design your product with all the advantages of digital signature analysis, we've prepared Application Note 222—"A Designers Guide to Signature Analysis." It's yours for the asking, just contact your nearest HP field sales office, or write.

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WESCON/77

Sessions devoted to one-chip computers, LSI peripherals, and new microprocessor in-circuit design aids show how to lower the cost of more powerful digital systems

☐ Scratch Wescon/77 and you'll uncover a microprocessor. San Francisco, site of the 26th annual edition and a city that has weathered pirates, earthquake, fire, beatniks, hippies, and tourists only to emerge with its charm intact, will no doubt be able to handle the Sept. 19–21 silicon onslaught. But engineers in town to tune in to some of Wescon's technical sessions and check out the exhibit booths are liable to find themselves thinking they have disturbed a nest of microprocessors.

Moreover, a fast turn through the booths crowded into several locations will show that the merchants of Wescon have not been outdone in the microprocessor race. Just as the technical sessions are to be heavy in microprocessor talk, so will the exhibit areas.

But while the exhibits set Wescon's pace, the technical sessions set its tone. As it turns out, the two components are well matched—while the exhibition leans strongly toward microprocessor design, the technical sessions are peppered with advice on what to do and how to do it with the ubiquitous device. However, if there is any shift in emphasis from 1976, then it is toward microprocessor peripherals.

Microprocessors occupy center stage in one of the sessions devoted to communications and also in a pair of discussions on components. There also are two forums on designing with microprocessors and programmable pocket calculators. In all, no fewer than eight of Wescon /77's 32 technical sessions are devoted in whole or in part to the microprocessor. Also, many of the others can be expected to make some mention of the devices in discussions of systems.

Microcomputers

Reflecting the trend to single-chip microprocessors for low-end byte-oriented controller applications, Dan Hammond of Mostek Corp., Carrollton, Texas, organizer of session 27 on one-chippers, has put together three good applications examples using the most popular device on the market. Included are the TMS 9940 from Texas Instruments Inc. of Dallas, shown designed into a data terminal; an 8048-based keyboard/display module from Intel Corp., Santa Clara, Calif.; and Mostek Corp.'s own 3870 chip, working as an asynchronous data-link controller.

To the user, the three chips offer about the same system capability: plenty of computational power, 1 or 2 kilobytes of program memory, a small but adequate store of data random-access memory, and sufficient input and output ports for accommodating many control applications that till now required more expensive, multichip solutions.

Illustrating how far one-chippers can go in reducing hardware (and software) costs is John Bryant's design of a data terminal, first with an 8080A and then with the TMS 9940. Bryant, who is TI's program manager for the 9940, will show that TI's own model 745 electronic data terminal, first introduced in 1975, needs only two chips with the TMS 9940 device, but it needed all of 17 chips with the 8080A.

Whereas this paper emphasizes simplicity, the Intel 8048 keyboard/display design described by Intel's Larry Goss stresses flexibility. Indeed, the 8048, which can be expanded into fairly complex systems, can be used for terminals having keyboards with up to 128 keys and 16-digit displays of either the seven-segment or dot-matrix format. In the Intel designs, the processor handles debounce, N-key roll-over, first-in, first-out character buffers, and various programmable modes for error indication, automatic repeat, the detection of key depression release, and so on.

While session 27 talks about the lowest-performance one-chip end of microcomputer applications, session 16 treats the highest end: the bipolar bit slices and peripheral large-scale integrated circuits. These are the chips that are the meat of the minicomputer and real-time data-processing applications, where n-channel metal-oxide-semiconductor devices are too slow and too limited to do the job. Here, instruction-time requirements are in the 100-nanosecond range and data memory capacity in the 32- to 64-kilobyte range.

In these high-speed, complex systems, the industry standard bit-slice family is the AM2900 system pioneered by Advanced Micro Devices Inc., Sunnyvale, Calif., and that's the subject of the paper by Bill Harmon, who describes the capability of the family, including the new sequencer and microprogrammable peripheral chips.

If the AM2900 family was a tough act to follow, the new 4-bit-slice central processing unit described by Harmon—with Vernon Coleman and Michael Economidis—will be even tougher. Designated the AM2903, the 30,000-square-mil, 48-pin device replaces and performs all the functions of the present family's AM2901 4-bit slice, which is 30% smaller. But in addition, it provides a number of enhancements that are especially useful in arithmetic-oriented computer systems. The basic microcycle of the AM2903 is about the same as the AM2901's, around 200 to 250 ns. But in a typical system, the increased integration and improvement in circuit architecture obtainable from the new parts will allow at least a 20% to 30% reduction in total throughput, say the authors.

The last few years have seen a remarkable increase in the use of digital signal-processing techniques in medical electronics, speech processing, and music processing, for example. Paralleling this development has been an increase in the level of integration of the bipolar devices used in these systems; in the case of multipliers, it has moved from 1-by-4-bit to 4-by-4-bit, 8-by-1-bit, and, most recently, 8-by-8-bit arrays.

The newest entry in this marketplace is an 8-by-8 combinatorial multiplier, designated the 57558/67558, from Monolithic Memories Inc. in Sunnyvale, Calif. As described by Schlomo Wasser, senior engineer for new product development, the device promises one of the lowest speed-power products on the market. The 5-volt, 40-pin low-power Schottky device, says Wasser, can multiply two 8-bit unsigned or signed 2's complement numbers and generate the 16-bit signed or unsigned product in an average time of about 100 ns, about 25% to 30% faster than combinatorial devices of the same complexity. More remarkable is the power dissipation of the device, only 1 w less than half of that required of similar devices. The 57558/67558 is designed for such high-speed applications as digital filters, fast-Fourier-transform signal processors, and floating-point arithmetic units.

With low and high ends of the microprocessor universe covered, Wescon is not neglecting the midrange devices. Two sessions—2 and 7—are devoted to developments in peripheral devices that will add flexibility to machines in this range.

As Ken McKenzie of Zilog Inc., Los Altos, Calif., points out in session 2, the microcomputer has evolved into the standard tool for solving product design problems. Its inherent flexibility, low cost, and short development cycle have caused the total applications spectrum to explode. But, he predicts in his paper on the role of peripherals, the real impact of the microcomputer has yet to be felt—and playing key roles in these new developments will be many advanced peripheral circuits.

Some good examples of advanced peripheral support circuits are described by Andrew Allison, of Advanced Micro Devices Inc., Sunnyvale, Calif. To date, says Allison, the development of truly high-performance microcomputer systems has been inhibited by two factors: poor arithmetic capability and limited system throughput. The introduction of sophisticated peripheral controllers, he says, has only worsened these throughput limitations by making it easy to connect high-speed input/output devices to microcomputers.

AMD has designed several products to resolve these problems. Among them are the AM9511, a powerful n-channel depletion-mode MOS floating- and fixed-point processor "slave" with derived function capability; the AM9517, a multimode direct-memory-access controller designed to speed the transfer of information between peripheral devices and system memory without CPU intervention; and the AM9519, a universal priority-interrupt controller that generates up to four fully programmable bytes of response information for each interrupt request input.

But proliferation brings its problems, and with computers one of the big headaches is seeing that important information does not fall into the wrong hands. The National Bureau of Standards has adopted a data-encryption standard for Government and industry to use to allay those fears, and makers of semiconductors and communications equipment, viewing the standard as the source of a major new market, are developing devices and systems to implement it. One, an advanced bipolar large-scale-integration design [*Electronics*, Sept. 1, p. 32], will be described by Krishna Rallipalli, advanced products manager at Fairchild Camera and Instrument Corp., Mountain View, Calif.

In session 7, the focus will be on controllers to interface peripheral devices. Ross Freeman of Zilog will describe his company's advanced serial interface controller, designed to provide simple interfacing of a Z-80-based system to a broad range of serial devices (such as floppy disks) and communications links. The controller is also flexible enough to work with most 8-bit microcomputers on the market. It combines all of the usual functions of a universal synchronous/asynchronous receiver/transmitter (Usart) with additional character-oriented protocol capabilities. Under DMA control, Freeman says, data-transfer rates of 500 kilobits per second are possible with a 2.5-megahertz clock and 800-kb/s with a 4-MHz clock. And by taking advantage of the increasing density and yield of LSI processing, says Freeman, it was possible to put dual channels on the device, thus reducing the total number of devices in a typical system.

Jack Kister, microprocessor applications engineer at Motorola's Integrated Circuits division in Austin, Texas, will describe Motorola's new cathode-ray-tube controller, an n-channel MOS device that—like other monolithic CRT controllers on the market and in design—strives to replace as much discrete logic as possible between the microprocessor and the raster-scan CRT terminal.

The MC6845 chip is perhaps the most flexible CRT controller yet introduced. Screen and character formatting is fully programmable, Kister explains: instead of giving the terminal designer a number of standard options, the device can put any number of characters on a line and any number of lines on a screen. Included is an important feature that makes the device useful in graphics as well as data terminals. This is an address multiplexer, which switches memory address lines from the microprocessor address bus to the CRT controller address bus after the processor has written into the display memory. This bufferless display-refresh technique frees the microprocessor for more demanding graphics tasks. The controller also includes cursor control and format functions, character-by-character video control, hardware scrolling and paging, and a light-pen detection capability.

Session 3, the only one that concerns microprocessor development, will include some good design hints for cutting development time. For instance, a paper by Dick Woods of Data I/O Corp. of Issaquah, Wash., recommends using random-access memories to emulate the ROMs and programmable ROMs used for program storage, since the RAMs can be instantly modified.

As for microprocessor applications, Wescon has assembled a strong forum, session 24, on communicating with the real world. Microprocessor applications group

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Wescon is again a sellout. As the show—in full, the Western Electronic Show and Convention—moves up the California coast to San Francisco for its 26th annual edition, Sept. 19 through 21, officials report they have more applications for exhibit space than they can handle, even using all of Brooks Hall plus all of the adjacent Civic Auditorium including the main auditorium and Polk and Larkin Halls. It will add up to more than 400 exhibitors filling 680 exhibit units, the largest Wescon in San Francisco since 1969.

Moreover, Wescon will try something new this year. With the show running from Monday through Wednesday, it will be the first to be packed into three days instead of four and the first to open on a Monday. The format responds to an exhibitor survey conducted last summer that suggested a three-day Wescon as an experiment, and it also avoids a conflict with Yom Kippur, which falls on Sept. 22.

However, two events previewing the show are scheduled for Sunday, the day before the official opening. They are the 23rd Wescon Distributor-Manufacturer-Representative Conference and the Wescon Luncheon. Both will take place at the St. Francis Hotel, and the luncheon will feature a keynote address by Bernard M. Oliver, vice president for research and development at Hewlett-Packard Co. and a past president of the Institute of Electrical and Electronics Engineers.

Once the doors open and the show gets under way, show officials won't be surprised to see a record attendance. They predict that more than 30,000 persons will pass through the turnstiles—perhaps even more than the 1975 San Francisco total of about 31,000 during a four-day event.

leader Larry A. Solomon of RCA Corp.'s Solid State division in Somerville, N. J., asks, "Why not do it in software?" when it comes to deciding whether software or a peripheral controller chip is better for performing a particular task.

"When you set out to do microprocessor designs, you should plan on doing everything in software. The only time one should back off and implement in hardware," says Solomon, "is when all the software possibilities have been exhausted." This obviously increases the user's software package. But, he adds, "there's a tradeoff in the amount of read-only memory one needs versus the number of external hardware chips needed."

Since ROMs come in quantums of 512 bits, 1,024 bits, and up, "if you are already a couple of bits into the next quantum, then any additional space is free," says Solomon, "so you might as well use all of it." Unfortunately, one cannot tell ahead of time precisely how many bits will be needed. "But you can guesstimate and come pretty close. For example," he notes, "if you estimate that about 1 kilobit of ROM is needed, then you can buy 1.5 kilobits of ROM."

Another justification for using extra ROM in the system is from the standpoint of testing, says Solomon. "It's a lot easier to test a ROM than it is an intelligent peripheral chip. Incoming inspection is so much simpler for ROMs." What's more, he adds, "by implementing most of the functions in software, one can defer final design decisions to later in the development cycle."

Accessing peripherals through a memory-mapping approach should be used as widely in microcomputers as in minis, in the opinion of Mitchell Gooze of Motorola in Austin. In his paper on addressing peripherals as memory locations, he notes that the flexibility of the procedure is such that the full power of the instruction set is available for input/output manipulation. This not only improves peripheral handling and enhances system throughput, but requires simpler software and less hardware than the isolated input/output technique.

Gooze defines memory-mapping as assigning a peripheral I/O device to an area of memory address space, in effect, treating it as a memory location. It is a "powerful architecture" that can manipulate I/O with the same instructions as those to access memory. This structure was first popularized with the Digital Equipment Corp. PDP-11 minicomputers and was incorporated in the Motorola 6800 microprocessor family, Gooze explains.

The alternate isolated-I/O technique, while communicating directly with the central processor, loses flexibility by being tied to this extremely simple format. The technique is best used in limited I/O requirements or when the entire memory address space is filled.

The concern of Mark Mayes and R. Wade Williams of GenRad Inc. is that electronics designers seldom think of the need for production testing of their finished product when they set out to design it. Williams is a senior development engineer and Mayes an engineer in the Electronic Manufacturing Test division of the Concord, Mass., manufacturer of circuit-board testers and instruments.

In essence, says Mayes, designers of complex digital assemblies go too far when they partition, say, a microcomputer board. They plan for all the components to be soldered down, for example, which means that when production testing is reached, the board may have to be partially disassembled in order to be tested.

"Too often," Mayes continues, "designers are mainly concerned about having a device or module perform the function for which it's intended, and only think of design-verification testing, not production testing." This often leads to a circuit board that becomes a nightmare for the production test engineer. An example Mayes uses to show how the designer can ease the production-testing problem for such a board is the use of a simple address decoder in a 5 cent socket—not soldered down—on the board. "A lot of peripheral devices have to communicate with the microprocessor over the bus," Mayes notes, "and the integrity of the bus must be tested." That can

Career session hits gut issues

Session 6, "Engineering Career Problems," addresses some of the basic needs of the engineer and should be of interest to all. The idea, says session organizer Jack Kinn, who is staff director of the Institute of Electrical and Electronics Engineers' U. S. Activities Board in Washington, is to identify the area crucial to career planning and present papers dealing with the latest information on these topics.

Thus, the first subject will be job security. Raymond Price of the School of Business Administration at Stanford University will suggest ways in which EEs and employers can overcome worries that engineering is no longer a lifetime career.

Another critical issue is pay. John L. Lipp of Hay Associates in San Francisco, an expert on compensation, will describe how companies arrive at salary scales and how the elements that make up the compensation package are weighted.

A highlight of this gut-issue session will be Donald B. Miller's talk on recognition of contributions. Director of human resources at International Business Machines Corp.'s General Systems division, San Jose, Calif., Miller has become an expert in developing motivation and reward concepts for engineers.

Capping the session will be a paper describing how management policies can actually work against the career interests of engineers. Describing what he calls "organizational mugging," Peter Graves of the department of business administration, California State College, San Bernardino, Calif., will point out that an organization that rewards managerial behavior having an adverse impact on subordinates' careers may wittingly or unwittingly be guilty of mugging. "Organizations seldom even view the issue of career development as a concern of management at all," he states.

Graves' solutions include, first of all, recognizing that organizations do have a responsibility for the career development of its engineers and, second, rewarding managers who then take steps to advance the careers of their subordinates.

be done before the microprocessor goes onto the board, or the microprocessor can be removed to make sure the bus and peripheral units are working by using the address decoder to exercise them without removing the peripheral units, which would be too expensive. Those peripheral units could consist of RAMS, ROMS, I/O ports, or floppy-disk controllers, for example.

Summing up, Williams adds that he would like to see circuit boards partitioned into small subfunctions with a few sockets provided to accommodate production testing of the finished board.

Computers

For those involved with computers, Wescon has two futuristic sessions, one addressing big machines and another covering distributed processing—a hot topic in the minicomputer area.

Session 23, "Transition to distributed processing," will assess the forthcoming distributed processing evolution (if not revolution) from the business and practical as well as the technological aspects. After a discussion of the meaning of distributed processing, business rationales will be outlined, with one paper disclosing how a major U. S. corporation—Citibank—profited from the decentralization in terms of productivity and accountability. In a more technical vein, planning of distributed-processing structures will be discussed in a talk that covers hardware, software, communications, and the interaction among them. Also, the microcomputer's impact on distributed processing will get attention.

As for large-scale computers, session 12 attacks the more esoteric reaches of computer technology. Papers by the top engineers from the Institute for Advanced Computation in Sunnyvale, Calif., will emphasize the superscale memories that will support the supercomputers of the future (particularly the Illiac IV now under development).

Included is a paper by R. S. Lim and J. E. Korpi on laser mass storage, which can put upwards of several hundred billion bits on a 4¾-by-31½-inch strip of polyester. But fault-correcting schemes must be developed for these memories since dust and dirt limit their present error rates to about 10^{-9} per bit—and commercial data-processing applications require error rates of at most 10^{-12} per bit. However, when special correction codes are employed in laser mass storage, they often require inordinately long decoding times that stifle system throughput. So speed must be traded off, at this time, for reliability.

Another paper will discuss alternate methods of ensuring data integrity in optical stores, such as a dual-writing approach that duplicates each optical strip. The system, which is employed in Precision Instrument Co.'s Unicon 690 optical archival memory, allows low-error storage in excess of 240 billion bits of data, with access times of less than a 0.25 second worse case.

Perhaps the most futuristic concepts arise in a discussion of optical memories, the paper in this case crystalballing the potential of optical-disk memory. Simple systems that are optical variants of magnetic-disk designs—a focused laser beam melts bit patterns in evaporated metal film—are already providing storage in the billion-bit range, and Harry G. Heard, who is organizing the session, remarks that advanced systems will surely provide direct access to 10^{15}-bit stores in a single disk drive—the equivalent of hundreds of thousands of today's magnetic tapes or disks. Moreover, he says, bandwidth limitations, head and media wear, and other problems that befall magnetic technology, are virtually nonexistent in the optical techniques.

Finally, the central memory for the Illiac IV computer is explained by Lim and Heard, who discuss how it achieves its fantastic memory bandwidth—over 1½ gigabits per second. The memory, a 20-port synchronous core-type designed by System Concepts Inc., can store a million 36-bit words, but its organization should be inspirational to today's memory designers. With a 93-nanosecond clock, the maximum data transfer rate per port would normally be one word every clock cycle; but by using four special switch modules and a minicomputer to keep four parts active concurrently, the maximum data transfer is upped to 144 bits per 93 ns, and the throughput is thus a whomping 1.548 billion b/s.

Components

The growing use of microprocessors to process real-world analog data, especially in automobiles, instrumentation, and industrial process control, is breeding a whole new generation of microprocessor-compatible data-conversion products—units that aim to make the job of interfacing as simple as possible for the user. In recognition of this trend, Wescon will devote two of its technical sessions to the subject: "Analog and Digital Data Acquisition and Distribution with Microprocessors" (session 26) and "Analog Interface in Microprocessor Systems" (session 21).

In his overview for the first session, chairman Robert Morrison of Burr-Brown Research Corp., Tucson, Ariz., examines the individual analog components involved in microcomputer applications and discusses interfacing techniques. The other three papers offer some hard-line applications guidance. For example, Claude Wiatrowski from the University of Colorado in Colorado Springs looks at various architectures for implementing a front-end preprocessor in microcomputers for industrial applications. The proper use of analog conversion products in microcomputer systems is the concern of George Bryant of Datel Systems Inc., Canton, Mass. To make his point, he cites several specific applications examples, among them a test system for computer memories and a system for monitoring a number of hospital patients. Additionally, M. L. Roginski and J. A. Tabb of Lockheed-

Georgia in Marietta, Ga., describe a microcomputer-controlled system for monitoring the flight-by-flight fatigue load of an aircraft.

In the analog-interfacing session, David Fullegar of Intersil Inc., Cupertino, Calif., will lead off by reviewing the characteristics of integrating and successive-approximation analog-to-digital converters and comparing serial and parallel methods of data transfer. David Chung of Umtech Inc., Sunnyvale, Calif., will emphasize cost-effective ways of converting analog data to digital and vice versa, even taking into consideration the type of sensor being used in the application.

Two of the papers in this session reveal details on new microprocessor-compatible data-conversion products. One paper, to be given by Jim Simmons of Signetics Corp., Sunnyvale, Calif., describes the first self-contained 8-bit digital-to-analog converter to be microprocessor-compatible. It is a bipolar chip that contains an 8-bit input latch, an internal voltage reference, binary-scaled current switches, and an output operational amplifier. The second new device, to be described by Russell Apfel and John Conover of Fairchild Camera and Instrument Corp., Mountain View, Calif., is a multichannel converter subsystem. Depending on a microprocessor for its digital intelligence, this bipolar chip includes a sample-and-hold circuit, multiplexer, and voltage-to-pulse-width converter. It can handle six channels of input, completing an 8-bit conversion in 300 microseconds in a cycle that incorporates both automatic zeroing and full-scale calibration.

Because of the clocking and timing needs of digital watches and microprocessors, quartz crystals have been rediscovered as easy-to-use cost-effective components. And this year, they will have a session (29) of their own at Wescon. Kicking off the session, Richard Nelson of Statek Corp., Orange, Calif., extols the versatility of low-frequency quartz tuning forks, reviewing such applications as Touch-Tone pads, long-period timers, time-of-day clocks, audio standards, and instrument time bases. In another applications-oriented paper, Daryl Kemper and Richard Bush of Tyco Crystal Products Inc., Phoenix, Ariz., discuss applying crystal bandpass filters to communications systems.

In a third paper, Paul Bryan of Colorado Crystal Corp., Loveland, Colo., suggests optimum ways to specify precision quartz crystals for sophisticated frequency-control applications. Finally, for IC and microprocessor applications, John Fisher of Standard Crystal Corp. in El Monte, Calif., explains how to interface a quartz crystal to an oscillator, whether this circuit is built with bipolar or MOS devices.

Communications

The ubiquitous microprocessor makes its influence felt at Wescon's communications sessions. One in particular, session 20, should interest those looking for high-performance capability for use in digital signal-processing systems. The session underscores the fact that although it is tempting for the designer to look to standard microprocessors with everything on one chip and a fixed instruction set, such MOS devices lack the speed needed for real-time processing chores. The faster bit-slice bipolar microprocessors are better suited for signal-processing applications that demand efficient code in time-critical domain and, in addition, allow the user to tailor his own instruction set.

The session examines the software, hardware, and application problems involved in getting very-high-performance signal-processing systems with bit-slice microprocessors. Howard I. Cohen of GTE Sylvania Inc. in Needham Heights, Mass., the session organizer and chairman, says, "The speakers will focus on some of their design approaches because it's important that the engineer consider his requirements carefully and think about how he might use bit-slice machines."

A paper on software strategies in the use of bit-slice microprocessors for radar signal processing by P. C. Barr of Raytheon Corp., Wayland, Mass., and M. S. Gerhardt of Digital Equipment Corp., Maynard, Mass., emphasizes the fact that an important aspect of the architecture design is the ease with which a design engineer programs the microprocessor to perform the many signal-processing tasks.

A paper cowritten by Cohen will show that it is possible to handle hardware efficiently so that life can be made tolerable for the programmer. "If the hardware design can't be used conveniently by the programmer, then it's a failure," says Cohen.

A different facet of the problem of programming ease is covered by Allen Peterson of Stanford University's Center for Radio Astronomy in Palo Alto, Calif. Peterson will deal with the advantages and limitations of architecture for real-time digital filtering and linear predictive-coding applications.

Satellite systems of the 1980s, the topic of session 5, offers the nonspecialist an up-to-date view of several satellite systems currently under development. All five papers emphasize the novel aspects of spacecraft antenna systems, transponders, and sensors.

The paper on Intelsat V (scheduled for a late 1979 launch) details a dual-polarization scheme for frequency reuse at K-band frequencies, which have never been used before on Intelsat satellites. The authors, F. J. Dietrich and C. F. Holber of Ford Aerospace Corp., Palo Alto, Calif., deal mainly with the new equipment designed for that craft.

A second paper, by P. Walker of TRW Systems Group, Redondo Beach, Calif., discusses the tracking and data relay satellite system that will use two synchronous tracking satellites to relay data between orbiting user satellites and a single ground station located at White Sands, N. M. The two TDRSS satellites will "see" virtually 85% of all satellite orbits and will therefore do away with the need for elaborate ground tracking stations and the dependence on other nations for help in system operation.

A third and fourth share a common theme—electronic beam-steering and beam-shaping techniques. K. Swimm of General Electric Co.'s Space division in Philadelphia, will focus on a system designed for the Defense Satellite Communications System that shapes and steers the antenna beam upon command from ground control. S. H. Durrani from NASA-Goddard Space Flight Center, Greenbelt, Md., will discuss an experimental system for doing the same thing automatically with onboard processing.

His paper, cowritten by T. Noji of AIL, Melville, N.Y., and C. Allen of General Electric Co., Valley Forge, Pa., examines the system they are proposing to include with the Space Laboratory experiments that will fly in the shuttle. The ultimate application of their system is to provide communications between small mobile terminals and satellites in stationary orbits.

Instruments

Test systems are taking wing, borne along by the advent of high-speed digital circuits that can generate pulses in the subnanosecond range, plus other high-speed digital sampling and conversion circuits. These new systems obtain much faster and more accurate results by taking measurements in the time domain and converting to the frequency domain and by using computers to take advantage of the latest Fourier analysis techniques.

In session 10, "Applications of Time Domain Measurement Systems," organizer Norris S. Nahman of the National Bureau of Standards, Boulder, Colo., will describe NBS measurements in the picosecond and nanosecond range, using continuous and sampled data measurements in real and equivalent time. Real time, he points out, means measurements are made on signals that occur only once, whereas equivalent-time methods require multiple occurrences of the signal. He then will explain the NBS automatic pulse measurement system/time-domain automatic network analyzer, which uses a sampling head with a bandwidth from dc to 18 gigahertz, a sampling oscilloscope, 14-bit analog-to-digital and digital-to-analog converters, and a minicomputer to control the system.

Harry M. Cronson of the Sperry Rand Research Center, Sudbury, Mass., will discuss a computer-controlled time-domain system used to obtain properties of both networks and materials between 100 megahertz and 16 GHz. Cronson says it can make such measurements in many cases more directly and with less error than can conventional continuous-wave methods. For example, he will discuss an insertion-loss measurement system based on an impulse generator producing a pulse with a half width of about 60 picoseconds and accuracies of about 0.1 dB in 10 dB. He also will describe measurements of permittivity and permeability of materials such as Teflon and ferrites.

Fred J. Deadrick of the Lawrence Livermore Laboratory, Livermore, Calif., will examine the uses of picosecond pulses for measurements of antenna parameters, such as input impedance and effective heights, using a 300-ps pulse. By time-windowing, he says, unwanted reflections from walls and ceilings are eliminated so that an anechoic chamber is not needed.

Finally, S. Gottfried of Bell Laboratories in Holmdel, N. J., will describe optoelectronic components such as optical fibers, sources, and photodetectors, and then methods of characterizing the fibers with time-domain measurements. The system uses a sampling and compares the output of an optical attenuator with that of the optical fiber.

Production

Present practice and the state of the art in automatic test equipment are important enough to rate a session each at Wescon. Indicative of session 4's practical approach, a paper on detecting race conditions with a production environment simulator comes from Paul Accampo of Hewlett-Packard Co.'s Automatic Measurement division, Sunnyvale, Calif. A race condition occurs when two or more signals at a logic circuit's input change simultaneously, and it can be critical if the order of the signals' arrival affects the circuit's output state.

Also in this session, Noel Lyons of Fluke-Trendar Corp., Mountain View, Calif., will take on microprocessor board testing. His paper reviews microprocessor boards and how they differ from conventional logic. In addition, there is an analysis of the pros and cons of various test approaches including cost of implementation, one-time costs, and relative effectiveness.

At the ATE forum on state-of-the-art techniques, vendors and a user will talk about the application of testers to boards bearing microprocessors and other complex LSI circuits. A paper by Thomas Bush of GenRad explores current and upcoming techniques for troubleshooting microprocessor boards after first listing the boards' unique properties—high data rates, bit architectures, and complex failure modes—and analyzing the implications of these for testing. A companion paper by Ed Steinberg and Robert Lecoq of Digital Equipment Corp., Maynard, Mass., will give a black-box approach to testing and isolating manufacturing-type faults in an 8080 chip set.

The tape chip carrier with its suitability to automation could be one of the most exciting things ever to have happened to the hybrid industry. However, says session 15's chairman, Stanley Stulbarg of Hughes Aircraft Co., Newport Beach, Calif., because of practical difficulties, small leadless ceramic and plastic chip carriers have been seized upon as an interim chip packaging approach.

An important paper, by Dan Amey of Sperry Univac Computer Systems, Blue Bell, Pa., reviews the five available forms of the chip carrier and shows how a proposed Jedec standard has attempted to make them interchangeable when referenced to a standard printed-circuit footprint. □

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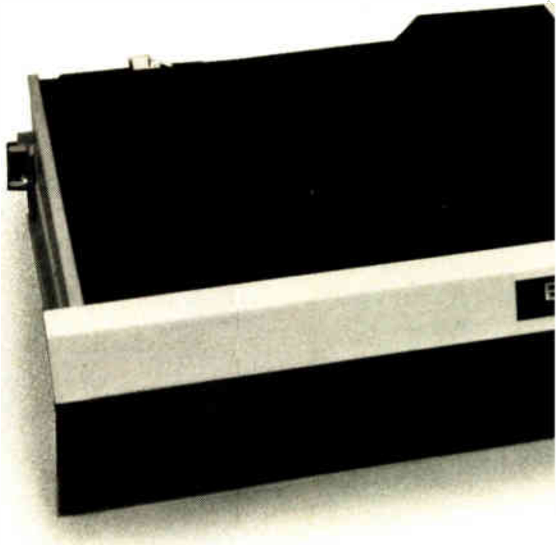

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	Compatibility	DEC RK05	DEC RK05	—	—	—	—
CAPACITY	PDP-11 (megabytes)	2.5	5	10	2.5	5	10
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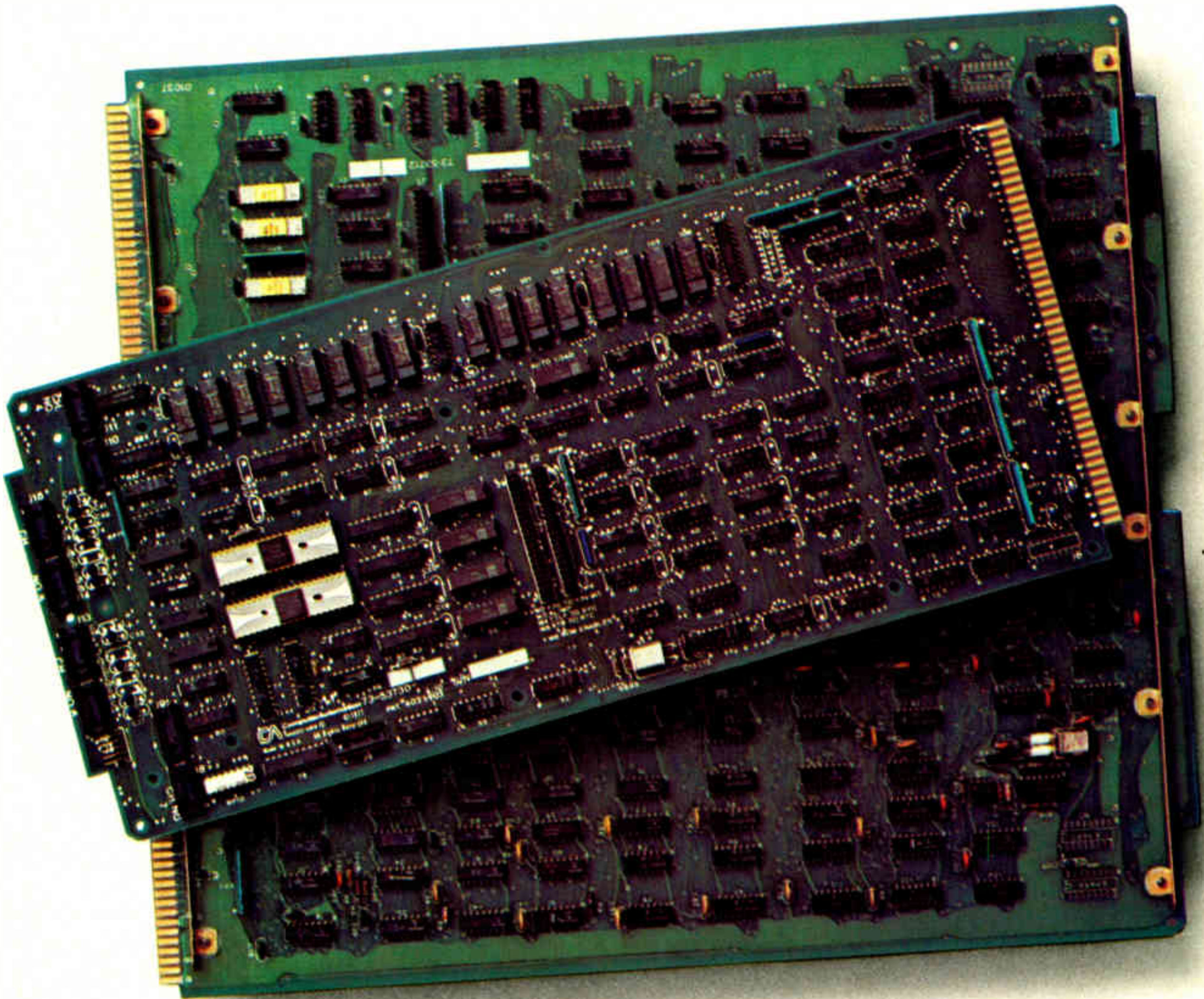
BRAND NEW MINICOMPUTERS



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BACKWARDS. Hard on the heels of our successful Sentry VII tester (recognized as the most advanced LSI tester in the industry), Fairchild introduces Sentry V: modified for high volume testing and a heck of a lot less expensive.

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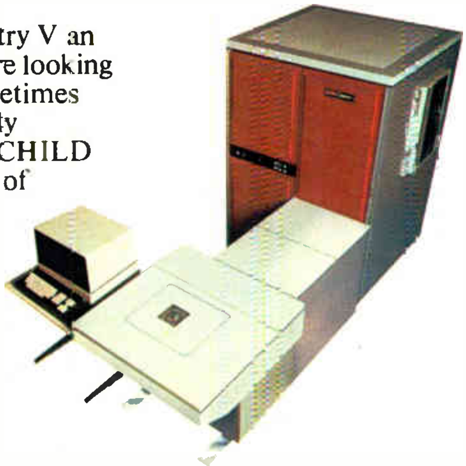
A GIANT STEP...

test stations for fast, accurate testing of TTL, ECL and TTL compatible NMOS devices.

Come to think of it, you might call Sentry V an advancement in the state-of-the-art if you're looking for a cost effective production tester. Sometimes you take a giant step forward by simply putting your foot down on costs. FAIRCHILD SYSTEMS TECHNOLOGY, A division of Fairchild Camera and Instrument Corporation, 1725 Technology Drive San Jose, California 95110 (408) 998-0123.



FAIRCHILD

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You can expand the capabilities of these SBCs and tailor a system to your specific application, selecting from over 25 memory expansion boards, digital and analog I/O boards, communications interface boards, mass storage systems and a high speed math processor. Or, you can choose one of our packaged System 80s with a customized complement of expansion boards.

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Product	CPU	RAM (bytes)	EPROM (bytes)	Bus interface
SBC 80/20-4	8080A	4K	8K (2716) 4K (2708)	Multimaster
SBC 80/20	8080A	2K	8K (2716) 4K (2708)	Multimaster
SBC 80/10	8080A	1K	4K (2708)	Single master
SBC 80/05	8085	512	4K (2716) 2K (2708)	Multimaster
SBC 80/04	8085	256	4K (2716) 2K (2708)	None

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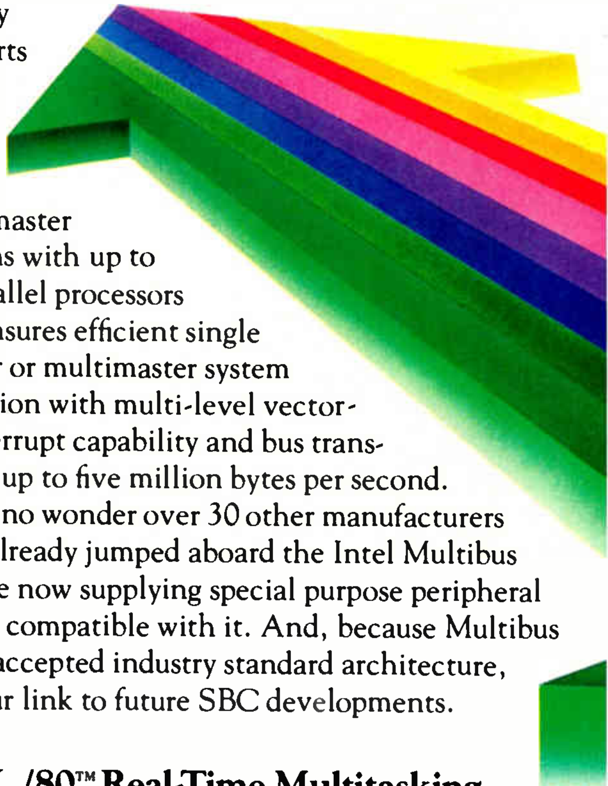
Multibus enables you to add processing power to your system in modular increments. It fully supports multimaster systems with up to 16 parallel processors and ensures efficient single master or multimaster system operation with multi-level vectored interrupt capability and bus transfers at up to five million bytes per second.

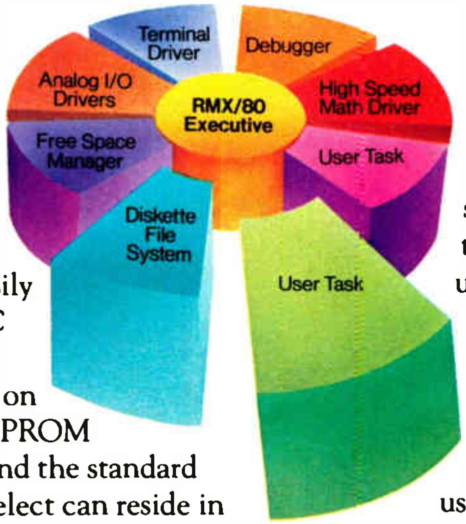


It's no wonder over 30 other manufacturers have already jumped aboard the Intel Multibus and are now supplying special purpose peripheral boards compatible with it. And, because Multibus is the accepted industry standard architecture, it's your link to future SBC developments.

RMX /80™ Real-Time Multitasking Executive provides a framework for your application software.

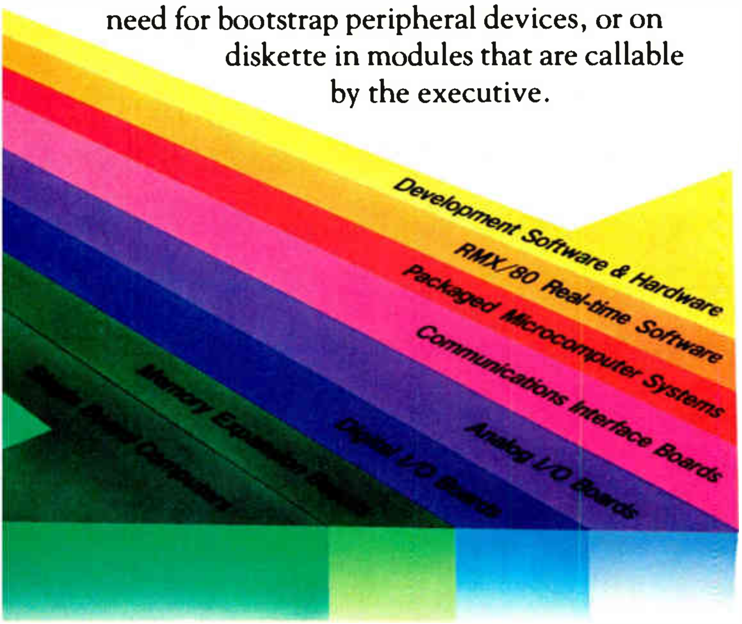
RMX/80 is the most advanced multitasking operating system for any Single Board Computer. For applications that monitor and control a number of interrelated asynchronously occurring events, it can dramatically cut software development time and costs. You develop software only for the individual tasks of your application, and the RMX/80 operating system does the rest providing all intertask communications and

multitasking software for the Single Board Computer family.



synchronization according to the task priorities you define.

RMX/80 is compact and modular, allowing you to expand and tailor your system software as easily and efficiently as your SBC hardware. The complete RMX/80 executive resides on board in a single 2K byte EPROM chip. Your task programs and the standard RMX/80 I/O drivers you select can reside in additional on-board memory, eliminating the need for bootstrap peripheral devices, or on diskette in modules that are callable by the executive.



For solutions to real time multitask applications, RMX/80 software makes Intel single board microcomputers the sensible alternative to component-level designs or far more costly minicomputer systems.

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And, integration of system software with system hardware is simplified by Intel ICE In-Circuit Emulation with symbolic debugging.

Intel gives Single Board Computer users a head start with our comprehensive SBC System Configuration Planning Kit. It's more than a catalog of our SBC products. It contains products, parameters and easy-to-use worksheets—everything you'll need to configure the optimum SBC solution for your application.

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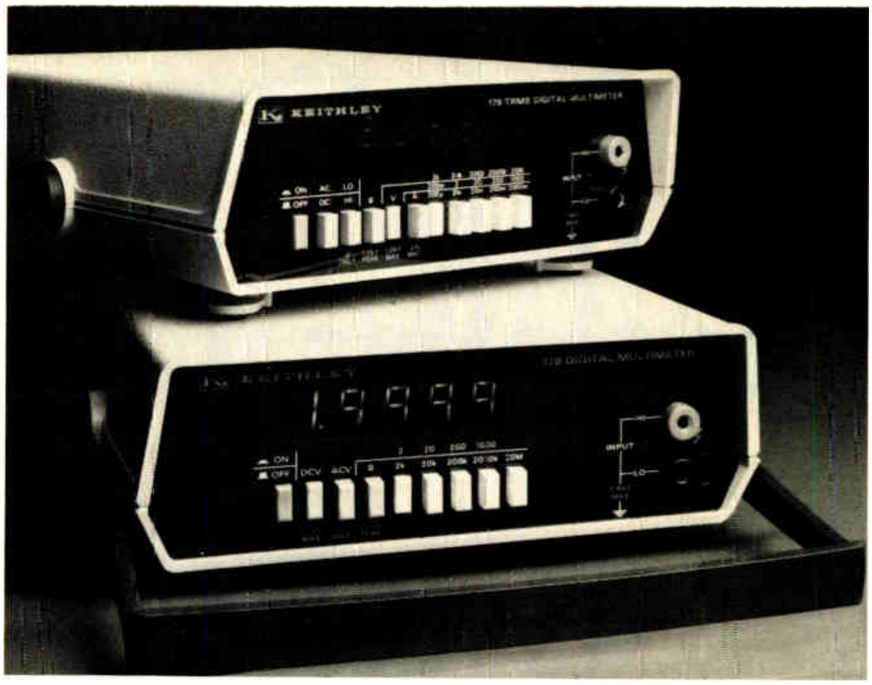
Circle No. 154 for information

Circle No. 155 for information and demonstration

ohms to 20 megohms full scale.

The 179, the true-rms meter, differs in that it performs rms measurements on ac and has one lower range on ac and dc volts, a 200-millivolt full-scale range, which means that the least significant digit corresponds to 10 microvolts. It also adds dc and true-rms current measurements with five ranges from 200 microamperes to 2 amperes full scale. Input frequencies can range between 45 hertz and 20 kilohertz.

The 179 has resistance ranges that are similar to those of the 178, but offers a higher protection voltage—it will stand 450 v rms sustained or a momentary 1 kilovolt dc or peak ac. (The 178 is protected to 250 v rms or dc.) It also adds high- and low-voltage drives on the resistance ranges; the low drive allows in-circuit measurements without turning on semiconductor junctions.



Each model uses 0.5-inch light-emitting-diode displays with automatic polarity indication (but neither model is automatic-ranging). When an overload is applied, the display blinks all zeroes. Each model also is powered from an ac line cord.

An optional rechargeable lead-acid battery, which is priced at $59, provides the user with up to six hours of operation.

Keithley Instruments Inc., 28775 Aurora Rd., Cleveland, Ohio 44139. Phone (216) 248-0400 [402]

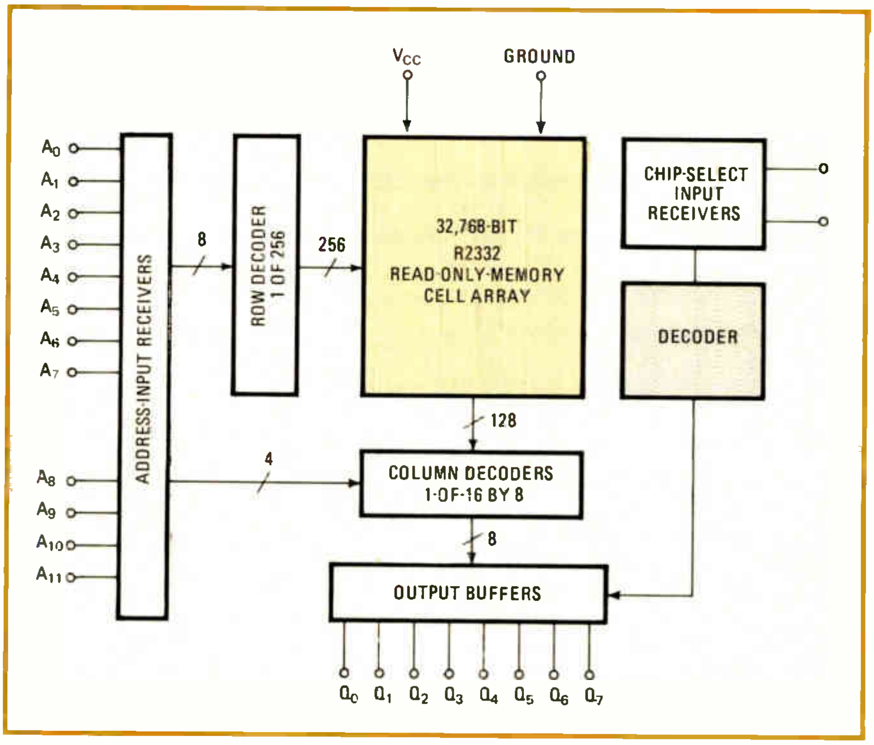
Rockwell to introduce 32-k static ROM

Spurred on to meet internal deadlines, the Microelectronic Devices group at Rockwell International has pushed development of a 32,768-word static read-only memory to the point where it is ready for the marketplace ahead of competitors.

"We can accept user codes immediately, and deliver eight weeks after receipt," promises H. R. Anderson, manager of product planning for the microelectronic devices operation. What is more, if samples are needed, "we can run a short turnaround." The price of the 24-pin model R2332 ROM comes to about $20 each in 1,000-piece orders.

Rockwell's development schedule escalated into a crash program in April when the firm opted to go ahead full speed with the System 65, a microcomputer development system. For the System 65, the ROM had to be ready by this month to go along with initial sales of the 6500 microprocessor that Rockwell is starting to turn out in volume under license from MOS Technology Inc. A key element in simplified design for the System 65 is that operating programs are resident in ROM, rather than fed in by paper tape.

Of course, the R2332 also was needed for other sales along with the 6500 processor family, observes Anderson. A critical specification of the R2332 is the 250-nanosecond access time, required by the 2-megahertz



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Kodak micro resist 747

RESULTS COUNT Kodak

speed of the 6500 family.

"We were in the position of not only being under the gun on deadline, but if the R2332 doesn't work in your own system, that's a double failure," says C. W. Padgett, circuit design engineer responsible for the new ROM. "The design is a trade-off between speed/power and chip size," he explains. The 191-by-237-mil chip uses about 375 milliwatts in reaching the 250-ns speed.

In a 4,096-word-by-8-bit organization, the ROM is compatible with all microprocessors, while primarily supporting the 6500 family. The Rockwell device offers transistor-transistor-logic input and drives at one TTL load, and probably one more as soon as performance characterization is completed, according to Padgett.

Other features include asynchronous operation and no clock input. Two chip-select inputs allow four 32-k ROMs to be OR-tied without external decoding. The chip-select delay parameters typically average 100 ns, with timing reference levels of 1.5 volts for input and 0.8 or 2 v for output. Current required is 70 to 80 milliamperes, and ambient operating temperature is over a 0° to +70° C range.

Although the R2332 ROM is the first n-channel memory produced by Rockwell, the semiconductor house has long built p-channel devices, including a 32-k chip, for its p-channel microprocessors, points out Anderson. Rockwell chose the 32-k market for its entry into n-channel because no design has yet established itself as the standard. In Anderson's view, the industry standard of the 32-k ROM will be the static type, just as at the 16-k level.

Microelectronic Devices, Rockwell International, 3310 Miraloma Ave., P. O. Box 3669, Anaheim, Calif. 92803. (714) 632-2558 [401]

DMMs tailored to communications

To round out its line of digital multimeters, Systron Donner Corp. is introducing five 4½ digit DMMs—four portable and one rack-mountable—at Wescon this year. The four portable models, designated the models 7141A, 7141B, 7241A, and 7241B, carry prices of $395, $450, $395 and $450 each. The fifth model, the 7344A, is designed as a systems multimeter for use in calculator-based systems and is priced at $945.

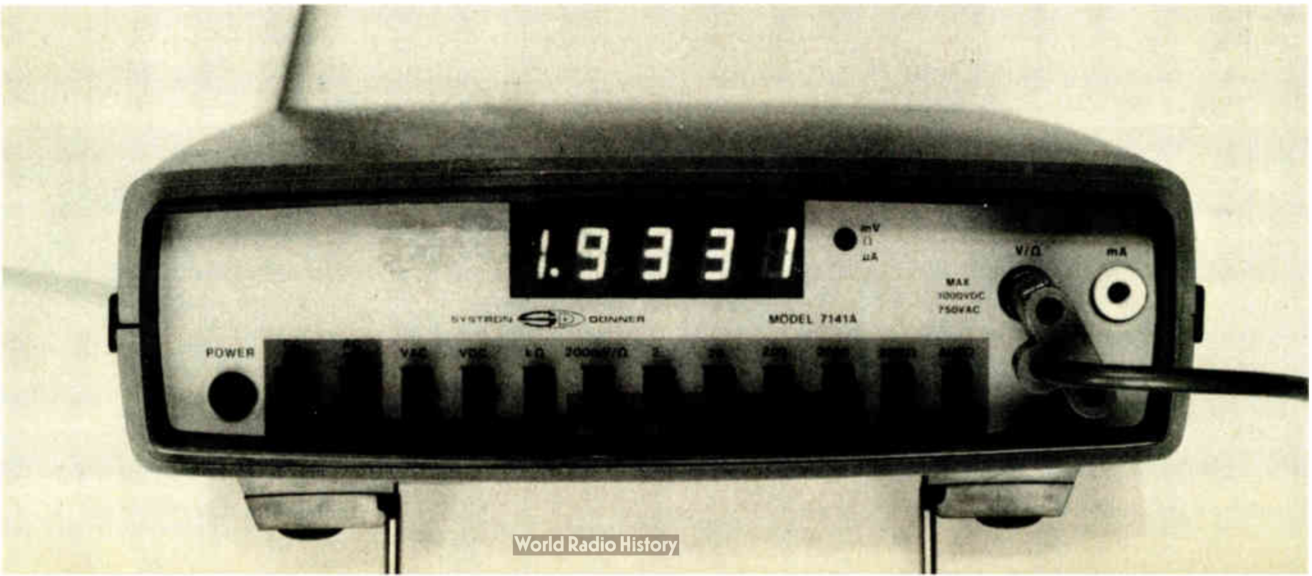
According to product marketing manager Chuck Bishop, the models plug a gap in Systron Donner's DMM line between its 3½-digit portables and 5½-digit bench and microprocessor-controlled DMMs. The 7141A has a basic dc accuracy of +0.05% of full scale and +0.05% of reading. For those applications requiring more accuracy, the model 7141B provides a basic dc accuracy of +0.02% of reading and ±0.01% of full scale.

The models, says Bishop, utilize a true-rms ac converter. Its crest factor of 4 at full scale allows the user to make virtually any kind of ac measurement from 45 hertz to 20 kilohertz. In addition, the two models offer five dc current ranges and five ac current ranges. Protection is provided by a resettable circuit, located on the rear, that automatically opens at 2 amperes.

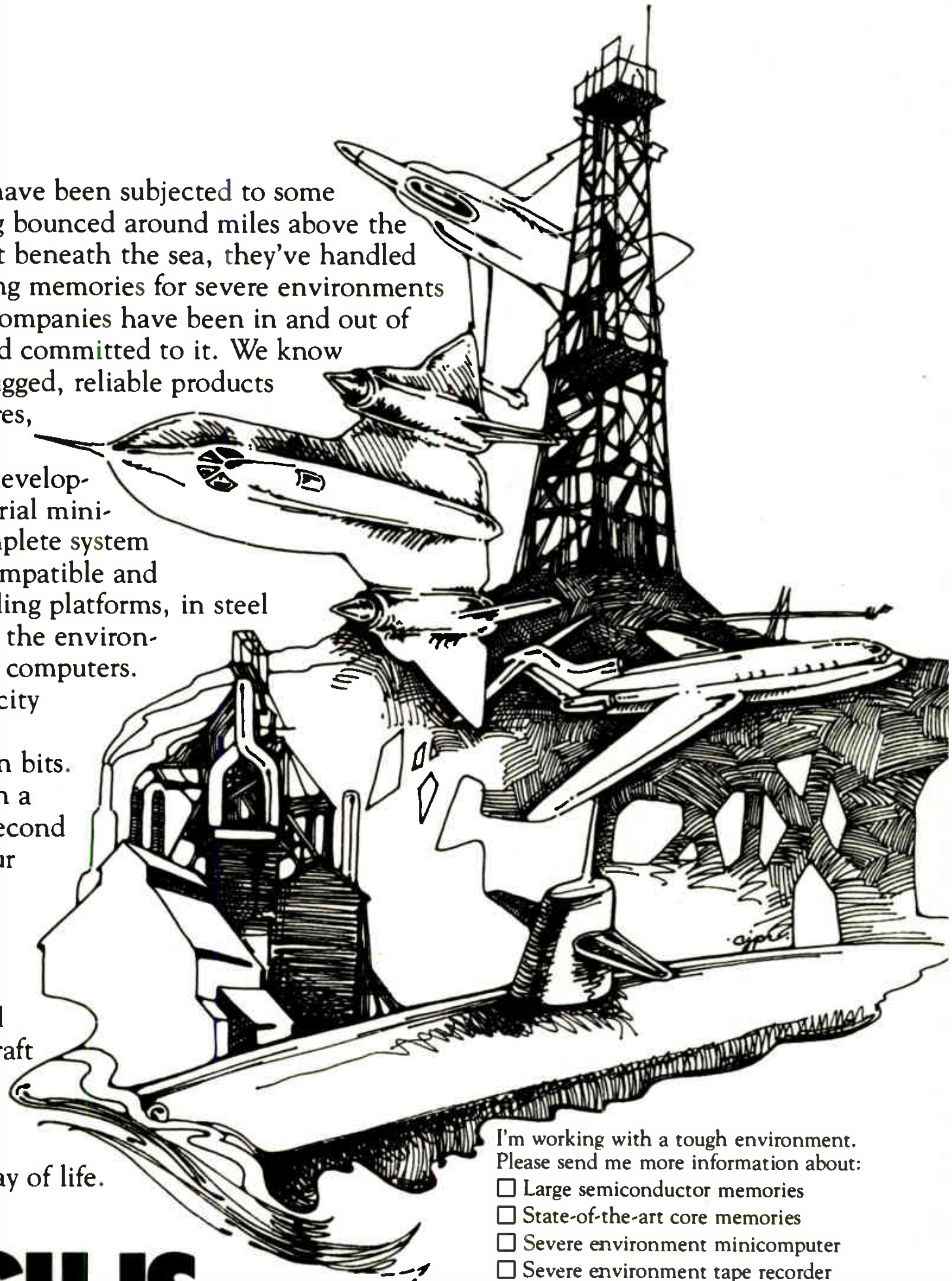
In the models 7241A and 7241B, the current-measuring capability has been replaced with five ranges of dBm, says Bishop. Dynamic range is from −60 dBm to +60 dBm referenced to a 600-ohm balanced line. The frequency range of 20 Hz to 20 kHz satisfies all requirements of the communications and telephone industry for checking tones, he says.

All of the models have an analog meter option. In addition to the light-emitting-diode display, Systron Donner has added an analog meter on the front of the panel. This feature gives the user the ability to make nulling and peaking measurements, which are usually impossible with a rapidly changing digital readout. The meter is connected to the integrator input so it gives a representation of the input regardless of range or function. All instruments have a battery-pack option, giving the user 4 hours of continuous use.

The model 7344A is a low-cost, high-performance, 20,000-count DMM that is IEEE-488 compatible. This instrument handles dc voltage,



Our severe environment products have been subjected to some pretty rough treatment. From being bounced around miles above the earth to operating thousands of feet beneath the sea, they've handled it all. At EMM, we've been building memories for severe environments longer than anyone else. A lot of companies have been in and out of this hostile market. We've remained committed to it. We know what it takes to design and build rugged, reliable products that withstand corrosive atmospheres, shock, vibration, and temperature extremes. And, we're continually developing new ideas. Like our new industrial minicomputer system available as a complete system or as a card set. It's PDP-11/34* compatible and built for tough jobs on oil well drilling platforms, in steel mills and paint plants, or wherever the environment is too rough for conventional computers. Another new idea is our high-capacity semiconductor memory for military applications with up to 28.8 million bits. If you need speed, we're working on a 200 nanosecond access, 500 nanosecond cycle core memory. Then there's our airborne data recorder. Compact, 4.0 x 6.0 x 3.0 with 23 million bits of storage and a removable sealed tape cartridge. We know it takes a lot to survive out in the rough, real world of industrial, military or aircraft electronics. So, when you're confronted with operating in a severe environment, we have your solutions. After all, rough is our way of life.



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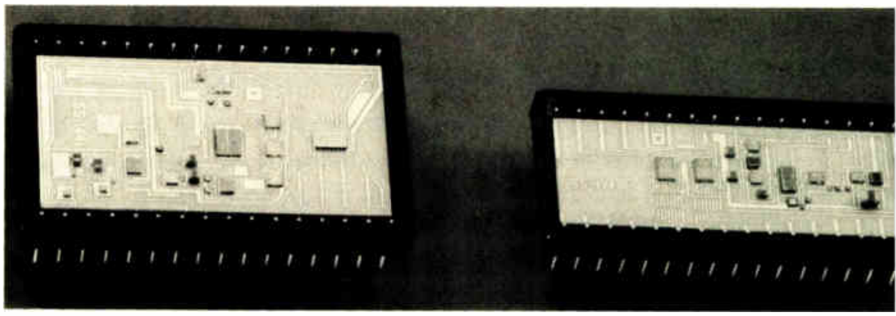
true-rms ac voltage, and resistance measurements, works with the IEEE 488 interface, and is rack-mountable. It features a 1¾-inch-high full rack configuration.

It features five dc voltage ranges from ±10 microvolts to +1,000 volts with dc accuracy of ±0.02% of reading and ±0.01% of full scale. With a true rms converter, the 7344 can measure virtually any kind of wave shape. Its crest factor of 4 at full scale and a dc-coupled input amplifier allow measurements of triangles, pulses, square waves, or distorted sine waves up to 20 kHz. The 7344A has six resistance ranges, allowing measurements down to 0.01 ohm. In addition, a novel circuit protects the ohms circuitry from overloads up to 350 volts rms. Autoranging is a standard feature, but the range can be selected manually or remotely. All functions, ranges, and sample rates can be controlled in the format specified by the IEEE 488 standard.

Systron Donner Corp., Concord Instruments Division, 10 Systron Dr., Concord, Calif. 94518 [403]

Hybrid data system comes in two DIPs

Most data-acquisition systems are fairly large modules that consume considerable space on a circuit board. But engineers at Micro Networks Corp., Worcester, Mass., have a hybrid alternative that provides a 12-bit, 16-channel data-acquisition system in two dual in-line packages that requires less than 4 square inches of board space. In addition, at $137.50 each for orders of 100 or more, the acquisition system is only about two thirds the price of competitive modules, says John Munn, marketing engineer.



The new ingredient in the system is the MN7130, which includes a multiplexer and a sample-and-hold amplifier. The previously available Micro Networks ADC80 analog-to-digital converter completes the two-package system. Together, they offer 16 single-ended or 8 differential input channels that may be addressed with a single digital word. Total throughput rate of the system is 30 kilohertz, including conversion.

Also included in the 32-pin MN7130 is an instrumentation amplifier that provides 250 megohms input impedance and more than 80 decibels of common-mode rejection in the differential-input mode. All the user needs to provide, says Robert Calkins, manager of circuit development, is addressing for the multiplexers and the analog inputs. The analog output goes to the a-d converter and the latter sends an end-of-conversion pulse to gate the sample-and-hold on and off.

Munn says the user may have to add about $10 worth of transistor-transistor-logic packages if he needs three-level output gates or address latches. In single units, the MN7130 sells for $120, and the ADC80 for $77.50. Those prices drop to $90 and $47.50, respectively, in quantities of 100 to 249.

Micro Networks Corp., 324 Clark St., Worcester, Mass. 01606. Phone John Munn at (617) 852-5400 [404]

Multimeter ranges up to 1,000 volts

A digital multimeter that provides eight input ranges will test instrument and system voltages of up to 1,000 volts. The model 5940, 5½-digit ratiometer has four ranges of ac references and four ranges of ac signal input (1, 10, 100, and 1,000 v) and is useful for checking ac-to-ac ratios on instruments with greater than 10-v outputs. The Dana Laboratories Inc. instrument also features true rms converters and switchable front/rear inputs.

A typical application—and one impossible with present multimeters, says a company official—would be to test a transformer with, for example, 115-v input and 500-v output. Previously it would have been necessary to attenuate at least one of the voltages to derive the ratio, he says. Similarly, entire guidance systems and their subsystem gyroscopes, servos, and accelerometers may be tested with the new Dana Lab instrument.

The true-rms ac converter feature allows a user to make accurate measurements of distorted or nonsinusoidal voltages, he adds. Also, by means of a blocking capacitor, either the ac or dc component of a signal may be measured.

For systems applications, the switchable front-rear inputs allow localized troubleshooting without disconnecting the first input. In such an application, the user, for instance, could maintain the rear input signal, while employing the model 5940's voltmeter for front input reference.

In addition to the ac-to-ac ratio

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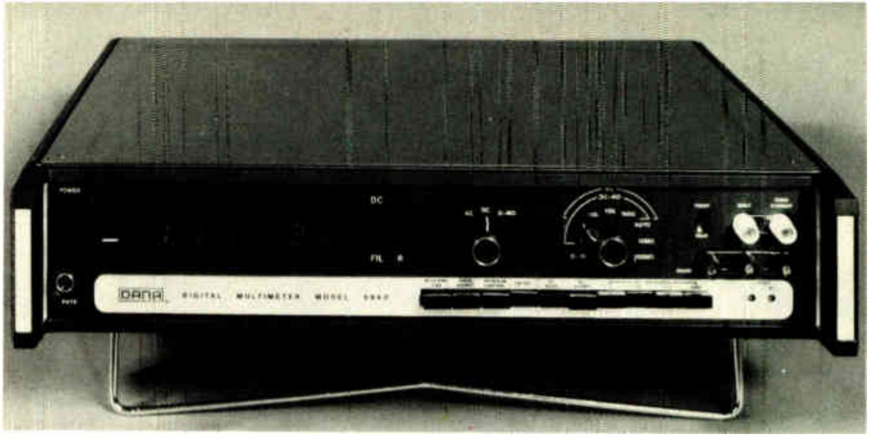
capability, the instrument has five dc ranges with accuracies of ±0.001% of full scale (10 ppm). In this mode, it has eight ranges of resistance and a four-wire—four-quadrant dc ratio. Inputs are protected up to 1,000 v on all ranges.

Another feature is guaranteed one-year specifications on the new instrument, which eliminates the need for frequent calibration, the company says, reducing both this expense and system downtime.



Base price of the model 5940 is $3,495, termed substantially cheaper than previous comparable models by the Dana official, through incorporation of improved transistor-transistor-logic and linear circuits. Delivery time is 90 days.

Dana Laboratories Inc., 2410 Campus Dr., P.O. Box C-19541, Irvine, Calif. 92713. Phone (714) 833-1234 [405]

Printer interfaces with data sources

Printers for industrial and instrumentation applications are often computer peripherals with price tags that are too high for these applications. Engineers at the Measurement and Control Systems division of Gulton Industries Inc. have attacked that problem with two units that will debut at Wescon. They are the AP-20L, an alphanumeric lab printer, and a dedicated numeric printer.

The AP-20L offers the user direct connection to a variety of data sources, including data-communications equipment, microcomputers and minicomputers, teletypewriter and keyboard equipment, and the IEEE standard-488 instrument bus. The 20-column unit prints 2½ lines per second in a 64-character ASCII upper-case font using a 5-by-7-dot matrix.

Any of the following interface options may be included: two versions of bit-serial/character-serial data interfaces, a bit-parallel/character-serial IEEE instrument-bus interface, or a binary-coded-decimal interface. The latter produces four-line BCD data that is bit-parallel/character-serial, is 10 columns wide, and is programmable over any of the 20 columns.

The AP-20L's interfaces are built as self-contained plug-in modules that come complete with a dedicated input/output connector and whatever controls are needed. They plug into a dedicated opening in the unit's rear panel. The lab printer also provides access to the bit-parallel/character-serial interface offered in an earlier OEM version by a D connector on the back.

Gulton engineers point out that in some instances, this input can be used concurrently with a dedicated interface, each printing on a separate portion of the paper tape. Such a bilingual mode can be especially useful in labeling or identifying BCD data with bit-parallel/character-serial alphanumerics.

The AP-20L also provides space for an optional real-time clock, front-panel light-emitting-diode display, and a selector switch that would allow time-of-day printouts and print-sequence gating. The printer will be offered in panel-mount or self-supporting lab or bench-case versions, and it sells for $825 in single quantities.

The dedicated numeric printer, priced at $875, is a self-contained laboratory instrument that includes a 3½-digit panel meter, the division's NP-7 printer, and related electronics. It can measure voltage, current, and temperature, or, using appropriate transducers, will handle weight, pressure, and flow. The printout includes parameter and channel number at selected time intervals from 1 second to 1 hour. The 7-column printout assigns columns 1 and 2 to printing the channel number of interest, column 3 to a plus/minus sign or blank, and columns 4 through 7 for the parameter value.

Possible future options for the numeric printer include a switch-selected printout-by-exception feature, a real-time clock for printout of the time of an event, and autoscan of 10 channels. Delivery of both the AP-20L and the dedicated numeric printer is 60 to 90 days.

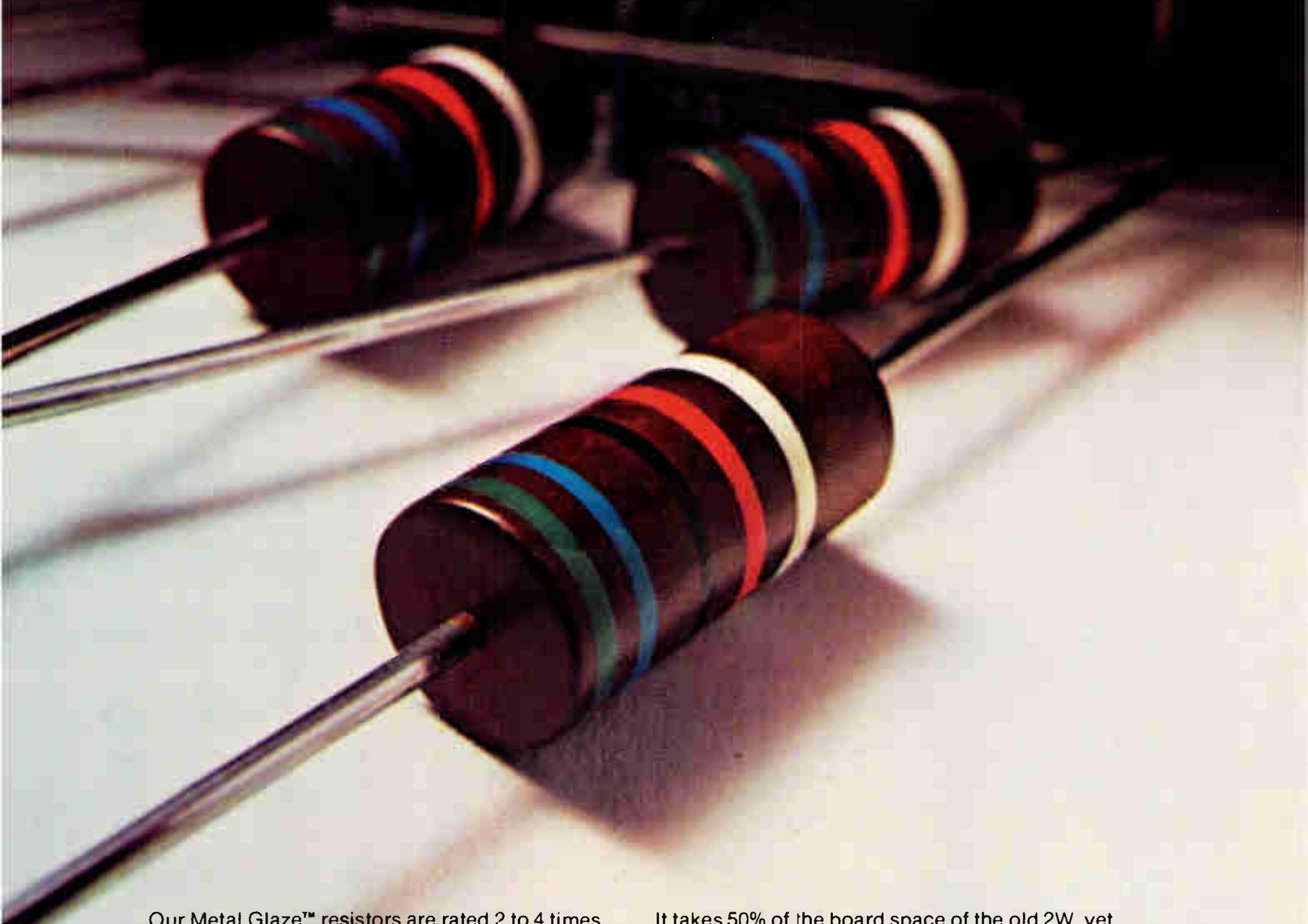
Measurement & Control Systems Division, Gulton Industries Inc., Gulton Industrial Park, East Greenwich, R. I. 02818. Phone (401) 884-6800. [406]

$195 counter resolves 8 digits

To measure frequencies below 1 kilohertz to a resolution of 0.01 hertz, an operator must wait 100 seconds if he is using a conventional frequency counter in the "period" mode. But the same measurement can be made in a second with a new low-cost 80-megahertz counter from Ballantine Laboratories Inc. of Boonton, N. J.

The 8-digit model 5720A achieves this resolution by phase-locking an internal 100-times multiplier oscillator to the input signal and counting the oscillator's 100× multiplied out-

Metal film with muscle.



Our Metal Glaze™ resistors are rated 2 to 4 times mil spec power, yet retain precision resistor characteristics.

Now, with both strength and precision, you can take advantage of these thick film resistors and standardize on one size. Or benefit from an improved safety factor. For example, our 1/8W 1% device will handle 1/2W @ 70° C, or up to 40W pulse.

What's more, we've added a new 2W standard. It takes 50% of the board space of the old 2W, yet is rated 3W @ 25° C. We're also in the process of substantially increasing resistance well into the megohms.

TRW metal films with muscle are available from 1/8W to 5W, 200 V to 15 KV, with 1, 2 and 5% tolerance. For standards in all types of resistors, contact your local TRW distributor. Or TRW/IRC Resistors, 401 N. Broad St., Philadelphia, Pa. 19108. (215) 922-8900, Dept. G.

TRW IRC RESISTORS

ANOTHER PRODUCT OF A COMPANY CALLED TRW

™ Metal Glaze is the TRW trademark for its thick metal film resistors.

Circle 167 on reader service card

New products

put during a one-gate period. The unit costs $195.

According to Ballantine president Fred L. Katzmann, this performance is "ideal for calibrating selected-tone communications circuits plus power line frequency, tachometers and other devices which normally use period measurements in more costly instruments." With 8-digit resolution, he continues, "the unit also can serve as a 'digital dial' for precision setting of test oscillators and signal generators."

The model 5720A has a sensitivity of 50 millivolts root-mean-square over its full range of 10 Hz to more than 80 MHz and, using 0.43-inch-high bright orange light-emitting diodes, reads out directly in megahertz, kilohertz, or hertz as selected by a front-panel switch. The same switch automatically positions the decimal point to give resolutions of 1 kHz, 1 Hz, or 0.01 Hz, with gate times of 1 millisecond or 1 s. The display is nonblinking.

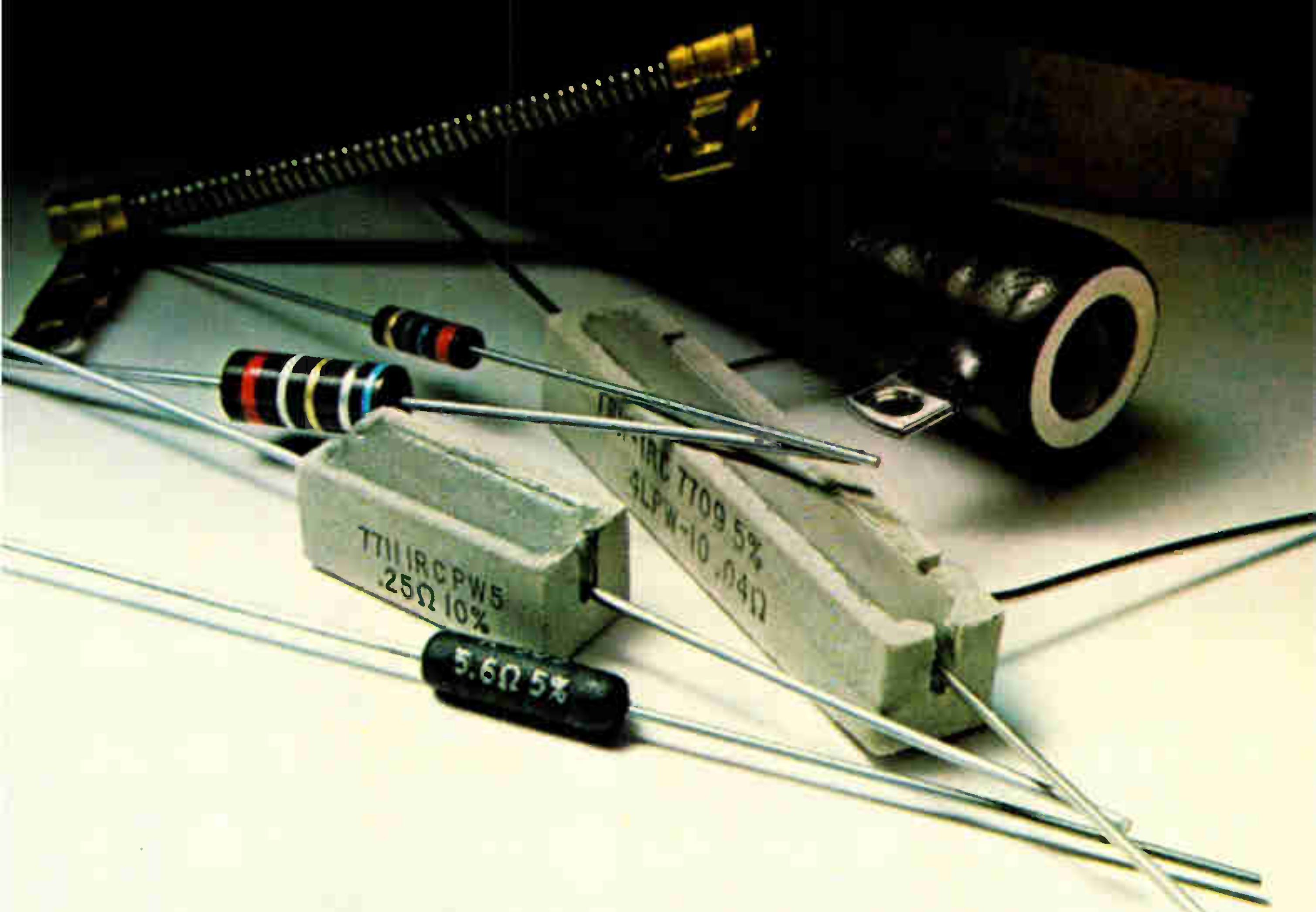
The portable counter weighs 2.5 pounds and operates from dc and ac. In the field, the 5720A draws about 600 mA when run on any 9-to-14-volt dc source, such as a car or boat battery, permitting it to be used to certify mobile communications equipment on site. For ac power use, optional wall-mounted ac-to-dc converters are available for 115 and 230 v ac, at a cost of $30 and $35, respectively.

The 5720A has a 1-megohm input impedance that is shunted by 25 picofarads. The maximum input to the counter is 250 v rms from 10 Hz to 1 kHz, decreasing to 10 v rms above 10 MHz. A front-panel adjustment provides for continuously variable input sensitivity to accommodate large-amplitude signals and discriminate against noise.

The 5720A's built-in crystal-controlled oscillator has an aging rate of less than 2 parts per million

What's TRW up to now?

Wirewounds that save.



For pennies you can buy circuit protection with our BWF series resistors, perhaps saving your company a bundle later. U.L. approved, they will fail safe under specified overload conditions.

And when it comes to cost and reliability, our molded BW and ceramic PW series are standards for 1-22W general purpose applications.

For higher power we've introduced new PW styles in 30, 40 and 50W ratings. Integral mounting brackets boost power dissipation up to 30%.

And, if it's good sense you're after, our 4LPW series is designed for current sensing and feedback circuits. Available in 5 ratings from 3 to 15W, with 2 or 4 leads, and resistance values as low as .01Ω.

For standards in all types of resistors, contact your local TRW distributor. Or TRW/IRC Resistors, 401 N. Broad St., Philadelphia, Pa. 19108. (215) 922-8900, Dept. W.

TRW IRC RESISTORS

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New products

per month and a temperature-induced drift of less than 5 parts in $10^7/°C$ from 0°C to 40°C. The temperature operating range of the counter is −10°C to 45°C. Access to the instrument's 1-MHz internal clock is via a rear-panel BNC connector. The same connector, notes Katzmann, also can be used to input any external 1-MHz frequency standard with higher stability or any signal in the range from 1 MHz to 10 Hz for frequency ratio measurements, and to perform a self-test of the digital and input signal analog circuits. "These are features not generally available in instruments of this kind selling below $300," he adds.

Ballantine Laboratories Inc., P. O. Box 97, Boonton, N. J. 07005 [407]

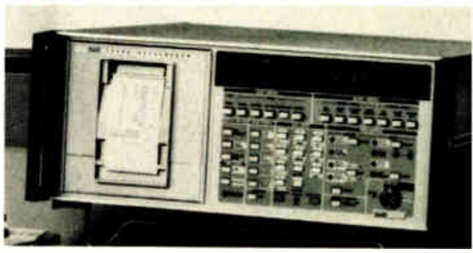
Loggers handle all detectors

Since its introduction in late 1975, the Fluke 2240A data logger has dominated the field. Now the firm is expanding its original logger into a full family of "B" instruments with expanded inputs, alarms, and remote programming for process monitoring.

The 2240B (shown in the photograph) includes new input conditioning and scaling to accept any transducer with current, voltage, or digital output and can handle resistance-temperature detectors and virtually any thermocouple.

The full-control mainframe, expandable to 1,000 channels, is $3,995; minus a printer, it is $3,595. When remote control only is desired, the mainframe is $2,700 with a blank panel.

The addressing capabilities of the



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TRW IRC RESISTORS

ANOTHER PRODUCT OF A COMPANY CALLED TRW

Circle 171 on reader service card

remote-control option permit up to six data loggers to be controlled from a single terminal. Four ASCII characters may be assigned to any one channel for units, control characters, or identifiers. Four alarm-mode choices are possible, all settable from a remote terminal.

The unit measures voltage to 1 microvolt and temperature to 0.1°C. It will scan up to 1,000 points at nearly 15 readings per second with high noise rejection, as often as once a second or as seldom as once every 24 hours. It can be programmed to continuously monitor a single channel, and it will record all the data or only the data that exceeds preselected limits.

The 2240B is key-programmable from the front panel, requiring no special language. Simple front-panel buttons, which are color-coded, allow storage by the internal microprocessor of instructions and exact execution of the measurement routine. Switches are grouped by function, with a minimum use of multiple function keys. If a signal range or function changes, the front-panel programming allows the operator to make most changes without equipment changes, according to the company.

John Fluke Manufacturing Co., P. O. Box 43210, Mountlake Terrace, Wash. 98043 [408]

Pulse generators are programmable

Three new pulse generators—two programmable units directed at automatic test applications and a third for the laboratory or production line—are being added to EH Research Laboratories Inc.'s line of instruments. The programmable units, called the models 1503 and 1504, are priced at \$5,195 and \$5,145, and the third, the model 136A, carries a \$1,895 price tag.

The model 1503 is aimed at test systems requiring the subnanosecond rise times typical of emitter-coupled logic. The compact 5¼-inch instru-

Mini-microcomputer users.

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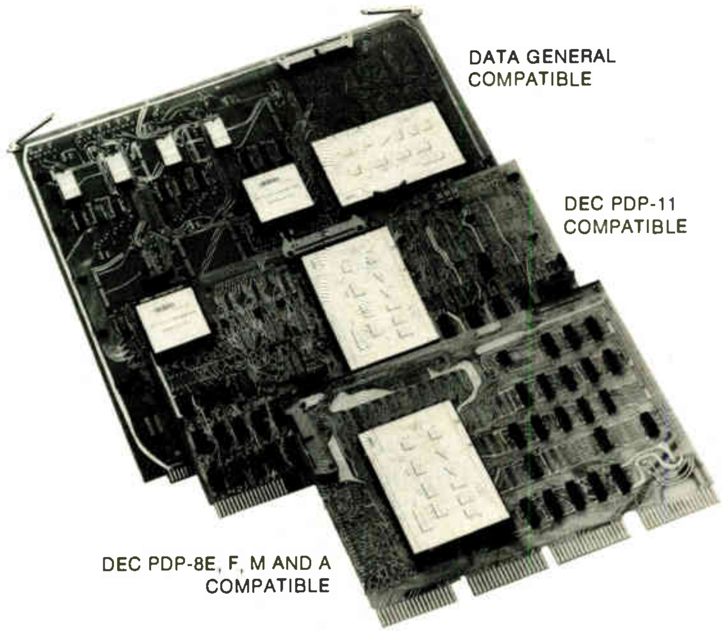

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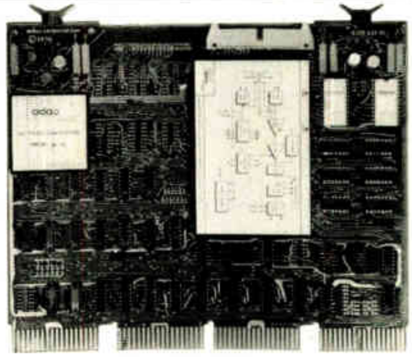
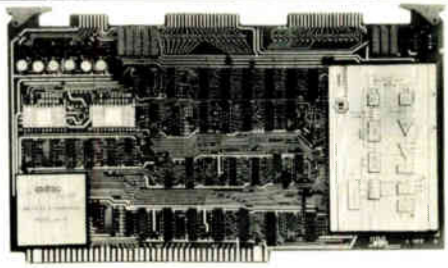


DEC LSI-11 COMPATIBLE



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Circle 173 on reader service card

ment provides frequencies from 0.5 hertz to 50 megahertz, fixed rise and fall times of less than 550 picoseconds, and complete programmable control of all pulse parameters.

Capable of driving the fastest digital logic circuits, this instrument offers output amplitudes of 12 volts into 50 ohms with a baseline-offset variable in the range of 1 v. Both positive and negative polarities as well as normal and complement mode are selectable under program control. External trigger and gate inputs plus three trigger outputs provide the flexibility needed to integrate the 1503 into an automatic test system. A wide range of program-bus options are available for the 1503 including the IEEE standard 488-1975 digital interface.

The 1504, on the other hand, is designed for test systems requiring a wide range of pulse-parameter control with amplitudes up to 20 v. The IEEE interface option is also provided on the model 1504, as are the external trigger and gate inputs plus three trigger outputs.

For semiconductor component- and circuit-testing, the 1504 is equipped to handle most device families, with flexible 50-MHz timing circuits and a fast-rise-time output amplifier ranging from millivolts to 20 v full scale.

The lab model 136A features a pulse repetition frequency of 10 Hz to 60 MHz and pulse amplitude ranges from 140 mv to 120 v. It also offers controllable rise and fall times from 3 nanoseconds to greater than 8 milliseconds up to 10 v in seven common ranges, a variable delay from 10 ns to 50 ms in 10 ranges, width from 10 ns to 50 ms, and offset from 0 to 5 v into 50 ohms.

EH Research Laboratories Inc., Box 1289, Oakland, Calif. 94604 [409]

Devices handle graphics

Two new peripheral devices from Wang Laboratories Inc. are being billed by the company as a complete

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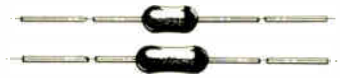

Type: FM50, 75, 100 & 150
PIV: 5,000, 7,500, 10,000 & 15,000V
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Static Forward Voltage, 10mA @25°C: 10 & 20V
Reverse Recovery Time (Max.): 300ns
Case Size (Max.):
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Type: SH75 & SH100
PIV @25°C: 7500 & 10,000V
Average Rectified Current @55°C in Oil: 200mA
Static Forward Voltage, 100mA @25°C: 12V
D.C. Blocking Voltage @25°C: 7500 & 10,000V
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Circle 175 on reader service card

graphics system suitable for end users. One is the model 2282 graphic cathode-ray tube, and the other is the model 2231W-3 printer/plotter. Together, they provide small business users with both CRT display and hard-copy printouts of alphanumeric and graphical data.

Samuel Gagliano, product manager for small systems in Lowell, Mass., says both peripherals use an 8080 microprocessor controller and both are fully compatible with Wang's 2200 small computer line, some 14,000 of which have been installed. The 2282 is enclosed in a standard CRT console, without a keyboard. It uses scan-refresh technology, with a memory location for each of the 800 horizontal and 512 vertical dots on the screen.

Gagliano says the company initially considered using a storage tube, but its higher cost plus the inability to selectively erase led to the choice of electronic scan refreshing in a conventional CRT.

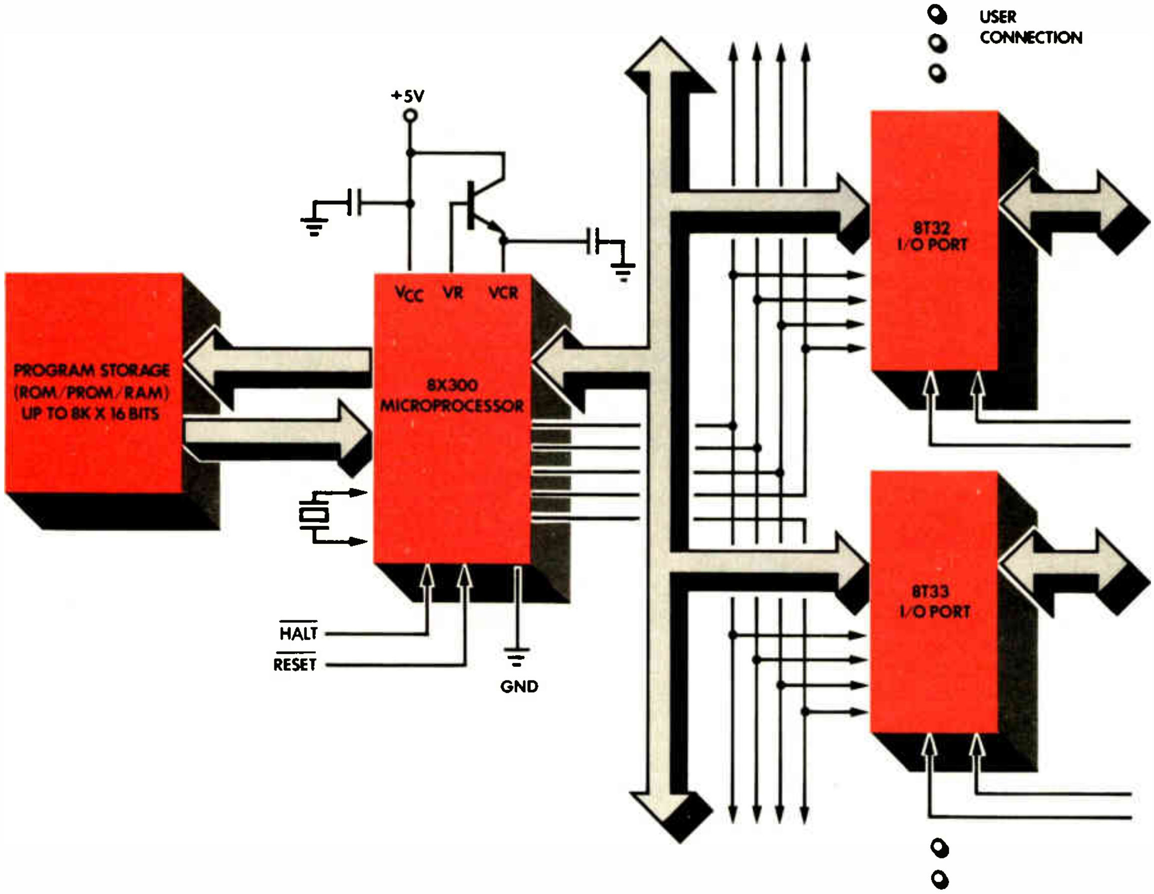
To make the peripherals work together, Wang uses a printer interface controller for both and regards the CRT as a printer output device. "The controller daisy-chains into the CRT and printer so that we don't need the second interface controller that would normally be used for a line printer or other hard-copy device," Gagliano explains. The printer is a 132-column unit that would normally run at 120 characters per second. Wang, however, has used a new character set to get better resolution, an adaptation that slows the rate to between 100 and 110 characters per second.

Gagliano says most of Wang's existing plotter software can run on the CRT without modification, but a plotter utility software package comes with the system to allow the printer to plot such things as bar and pie charts. That feature, he says, gives the systems the ability to generate business forms.

The 2282 graphic CRT is priced at $3,600; the 2231W-3 printer/plotter sells for $3,800.

Wang Laboratories Inc., One Industrial Ave., Lowell, Mass. 01851. Phone Samuel Gagliano at (617) 851-4111 [410]

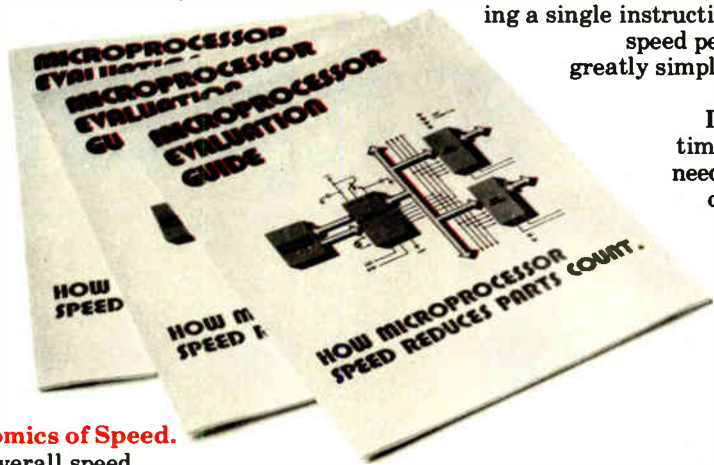
Our 8X300 Bipolar Microprocessor handles 4 million operations/second with an optimized fixed-instruction set.



That kind of speed even makes sense for slow systems because it reduces parts count. This Guide explains why.

Our new Evaluation Guide was written to help you analyze the system design economics of microprocessor speed. It describes how a typical application can be implemented four different ways. Use of the Signetics 8X300 is compared with three other alternatives.

This Guide explains how microprocessor speed can shrink system cost by reducing parts count. You need it if you're sincerely interested in an apples-to-apples comparison of popular design techniques. Chances are, it may also convince you that you need the 8X300.



Learn the Hidden Economics of Speed.
Regardless of a system's overall speed requirement, microprocessor speed affects the most important selection criteria you can apply—operations/second/dollar.

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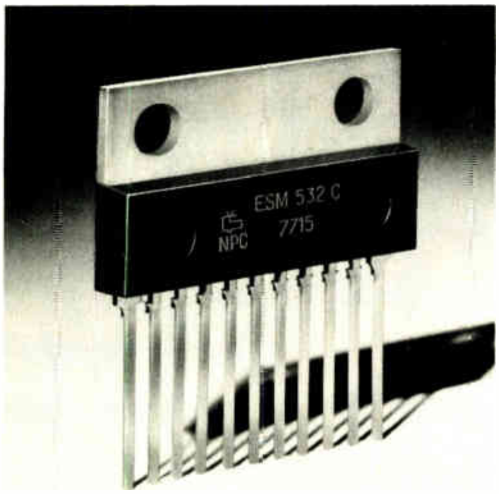

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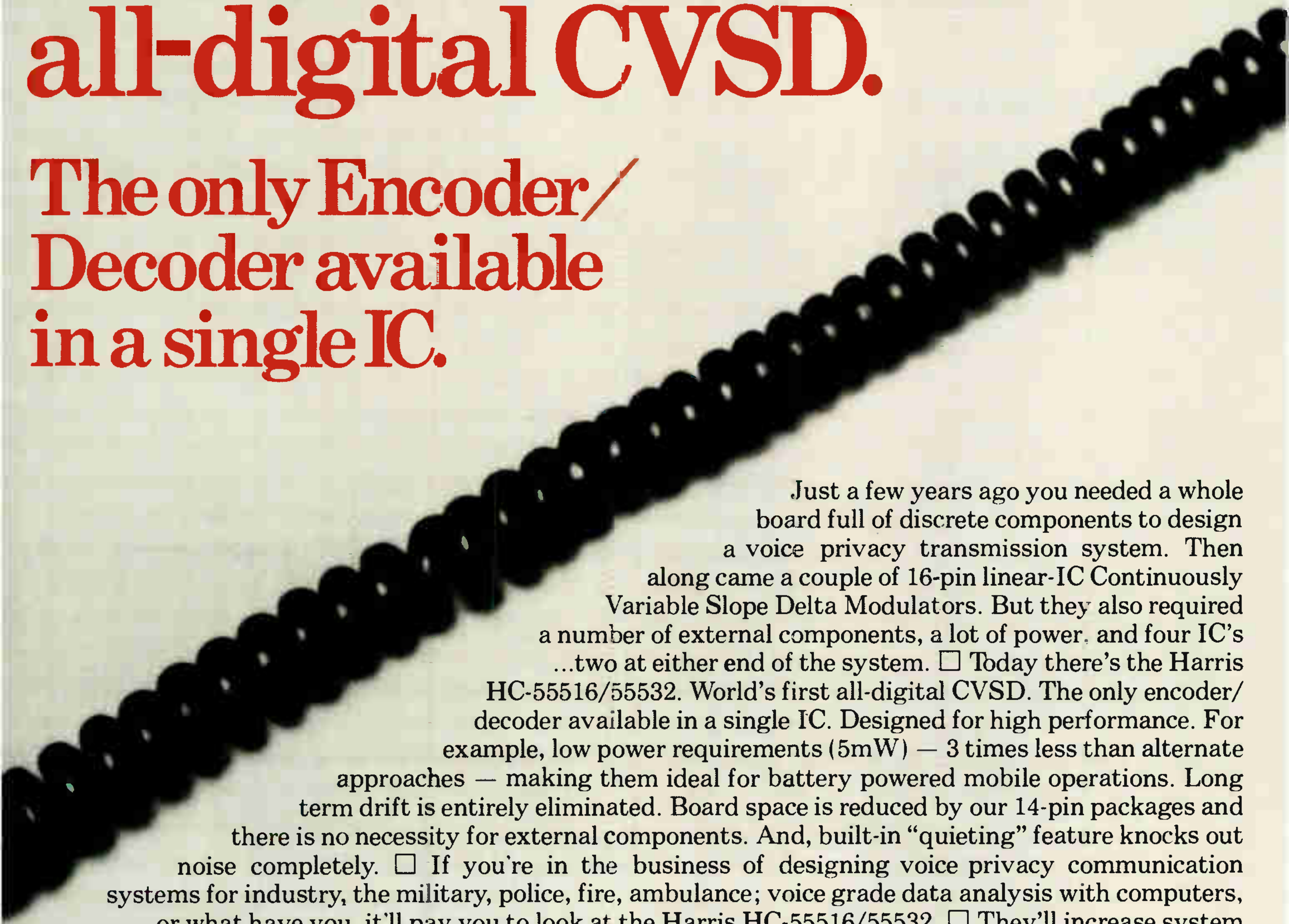

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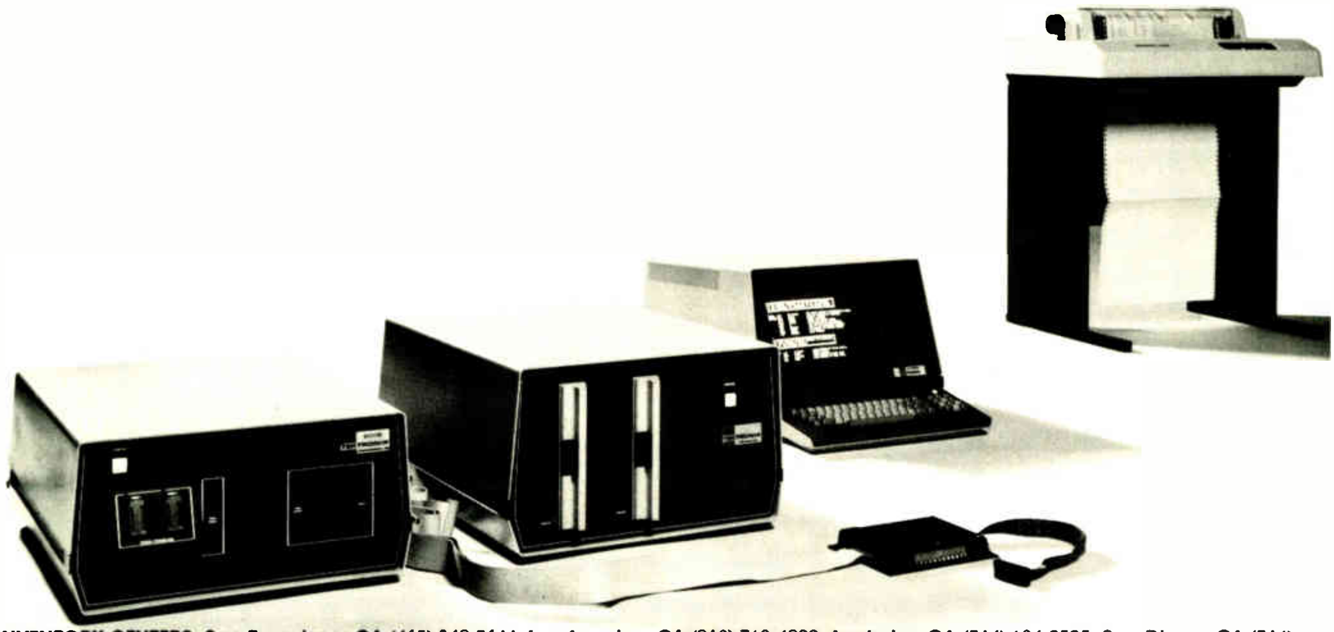

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Data system plays triple role

Equipment can be configured as a smart data-acquisition front end, a computer-based system, or a peripheral for a large computer

by Michael J. Riezenman, New Products Editor

The term "data-acquisition system" has come to cover so many types of products—from small hybrid subsystems to dedicated data loggers—that the advent of a true system capable of being configured to perform a variety of tasks is something of a rarity. Such a rarity is Adac's system 1000.

Built around a bus architecture identical to that of Digital Equipment Corp.'s LSI-11 microcomputer, the system 1000 consists of three main components: a card-cage/backplane assembly, a rack drawer, and a power supply. Key to the system's versatility is the card-cage/backplane. This section can accommodate up to 11 8.5-by-10-inch (quad) boards or 22 8.5-by-5-in. (half-quad) boards in any combination. Among the boards that can be plugged into the backplane is the LSI-11 microcomputer itself. Another is a board that interfaces the LSI-11 bus to the DEC Unibus so that any PDP-11 series minicomputer can use the system 1000 as a data-acquisition front end. This capability to be configured as a complete stand-alone computer-based system, as a data-acquisition system with a preprocessor, or as a simple peripheral for a large computer is what makes the unit unique, according to Al Grant, Adac's vice president for marketing.

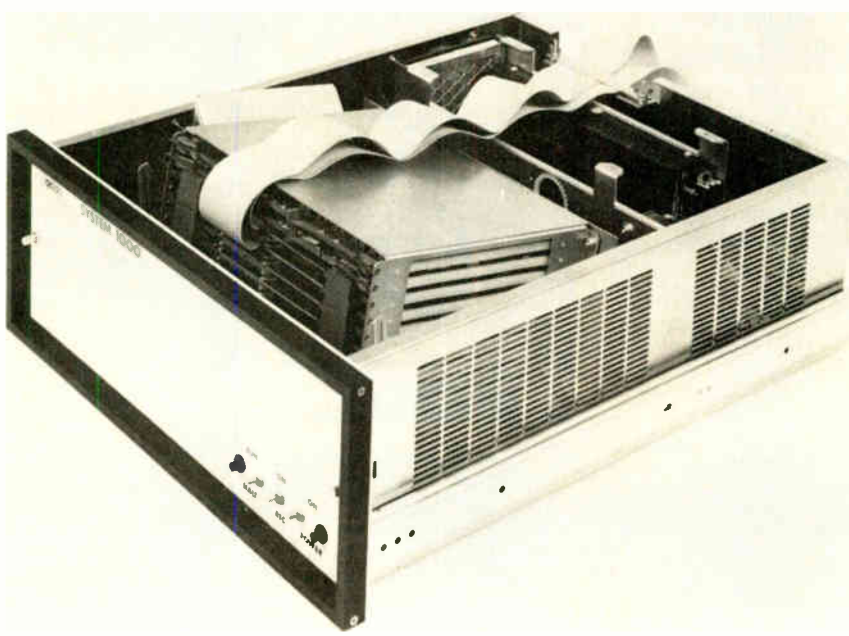
Adding to the system's versatility is its rack drawer, which has 2 inches of unused space behind its front panel. This makes it easy for users to mount their own switches, indicators, and other components on the panel to customize the system for their individual applications.

To make sure that a backplane full of boards and a front panel full of extra equipment causes no power-supply problems, the system 1000 is equipped with a really hefty supply. It is rated to deliver 25 amperes at 5 volts dc, 4 A at 12 V dc, and ±1.5 A at ±15 V dc. Two fans cool the system; one is dedicated to the power supply, the other cools the card cage.

A modular system is no more flexible than the modules it accommodates. In the case of the system 1000 there are 13 modules currently available, with many more on the way. (Announcements on new cards are expected over the next two to three months. Among them, Adac says, will be translators for other minicomputers.) These include boards for acquiring high- and low-level analog data with 12-bit resolution. The high-level boards are available with from 16 to 64 single-ended or isolated-ground input channels. The low-level units offer 8 or 16 differential inputs. The remaining analog board is an output device that contains from one to four 12-bit digital-to-analog converters.

A series of digital input/output boards [*Electronics*, July 21, p. 140] includes units for detecting transistor-transistor-logic signals, putting out TTL signals, detecting contact closures, and putting out up to 300 milliamperes for driving lamps or relays.

The remaining boards include a programmable crystal clock, a bus-repeater card, the Unibus-to-LSI-11-bus translator, and a serial I/O card for connecting the system to a 20-milliampere current loop or EIA RS-232-C standard interface. The card provides for jumper-selectable



Electronics/September 15, 1977

Semiconductors

Reference diode offers wide range

Linear integrated circuit has adjustable breakdown voltage and temperature coefficient

Using a novel differential-input-circuit technique, National Semiconductor has built a 2.5-volt band-gap-reference integrated circuit that performs as if it were a zener shunt regulator.

The result is a 2.5-v reference diode that is not only usable as either a positive or negative reference but has an adjustable breakdown voltage and temperature coefficient. The device, which is designated the LM136/236/336, can operate over a wide input-current range, anywhere from 300 microamperes to 10 milliamperes. It can be trimmed to operate with a minimum temperature coefficient. Over the commercial temperature range, for example, the LM336 variation is typically 2.5 millivolts, and it is guaranteed at no more than 6 mv.

Dynamic impedance on the LM136 series is 0.5 ohm maximum, which is 25 to 250 times lower than the resistances of discrete zener devices on the market, says Robert C. Dobkin, director of advance linear circuits.

Like other 2.5-v references, the LM136 is basically a two-terminal device, says Dobkin. An option allows users to trim the device to their particular needs. "The series units, as a result, are much easier devices to use than other 2.5-v references," says Dobkin. "The low impedance and wide operating current range simplify biasing in almost any circuit. Moreover, since either the breakdown voltage or the temperature coefficient can be adjusted, it's easier to optimize any circuit's performance."

To use the LM136 as either a positive or negative reference is a simple matter of connecting a resistor to either the positive or negative terminals, says Dobkin. Current range is determined by the value of the resistor. To adjust the reverse breakdown voltage, a potentiometer is connected between the adjust pin and the other two terminals without affecting the temperature coefficient of the device. The adjustment range, is usually sufficient for both the initial device tolerance (±1%) and any inaccuracies in buffer circuitry, Dobkin says.

Key to the performance of the LM136 is the fact it is designed to be independent of the current gain of the transistors from which it was fabricated. To achieve this, the input stage to the LM136 reference is configured as a differential amplifier much as in an operational amplifier, says Dobkin, using a pair of transistors with a 10:1 ratio between their emitter stages. "This gives us an offset proportional to the absolute temperature," he adds. "And because it is a differential configuration, many of the secondary errors tend to cancel out."

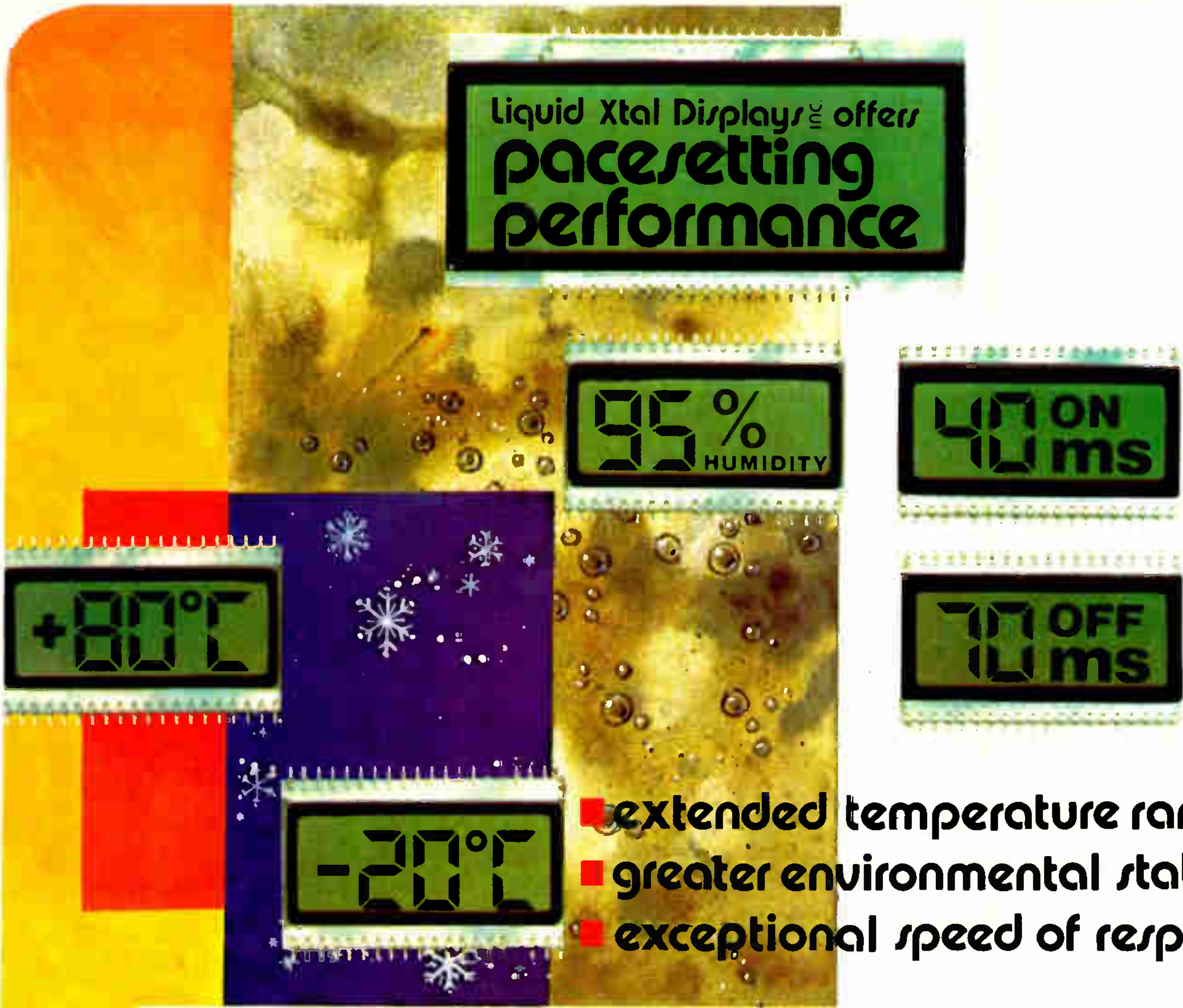
The LM136 is rated for operation over −55°C to 125°C; the LM236, from −25°C to 85°C. Both are housed in TO-46 metal packages. In 100-up quantities, the price is $6 each.

The LM336 is rated for operation over the commercial temperature range from 0°C to 70°C and is available in either a three-lead TO-46 metal package or in a TO-92 plastic package for $2.25 and $1.20 each, respectively, in 100-up quantities.

National Semiconductor Corp., 2900 Semiconductor Dr., Santa Clara, Calif. 95052 [411]

Bar-graph driver IC replaces 30 to 50 devices

A bar-graph driver integrated circuit, replacing as many as 30 to 50 discrete devices and other components, has been developed by Signetics Corp. Designated the NE580, the 140-by-140-mil bipolar linear IC is another in a series of large-scale



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Circle 189 on reader service card

linear ICs, under development by the Sunnyvale, Calif., semiconductor firm, that combines linear and digital devices on the same chip.

The NE580 is a dual bar-graph logic circuit designed to provide all the functions necessary to drive a gas-discharge self-scan bar-graph panel. It is configured to drive a 201-element bar graph in either five- or six-phase operation. Phase-number selection is obtained by applying a logic 0 or 1 level to the phase-select pin.

On-chip functions include a clock generator, linear ramp generator, control logic, sample-and-hold circuitry, counter circuitry, phase decoder, two comparators and buffer circuitry. Output functions include two anode control lines, two over-range indication outputs, six cathode phase outputs, and one cathode reset output. The device accepts an analog voltage in the range of 0 to 2.5 volts and requires a digital supply voltage in the range from +5 to +7 volts dc.

A bar-graph display operates in a self-scan mode, in which a neon glow discharge is propagated from one cathode spot to another under one anode. The NE580 has most of the components necessary to interface an analog voltage level to the bar-graph display.

Each column of the display requires an anode control signal and each cathode—usually from four to seven—requires an interlaced logic signal. An on-chip clock generator drives the master counter and cathode phase generator. The clock also gates a constant-current source, which charges the ramp capacitor of the system with a staircase waveform of equal increment steps, corresponding to the cathode segments. At the 200th count, the ramp voltage is compared with the reference voltage and a signal is fed back to the ramp constant-current source.

A minimum of external components is required for the whole conversion and display system. The NE580 can be expanded to handle more analog channels using external comparators. A few external low-cost logic packages can, in addition,

provide binary or binary-coded-decimal encoded data to interface with a logic control system. The device is supplied in a 22-pin plastic molded or ceramic dual in-line package and is priced at about $6 each in a 100-piece quantities.

Signetics Corp., 811 E. Arques Ave., Sunnyvale, Calif. 94086 [412]

PMI introduces family of bi-FET op amps

Precision Monolithics has introduced a family of three high-performance bi-FET operational amplifiers that combine high speed with low input offset voltage.

The low-power member of the family is the OP-15, which has a slew rate of 17 volts per microsecond, a maximum input offset voltage of 500 microvolts, and a maximum supply current of 4 milliamperes. A temperature-compensated front end keeps the input bias current low at all temperatures, with a maximum of 9 nanoamperes at 125°C. At 25°C, the current is typically only 18 picoamperes.

The OP-16 is a faster unit with a slew rate of 25 V/μs and a maximum supply current of 7.0 mA. Like the OP-15 it has an 18-pA 25°C bias current, but this can rise to 11 nA at 125°C. Where the OP-15 has a gain-bandwidth product of 6 megahertz, the OP-16 is rated at 8 MHz.

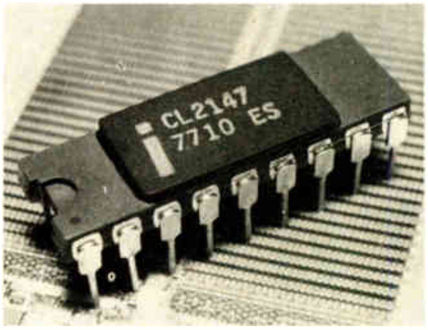
The fastest op amp in the family is the uncompensated OP-17. Its key specifications are a slew rate of 70 V/μs, a gain-bandwidth product of 30 MHz, a typical input bias current of 20 pA (11 nA at 125°C), and a supply current of 8 mA. Like the other units, the OP-17 has a maximum input offset voltage of 500 μV and a drift of 2 μV/°C.

Versions of the op amps that operate from −55°C to 125°C sell for $18 each in hundreds, while units rated for use from 0°C to 70°C are priced at $10. Cheaper devices with relaxed input offset voltage specifications are also available. All models in both temperature ranges are available from stock.

Precision Monolithics Inc., 1500 Space Park Dr., Santa Clara, Calif. 95050 [413]

4,096-bit static RAMs have 45-ns access time

Built with Intel's high-performance metal-oxide-semiconductor (H-MOS) technology [*Electronics*, August 18, p. 94], the 2147 family of 4,096-bit static random-access memories features a typical access time of 45 nanoseconds (55 ns maximum for the 2147-3 and 70 ns maximum for the 2147) and typical power dissipations of 500 milliwatts (2147) and 600 mW (2147-3). The speeds are



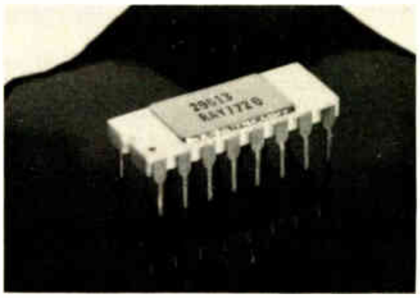
guaranteed for temperatures from 0°C to 70°C and for a power-supply voltage of 5 v dc ±5%. The RAMS have a standby mode with an eighth the power consumption of the normal operating mode.

Housed in the industry-standard 18-pin package, the RAMS are compatible with transistor-transistor logic on all inputs and outputs. Their three-state outputs typically sink 25 milliamperes and source 15 mA at TTL levels, allowing them to drive a data bus and several TTL loads without difficulty. In hundreds, the 2147 sells for $37.50 each and the 2147-3 goes for $45.

Intel Corp., 3065 Bowers Ave., Santa Clara, Calif. 94301. Phone Rob Walker at (408) 246-7501 [414]

Bipolar PROM includes power-switching circuitry

Called a SPROM, a new memory device is a bipolar programmable read-only memory with built-in circuitry for reducing the average power dissipation of large PROM arrays by switching off the collector supply to all unselected chips. Until the development of the SPROM, this power-switching function had to be performed by external circuitry. The



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Your way.

(About 5 minutes.)

1. Connect signal to scope. **2.** Adjust trace intensity. **3.** Adjust focus. **4.** Select VOLTS/DIV range. **5.** Select TIME/DIV range. **6.** Adjust vertical gain to fill screen for location of 10% & 90% points. **7.** Locate 10% point. **8.** Locate 90% point. **9.** Determine horizontal displacement between 10% & 90% points. **10.** Multiply displacement by horizontal scale factor.

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Circle 143 for Product Demonstration
Circle 195 for Literature Only

new device uses industry-standard pinouts and can be plugged into existing designs without any wiring changes. Both the 256-by-4 and the 512-by-4 units are available in a choice of open-collector and three-state configurations.

Address access times are a maximum of 70 nanoseconds for the commercial versions and 80 ns for the memories that operate over the full military temperature range. Because the chip-select inputs activate the power switch, their access times are 10 ns longer than the address access times.

The 1,024-bit memory sells for \$4.25 each in hundreds, in its commercial version and \$7.90 in its military form. The 2,048-bit RAMS have respective prices of \$7.25 and \$14.50. The units are currently available in sample quantities.

Raytheon Semiconductor, 350 Ellis St., Mountain View, Calif. 94040. Phone (415) 968-9211 [415]

OR/NOR gate switches in 500 picoseconds

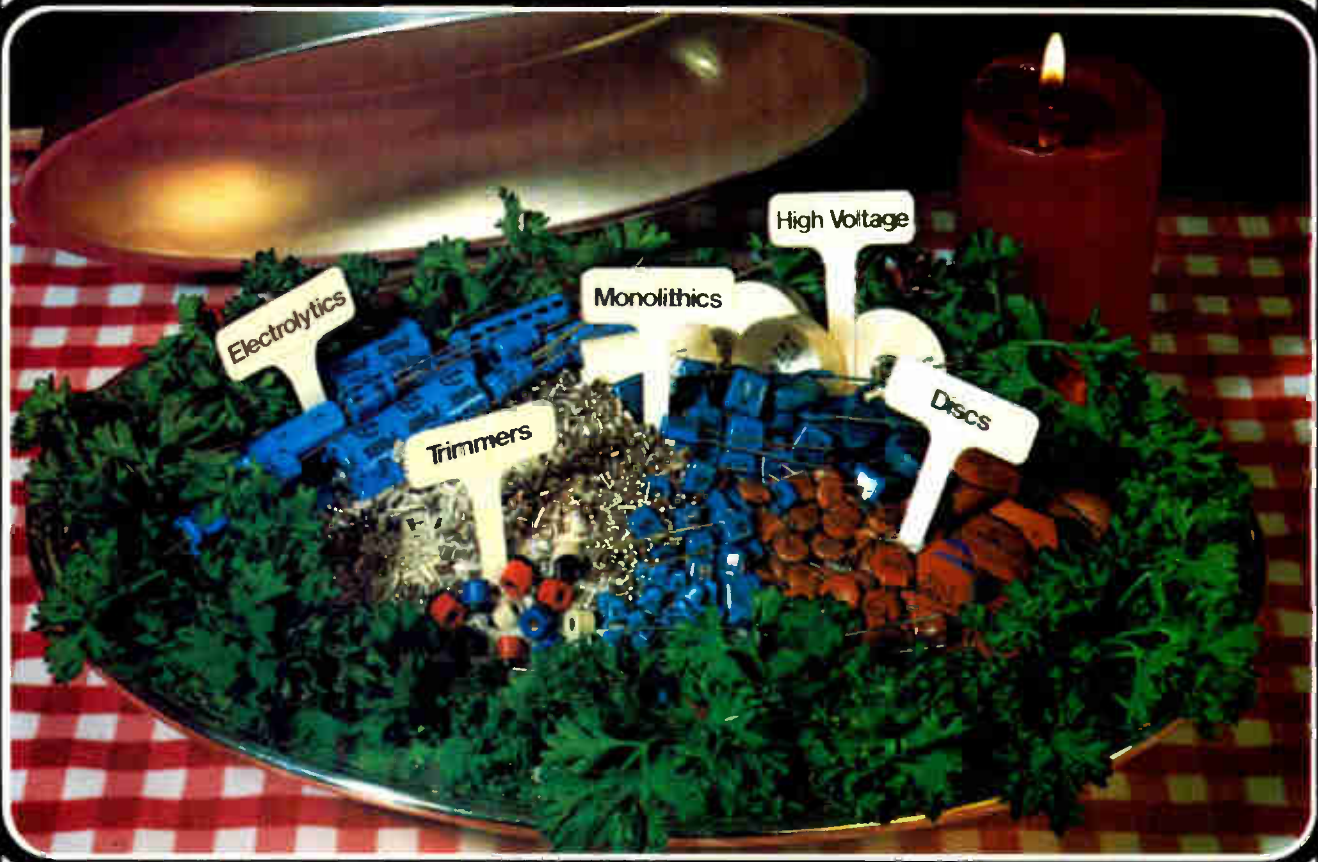
A dual four-input OR/NOR gate fabricated in emitter-coupled logic has a gate switching time of just 500 picoseconds. Designated the SP16F60, the device provides simultaneous OR and NOR outputs, drives 50-ohm loads, and is internally compensated so that its threshold point is in the center of the transition region over the temperature range from −30°C to 85°C. No-load power dissipation is typically 120 milliwatts. Housed in a ceramic dual in-line package, the SP16F60 sells for \$12 each in hundreds.

Plessey Semiconductors, 1641 Kaiser Ave., Irvine, Calif. 92714. Phone (714) 540-9979 [417]

Bucket-brigade device delays audio signals up to 205 ms

The MN-3005 is a one-chip bucket-brigade device that can delay an audio signal for as long as 205 milli-

Specialties of the House



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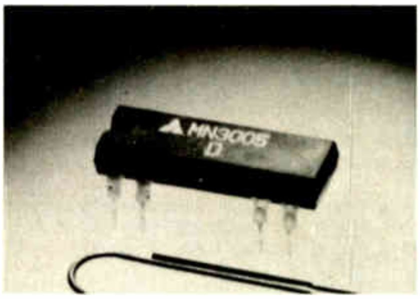
Circle 197 on reader service card



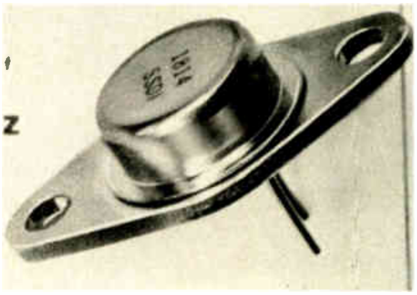
seconds. The 4,096-stage unit has a signal-to-noise ratio of 75 decibels and essentially no insertion loss. Intended primarily for use in high-quality electronic music equipment—echo chambers, organs, and synthesizers—the device can also be used to implement fixed or variable analog delays in a variety of other applications: time compression and voice scrambling in communications systems, for example.

Panasonic Co., Electronic Components Division, 1 Panasonic Way, Secaucus, N. J. 07094. Phone (201) 348-7276 [416]

40-watt transistors operate to 50 MHz

Developed for use in power supplies, regulators, and other switching applications, the 1814 series of power transistors can dissipate 44 watts at 25°C. Maximum turn-on and fall times of 600 nanoseconds allow efficient switching up to 50 megahertz. The npn devices have collector-emitter voltage ratings from 200 v to 375 v with peak collector currents of 10 amperes. They are housed in TO-66 cases and sell for $10 to $28.50 each in hundreds.

Solid State Devices Inc., 14830 Valley View Ave., La Mirada, Calif. 90638. Phone (213) 921-9660 [418]



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Sealed to shrug off 650°F wave soldering or immersion in cleaning solvents. Sealed to keep contamination outside—where it can't foul contacts. Fast acting, with typical attract time of 3.5 ms; release time, 2.2 ms at up to 50 operations per second. With contact bounce of less than 1 ms on N.O. contact. Shock and vibration resistant. Typical mechanical life of 100 million operations.

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Time interval measurements, on the other hand, have fundamentally different requirements for the input circuitry. Timing demands a narrow trigger window in order to minimise the influence of hysteresis. Therefore error-free, high frequency counting and timing facilities cannot be provided by the same input circuitry without compromising one or both measurement parameters. Therefore all our instruments have separate input channels, each optimised for either frequency or time interval measurements. With Philips you can thus be sure of a better, as well as a bigger choice: whatever your application.

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Universal counters:
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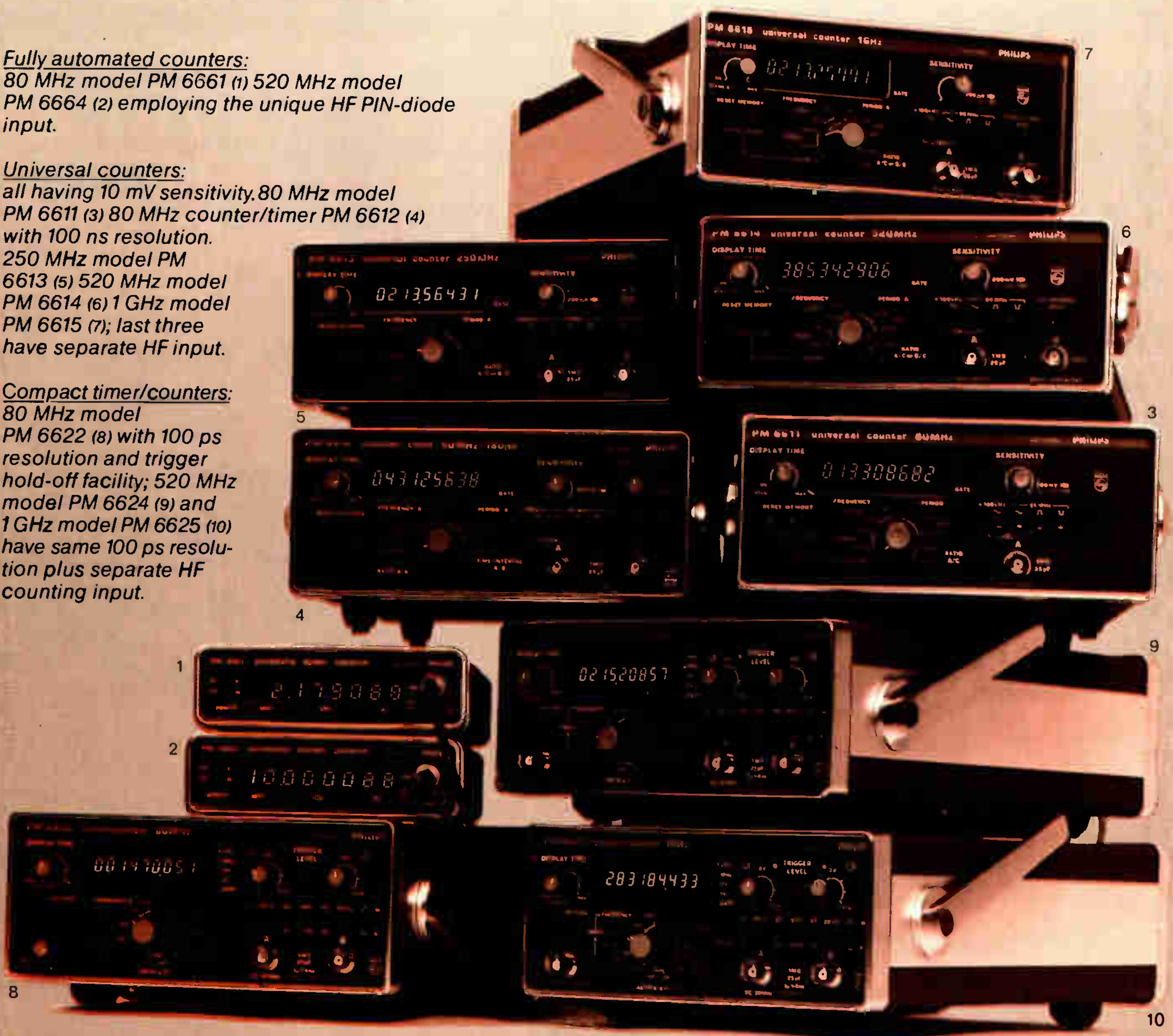
Compact timer/counters:
80 MHz model PM 6622 (8) with 100 ps resolution and trigger hold-off facility; 520 MHz model PM 6624 (9) and 1 GHz model PM 6625 (10) have same 100 ps resolution plus separate HF counting input.



timer/counters too

An eleven-model choice of fully automatic counters; universal counters and counter/timers

Fully automatic counting
Models PM 6661 and PM 6664 are fully automatic and represent the ultimate in easy operation, by having no controls other than the on/off switch. The former counts to 80 MHz, the latter to 520 MHz: both with optimum signal conditioning and high stability time-bases. Dimensions are extremely compact, weight only 1,45 kg and the 8-digit LED display is bright and easy to read.

Error-free from 80 to 1000 MHz
Four universal counters and one counter/timer cover this frequency range, the VHF and UHF models having the unique Philips PIN-diode cicuitry that is proof against noise and that maximises the value of a high 10 mV sensitivity. Moreover, optimum counting accuracy is ensured by a wide choice of high-stability X-tal oscillators, which match your individual needs. This accuracy is extended to the field via the optional built-in battery pack.

The basic 80 MHz instrument is model PM 6611, while the PM 6612 offers basic timing facilities in addition to error-free counting. Models PM 6613, 6614 and 6615 are dedicated counters having frequency ranges of 250 MHz, 520 MHz and 1 GHz.

The high-performance standards of all these instruments can be further extended by plug-in options that provide:
- a BCD output
- a D/A converter that gives an analog "magnifying glass" view of any three digits
- and a serial data output for operation with IEC/IEEE Bus interface systems.

Compact timer/counters
The timer/counters feature powerful performance in the same compact housing as the previously described frequency counters. Each has specific measurement facilities. All have the following common features:
- 80 MHz direct frequency counting
- high DC-coupled 20 mV sensitivity
- versatile time interval (averaging) measurements down to 1 ns
- and period, ratio and conditioned pulse counting

  Depending on your individual needs, you then select the specific model with either:
- trigger hold-off to extend the timing capability as provided by model PM 6622. This allows spurious signals such as contact bounce to be ignored; enables period measurements to be made on double-pulse signals and permits a specific signal to be "picked-out" from a pulse train, to give just three examples of this instruments timing versatility.
- extended frequency counting, on a separate input, to 520 MHz for model PM 6624 or to 1 GHz for model PM 6625. These two instruments thus offer the same error-free counting facilities as the universal counters, while retaining the 100 ps resolution of the time interval averaging technique.

The timer/counters also offer the same choice of timebase as the universal counters and the same plug-in options and battery operation.

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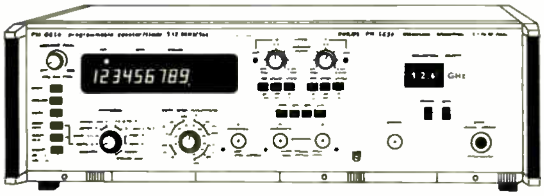
Model PM 6650 below is a systems instrument that features accurate, noise- and transient-suppressed counting to 512 MHz on a special frequency channel. And time interval averaging measurements with up to 1 ps resolution on the timing channel. Plug-in modules extend the performance: two increase the frequency range to either 1 GHz or 12.6 GHz; another boosts the basic 50 mV sensitivity to 1 mV. User options are numerous.



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Philips Test & Measuring Instruments Inc.
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PHILIPS

Circle 201 on reader service card

Send enquiries to Mr. Alridge / Eundhover and Mr.Rauch in Mahwah

"Hey buddy. . . wanna buy a connector?"

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Circle 146 Fabri-Pak® backpanel system
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Circle 150 Plate connectors
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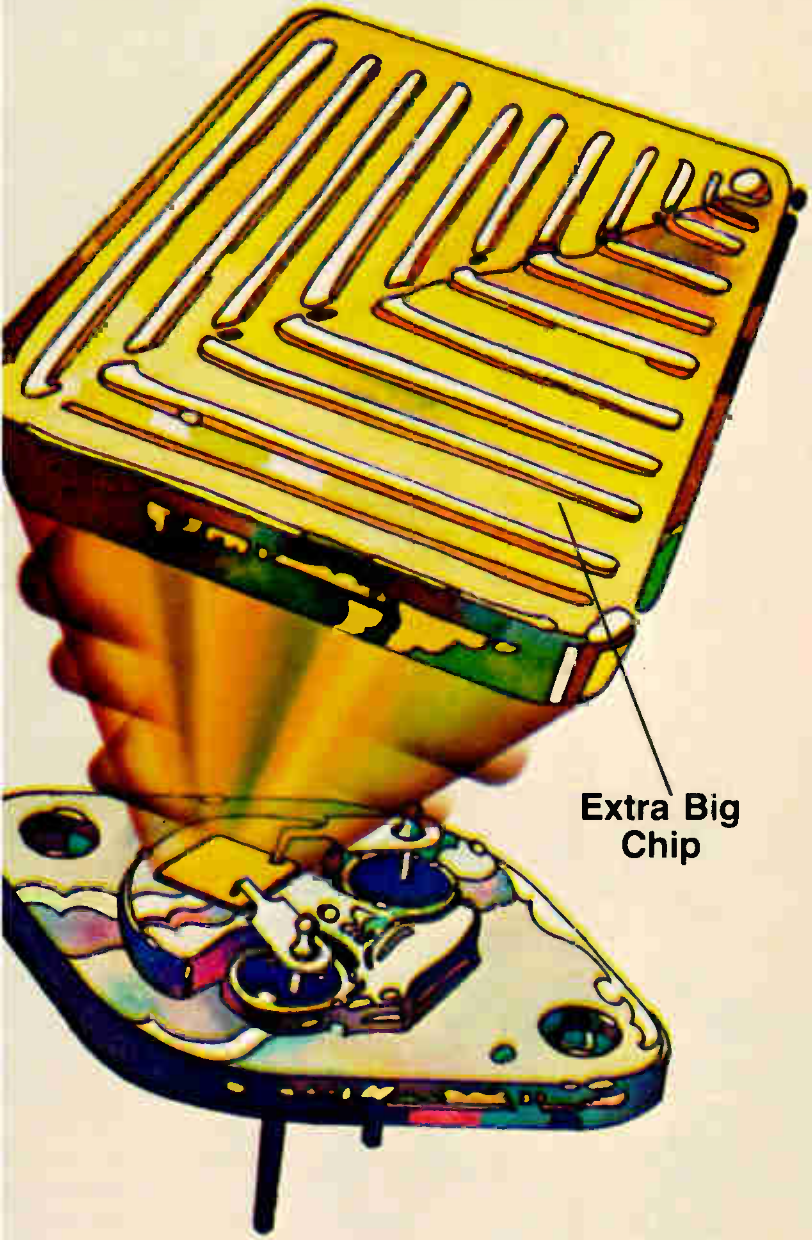
The Panasonic Plus: you get more power transistor than you pay for.

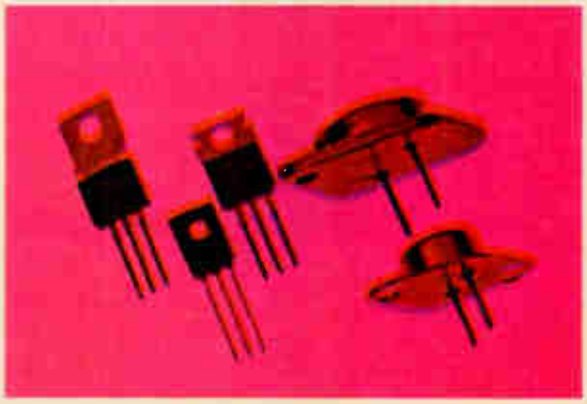


One look at the extra big chip in any Panasonic power transistor makes it obvious—not all transistors are created equal.

Because of our extra big chip and proprietary construction we could rate these devices higher, but we don't. They're always conservatively rated. Which, along with our rigid QC system, is why we have such a low rejection rate.

That's part of the Panasonic Plus...one reason to switch to our power transistors. There's also competitive pricing and broad range.

Many of our power transistors are matched to 2N numbers, and are available in standard TO plastic or metal packages, in a complete range of power, voltage and current ratings. And we also offer a line of small signal transistors, Hall Effect devices, and 4-bit microprocessors. All at prices that are highly competitive with those of other makers of quality semiconductor devices.



For complete information and prices, write to Panasonic Electronic Components, One Panasonic Way, Secaucus, N.J. 07094; or call (201) 348-7269.

Specifications

	TO-3	TO-66	TO-126	TO-202 TO-220
Vceo (V)	80–1500V	40–300V	18–300V	20–300V
Ic (A)	100m–6A	100m–2.5A	50m–1.5A	100m–4A

Also available: TO-92 and other semiconductor packages

Panasonic®
just slightly ahead of our time

Circle 203 on reader service card

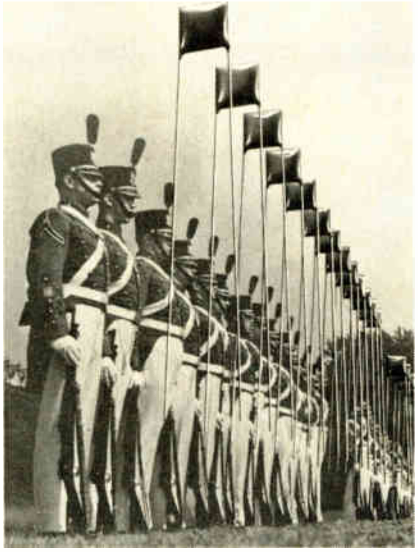
Industrial

Thermistors are interchangeable

Tight matching makes recalibration unnecessary when sensors are replaced

The Unichip is a single-chip thermistor that has been R-T matched for complete interchangeability to within a maximum error of 0.2°C without recalibration. Designed for operation between 0°C and 70°C, the Unichip is capable of realizing its full 0.2°C accuracy because its manufacturer publishes resistance values for temperature increments of 0.1°C. Other units with similar accuracy, but with published values in only 1.0°C increments, can lead to measurement errors as large as 0.6°C, according to the manufacturer.

Applications for the Unichip include the measurement and control of temperature in heating and ventilating systems, photographic laboratories, and some chemical manufacturing. It is also expected to find many uses in clinical medicine where its short time constant (typically 4 seconds) gives it an edge over competitive devices.



If operated within its specified range, the Unichip is expected to meet its specifications indefinitely. Continuous operation or cycling above 75°C may eventually cause it to drift out of spec. Temperature storage range is −80°C to 120°C.

In addition to the 0.2°C device, the Unichip is offered in a 0.5°C version (with 0.2°C chart) and a 1.0°C version (with a 0.5°C chart). Presently available resistance values are 10,000, 5,000, and 2,500 ohms, all with a 0/50 ratio of 9.3. Additional values and ratios are planned for the future.

Supplied with a polyurethane protective coating, the Unichip has a nominal thickness of 75 mils and a small-quantity price of approximately $4. It is available from stock.

Victory Engineering Corp., Victory Road, Springfield, N. J. 07081. Phone (201) 379-5900 [371]

Rugged transducer measures pressures to 5,000 psia

Actually a pressure-to-frequency converter, the Digiquartz high-pressure transducer is a rugged sensor that can accurately measure abso-

lute pressures as high as 5,000 pounds per square inch. The heart of the unit is a quartz-crystal resonator whose resonant frequency varies with the stress induced by the applied pressure. It is relatively insensitive to most other environmental effects and thus can be used in such hostile environments as oil wells, gas wells, the ocean, and geothermal wells.

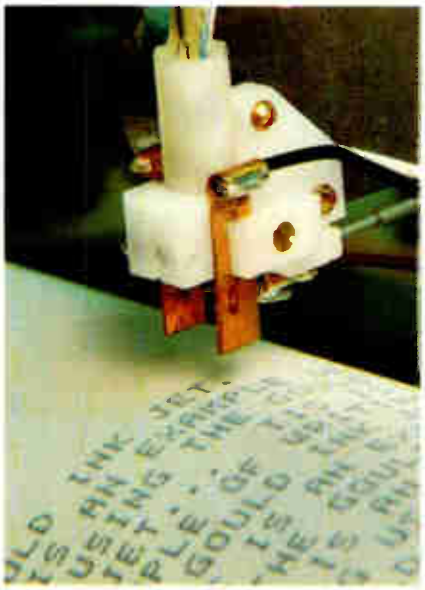
The transducer, which includes a miniature hybrid oscillator, is housed in a cylindrical package with

INK JET WILL TELL YOU WHAT HAPPENED, WHEN IT HAPPENED.

Gould's new Ink Jet annotation device allows you to automatically print time, date and other data parameters alongside your Gould analog traces.

The Ink Jet writing system employs the most advanced technology consisting of ink reservoir and electrostatic charging and deflection plates to print highly legible characters in a 5 x 7 dot matrix at chart speeds of up to 50 mm/sec. Any desired annotation of up to 256 characters may be entered by means of our optional keyboard or from an external ASCII parallel data source.

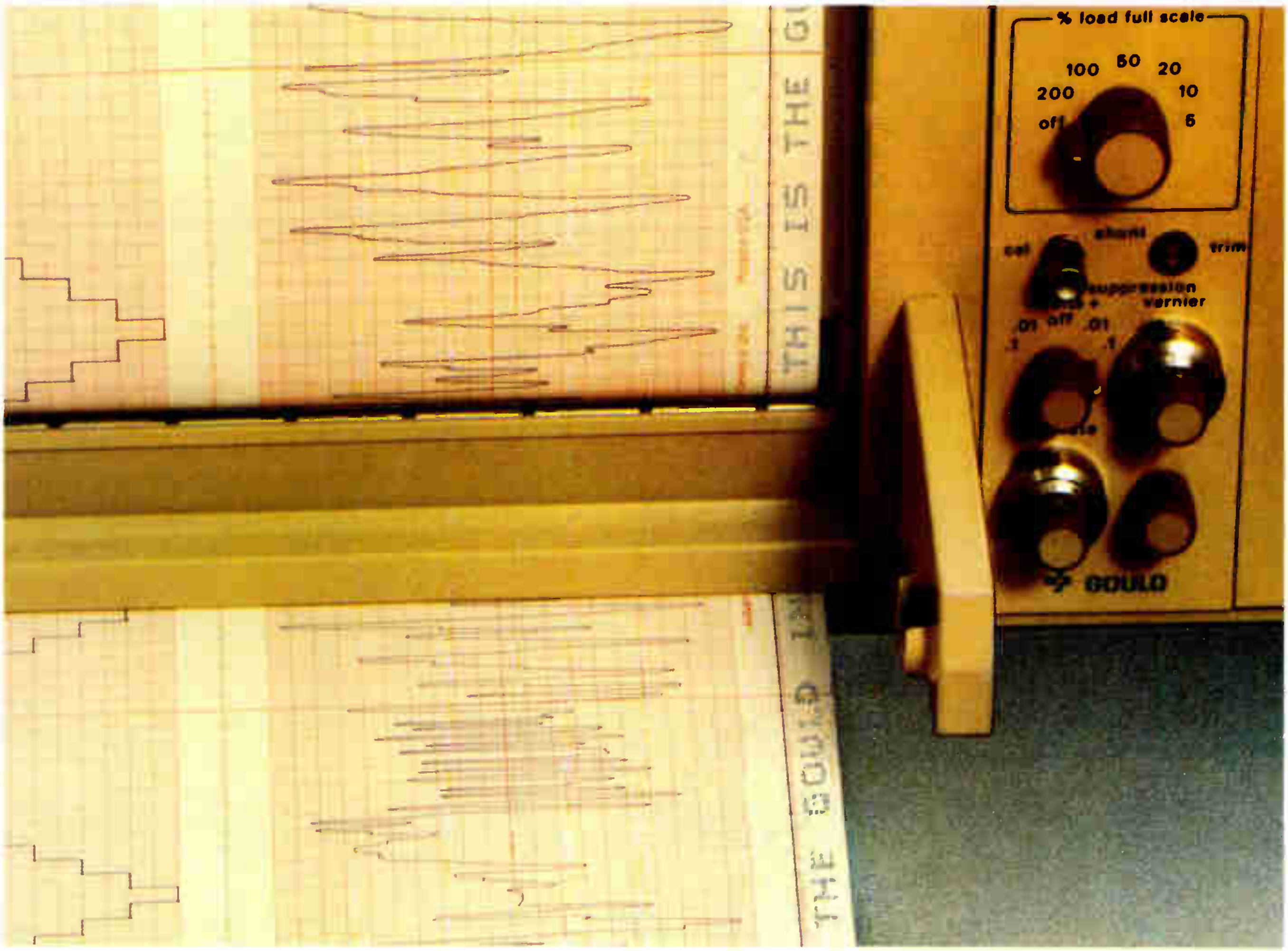
Designed to complement the Gould 2000 Series pressure ink direct writing recorders, Ink Jet



adds an entirely new dimension to analog data display. Medical, industrial, research and engineering users now have a means of immediately annotating all pertinent information while a study is taking place.

Consider the additional breadth of data display that only Ink Jet applications will bring to you. For a descriptive brochure, contact Gould Inc., Instrument Systems Division, 3631 Perkins Av., 57 rue St. Sauveur, 91160. Ballainvilliers, France. Or call toll free at (800) 325-6400, Ext. 77. In Missouri: (800) 342-6600.

GOULD



a diameter of 1.15 inches and a length of 3.85 in. In small quantities, the transducers sell for $2,900 each.

Paroscientific Inc., 14827 N. E. 40th St., Redmond, Wash. 98052. Phone (206) 883-8700 [373]

Pressure transducer is easily customized

In an effort to provide users with a virtually custom pressure transducer as a standard item, Bourns Inc. has introduced its model 2900. This transducer system gives the user a wide choice of parameters at no extra charge. Among the choices are one of three electrical connectors, one of four pressure connectors, one of three spans, one of three zero

balances, and one of three temperature coefficients. A choice of ac or dc operation is also provided.

Depending upon application, the model 2900 can measure pressures relative to three different references: vacuum (absolute pressure), ambient pressure (gage pressure), or the standard sea-level pressure of 14.7 psia (sealed pressure). Full-scale ranges from 15 to 5,000 psi are available.

Industrial Products Group, Instrument Division, Bourns Inc., 6135 Magnolia Ave., Riverside, Calif. 92506. Phone (714) 781-5182 [376]

Proximity switches offer three outputs

A series of rugged proximity switches for demanding industrial applications is available with a choice of three outputs: a dc voltage output, a dc current output, and an

;EL-REX: An important)art in the OMI world of metal inishing.

el-Rex has led its industry for ıore than a generation in ad- ancing the technology f precious metal elec- oplating. For both ecorative and func- onal plating deposits, el-Rex has been the leading innovator, with more rocesses than any other company in the industry.

The world's first bright gold plating process was an ıvention of Sel-Rex researchers. Sel-Rex made signifi- ant contributions to high-speed gold plating for the elec- onics industry. Their low-karat, cost-cutting alloy systems 're currently changing cost patterns in many markets. And el-Rex research led to a complete chemical system for rinted circuit board processing, from cleaners and surface onditioners, to electroless copper baths, to final tin/lead ıd gold coatings uniquely suited to the special require- ıents of printed circuits.

Sel-Rex refineries on the east and west coasts help plat- rs reclaim and reuse precious metals from scrap and solu- ons. And Sel-Rex's in-depth knowledge of precious metal lectroplating has been applied to enable OMI's Equipment Division to improve its full range of semi-automatic equip- ment for high-speed, high-volume plating, as well as cost- saving selective strip, stripe, and spot plating equipment.

Today, Sel-Rex's position of leadership has been further strengthened as an integral member of OMI.

With its components, the Sel-Rex Division; the Udylite Division, leader in base metal plating processes; the Parker Division, industry's major supplier of cleaning, treating, and prefinishing chemicals; Recovery Systems Division, a pioneer in designing and engineering environmental and metals recovery systems; and the Equipment Division; OMI represents the most complete source of processes, equipment, supplies, and services, to the world of metal finishing.

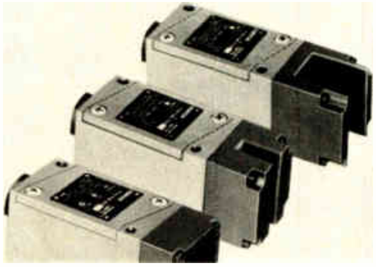
For further information, write to
Oxy Metal Industries Corporation,
21441 Hoover Rd., Warren, Mi. 48089.

OMI

OXY METAL INDUSTRIES CORPORATION

Circle 207 on reader service card

ac output. The voltage-output switch delivers 12 v from a source impedance of 4.7 kilohms. The current-output unit is similar except that a current amplifier is added to boost the output to a maximum of 200 milliamperes at 24 v dc. The ac unit uses a thyristor to switch up to 1 ampere (resistive) over a range of



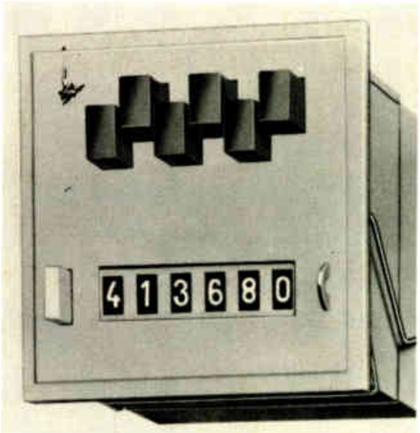
applied voltages from 110 to 220 v.

All three types are made with a variety of sensing-head shapes and are enclosed in drip-and-dust-proof housings. Their die-cast aluminum cases are designed for mounting on 2.36-by-1.18-inch centers in accordance with DIN standards. Water resistance conforms to JIS-C0920 requirements. Prices range from $77 to $319.

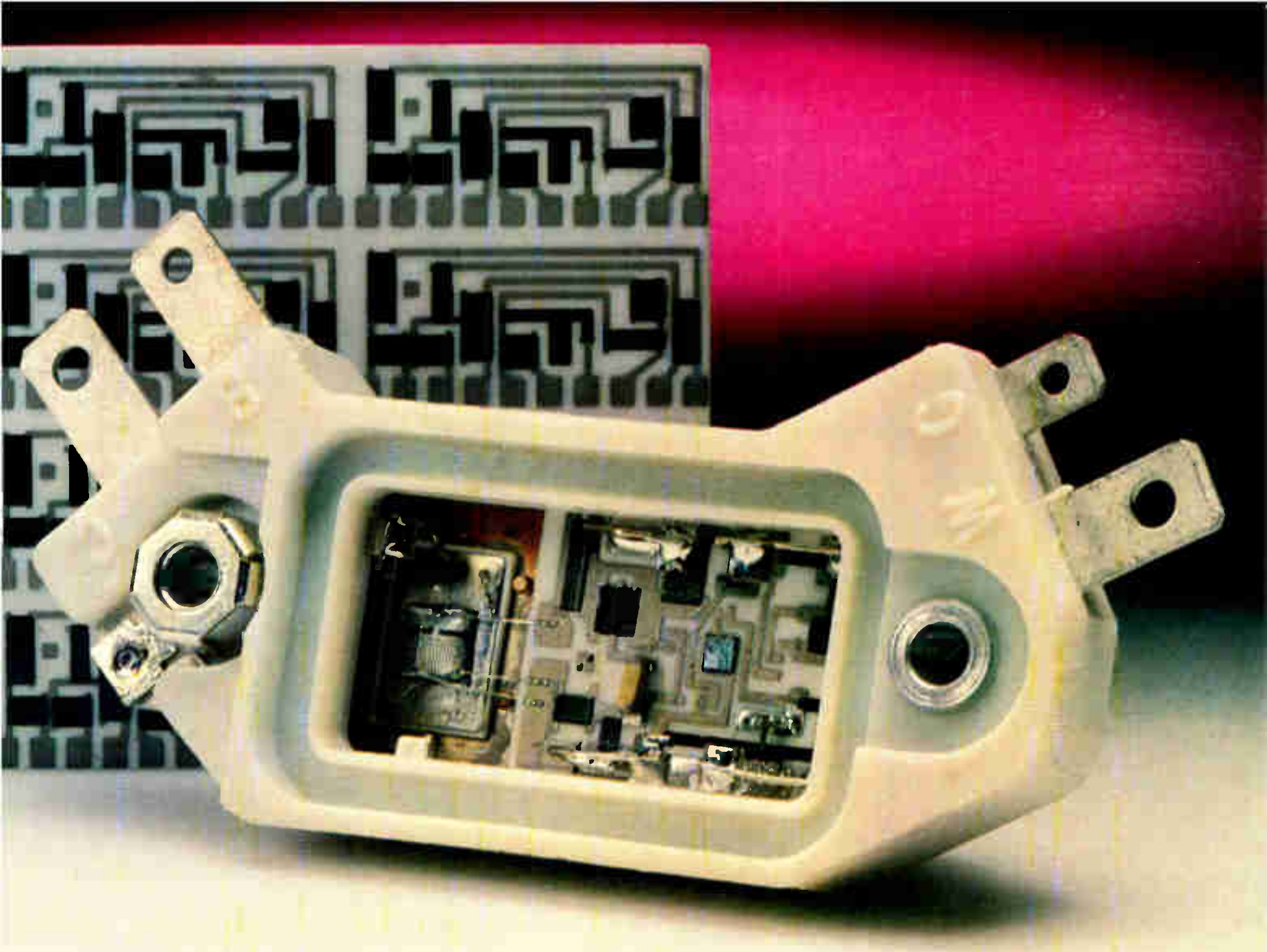
Omron Electronics Inc., 233 S. Wacker Dr., Chicago, Ill. 60606. Phone Don Papesh at (312) 876-0800 [374]

Predetermining counter includes presignalling

The MVS16 predetermining counter is a six-digit unit that operates a single-pole, double-throw switch any factory-fixed number of counts before it operates the main switch at the zero count. The presignal can be used, for example, to slow down a machine, refill a low batch, or warn an operator that something is running low or nearing an end.



The MVS16 uses large, staggered push buttons to set the predetermined number into the counter. Electrical pulses from the machine or process under control cause the counter to count backwards, activating first the presignal switch and then the main, or zero, switch. The unit can be reset to the same starting number automatically, manually, or by an externally applied electrical signal. The counter sells for about



Lower your costs in high-volume microcircuit applications with Du Pont's new system of thick film materials.

To help cut your costs and raise your yields, Du Pont has developed a new system of cost-effective, compatible resistor and conductor materials for high-volume production.

With the new vehicle technology in our CERTI-FIRED® 4800-Series Resistors, you can get more consistent prints and reproducible resistance values, even with high-speed printers and long production runs. You get the same consistency if you print multiple circuit patterns on one large substrate.

Our new Palladium/Silver Conductor 9843—compatible with the 4800-Series—uses the same new vehicle technology and offers the same processing advantages.

Altogether, it's a low-cost system that offers more of the quality and performance for which Du Pont is known. Palladium/Silver Conductor 9843 offers high adhesion and excellent soldering. The 4800-Series Resistors offer tight laser trimming tolerances, excellent stability and TCR's less than 250ppm/°C. Both offer reproducible performance, lot-to-lot and substrate-to-substrate.

If you manufacture circuits or networks for any application, from consumer to military, Du Pont has a cost-effective system of thick film materials for you. Call 800-441-9475 toll-free. Or write Du Pont Company, Rm. 35639, Wilmington, DE 19898.

Electronic Materials Division

DU PONT

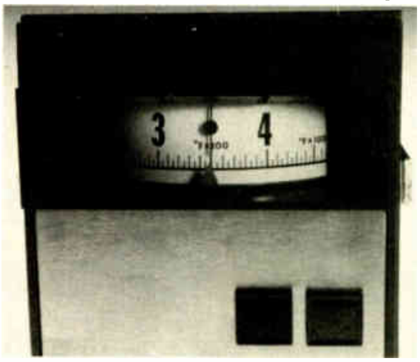
Circle 209 on reader service card

$50 and is available from stock.

Kessler-Ellis Products Co., Atlantic Highlands, N. J. 07716. Phone Leslie Gleason, Product Manager toll-free at (800) 631-2165 [375]

Temperature controllers handle severe load changes

Series 400 three-mode temperature controllers are designed for use in applications where severe and frequent load upsets occur, where there is a time lag between changes in the heat supply and a temperature change at the sensor, where there is heat generated by the process itself, and where the process is fuel-fired and requires continuous control of



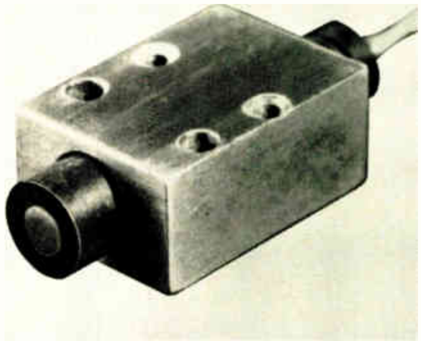
the fuel flow. The proportional controllers include a meter and provide for the adjustment of loop bandwidth and cycle time. Two models offer a choice of one or two set points.

Controllers in the 800 series can also handle time lags, but they are intended for use in situations where temperature changes are small and load changes are infrequent.

Omega Engineering Inc., P. O. Box 4047, Stamford, Conn. 06907. Phone (203) 359-1660 [377]

Direct-contact thermocouples work on rotating parts

Designed to determine the temperatures of rotating drums, disks, and shafts, a line of direct-contact temperature sensors consists of a spring-



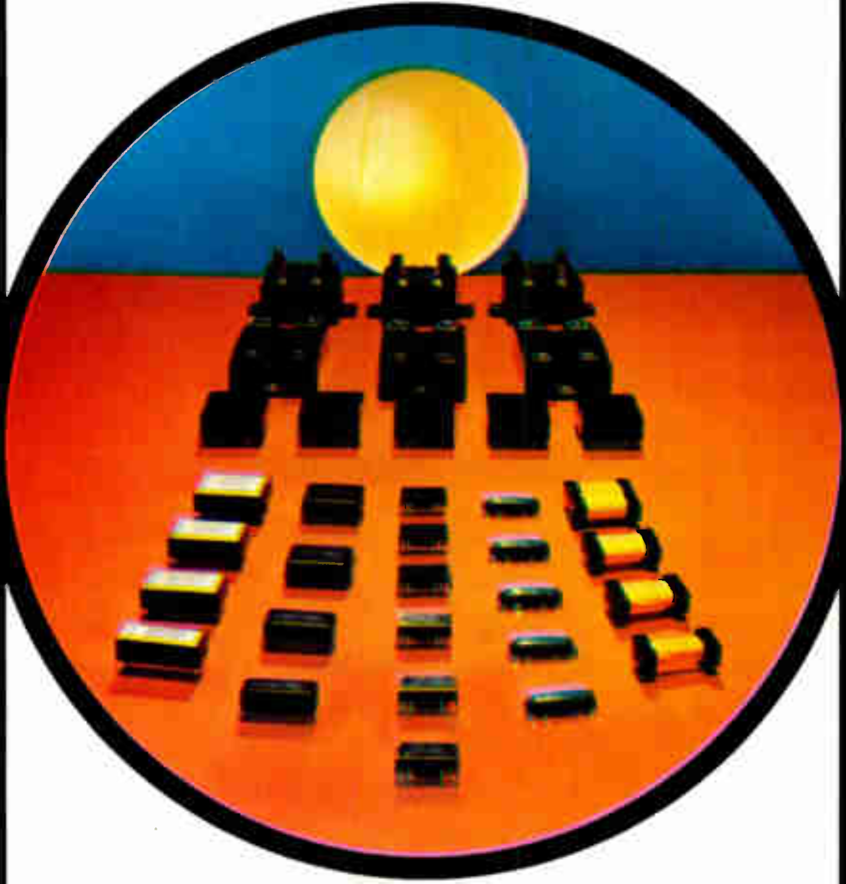
loaded thermocouple sensor mounted in an aluminum block. The thermocouple junction is welded to a soft brass disk attached to a phenolic thermowell. Units are available for use up to 600°F. A complete assembly sells for $35 with replacement sensing tips priced at $20 each. Delivery time is two to three weeks.

Nanmac Corp., 9–11 Mayhew St., Framingham Centre, Mass. 01701. Phone (617) 872-4811 [378]

Plug-in counter/timer uses microprocessor control

The series TC-100 plug-in counter/timer is a microprocessor-based unit with an internal time base and three sets of 10-ampere isolated output contacts. The instrument, which has debounced inputs, is designed to control timing and counting operations at rates to 600 pulses per second. Timing ranges are from 0.01 second to 99.99 hours. Counting ranges, in either a total-

ELEC-TROL RELAYS



YOUR BEST BET FOR REED AND SOLID STATE RELAYS

For those of you who haven't used our relays yet – here are two good reasons for making Elec-Trol your first call.

(1) Reed Relays We sell more dry reed relays than any other manufacturer in the United States. We offer packaging styles like DIP's, Open Lines, Encased Lines, Molded Lines, and Blue Boys – in a complete range of coil voltages and contact forms. You can get optional features like magnetic shielding, electrostatic shielding, and contact run-ins. Also available – the best in mercury-wetted.

(2) Solid State Relays We're coming on strong with printed circuit board and standard high-power-switching models that feature: zero-crossover switching, photo isolation between input and output, positive on/off control, TTL compatibility, long life, immunity to shock and vibration, and competitive pricing.

So the next time you're thinking relays – think Elec-Trol. Send for a quick overview of our products. Ask for our Short Form Catalog.

Elec-Trol, Inc., 26477 N. Golden Valley Road, Saugus, CA 91350, (213) 788-7292, (805) 252-8330. TWX 910-336-1556.

ELEC-TROL

ELEC-TROL REED RELAYS

Now! The Miniature 100 WATT "Powermite"!

Elec-Trol now offers the "Powermite" series of Reed Relays – the industry's first line of miniature dry reed relays capable of switching up to **100 watts,** 1 Amp, and 200 VDC.

These super-space-saver "miniatures" (down to .375" wide by 1.125" long by .350" high) are designed for high-wattage applications such as switching the gates of power-switching thyristors, or handling greater lamp and reactive loads.

Powermites are available in the 1 through 4 pole form A Open Line and the totally sealed Encased Line body styles with both .100" X 1.000" and .150" X 1.000" industry standard terminal spacing. Optional features include magnetic shielding and electrostatic shielding.

For more information, use the reader service card. For immediate action, contact your local distributor, representative, or the factory direct:

Elec-Trol, Inc., 26477 N. Golden Valley Road, Saugus, CA 91350, (213) 788-7292, (805) 252-8330. TWX 910-336-1556.

ELEC-TROL

Circle 152 on reader service card

izing or predeterming mode, go up to 9,999. Typical applications include injection-molding machines, hot-stamping machines, and materials-handling equipment. The TC-100 sells for $300 and is subject to Schedule A discounts.

Industrial Timer Corp., U. S. Highway 287, Parsippany, N. J. 07054. Phone (201) 887-2200 [379]

Solid-state timing relay needs little panel space

Designated the Agastat STA, a new solid-state timing relay requires less than two thirds the front-panel space of conventional units, while its tab-type headers fit most popular sockets. The STA also features two light-emitting-diode indicators that show the status of its input and output circuits and aid in circuit checkout and performance monitoring.

The relay is offered in three operating modes, provides a choice of seven ac and dc operating voltages, and has 12 timing ranges that cover a total span of 0.1 second to 60 minutes. Repeatability is within approximately 0.5% and is enhanced by adjustment dials that are calibrated in time increments. In addition to adjustments mounted directly on the relay, versions are available with remote adjustments (external potentiometer) and with fixed time intervals.

The STA's double-pole, double-throw output relay is rated to switch 10 amperes at 28 v dc or 120 v ac. The unit has a reset time of 30 milliseconds, an operating temperature range of −20°F to 149°F, and transient protection against up to 3,000 v for 100 microseconds.

Amerace Corp., Control Products Division, 2330 Vauxhall Rd., Union, N. J. 07083. Phone (201) 964-4400 [380]

NEC JUST MADE INTEL'S 8080A TWICE THE MICROPROCESSOR IT USED TO BE.

Introducing the μPD8080AF. From NEC Microcomputers.

Now you can get a microprocessor that's absolutely identical to Intel's 8080A.

And we can prove it.

In three separate tests using standard Intel programs, conducted by three independent laboratories, the μPD8080AF was demonstrated to be, both parametrically and functionally, exactly the same as the 8080A. (The certified results of the tests are available upon request).

Which means that now there's a microprocessor that's pin for pin and program compatible to the Intel 8080A. And available in plastic or ceramic.

Of course, we continue to offer our original μPD8080A – a microprocessor with enhanced arithmetic capability and logical flags.

With either an μPD8080AF or μPD8080A comes our complete line of standard peripheral chips. Plus state-of-the-art support chips like the 8K Electrically Erasable PROM (μPD458), a Universal Synchronous Receiver/Transmitter Data Communications Controller (μPD379), a 450ns 32K ROM (μPD2332) and a Floppy Disc Controller (μPD372) that can control up to four IBM 3740-compatible drives, and a complete line of the most reliable memories you can buy.

All backed up by applications support available nationwide.

The μPD8080AF from us. And the 8080A from them.

Even with a program, you won't be able to tell them apart.

NEC Microcomputers, Inc., Five Militia Drive, Lexington, MA 02173. (617) 862-6410.

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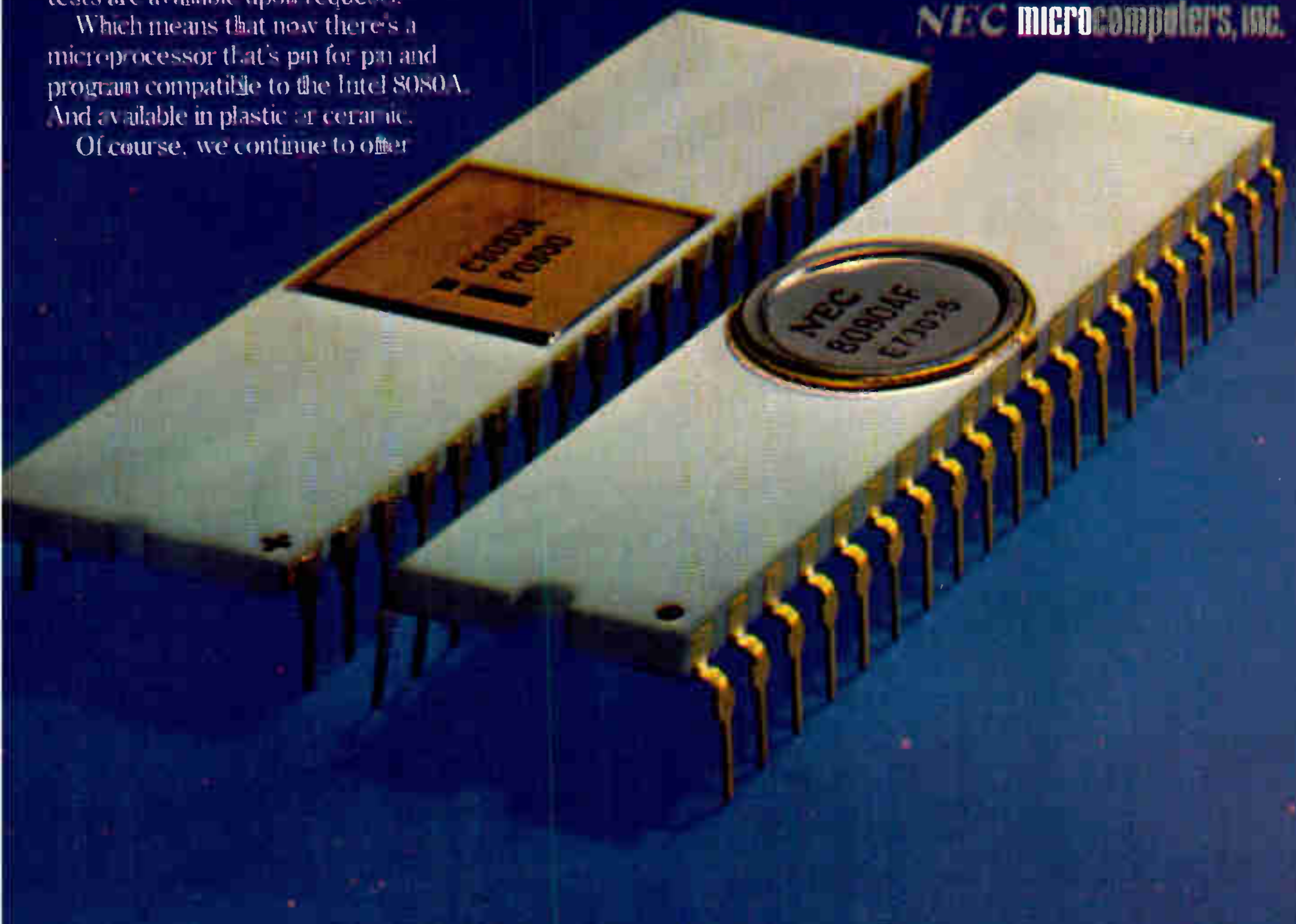


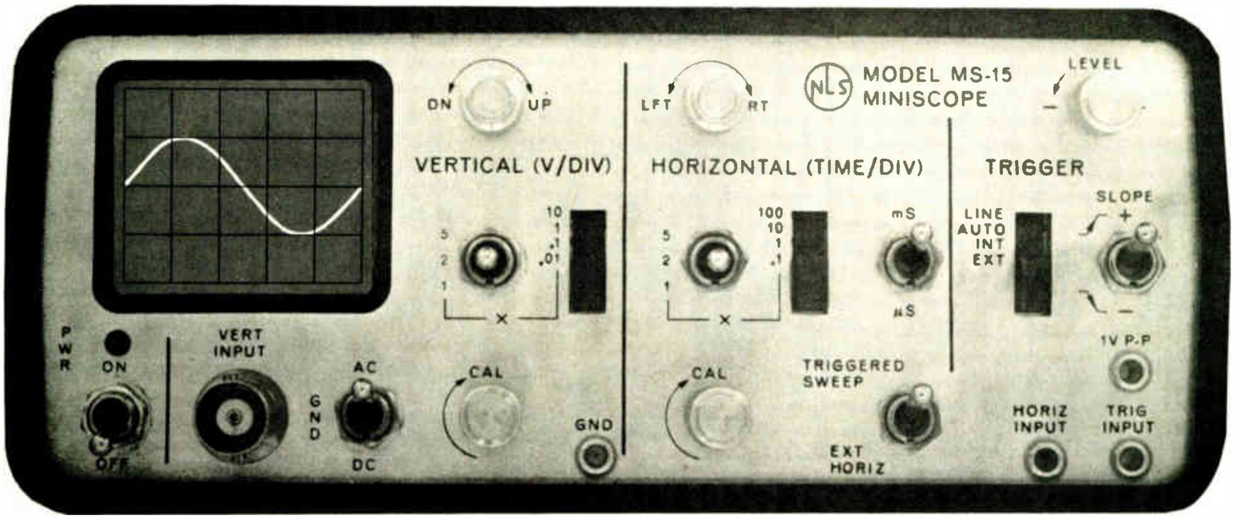
REPS: East—[illegible] Sales 301 [illegible] Contact [illegible] 617-[illegible] 1520, Harry Nash Assoc. 215 657-[illegible], Rome 516 249-[illegible], Tech Mark 607 748-7473, 716-223-12[illegible], [illegible] Tecnic Assoc. [illegible], South—[illegible] Assoc. 305-[illegible] 3211, 813-585-[illegible], 305 275-11[illegible], 20th Century Mktg. 20[illegible] 9237, Wolffs Sales Serv. Co. 919-781-0164, Midwest—Electronic Innovators [illegible] 7471, W. Pat Fralia Co. 817 640-9101, 817 649-[illegible]81, 713-[illegible], Imtech 216 826-3400, 513 278-6507, K-MAR Eng. & Sales 816-763-5345, R.C. Nordstrom & Co. 313 559-7373, 616 [illegible], Technology Sales 312-438-3300, West—Carrco 714-566-3113, D[illegible] Assoc. 303 534-3649, Electronic Component Mktg. 714-879-9460, Summit Sales 602-994-4587, Trident Assoc. 408-[illegible], Tri Tronix 206-[illegible] 503-261-8400, Canada—R.F.Q. Ltd. 416-[illegible] 1441, 514-[illegible]

DISTRIBUTORS: A[illegible] Electronics (Baltimore), Bell Ind. (Bellevue WA), Century Electronics (Albuquerque, Salt Lake City, Wheatridge CO), Diplomat (Chicopee Falls MA, Clearwater FL, Elk Grove Village IL, Farmington MI, Minneapolis MN, Laurel NJ, Salt Lake City, St. Louis, Sunnyvale, Totowa NJ, Woodbury NY), Future Electronics (Montreal, Ottawa, Rexdale Canada), Harvey Electronics (Fairfield NJ, Lexington MA, Norwalk CT, Woodbury NY), Intermark Electronics (San Diego, Santa Ana, Sunnyvale), G.S. Marshall (Sunnyvale), M[illegible] Electronics (Phoenix), Resco (Raleigh), R-M Electronic (Kentwood MI, Madison Hgts MI), Semicomp (Costa Mesa CA), Semiconductor Specialists (Burlington MA, Chicago, Dallas, Dayton, Farmington MI, Hazelwood MO, Indianapolis, Kansas City, Milwaukee, Minneapolis, Pittsburgh, Malton Canada), Sterling Electronics (Albuquerque, Dallas, Houston, New Orleans, Phoenix, San Diego, Seattle, Sun Valley CA, Watertown MA), Summit Distributors (Buffalo), Summit Electronics (Rochester), Technico (Columbia MD, Roanoke VA), Western Microtechnology Sales (Sunnyvale), Zeus Components (Elmsford NY)

From Non-Linear Systems, Inc.

A Professional 15 MHz Oscilloscope for $289.

THE NEW MS-15 MINISCOPE



ACTUAL SIZE

The Model MS-15 Miniscope has been designed to provide the basic features associated with more expensive oscilloscopes. Some of these features are: calibrated gain settings, calibrated sweep rates, external synchronization and external horizontal input. A few features of the more expensive 'scopes which we considered to be nonessential were omitted in the interest of economy, portability, reliability and ease of operation

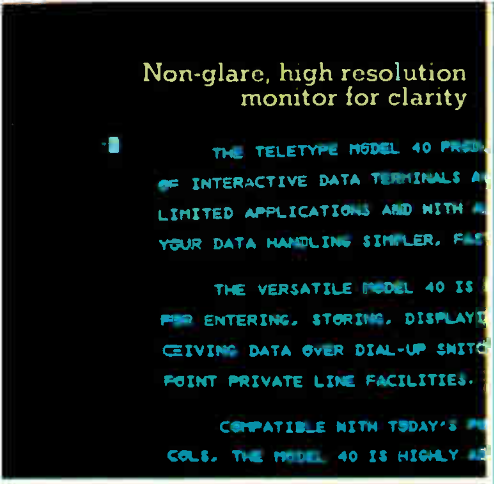
The MS-15 is the ultimate in state-of-the-art design sophistication and was developed with ruggedness and durability as a matter of prime concern. It is battery or line operated with batteries and charger unit included.

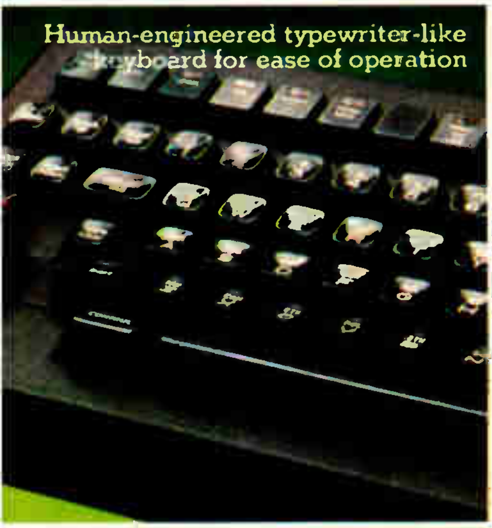
We expect the experienced user to feel comfortable with the MS-15 and to find the instrument capable of performing most of the tasks for which he has used an oscilloscope in the past. We also expect that the inexperienced oscilloscope user will not be intimidated by the multiplicity of controls normally associated with older oscilloscopes and will find it easy to become proficient in using the MS-15.

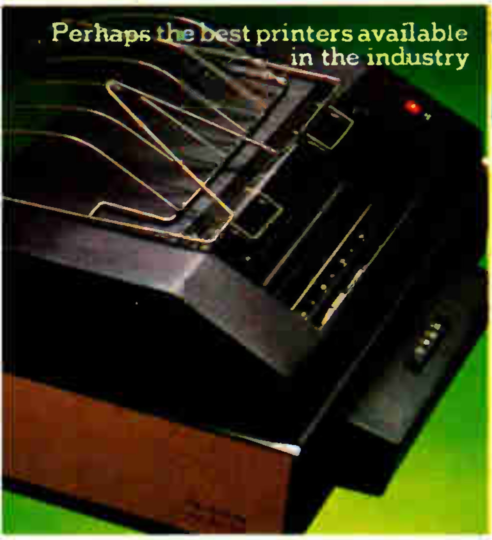
The Miniscope is a real jewel—try it, you'll like it!

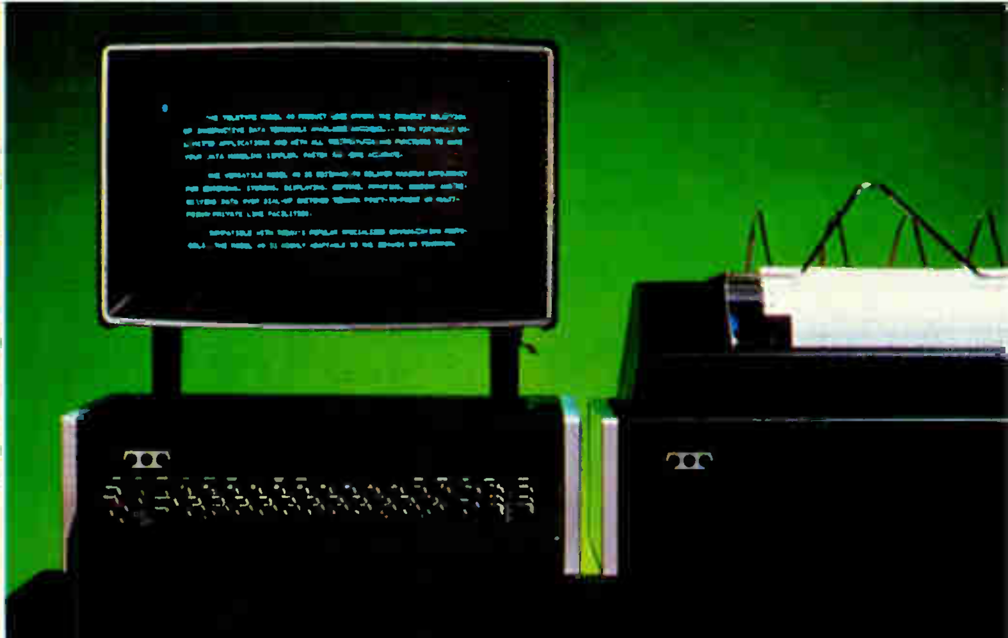
NLS' 25th Anniversary Year

Non-Linear Systems, Inc.
Originator of the digital voltmeter.
Box N, Del Mar, California 92014 Telephone (714) 755-1134 TWX 910-322-1132









THE MODEL 40 IS SO GOOD, NOTHING EVEN COMES CLOSE. AND WE CAN PROVE IT, COMPONENT BY COMPONENT.

We're convinced the Teletype® model 40 product line matches—if not exceeds—any data terminal system on the market today. Because on a cost/performance basis, nothing even comes close.

The 40 printer, using a unique design, is incredibly dependable. And its CMOS/LSI drive electronics are so advanced and compact, they fit inside the printer itself on a single circuit card.

Our keyboard is anything but ordinary, too. Naturally, all controls are grouped according to function. But more importantly, the entire unit is human engineered to provide the most in throughput. Not only do the keys impart a typewriter feel, they're also contoured to the shape of the operators' fingers.

We admit we could have cut corners when we designed and built our display tube. But good enough wouldn't have been good enough. So we used a glare reducing screen. Even the display type is specially designed for legibility, with a flicker-free refresh rate of 60 times/second. Character separation and clarity are insured by a large 7 x 9 dot matrix. And the whole unit tilts through 20° for the best viewing angle.

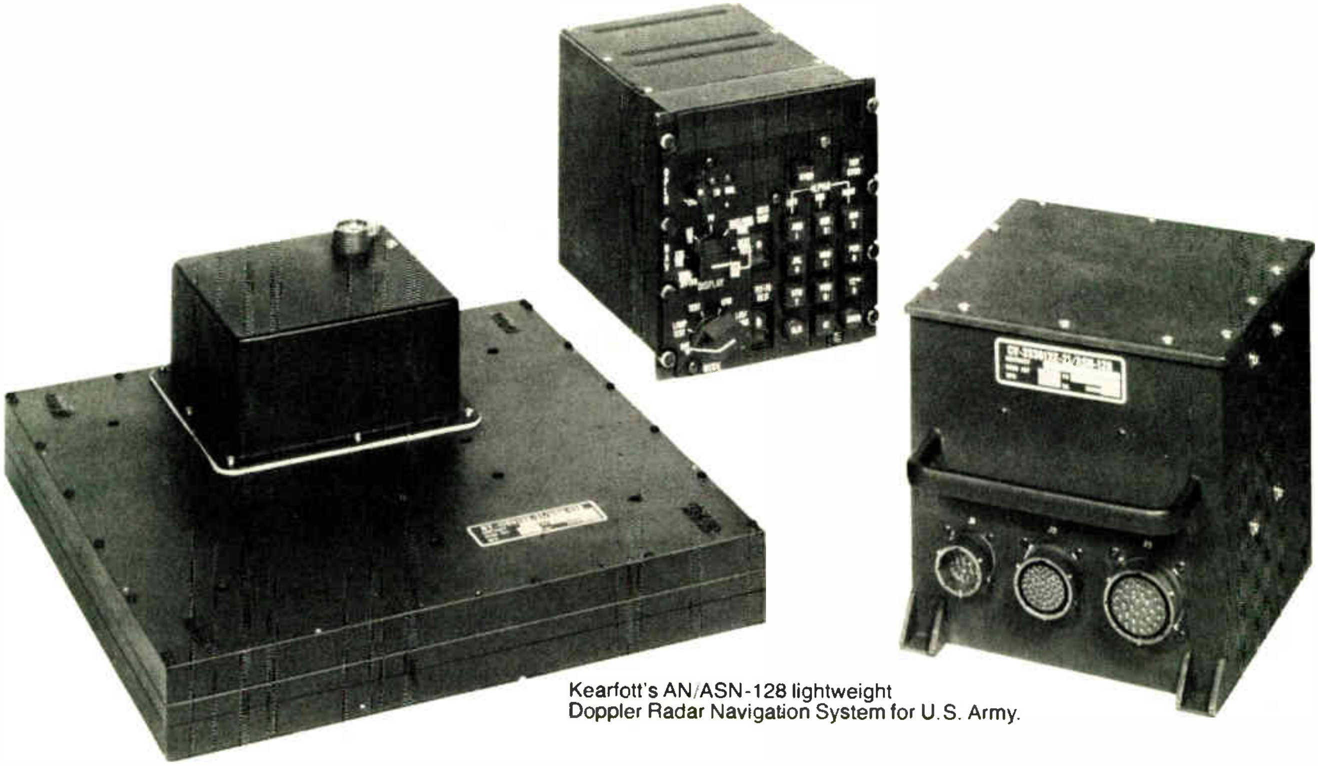
As good as the individual components are, added together they put the model 40 product line in a class by itself. For more information, write or call: Teletype, 5555 Touhy Ave., Skokie, IL 60076. Phone 312/982-2000.

TELETYPE

Teletype is a trademark and service mark registered in the United States Patent and Trademark Office.

Circle 217 on reader service card

THE STANDARD FOR DOPPLER RADAR NAVIGATION SYSTEMS



Kearfott's AN/ASN-128 lightweight Doppler Radar Navigation System for U.S. Army.

Kearfott's AN/ASN-128 Lightweight Doppler Navigation System is the U.S. Army's standard airborne doppler navigator.

The Receiver/Transmitter Antenna (RTA) and Signal Data Converter (SDC) constitute the Doppler Radar Velocity Sensor (DRVS), which continuously measures the velocity of the aircraft. The Control Display Unit (CDU) provides control and display functions for the operator, and contains the navigation computer.

With inputs from external heading and vertical references, the ASN-128 system provides accurate aircraft velocity, present position, and steering information. It is completely self-contained and requires no ground based aids.

The DRVS accepts heading, roll, and pitch as synchro inputs and converts them into digital format for transmission to the computer. The DRVS can also be used separately from the ASN-128 to provide velocity inputs to other aircraft equipment.

The CDU accepts beam velocities, heading, roll, pitch and true air speed (in some installations) from the Doppler Radar Velocity Sensor and performs the navigation computations. The front panel includes provisions for entering operator inputs and for displaying system data such as present position, steering information to 10 destinations, and status of the system. The CDU also puts out velocity and navigation data in ARINC digital format.

The CDU performs three functions for the ASN-128:

- Provides mode controls, display controls, and keyboard entry of destinations and other data.
- Performs all computations for LDNS including Doppler processing, velocity coordinate transformations, navigation in both UTM and latitude/longitude, steering signals to 10 destinations, and BITE functions.
- Displays navigation data on its front panel.
- BITE function identifies and displays failed LRU.
- Provides BCD and binary outputs for external equipment.

Operational Advantages:

- Weight 28 lb (12.7 kg)
- FM-CW transmission, with Doppler tracking of the J1 sideband providing accurate velocity measurement from ground level, to over 10,000 feet (3,048m).
- Printed-Grid Antenna—"Land-sea" switch eliminated, because of inherent beam shaping.
- Single transmit-receive antenna, utilizing the full aperture for both transmission and reception, minimizing beam width and reducing fluctuation noise.
- Navigation data in both UTM coordinates and Latitude/Longitude.
- Redundant navigation modes for backup.
- Single time-multiplexed signal processor module—only one-fourth the number of components of previous designs.
- Over 2000 hour MTBF for the ASN-128 and over 4500 hour MTBF for the DRVS alone.
- No maintenance adjustments at any maintenance level.
- No special test equipment at the flight line.

For additional information write to: The Singer Company, Kearfott Division, 1150 Mc Bride Ave., Little Falls, N.J. 07424.

Kearfott

a division of The **SINGER** Company

80 tests per second with GenRad's 2230

The GR 2230 is the first computer-controlled network and module tester for under $20,000. This extremely flexible multifunctional circuit tester increases productivity in both manufacturing and incoming inspection areas. It has total programming flexibility and readily interfaces with handlers and other instrumentation.

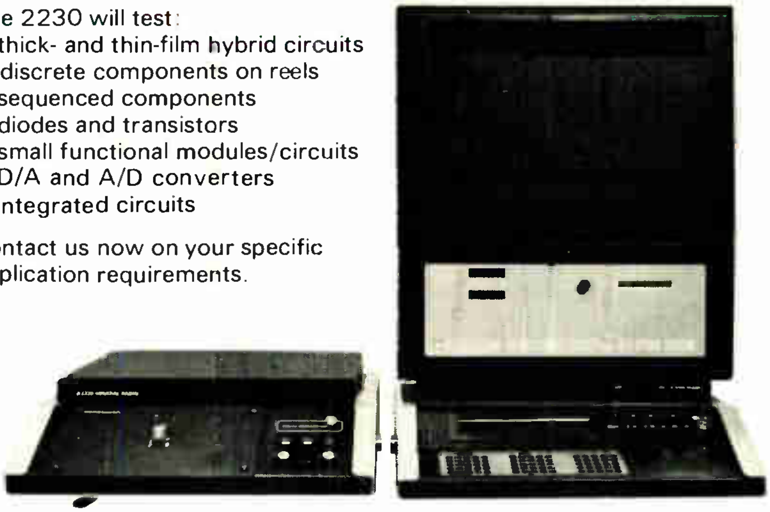
The 2230 provides:

- mixed R, L, C and dc measurements with individualized test limits
- point to any other point scanning with Kelvin connections
- simple programming with macro-instruction keyboard
- both Go/No-Go and parameter read-out modes of operation
- quick-disconnect device adaptors for various package styles
- data-logging and data-reduction capabilities with hard-copy output
- ease of interface to automatic device handlers
- computer-controlled speed and accuracy at low cost

The 2230 will test:

- thick- and thin-film hybrid circuits
- discrete components on reels
- sequenced components
- diodes and transistors
- small functional modules/circuits
- D/A and A/D converters
- integrated circuits

Contact us now on your specific application requirements.



GenRad

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Circle 231 on reader service card

Instruments

Logic analyzer, scope combined

Package is designed for troubleshooting microprocessor circuits

Logic analyzers have greatly eased the problem of troubleshooting microprocessor-based circuits, but probably there will always be a need for an oscilloscope to completely check out such circuits. Recognizing this likelihood, Scanoptik Inc., Rockville, Md., has designed a combined logic analyzer-scope unit that is portable and easy to use. It is built in the Tektronix TM-500 series package format.

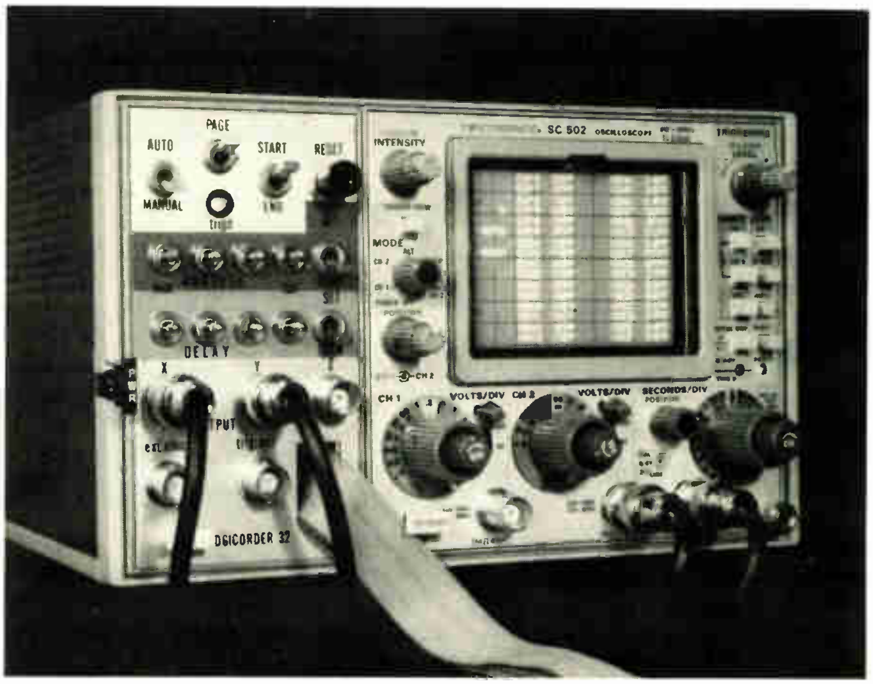
Called the LC-320 instrument package, it combines a 32-channel-by-64-word logic-state analyzer with a Tektronix type SC-502 15-megahertz dual-trace oscilloscope. Scanoptik slightly modifies the scope and adds interconnecting circuitry to allow simple switching between the logic-analyzer and waveform-display modes.

In the analyzer mode, the user connects 32 leads to his circuitry—16 for the address bus and the other 16 to various data and machine logic-state lines. A 16-bit trigger address can be set on the front panel, and when the state of the address bus corresponds to the trigger address, the analyzer stores the next 64 states of the 32 connection points. It then formats the 64 words into a 64 eight-digit hexadecimal word block for display on the scope. The analyzer will handle microprocessors with clock rates up to 4 MHz.

The scope, which can also be used to display waveforms, can be triggered from the 16-bit address match to show the behavior of various circuit elements and to show timing relationships at a critical point in the program.

Price of the combination is $4,490. Options are available.

Scanoptik Inc., P. O. Box 1745, Rockville, Md., 20850. Phone (301) 977-9660 [351]



Portable, 4½-digit DMM resolves 1 microvolt

Designed for both bench and field use, the 3466A is a five-function 4½-digit multimeter that can resolve 1

Did you know that you can save $1,005 by buying a Fluke 1953A Counter instead?

That's right.

Fluke's 1953A Universal Counter-Timer mainframe plus IEEE Programming option will cost you just $1,595.* Instead of the $2,600 or more you'd pay for comparable models.

And you'll get excellent systems performance plus extras you didn't count on.

Like "clean dropout." If the signal is too small, the 1953A will show zeros. Theirs can give you a wrong reading.

Our frequency range on Channel A is 125 MHz. Theirs is 100 MHz.

Our Z-axis time interval marker is standard. Theirs is optional.

Board access is better on the 1953A. We use one custom I.C. They use many.

Our input capacity on Channels A and B is 30 pF. Theirs is 40 pF. And our Channel B frequency response is 25 MHz. Theirs is 10 MHz.

The 1953A is half the weight, consumes one-fifth the power and makes no noise at all. On theirs you'll hear the fan and switching regulator.

Our switch and control "feel" is as good as theirs, and our front panel labeling is much less confusing.

Where the 1953A shows 9 digits all the time, theirs offers 9 digits only on Channel C.

And, if you need the option of Parallel BCD for both control and data out, we have it. They don't.

So, if you're in the market for a programmable counter, consider the Fluke 1953A.

And consider how much you'll save.

For data out today, dial our toll-free hotline, 800-426-0361. John Fluke Mfg. Co., Inc., P.O. Box 43210, Mountlake Terrace, WA 98043. Fluke (Nederland) B.V., P.O. Box 5053, Tilburg, The Netherlands. Phone: (013) 673-973. Telex: 52237.

*U.S. price only

The 1953A. A programmable counter at a reasonable price.

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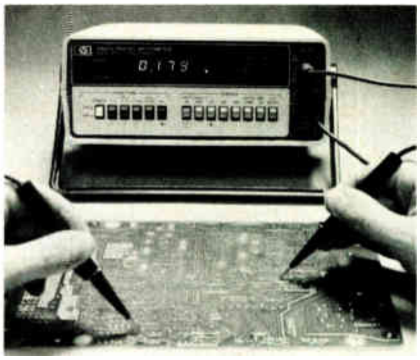
For literature only circle 221



microvolt on its lowest (20-millivolt) dc voltage range. The autoranging instrument makes true-root-mean-square measurements on ac voltages and currents. The operator may select either ac or dc coupling for these measurements, which enables him either to block the dc component or to determine the true-rms value of the combined ac plus dc signal. For dc voltage, maximum midrange error is 0.03% of reading plus 1 count; for ac voltage, it is 0.3% of reading plus 20 counts from 20 hertz to 100 kilohertz.

The 3466A measures ac and dc currents from 200 microamperes full scale to 2 amperes and resistances from 20 ohms full scale to 20 megohms. On its 2-kilohm resistance range, the meter provides a 1-milliampere current source, which can be used to display the forward voltage drop across a diode.

The standard unit sells for $650 and includes a rechargeable lead-acid battery. A line-only version is priced at $575. Delivery is from stock.

Hewlett-Packard Co., 1507 Page Mill Rd., Palo Alto, Calif. 94304 [353]

Function generator offers burst-mode operation

A low-frequency function generator that covers the frequency range from 1 millihertz to 1 megahertz offers single-shot and burst-mode operation as well as normal continuous-wave generation. The model PM5129 produces sine, square, and triangle waveforms that can be varied in amplitude, dc-offset level,

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UNITED KINGDOM **Spectrol Reliance Ltd.** Drakes Way, Swindon, Wiltshire, England • Swindon 21351 • TELEX. 44692

ITALY **SP Elettronica SpA** Via Carlo Pisacane 7 20016 Pero (Milan) Italy • 35 30 241 • TELEX. 36091

Circle 223 on reader service card

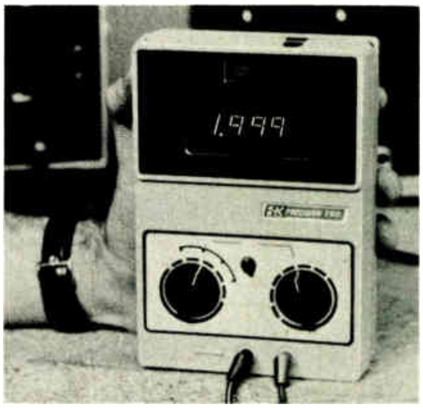
New products

frequency, and duty cycle. Its maximum output is 30 volts across 50 ohms; a step attenuator can reduce this figure by up to 68 decibels. The PM5129 sells for $1,140 and has a delivery time of six weeks.

Philips Test & Measuring Instruments Inc., 85 McKee Dr., Mahwah, N. J. 07430. Phone (201) 529-3800 [354]

3½-digit multimeter sells for $119.95

Shielded against radio-frequency interference, the model 2810 portable 3½-digit multimeter is a five-function instrument that sells for only $119.95. Among its features are a switch that allows resistance measurements to be made with either a high voltage or a low voltage; the low-voltage position allows in-circuit resistance measurements without biasing semiconductor junctions. All ranges are protected against overloads. The ohms circuitry, for example, can withstand momentary dc or ac-peak overloads of up to 1,000 volts; continuous protection is pro-



Here are two ways to measure ceramic capacitor reliability

40

Major Hi-Rel Programs

You'll find our ceramic capacitors functioning in some of the toughest environments known to man. Here are just a few of the programs. Space: Surveyor, Mercury, Gemini, Apollo (Command Module, LEM, PLSS). Defense: Minuteman II and III, F-14, F-15 and F-16, Polaris and Poseidon, Sparrow, Hawk and Maverick, F-111 and the B-1 bomber.

15

Years of Hi-Rel Experience

Founded in 1960 to supply ceramic capacitors for Hi-Rel programs, we were a technology leader almost from the start. We were the first to develop precious metal alloy electrode systems; the first to automate chip production to meet a proven failure rate level of .001% per 1000 hours; the first to perfect the use of base metals in electrodes. Latest — the totally redundant fail-safe feed-thru capacitor.

Unlike many companies, we do not have separate chip lines for Hi-Rel military and commercial MonoKap products. You get the same high quality in both. And, you can buy MonoKaps right off our distributor's shelves.

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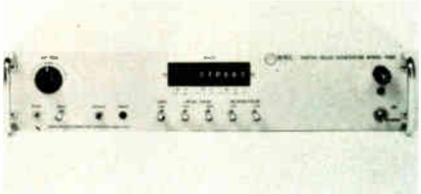
vided up to 300 v ac, −450 v dc, and +100 v dc. The meter will operate for more than 40 hours on a set of alkaline batteries. Nickel-cadmium batteries and a charger are available as options. Delivery is immediate from B&K-Precision distributors.

B&K-Precision, Dynascan Corp., 6460 W. Cortland, Chicago, Ill. 60635. Phone Myron Bond at (312) 889-9087 [355]

Unit generates delays up to 1 ms in 1-ns increments

Capable of generating delays and gate times up to 1 millisecond in 1-nanosecond increments, the model 7065 digital delay generator keeps its jitter below ±100 picoseconds. An option extends the maximum range to 1 second. In case the user inadvertently selects a delay time longer than the triggering period, an error-indication lamp will glow as a warning that some of the delay



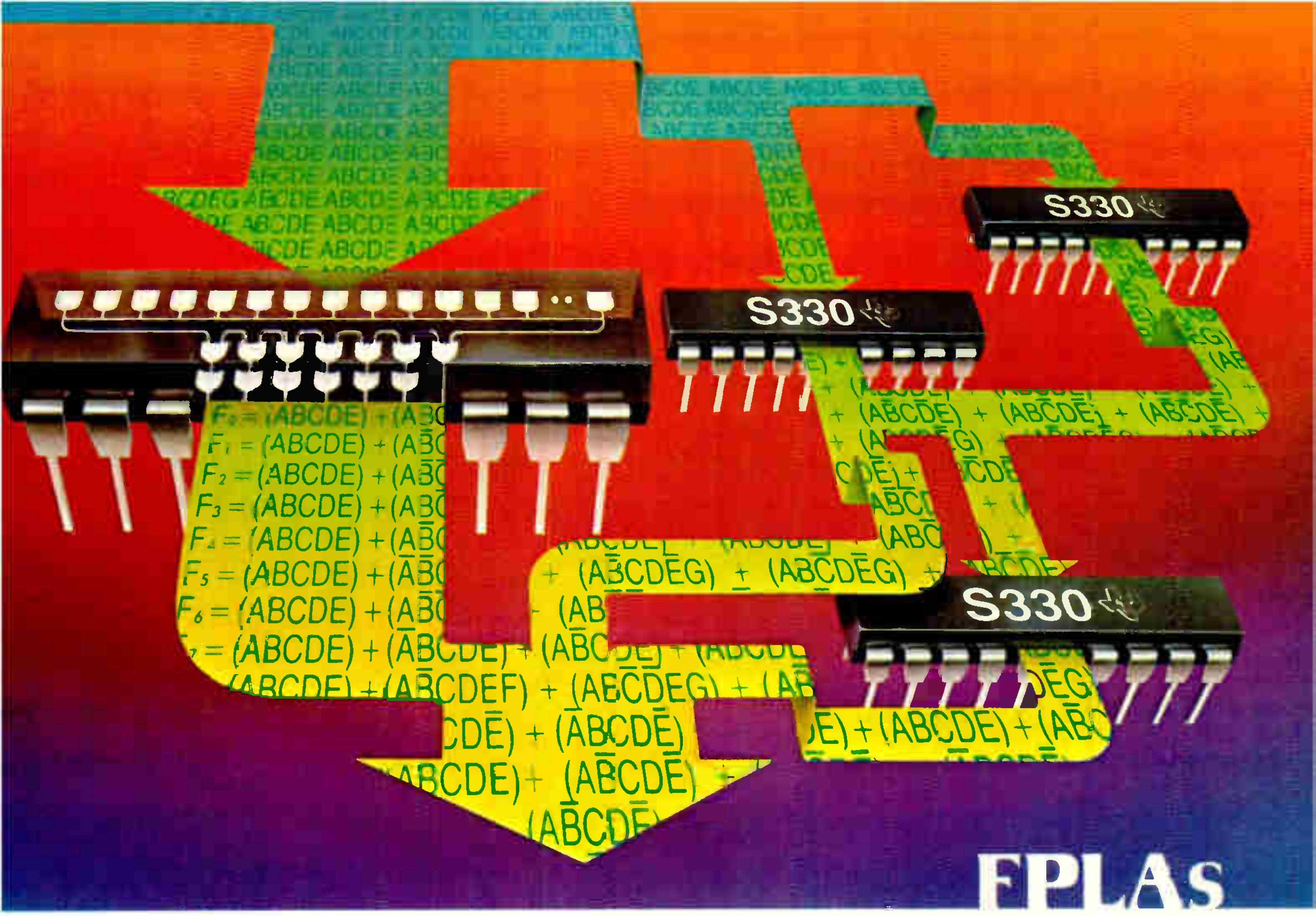
cycles are now being missed.

Standard features of the instrument include input trigger level and slope selection, positive and negative outputs, and output pulse rise times of 3 ns. The 7065 sells for $2,950 and has a delivery time of four to six weeks.

Berkeley Nucleonics Corp., 1198 Tenth St., Berkeley, Calif. 94710 [356]

Snap-around ac VOM has 3½-digit display

The latest snap-around ac volt-ohm-ammeter from A. W. Sperry is a digital unit with a 3½-digit liquid-crystal display. Called the Digisnap, the portable instrument uses its



New dimensions in logic...

Field Programmable Logic Arrays. From Texas Instruments.

TI's new S330 and S331 Schottky TTL FPLAs open new dimensions in logic design. They feature a unique built-in capability for multidimensional expansion of the basic 12 input x 50 term x 6 output organization. A flexible means for achieving more efficient designs.

Automatic enable

A special circuit resides dormant in TI's new FPLAs. Fuse a single link and the FPLA turns "smart". Automatically enabling itself by decoding true product terms. Result: Multidimensional expansion to almost any size array. You expand variables, product terms, and outputs. Without external components, logic or control.

Efficient, flexible, user programmable

Use these LSI FPLAs to replace standard SSI and MSI logic functions. To implement unique random logic. To supplement PROMs.

They're field programmable. Using proven titanium-tungsten fuse links for fast, low-voltage, reliable programming. You can "wire up" whatever combination of AND, NAND, OR, NOR logic that most precisely fits your design. Reducing design time. Package count. And cost.

20-pin Schottky TTL

With the S330 and S331, you get the high performance of TI's Schottky TTL. Typical delay time: 35ns. Typical enable time: 20ns.

They come in TI's space-saving 20-pin plastic or ceramic packages. For greater board density, greater reliability, lower cost. In both commercial and military applications.

Useful, economical

The SN54S/74S330 (3-state output) and SN54S/74S331 (2500-ohm passive pullup output) are both available now at $9.00 for commercial (plastic) versions (100 pieces).

Order today from your TI distributor. Or for more details, write Texas Instruments Incorporated, P.O. Box 5012, M/S 308, Dallas, Texas 75222.

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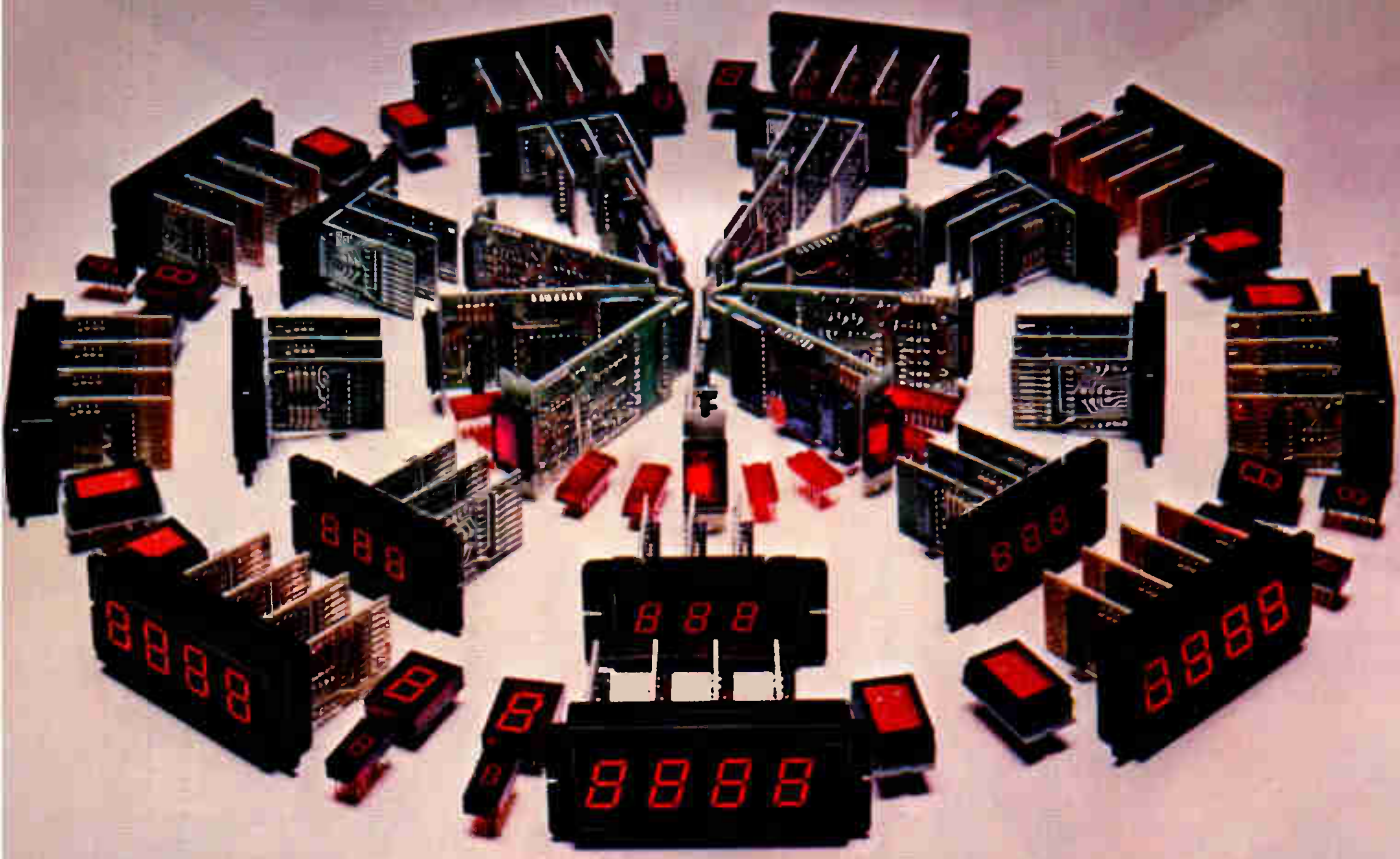
Circle 227 on reader service card

When you need LED readout displays or more than LED readout displays...



Come to Dialight. For built-in circuitry for example. If that's the type of convenience you're considering, then Dialight's the first place to look . . . because Dialight's the first in value-added LED readout displays.

For many years now we've been offering not only the latest technology, but also the latest in time and labor-saving pre-engineered displays. These can be ordered any way you wish: with or without on-board decoder/driver, with or without code generator, in any number of digits in an assembly, complete with bezel for instant panel mounting.

We also offer high brightness, low cost design flexibility with a choice of discrete and assembly displays with character heights of .270", .300" and .600".

For your free copy of our new Readout Product Selector Guide, call or write to us at Dialight today.

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Dialight, 203 Harrison Place, Brooklyn, N.Y. 11237 (212) 497-7600

Circle 229 on reader service card

display to indicate overload conditions, low battery voltage, and the type of measurement being made, as well as the numerical value of the parameter.

The meter is powered by a 50,000-hour rechargeable battery pack that will operate the meter for 50 hours on one charge. Accuracy is within 1% of full scale for voltage and resistance readings and 2% of full scale for current measurements. The instrument also has a peak mode of operation for voltage and current in which the maximum error rises to 3% of full scale. A data-lock push button allows the user to freeze the reading for examination in a convenient position. Called the model DSA-1000, the meter is protected against overloads and covers the frequency range from 50 to 400 hertz.

A. W. Sperry Instruments Inc., 245 Marcus Blvd., Hauppauge, N. Y. 11787. Phone (516) 231-7050 [358]

Function generator sweeps across 100,000:1 range

Capable of sweeping over a 100,000:1 frequency range, the mod-

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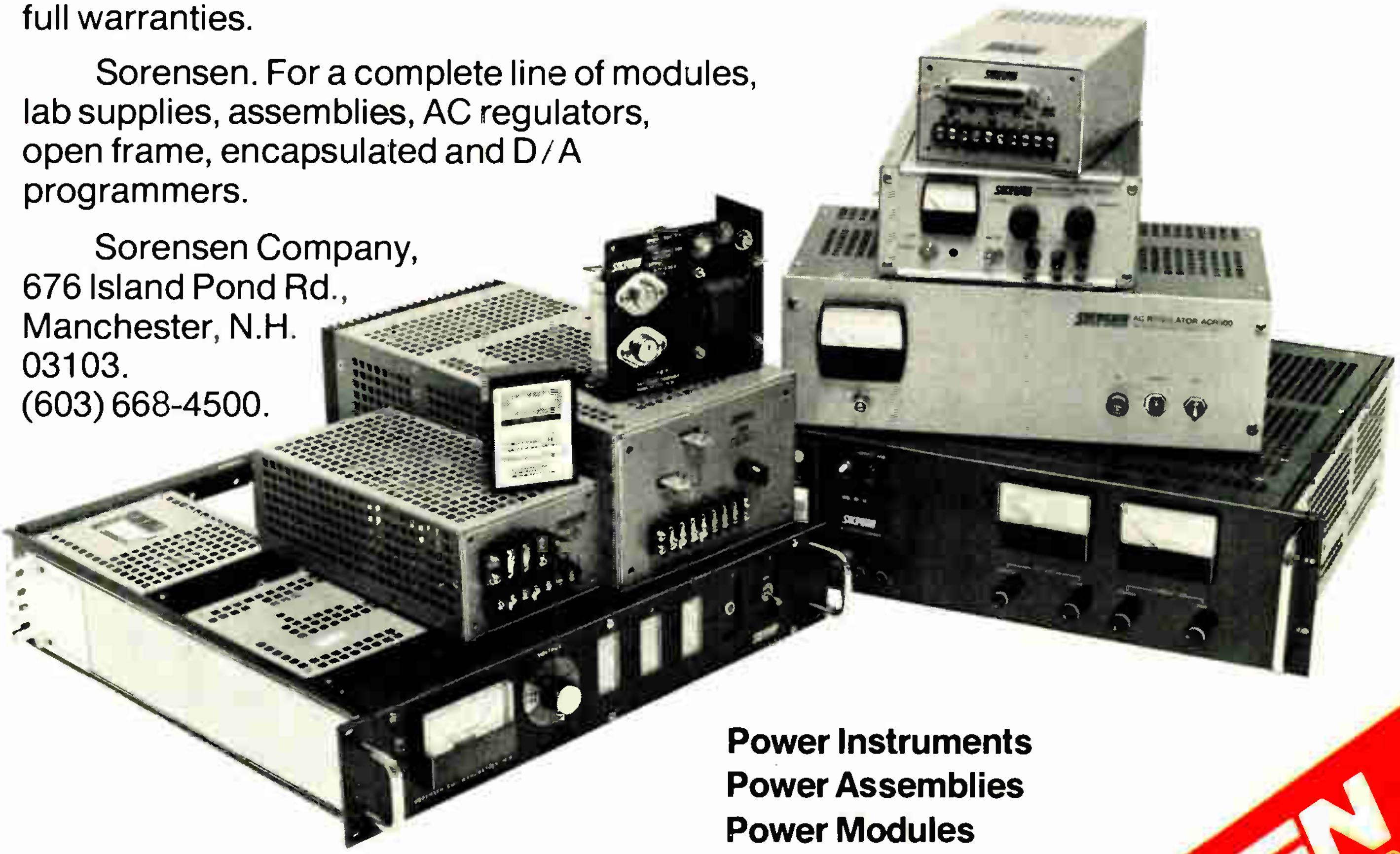

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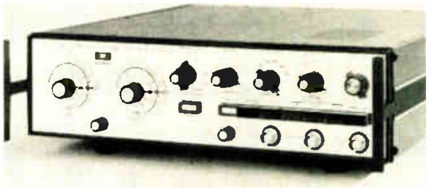


el 508 5-megahertz function generator is really two generators in one. The main unit, which can be frequency-controlled by an external voltage, covers the range from 0.1 millihertz to 5.5 MHz producing sine, square, triangle, pulse, haversine, and havertriangle waveforms. The other generator produces ramps with periods from 10 microseconds to 100 seconds and is used for direct output as well as for sweeping, triggering, and gating the main generator.

When the main generator is swept by the ramp generator, frequency ranges of up to 1,000:1 can be covered linearly. A logarithmic mode allows the 100,000:1 range.

In its pulse-generator mode, the model 508 uses its ramp generator to trigger the main unit to produce pulses of either polarity. In this application, the ramp generator can be free-running, or it can be triggered either manually or by an external signal.

In addition to being operated under control of the ramp generator, the main generator can also be swept manually or by an external voltage. Its start- and stop-frequency dials can be used to provide 10-turn resolution, single-turn resolution with 1,000:1 linear coverage, or single-turn resolution with 100,000:1 logarithmic coverage. Light-emitting diodes, visible through the dials, indicate both the mode of operation and the frequency setting. Improper combinations of control settings cause the LEDs to flash. Priced at $745, the model 508 has a delivery time of 45 days.

Exact Electronics Inc., P. O. Box 160, Hillsboro, Ore. 97123. Phone (503) 648-6661 [357]

Circle 223 on reader service card →

LAMBDA ELECTRONICS
DIVISION of Veeco INSTRUMENTS INC

MORE NEW SEMICONDUCTORS FROM LAMBDA

NEW 30 AMP MONOLITHIC FULL-WAVE, CENTER-TAP RECTIFIERS

Replaces two stud rectifiers

Up to 200V PIV: 30 amps.
Available in common-cathode and common anode arrays in a TO 3 package.
Designed for and used in Lambda's 5-year guaranteed power supplies.

BETTER THAN MOTOROLA!

Parameter	Compare these specifications Lambda PMR35K200	Motorola 1N1186	Units
V_{RRM}	200	200	Volts
Io (Avg)	30	35	Amps
I^2T	600	—	$A_{rms}{}^2S$
I_{fsm}	400	400	Amps
V_F @ Io	1.4	1.3	Volts
$T_{J\text{-}STG}$	−65° to +200°	−65° to +175°	°C
Quantity required for full-wave center-tap bridge	1	2	—
Price quantity 100 for full wave center tap bridge	3.15 ea.	2.24 ea. (2 needed)	—

NEW 2 AMP MONOLITHIC OVERVOLTAGE PROTECTORS
No external components needed.

$1.70 Qty. 1000

LAMBDA'S MONOLITHIC FULL-WAVE PMR 27, 31, 35, 36 CENTER-TAP RECTIFIERS TO 3 Package

Replaces two stud mount rectifiers.

GENERAL DESCRIPTION

The PMR 27K, PMR 31K series and PMR 35K, PMR 36K series of devices are center tapped Common Cathode, Common Anode rectifiers designed for use in power supplies. They are designed for 15 Amp and 30 Amp average current applications requiring 200V, 100V, or 50V peak inverse voltage. Both devices are Monolithic construction.

ABSOLUTE MAXIMUM RATINGS

	PMR27K050 PMR31K050	PMR27K100 PMR31K100	PMR27K200 PMR31K200	PMR27K400 PMR31K400	PMR35K050 PMR36K050	PMR35K100 PMR36K100	PMR35K200 PMR36K200	UNITS
RRM—Maximum Repetitive Peak Reverse Voltage	50	100	200	400	50	100	200	Volts
R(RMS)—Maximum RMS Reverse Voltage	35	70	141	282	35	70	141	Volts
—Average Rectified Forward Current	15	15	15	15	30	30	30	Amps
SM—Peak Non-Repetitive Surge Current (½ cycle)	250	250	250	250	400	400	400	Amps
T RATING—Non-Repetitive or 1mS<t<8.3mS	240	240	240	240	600	600	600	$A_{RMS}{}^2S$
D—Power Dissipation Total Package Derate @ 1W/°C above 50°C	150	150	150	150	150	150	150	Watts
, T_{STG}—Operating and Storage Temperature			−65 to +200					°C
θ_{JC}—Thermal Resistance Junction to Case	1.0	1.0	1.0	1.0	0.67	0.67	0.67	°C/W

LECTRICAL CHARACTERISTIC (T_J0°C to 200°C)

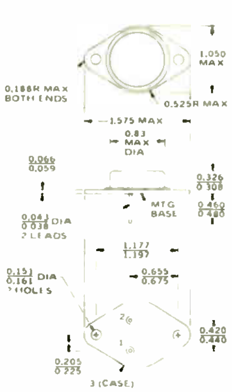
	MIN	MAX	
F(av)—Full Cycle Average Forward Voltage Drop, I_o = 15A, (PMR 27/31); I_o = 30A (PMR 35/36) f = 60 Hz, each diode		1.4	Volts
RM—Maximum Reverse Current at V_{RRM}, each diode		10	mAdc

ORDERING INFORMATION

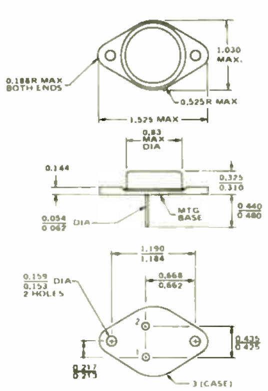
COMMON CATHODE	COMMON ANODE	V_{RRM}	I_o	PRICE QTY 1	100	250	1000	2500
PMR 27K 050	PMR 31K 050	50	15	2.08	1.25	1.10	.95	.91
PMR 27K 100	PMR 31K 100	100	15	2.15	1.30	1.15	1.00	.96
PMR 27K 200	PMR 31K 200	200	15	2.25	1.35	1.20	1.05	1.00
PMR 27K 400	PMR 31K 400	400	15	2.75	1.65	1.50	1.27	1.21
PMR 35K 050	PMR 36K 050	50	30	4.75	2.85	2.57	2.18	2.10
PMR 35K 100	PMR 36K 100	100	30	5.00	3.00	2.70	2.30	2.20
PMR 35K 200	PMR 36K 200	200	30	5.25	3.15	2.83	2.42	2.30

Contact the factory for higher quantity prices.
Device configrations, Specifications, and prices subject to change without notice.

OUTLINE DRAWINGS

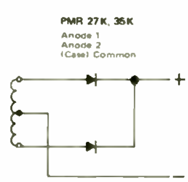


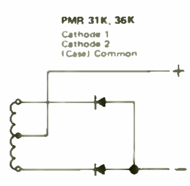
PMR 27, 31



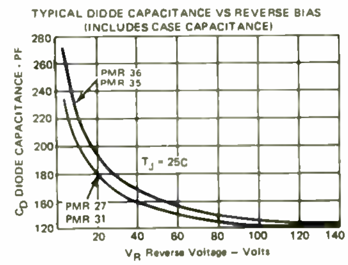
PMR 35, 36

PIN CONNECTIONS

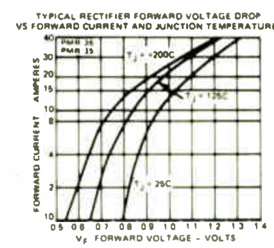




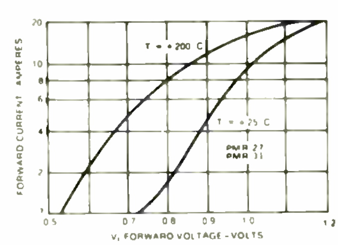
OPERATION DATA



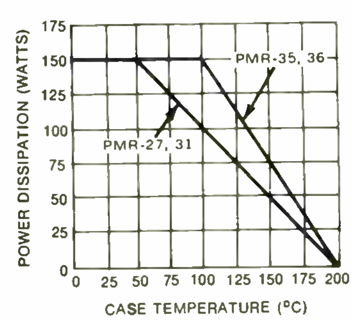
TYPICAL DIODE CAPACITANCE VS REVERSE BIAS (INCLUDES CASE CAPACITANCE)



TYPICAL RECTIFIED FORWARD VOLTAGE DROP VS FORWARD CURRENT AND JUNCTION TEMPERATURE: PMR 35,36

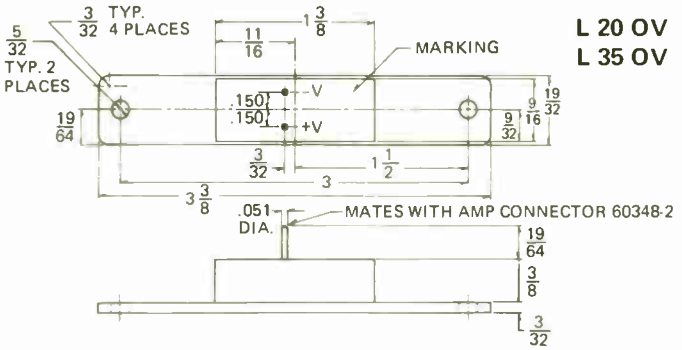


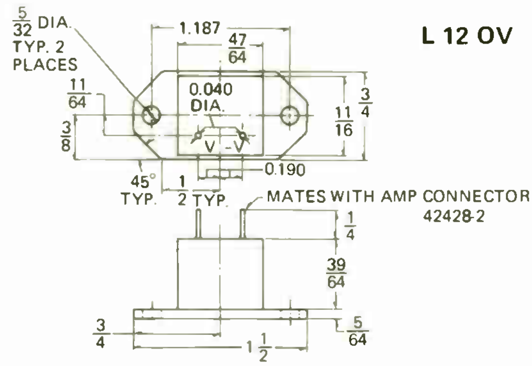
TYPICAL FORWARD VOLTAGE VS CURRENT: PMR 27,31



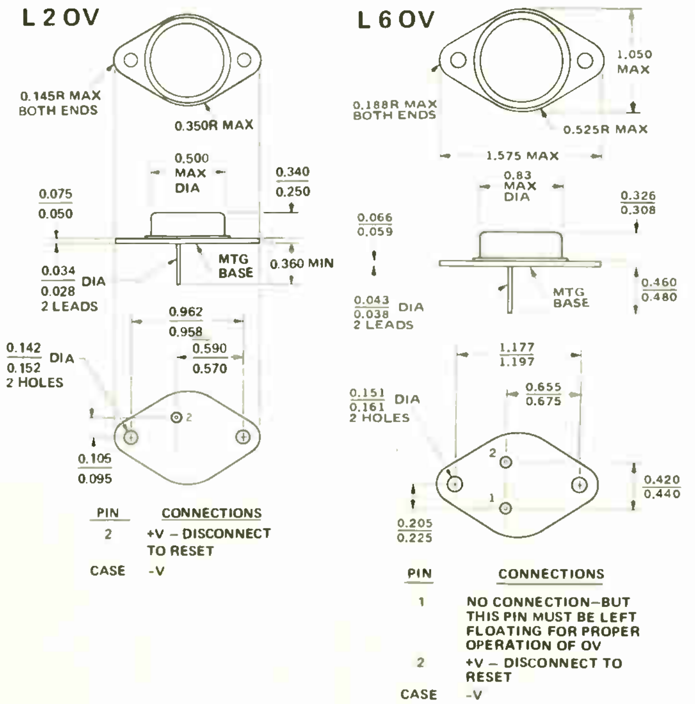
POWER DERATING

OUTLINE DRAWING

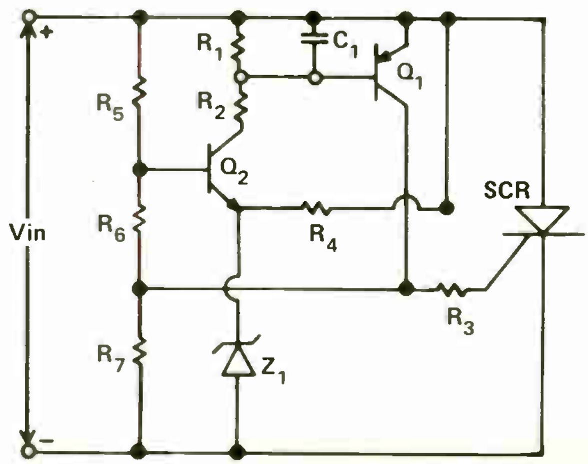




OUTLINE DRAWING



HYBRID OVERVOLTAGE PROTECTOR SCHEMATIC DIAGRAM



L 2 OV, L 6 OV, L-12-OV, L-20-OV, L-35-OV SERIES

Lambda Overvoltage Protectors
Monolithic & Hybrid - No external components needed

GENERAL DESCRIPTION

The Lambda overvoltage protector prevents damage to the load caused by excessive power supply output voltage due to improper adjustment, improper connection, a disconnected sense lead, or failure of the power supply. Load protection is accomplished by effectively short circuiting the output terminals of the power supply when a preset limit voltage has been exceeded. The trip-point limit voltage cannot be adjusted. To reset overvoltage protector, remove AC input to power supply, allow overvoltage protector to cool, and reapply power.

OVERVOLTAGE PROTECTOR ABSOLUTE MAXIMUM RATING

PARAMETER	SYMBOL	L2 OV SERIES MIN	L2 OV SERIES MAX	L 6 OV SERIES MIN	L 6 OV SERIES MAX	L-12-OV SERIES MIN	L-12-OV SERIES MAX	L-20-OV SERIES MIN	L-20-OV SERIES MAX	L-35-OV SERIES MIN	L-35-OV SERIES MAX
On State Current	I_{DC}		2A	–	6A	–	12A	–	20A	–	35A
On State Voltage	V_{DC}		2.6V	–	2.6V	–	1.3V	–	1.4V	–	1.6V
Non-Repetitive Peak Surge Current*	I_P		20A	–	70A	–	200A	–	260A	–	350A
Standby Current	I_S		35mA	–	25mA	–	5mA	–	5mA	–	5mA
Operating Temperature (Blocking)**	T_{CB}	-40°C	+100°C	-40°C	+100°C	-40°C	+100°C	-40°C	+100°C	-40°C	+100°C
Operating Temperature (Conducting)***	T_{CC}	-40°C	+150°C	-40°C	+150°C	-40°C	+140°C	-40°C	+140°C	-40°C	+140°C
Storage Temperature	T_S	-40°C	+150°C	-40°C	+150°C	-40°C	+125°C	-40°C	+125°C	-40°C	+125°C
Power Dissipation @ T_C = 25°C Derate @ 1.5W/°C above 50°C	P_D		30 Watts		150 Watts						
Thermal Resistance	$R_{\theta JC}$		5.0°C/W		1.0°C/W						

*For sinusoidal current duration of 8.3 milliseconds max.

**Case temperature for overvoltage protector in non-conducting or "OFF" state.

***Case temperature for overvoltage protector in conducting or "ON" state. Power must be removed and case temperature allowed to drop to 100°C before application of output voltage.

The overvoltage protector requires an external heat sink to maintain case temperature below rated limit. When the overvoltage protector is used with a Lambda power supply, the power supply chassis acts as the heat sink. The L-12-OV, L-20-OV, L-35-OV, overvoltage protector is supplied with mating connectors for pins on overvoltage protector (+V and −V engraved on unit.).

ORDERING INFORMATION

NOM SUPPLY VOLTAGE (VOLTS)	TRIP POINT VOLTAGE^ (VOLTS)	2 AMP MODELS	PRICE QTY 1	PRICE QTY 100	PRICE QTY 250	PRICE QTY 1000	6 AMP MODELS	PRICE QTY 1	PRICE QTY 100	PRICE QTY 250	PRICE QTY 1000
5	6.6 ± .2	L2 OV 5	$2.50	$2.00	$1.90	$1.70	L 6 OV 5	$5	$4	$3.75	$3.40
6	7.3 ± .2	L2 OV 6	2.50	2.00	1.90	1.70	L 6 OV 6	5	4	3.75	3.40
9	10.5 ± .4	L2 OV 9	2.50	2.00	1.90	1.70	L 6 OV 9	5	4	3.75	3.40
10	11.0±.5						L 6 OV 10	5	4	3.75	3.40
12	13.7 ± .4	L2 OV 12	2.50	2.00	1.90	1.70	L 6 OV 12	5	4	3.75	3.40
15	17.0 ± .5	L2 OV 15	2.50	2.00	1.90	1.70	L 6 OV 15	5	4	3.75	3.40
18	20.5±1.0						L 6 OV 18	5	4	3.75	3.40
20	22.8 ± .7	L2 OV 20	2.50	2.00	1.90	1.70	L 6 OV 20	5	4	3.75	3.40
24	27.3 ± .8	L2 OV 24	2.50	2.00	1.90	1.70	L 6 OV 24	5	4	3.75	3.40
28	31.9 ± 1.0	L2 OV 28	2.50	2.00	1.90	1.70	L 6 OV 28	5	4	3.75	3.40

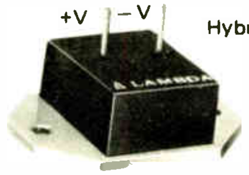
NOM SUPPLY VOLTAGE (VOLTS)	TRIP POINT VOLTAGE^ (VOLTS)	12 AMP MODELS	PRICE QTY 1	PRICE QTY 100	PRICE QTY 250	PRICE QTY 1000	20 AMP MODELS	PRICE QTY 1	PRICE QTY 100	PRICE QTY 250	PRICE QTY 1000	35 AMP MODELS	PRICE QTY 1	PRICE QTY 100	PRICE QTY 250	PRICE QTY 1000
5	6.6 ± .2	L 12 OV 5	$10	$8	$7.50	$6.80	L 20-OV-5	$14	$11.20	$10.50	$9.50	L 35-OV-5	$18	$14.40	$13.60	$12.30
6	7.3 ± .2	L 12 OV 6	10	8	7.50	6.80	L-20-OV-6	14	11.20	10.50	9.50	L-35-OV-6	18	14.40	13.60	12.30
9	10.5 ± .4	L 12 OV 9	10	8	7.50	6.80										
12	13.7 ± .4	L 12-OV-12	10	8	7.50	6.80	L-20-OV-12	14	11.20	10.50	9.50	L-35-OV-12	18	14.40	13.60	12.30
15	17.0 ± .5	L 12-OV-15	10	8	7.50	6.80	L-20-OV-15	14	11.20	10.50	9.50					
20	22.8 ± .7	L 12-OV-20	10	8	7.50	6.80	L-20-OV-20	14	11.20	10.50	9.50					
24	27.3 ± .8	L 12 OV 24	10	8	7.50	6.80	L-20-OV-24	14	11.20	10.50	9.50					
28	31.9 ± 1.0	L 12-OV-28	10	8	7.50	6.80	L 20 OV 28	14	11.20	10.50	9.50					
30	33.5 ± 1.0	L 12-OV-30	10	8	7.50	6.80	L 20 OV 30	14	11.20	10.50	9.50					

^VOLTAGE TOLERANCE MAINTAINED OVER 0-71°C DUE TO POWER DESIGN

Monolithic

L 6 OV

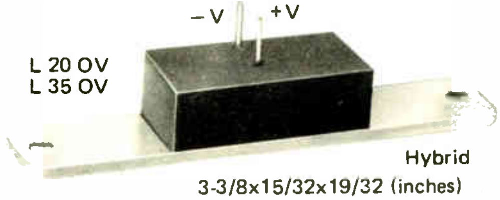
Monolithic
L 2 OV



Hybrid

L 12 OV

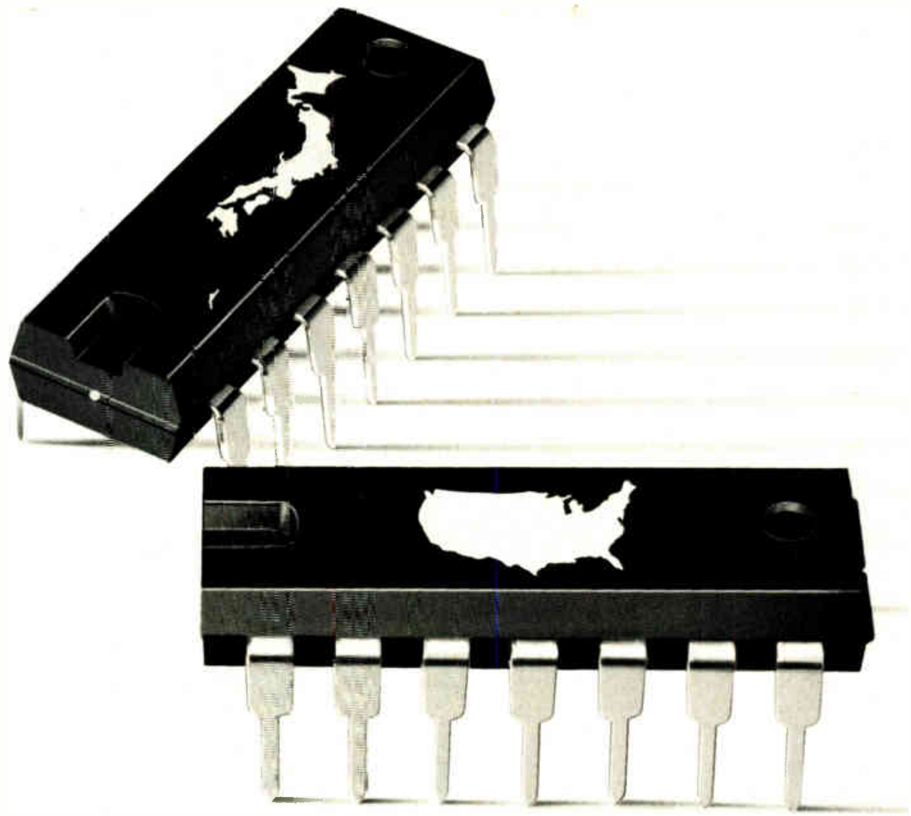
1-1/2x11/16x3/4 (inches)



L 20 OV
L 35 OV

Hybrid

3-3/8x15/32x19/32 (inches)



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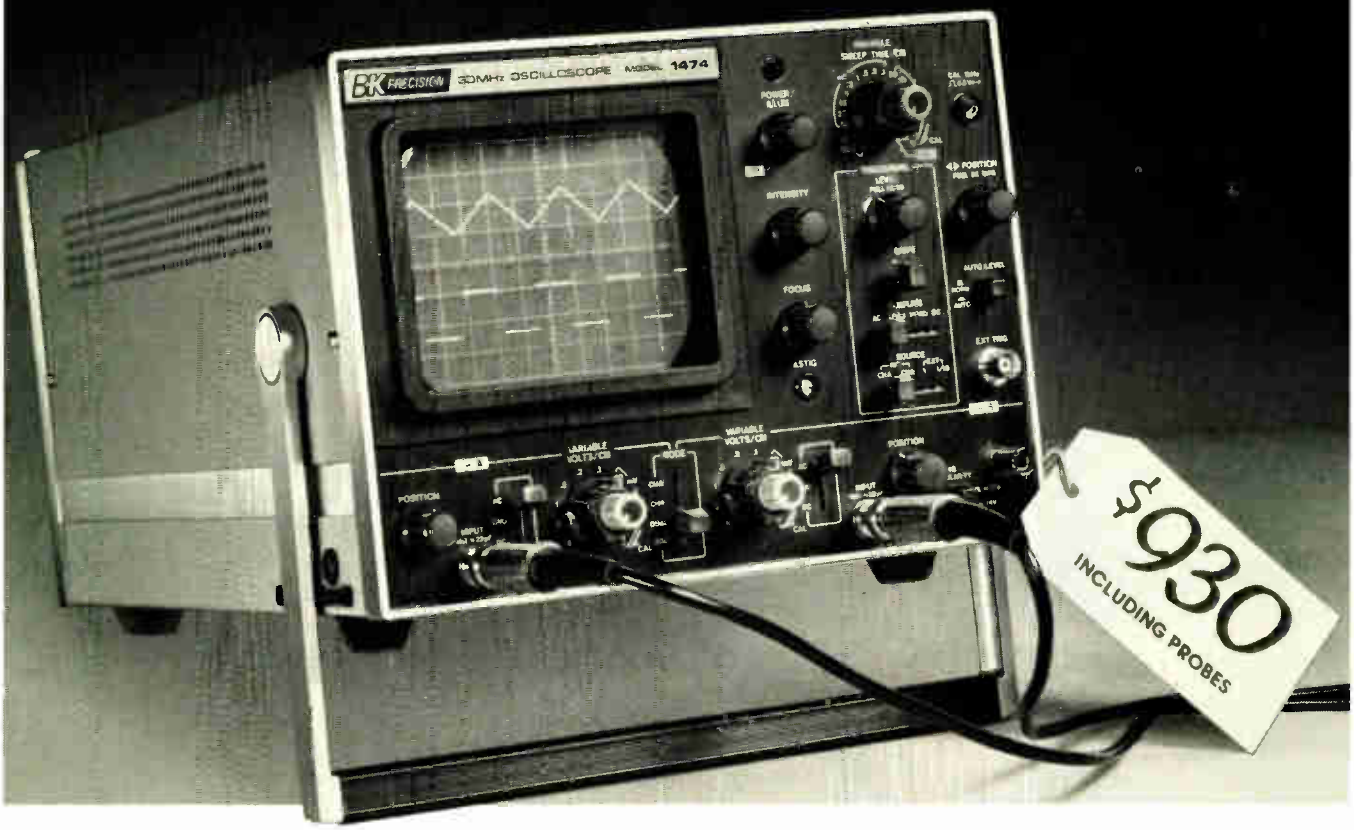
B&K-PRECISION's 30MHz scope has a feature that Tektronix and H-P would love to have...our price!

(and immediate delivery, too.)



But we don't think they'd complain about the performance or features of our Model 1474 either.

The B&K-PRECISION Model 1474 is the most cost-effective 30 MHz dual-trace scope available. No compromise features include a built-in single delay line, 5mV/cm sensitivity, switchable high- and low-pass triggering filters and a TTL compatible Z-axis input. Vertical response is typically down only −6dB at 49 MHz.

Like other B&K-PRECISION products, the 1474 is designed to fill most user requirements at the lowest realistic price possible. The 1474 isn't loaded down with expensive features you may never use, but it does have every feature you're likely to need. Don't take our word for it though, prove it to yourself.

We're so sure that the B&K-PRECISION 1474 will fill your needs that we can offer a no obligation ten-day free trial.

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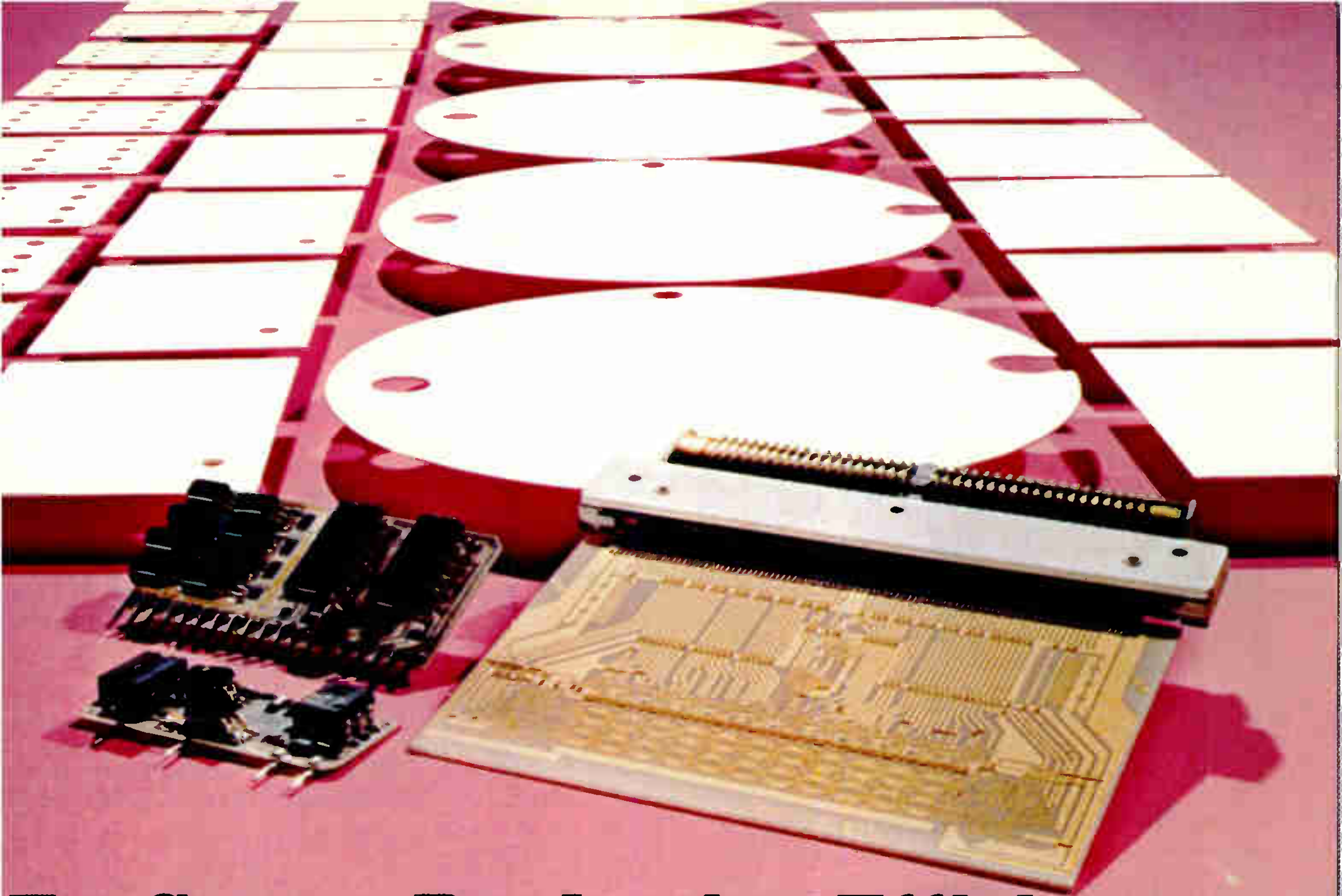

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Circle 245 on reader service card

Packaging & production

Probe catches narrow pulses

Circuit-powered unit tests logic state and pulse symmetry

The digital logic probe, with its price of about 1/100 that of a good memory oscilloscope, has rapidly become the favored troubleshooting tool for production, test, and field engineers. This probe can be used to check all types of digital circuits, such as clocks, gates, registers, counters, arithmetic/logic units, and central processing units.

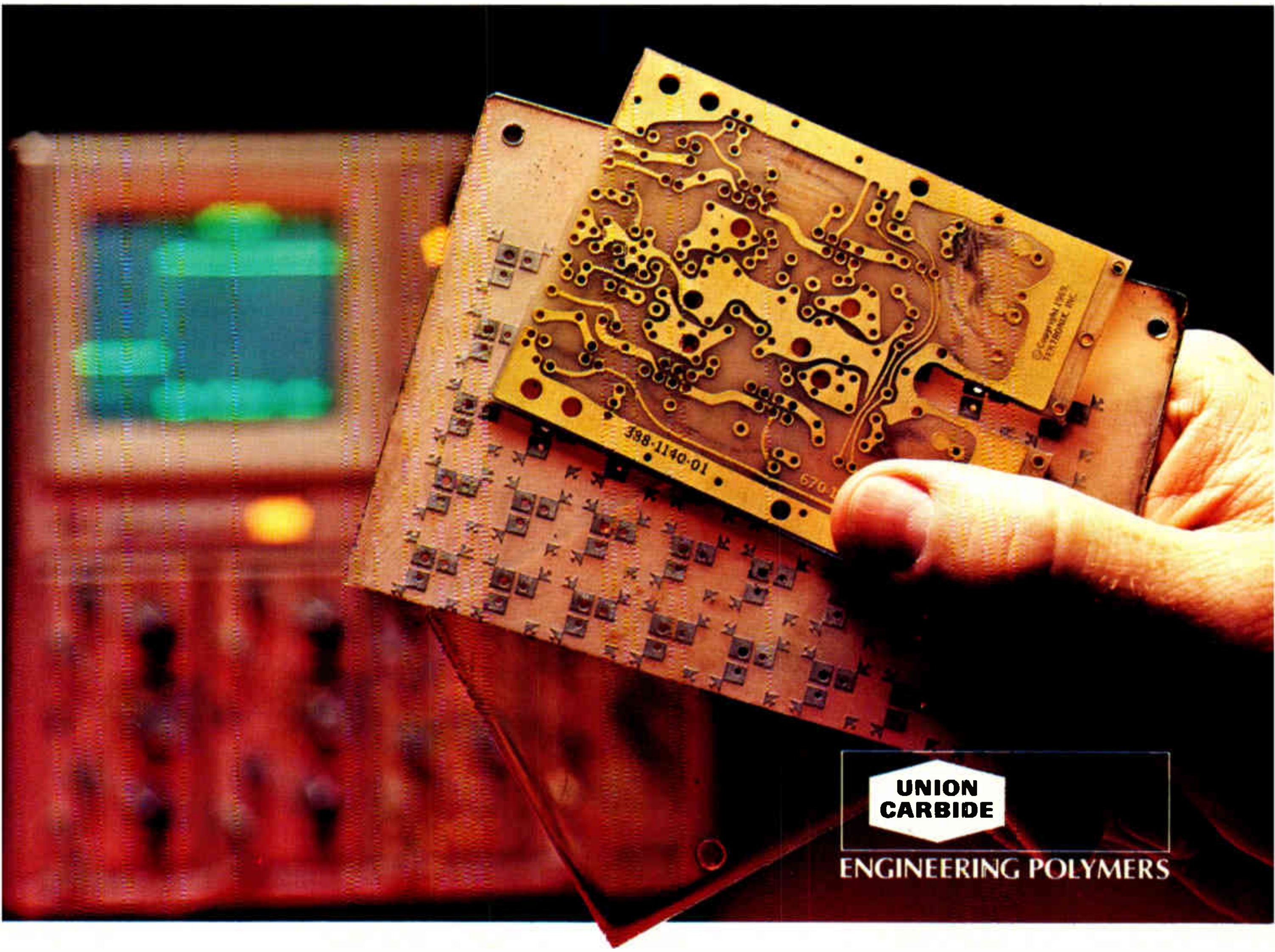
A new low-cost ($69.95) probe from Continental Specialities Corp., the LP-3, can test four popular high-speed logic families—transistor-transistor, diode-transistor, high-threshold, and complementary metal-oxide-semiconductor. Drawing its power from the circuit under test, the LP-3 has pulse-detection, pulse-stretching, and latching capabilities. It also gives an instant readout of logic levels, positive and negative transitions, and pulse symmetry.

The new probe allows detection of pulses as short as 10 nanoseconds. In the pulse mode, a built-in stretcher causes the pulse light-emitting diode to blink at a 10-hertz rate to indicate pulse transitions. Two LEDs—high (logic 1) and low (logic 0)—indicate logic levels present in the circuit. At high frequencies, the LP-3 will also indicate whether signals are symmetrical. Pulse trains with duty cycles of less than 30% will activate the low LED and the pulse LED, while duty cycles of 70% or more will activate the high and pulse LEDs. The probe's 500-kilohm input impedance prevents circuit-loading problems.

The new testing aid, whose dimensions are 5.8 by 1 by 0.7 inches, features a plug-in connector system. The rear of its high-impact plastic housing is equipped with a phono jack that accepts the unit's standard 36-in.-long clip leads or leads of any other desired length, terminated in a phono plug. The front of the probe accommodates plug-in interchangeable tips, including a straight needle probe, alligator clip, and quick-attaching insulated clip, as well as a ground lead.

Another new instrument developed by CSC, the DP-1 pulser, is a

If you could cut base material cost from $15 or $30 down to $3 per square foot, how much would you save next month?



Maybe $10,000 per month? More? Less?

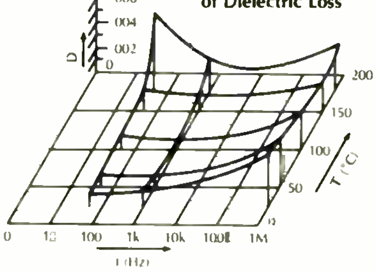
Well, Tektronix, Inc. of Beaverton, Oregon thought the savings impressive enough for their high frequency circuit boards to switch from polyphenylene oxide to an extruded polysulfone (UDEL Polysulfone, of course) just 1/16 of an inch thick.

Their processing costs are about the same as for other base materials with similar electrical properties. Even the quality and yields (c. 80%) are close on. But since they stopped using copper clad polyphenylene oxide they also get a use temperature 100 deg. F. *above* that material.

Polysulfone outperforms other materials at a lower cost in high frequency applications because of its excellent electricals (see graph) plus all these advantages:

- withstands 500 deg. F. wave solder bath for 5 secs.
- good notched Izod: 1 ft-lb/in.
- impressive chemical resistance
- ink and adhesive baking at 320 deg. F.
- good peel strength
- and polysulfone can be *molded* with stand-offs, holes of all sizes, and any shape, to save machining and finishing time.

Contour Plot of Dielectric Loss



How much more can we tell you here? Write for full data using the coupon below or the reader service card.

Maybe I can cut my high frequency circuit boards cost by 90%. Let me look at your data on UDEL Polysulfone

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State ______________ Zip ______________

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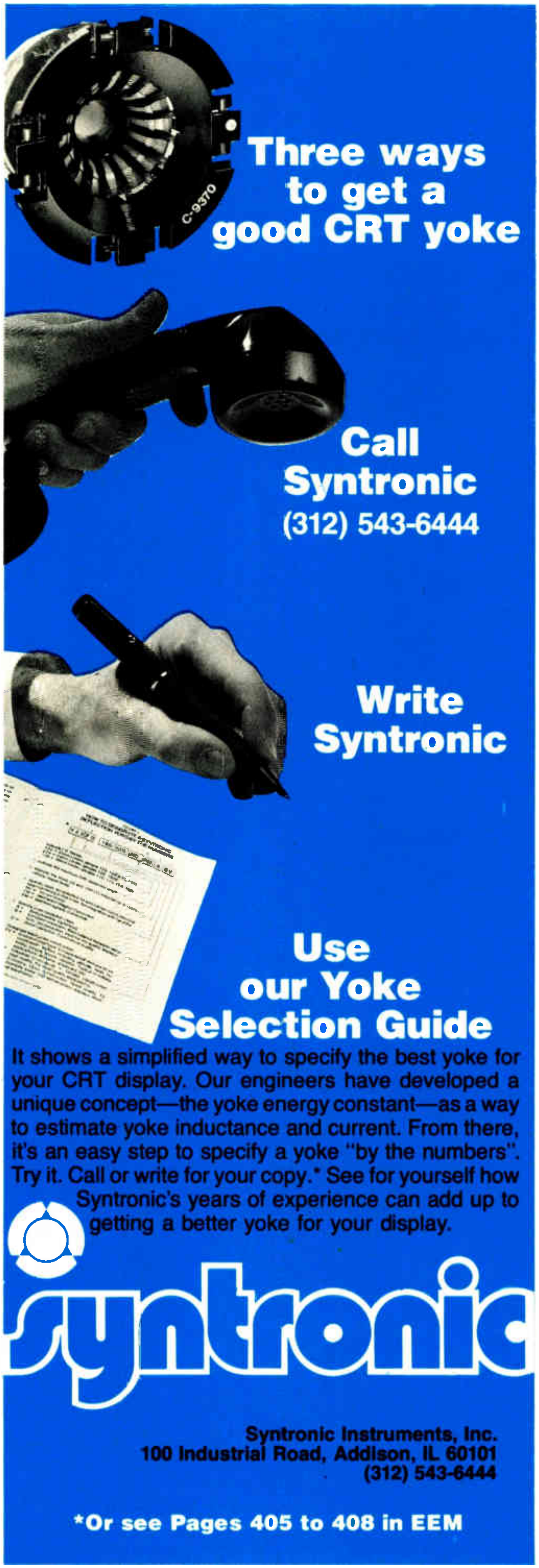
270 Park Avenue, New York, N.Y. 10017.

Circle 247 on reader service card



useful adjunct to the LP-3. The pulser, powered from the circuit under test, is used to inject signals at key points in TTL or DTL and in C-MOS circuitry. A logic probe can then sense the circuit's state or response.

The short-circuit-proof DP-1 tests either with a single pulse or at a 100 pulse-per-second rate. Pulse width can be selected to accommodate C-MOS, TTL or DTL. The pulser senses the initial state of the circuit under test and produces an input pulse of the opposite polarity.

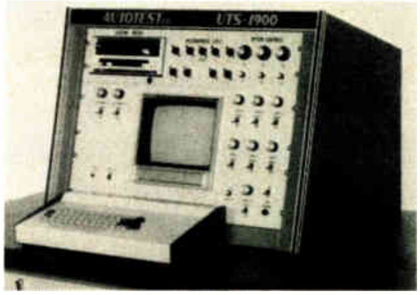
The DP-1's size is identical to that of the logic probe. Price of the DP-1 is $74.95.

Continental Specialties Corp., 44 Kendall St., Box 1942, New Haven, Conn. 06509. Phone (203) 624-3103 [391]

System tests power supplies automatically

Unlike manual testers, which are subject to human variability and even outright error, the computer-controlled UTS-1900 power-supply tester ensures tight quality control by performing every test in exactly the same way. The unit is also estimated to be some 80% faster than a manual tester although its actual throughput will depend, of course, on the power supply under test and on the tests to be performed.

The system runs on a Basic interpreter that gives full program control of all test functions. This multitasking executive makes maximum use of the interrupts of input/output devices to speed test execution by allowing wait periods only when really necessary. Although the 8080-based microcomputer will normally



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There's now a new energy source that's a superb alternative: Rechargeable, sealed lead-acid batteries from Gates.

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Advantages: Gates Energy Cells are as compact as nickel cadmium or gelled type cells. And they are completely sealed, so that no acid vapor can leak out (they also include a self-sealing vent for extra safety). Gates Energy Cells provide low internal impedance for high discharge rates (more than 100 amps from the D cell and 200 amps from our X cell for short periods of time). And can be operated or stored in any position.

Gates Energy Cells offer great packaging flexibility. In fact, our individual cell availability allows you to choose your own specific voltage (in 2-volt increments) and current, as well as configuration.

Just as important as what Gates Energy Cells have to offer is what they don't have to offer. Like outgassing problems. Or cell reversal. Or "memory" problems.

Because Gates Energy Cells are made from low-cost materials that are readily available, they're very high in watt-hr. per dollar value. Which means that if you specify them, you'll probably save your company more than a few dollars. And make yourself into something of a hero in the bargain.

To find out more about the future in energy cells, circle our reader service number or write us. We'll send you *free* literature containing features, application information, ratings and specifications. George Sahl, Gates Energy Products, Inc., 1050 S. Broadway, Denver, CO 80217.

E-9

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Energy Products

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Circle 249 on reader service card

run a complete test in its stored-program mode, it can also step through the program line by line to facilitate power-supply troubleshooting or program debugging.

Maximum load capability is 1,900 watts dc distributed among six electrically isolated loads. Loading accuracy is within 0.5% of full scale. Line input is provided by a feedback-controlled autotransformer capable of supplying 0 to 280 volts root-mean-square at 20 amperes, accurate to within 1 v rms. Two programmable dc supplies are also included for testing dc-to-dc converters. These supplies are rated to deliver 5 A at 0 to 30 v dc.

The measurement system consists of 16 lines, any of which can be connected to a built-in 5½-digit Systron-Donner multimeter, which measures ac and dc voltage and resistance. In addition, a 3½-digit scanning measurement system, capable of 100 conversions per second, continuously monitors load current, line voltage, and line current and displays them on the system's cathode-ray-tube display.

The basic UTS-1900, which includes everything needed to test power supplies, sells for $44,975. Most users will probably want to add an ASR-33 printer. Other options include a true-rms or peak detector for ripple measurements, data-logging capability, a floppy-disk system, a line-isolation transformer, a 50-hertz line selector, and pulsed-load capability.

Autotest Co., P. O. Box 20264, San Antonio, Texas 78220. Phone Robert W. Cox at (512) 661-8391 or 661-4111 [393]

Unit programs eight EPROMS in less than three minutes

A gang personality module capable of simultaneously programming as many as eight 2708-type 8,192-bit MOS erasable programmable read-only memories works with both Pro-Log's series 90 PROM programmer and series 92 PROM programmer/duplicator control units. Called the PM 9051, the module can program,

acdc explodes a myth!

We've got a mighty short fuse when it comes to the myth about ACDC not being competitive in low-cost open-frame power supplies. And while myths usually aren't worth the powder to blow 'em up, we've taken aim at this one.

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Use the coupon to tell us what types of power supplies you need, the quantities you require, *and the prices you'd like to pay.* Fire it off to us right away, and by return salvo we'll tell you how quickly we can get them into your arsenal.

If you don't have a requirement yet, but would like full specs on our low-cost power supplies, just circle the reader service number.

DO IT YOURSELF POWER SUPPLY PRICING

I'd like to help you explode your myth. Listed below are the details of the linear power supplies we'd like to have in our arsenal.

Description	Overvoltage Protection Yes	Overvoltage Protection No	Quantity	Price I'd Like to Pay
1. ____V@ ____Amps	( )	( )	____	____
2. ____V@ ____Amps	( )	( )	____	____
3. ____V@ ____Amps	( )	( )	____	____

Special features, number of outputs, etc.__________

Name__________ Title__________

Company__________

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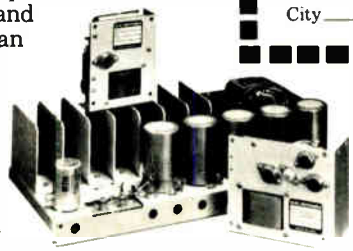

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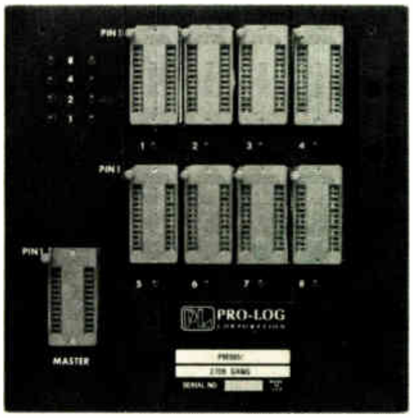
401 Jones Road, Oceanside, California 92054, (714) 757-1880

Circle 251 on reader service card

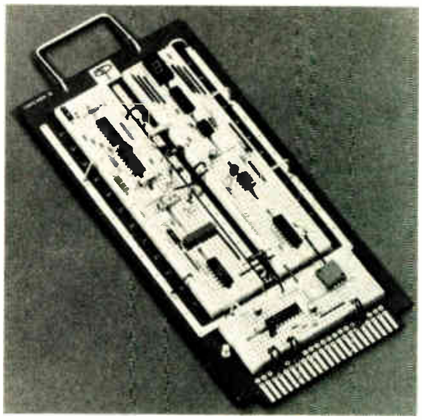


duplicate, list, and verify 2708-type erasable PROMs from Advanced Micro Devices, Electronic Arrays, Intel, Intersil, Motorola, National Semiconductor, Signetics, and Texas Instruments. With the PM 9051 priced at $895, users can do gang programming with a series 90 for as little as $2,695 or gang duplicating with a series 92 for as little as $1,890. The units are available from stock.

Pro-Log Corp., 2411 Garden Rd., Monterey, Calif. 93940. Phone (408) 372-4593 [394]

Reusable solderless cards have five tie points

Because they have five tie points instead of the four of their predecessors, the latest Unicard solderless breadboards are particularly well suited for use with large-scale integrated circuits. The reusable devices require no special patch cords and plug into standard 5.25-inch racks. Unicard I has 960 tie points (192

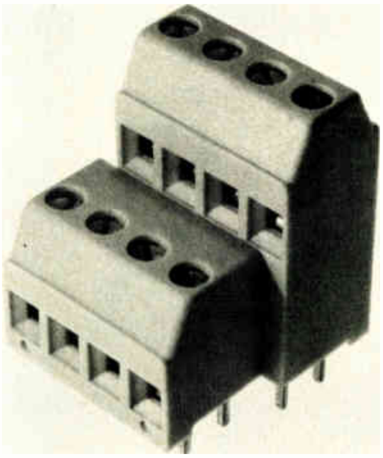


terminals each with five tie points), and Unicard II offers 1,620 tie points (324 terminals). Prices start at $31.50—the same as for the earlier four-tie-point cards.

A P Products Inc., 72 Corwin Dr., Box 110, Painesville, Ohio 44077. Phone Ken Braund at (216) 354-2101 [396]

Small screw-clamp terminal blocks mount on pc boards

Three series of UL-recognized miniature terminal blocks are designed for mounting on printed-circuit boards. The units, all of which have screw-clamp terminals, differ in the number and spacing of their connecting



pins. Of particular interest for high-density wiring is the model GSD 5/8, with pins on the widely used 0.1-inch centers.

Weidmuller Terminations Inc., 4326 Eubank Rd., Richmond, Va. 23231. Phone (804) 226-2877 [395]

48-pin socket has staggered contacts

Designed to be used with devices like Texas Instruments SN74S481 or SN54S481, a line of 48-pin sockets has its contacts arranged in four 12-pin rows: the outer rows are 0.8 inch apart while the offset inner rows have a 0.6-in. spacing. Spacing between pins within a row is 0.1 in.

One Mallory THF capacitor can replace up to four CSR types in a switching power supply.

These small, solid-tantalum capacitors give you a per-unit substitution factor as high as one for four and can by-pass 4.5 amp rms at 100kHz. So by using these high ripple performance capacitors you save in space, weight and cost.

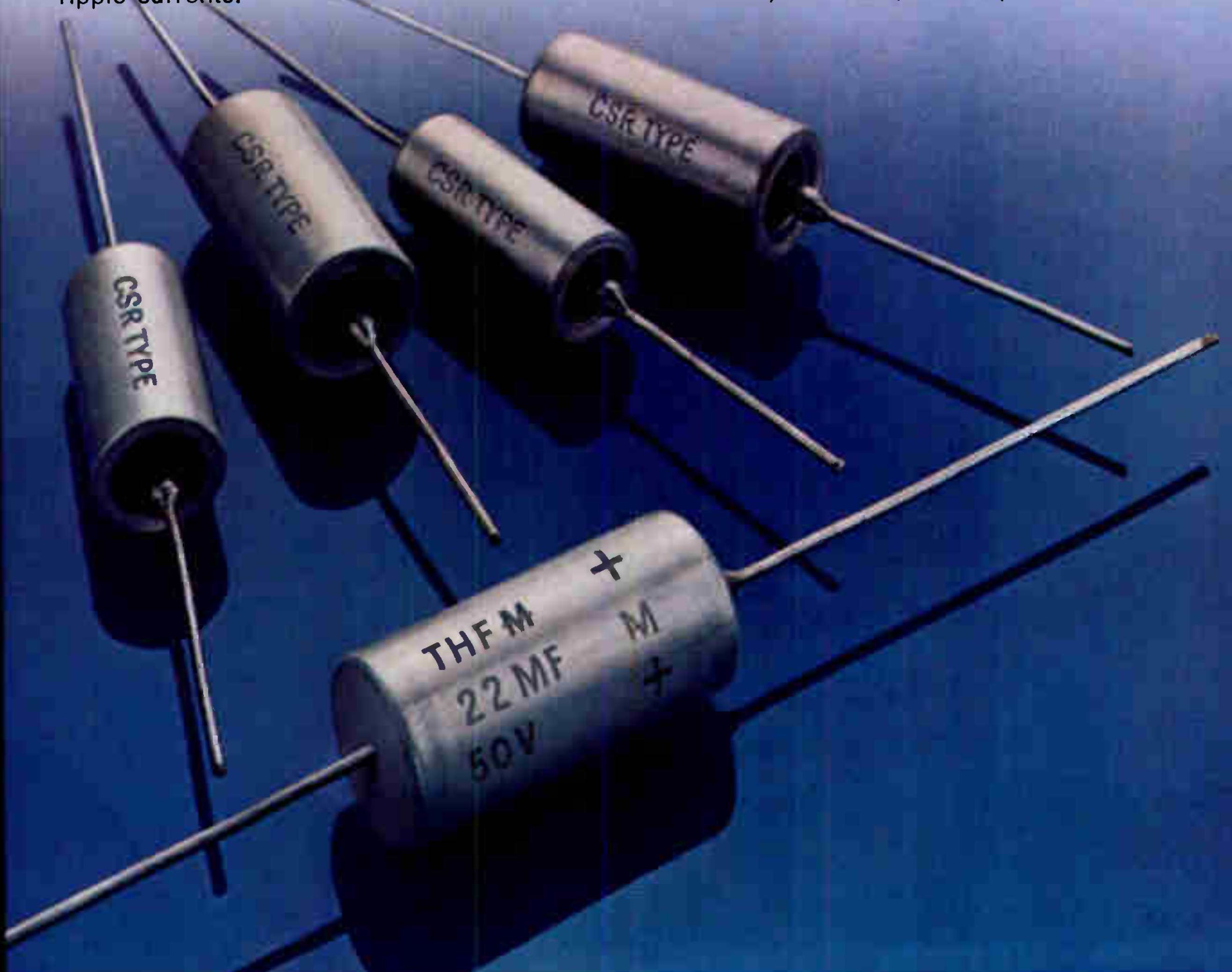
Specially designed for low equivalent series resistance, at frequencies from 1 kHz through 1 M Hz. They're ideal for high frequency power supply switching, for regulator switching, or for bypassing or filtering unwanted ripple currents.

Because ESR is low, power losses are low. With the solid electrolyte and hermetic seal, long life is inherent. Electrical characteristics are very stable over a temperature range of −80°C through 125°C. Two case sizes: .29 x .69 and .35 x .79 inches.

Mallory THF capacitors are available in a wide range of ratings: 5.6 to 330μF, 6 to 50VDC.

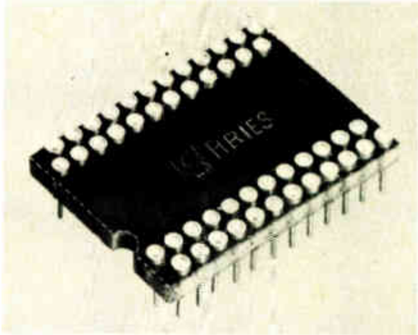
They're the result of Mallory's engineering program that's finding ways to produce high performance type capacitors at less cost to you.

Just ask your Mallory representative. Available direct, or through authorized Mallory Distributors in U.S. or overseas. Or call Help-Force Headquarters at (317) 856-3731. Mallory Capacitor Company, a division of P. R. Mallory & Co. Inc., Box 1284, Indianapolis, IN 46206.



MALLORY

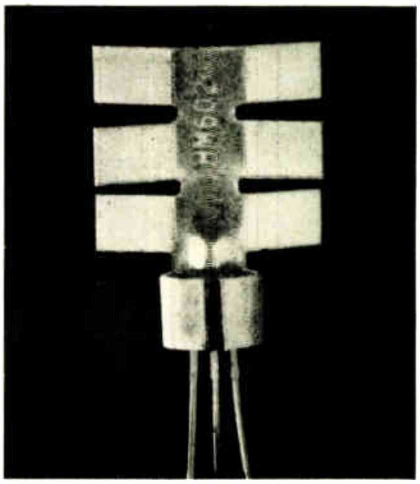
New products



The solder-tail socket, 48-513-10S, sells for $3.36 each, while the three-level wire-wrap version, 48-503-31S, costs $3.84. Delivery is from stock.
Aries Electronics Inc., P. O. Box 231, Frenchtown, N. J. 08825. Phone (201) 996-4096 [397]

Clip-on heat sink fits TO-92 packages

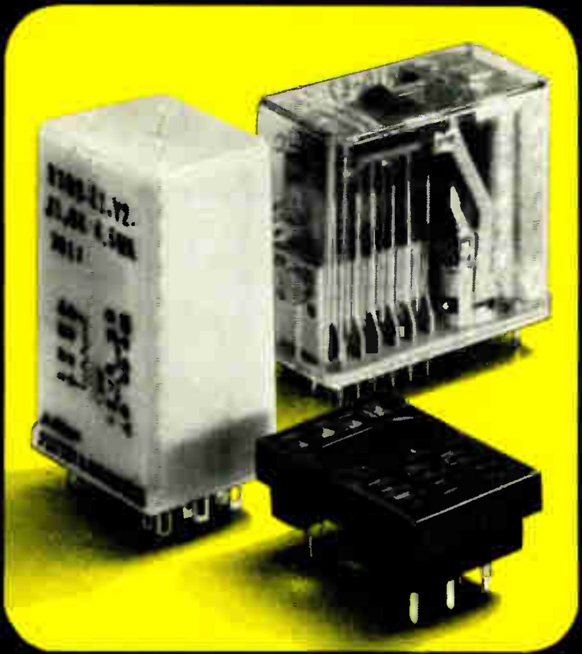
The model 6024 heat sink clips onto standard TO-92 packages with no need for mounting hardware or adhesives. It can be installed after board assembly is complete (a boon in solving last-minute thermal problems) and takes up very little space.



Its thermal performance in natural convection is 58°C per watt. The heat sink is made of phosphor bronze and weighs only 0.6 gram. Typical pricing is 2 cents each in thousands. Availability is from stock.
Thermalloy Inc., Dept. M, 2021 W. Valley View Lane, Dallas, Texas 75234. Phone (214) 243-4321 [398]

Our R-10 series Relays will switch you 7 ways to Sunday.

Giving you more design options than any other relay.



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A compact, reliable multi-
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rals, copiers, communica-
ions equipment, precision
nstruments and more.
Consider these options that
re available with the R10.
Ratings from dry circuit to 10
mperes. Contact arrange-
nents to 8PDT. Six styles of
ontacts including bifur-
ated types. Sockets with solder or printed circuit
erminals, including one for mounting the relay
arallel to a printed circuit board. All with or with-
ut grounding provision.

Mechanical life expectancy of the R10 is to 100 million operations—except W contacts, 1 million—and is available with a voltage or current-sensitive coil. It weighs, depending on the number of contacts, from 22 to 40 grams. Pickup ranges from 2.25 to 86 VDC, 5 to 86 VAC, or 0.6 to 45 milliamp with proper power supply.

Design options by the dozen, all from a single relay. The R10. It's in stock now at your distributor. Call your P&B Representative or write to us direct for a copy of our latest catalog. Potter & Brumfield Division of AMF Incorporated, 200 Richland Creek Drive, Princeton, Indiana 47671. 812/386-1000.

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Circle 257 on reader service card

One company can cut keyboard costs. Even when their keyboards cost more.

The most expensive mistake you'll ever make selecting a keyboard could be spending too little. In the long run, that adds up to cutting corners, not costs.

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Through Value Engineering, we look at your particular product needs to design a cost-effective solution to your problems. That means designing a keyboard that interfaces with your total system and meets your needs. Precisely.

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Circle 258 For Data

New products

Components

Air activates button cell

Zinc-air battery designed for consumer applications

Electrochemists have long been aware that oxygen from the air would react chemically with certain metals in the presence of a caustic to produce electrical energy. In the 1930's, rather large, cumbersome zinc-air batteries were developed and applied to low-cost, high-capability power sources for railroad use.

Scientists from Gould Inc.'s portable battery division have now developed a button-sized zinc-air cell, called Activair, which is said to have twice the life of competitive button cells. The new unit's cathode has a membrane of polytetrafluroethylene only 20 mils thick. The laminated membrane includes separating, conducting, structural, catalytic and wet-proofing layers.

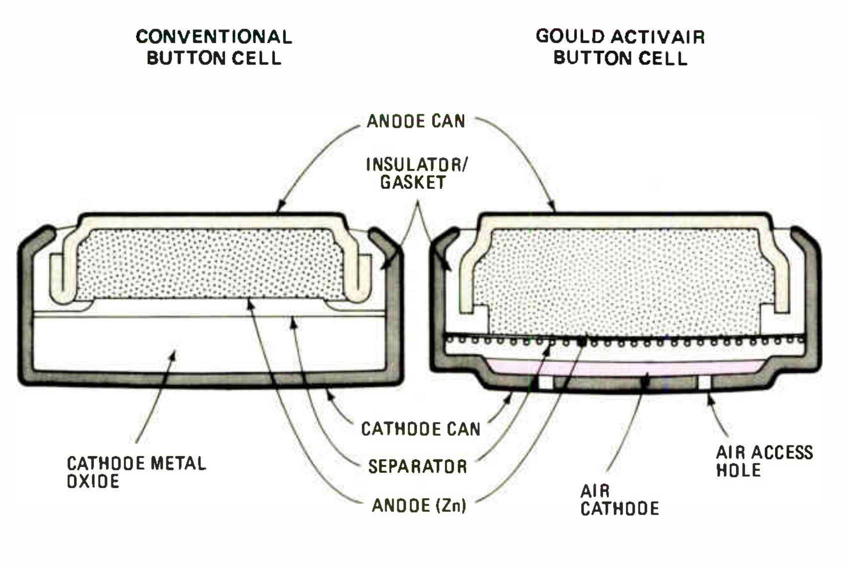
The anode of the new battery is zinc, and the cathode is oxygen from the air. The cells, which will be available in sizes A 675, A 13 and A 41, can be used instead of conventional silver or mercury units.

The capacity for the 1.4-volt A 675, A 13 and A 41 are 400 milliampere-hours, 170 mAH and 300 mAH respectively. These capacities are double those provided by competitive button cells now on the market. This increase mainly comes about because no storage space is needed within the cell for cathode reactants. The available space is used for added anode material.

The Activair cells have been specifically designed for hearing aids. Other applications for the new Gould cell are electromechanical watches, and watches and calculators with liquid-crystal displays.

The new zinc-air button cell has an energy density of 125 watt-hours/pound; an operating temperature of −10° C to +55° C and excellent shelf life. The cell has a flatter discharge characteristic than competitive button cells along with a low internal impedance.

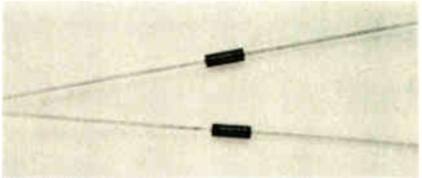
Gould Inc., Portable Battery Division, 931 North Vandalia St., St. Paul, Minn. 55114. Phone (612) 645-8531 [341]



Metal-film resistors are compact, accurate, and stable

Type FM metal-film resistors are fixed-value components intended for precision applications that require

New products



both high initial accuracy and good stability over temperature and time. Rated to dissipate 0.25 watt at an ambient temperature of 70°C and 0.1 w at 125°C, the resistors are available with tolerances of 1%, 0.5%, 0.25%, 0.1%, and 0.05%. A choice of three temperature coefficients of resistance is offered: 25 parts per million per °C, 15 ppm/°C, and 10 ppm/°C.

Units in the FM series have bodies molded to a uniform maximum length of 0.281 inch (7.14 millimeters) and a maximum diameter of 0.098 in. (2.49 mm). Standard resistance values in the nominal range from 20 ohms to 357 kilohms are offered. Type FM is approved to MIL-R-10509F for Style RN55, characteristic E, resistance values 49.9 ohms to 100 kilohms, all tolerances.

Prototype quantities of RN55E with a 1% tolerance and a TCR of 25 ppm/°C are available from stock in popular values. They sell for 25 cents each in thousands with delivery times ranging from 10 to 12 weeks depending upon volume and specifications.

Marketing Dept., Electronics Division, Allen-Bradley Co., 1201 S. Second St., Milwaukee, Wis. 53204 [342]

Low-inductance resistors dissipate up to 15 watts

For applications requiring extremely low inductances, wirewound resistors are outmatched by a new family of metal-film power resistors having a serpentine resistive pattern that keeps both inductance and distributed capacitance at much lower levels than can be achieved by any practical method of noninductive winding. As an example, the 2-watt model 220 N has an inductance of less than 100 nanohenries.

Resistors in the MS family have a

Power Transistors ? We've got em!

High Voltage

PART #	BVCBO	BVCEO	Ic max	hFE @ Ic	ES/B	Pkg.
2N6542	650	300	5.0A	12-60 2A	180 μJ	TO-3
2N6543	850	400	5.0A	12-60 2A	180 μJ	TO-3
2N6544	650	300	8.0A	12-60 2A	500 μJ	TO-3
2N6545	850	400	8.0A	12-60 2A	500 μJ	TO-3
2N6546	650	300	15A	12-60 2A	2.0mJ	TO-3
2N6547	850	400	15A	12-60 2A	2.0mJ	TO-3
2N6249	300	200	10A	10-50 3A	2.5mJ	TO-3
2N6250	375	275	10A	8-50 3A	2.5mJ	TO-3
2N6251	450	350	10A	6-50 3A	2.5mJ	TO-3
2N6306	500	250	16A	15-75 3A	180mJ	TO-3
2N6307	600	300	16A	15-75 3A	180mJ	TO-3
2N6308	700	350	16A	12-60 3A	180mJ	TO-3

High Speed Fast Switching

PART #	BVCBO	Ic max	hFE @ Ic	ton (nS)	toff (nS)	Pkg.
KS6038	80	2A	25 1A	50	150	TO-60/I
KS6039	80	2A	10 1A	50	150	TO-60/I
KS6107	60	2A	15 1A	42	105	TO-37
KS6108	40	2A	15 1A	50	135	TO-37
KS6109	80	2A	15 1A	30	120	TO-60/I
KS6110	40	2A	15 1A	30	120	TO-60/I
KS6111	80	2A	15 1A	42	150	TO-60/I
KS6112	40	2A	15 1A	42	150	TO-60/I
KS6113	30	4A	15 2A	20	45	TO-60/GE
KS6114	20	4A	15 2A	25	55	TO-60/GE
KS6115	30	7A	15 5A	35	70	TO-60/GE
KS6116	20	7A	15 5A	35	90	TO-60/GE
KS6117	100	10A	15 5A	37	120	TO-3
KS6118	60	10A	15 5A	45	140	TO-3
KS6119	40	10A	15 5A	70	180	TO-3
KS6120	100	15A	15 5A	37	120	TO-3
KS6121	60	15A	15 5A	45	140	TO-3

High Current

PART #	BVCBO	Ic max	VCE (sat) @ Ic	VBE (sat) @ Ic	hFE @ Ic	Pkg.
2N5685	60	50A	1.0V 25A	2.0V 25A	15-60 25A	• TO-3
2N5686	80	50A	1.0V 25A	2.0V 25A	15-60 25A	• TO-3
2N6274	120	100A	1.0V 20A	1.8V 20A	30-120 20A	• TO-3
2N6275	140	100A	1.0V 20A	1.8V 20A	30-120 20A	• TO-3
2N6276	160	100A	1.0V 20A	1.8V 20A	30-120 20A	• TO-3
2N6277	180	100A	1.0V 20A	1.8V 20A	30-120 20A	• TO-3

• .060" pins

General Purpose

PART #	BVCBO	BVEBO	Ic max	hFE @ Ic	ICEO @ VCE	Pkg.
2N2880	100	8.0	5A	40-120 1A	60V 0.1 μA	TO-111
2N3749	100	8.0	5A	40-120 1A	60V 0.1 μA	TO-111/I
2N3879	120	7.0	10A	20-80 5A	⊕ 75V 0.20A	TO-66
2N5000	100	6.0	5A	70-200 1A	40V 50 μA	TO-59
2N5001 •	100	5.5	5A	70-200 1A	40V 50 μA	TO-59
2N5002	100	6.0	10A	30-90 2.5A	40V 50 μA	TO-59
2N5003 •	100	5.5	10A	30-90 2.5A	40V 50 μA	TO-59
2N5004	100	6.0	10A	70-200 2.5A	40V 50 μA	TO-59
2N5005 •	100	5.5	10A	70-200 2.5A	40V 50 μA	TO-59
2N5006	100	6.0	20A	30-90 5A	40V 50 μA	TO-60/I
2N5007 •	100	5.5	20A	30-90 5A	40V 50 μA	TO-60/I
2N5008	100	6.0	20A	70-200 5A	40V 50 μA	TO-60/I
2N5009 •	100	5.5	20A	70-200 5A	40V 50 μA	TO-60/I
2N5660	250	6.0	1A	40-120 0.5A	⊕ 200V 10mA	TO-66
2N5661	400	6.0	1A	25-75 0.5A	⊕ 300V 10mA	TO-66
2N5662	250	6.0	1A	40-120 0.5A	⊕ 200V 10mA	TO-5
2N5663	400	6.0	1A	25-75 0.5A	⊕ 300V 10mA	TO-5
2N5664	250	6.0	3A	40-120 1A	⊕ 200V 10mA	TO-66
2N5665	400	6.0	3A	25-75 1.0A	⊕ 300V 10mA	TO-66
2N5671	120	7.0	30A	20-100 15A	⊕ 90V 0.20A	TO-3
2N6233	250	6.0	10A	25-125 1A	225V 1.0mA	TO-66
2N6234	300	6.0	10A	25-125 1A	275V 1.0mA	TO-66
2N6235	350	6.0	10A	25-125 1A	325V 1.0mA	TO-66
2N6338	120	6.0	50A	30-120 10A	⊕ 100V 50mA	TO-3
2N6339	140	6.0	50A	30-120 10A	⊕ 120V 50mA	TO-3
2N6340	160	6.0	50A	30-120 10A	⊕ 140V 50mA	TO-3
2N6341	180	6.0	50A	30-120 10A	⊕ 150V 50mA	TO-3

• PNP device
⊕ VCEO (sus)

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temperature coefficient of 50 parts per million per °C and are available with resistances from 10 ohms to 30 megohms and power dissipations from 0.5 watt to 15 w. Maximum operating temperature is 275°C. Tests run for more than five years indicate that typical long-term drift is less than 0.05% per 1,000 hours.

As an example of pricing for units in the MS family, the MS 310 is rated at 10 w, has a 1% standard tolerance, is available with values from 30 ohms to 20 megohms, and sells for $1.65 each in thousands.

Caddock Electronics Inc., 3127 Chicago Ave., Riverside, Calif. 92507. Phone Richard Caddock at (714) 683-5361 [343]

Hospital-grade nylon plug offers 12 assembly angles

An all-nylon angle plug, which can be assembled in any of 12 positions for maximum outlet convenience, gives users the safety of straight-in wiring. Its transparency also allows easy visual verification of proper wire termination, while its hospital-grade designation means it can handle severe abuse of the kind that may occur in hospitals, schools, factories, and some commercial facilities, according to the company.

Bryant Division, Westinghouse Electric Corp., Marketing Communications Department, 1421 State St., Bridgeport, Conn. 06602 [345]

Heavy-duty ac capacitors use a nontoxic impregnant

A series of drawn-case oil capacitors for alternating-current applications use a nontoxic, biodegradable impregnant instead of polychlorinated biphenyl oils, which have been banned by the Environmental Protection Agency. Type 520P Eccol capacitors are intended for use in air-conditioning and refrigeration equipment, in phase-splitting and power-factor-correction applications, for stabilizing transformers, and so on.

Capable of continuous operation at case temperatures up to 70°C, the

If you have one of these...

...you can start automatic testing with one of these

Now you can get into automatic testing equipment (ATE) for well under $10,000, total cost.

All you need is one of the units pictured, the new SPG-800 Synthesized Programmable Generator, and a little do-it-yourself effort. Just use one of the units pictured to store your test procedure program with simple instructions to command the SPG-800 (and any other programmable instruments you use) and you're off and running.

No more knob spinning. No more hooking up counters and scopes and voltmeters to your signal source. Now automatic testing is within reach of every manufacturer—along with the savings in time and labor it means.

And the Model SPG-800 is a *modular* instrument. So you can get started with just the basic unit for only $3195. It is a combination programmable function generator operating in the 0.1Hz to 13MHz range and a programmable DC voltage source.

Now or later, add Interstate's low cost field-installable plug-in cards and you'll have a programmable synthesizer and pulse generator too— four programmable test instruments in one.

Interfacing the SPG-800 is easy, too. Use its basic ASCII interface or one of its (optional) plug-in cards for the IEEE bus, the RS-232C or 20 mil loop or parallel interface.

No matter what configuration you order, you'll find the SPG-800 easy to program and reliable in use. And the optional operator control panel—in English—is easily learned by non-technical personnel, so you can program it directly, the day you get it.

If you didn't think your company could afford ATE, it's time to re-think... write today for more information Or call us at (714) 772-2811 or (800) 854-3825 toll free.

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P.O. Box 3117, Anaheim, CA 92803

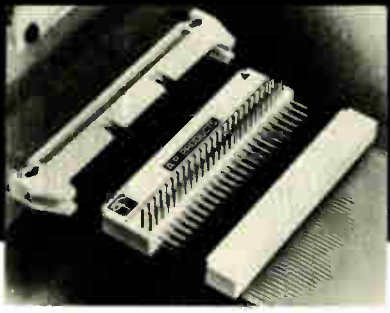
INTERSTATE ELECTRONICS CORPORATION

SUBSIDIARY OF **ATO**

Circle 16 on reader service card

Connect with a little help from A P.

Intra-Connector



Intra-Switch

Intra-Connector and Intra-Switch do for flat cable systems what our IC Test Clips do for DIPs, which can do a lot for you.

Intra-Connector mates in-line with standard double row socket connectors. It has one set of female contacts, but two sets of male, at right angles. So it provides instant line-by-line probeability, and, allows for attachment of test probes, components or an additional connector.

Intra-Switch plugs right in line, too. But small, dependable slide switches are built right in to switch each line, independently. So it's great for diagnostic and quality testing, terrific for programming or selective line inhibiting.

Intra-Connector and Intra-Switch are available in 20, 26, 34, 40 and 50 contact versions at the dealer or distributor in your area who stocks our Faster and Easier Line. You can locate him by calling our toll-free number, 800-321-9668.

Faster and easier is what we're all about.

A P PRODUCTS INCORPORATED

Box 110 • 72 Corwin Dr., Painesville, OH 44077 • (216) 354-2101 TWX: 810-425-2250

Circle 264 on reader service card

Productronica 77

Munich, 22-26 November 1977

Processes and Equipment for the Manufacture of Semiconductors, Components and Assemblies in the Electronics Field

International Trade Fair with Demonstrations and Conferences

The Demonstrations

Yellow Zone: Artwork generation and copying techniques
Brown Zone: Measuring and testing equipment
Red Zone: Semiconductor technology
Green Zone: Equipment and materials for the production of PC-boards and mounting techniques
Blue Zone: Mounting and connecting techniques, workplace equipment, also hybrid technology
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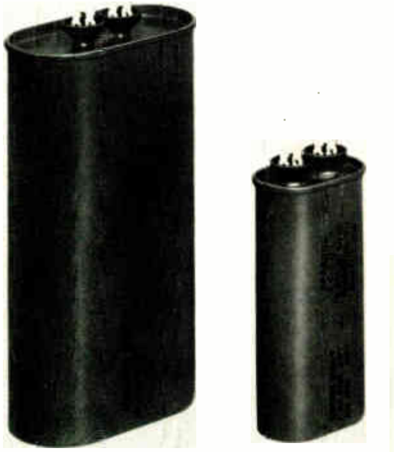


capacitors have an internal pressure-activated switch that will disconnect the capacitor element if excessive pressure develops within the case. Units are available with capacitances from 1.0 microfarad to 50 μF and with voltage ratings from 330 volts ac to 660 v ac. Their service life is in excess of 60,000 hours on voltage with 94% survival. First-year survival is designed to be at least 99.5% under rated conditions.

Sprague Electric Co., 35 Marshall St., North Adams, Mass. 01247. Ask for Bulletin 4551 [344]

Solid-state relay sells for $12.55

Because it uses a pulse-transformer input circuit instead of an opto-isolator, the model EAX solid-state relay can be sold in small quantities at a list price of only $12.55. The unit has an input/output isolation resistance of 10^9 ohms and a breakdown rating of 1,500 volts rms at 60 hertz.

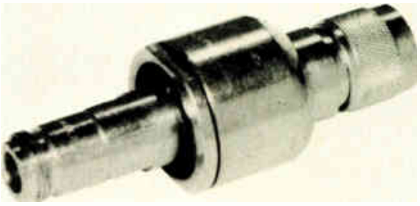
Input requirements are 8 milliam-

peres at 5, 12, or 24 v dc. Output rating is 1.2 A at 120 v ac. The relay has a turn-on time of no more than 0.5 millisecond and a maximum turn-off time of 10 ms (60 Hz) or 12 ms (50 Hz). Expected life is at least 100 million operations at rated load across the temperature range from −10°C to 55°C. Delivery time is four weeks.

Potter & Brumfield Division of AMF Inc., Princeton, Ind. 47671. Phone Wm. Sidmore at (812) 386-1000 [347]

Rotating coaxial connector handles 15 A at 2,000 rpm

Ball-bearing construction and mercury sliprings allow the model RTX-2 rotating coaxial connector to carry 15 amperes at 1,500 v rms while rotating at 2,000 revolutions per minute. Built in a rugged UG series housing, the connector weighs just 8 ounces.



Meridian Laboratory Inc., 2415 Evergreen Rd., Middleton, Wis. 53562 [346]

Thin-film thermistors offer high accuracy

A line of thin-film thermistors that cover the range from −55°C to 125°C are accurate to within 0.5°C over the limited span of 0°C to 60°C. The low-cost, interchangeable thermistors in the TFT304 series have a temperature coefficient of resistance of −3%/°C over the full operating range. Priced at $1.20 each in hundreds, the devices are packaged in a plastic TO-92 style transistor case with an integral metal mounting tab that also pro-

United Systems' NEW Datalogger 1000

Doesn't make mistakes, take coffee breaks or get sick...
Doesn't watch the clock (although it has one)...
Doesn't get premium or overtime pay and never complains...

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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.

It provides continuous display of time, channel and 20,000 counts of measured data for instant visual analysis while the hard-copy printout permanently records the same information for future reference...all standard.

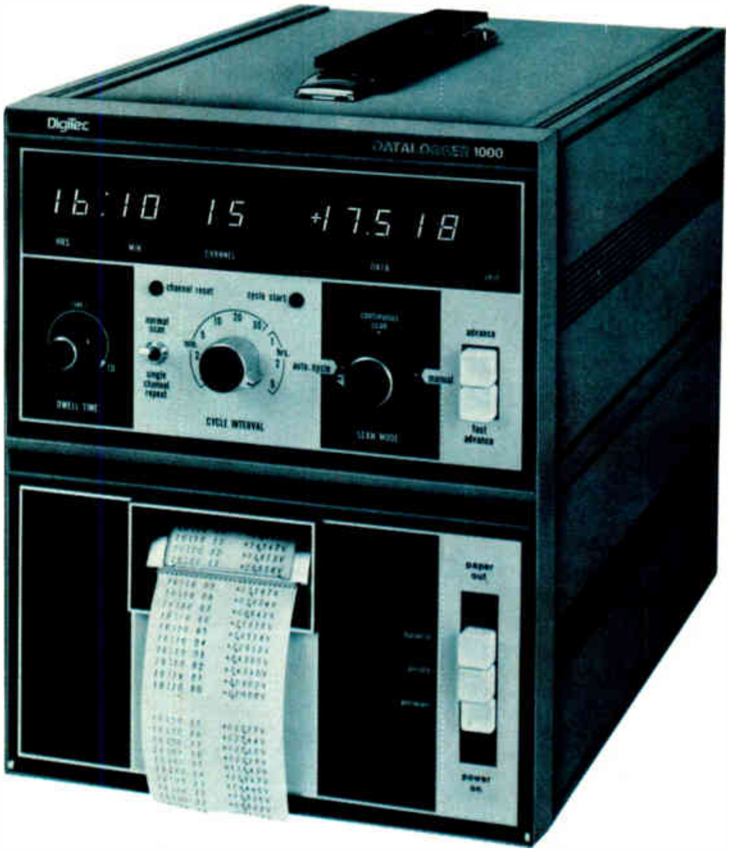
With the Datalogger 1000, you only pay for the capability you require. A minimum initial investment will meet your present measuring needs, while low-cost field-installable modules provide the flexibility to change parameters as required.

Simplicity of front panel controls provides straightforward operation...easy enough for anyone to use without special training.

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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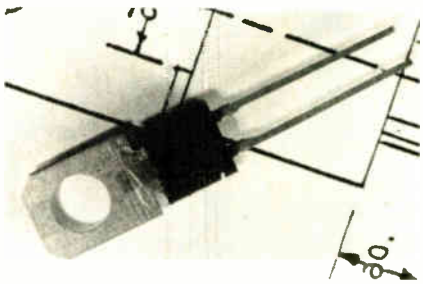


vides high thermal conductivity.
Multi-State Devices Ltd., 2255 Dandurand St., Montreal, Quebec H2G 1Z6, Canada. Phone Goeffrey Geduld at (514) 279-4507 [348]

One relay provides two time delays

Known as the Double Time, a new time-delay relay makes it possible to obtain two factory-preset time delays from a single device. The double-pole, double-throw thermal device is designed so that both time delays are initiated upon the energization of a common thermal actuator. Upon completion of each preset delay, a separate set of double-pole snap-action contacts is transferred.

Originally developed to help telephone companies determine the source of interrupted service, the Double Time can also be used for stagger starting and other sequencing operations and to detect the loss of voltage or resistance on a line.

Contacts are rated at 3 amperes at 115 volts ac or 28 v dc. Each delay can be adjusted at the factory from 10 to 60 seconds. Standard heater ratings are 6.3, 26.5, and 115 v.
Relay Specialties Inc., 1300 Plaza Rd., Fair Lawn, N. J. 07410 [349]

Versatility is written all over its face.

First thing you probably notice—it's a dual filter. Each of the 24db/octave filters can be used as high pass, or low pass, with selectable gain of 1 or 10.

Consider the possibilities.

Connect the dual channels in series for bandpass, 48db/octave high pass, and 48db/octave low pass, with selective gain of 1, 10, or 100. Butterworth and Bessel modes are available at the push of a button. And you can select AC or DC coupling.

Versatility is not just skin deep.

Switch selectable frequency settings ensure repeatability of settings from 10Hz to 1MHz. And repeatability of settings, combined with only .005% distortion at 20 volts output, means you can predict results—without having to calibrate your tail off.

Look a little deeper and you'll find 100db outband noise rejection, and a remarkably low 25 μvolts noise.

Ask for a demonstration.

Versatility like this should be seen to be believed. And wait till you see the price. $655. Not bad for all that versatility.

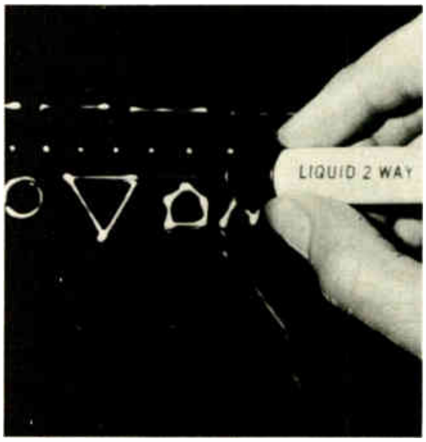
Call or write John Hanson at Ithaco, Box 818, Ithaca, N.Y. 14850. Phone (607) 272-7640.

ITHACO

Circle 711 on reader service card

New products/materials

Liquid two-way tape is a pressure-sensitive adhesive that can be applied like ink with a marker pen. The water-based material will adhere to any dry, nonoily surface—even Teflon—where it polymerizes and turns into a tacky, transparent surface in about half an hour at room temperature. In this state, the adhesive may be used for many of the applications in which one usually



finds double-sided tape: film overlaying, pre-positioning of electronic parts, and flexible bonding in general. If speed is important, the adhesive can be polymerized in five minutes with a hot-air blower. Pens filled with the adhesive sell for $2.95 each in singles or $2.65 each in quantities of five or more.

Metron Optics, Box 690, Solana Beach, Calif. 92075. Phone (714) 755-4477 [476]

Experimental indium plating is easy and inexpensive with a kit that includes a liter of indium-sulfamate

The Simpson DIGITAL MULTIMETER FAMILY KEEPS GROWING!

Here's our latest addition For $130

New Compact Portable Model 461
Complete with nickel-cadmium batteries, AC charger/adapter, test leads and instruction manual

- 8 FULL HOURS continuous battery operation . . . a full day's work without interruption
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- **Reliable overload-protected LSI circuitry**
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- **Complete line of accessories is available**

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Popular Priced Model 464A
- 0.1% DC V accuracy
- 28 pushbutton ranges including 10A AC/DC
- Bright 0.43" LEDs, automatic zero
- High-impact case with tilt-view adjustable handle
- For AC line operation. Optional AC/rechargeable version available for $247

For $285

Deluxe 460-3A
- 0.1% DC V accuracy, custom MOS/LSI circuitry
- 32 ranges including low power resistance ranges and 10A AC/DC current
- Bright 0.43" LEDs, automatic ZERO
- Calibrated auxiliary analog meter
- For AC line operation. Optional AC/rechargeable version available for $322

For $295

Autoranging Model 465A
- Automatically selects and displays the proper measuring range
- High 0.1% DC V accuracy, custom MOS/LSI circuitry, 0.43" LEDs
- Measures DC voltage to 1000 V, AC voltage to 600 V, resistance to 20 megohms, low power ohms ranges AC/DC current to 10A
- AC line operation. Optional AC/rechargeable version available for $332

For $257

Digital VOM — the 360-2
- AC line and rechargeable operation standard
- 0.25% DC V accuracy exclusive MOS/LSI circuitry, automatic zero
- 29 ranges including low power resistance
- Calibrated zero center analog meter
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bath, two 99.99% indium anodes, and an instruction manual. The anodes measure 1 by 12 by 0.030 inches. The plating research kit sells for $95.

The Indium Corp. of America, P. O. Box 269, Utica, N. Y. 13503 [477]

Conductive natural rubber combines low cost with high wear resistance, making it suitable as a floor covering in areas in which static electricity can cause problems. Called Stati-Ex, the material is offered in two thicknesses: 1 millimeter and 2 mm. The 2-mm thickness is recommended for floor covering and other heavy-duty applications, while the 1-mm is good for bench tops and other light duties. Standard sizes are 1 meter by 5 m and 10 m by 20 m. Sample squares that measure 1 m on a side sell for $15 in the 1-mm thickness and $25 in the 2-mm.

Signalarm Inc., P. O. Box 3128, Springfield, Mass. 01101 [478]

Interference filter tubing in the Eccoshield FC family is a plastic extrusion useful for suppressing electromagnetic interference along a wire or cable. A replacement for conventional emi filters and ferrite transmission-line beads, the flexible Eccoshield FC also provides some shielding against radiated energy. Three types are available: a conductive tubing for use above several hundred megahertz where magnetic properties are not required, a magnetically loaded nonconducting tubing for use from 50 MHz to 100 gigahertz, and a ferrite-loaded tubing for use from 30 MHz to 100 GHz. Prices range from $1.26 to $3.42 per foot for quantities from 1 to 49 feet.

Emerson & Cuming Inc., Canton, Mass. 02021 [479]

A substrate material for microwave integrated circuits, RT/duroid 5870 has a dielectric constant of 2.34 ±0.03% from 1 megahertz to 10 gigahertz. Made of glass-fiber-reinforced polytetrafluoroethylene clad with a conductive layer, the material can be machined and soldered without damage. Samples measuring 5 by 8 inches may be obtained by

METSHIELD™ Fabric. The first major advance in magnetic shielding in 50 years.

This is the magnetic shielding product whose time has come.

Increased sales of electronic equipment, a trend toward miniaturization and intensified regulatory considerations have put increased emphasis on EMC.

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Check boxes for information on METGLAS® alloys and METSHIELD™ fabric.

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- ☐ Grounding and contacting
- ☐ Other (specify)________
- ☐ Send me sample of METSHIELD fabric

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Company________

City/State/Zip________

Mail to: Metglas Products, Allied Chemical Corporation
7 Vreeland Road, Florham Park, NJ 07932

Allied Chemical
Metglas Products

letterhead request.
Rogers Corp., Chandler, Ariz., 85224, Attn: Barbara Boss [480]

Oxide-free solder cream, resulting from a new processing technique, eliminates solder balls, contamination of joints, and dewetting. At the same time, the performance and shelf-life of the solder cream are improved, according to the manufacturer, Multicore Solders. Because of the new manufacturing method, the company says, the cream requires shorter dwell time and lower soldering temperatures. The flux residue is light and clear in color, which makes it easier to inspect joints. Wetting properties are improved since flux activity is not expended in removing oxides from the metal powder during heating, but rather can be concentrated on the surfaces to be soldered. Multicore solder is available in a variety of tin-lead as well as silver-bearing alloys with either an active or a mildly active rosin-base flux. Purity, mesh size and flux properties conform to QQ-S-571. Under normal circumstances, stirring before use is not required. The tacky consistency of the material enables it to be used as a temporary adhesive to hold components in place before and during application of heat. Depending on alloy and quantity, prices average about 10 cents per gram.
Multicore Solders, Westbury, N. Y. 11590 [362]

High-temperature conductive coating, Electro-Chem 100, provides continuous service at 800°F and higher. The material consists of conductive carbon suspended in a solution of highly polymerized silicone resin. In its final form, as shipped, the highly viscous solution is diluted with xylol to form a 50% solids solution that is easy to apply to the inside of cathode-ray tubes and other surfaces. Electro-Chem 100 bonds readily to glass and ceramic. It can be sprayed, brushed on, or be applied by dipping.
Delta Electro-Chemical Products Co., Division of Brunswick Chemical Corp., 49 Brunswick Rd., Montclair, N. J. 07042. Phone (201) 744-8117 [363]

PROVEN PERFORMANCE CRYSTAL CLOCK OSCILLATORS

Motorola's K1100A leads the industry with a crystal clock oscillator that has a proven track record of more than two million units. That's right...over two million oscillators are in use by satisfied, repeat customers.

How versatile is the K1100A? With over 1200 frequencies already designed, and same-day shipment for standard stock frequencies of 4, 4.9152, 5, 10, and 20 MHz, you make the decision.

Oscillators are available from 250 kHz to 70 MHz, ±0.01% stability from 0°C to 70°C, TTL-compatible, and standard +5V dc input.

For full specifications and prices on the oscillator that design engineers trust, write Motorola, Component Products Department, 2553 N. Edgington, Franklin Park, Illinois 60131.
Or call (312) 451-1000, ext. 4183.

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Communications and Electronics Inc.

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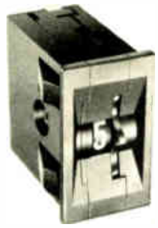
THUMBWHEEL SWITCHES

NEW . . . 8mm WIDE 1800 SERIES



Slim—only .315" (8mm) wide with large .234" high characters. Assemblies snap into panels; no tools or screw holes required. All popular codes. P.C. Board Termination. Front mount.

1776 and 1976 SERIES

1776 series, miniature .500" wide thumbwheel switches offers a selection of over 50 codes, and plastic window dust seal protection. 1976 is a slimmer .350" wide switch with the same advantages. Options include Fast-Mount Hardware, lighting, RFI shielding, stops to limit rotation and notched terminals for direct P.C. Board mounting.

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MICRO-DIP

Binary coded dip switch. Solder directly to circuit boards or plug into one-half of a 14-pin socket. 10 and 16-positions, screw-driver setting.

NEW

MINI-DIP

Positive wiping SPST gold contacts give tease-proof reliability. Dust-free design, improved legibility and rocker-locking device. 2-10 stations.

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Series 21 and 2500 stripswitches mount directly on printed circuit boards. Available in BCD, decimal and other popular 10 and 16-position codes. Screwdriver, thumbwheel and extended knob setting models are available.

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Circle 107 on reader service card

At+125°C you can burn your fingers on some DAC's our 4058 stays cool

Because this new, hybrid 12 bit DAC was specifically designed for the temperature range −55 to +125°C. It is not merely a top-end selection of commercial DAC's, where you don't know today what tomorrow's yield will be.

Your application may not need the full temperature range nor the hermetically sealed metal DIP. But for a lot of industrial applications these and other features of the new DAC offer you vital safety factors. For example, it is produced to MIL Std 883 giving extremely high reliability. It has a very low temperature drift of 5 ppm/°C gain, 10 ppm/°C max. offset.

And if you want to fly with it, the 4058 is shock, vibration and acceleration tested - its already being used in the new MRCA.

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New literature

Indium-tin-oxide films. Application note CAN-4 explains the procedure for depositing indium-tin-oxide films into a diffusion pump vacuum system with a magnetron S-Gun. The productivity of the 3120-H S-gun sputtering system for ITO films is briefly discussed, along with some of the characteristics of ITO films deposited with the S-gun source. Varian Palo Alto Vacuum Division, 611 Hansen Way, Palo Alto, Calif. 94303. Circle reader service number 421.

Pincushion distortion. Application note 1, entitled "Pincushion Distortion, a Significant Factor in CRT Displays," is being offered by Syntronic Instruments Inc., 100 Industrial Rd., Addison, Ill. 60101 [422]

Benchmarking ADP systems. Methods that can be applied by Federal agencies to validate hardware and software performance are contained in the pamphlet "Guidelines for Benchmarking ADP Systems in the Competitive Procurement Environment." Included are an overview of the process, ways to reduce problems, and recommended procedures. Copies can be obtained at $4.00 each using order number NBS-FIPS-PUB-42-1. Microfiche copies can be ordered at $3.00 each. National Technical Information Service, U. S. Department of Commerce, Springfield, Va. 22161.

Converters. A large variety of design engineering problems can be solved by using voltage-to-frequency and frequency-to-voltage converters. Application note 32 gives information on how to optimize uses of these converters for improving response time, for tailoring performance to specific input/output requirements and for maximizing usefulness. Teledyne Philbrick, Allied Drive at Route 128, Dedham, Mass. 02026 [424]

Integrated circuits. Seventeen types of display-driver integrated circuits are discussed in a 71-page data book. Metal-oxide semiconductors drive light-emitting diodes, thermal print-

Active filter products. A 36-page catalog, "Active Filter Products," is designed to help an engineer select

For literature only circle 76

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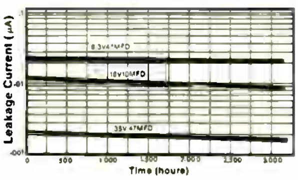


Matsuo developed the world's first resin dipped tantalum capacitor in 1960. Today, Matsuo delivers a broad range of capacitors to meet your needs. 5 types, 22 case sizes, 348 ratings. **And one standard of excellence.**

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.

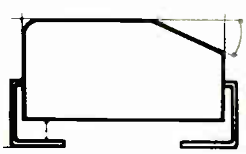
NEW! DIPPED TANTALUM WITH WIRE LEADS.

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 correct filter for a specific application. Selection guides are given for high-pass, low-pass, bandpass, and band-reject filter types. Information on the four filter types includes the range of center or cutoff frequencies, number of poles, transfer characteristics, frequency tuning, and case dimension drawing number. Frequency Devices Inc., 25 Locust St., Haverhill, Mass. 01830 [428]

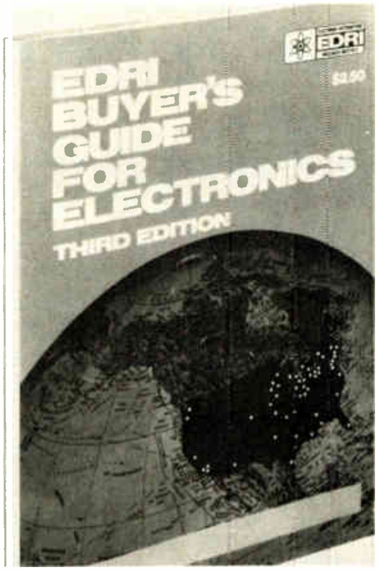
Line drivers and receivers. A 206-page publication, "The Line Driver and Line Receiver Data Book for Design Engineers," discusses over 70 types of line-driver and receiver integrated circuits. Detailed technical information is given for dual line drivers, differential line and quad-bus transceivers, and triple and quad line receivers. The book also provides selection guides for each device. Texas Instruments Inc., Inquiry Answering Service, P.O. Box 5012, M/S 308 (Attn: LCC 4290) Dallas, Texas 75222 [429]

Switching relays. A 28-page catalog describes cable-coaxial relays, integral-connector coaxial relays, and radio-frequency switching relays. Specifications, charts and drawings

are provided for each type, as well as shipping instructions for special orders. Magnecraft Electric Co., 5575 North Lynch Ave., Chicago, Ill. 60630 [433]

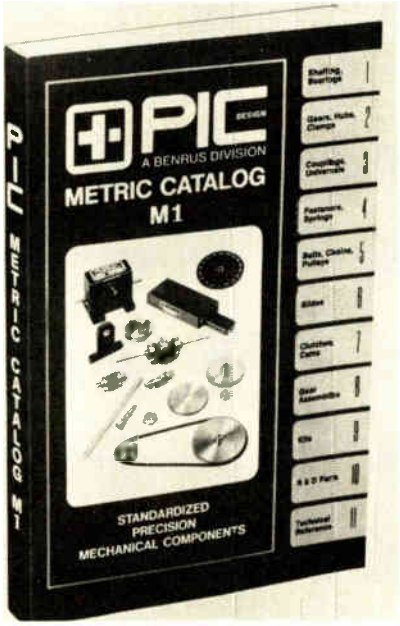
Industrial electronic equipment. Over 100 items used in the manufacture, repair, and service of industrial

New literature



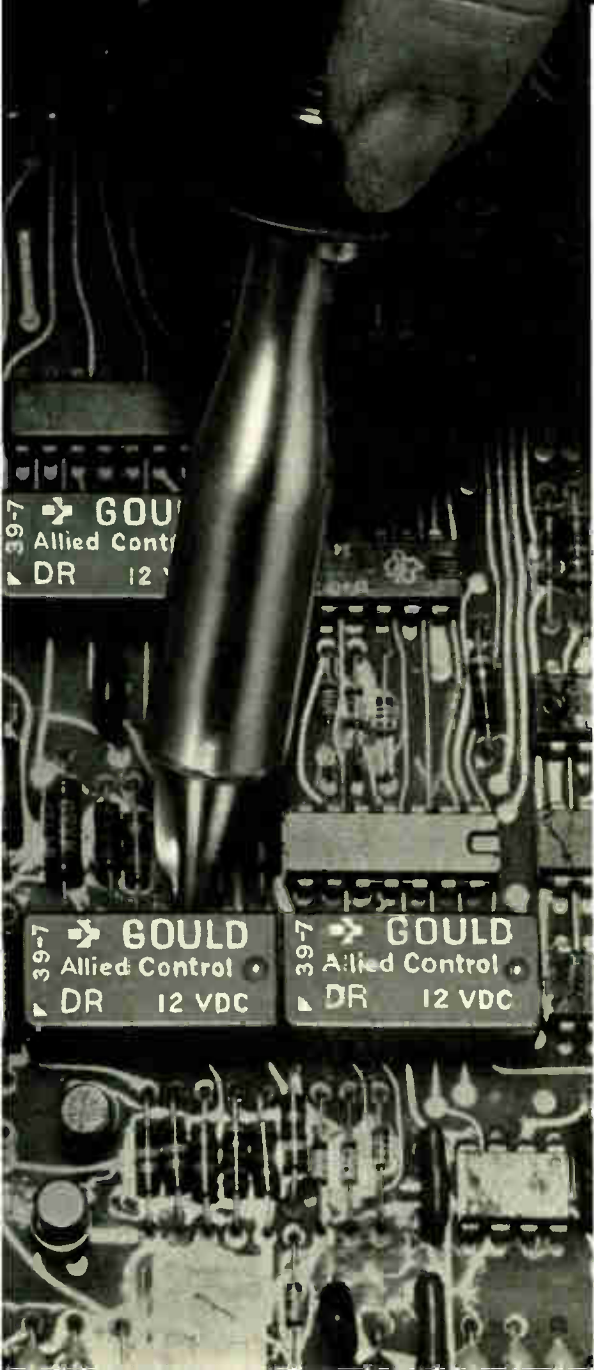
equipment are listed in a 280-page buyer's guide. In addition, replacement and substitution data are provided for each item, along with ordering information. EDRI Buyers Guide, P. O. Box 23875, Fort Lauderdale, Fla. 33307 [430]

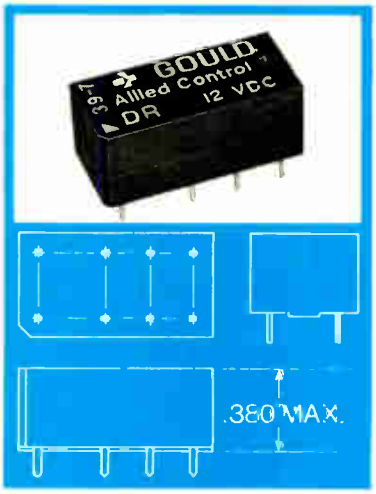
Metric precision components. A compilation of over 25,000 standardized metric precision mechanical components and assemblies is being offered in a 208-page booklet,



which also gives design information and specifies production material. PIC Design Division, Benrus Corp.,

Introducing the 0.38" DIP relay





The most sensitive DPDT relay costs less than two SPDT equivalent reeds!

Consider these parameters for your next PC board:

Lowest profile—fits well within 0.5" spacings when mounted directly on PC board.

Adaptability—fits standard 16-pin I.C. sockets; footprints are interchangeable with similar-but-higher e/m DIP relays.

Sensitivity—200 mw max. at pull-in, with 1 amp 28 vdc switching and 5 amp carrying capacity.

2 form C configuration.

Life expectancy—10,000,000 cycles low level or mechanical.

Gould/Allied Control has just packaged a lot more performance into a lot lower relay!

The new miniature Dual-in-line Relay combines the compactness of reed relays with the low cost and high switching capabilities of electromechanical units.

It's particularly suited to telecommunications and medical electronic equipment, but it is already finding widespread usage in other areas as well.

Call your Gould/Allied Control distributor for full details or write us at Gould Inc., Control and Systems Division, Allied Control Operation, 100 Relay Road, Plantsville, Conn. 06479

GOULD ALLIED CONTROL

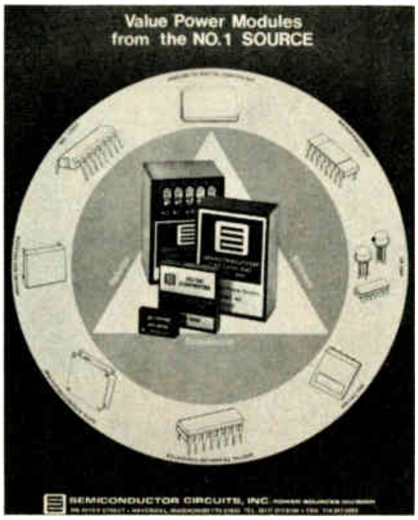
Circle 86 on reader service card

New literature

P. O. Box 335, Benrus Center; Ridgefield, Conn. 06877 [432]

Lasers. "Lexel Argon and Krypton Ion Lasers" is a 28-page brochure that clarifies how to purchase the correct laser for a particular need. Every feature of each laser model is discussed, including the laser head, optical resonator, plasma tube, and power supply. Diagrams and charts help to further explain laser capabilities. Lexel Corp., 928 Meadow Drive, Palo Alto, Calif. 94303 [434]

Power supplies. Test procedures and recommendations for users of both line-operated and dc-dc converter power supplies are presented in a 40-page application and selection guide. It gives electrical and mechanical specifications for both power supply types and describes sockets according to the power supply with which they will mate. Semiconductor Circuits Inc., 306 River St., Haverhill, Mass. 01830 [435]



Varactors. Detailed information on silicon- and gallium-arsenide varactors and silicon switching diodes is given in a 72-page booklet. A special section explains how to reliably test the diodes and components, and a section on microwave control devices covers switch modules, switches, and diode limiters and modules. GHZ Devices Inc., 16 Maple Rd., Chelmsford, Mass. 01824 [436]

Until now, you had good reasons for shying away from foam-in-place packaging.

Until Tri-Wall Containers introduced SolidiFoam.[T.M.]

Ideally there are many benefits you can get from a foam-in-place system. Outstanding protection because your product is completely encapsulated. Space savings because you produce foam only as you need it, eliminating storage of bulky packaging materials like air pillows, corrugated inserts and excelsior . Lower shipping costs because urethane foam is light, reducing tare weight. And more.

But until now, you couldn't be sure of getting all these benefits. You couldn't be sure you had the proper chemical mix, so inferior foam was often produced. You couldn't be sure the dispenser gun wouldn't clog. You were only supplied with small quantities of chemicals. And you even had to wait each morning for the chemicals to heat up.

With SolidiFoam, at last you can be sure of producing high quality urethane foam economically and in foam densities to fit your requirements.

SolidiFoam Means Consistent Foam Every Time. With SolidiFoam, you always have the proper mixture of isocyanate and polyol resin. Positive rationing is insured through the use of rotary proportioning pumps (not the aerosol type piston pumps found in many other systems) and by a common mechanical drive that locks the pumps together.

Internal hose heaters in each line guarantee positive heat control. This feature, combined with the proper mix ratio, makes certain the urethane foam will never be out of balance. So you won't waste chemicals.

Additional quality control is provided by an automatic interlock that shuts down the system when there is an insufficient amount of pressure or the chemical supply is depleted.

The SolidiFoam System is Easy to Operate. Four switches control everything. And the SolidiFoam system is completely adaptable to a timer to control metering of each shot and for use in automated operations.

The dispenser gun has a mechanical purge that automatically cleans the chamber after each use, eliminating the need for solvents.

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New books

Electronic Designers' Handbook, 2nd ed., L. J. Giacoletto, ed., McGraw-Hill, 2,344 pp., $47.50.

Engineers with 1950s-vintage bachelors degrees may remember the first edition of this book, edited by Robert W. Landee, Donovan C. Davis, and Albert P. Albrecht and published in 1957. For its time, it was a valuable handbook. But the editors, in the mid 1950s when the book was in preparation, could not have foreseen the tremendous impact that integrated circuits would have on the electronics engineer. This second edition remedies that situation and more, just about doubling the size of the first edition.

First of all, to dispose of the major criticism that could be made against the book—it makes no mention of microprocessors, in terms either of hardware or software. But that field is moving so rapidly that any handbook intended to be useful for more than a couple of years would quickly become obsolete with respect to microprocessors anyway. And there are already plenty of books available on the devices.

What this book has to offer is solid design information on all types of electronic hardware as well as the mathematics of signal and circuit analysis. In its 2,344 pages, it covers filters, attenuators and equalizers, and transmission lines in three chapters, active and passive components, power supplies, various types of amplifiers, signal sources, wave-shaping and -generating circuits, digital logic design, computer-aided design, and various aspects of communications, including modulation, transmitters and receivers, and radar systems. It closes with chapters on information theory and on system reliability.

As with all handbooks, the specialist in any particular area will probably find the chapter related to his own area to be rather basic, but it is in the other chapters that the book's usefulness lies. For example, few engineers specialize today in power supplies, yet this book gives a good 64 pages of information that would start any engineer off on the

THE ELECTRONICS CONFERENCE ON MANAGING ENGINEERS

sponsored by Electronics,
McGraw-Hill's International Magazine of Electronics Technology

The growing challenge of motivating, training, and utilizing the EE

If you hire, fire, manage, motivate, train, or educate EEs, here are some facts that you should know:

- *74% of 1,300 engineers surveyed this year by* Electronics *believe that electrical engineers in the next decade will not attain the professional status of physicians or lawyers;*
- *55.4% think that employers practice age discrimination;*
- *51.5% are only moderately satisfied with their engineering careers;*
- *Over 45% said that their companies do not have adequate dual ladder systems for engineers who prefer to stay in technical assignments;*
- *Fewer than half of those responding—45.3%—said that employers usually recognize engineering contributions appropriately;*
- *49.4% feel underutilized in their present positions;*
- *Many engineers believe that promotions are slow in coming.*

These are just a few of the findings from the Electronics *survey of engineers' attitudes. Such career-oriented attitudes will be analyzed at the* Electronics *Conference on Managing Engineers at the Fairmont Hotel in San Francisco on November 8th, and at the McGraw-Hill Corporate Headquarters in New York City on November 15th. You can't afford to miss the opportunity to learn more about the significant role managers must play in successfully handling these emerging EE career problems.*

Conference Program:

9:00-9:30 AM **Electronics Career View Survey**

What are 1,300 electrical engineers' attitudes toward the engineering career, its satisfactions and frustrations? What is the impact of the microprocessor on the way EEs do their jobs? What are the future career trends, both professional and technical?

Gerald M. Walker
Senior Editor
Electronics

10:00-11:00 AM **The Thompson-Dalton Study of the Four Stages of Career Development**

How do you get a company to recognize the problem of obsolescence—the corporation's and the individual's? What is the relationship between age and performance? How can you educate management to include the EE's career in its planning? How do you convince management that the project engineer is as important as the project?

Gene W. Dalton
Professor of Organizational Behavior
Brigham Young University

Paul H. Thompson
Associate Professor and Chairman
Department of Organizational Behavior
Brigham Young University

11:00-1:00 PM

Coping with the problems of education, motivation, and utilization of the EE

Part I: The academic world: Can engineering schools stay up-to-date with current technologies—especially in the field of microprocessors? Is there too much theory and not enough practical application?

Is it necessary to achieve a graduate degree or is an MBA more valuable? How can universities counter complaints of current graduates—unqualified instructors, inadequate textbooks, etc?

James D. Bruce
Associate Dean
School of Engineering
Massachusetts Institute of Technology

Kenneth S. Down
Assistant Dean and Director,
Stanford Instructional Television Network
School of Engineering
Stanford University

Part II: The Corporate World: How do your deal with the underutilized EE? The problems of shifting technologies? Career anxiety? Career motivation? Is the 'dual ladder' a myth? What should the EE consider when deciding to remain in technology—financial gain, career potential, etc? What in-house programs have corporations developed to keep EEs updated?

William O. Nilsson
Corporate Training & Management
Development Manager
Hewlett-Packard Company

1:00-2:15 PM

Luncheon

2:30-3:30 PM

Is competency assessment the wave of the future?

Is it possible to identify the successful performer? What are the pros and cons? The alternatives?

George Klemp
Director of Research
McBer and Company

Other speakers to be announced

3:30-5:00 PM

Performance Appraisal

Should performance appraisal become an integral part of the career development program? Is forced turnover an effective means of achieving high performance? Is it possible to quantify performance so that the individual who is of most value to the department receives the best salary?

John D. Porter
Organizational Development Consultant
Lawrence Livermore Laboratory

C. R. Wischmeyer
Director of Education
Bell Laboratories

Your registration fee includes the *Electronics* 140-page survey of over 1,300 electrical engineers (the suvey will not be sold independently), and the magazine's three-part editorial analysis of the Career View Survey.

***NOTE:** While the program issues will remain the same in both New York and San Francisco, some of the above speakers will appear in only one city.*

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The growing challenge of motivating, training, and utilizing the EE

____San Francisco, November 8, 1977, Fairmont Hotel
____New York, November 15, 1977, McGraw-Hill Corporate Headquarters

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New books

right foot toward designing a supply. Similarly, as the microprocessor extends its realm into nearly every type of electronic equipment, even a microprocessor specialist will have to brush up on the techniques involved in each kind of equipment, and this book could well serve as his starting point.

At $47.50, it's a high-ticket item. And, weighing in at 4½ pounds, that comes to about $10 per pound. More expensive than coffee at present, but decidedly a lot more useful.

The Design of Active Filters with Experiments, Howard M. Berlin, E&L Instruments Inc. (Derby, Conn.), 285 pp., $8.50 (paper).

The Data Processing Security Game, Robert S. Becker, Pergamon, 103 pp., $5.95.

Turning Points in American Electrical History, James E. Brittain, ed. IEEE Press, 397 pp., $29.95 (hardcover—$19.45 for IEEE members), $12.95 (paper—only to IEEE members for educational purposes).

Solid State Design for the Radio Amateur, Wes Hayward and Doug DeMaw, American Radio Relay League (Newington, Conn.), 256 pp., $7 (paper).

Servomechanisms—Devices and Fundamentals, Richard W. Miller, Reston, 260 pp., $14.95.

Microcomputer-Based Design, John B. Peatman, McGraw-Hill, 540 pp., $21.

Display Electronics, Ken Tracton, Tab Books, 252 pp., $8.95 (hardcover), $5.95 (paper).

The Complete Handbook of Slow-Scan TV, Dave Ingram, Tab Books, 304 pp., $14.95 (hardcover), $9.95 (paper).

Programming Microprocessors, M. W. McMurran, Tab Books, 280 pp., $9.95 (hardcover), $6.95 (paper).

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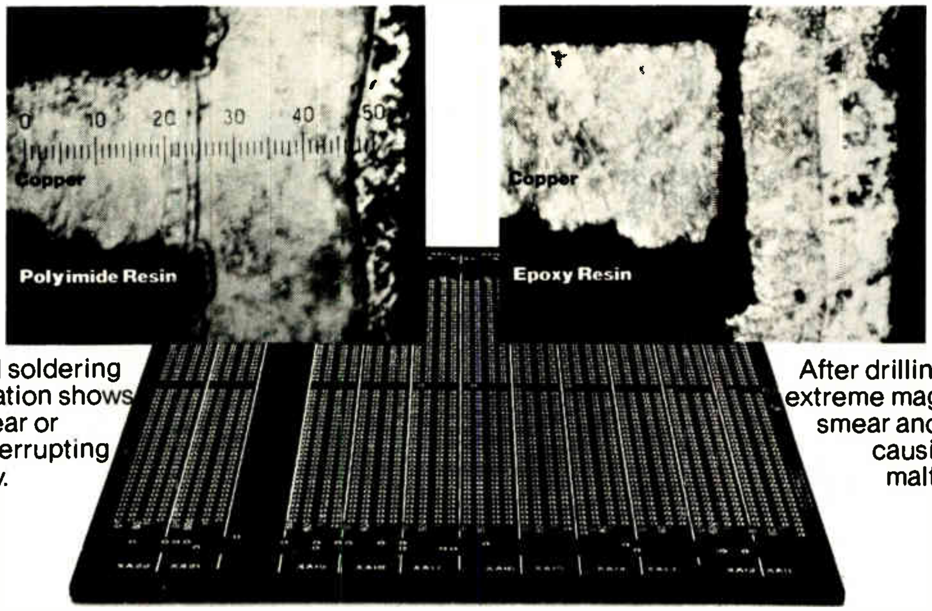

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* MIL P-13949/10 Amendment 2; MIL P-55617 revision B; MIL G-55636 revision B.

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Mechanical production design background including mechanical processes as they apply to design, and value engineering techniques. Proven product development experience with expertise in mechanisms, structures, electromagnetics, electronic packaging/cooling, and value engineering. A BSME or th equivalent plus 4-6years' related design and manufacturing experience.

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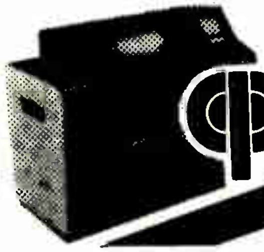

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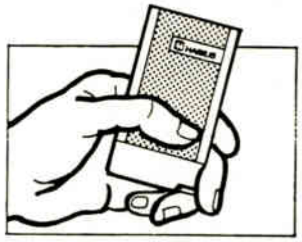

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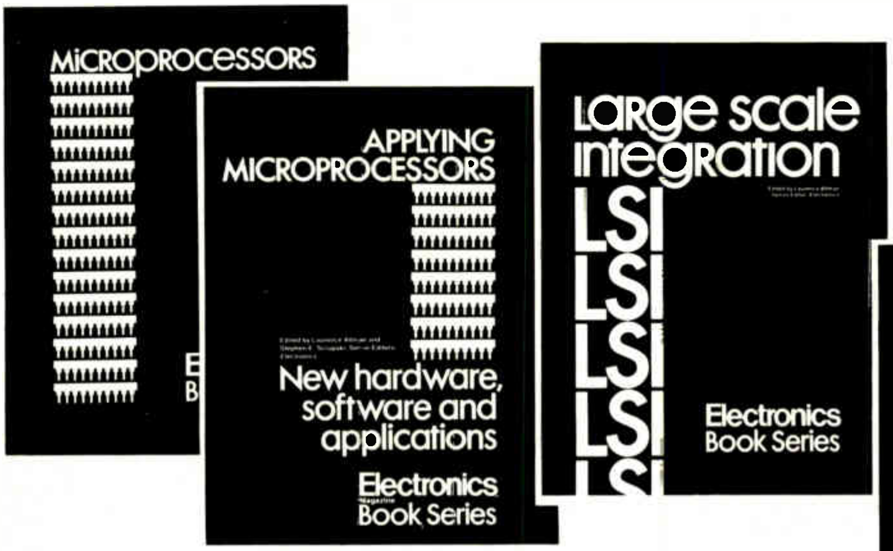

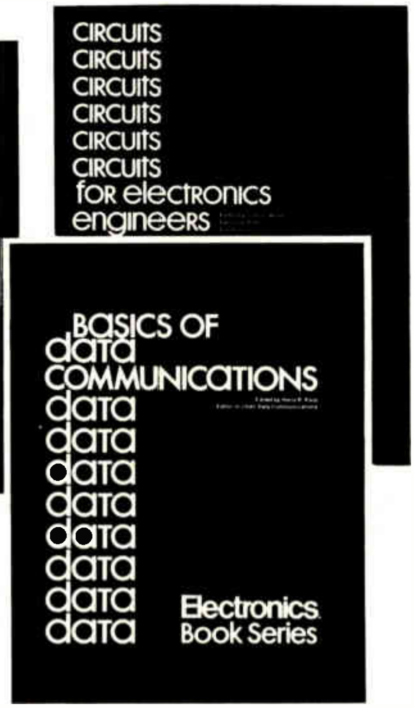

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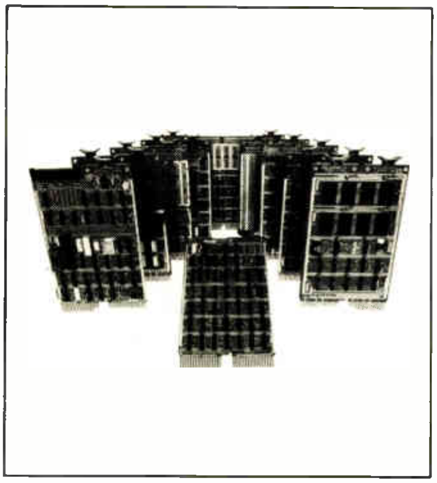

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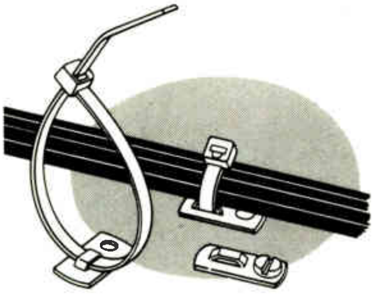

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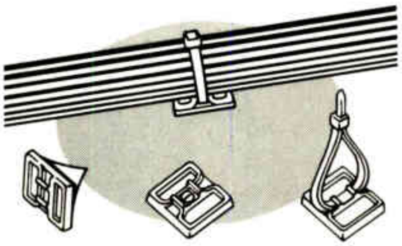

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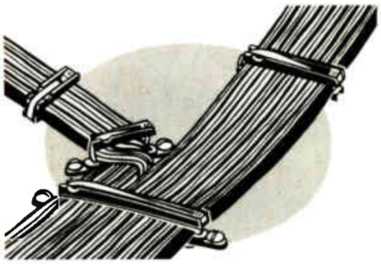

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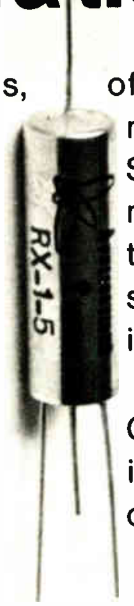

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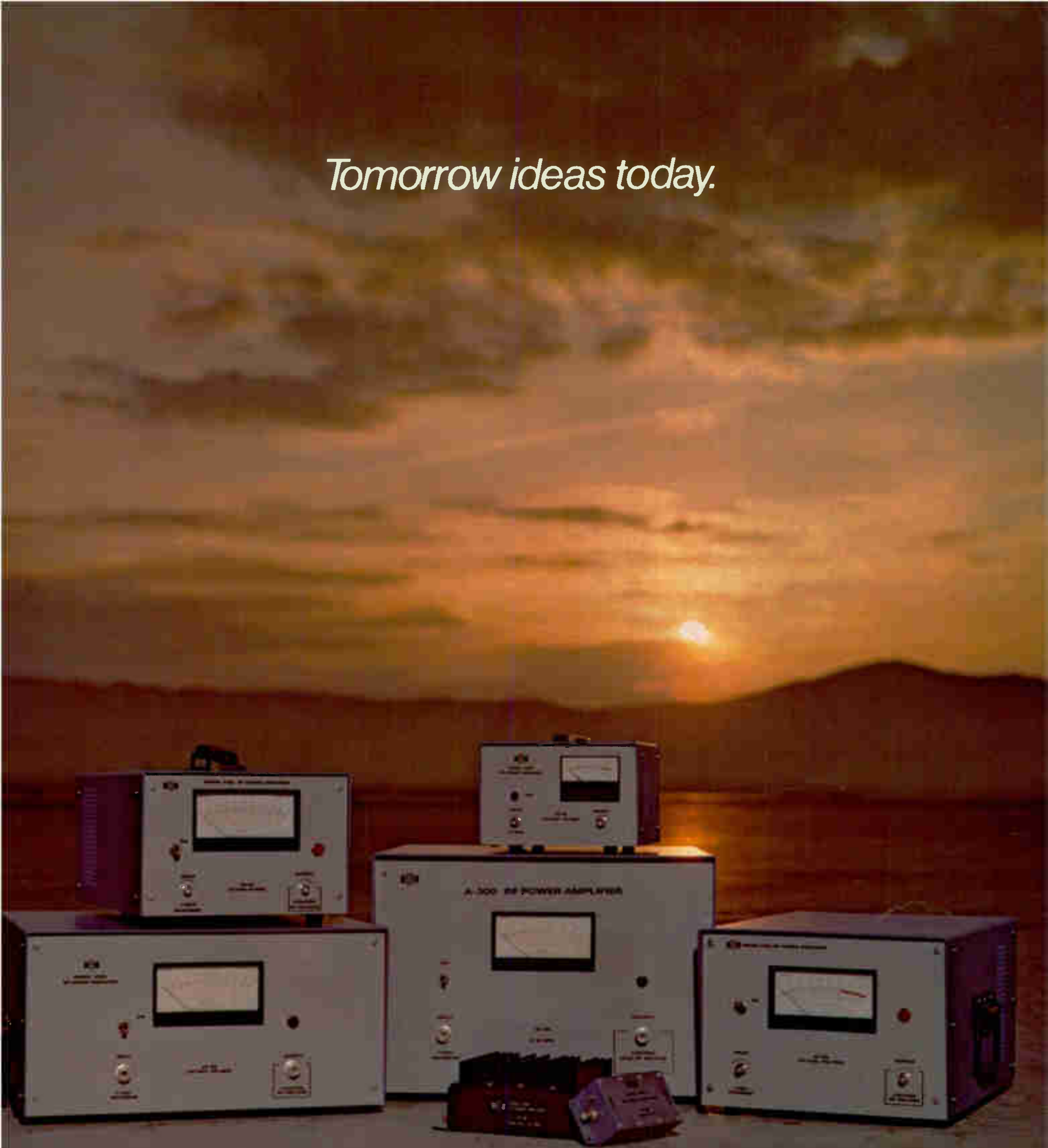

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