OCTOBER 17, 1974

SPECIAL TECHNOLOGY UPDATE ISSUE

A report on the significant technical developments of 1974, the forces that are shaping them, and their impact on product design / 68

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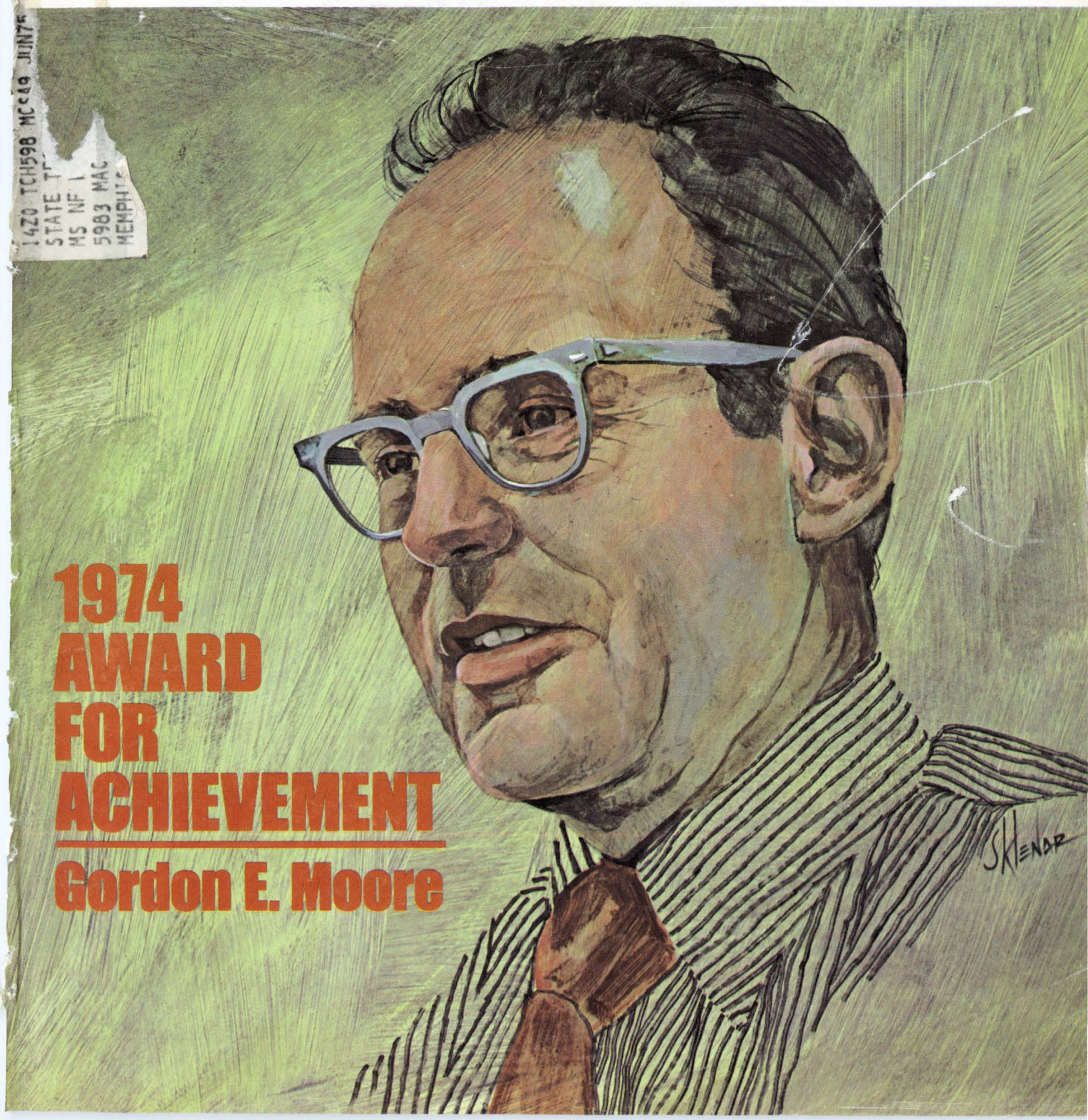

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Gordon E. Moore

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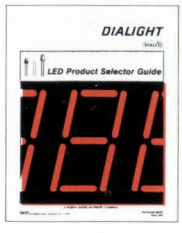

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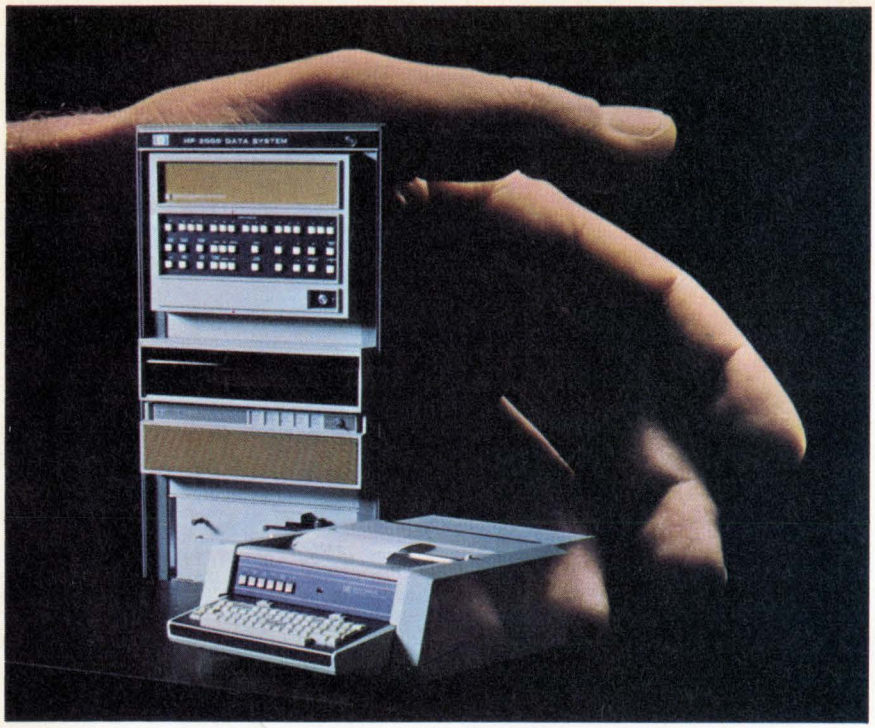

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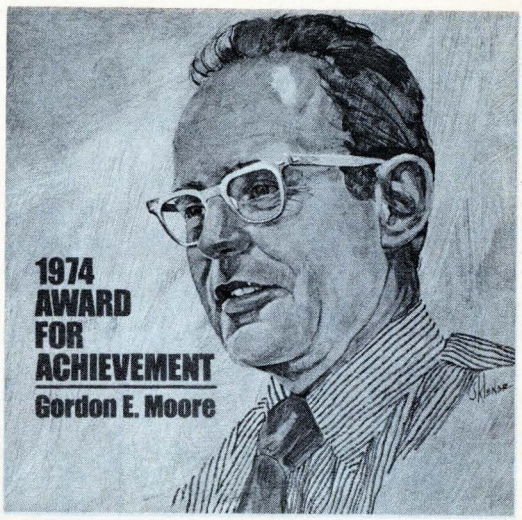
Electronics

The International Magazine of Electronics Technology

Vol. 47, No. 21•October 17, 1974



The cover: Award is won by Intel's Moore, 62
Electronics honors a man whose ideas and leadership have influenced the direction taken by current technology. Cover portrait is by Art Director Fred Sklenar.

Technology update, 68
To keep system design engineers abreast of developments in the fast-changing field of electronics, this special issue pinpoints significant trends in nine areas.
Computers, 70: Microprocessors, large networks extend reach of computer control.
Communications, 82: The news is digital techniques, fiber optics, mm waves, satellites.
Instruments, 98: LSI simplifies use of testers but requires complex testing itself.
Industrial, 114: Energy crisis creates demand for solid-state sensors, controls, displays.
Consumer, 122: Need for low cost and reliability is encouraging shift to semiconductors.
Solid state, 138: Refinement of bipolar and MOS processing breeds powerful devices.
Components, 154: Higher performance, reduced size means compatibility with LSI.
The year in electronics, a chronology, 162
Government, 170: Congress is forcing all agencies to become very cost-conscious.
R&D, 178: Research is applications-oriented, even in university laboratories.

And in the next issue . . .
An improved bipolar-MOS process enhances high-frequency linear integrated circuits . . . modeling the bipolar transistor, Part 2 . . . measuring the thermal resistance of ICs, Part 9 in the thermal design series.

Electronics

Publisher's letter

Technology update—that's the theme of this special issue of *Electronics.* Here, in more than 60 pages, we have detailed the major technological trends all across the electronics industries.

We decided to put together this special issue—and we plan to do it annually—because the pace of technology is so rapid that keeping abreast of what's happening at the leading edge of technology can be a full-time job. But the electronic-equipment designer already has a full-time job and often has little time left for keeping up-to-date on how the latest developments may impact his efforts.

Yet, as we point out in the introduction on page 69, pinpointing these trends—separating the really significant from the merely novel, sorting out the trade-offs, putting technology into perspective—while one of the most difficult tasks facing the engineer today, can spell the difference between success in the marketplace and obsolescence.

Thus, we feel that the picture we present of where technology stands today should prove of value to the engineer as he faces the basic decisions that ultimately determine the course of electronics progress.

Included in our Technology Update package are run-downs on what's going on in:

- Computers, page 70
- Communications, page 82
- Instruments, page 98
- Industrial electronics, page 114
- Consumer electronics, page 122
- Solid state, page 138
- Components, page 154

What's more, we've put together a month-by-month listing of the past year's major developments, complete with references to when we published the details (p. 162). And, two additional sections deal with the impact that Government policies and programs have on electronics technology (p. 170) and with the way research and development is organized at industrial and university laboratories (p. 178).

And, befitting the technological nature of this special issue, we are using it as the vehicle to announce the first winner of our Award for Achievement—Gordon E. Moore. In singling him out for the award, the editors of *Electronics* cited his contributions to electronics technology, especially for the leadership he exhibited in setting up and running the technical staff at Intel Corp. Thanks in large part to Moore's success in evaluating new technology, the company has to its credit such significant developments as the 1103 1,024-bit random-access memory, the MCS-4 microprocessor chip set and the follow-on 8080 eight-bit units, and the Schottky-bipolar 3000 microprocessor line.

This year's award is the first in what will become an annual means of recognizing the people behind—indeed responsible for—technological progress. We welcome any comments you may have about our award and suggestions for people to be considered for future awards.

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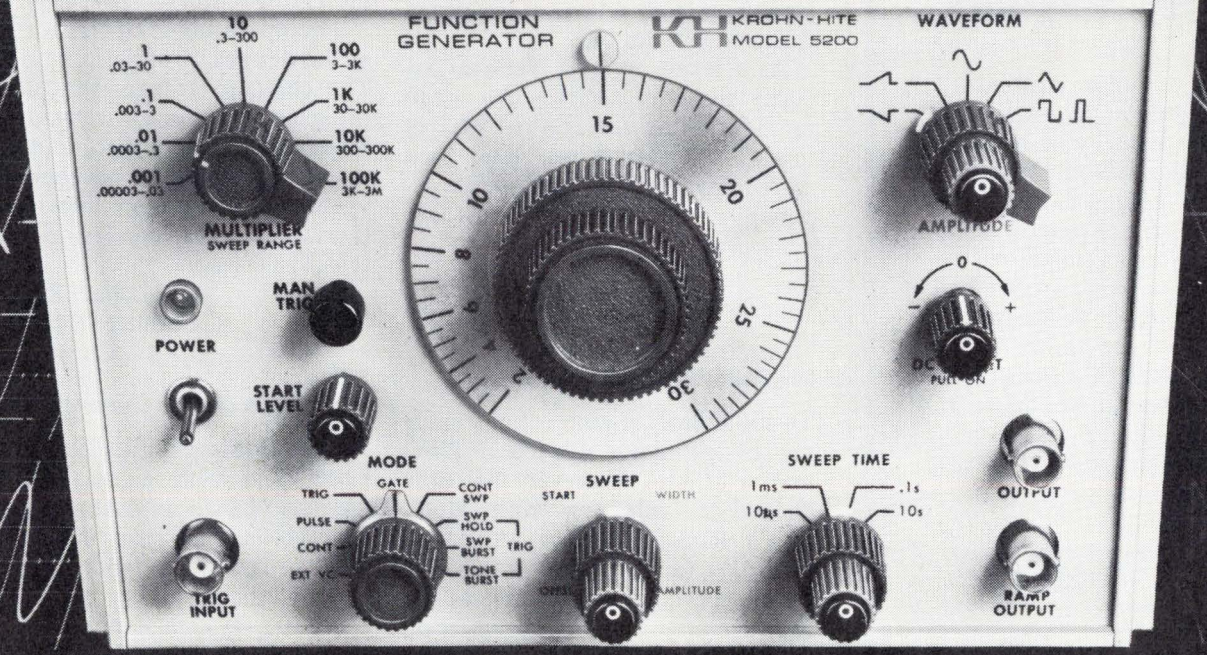

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Readers comment

Reinventing with public funds

To the Editor: I read with interest your article, "Citizen alarm sends digital signals through wrist transmitter" [*Electronics*, Aug. 22, p. 29]. I would like to point out that the original idea for personal alarms emanated from NASA through the Jet Propulsion Laboratory in 1970. This resulted in a small, inexpensive personal alarm transmitter the size of a cigar, first installed in two California schools by the Mentorous Co. of California. The advantage of this system was its low cost; however it had several disadvantages: the transmitter had to be aimed at the receiver, it had short range, was expensive to install, and could not produce multitransmitter codes for identifying transmitters or locations.

In 1972, the New York City Board of Education, in reviewing the then-available equipment, suggested to us that an alternate, more effective means of transmitting personal alarms be developed. Using our own funds, we developed in early 1972 the idea of an alarm mounted on a wristwatch, pendant with chain, or belt clip. We wrote the specifications, which were used by the boards of education of both New York City and Los Angeles in their requests for bids.

As a result, we feel National Security Systems deserves the credit for developing the original idea of this system, which was later used and reinvented at taxpayers' expense through LEAA funds dispensed by Aerospace Corp.

John W. Walter
National Security Systems Inc.,
Port Washington, N.Y.

Engineers repeat their history

To the Editor: Humor is not usually one of the major subjects of *Electronics* articles. However, that little "boxed-in" interview with Motorola's Rod O'Connor [Aug. 22, p. 121] is funny in its own fashion. To put it mildly, trying to blame the shortage of graduating engineers on ". . . kids look(ing) at technology as the cause of problems that face the world, not the solution . . ." is just so much hot air. The truth is much simpler and down to earth:

In the early '70s, thousands of engineers were thrown out on their tailbones without even a "thanks, pal," let alone adequate compensation. They lost their pension rights—a joke in any case, but that's another story—seniority, security, and often their homes and cars. High-school students interested in engineering caught the static and were frightened off into other more stable professions. This happened in the late '50s and early '60s, too.

How many times does history have to repeat itself?

Trevor Davis
M.G. Electronics Ltd.
Rehovot, Israel

Resistor reactions are similar

To the Editor: The Electronics newsletter [*Electronics*, Sept. 19, p. 27] credits me with asserting that a film-type temperature-sensitive resistor offers a more linear temperature/resistance characteristic than an equivalent wire-wound component. This is not true. Both devices would have similar linearity specifications, and the maximum percentage of deviation from linear of either device would increase with increasing temperature span.

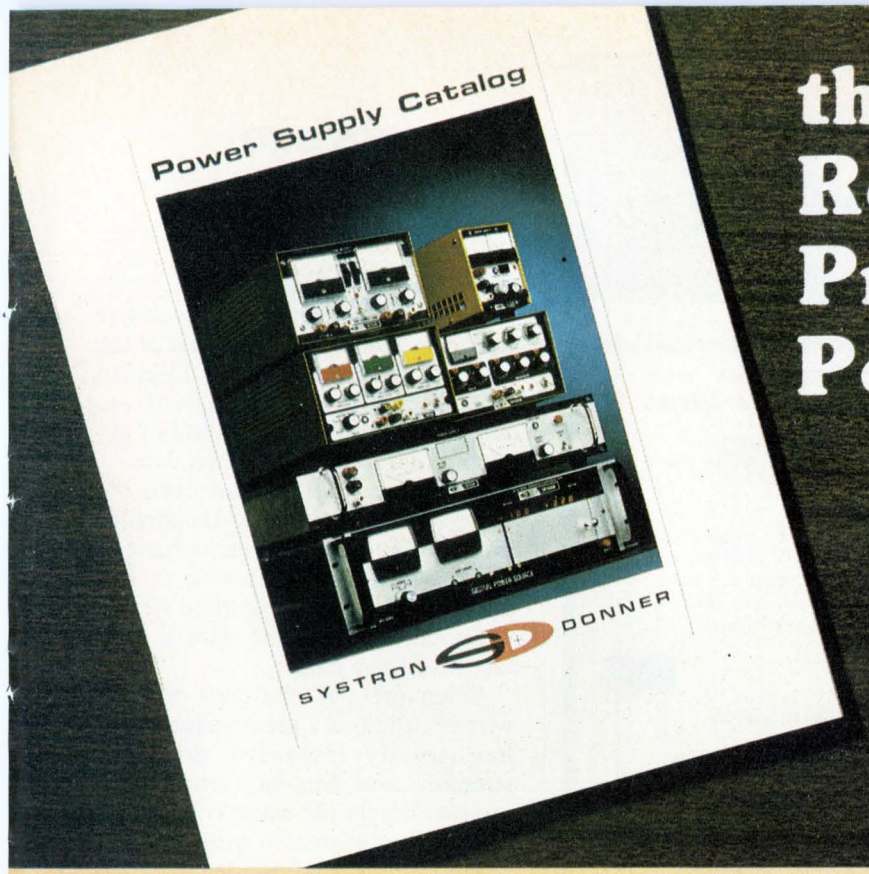
The operating-temperature range of the devices would also be similar. The chief advantages the film approach offers over a wire-wound are lower cost, smaller size, and faster response. It has the additional advantage of being more linear than a thermistor or silicon temperature-sensitive resistor.

Michael R. Teders
Corning Glass Works
Corning, N.Y.

Microdata claims memory 'first'

To the Editor: Fujitsu's claim to being first with a small virtual-memory [*Electronics*, Aug. 22, p. 56] computer system ready for delivery in February 1975 ignores at least Reality, the small virtual memory computer system being delivered since December 1973 by Microdata.

Donald W. Fuller
Microdata Corp.
Irvine, Calif.



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0 to 20	12	H	425	HR20-12C
0 to 20	20	R3	575	RS20-20B
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0 to 40	2x1 Dual	H	375	DL40-1 (2 outputs)
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0 to 40	10	H	475	HR40-10C
0 to 40	15	R3	575	RS40-15B
0 to 40	30	R5	895	M5C40-30 OV*
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0 to 160	15	R7	1790	M7C160-15
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24	60	R5	660	VP24-60
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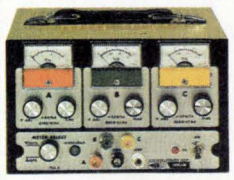

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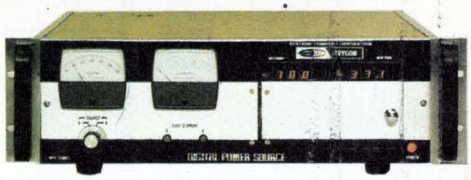

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40 years ago

From the pages of Electronics, October, 1934

Cellophane-wrapped wire

A novel insulation for electrical wire has been applied by engineers of the DuPont Cellophane Co. and Belden Manufacturing Co., Chicago, Ill., to the development of a method of applying cellophane to magnet wire.

Special machinery had been developed and installed at the Belden plant for applying the cellophane to the magnet wire. Adhesive is first applied, then the cellophane strip is wrapped in place; the wire is then lacquered and baked.

Celenamel, as the new magnet wire is called, is a great space saver, has greatly increased dielectric strength, and can be furnished at approximately the same cost as cotton-covered enameled wire.

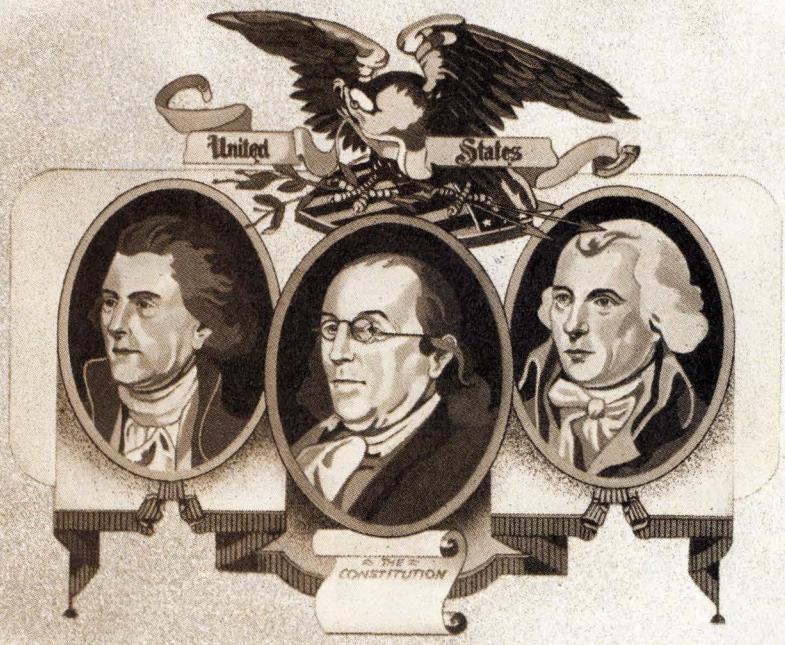
Tests show that Belden Celenamel has approximately the same space factor as silk enameled wire. Celenamel has already supplanted silk-covered magnet wire in a number of applications.

Compandor overcomes static

To aid in overcoming the static and general noise level encountered in transoceanic telephony, a device known as the Compandor (from Compressor and Expandor) has been developed by engineers of the Bell Telephone Laboratories. At the transmitting end, the Compandor compresses the range of volume in the voice frequencies, so that all of the speech sounds are as nearly equally loud as possible. All parts of the speech are thus equally effective in piercing static and the other noise encountered in transmission overseas. At the receiving end, the expandor part of the compandor expands the range of volume to its original state, thus restoring the naturalness of the sound.

The principle of the Compandor rests in the fact that the amplifying vacuum tubes are operated on the non-linear portions of the characteristic curve. The resulting amplitude distortion is used to increase automatically the intensity of the weaker parts of the speech in an inverse proportion to their original strength.

Great American Logic. From Jefferson, Franklin, Madison, and HiNIL.



Give your industrial control system a great constitution with HiNIL, the high noise immunity logic from Teledyne. It works reliably in adversity—like the great political logic our Founding Fathers used in the Constitutional system.

HiNIL doesn't operate illogically when it sees electrical noise and high voltage transients. With a 3.5 volt guaranteed noise margin (versus 1.0 V for CMOS and 400 mV for TTL), it runs without shielding.

HiNIL also runs true when the power supply doesn't. It doesn't need expensive regulated supplies, filters and spot regulators because HiNIL's power supply tolerance is a comfortable ±1 V.

And HiNIL is slow—that's right, slow not fast. Its 100 nanosecond propagation delay is fast enough for most control systems. But it won't be switched falsely by noise spikes when a fork lift rolls by (can you say the same for the hair-trigger logic you've been using?).

Like the Constitution, HiNIL is adaptable. It interfaces easily with TTL, DTL, RTL, MOS and CMOS directly, through open-collector outputs or through interface circuits. And it comes in about 40 types: from diode-expandable gates to quad schmitt triggers, shift registers, display decoder/drivers and a dozen other complex MSI functions. All conveniently packaged in ceramic or molded silicone DIPs.

Finally, HiNIL is cheap. It's priced right in there with TTL so you can save a small fortune on supply regulation, noise suppression and other "extras" you'll no longer need.

So if you want to read about great logic, trade in your history books for Teledyne's free literature on HiNIL. Better yet, experience HiNIL in your own designs. Get it from Teledyne, reps or distributors. Write or call now.

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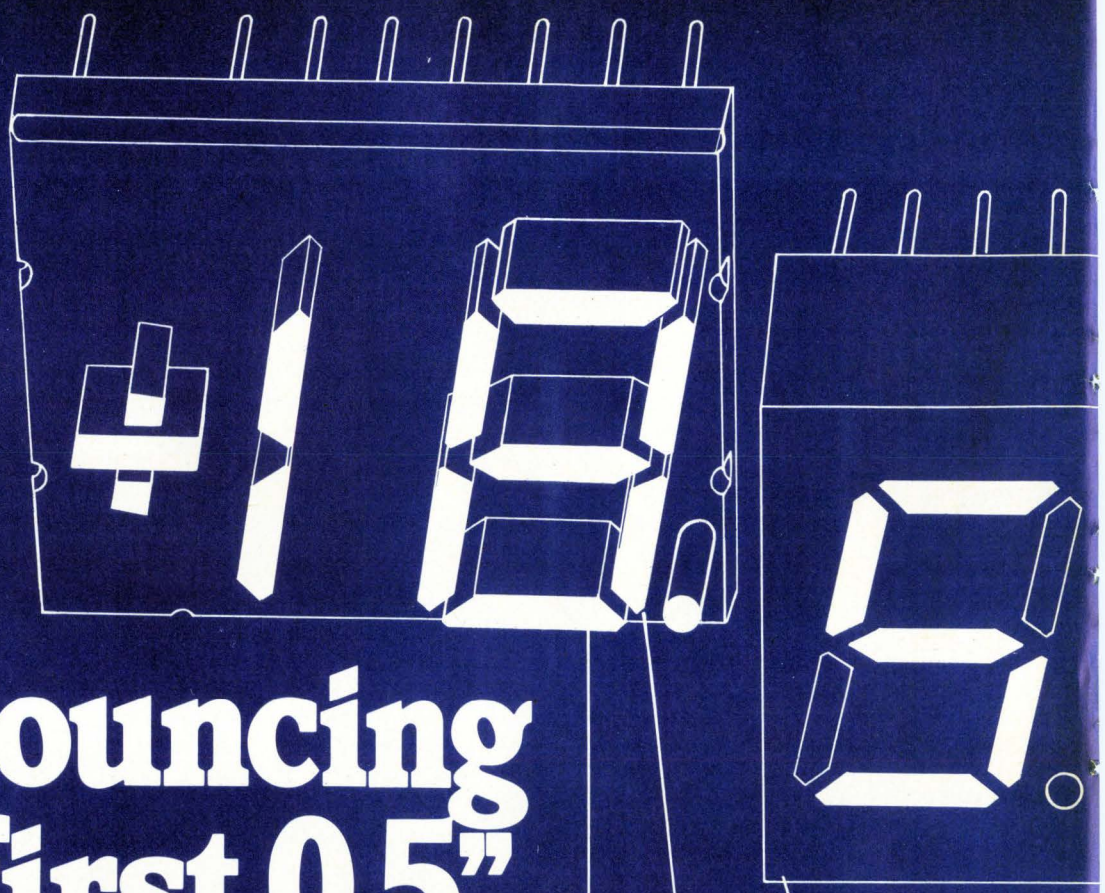
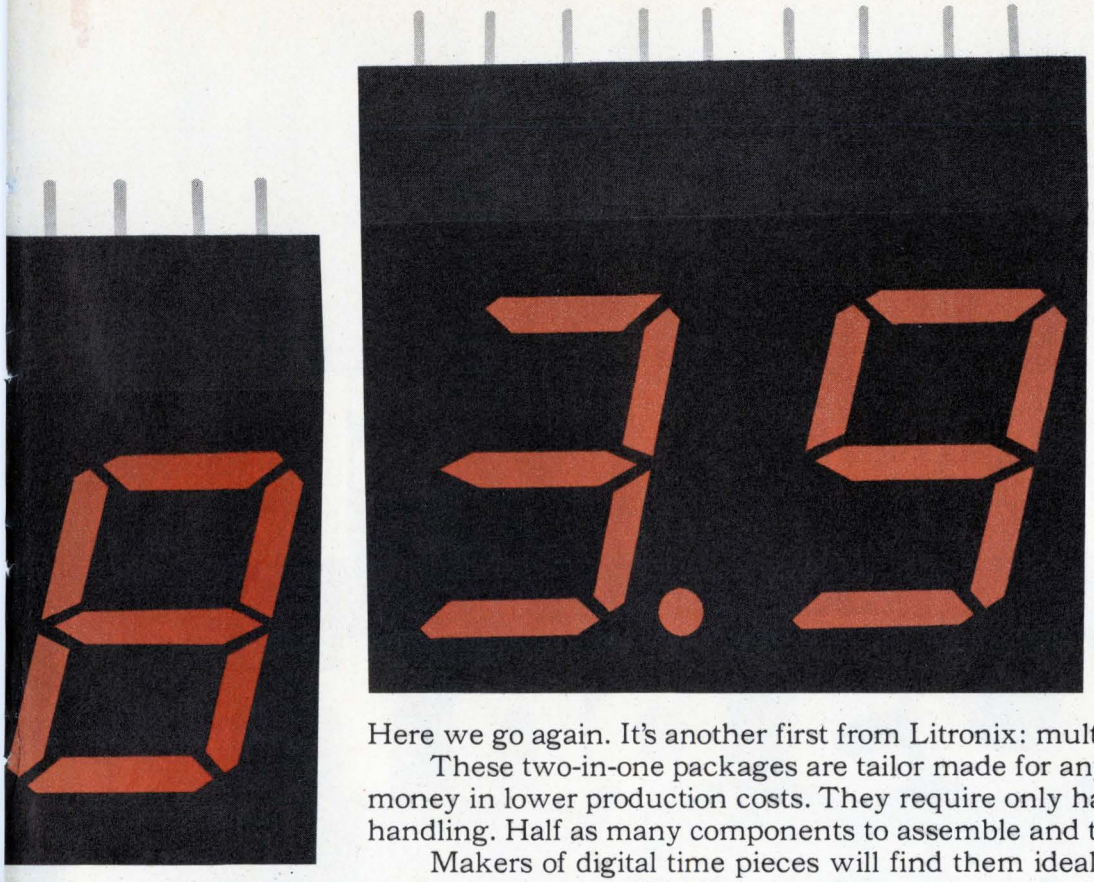


Announcing the first 0.5" multi-digit LEDs

One DIP handles two digits

Mitered corners increase eye appeal

Light pipes spread illumination evenly over broad segments



Here we go again. It's another first from Litronix: multi-digit 0.5″-high LEDs.

These two-in-one packages are tailor made for anyone who wants to save money in lower production costs. They require only half the inventory. Half the handling. Half as many components to assemble and test.

Makers of digital time pieces will find them ideal, as will those who manufacture point-of-sale terminals. FM digital readout tuning systems. TV channel tuners, and instrumentation.

The modules are end-stackable to produce any combination of 0.5″ digits on 0.5″ centers. The DL-727 is a two-digit module that's ideal for clocks. And our DL-721 module offers a ± sign and a "1" for polarity and over-range indications on instruments.

Each module has the same drive requirements. Power required is only 30 to 40 mW per segment from standard logic voltage supplies. Modules are packaged in standard DIPs.

Naturally, you enjoy all the solid state advantages of LEDs. They're compatible with today's IC circuits. Rugged. Easy to multiplex. And offer fast response.

In any business lower costs make a difference. Our dual 0.5″-high digits help your products keep a competitive edge.

Our data sheets tell all. Contact Litronix, 19000 Homestead Road, Cupertino, Calif. 95014. Phone (408) 257-7910.

No wonder we're No.1 in LEDs

litronix

RCA announces a major breakthrough in the world of op amps.

MOS/FET, CMOS on the

It's the low cost CA3130 from RCA. The people who first combined PMOS and bipolar technologies in the CA3100T.
A simple, accurate and easy-to-work-with op amp at a price you can afford, it's the result of combining PMOS/FET, bipolar and CMOS technologies on a single chip.

It's simple to apply. Simple to design. Simple to manufacture.

And simplicity is why you get a lot of op amp for a little change. $0.75 at 1K.

Here are some of the principal features you get for your change (values shown are typical):

General Purpose

High open loop voltage gain: 110 dB
Low input offset voltage: 8mV
Low input current: 5 pA
Input offset current: 0.5 pA

FET input

Very high input impedance: 1500 MΩ

Wideband

Unity gain crossover frequency: 15 MHz
High slew rate: 10 V/μs
Fast settling time: 1.2 μs

Micropower

2.5 mW at 5 V supply voltage

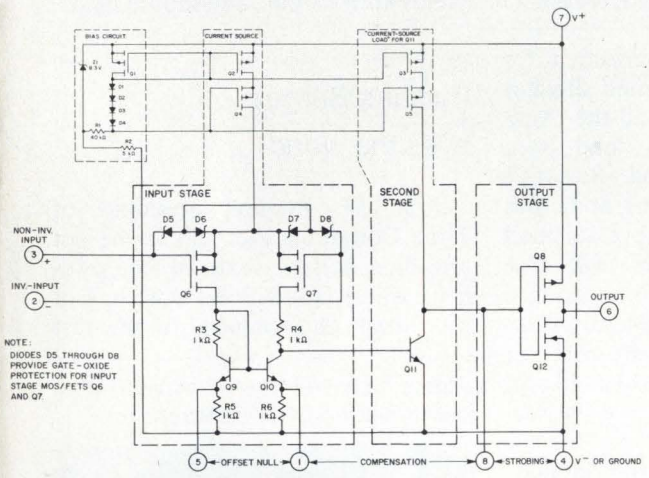
High current

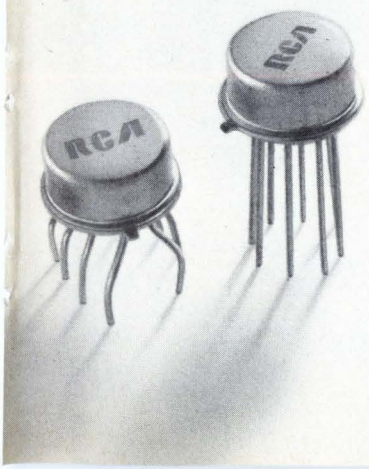
22 mA output

A voltage swing to within 10 millivolts of either rail on a single power supply is now possible for the first time because of the CMOS output stage.

These are some of the features that make the CA3130 the op amp you should use in such applications as D to A conversion, voltage follower circuits, fast sample-hold amplifiers. And many more.

Bipolar and same chip.





Premium versions of the CA3130 are also available. The CA3130A ($2.95 at 1K) offers lower input offset voltage (5mV max) and current (20 pA max). You can even get a full military temperature range version, the CA3130B ($9.95 at 1K).

Available in 8-lead TO-5 ("T") or 8-lead dual in-line ("S") packages off the shelf from your RCA Solid State distributor. For more information, call him or write RCA Solid State, Box 3200, Somerville, N.J. 08876. Phone (201) 722-3200. Ask for Bob Rauth, Marketing Administrator (Ex 3142).

RCA Solid State

A full house in Linear ICs

Circle 13 on reader service card

People

Watson applies maxi touch to minicomputers

"Small computers are where the action is," says W. Joe Watson. That's why he moved from supervising Texas Instruments' supercomputer effort to the minis and micros made at General Automation Inc. Watson, already a GA vice president for R&D and newly appointed director of standard products at the Anaheim, Calif., company, had been manager of Advanced Scientific Computer manufacturing at TI. But he doesn't think the move to small computers and systems will faze him. He hopes to add his experience in large systems to General Automation's increasingly more complex systems, although he hastens to add that GA won't build a supercomputer.

Action. General Automation's Watson expects things to happen in minicomputers.

Expanding. Instead, the 38-year-old native of Konawa, Okla., sees a greatly expanding role for the small computer. "We built six ASCs, but there aren't many budgets that can afford machines in that class." And, he adds, "Look at history. The first minicomputers were very simple, but they've gotten more and more complex. Instruction sets have become very large, and we're now getting started in memory management. All these things have come down from larger computers. I expect to see us pushing more capability from big computers into minis."

Link up. Watson, who moved to General Automation from TI in July, also notes the great increase in systems based on tying together large numbers of processors. "More and more of General Automation's business will involve linking together many computers, as we did in the ASC."

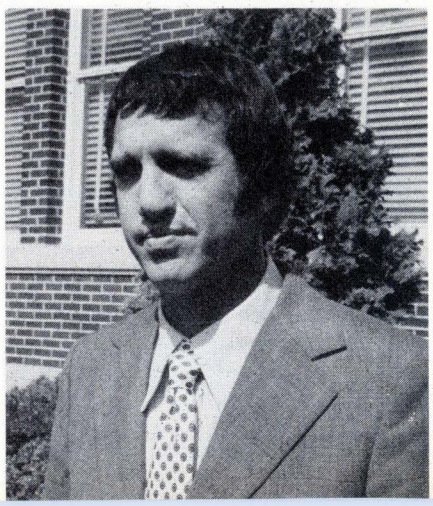
The gracious, soft-spoken Watson has also had first-hand experience with small computers. At TI in the early 1960s and with a master's degree in electrical engineering, he worked with IC inventor Jack Kilby. And he helped design TI's small-size seismic computer, the first to use the famous 54/74 transistor-transistor-logic family.

Along with the standard minis, Watson is responsible for GA's silicon-on-sapphire microcomputer program. "There's no secret we've had delays with SOS. They're not catastrophic, however, and we have gotten parts and delivered some 8-bit LSI-12 microcomputers, but yields aren't what they should be."

Pulsar's Bergey eyes the world

John M. Bergey, president of Time Computer Inc., figures he got a million dollars worth of free publicity when James Bond wore one of his Pulsar LED watches in the last

Infancy. Digital watches will do much more than tell time, says Pulsar's Bergey.



Fast and easy... MOSTEK's MK4102-6 static 1K RAM.

275 ns!

MOSTEK's MK4102P-6 is fast—275 ns access time! But speed is only one of its features. Just as important, it's easy to use, requiring only one +5 V power supply. All inputs are TTL compatible. And the processing technology is strictly state-of-the-art utilizing a combination of N-channel silicon gate plus ion implantation.

Also, you can accomplish large memory array construction with a minimum of additional circuitry because of the high impedance "off state" coupled with "chip select" input.

What else? Well, the MK4102P-6 is a pin - for - pin alternate for the 2102. But there's no comparison in access time. Check for yourself.

MOSTEK's line of 1K RAMs gives you plenty to select from, static or dynamic. They range from the MK4008-9 (at 800 ns) through two other versions of the MK-4102 (450 ns or 1 μ sec) up to the popular MK4006 (at 400 ns). Check the table below for the part number you need.

When your design requires an MOS memory, remember MOSTEK. Call your nearest MOSTEK distributor or representative or contact MOSTEK, 1215 W. Crosby Road, Carrollton, Texas 75006, (214) 242-0444. In Europe contact MOSTEK GmbH, TALSTR. 172, 7024 Bernhausen, West Germany, Tel. 798038.

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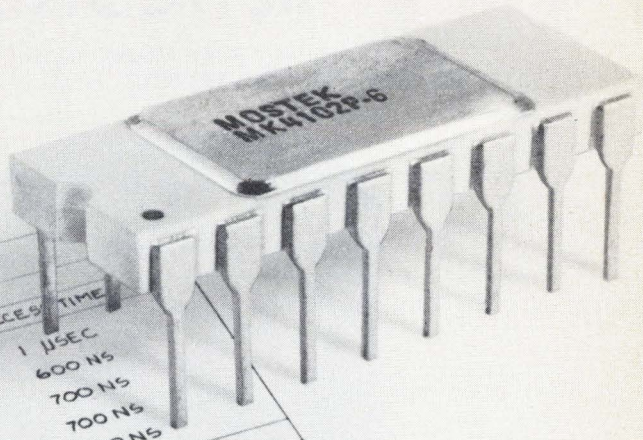

MOSTEK MEMORIES		
ROMs		MAX ACCESS TIME
TYPE		
2240 - BIT CHARACTER GENERATOR		1 µSEC
2560 - BIT ROM		600 NS
4096 - BIT ROM	(REPLACES MM 5232)	700 NS
4096 - BIT ROM	(REPLACES FSC 3514)	700 NS
16K - BIT ROM	(REPLACES EA 4800)	900 NS
RAMs		
1024 - BIT DYNAMIC RAM	MK 4006P	400 NS
256 - BIT STATIC RAM	MK 4007P	900 NS
1024 - BIT DYNAMIC RAM	MK 4008P	500 NS
1024 - BIT DYNAMIC RAM	MK 4008P-9	800 NS
1024 - BIT STATIC RAM	MK 4102P	1 µSEC
1024 - BIT STATIC RAM	MK 4102P-1	450 NS
1024 - BIT STATIC RAM	MK 4102P-6	275 NS
4096 - BIT DYNAMIC RAM	MK 4096P	350 NS

People

007 thriller. It's the kind of exposure that helped boost Pulsar to the top in the high-end digital watch market—a fact duly noted by HMW Industries Inc., Time Computer's parent company, which recently named Bergey a corporate vice president. The promotion, says Jerome W. Robbins, HMW's chairman and president, indicates the "increasingly important role" the Pulsar operation is playing in the company's sales and earnings picture.

Bergey expects to boost sales significantly through the formation of a new subsidiary to market the digital watches internationally—Pulsar S. A., headquartered in Neuchatel, Switzerland. Worldwide distribution should begin in January. All production of Pulsar timepieces will continue, however, in Time Computer's Lancaster, Pa., headquarters.

A tall, athletic-looking man (he plays golf and tennis), Bergey joined HMW (formerly Hamilton Watch Co.) in 1959 as an ordnance engineer. In 1968 he was named director of watch R&D and headed the group that developed Pulsar. He holds 15 U. S. patents relating to digital watches. Bergey was named president of Time Computer in 1972.

Beginning. He believes the digital watch of today is "just the beginning of some very significant advances in these products." He looks for watches to perform as paging systems, to have computational capability, and perform "information-systems" functions. "Telling time may be only 10% to 20% of the functions available with these units, let's say, in 5 to 10 years."

Bergey doesn't plan to compete on a price basis. The electronics firms and other watch companies can fight for the remainder of the low-end market. His strategy, at least in the early going, is to maintain a minimum retail price of about $275 on Pulsar watches while periodically introducing new generations of Pulsars with new features.

"Anyone who expects to do anything in this business will be off and running in 1975," says Bergey. "We'll know by the end of '75 who the leaders will be."

CAUTION: 50,000 VOLTS

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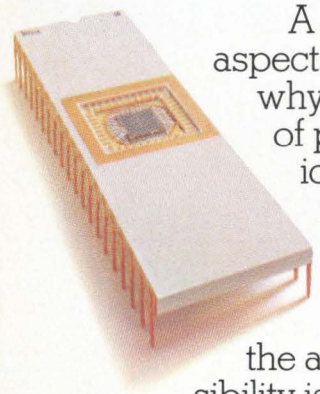
Circle 17 on reader service card

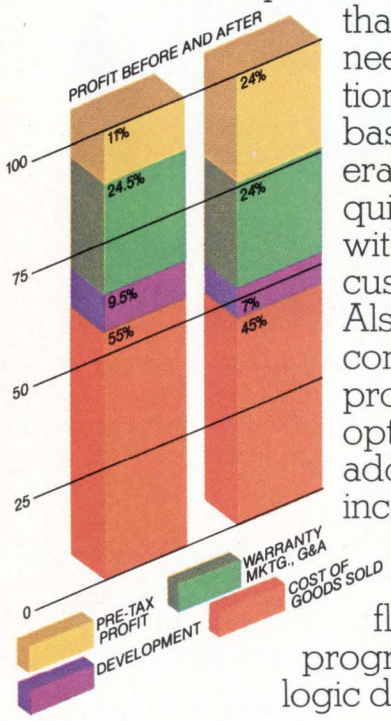
From design microcomputers in

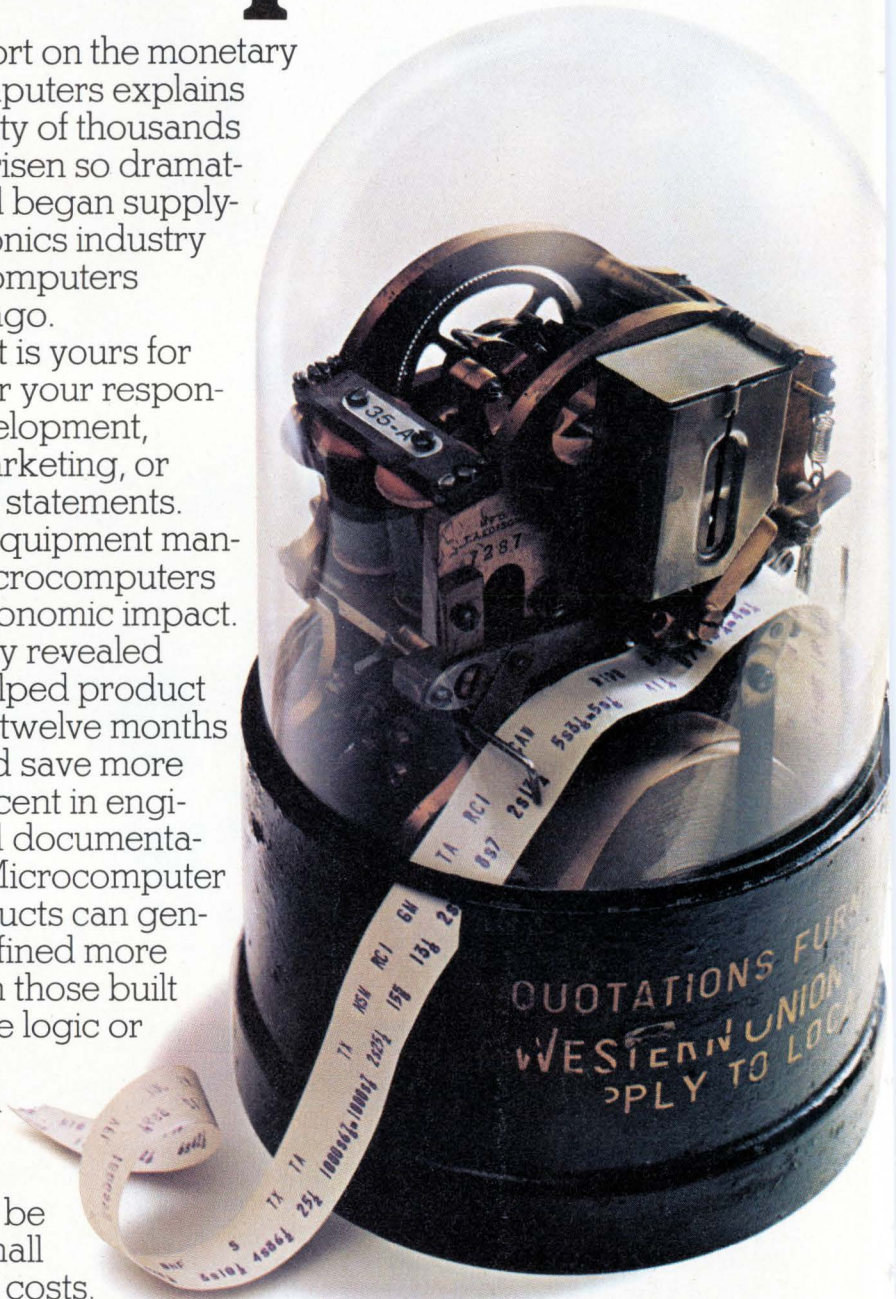


A new Intel report on the monetary aspects of microcomputers explains why the profitability of thousands of products has risen so dramatically since Intel began supplying the electronics industry with micro computers three years ago.

The report is yours for the asking, whether your responsibility is product development, production management, marketing, or preparing the company P&L statements. Our discussions with many equipment manufacturers confirmed that microcomputers often have company wide economic impact.

The interviews frequently revealed that Intel microcomputers helped product development staffs cut six to twelve months from development cycles and save more than 30 percent in engineering and documentation costs. Microcomputer based products can generally be defined more quickly than those built with discrete logic or custom LSI. Also special control and processing options can be added at small incremental costs.





Engineering time shrinks because microcomputers provide the designer with an LSI logic structure that attains great flexibility through software. In fact, the engineer designs through programming, a much faster procedure than working through logic diagrams. Supporting design and documentation tasks often

to market, Intel crease your profits.

become trivial. And simple changes in software generally replace major revisions in hardware and documentation.

Microcomputers also reduce manufacturing costs. Estimates of savings in circuits, hardware and assembly costs usually fall in the 20 to 50 percent range. It is possible to displace hundreds or even thousands of TTL packages, for example, with an Intel microcomputer system. Even a small one, costing less than $100, displaces $150 to $600 of TTL assemblies. And since simpler systems are more reliable, field service costs drop.

Furthermore, a shorter development cycle gives marketing an opportunity to introduce a new product faster than the competition and win a larger market share. This can generate much higher sales income for a longer period of time.

Another bonus accrues from the small incremental costs of programmable special features. End users often request computation or control options with a market value 10 to 20 times higher than the cost of adding the additional program storage to the basic model. In fact, a marginal product line can be made profitable by redeveloping it around a microcomputer and offering attractive new options. And the line's market life may be extended further with enhancements added as new programs.

The net effect of all these advantages can be a 10 to 20 percent rise in the overall profitability of a product line.

But you owe it to your company to get all the details of how microcomputers can give your products higher profitability from design to market. Read "Microcomputers—What They Mean To Your Company." It's yours for the asking from Intel, the company that supplies the most microcomputers to equipment manufacturers.

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Meetings

1974 Symposium of the International Society for Hybrid Microelectronics, (Montgomery, Ala.), Sheraton-Boston Hotel, Oct. 21–23.

ISA Conference and Exhibit, Instrument Society of America (Pittsburgh, Pa.), New York Sheraton Hotel and New York Coliseum, Oct. 28–31.

Nerem-74, Northeast Electronics Research and Engineering Meeting, IEEE, Sheraton-Boston Hotel and John B. Hynes Veterans Auditorium, Boston, Oct. 29–31.

International Symposium on Information Theory, IEEE, Notre Dame, Ind., Oct. 27–31.

'74 ASSC, Automatic Support Systems Symposium for Advanced Maintainability, IEEE, Sheraton Inn, Harbor Island, San Diego, Calif., Oct. 30–Nov. 1.

Electro-Optical Systems Design Conference and Exhibition, Civic Auditorium/Brooks Hall, San Francisco, Nov. 5–7.

Communications and Power Conference, IEEE, Queen Elizabeth Hotel, Montreal, Que., Nov. 6–8.

Ultrasonics Symposium, IEEE, Pfister Hotel, Milwaukee, Wis., Nov. 11–13.

Electrical/Electronics Insulation Conference, NEMA, IEEE, and IPC, John B. Hynes Veterans Auditorium and Sheraton-Boston Hotel, Boston, Nov. 11–14.

International Semiconductor Laser Conference, IEEE, Atlanta Inn, Atlanta, Ga., Nov. 18–20.

Communications Transmission Seminar on Wideband Analog Cable Systems, IEEE and Princeton University, Princeton, N.J., Nov. 19.

Specialist Conference on Technology of Electroluminescent Diodes, IEEE, Atlanta Inn, Atlanta, Ga., Nov. 20-21.

NOW THERE'S A MASS-PRODUCED LASER TO TAKE YOU TO YOUR MARKETS ECONOMICALLY.

Spectra-Physics, the world's leading laser manufacturer, has achieved the breakthroughs necessary to mass-produce a high-quality laser that meets all the requirements of a true system component.

The Model 136 is priced 30% to 40% below most other low-cost helium-neon lasers. It culminates three years of intensive research, development, and testing by Spectra-Physics. Its introduction marks a turning point in laser reliability and in the ease with which lasers can be set to a precise power level, installed and aligned in equipment. In most applications you never have to touch it again for the useful life of the system.

This revolutionary laser is inexpensive, precise, and reliable. It is easily adapted to a large variety of applications with minimum technical and packaging involvement by the system manufacturer. These applications include products for the home, business, and industrial use—video record players, recorders, optical copiers, scanners, pollution monitors, industrial measuring instruments and alignment systems.

Instead of a bare, fragile tube, you get a hermetically-sealed metal cylinder only 1⅓ inch in diameter and less than a foot long. It contains the tube, beam power control, shock mounts, thermal stress reliefs, ballast circuit, and safety ground. The Model 136 has been designed to operate reliably in the toughest of environments—it even works under water.

You can adjust output power from less than 1mW to more than 2mW, with full consideration of all applicable safety regulations. To assure interchangeability with little or no realignment, the beam is concentric within 0.05 millimeters of the package's precision alignment surfaces.

Typical continuous operating life is more than 20,000 hours—twice that of most other lasers and electronic products. And this laser requires only 6 watts from a system supply. Or you can buy plug-in subsystems with sealed power supplies that draw less than 0.2 amps from a 115V AC line or less than 9 watts of battery power.

Yet the Model 136 is priced under the so-called economy lasers that are less precise, less reliable, and less efficient. Its low cost results from our ability to mass-produce it without compromising performance.

The Spectra-Physics Model 136—whether you buy it in small quantities, in OEM discount volumes, or customized to meet your special needs, it's the only laser that can take you to your markets, economically.

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Designers'

Toggle Switches
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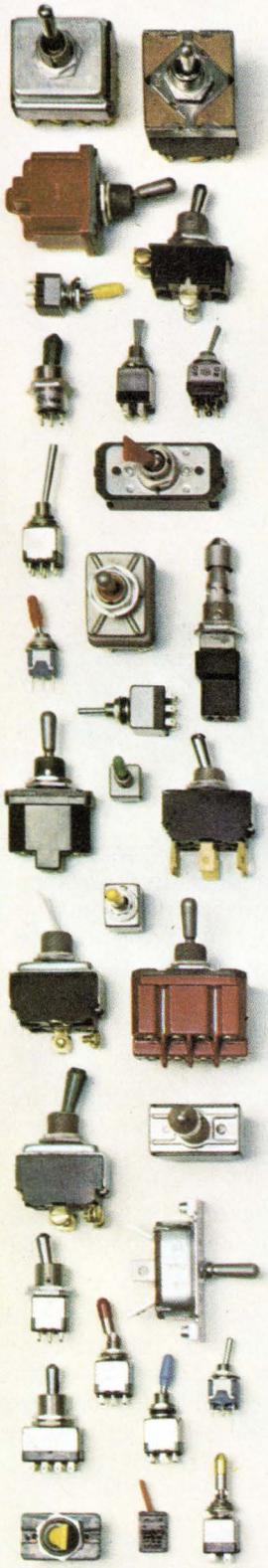
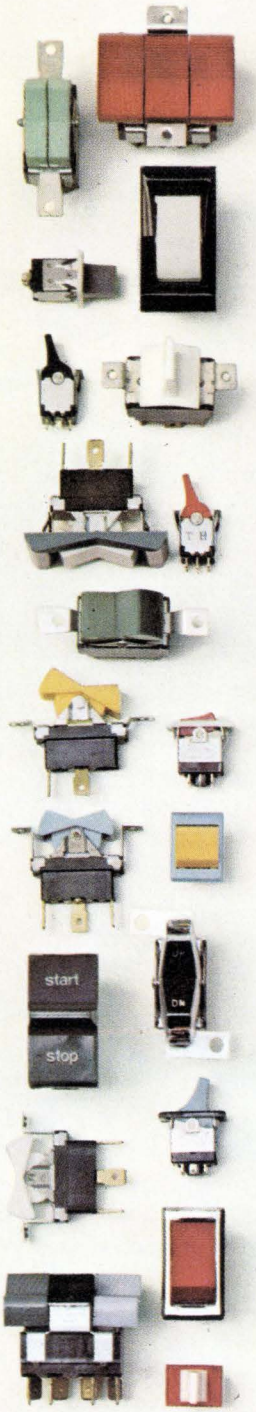
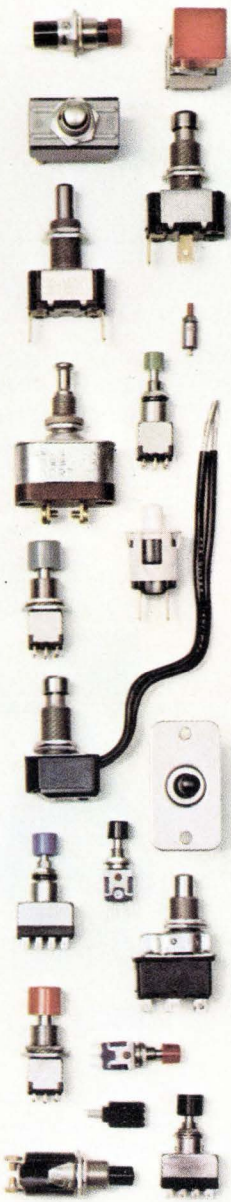


Rocker Switches
Singles and multiples. Wide, colorful selection range. Legends, too.

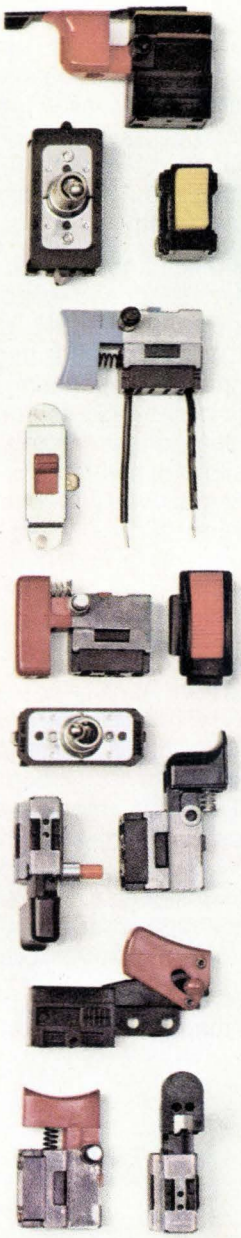


Cutler-Hammer, of course! The broadest line. Styled to meet today's and tomorrow's requirements. They're solid quality, look great, work long and hard. Carried in stock for local availability by Switch Distributors. Backed by Cutler-Hammer sales engineers who can deliver innovative design help for

Pushbutton Switches
Choice of sizes, colors, circuits, ratings. Styled to "turn you on".



Tool Handle & Slide Switches
Variable speed, reversing. Double insulated.



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It's no wonder so many designers specify Cutler-Hammer. For quality, reliability, availability, and style. For commercial, industrial, and military applications.

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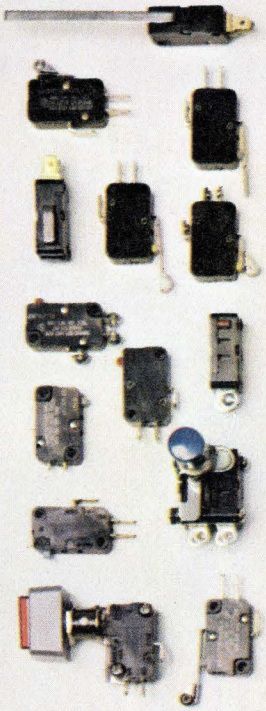
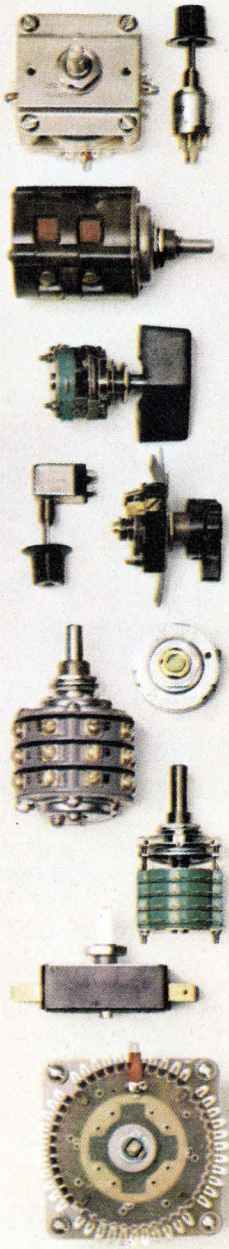
Lever, roller, leaf, and pushbutton actuators. Four terminal styles.

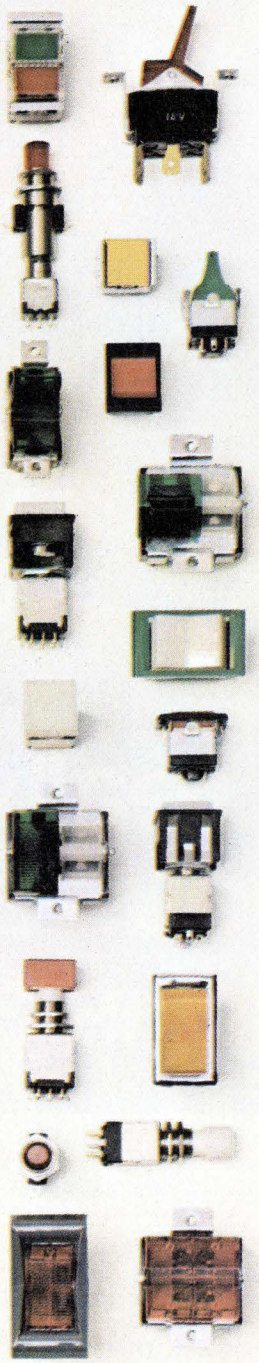


Switch Accessories
Guards. Boots. Seals. Caps. Decorator facenuts. And much more to protect, code or customize.

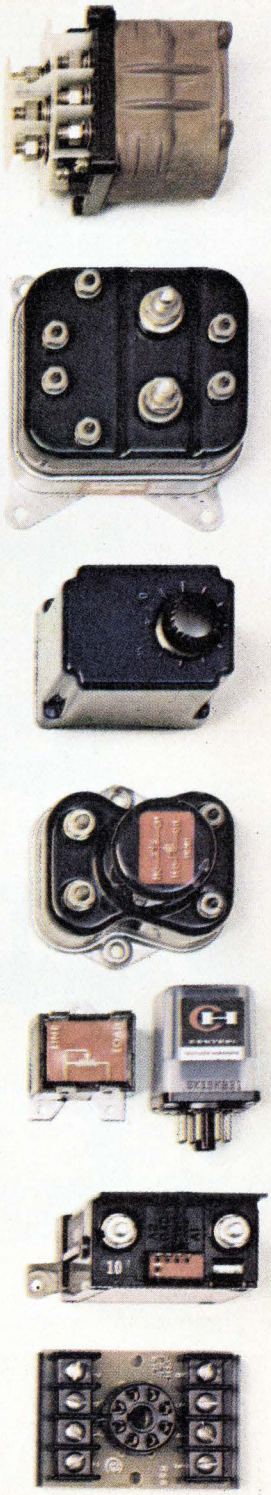
Rotary Switches
Precision and general purpose. Single and multiple wafer.



Illuminated Switches
Rockers, paddles, pushbuttons, indicators. Snap-in and bushing.



Relays
Hermetics, non-sealed, potted. Power, latching, and timing functions.



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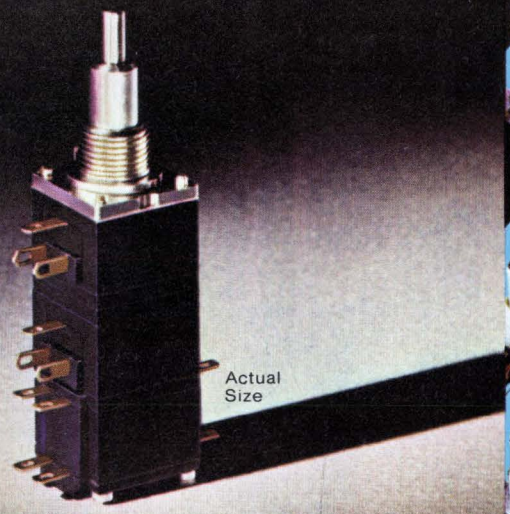
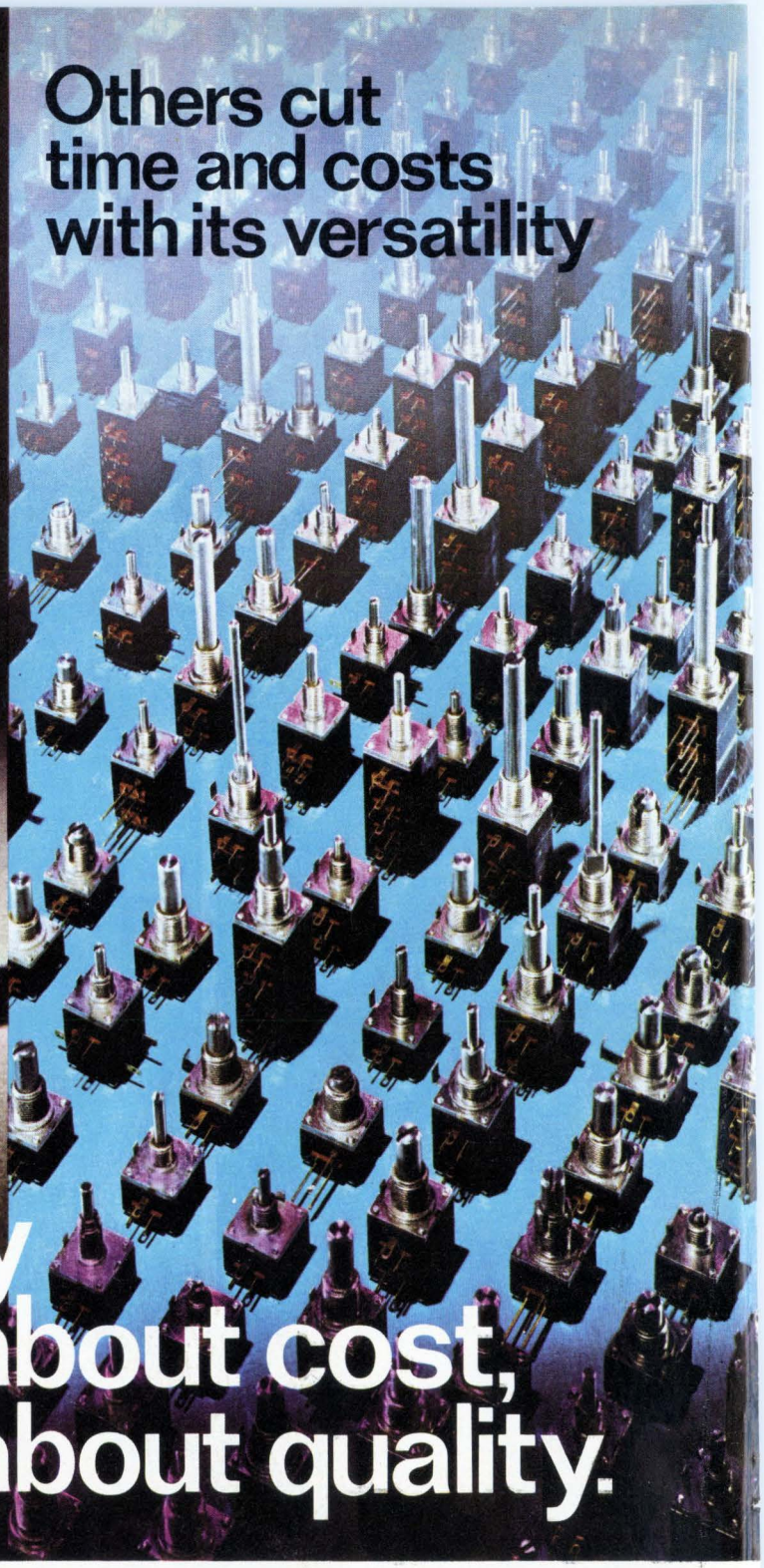
SPECIALTY PRODUCTS DIVISION, Milwaukee, Wis. 53201

Circle 23 on reader service card

Some people buy our MOD POT® just to save panel space



Others cut time and costs with its versatility



If you're really serious about cost, be serious about quality.

The first square deal in potentiometers. Compact size solves the shrinking panel space race. Modular design saves the extra charges and delays many manufacturers add for non-standards. MOD POT offers a whole family of pre-engineered, pre-tested modules that combine to form millions of single, dual, triple and quadruple section controls. Cermet or hot-molded composition resistance elements, switch options and vernier drives with single or concentric shafts. Solder terminals or .100 grid pin terminals. Backed by the fast delivery of our distributor assembly MOD POT ACTION CENTERS. Ask for Publications 5217 and 5217S. At your Allen-Bradley electronics distributor, or write: Allen-Bradley Electronics Division, 1201 South Second Street, Milwaukee, Wisconsin 53204. Export: Bloomfield, New Jersey 07003. Canada: Allen-Bradley Canada Limited, Cambridge, Ontario. United Kingdom, Jarrow, County Durham NE32 3EN.

A-B QUALITY **ALLEN-BRADLEY**
Milwaukee, Wisconsin 53204

Circle 24 on reader service card

DEC to sell LSI PDP-11 from new division

The new LSI minicomputer to be added to Digital Equipment Corp.'s PDP-11 line will be introduced before the end of the year. **Significantly, it will be marketed by DEC's new Components Group in Marlboro, Mass.,** which markets minis in large quantities with little software support. The microprocessor chips for the new computer will come from Western Digital Corp. The one-board processor will be compatible with the PDP-11/15, the low end of the line.

Sylvania buys Philco-Ford TV

GTE Sylvania, ranked seventh in Share of the 1974 model-year color-television market, **has acquired Philco-Ford's domestic Philco name and distribution rights.** Both companies reported the deal two months after talks between Philco and Sylvania's parent, General Telephone & Electronics Corp., Stamford, Conn., fell through. The new deal is different in that GTE was after Philco's plants in Canada, Brazil, Mexico, and Argentina, while **Sylvania, primarily a U. S.-only operation, wants only Philco's domestic home-entertainment organization.**

Solid State plans return to memory by end of year

Look for Solid State Scientific Inc. to reenter the memory-products market by the end of this year. Walter F. Kalin, the company's C-MOS marketing manager, says two C-MOS RAMs will get a new push; one will be in a 64-by-4 layout and the other will be 256 by 1. **Solid State Scientific introduced the same devices last year, then let them slide because of "other priorities."**

Benrus to drop Optel LCDs

Benrus Corp. is breadboarding components from several sources in **the first phase of an effort to assemble its own digital-watch modules.** Benrus now buys its liquid-crystal-display modules from Optel Corp., Princeton, N. J., but the watchmaker expects to drop Optel when it gets its parts sources lined up and its assembly line in shape. The move, sources say, is for reasons of economy. The Benrus-assembled LCD model will include a full-time backlighting feature, developed by Benrus' Technipower Inc. subsidiary in Ridgefield, Conn., Benrus expects to make the switch about February.

H-P minis house 32-bit processor

A 32-bit bipolar microprocessor chip set provides 176 instructions for a new family of four minicomputers from Hewlett-Packard. The machines, part of the HP3000 series, are aimed at distributed-computer networks, as well as buyers of single dedicated computers. **H-P hopes the new family will crack the lucrative business-machine market.** Designated the 50CX, 100CX, 200CX and 300CX, they are priced 10% to 15% below earlier HP3000 models. They range from $99,500 for the 50CX to about $200,000 for the 300CX.

These interactive systems have a new common multiprogramed operating system that features spooling, virtual memory, and a communications subsystem link from each CX to larger computers, as well as to each other. The system 50CX, the starter system, comes with a processor, a 98,000-word memory, a 5-megabyte moving-head disk file, 800 bits-per-inch magnetic-tape unit, a system console, and a 16-port asynchronous terminal controller. The top of the line 300CX includes a

131,000-word memory and an expandable 2-megabyte swapping disk, a 47-megabyte disk file, plus a new 1,250-line-per-minute printer and card reader/punch.

AT&T installs its first credit phone

AT&T's first Transaction system, the company's entry in the telephone credit-verification market, has gone into service at Central Trust, a bank in Cincinnati. The basic Transaction phone, developed by Bell Laboratories, doubles as a regular business phone. **It's due to become widely available in the second quarter of next year**

AMS n-RAM has RCA as second source

The battle between makers of the 4,096-bit RAM will become a bit more intense in December and January, when Advanced Memory Systems Inc. and RCA enter the fray. AMS has been making a 4-kilobit p-channel RAM, but will unveil its AMS 7004 n-channel part by the end of the year. The Sunnyvale, Calif., firm has chosen the 22-pin package used by Texas Instruments and Intel Corp., and **the AMS part will have an access time no greater than 200 nanoseconds.** It will run as fast as 120 ns when driven at 15 volts in a double-ended configuration. AMS and RCA have a business relationship that includes mask and process exchanges, and RCA is expected to have its version of the AMS 7004 ready for January introduction.

Addenda

Intersil Inc. plans to introduce in the first quarter of 1975 a C-MOS microprocessor chip set **designed around the software and instruction set of Digital Equipment Corp.'s PDP-8 minicomputer.** . . . Intel Corp. will offer **a very-high-speed version—200 nanoseconds vs 500 ns—of its static 1,024-bit n-channel MOS RAM** as part of a broadening of its static RAM line. Included are three 256-by-4 configurations for microprocessors where longer words are desired . . . the Army's Tacfire program for automated artillery control [*Electronics*, Aug. 2, 1973, p. 44] is finally approaching the production stage, some 18 months late. The Data Systems division of Litton Industries is looking for **limited-production approval from the Army in February** for the first 14 systems. . . . Motorola's Semiconductor Products division is sampling its M-6800 microprocessor family, and will introduce the six-chip set this week [*Electronics*, March 7, p. 29]. **Quantities of each chips are in inventory,** and considerable software support is available. . . . Another shot is being taken at a flat TV screen. Westinghouse Research Laboratories, Pittsburgh, Pa., has developed a six-inch-square glass screen coated with a phosphor triggered by deposited thin-film transistor circuits. **Resolution of the prototype is 20 lines per inch,** and the panel—as thick as a pane of glass—consumes 250 milliwatts. . . . The Navy, seeking to replace the miles of copper cable aboard each ship, **has awarded a $2 million contract to Autonetics to develop a multiplex system.** To interface with all a ship electronics, the so-called Ships Data Multiplex System would be reduced to four multiplexed cables. Autonetics, a Rockwell International group, is to deliver an advanced development model by next August.

These new Unitrode 300V power darlingtons

perform like this

I_C A	V_{CEO}† V	h_{FE}	$V_{CE\ (sat)}$ V	Type No.	Package (Modified)	Polarity	Power Dissipation 100°C Case W
2	300	1000 @ $I_C = 1A$	1.5* @ 2A	U2T103	TO-33	NPN	5
2	300	1000 @ $I_C = 1A$	1.5* @ 2A	U2T203	TO-66	NPN	20
5	300	1000 @ $I_C = 3A$	1.5* @ 5A	U2T303	TO-3	NPN	50

†V_{CEO} measured at 10 mA *Forced gain = 100

and...

Like all Unitrode Power Darlingtons these new 300-volt units exhibit the lowest saturation voltages available.

Like all Unitrode Power Darlingtons their short turn-on and turn-off times mean unusually high efficiency in fast-switching applications.

Like all Unitrode Power Darlingtons they give you greater savings in design and assembly time and lower component cost than is possible with discrete components.

Like all Unitrode Power Darlingtons they are planar for the highest reliability and stability.

Unitrode's full line of Power Darlingtons includes PNP and NPN transistors and a wide choice of characteristics in single and dual, mixed or matched, units.

Send for complete details on the entire line of Unitrode Darlingtons. For faster action, call Peter Jenner at (617) 926-0404. Describe your application on your company letterhead and we'll send a suitable sample.

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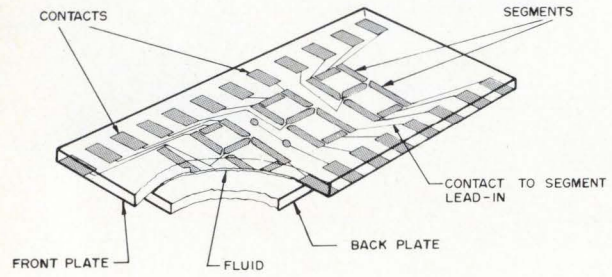
580 PLEASANT STREET, WATERTOWN, MA 02172

The case for Liquid Crystal Displays

Dynamic Scattering or Field Effect

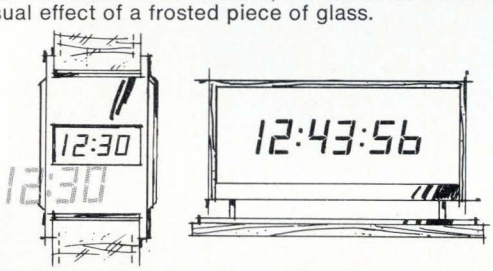
Liquid Crystal Displays; light emitting diodes; incandescent and fluorescent displays and "Nixie" tubes are becoming solidly established in circuit design as the trend to digital readout continues. The design engineer faces an unusually formidable task in determining the type of display most suitable and practical for his product. We make liquid crystal displays — dynamic scattering **and** field effect.

The display of the future? Our displays are as sandwiches of two glass plates, spaced typically about .0005″ apart with a nematic liquid crystal solution between them and hermetically sealed at the perimeters.



How they work. When the liquid is not electrically excited, its long cigar-shaped molecules are parallel to one another in a position perpendicular to the plates. The liquid appears transparent. When an electric current is applied, ion activity of the molecules leads to turbulence causing the liquid to scatter incident light. Depending on the type of nematic liquid used, either a dynamic scattering or field effect display results.

Dynamic scattering. We use a nematic liquid crystal solution in our dynamic scattering displays. This nematic liquid crystal is conductive, has negative dielectric anisotropy, and is oriented in either a homeotropic or homogeneous alignment. In either case the liquid is clear in the absence of an electric field. When an electric field is induced, the molecules scatter, giving the visual effect of a frosted piece of glass.



Field effect. These displays also utilize a nematic liquid crystal but with a different molecular orientation. The molecules are arranged in a helical stack, like a spiral staircase. The liquid is also sandwiched between two polarizers which are at right angles with each other. When current is applied the molecules rotate 90° so that they become perpendicular to the front polarizer. Light that passes through them is not rotated and therefore is absorbed by the rear polarizer. The result is a dark image on a light background. The image also can be reversed — light on dark.

Producing an image — digital or other — simply requires a conductive surface the shape of the desired image on the front glass plate. Current flowing from the conductive image through the liquid crystal to the common ground back plate causes the liquid to change from clear to a frosted appearance in the current-carrying areas.

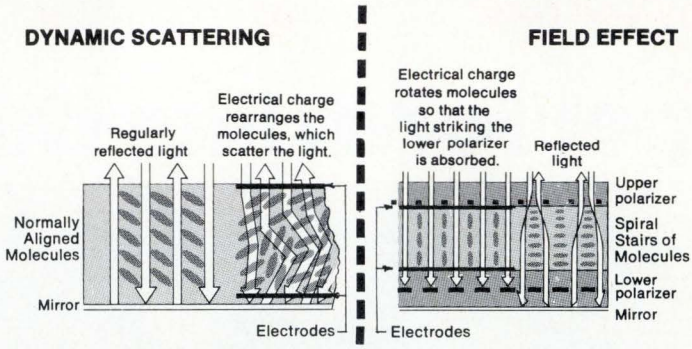
The images almost always are in the form of seven segments formed on the front glass with transparent oxide and each with its own electrical lead. Energizing the proper segments produces the desired numerals. Lead-ins connect the segments to external contacts on the sandwich (display).

Consider the advantages. Liquid crystal displays have a number of distinct advantages. Simplicity is the reason for several of these. The elements are few and passive — very little can go wrong with an LCD and this means reliability and long life.

Simplicity means low cost too — lower than that of most similar displays. Packaging costs are low because LCD's can be driven directly by MOS and C/MOS circuits. Very narrow character widths are possible and still provide a good viewing angle — 60 degrees in many cases.

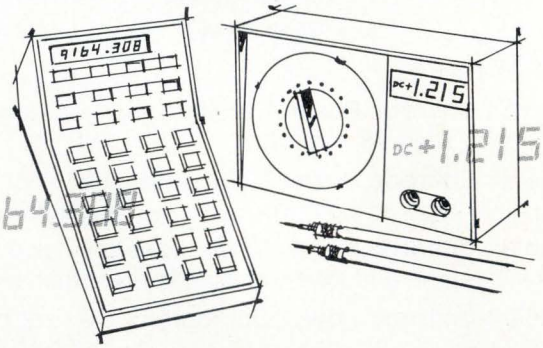
Low power consumption makes LCD's a logical choice where power limitations rule other displays out. They do not generate light as do other displays so use no power for that purpose. Watch type field effect LCD's use only 3 μW. for example with all segments energized at 7 Volts.

LCD's offer the greatest flexibility of any display type. Several standard displays, dynamic scattering or field effect, are immediately available from Hamlin's stock. Special displays with virtually any type of image can be produced with surprisingly low preparation or "tooling" cost. Because of the LCD's simplicity, lead time on specials is only a matter of weeks.



A few limitations. LCD's have limitations too. Operating temperature range is one. Liquid crystals slow down and may even cease to function at temperatures below 0°C. Above 50-60°C, crystals go into solution and will not function properly. But extremes do not damage LCD's. Once the temperature returns to normal, operation is automatically resumed.

LCD's are somewhat difficult to read under low ambient light conditions. (Side or back lighting can remedy this.) Visibility under medium to high ambient light conditions is excellent.



Conclusion. In the majority of display applications, MOS and C/MOS compatibility, reliability, flexibility and low power requirements are important considerations. No other display can match the liquid crystal display on these jobs. They could be the display of the future.

And that's the case for the LCD. For specifications, and application data, write Hamlin, Inc., Lake Mills, WI 53551 • 414/648-2361. Or dial toll-free 800-645-9200 for name of nearest representative. (Evaluation samples are available at moderate cost.)

HAMLIN
INCORPORATED

1054

Broadcasters hear of all-solid-state transmitters

Westinghouse engineers have built prototype unit with 5-kW output for probable test in Chicago

Another stronghold of vacuum-tube technology appears to be falling. Transmitter designers at Westinghouse Electric Corp.'s Defense and Electronics Systems Center, Baltimore, Md., have come up with prototype a-m broadcast transmitters that are completely solid-state and produce outputs in the kilowatt range.

Solid-state circuitry has been applied to broadcast transmitters before, but mainly to the low-power control and driver stages. The high-power output stages have had to rely, for example, on vacuum-tube amplifier chains in the case of a-m radio, or klystrons in TV systems.

Westinghouse designers decline to give any specific details. Apparently, however, the development came in the group that has been regularly turning out high-power semiconductor circuits for military programs. Existence of the prototypes came to light when the company requested permission from the Federal Communications Commission to test a 5-kW a-m unit at its Chicago radio station WIND.

Industry sources, however, who have seen pictures and specifications, indicate Westinghouse may have developed solid-state devices and circuitry which promise to cover the broad frequency ranges of fm as well as a-m radio broadcasting (respectively 88 to 108 megahertz and 0.535–1.605 MHz) and even out to very-high-frequency TV broadcasting (174–216 MHz). Moreover, the circuits can also produce the high power levels required by broadcast transmitters.

Westinghouse's initial a-m broadcast prototypes supply 1 and 5 kilowatts. And they are said to be small enough to fit under a person's arm. The question of just how well the company can extend its design to produce up to 50 kilowatts permitted by the FCC and higher for overseas markets is still unanswered.

Company officials say a decision whether to manufacture and market the solid-state transmitters will follow completion of the Chicago tests. Nevertheless, industry sources say the April 1975 convention of the National Association of Broadcasters at Las Vegas is where Westinghouse will unveil its new transmitters, which are also designed for unattended (automatic) operation [*Electronics,* Oct. 3, p. 88].

Acceptance. Broadcasters' response to the Westinghouse units is expected to weigh heavily with the company when it decides whether or not to get back into the transmitter market that it quit after World War II. Its own marketing staff reportedly sees a "fantastic potential" for international sales in an industry where broadcast transmitters generate $100 million in sales annually. Moreover, industry officials familiar with the Westinghouse units and their specifications are enthusiastic. "It will revolutionize the transmitter industry," contends an NAB source.

Says an RCA Corp. engineering specialist in transmitter R&D: "If they can produce a completely solid-state transmitter that is cost-effective over the entire broadcast range, then Westinghouse has achieved a considerable advance."

Cost-effectiveness is the key phrase, of course, since transmitter unit prices are high—up to several hundred thousand dollars—and annual production runs number in the hundreds, facts often obscured when industry volume is expressed in dollars only. □

Displays

Conic sections yield fancy graphics

Although cathode-ray-tube displays of graphic materials can be fairly complex, they're really only collections of extremely short straight lines presented so close together that the eye sees them as curves. But a new graphics terminal relies instead on the curved segments of conic sections to represent the curves needed for, say, computer-aided design or for fitting lines to experimental data points.

The result is a graphics terminal that can reproduce far more complex and attractive shapes, yet, its developers say, requires 10 to 100 times less memory storage to do it. Called the Conographic-12, it was originally designed by a small company with the Conographic name. But it's now being produced by the Industrial Products division of Hughes Aircraft Co., Fullerton, Calif., which rescued the developer

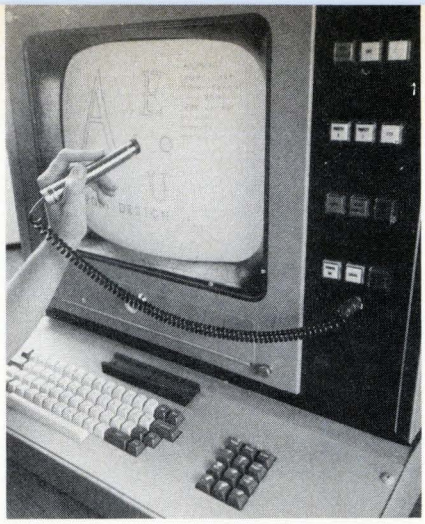
from financial difficulties last year.

In the traditional method, the shorter the line segments, the more nearly perfect the approximation to a desired curve, but the more data required to generate that curve. Thus, relatively large amounts of data have to be stored in a computer memory and require a correspondingly long time to process. Such processing may, for example, compute a change to the pattern, or it may only transmit the pattern from the main memory to the display unit, for transformation into the actual display medium through the deflections of an electron beam.

The Conographic display, on the other hand, approximates curves with segments of a circle, ellipse, parabola or hyperbola. Only four parameters—for example, two end points and the slopes of the curve at these points, or three points and the slope at one of them—are required to define one of these segments. Additional data specifies the size of the segment and its location on the CRT, just as in conventional displays. From a series of these curves any complex curved pattern can be put together. While each small piece requires four parameters instead of two (its end points) for a straight line, many fewer small pieces are necessary, thereby yielding a large net saving of memory capacity.

Weather service. Data from the computer can be translated directly into the four parameters for each conic section segment by the display's curve generator, a special-purpose transistor-transistor logic processor. Or one coded character from the computer in Ascii can trigger a read-only memory to produce several sets of parameters which trace out the letter or digit on the display screen. The display can be of the simple kind normally seen on CRTs, or much more elaborate. For example, the U.S. Weather Service is using the display "to generate a geopolitical map of the entire United States from a single control character in memory," says Fred A. Jancewicz, Conographic marketing manager at Hughes.

Such a map is complete with state lines, major topographical features, and other reference data. Symbols representing wind and cloud conditions are also stored and called out. One Ascii code character is used for each symbol, and two numbers specify its position on the map. In addition, lines of equal temperature (isotherms) and equal pressure (isobars) can be plotted as well.



Display. Conic sections produce high-quality characters, yet take up less memory.

Conventional graphic displays can draw weather maps, too, out of straight lines, but need so much more memory and processing that storing a map and calling it out with a single control character from the computer is impractical.

The basic price of a Conographic-12 is $13,300. This includes the curve generator and about 1,000 16-bit words in a read-only memory from which the curve generator traces out the 96 standard Ascii characters. The terminal has room for about 4,000 of these words—as masked or programable read-only-memory chips.

An optional core memory is also available for $3,900. It includes a power supply that can be loaded under program control with the necessary data. □

Word processing

Xerox debuts 'smart' typewriter

Xerox Corp., the copying-machine giant, entered the automatic typewriter market last week with a word-processing system designed to operate primarily under electronic, rather than electromechanical, controls. The new Xerox 800 can pound out up to 350 characters per minute, asserts Xerox, or twice the speed of the system IBM has built around its electromechanical Selectric typewriter. Since most of the 150,000 automatic typewriters in the U.S. use the IBM Selectric and its rotating "golf ball" print head, comparison between the IBM and Xerox units is inevitable. Olivetti Corp. of America, another competitor, uses one of its own typewriters in its word-processing system.

In the Xerox 800, electronic servos position the printing head and its carrier, while in the Selectric, mechanical linkages position the ribbon carrier, printing head, and platen. The Selectric, which has changed very little since it was first introduced in 1960, types out 14.8 characters per second, or about 175 words per minute. Also, the 800's magnetic-card capacity is 72 lines with 150 characters per line, or 10,800 characters, the equivalent of a full legal-size page, whereas the storage capacity of IBM Mag Cards is 5,000 characters.

Wheel invention. The most obvious difference in the Xerox typewriter, however, is its printing head. The 800 uses a flexible-spoke printing wheel with 88 characters. Type characters are affixed to the end of each spoke. A servo rotates the wheel, under command of the system logic, to bring the proper character into printing position. The printing wheel appears to have been adapted from Diablo Systems Inc.'s HyType I serial terminal printer, apparently after Xerox acquired Diablo a few years ago. However, the Diablo "Daisy" printing wheel has been strengthened to make it wear better, and several new features have been designed into the printer mechanism, such as a keyboard-tension adjustment, to enhance its typing functions.

A "reverse printout" feature eliminates the conventional carriage return. After typing a line from left to right, the carriage drops to the next line, then prints from right to left.

The 800 will be marketed in four configurations to meet customers' preferences for double or single magnetic-card or magnetic-tape cassettes. First orders will be taken this week in Dallas, where the system has been test-marketed. Deliveries to customers are expected to begin next month in Dallas and Houston. Raymond A. Hay, executive vice president and president of the company's United States operations, would not disclose specific long-range marketing plans, except to say that the new system is scheduled to be available in other major metropolitan areas throughout the U.S., as well as in Canada and some European countries, before the end of 1975.

Lease alone. He said the equipment initially will be marketed by lease only, with prices ranging from $210 to $310 per month, depending on configuration. Xerox also will market supplies, such as ribbons, cards, and tapes. The lease prices are roughly comparable to IBM lease rates.

As for the selling price, Hay says it will be determined "when we have a little more experience with the machines, probably next year." The delay, some industry observers speculated last week, also may give IBM time to respond with a new automatic-typing innovation of its own. "I would find it very difficult to believe," says one source, "that IBM wasn't waiting in the wings with something that would put it into another generation of automatic-typing systems." □

Solid state

Fairchild shifts MOS task to Longo

The burden of putting Fairchild Semiconductor profitably into the MOS business has been placed on the shoulders of its vice president and group general manager of integrated circuits, Thomas A. Longo.

The MOS Products division general manager—Philip R. Thomas—has been removed from direct responsibility for the division's operation and is on "staff assignment for Longo." Thomas joined Fairchild 18 months ago, in April 1973, when he was recruited from General Instrument Corp. to run Fairchild's MOS division.

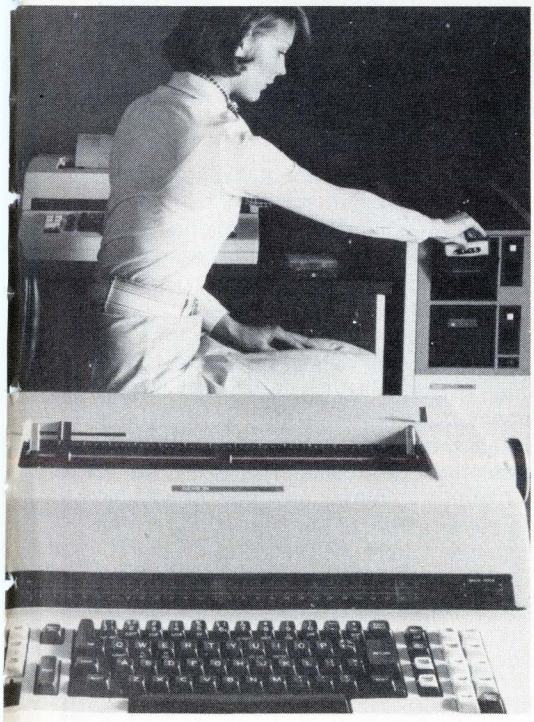
The change suggests a continuation of problems with Fairchild's MOS effort. Thomas' predecessor, Roy H. Pollack, left Fairchild in February 1973, after about one year. At that time, Pollack's departure was considered a reaction to Fairchild's reorganization, which brought the MOS group under Longo's umbrella.

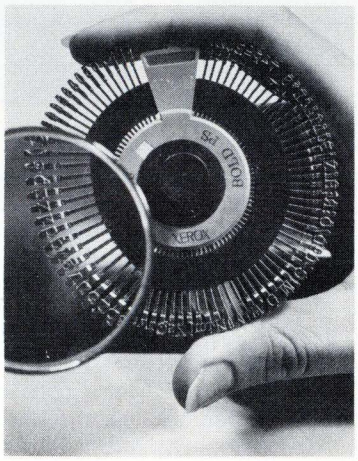
As matters stand, the MOS division has never been successful in marketing standard products—even though Fairchild's MOS technology has always been considered first-class. For example, Fairchild has never developed a standard calculator product, although the division has produced some noteworthy custom-MOS calculator circuits—most notably a calculator chip with printer for Olivetti.

In memories, Fairchild developed its own improved version of the 1103-type 1,024-bit p-channel random-access memory—the 3574 [*Electronics*, Aug. 28, 1972, p. 68]—but apparently too late to penetrate the already established 1103 market. Fairchild's only other memory products in volume production are shift registers and first-in first-out memories.

New start. Proprietary products now intended to erase the past and establish MOS as a long-term business for Fairchild include the F-8—a second-generation 8-bit n-channel microprocessor; a high-speed version of Mostek's 16-pin 4,096-bit n-channel RAM; high-speed versions of the 1103, and the popular 2102 static n-channel RAM; a proprietary 22-pin 4-kilobit RAM, and a broad line of charge-coupled-device memories [*Electronics*, July 25, p. 36]. These products have not yet appeared in volume production, although Longo says they are "on schedule."

The process that Longo expects will give Fairchild a competitive edge in MOS is Isoplanar, the technique that uses oxide isolation to boost speed and lower costs by allowing higher circuit-packing density and higher yields. In contrast, most manufacturers have stayed with the more conventional ion-im-





Word machine. New electronic typewriter with rotating typing wheel is key to automatic typing system from Xerox Corp. Typewriter is more reliable because of fewer moving parts, and it types 350 words per minute, said to be twice as fast as the competing machine from IBM.

plantation process to achieve the same goals.

Longo says the problem Fairchild is facing is not one of development, yields, or production. It is a problem of transition. "The transition from the laboratory to the production line to the market place is the most difficult period in the history of any product," Longo says. "That is the case with our MOS effort as well—only more so.

"Not only are we in the process of introducing a number of new products, we are also introducing several new technologies in each one. In addition to blending these two efforts smoothly, we have to be geared into high volume and market them in such a way as to realize a profitable return as soon as possible."

The importance of the job was such that Longo finally came to the conclusion that he could delegate it to no one. "It is an effort of such importance to Fairchild that I felt it was necessary to take over direct responsibility myself," he says. □

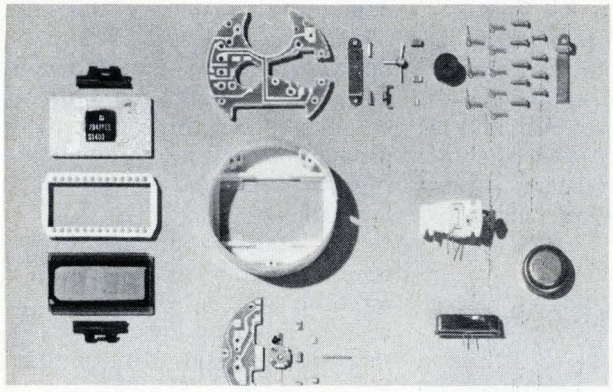
Computers

Data General moves up from minis

Technical innovation in minicomputers has made a name for Data General Corp. since the company was founded six years ago. And that reputation is enhanced now that the company has graduated into the small-computer market. In its new Eclipse series, Data General has introduced machines capable of a high level of error correction and a novel architecture based on a cache memory. The cache, however, differs radically from the cache used in some large computers.

The error-correcting capability is based on a modification of the Hamming code, which requires five check bits to be added to every 16-bit word in the memory—a much larger proportion than is required by similar codes in large computers. It has therefore never been tried be-

Digital watches on the move



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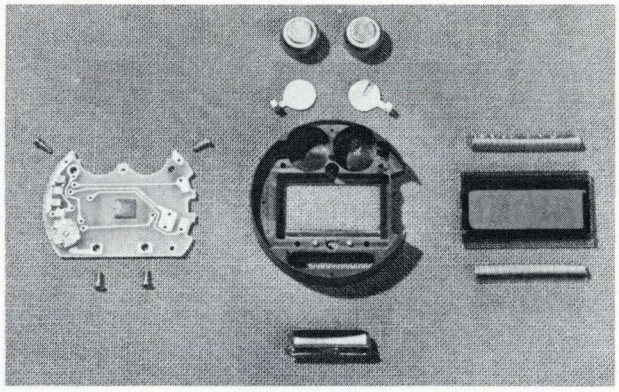


AFTER

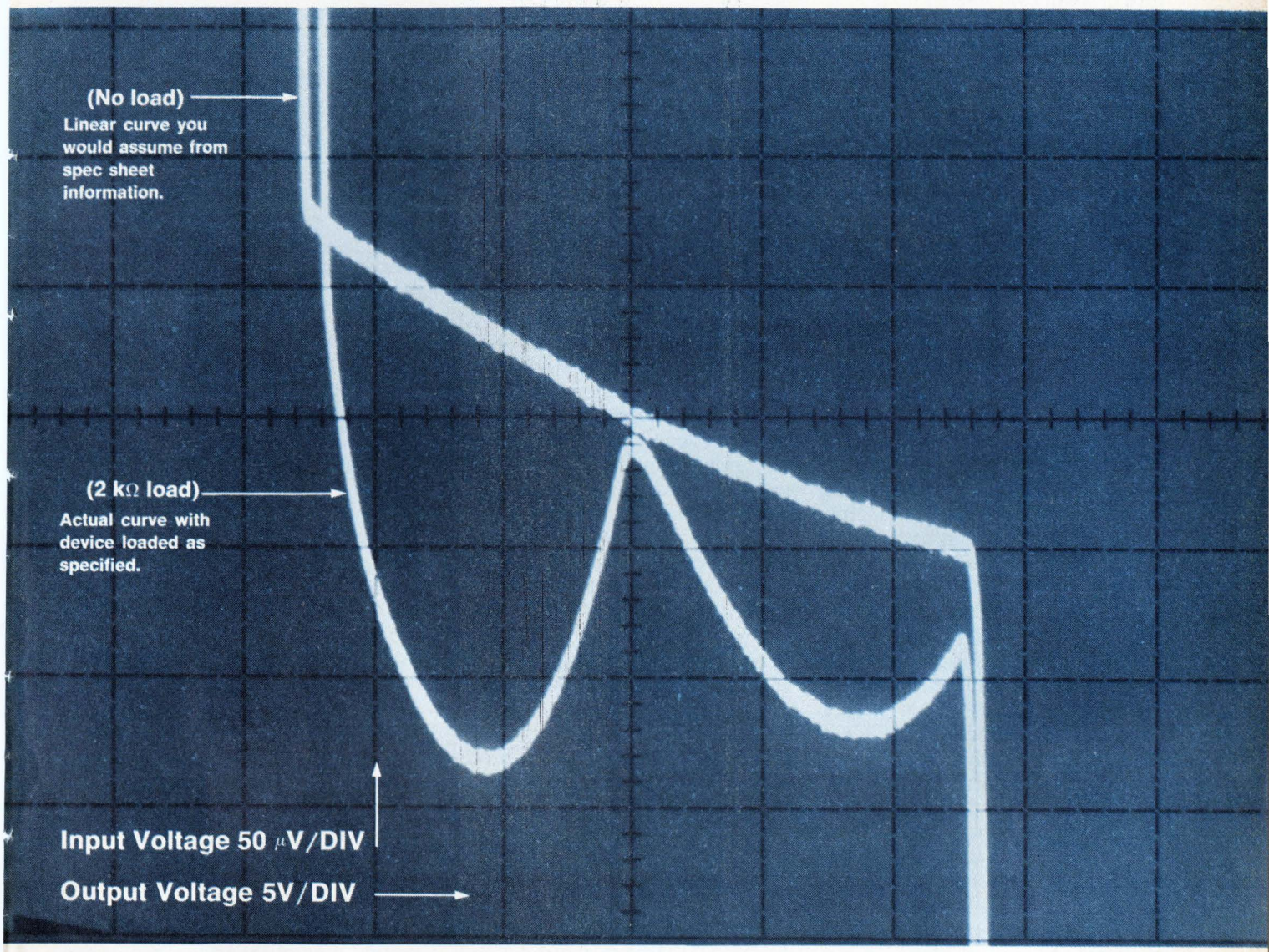
American Microsystems Inc. has begun an all-out campaign in the digital-watch module market with a redesigned unit that's smaller and uses almost half the power of earlier modules. Between now and next February, six new products will be available for OEM sales. The first, the Compact Watch Module (above right), replaces the Hours Minutes Module (at the left). The CWM shrinks thickness by 30% and power consumption by 42% compared to the older module, and should cost about 25% less. Its C-MOS logic and driver chip is not packaged on a circuit board, as before, but directly on the substrate. It also uses two thin nickel-cadmium batteries instead of a single thick one, and a simplified mounting for the 3-volt field-effect liquid-crystal display that reduces interconnects. A transformer and a switch assembly are eliminated completely.

AMI is also developing a new liquid-crystal material that promises to reduce power needs of future modules to 1.5 V. The older module has a single 5-V cell and consumes 12 microamperes. The CWM has two 1.5-V cells and consumes 7 μA. Component count has been cut from 45 to 23, total interconnects from 51 to 21.

Following the recent announcement of National Semiconductor's entry into the digital watch business [*Electronics*, Oct. 3, p. 52] and an expected entry soon by Texas Instruments, AMI's plan increases the likelihood of a digital watch market dominated by semiconductor manufacturers. However, the Santa Clara, Calif.-based AMI has emphasized that its line will be for OEM sales, largely because the company does not have the marketing and distribution organization for consumer product sales. By comparison, as a company spokesman points out, handheld calculators created an entirely new market with no established selling pattern. The solid-state watch, on the other hand, is bucking an entrenched retailing structure.

Other models due from AMI are a back-lighted display version of the CWM, a ladies' module, a LED display type with a simplified setting mechanism, a six-digit time-date-second LCD model, and a four-digit time-date-second unit.

The spec sheets tell you what should happen.



The 577 shows you what did.

When you're designing circuits using linear IC's, you count on spec sheets for the information you need. Generally, gain, CMRR and power supply rejection ratio are given as the ratios of voltage changes measured between discrete points. You assume a "linear" integrated circuit has a linear gain curve (a straight line) with no spurious excursions. But an actual device operating in real-life conditions isn't always linear. Often it produces very irregular curves that may make a big difference in your finished circuit.

These irregular curves are hidden from meters, digital read-outs and go no-go indicators. In fact, a Curve Tracer with its CRT display is the only way to see what is actually happening across the entire operating range of the device you're testing.

The Tektronix 577/178 Curve Tracer will measure and display gain. Offset voltage. Input bias current. Common-mode rejection ratio. And power supply rejection ratio. In addition, the 577/178 displays thermal effects. Popcorn (or flicker) noise. And parameter nonlinearities. And the 577/178 has a storage display to retain curves for comparison or detailed evaluation. Yet it costs only $3100.

For demonstration circle 32 on reader service card
Circle 33 on reader service card

To learn about the pitfalls of linear IC performance and measurements write to Tektronix for pamphlets No. A3040, and A3061. For more information contact your local Tektronix Field Engineer, or write Tektronix, Inc., P.O. Box 500, Beaverton, Oregon 97077. In Europe write Tektronix Ltd., P.O. Box 36, St. Peter Port, Guernsey, Channel Islands.

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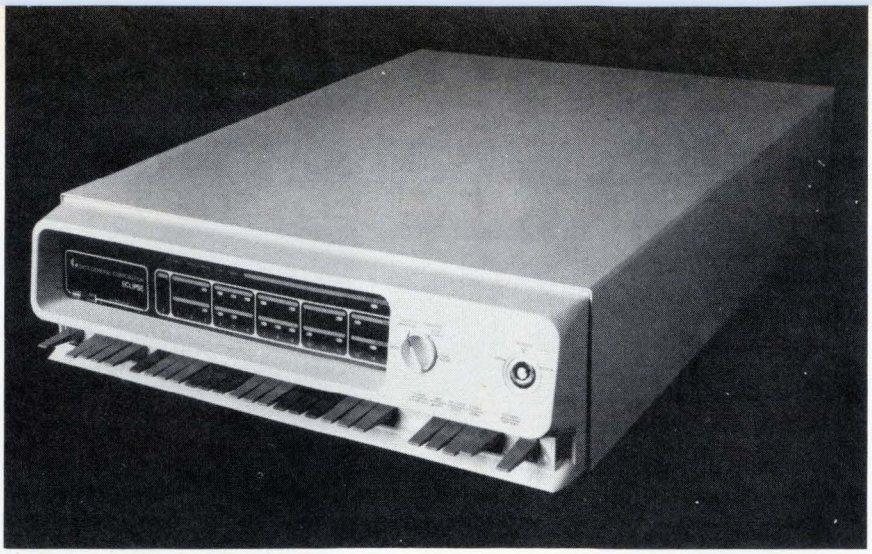

More power. Small computer introduced by Data General Corp. is first of its size to feature error correction capability as well as cache-memory architecture.

fore in small computers.

In the Eclipse series, however, error correction, an optional extra, is justified because the five check bits are only three more than what simple parity for the two eight-bit bytes would require (earlier Data General computers had no parity checking at all). Thus its cost is not excessive.

Cache. The other big innovation in the Eclipse computer is the cache memory—a relatively small, fast buffer memory that stands between the central processor and the main memory. Whenever the processor calls for a word from the main memory, a hardware algorithm transfers not only that word but also a block of adjacent words into the buffer. Then, when the processor requests the next word, it is probably already in the buffer, so that it gets to the processor more quickly than the first word did.

In general, the cache contains several blocks, possibly from widely separated areas of the main memory. In a well-designed system, more than 90% of the words requested by the processor are found in the cache, thus sharply increasing the system's performance over the level it would have if all data had to come from the main memory.

Cost-effective use of cache memory in large computers requires it to be many times faster than main memory and to contain thousands of words grouped in blocks of several hundred words. But in the Eclipse series, the cache memory has a total capacity of only 16 words per semiconductor module, and the blocks have four words each, reducing the average memory access time from 700 nanoseconds to 200 ns. These small sizes pay off for two reasons: First, the cache is only 3½ times as fast as the main memory, so the penalty of going to the main memory is small. Second, successive accesses to the memory tend to be localized more than usual, as the result of including a hardware-controlled stack, or "first-in-first-out" buffer, in the main memory.

The cache memory is available only with versions of the Eclipse S100 and S200 machines that have semiconductor memories. They may also have all-ferrite-core memories, or even combined chip-and-core memories in any proportion. Up to eight 800-ns core memory modules or four 700-ns semiconductor modules—each of 16,384 bytes—can be interleaved to reduce the basic cycle time by an average of 45%.

In another first for Data General, but not for the industry, the Eclipse line is microprogramed, and the microprograms are kept in a writable control store, so that the user can define his own instruction set, up to a point. A fast floating-point processor is also available as an option. This unit can add two 32-bit numbers in 2.4 microseconds—a speed comparable to that of the IBM 370/158. □

Computers oust stale cache data

No sooner had Data General Corp. brought out its new line of small computers (see preceding story) than its archrival, Digital Equipment Corp., moved in at the other end of the spectrum by adding two models, the 1080 and 1090, to its large-scale DECsystem 10 computer line. Both DEC models are based on a single new processor, the KL10, built with emitter-coupled logic.

Like Data General and a growing number of other manufacturers, DEC uses a cache memory in the new processor. The 2,048-word cache, also ECL, has an access time of 125 nanoseconds. But most computers that have a cache use it only when reading data from the memory; the write operation bypasses the cache.

This "write-through" mode avoids having stale data in the main memory and fresh data in corresponding locations in the cache. That would be dangerous, especially where the main memory is accessible to two or more processors, each with its own cache. However, independent studies of cache operation show that only 10% of the data written into a memory is used by other than its originating processor.

Update. Nevertheless, stale data can accumulate in the main memory. To avoid this, DEC has included a "cache sweep," which updates the main memory from the cache. The sweep, a 150-microsecond scan of the cache that transfers new data to the main memory while processing continues, is triggered by an instruction or by any output operation involving a peripheral unit.

The ferrite-core main memory for the 1080 or 1090 ranges from 131,072 to 4,194,304 words of 36 bits each. The memory modules, of 65,536 words, can be arranged along four independent radial buses that permit the simultaneous transfer of up to four words to or from the cache. Cycle time is 1 μs.

Both new models are identical, except for the inclusion with the 1090 of time-sharing accessories, including a disk-storage unit, to handle up to 128 different jobs (dif-

MC14000/MC14500 CMOS...

Mc MOS INTEGRATED CIRCUITS

Type No.	Description	1-99	100-999	1K-4999
MC14000AL	*Dual 3-Input NOR Gate/Inverter*	1.22	1.01	.84
MC14000CL	*Dual 3-Input NOR Gate/Inverter*	1.06	.87	.73
MC14000CP	*Dual 3-Input NOR Gate/Inverter*	.81	.67	.56
MC14001AL	*Quad 2-Input NOR Gate*	1.22	1.01	.84
MC14001CL	*Quad 2-Input NOR Gate*	1.06	.87	.73
MC14001CP	*Quad 2-Input NOR Gate*	.81	.67	.56
MC14002AL	*Dual 4-Input NOR Gate*	1.22	1.01	.84
MC14002CL	*Dual 4-Input NOR Gate*	1.06	.87	.73
MC14002CP	*Dual 4-Input NOR Gate*	.81	.67	.56
MC14006AL	*18-Bit Static Shift Register*	5.39	4.46	3.72
MC14006CL	*18-Bit Static Shift Register*	4.67	3.87	3.22
MC14006CP	*18-Bit Static Shift Register*	3.60	2.98	2.48
MC14007AL	*Dual Pair and Inverter*	1.22	1.01	.84
MC14007CL	*Dual Pair and Inverter*	1.06	.87	.73
MC14007CP	*Dual Pair and Inverter*	.81	.67	.56
MC14008AL	*4-Bit Full Adder*	5.59	4.63	3.85
MC14008CL	*4-Bit Full Adder*	4.84	4.01	3.34
MC14008CP	*4-Bit Full Adder*	3.73	3.08	2.57
MC14011AL	*Quad 2-Input NAND Gate*	1.22	1.01	.84
MC14011CL	*Quad 2-Input NAND Gate*	1.06	.87	.73
MC14011CP	*Quad 2-Input NAND Gate*	.81	.67	.56
MC14012AL	*Dual 4-Input NAND Gate*	1.22	1.01	.84
MC14012CL	*Dual 4-Input NAND Gate*	1.06	.87	.73
MC14012CP	*Dual 4-Input NAND Gate*	.81	.67	.56
MC14013AL	*Dual Type D Flip-Flop*	2.26	1.87	1.56
MC14013CL	*Dual Type D Flip-Flop*	1.96	1.62	1.35
MC14013CP	*Dual Type D Flip-Flop*	1.51	1.25	1.04
MC14014AL	*8-Bit Static Shift Register*	5.87	4.86	4.05
MC14014CL	*8-Bit Static Shift Register*	5.09	4.21	3.51
MC14014CP	*8-Bit Static Shift Register*	3.91	3.24	2.70
MC14015AL	*Dual 4-Bit Static Shift Register*	5.87	4.86	4.05
MC14015CL	*Dual 4-Bit Static Shift Register*	5.09	4.21	3.51
MC14015CP	*Dual 4-Bit Static Shift Register*	3.91	3.24	2.70
MC14016AL	*Quad Analog Switch/Quad Multi.*	2.26	1.87	1.56
MC14016CL	*Quad Analog Switch/Quad Multi.*	1.96	1.62	1.35
MC14016CP	*Quad Analog Switch/Quad Multi.*	1.51	1.25	1.04
MC14017AL	*Decade Counter/Divider*	5.87	4.86	4.05
MC14017CL	*Decade Counter/Divider*	5.09	4.21	3.51
MC14017CP	*Decade Counter/Divider*	3.91	3.24	2.70
MC14020AL	*14-Bit Binary Counter*	6.52	5.40	4.50
MC14020CL	*14-Bit Binary Counter*	5.65	4.68	3.90
MC14020CP	*14-Bit Binary Counter*	4.35	3.60	3.00
MC14021AL	*8-Bit Static Shift Register*	5.87	4.86	4.05
MC14021CL	*8-Bit Static Shift Register*	5.09	4.21	3.51
MC14021CP	*8-Bit Static Shift Register*	3.91	3.24	2.70
MC14022AL	*Octal Counter/Divider*	5.68	4.70	3.91
MC14022CL	*Octal Counter/Divider*	4.92	4.07	3.39
MC14022CP	*Octal Counter/Divider*	3.78	3.13	2.61
MC14023AL	*Triple-3-Input NAND Gate*	1.22	1.01	.84
MC14023CL	*Triple-3-Input NAND Gate*	1.06	.87	.73
MC14023CP	*Triple-3-Input NAND Gate*	.81	.67	.56
MC14024AL	*Seven-Stage Ripple Counter*	4.22	3.49	2.91
MC14024CL	*Seven-Stage Ripple Counter*	3.66	3.03	2.52
MC14024CP	*Seven-Stage Ripple Counter*	2.81	2.33	1.94
MC14025AL	*Triple 3-Input NOR Gate*	1.22	1.01	.84
MC14025CL	*Triple 3-Input NOR Gate*	1.06	.87	.73

Mc MOS INTEGRATED CIRCUITS

Type No.	Description	1-99	100-999	1K-4999
MC14046	*Phase-Locked Loop*	4th Qtr. '74 intro.		
MC14049AL	*Hex Inverter/Buffer*	2.24	1.85	1.54
MC14049CL	*Hex Inverter/Buffer*	1.94	1.61	1.34
MC14049CP	*Hex Inverter/Buffer*	1.49	1.24	1.03
MC14050AL	*Hex Buffer*	2.24	1.85	1.54
MC14050CL	*Hex Buffer*	1.94	1.61	1.34
MC14050CP	*Hex Buffer*	1.49	1.24	1.03
MC14051	*8-Ch Analog Multiplexer*	4th Qtr. '74 intro.		
MC14052	*Differential 4-Ch Analog Multiplexer*	4th Qtr. '74 intro.		
MC14053	*Triple 2-Ch Analog Multiplexer*	4th Qtr. '74 intro.		
MC14071AL	*Quad 2-Input OR Gate*	1.22	1.01	.84
MC14071CL	*Quad 2-Input OR Gate*	1.06	.87	.73
MC14071CP	*Quad 2-Input OR Gate*	.81	.67	.56
MC14076	*Quad D-Type Flip-Flop 3-State Outputs*	4th Qtr. '74 intro.		
MC14081AL	*Quad 2-Input AND Gate*	1.22	1.01	.84
MC14081CL	*Quad 2-Input AND Gate*	1.06	.87	.73
MC14081CP	*Quad 2-Input AND Gate*	.81	.67	.56
MC14501AL	*Triple Gate*	1.65	1.37	1.14
MC14501CL	*Triple Gate*	1.43	1.19	.99
MC14501CP	*Triple Gate*	1.10	.91	.76
MC14502AL	*Strobed Hex Inverter/Buffer*	3.70	3.06	2.55
MC14502CL	*Strobed Hex Inverter/Buffer*	3.20	2.65	2.21
MC14502CP	*Strobed Hex Inverter/Buffer*	2.46	2.04	1.70
MC14506AL	*Dual Expandable A.O.I. Gate*	1.65	1.37	1.14
MC14506CL	*Dual Expandable A.O.I. Gate*	1.43	1.19	.99
MC14506CP	*Dual Expandable A.O.I. Gate*	1.10	.91	.76
MC14507AL	*Quad Exclusive OR Gate*	2.22	1.84	1.53
MC14507CL	*Quad Exclusive OR Gate*	1.92	1.59	1.33
MC14507CP	*Quad Exclusive OR Gate*	1.48	1.22	1.02
MC14508AL	*Dual 4-Bit Latch*	13.68	11.32	9.43
MC14508CL	*Dual 4-Bit Latch*	11.86	9.81	8.18
MC14510AL	*BCD Up/Down Counter*	6.94	5.74	4.78
MC14510CL	*BCD Up/Down Counter*	6.01	4.98	4.15
MC14510CP	*BCD Up/Down Counter*	4.63	3.83	3.19
MC14511AL	*BCD-to-7 Seg. Latch/Decoder/Driver*	7.39	6.12	5.10
MC14511CL	*BCD-to-7 Seg. Latch/Decoder/Driver*	6.41	5.30	4.42
MC14511CP	*BCD-to-7 Seg. Latch/Decoder/Driver*	4.93	4.08	3.40
MC14512AL	*8-Channel Data Selector*	4.15	3.44	2.86
MC14512CL	*8-Channel Data Selector*	3.60	2.98	2.48
MC14512CP	*8-Channel Data Selector*	2.77	2.29	1.91
MC14514AL	*4/16 Line Decoder (Hi)*	14.96	12.38	10.32
MC14514CL	*4/16 Line Decoder (Hi)*	12.97	10.73	8.94
MC14515AL	*4/16 Line Decoder (Lo)*	14.96	12.38	10.32
MC14515CL	*4/16 Line Decoder (Lo)*	12.97	10.73	8.94
MC14516AL	*Binary Up/Down Counter*	6.00	4.97	4.14
MC14516CL	*Binary Up/Down Counter*	5.20	4.31	3.59
MC14516CP	*Binary Up/Down Counter*	4.00	3.31	2.76
MC14517AL	*Dual 64-Bit Static Shift Register*	20.66	17.10	14.25
MC14517CL	*Dual 64-Bit Static Shift Register*	17.91	14.82	12.35
MC14517CP	*Dual 64-Bit Static Shift Register*	13.77	11.40	9.50
MC14518AL	*Dual BCD Up Counter*	7.39	6.12	5.10
MC14518CL	*Dual BCD Up Counter*	6.41	5.30	4.42
MC14518CP	*Dual BCD Up Counter*	4.93	4.08	3.40
MC14519AL	*4-Bit AND/OR Selector*	2.22	1.84	1.53
MC14519CL	*4-Bit AND/OR Selector*	1.92	1.59	1.33
MC14519CP	*4-Bit AND/OR Selector*	1.48	1.22	1.02

Mc MOS INTEGRATED CIRCUITS

Type No.	Description	1-99	100-999	1K-4999
MC14531AL	*12-Bit Parity Tree*	4.81	3.98	3.31
MC14531CL	*12-Bit Parity Tree*	4.17	3.45	2.87
MC14531CP	*12-Bit Parity Tree*	3.20	2.65	2.21
MC14532AL	*8-Bit Priority Encoder*	6.20	5.13	4.27
MC14532CL	*8-Bit Priority Encoder*	5.37	4.45	3.70
MC14532CP	*8-Bit Priority Encoder*	4.13	3.42	2.85
MC14534AL	*Real Time 5-Decade Counter*	27.69	22.91	19.09
MC14534CL	*Real Time 5-Decade Counter*	24.00	19.86	16.55
MC14536AL	*Programmable Timer*	11.89	9.83	8.19
MC14536CL	*Programmable Timer*	10.29	8.52	7.10
MC14536CP	*Programmable Timer*	7.92	6.55	5.46
MC14539AL	*Dual 4-Channel Digital Mix*	4.15	3.44	2.86
MC14539CL	*Dual 4-Channel Digital Mix*	3.60	2.98	2.48
MC14539CP	*Dual 4-Channel Digital Mix*	2.77	2.29	1.91
MC14541	*Oscillator-Timer*	4th Qtr. '74 intro.		
MC14543AL	*BCD-to-7 Seg. Latch/Decoder/Driver*	7.39	6.12	5.10
MC14543CL	*BCD-to-7 Seg. Latch/Decoder/Driver*	6.41	5.30	4.42
MC14543CP	*BCD-to-7 Seg. Latch/Decoder/Driver*	4.93	4.08	3.40
MC14549AL	*Successive Approximation Register*	11.35	9.40	7.83
MC14549CL	*Successive Approximation Register*	9.84	8.14	6.79
MC14549CP	*Successive Approximation Register*	7.57	6.26	5.22
MCM14552	*64 x 4 RAM*	4th Qtr. '74 intro.		
MC14553AL	*Three-Digit BCD Counter*	15.49	12.82	10.68
MC14553CL	*Three-Digit BCD Counter*	13.42	11.11	9.26
MC14553CP	*Three-Digit BCD Counter*	10.32	8.54	7.12
MC14554AL	*2x2-Bit Parallel Binary Multi.*	4.61	3.82	3.18
MC14554CL	*2x2-Bit Parallel Binary Multi.*	4.00	3.31	2.76
MC14554CP	*2x2-Bit Parallel Binary Multi.*	3.07	2.54	2.12
MC14555AL	*Dual Binary 1 of 4 Decoder*	2.76	2.29	1.90
MC14555CL	*Dual Binary 1 of 4 Decoder*	2.39	1.98	1.65
MC14555CP	*Dual Binary 1 of 4 Decoder*	1.84	1.52	1.27
MC14556AL	*Dual Binary 1 of 4 Decoder (INV)*	2.76	2.29	1.90
MC14556CL	*Dual Binary 1 of 4 Decoder (INV)*	2.39	1.98	1.65
MC14556CP	*Dual Binary 1 of 4 Decoder (INV)*	1.84	1.52	1.27
MC14557AL	*1-to-64 Bit Shift Register*	13.05	10.80	9.00
MC14557CL	*1-to-64 Bit Shift Register*	11.31	9.36	7.80
MC14557CP	*1-to-64 Bit Shift Register*	8.70	7.20	6.00
MC14558	*BCD-to-7 Segment Decoder*	4th Qtr. '74 intro.		
MC14559AL	*Successive Approximation Register*	11.35	9.40	7.83
MC14559CL	*Successive Approximation Register*	9.84	8.14	6.79
MC14559CP	*Successive Approximation Register*	7.57	6.26	5.22
MC14560AL	*NBCD Adder*	7.07	5.85	4.87
MC14560CL	*NBCD Adder*	6.13	5.07	4.22
MC14560CP	*NBCD Adder*	4.71	3.90	3.25
MC14561AL	*9's Complementer*	2.17	1.80	1.50
MC14561CL	*9's Complementer*	1.88	1.56	1.30
MC14561CP	*9's Complementer*	1.45	1.20	1.00
MC14562AL	*128-Bit Static Shift Register*	18.60	15.39	12.82
MC14562CL	*128-Bit Static Shift Register*	16.12	13.34	11.11
MC14562CP	*128-Bit Static Shift Register*	12.40	10.26	8.55
MC14566AL	*Industrial Time Base Generator*	4.61	3.82	3.18
MC14566CL	*Industrial Time Base Generator*	4.00	3.31	2.76
MC14566CP	*Industrial Time Base Generator*	3.07	2.54	2.12
MC14572AL	*Hex Gate*	1.48	1.22	1.02
MC14572CL	*Hex Gate*	1.28	1.06	.88
MC14572CP	*Hex Gate*	.99	.82	.68

More than just a pretty price.

MC14025CP	*Triple 3-Input NOR Gate*	.81	.67	.56
MC14027AL	*Dual J-K Flip-Flop*	3.50	2.90	2.41
MC14027CL	*Dual J-K Flip-Flop*	3.03	2.51	2.09
MC14027CP	*Dual J-K Flip-Flop*	2.33	1.93	1.61
MC14028AL	*BCD-To-Decimal Decoder*	5.09	4.21	3.51
MC14028CL	*BCD-To-Decimal Decoder*	4.41	3.65	3.04
MC14028CP	*BCD-To-Decimal Decoder*	3.39	2.81	2.34
MC14032AL	*Triple Serial Adder (positive)*	5.96	4.93	4.11
MC14032CL	*Triple Serial Adder (positive)*	5.16	4.27	3.56
MC14032CP	*Triple Serial Adder (positive)*	3.97	3.29	2.74
MC14034AL	*8-Bit Universal Bus Register*	12.55	10.39	8.65
MC14034CL	*8-Bit Universal Bus Register*	10.88	9.00	7.50
MC14035AL	*4 Stage Shift Register*	5.83	4.82	4.02
MC14035CL	*4 Stage Shift Register*	5.05	4.18	3.48
MC14035CP	*4 Stage Shift Register*	3.89	3.22	2.68
MC14038AL	*Triple Serial Adder (negative)*	5.96	4.93	4.11
MC14038CL	*Triple Serial Adder (negative)*	5.16	4.27	3.56
MC14038CP	*Triple Serial Adder (negative)*	3.97	3.29	2.74
MC14040AL	*12-Bit Binary Counter*	6.20	5.13	4.27
MC14040CL	*12-Bit Binary Counter*	5.37	4.45	3.70
MC14040CP	*12-Bit Binary Counter*	4.13	3.42	2.85
MC14042AL	*Quad Latch*	4.70	3.89	3.24
MC14042CL	*Quad Latch*	4.07	3.37	2.81
MC14042CP	*Quad Latch*	3.13	2.59	2.16
MC14520AL	*Dual Binary Up Counter*	7.39	6.12	5.10
MC14520CL	*Dual Binary Up Counter*	6.41	5.30	4.42
MC14520CP	*Dual Binary Up Counter*	4.93	4.08	3.40
MC14521AL	*24-State Frequency Divider*	8.31	6.88	5.73
MC14521CL	*24-State Frequency Divider*	7.20	5.96	4.97
MC14521CP	*24-State Frequency Divider*	5.54	4.58	3.82
MC14522AL	*BCD Divide-by-N Counter*	6.46	5.35	4.45
MC14522CL	*BCD Divide-by-N Counter*	5.60	4.63	3.86
MC14522CP	*BCD Divide-by-N Counter*	4.31	3.56	2.97
MC14526AL	*Binary Divide by-N Counter*	6.46	5.35	4.45
MC14526CL	*Binary Divide by-N Counter*	5.60	4.63	3.86
MC14526CP	*Binary Divide by-N Counter*	4.31	3.56	2.97
MC14527AL	*BCD Rate Multiplier*	6.46	5.35	4.45
MC14527CL	*BCD Rate Multiplier*	5.60	4.63	3.86
MC14527CP	*BCD Rate Multiplier*	4.31	3.56	2.97
MC14528AL	*Dual Monostable Multivibrator*	4.15	3.44	2.86
MC14528CL	*Dual Monostable Multivibrator*	3.60	2.98	2.48
MC14528CP	*Dual Monostable Multivibrator*	2.77	2.29	1.91
MC14529AL	*Dual 4-Channel Multiplexer*	5.55	4.59	3.82
MC14529CL	*Dual 4-Channel Multiplexer*	4.81	3.98	3.31
MC14529CP	*Dual 4-Channel Multiplexer*	3.70	3.06	2.55
MC14530AL	*Dual 5-Input Majority Logic Gate*	2.50	2.07	1.72
MC14530CL	*Dual 5-Input Majority Logic Gate*	2.17	1.79	1.49
MC14530CP	*Dual 5-Input Majority Logic Gate*	1.67	1.38	1.15
MC14580AL	*4x4 Multiport Register*	21.18	17.53	14.61
MC14580CL	*4x4 Multiport Register*	18.36	15.19	12.66
MC14581AL	*4-Bit Arithmetic Logic Unit*	11.35	9.40	7.83
MC14581CL	*4-Bit Arithmetic Logic Unit*	9.84	8.14	6.79
MC14582AL	*Look-Ahead Carry Block*	4.15	3.44	2.86
MC14582CL	*Look-Ahead Carry Block*	3.60	2.98	2.48
MC14582CP	*Look-Ahead Carry Block*	2.77	2.29	1.91
MC14583AL	*Dual Schmitt Trigger*	2.76	2.29	1.90
MC14583CL	*Dual Schmitt Trigger*	2.39	1.98	1.65
MC14583CP	*Dual Schmitt Trigger*	1.84	1.52	1.27
MC14585AL	*4-Bit Magnitude Comparator*	5.55	4.59	3.82
MC14585CL	*4-Bit Magnitude Comparator*	4.81	3.98	3.31
MC14585CP	*4-Bit Magnitude Comparator*	3.70	3.06	2.55
MCM14505AL	*64-Bit Static RAM*	20.66	17.10	14.25
MCM14505CL	*64-Bit Static RAM*	17.91	14.82	12.35
MCM14505CP	*64-Bit Static RAM*	13.77	11.40	9.50
MCM14524L	*1024-Bit ROM*	Consult Factory		
MCM14537AL	*256-Bit Static RAM*	41.32	34.20	28.50
MCM14537CL	*256-Bit Static RAM*	35.81	29.64	24.70
MC14410	*2-of-8 Tone Encoder*	4th Qtr. '74 intro.		
MC14411	*Bit Rate Frequency Generator*	4th Qtr. '74 intro.		
MC14415	*Quad Precision Timer/Driver*	4th Qtr. '74 intro.		
MC14435	*3½ Digit A/D Logic Subsystem*	4th Qtr. '74 intro.		
MC14490	*Hex Contact Bounce Eliminator*	4th Qtr. '74 intro.		

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Electronics review

ferent data bases), or 512 terminals having access to the same data base. These models also use a PDP-11/40 minicomputer in the architecture for altering their microprograms and for diagnosing malfunctions. ☐

Military electronics

Next year's budget a military record?

"When Barry Goldwater says we're spending too much and can knock off $5 billion, you know we're in trouble," says a Pentagon economic planner involved with the fiscal 1976 defense budget now being prepared for submission to Congress next January. But despite the reductions that may be agreed to, Pentagon officials concede that inflation will make it difficult and perhaps impossible to hold next year's spending proposals below a record-setting sum of $100 billion.

A figure of that magnitude will represent an increase of nearly 20% over fiscal 1975's $82.6 billion appropriation that recently cleared Congress. Even though that total indicates a 5% cut on the $87.1 billion requested, only $2.6 billion—or about half—of the apparent economies will be realized this fiscal year, since the remaining cuts were made in funds programed for spending in future years.

Changes. A rumored reshuffling of Pentagon leadership—including replacement of Secretary James Schlesinger—may be matched by major cutbacks and even scrapping of some highly visible and expensive programs, predict DOD budget specialists. One candidate for elimination is the Air Force's B-1 bomber.

The North American Rockwell development project, which this year got back $45 million of the $55 million that had been cut out by Congress, has not been helped by

News briefs

AT&T asking $1,000 down on protective circuits

Independent manufacturers of phone-answering equipment are being asked to ante up $1,000 each as down payments to obtain the circuit diagram and component specs for the protective circuits that American Telephone & Telegraph Co. will allow to be built directly into the equipment [*Electronics*, Sept. 5, p. 34]. According to the one manufacturer, the circuit "looks reasonable, but the specs are very detailed." The circuit comprises 30 to 40 components, including an optoelectronic isolator to eliminate direct electrical connection in the ring circuit and a transformer to isolate the audio circuits.

The $1,000 goes to cover costs to AT&T of inspecting a potential manufacturer's facilities to determine whether it can fabricate the circuits adequately. Licensing fees, as well as fees for preproduction and on-going production inspection, will be negotiated later.

Air bags in cars may become mandatory

A requirement for mandatory air bags in 1977-model cars is being developed for industry comment by the National Highway Traffic Safety Administration in response to a House-Senate conference committee's accord on auto safety legislation. The compromise requires the Department of Transportation's agency to have a standard within 60 days after passage of the 1974 Motor Vehicle Safety Act, which is still being debated.

Meter reader relies on semiconductor memory

Two prototypes of a portable, solid-state water-meter reader have been developed by Rockwell International's Autonetics division, Anaheim, Calif. The company expects to bring a model to market in a year. Using 4,096-bit random-access memories, the new meters presumably would replace the company's tape-recorder models which are prone to dirt and shock.

new cost estimates that calculate the cost per plane at $76 million. The figure is based on a program cost of $18.6 billion through 1983—two thirds more than the $11.2 billion forecast in fiscal 1970, when full-scale development was begun.

Such ballooning figures are proving the rule, rather than the exception, reports DOD's controller. In its latest look at 44 major Air Force, Army, and Navy weapons systems, the controller's office estimates that costs to complete them will be $143.6 billion, or 35% more than when development started. Twenty-one Navy aircraft, ship, and missile projects have averaged a 28% hike, rising to $65 billion from $46 billion. Thirteen major Air Force planes and missiles are now expected to cost $53.9 billion, or 45% more, while 10 Army missiles and helicopters have racked up a dizzying 60% increase as costs have soared to $29.6 billion. "Something's got to give," admits one budget estimator, "We just aren't going to get that kind of money" from Congress, especially when new proposals like the lightweight fighter that will lead to major buys have yet to be factored in."

Navy troubles. New ship electronics provides doubtful opportunities for future business, says another Pentagon official, who predicts that some new ship programs will be cut back and others eliminated. One candidate for scuttling is the new patrol-frigate class that has been proposed as an economical substitute for the destroyer. New cost estimates for the patrol frigates contain an inflation factor of nearly 88%, pushing total program costs to $5.27 billion, or two thirds more than the $3.24 billion predicted at the time of the development decision less than two years ago.

Army programs hit hard by inflation include the Utility Tactical Transport Aircraft System where costs have jumped by 50% to $3.4 billion from the fiscal 1971 estimate of $2.3 billion. The Sam-D air-defense missile reflects a 22% cost gain, despite a reduction in the number of systems to be bought. Of

Electronics review

DOD's new $6.39 billion cost forecast for Sam-D, $2.58 billion is for inflation. □

Packaging and Production

Palladium gets plating replacement

With palladium prices rising at fairly astronomical rates—up from $76 per troy ounce about 18 months ago to the $129–$134 range—printed-circuit-board makers have been searching for substitutes to trigger the electroless, or chemical, plating process commonly used to build up the copper-conductor layer on the boards. Now, Surface Technology Inc., a Princeton, N.J., specialty-chemicals supplier, says it has developed some processes that don't need palladium. Instead, the company relies on aqueous solutions of "readily available chemical compounds" which act as the catalyst in plating the copper to any dielectric material, says Nathan Feldstein, Surface Technology's president, and ex-RCA Corp. researcher in chemical processes.

Feldstein claims that $1 worth of palladium can be matched by less than 10 cents worth of Surface Technology's chemical solutions. These solutions are said to be fully compatible with the electroless-plating systems now used, and adhesion characteristics are "at least as good" as those palladium provides for pc boards. And the new system minimizes some of the manufacturing-reliability problems of the palladium processes. Feldstein says, "in most cases, we know we have better adhesion, but we couldn't say that it is true in all applications."

However, he is not divulging details. He says, "we're not in production now, although we have submitted some plated samples to a number of pc-board and systems manufacturers for evaluation." Initially, at least, the company will sell its new solutions, but eventually, it may license other firms. □

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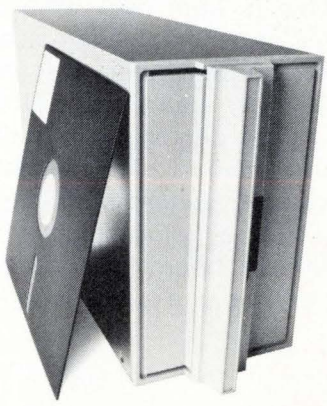

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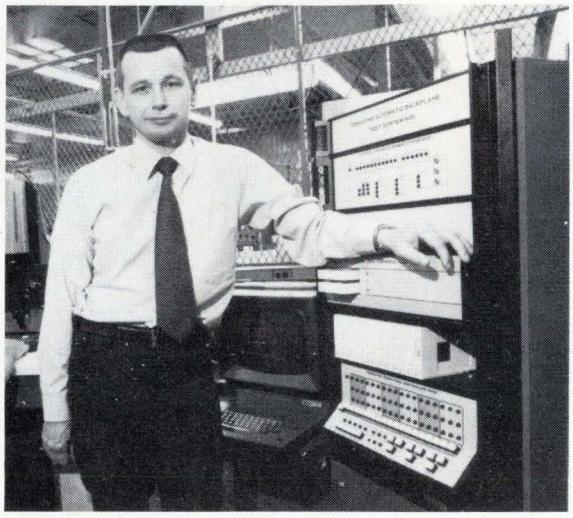

Ron Baker, Manufacturing Engineer
Lear Siegler, Inc., Instrument Division
Grand Rapids, Mich.

What Lear Siegler's Instrument Division wanted was a system that could reliably test over 200 varieties of bare PC boards and backplanes.

What they got was a system that did all they asked – and cut their testing costs by 75%.

According to Ron Baker, LSI Manufacturing Engineer, "We needed a bare-board test system that was versatile, easy to program, capable of reading out errors in plain English, and applicable to both backplane and bare-board testing." After evaluating automatic test systems from 19 companies, plus two in-house designs, LSI chose the Teradyne N151.

The principal application for LSI's N151 is the testing of bare multilayer boards (typically two-layer, laminated to both sides of an aluminum core) going into avionics systems. Over 200 different boards are tested, with the change-over from one type to another requiring only the keyboard commands needed to call up a new program.

LSI's N151 also tests seven different kinds of semi-automatically wrapped backplanes – mostly 4000-pin units used as chassis for the boards.

An important consideration for LSI was cost. And with the N151, Ron Baker couldn't be happier: "At the rate it's going, our N151 will pay for itself in a year."

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The more things change...

. . . the more they are the same in the TV business, with acquisitions expected to have little effect

by Larry Armstrong, Midwest bureau manager

This year's flurry of acquisitions in the U.S. television industry, highlighted by GTE Sylvania's acquisition of Philco-Ford's domestic TV-audio business, may have served no purpose other than to defer the day of reckoning for marginal TV-set producers. "We see the industry passing from weak hands into strong hands," says one insider, "but so far there's no merging of really significant manufacturers, which means no producer can dramatically increase his share of the market."

Edgy set makers, tight-lipped even in the best of times, are ducking the question of whether the acquisition route will help. Nonetheless, Admiral Corp., Chicago, acquired by Rockwell International Corp.; Quasar Electronic Corp., Franklin Park, Ill., formerly Motorola Inc. until its purchase by Matsushita Electric Industrial Co.; and Magnavox Co., New York, taken over by Philips Gloeilampenfabrieken, have got to be at least a tiny bit pleased at the financial and marketing power lined up behind them. Whether they can marshal that power to increase their shares of the market—and just where any added share will come from—remains to be seen. Meanwhile, competitors have settled back to watch the fireworks and Zenith Radio Corp., Chicago, has lighted the fuse.

Zenith, which according to a Television Digest survey ranks first in market share (23.75% in color, 17.75% in black and white), has filed a suit seeking treble damages of $900 million from 21 Japanese consumer-electronics producers and their U.S. subsidiaries. It also asks that Matsushita divest itself of all assets acquired from Motorola.

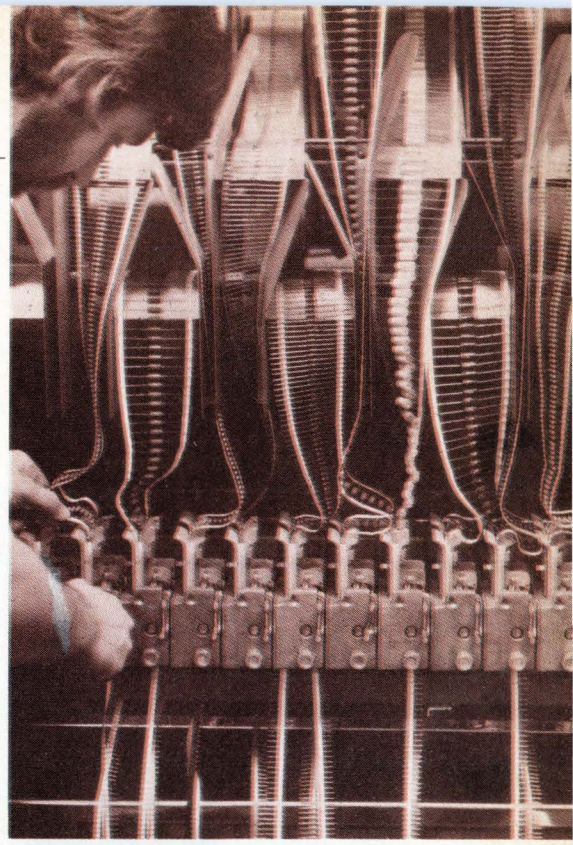
"The acquisitions aren't changing the TV industry at all, or the companies' position in it," contends one observer. "In any new field, you get lots of entrepreneurs that must adapt or fold as the markets grow."

The one thing that might change is pricing. Zenith has been one of the more aggressive makers in terms of pricing. If its motive has been to squeeze the margins of the smaller producers, the policy may not work against the guns of Matsushita, Philips, and Rockwell. And Zenith, after posting model-year-to-year increases of about 4% in June, tacked another $10 onto suggested retail prices effective Sept. 1.

The newcomers to the American TV industry, Philips and Rockwell, bring a potential influx of money that the shaky TV firms say they need. Matsushita, already marketing stateside as Matsushita of America under the Panasonic label, boosted its market share from 2.1% to almost 9% in color, and from 8.2% to just over 14% in black and white. All three firms have demonstrated a competence in electronic technology that may or may not be part of the answer to the industry's problems.

No technology. "In terms of what's required, additional electronic technology may not be viable," cautions an insider. "Teledyne tried that with Packard Bell, and it turned out that it wasn't what the market needed, or was willing to pay for."

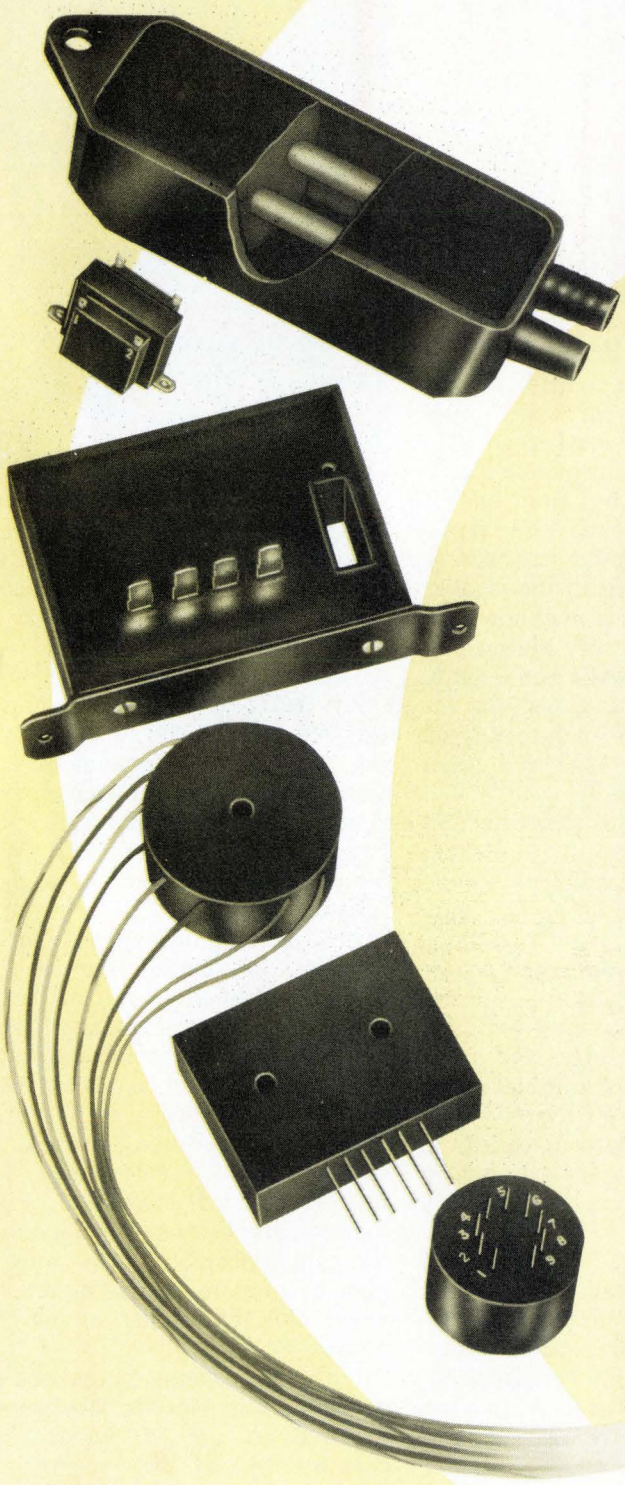
Industry experts seem to agree that Philips, already the largest TV-set supplier in Europe, simply wants to expand its horizons. At $8 a share, its tender offer for Magnavox was rejected; at $9, however, plus the promise of employment contracts, Magnavox management was heartily in favor. (Even $15 would have been a bargain, says one Wall Street analyst, in light of a prior Magnavox high of $62.50.)



Lining 'em up. Components for Zenith color TV sets are automatically placed into proper sequence for insertion, also automatic, into sets. Zenith, late with such manufacturing, once advertised "hand wiring."

In something of a surprise to the industry, Magnavox had successfully rebuffed at least two earlier takeover attempts. Magnavox, which got into the business as an assembler, had stubbed its toe on a number of ventures; it has done miserably in furniture, musical instruments, and mobile homes. The much-publicized "Odyssey" game that attaches to TV sets is not one of the games people seem to want to play, and reportedly will be retailed again this Christmas at bargain prices.

Philips isn't saying, but no one expects to see its Norelco label superimposed on the Magnavox merchandise. Indeed, there seems to be a question as to whether Philips will sink a lot of money into the Magnavox product. As one observer won-



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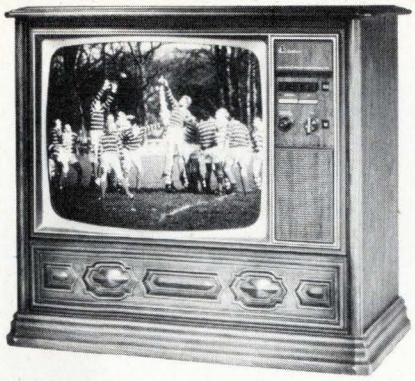
ders, "If it makes sense to borrow money from Philips, why wouldn't Magnavox have borrowed money on the open market? If it doesn't make sense, why does Philips even bother?" Most experts reply that it's the video disk.

Philips wants "a ready-made consumer electronics organization to move it [the video disk] in the U.S.," says a New York-based analyst. The Magnavox acquisition also gives Philips a ready market for its massive components operation—a market already partially served by Matsushita Electronics, the components subsidiary that was formed and operated in implementation of a joint-venture agreement between Matsushita Industrial and Philips. Picture tubes, however, have been made for Magnavox by Westinghouse, and the acquisition puts the Westinghouse tube operation "in great jeopardy," an observer says.

Inevitable. Less of a surprise was Rockwell's purchase of Admiral for some $75 million in Rockwell paper. On the block for years, Admiral had negotiated with Philco-Ford and Chrysler, and there were rumors that Montgomery Ward, Westinghouse, and Sanyo Electric had all tried to buy it at one time or other. Admiral's problems were management problems, most sources agree, stemming from an unwillingness to delegate responsibility. While Rockwell hasn't moved in heavily with its own management team, many feel the move is inevitable.

Motorola's Quasar TV receiver line is expected to benefit from its takeover by Matsushita, and Quasar officials already predict that a much-needed major facilities modernization program and other cost-cutting measures are expected to help make the company profitable within three years. Wall Street scuttlebutt has it, however, that Matsushita belatedly discovered that the Motorola plant is older than it thought, and modernization is costing more than expected. "But when Quasar is eventually combined with Panasonic, the group will probably be profitable overall," says an insider. "By itself, I don't see how they can increase share-of-market. Motorola tried like the devil—it invested money, made an intelligent effort, and couldn't do it."



Furniture. One reason Matsushita is believed to have acquired Motorola is to get console line without building plant.

The next target for acquisition is anybody's guess. Whirlpool Co., Benton Harbor, Mich., has hinted that it wouldn't refuse a decent offer for its Warwick subsidiary, formerly owned by Sears, Roebuck Co.

General Electric Co., New York, and GTE Sylvania Inc., Stamford, Conn., persist in the business, spreading TV losses over other components operations. But Sylvania's acquisition of Philco could give it new vitality through the addition of distributors and dealers who never handled Sylvania sets, not to mention Philco manufacturing facilities in Pennsylvania, if they're to continue in operation.

While Zenith has managed to maintain its number one position in the U.S. industry, first-half profits this year slumped 55% despite record revenues. Zenith stock is selling a little below book value, which makes it a potential takeover candidate, too, Wall Streeters point out. Hopes for a good third quarter were upset by a strike at the firm's Springfield, Mo., plant.

Ex-leader. And what of RCA, once the undisputed leader and now number two in color as well as monochrome? The communications giant eschewed its hybrid line earlier this year for the more profitable, more expensive, solid-state sets. It's trying hard to retain a leadership position that has been slipping in recent years, but nevertheless it has had to boost prices and has reported layoffs in a cost-cutting move. □

Looking for a sale. Here's RCA's postal point-of-sale system that's undergoing an 11-month evaluation. The Postal Service is also testing ECI's competing system.

Government

Is Postal Service really getting its act together?

Some suppliers encouraged by actions of new R&D chief as priorities seem clearer, though money is tight

by Larry Marion, Washington bureau

Almost any change at the U.S. Postal Service is hailed by suppliers as progress, so they're not too dismayed that the service is on its third R&D chief in two years, or that specs for automated mail-handling equipment won't be ready until 1977 at the earliest. Electronics firms have grumbled in the past about a shotgun approach to automation, and about postal R&D people having had a hard time getting the attention of superiors.

It seems now, however, that the service's new R&D chief, J. Thomas Ellington, is making changes. As one industry rep remarked at a postal forum earlier this month, the postal system is "finally getting its act together." Another said, "The post office has finally zeroed in on priorities." A number of colleagues agreed, but the big question for electronics suppliers is: when will the money come through.

"Slightly less than $1 billion in capital outlays has been pegged for this fiscal year," Ellington notes. That's a reduction of more than $250 million from initial budget requests, due to budget tightening and galloping inflation. The good news is that R&D's share of the budget will go up by about 40%, to $53 million. And things also look better in the more distant future. Ellington has indicated that the service will go into prototype procurement for automated mail-handling in 1976, meaning further increases for R&D. Postal procedure is to buy prototypes before issuing specs.

Ellington also points out that the five-year building program for the service will provide more than $5 billion just to replace old plant and equipment. Of this, electronics companies can expect about $1 billion to be spent on automated equipment.

Optical-character-reader (OCR) development and procurement alone, for example, is expected to cost more than $100 million now that the post office is going from testing to deployment.

There is still wariness, however, over the service's bureaucratic indecisiveness. A recent example of this is the point-of-sale terminal competition between the RCA Corp. and the ECI division of NCR, St. Petersburg, Fla. As demonstration projects are about to start in New York City and San Jose, Calif., for RCA's off-line version and ECI's on-line version, the Postal Service still hasn't told them how many terminals and assorted peripherals it wants. A request for proposals is due out by the end of the year on a large-scale demonstration of 1,000 or 2,000 machines.

OCRs still lead. Optical character readers will dominate R&D activity at the Postal Service in the foreseeable future, Ellington says. "Letter-mail processing will utilize automated sorting techniques, including major OCR applications to sort all the way down to carrier route." He adds that off-the-shelf equipment

can serve postal needs. Now the service has to determine what it wants the equipment to do, and how much equipment it needs.

Other electronic equipment to be developed for postal use includes:

- Address mark-up system (AMUS) to replace incorrect addresses after checking them against corrections stored in memory. Using an OCR, a minicomputer, and assorted printing peripherals, a prototype is scheduled for delivery next year. More than 50 and up to 200 systems may be purchased once bugs are shaken out, at a cost of perhaps $20 million.
- Sorting equipment. These will be keyboard terminals to go with the OCRs in major facilities, tied into conveyors and packaging systems. Hundreds of terminals will be needed. A decision on prototype development will be made by the end of this year.
- Parcel post coding. RCA is working on a prototype laser-read label system for package coding. The equipment is scheduled to be delivered next year.
- Satellite mail. Although plans for a six-city, $100 million satellite mail system have been discussed [Electronics, Feb. 7, p. 74], don't expect to see an electronic mail system until 1977, based on requests for proposals, to be issued next year or the year after.

Satellite circuits. The post office realizes there is excess capacity on existing satellites, says Ellington, and is now leaning toward renting test circuits, based on proposals submitted in 1975 or early 1976. A deployment decision will be made by the end of 1976, he says. Using existing terrestrial and space systems for facsimile transmission is another service the post office is studying.

But the success of the post office-Western Union "Mailgram" may have another influence on the service.

Ellington reports that Mailgrams bring a tidy profit, without new equipment purchases by the postal service. It is possible that the service will go into partnership with communications companies, such as American Satellite Co., and others, in similar arrangements. □

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Think of the MC14557 as a liberator, and as one heck of a shift register.

MC14557 – one of eight SRs

Of course the MC14557 is just the newest among the McMOS* family's line-up of eight different shift registers ranging from the 4-bit MC14035 to the 128-bit MC14562.

Yes, Motorola's broad CMOS family offers more, and not just in shift registers. There's an excellent selection of the older simple circuits, the gates, flip-flops, etc., to go with the widest assortment of more contemporary MSI functions. In addition to the shift registers, the McMOS MSI line serves system logic needs with timers, counters, decoders, latches, buffers, data routers, arithmetic functions, analog multiplexers, and supplies more three-state CMOS logic than any other source. Then there are the ROMs, RAMs, and specialized functions like the priority encoder, parity tree, and dual Schmitt trigger. Motorola's McMOS is, in fact, the broadest line of CMOS available.

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For additional technical information on the MC14557 variable length shift register, write to Motorola Semiconductor Products, Inc., P.O. Box 20912, Phoenix, Arizona 85036. For full technical and applications information, the McMOS Data Book and the McMOS Handbook are both on sale at franchised Motorola distributors.

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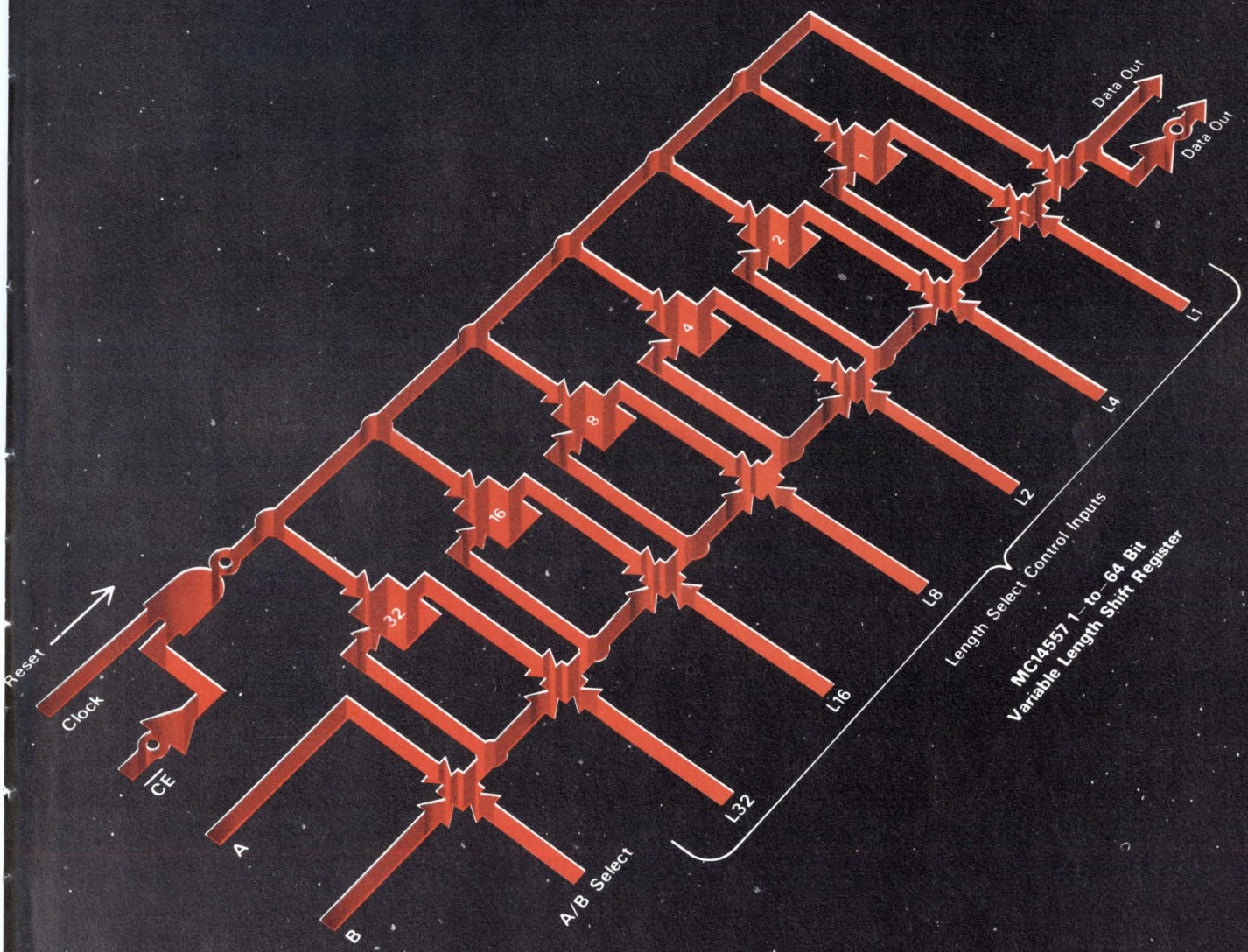

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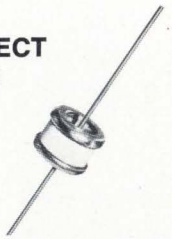

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SIGNALITE DIVISION
GENERAL INSTRUMENT CORP.

Washington newsletter

FAA favors doppler for microwave landing system

The Federal Aviation Administration is in the home stretch toward its January 1975 decision on which microwave-landing-system technology to adopt as the national standard [*Electronics*, July 25, p. 30], and industry sources say **pulsed doppler is the early favorite after field tests this summer.** ITT Gilfillan and Hazeltine Corp., both doppler specialists, are reportedly leading the competition for selection of two production prototypes. Sources say that though the pulsed-doppler and scanning-beam technologies are extremely competitive in performance, **reliability and maintenance points go to the doppler systems, since they have fewer parts.**

Nuclear-pumped laser proven feasible in U.S. experiments

Nuclear energy has for the first time been directly converted into laser light—an achievement by the Atomic Energy Commission that could lead to "major advances" in long-range communications, energy conversion, and long-distance power transmission, says the National Aeronautics and Space Administration. Defense specialists also report **a "significant potential for high-power lasers as weapons" to intercept missile warheads and aircraft.**

The experiments at AEC's Los Alamos, N.M., laboratory used a neutron pulse from a reactor to excite a helium-xenon gas laser with a technique described as "fission fragment excitation." However, a full-scale nuclear-pumped laser would most likely depend for energy on a gaseous-fuel reactor to permit system mobility in such applications as space propulsion. Research on such reactors is continuing at Los Alamos and NASA's Langley Research Center, Hampton, Va.

Air Force gets plan to sub F-15s for lightweight fighters

The Air Force is quietly sitting on **a proposal by F-15 fighter-maker McDonnell Douglas Corp., St. Louis, that wants the service to buy 300 more of the company's planes in lieu of plans to acquire a new lightweight fighter** to be chosen from either the General Dynamics' YF-16 or Northrop Corp.'s YF-17. According to USAF insiders, the proposal would boost F-15 sales to the U. S. to 1,049 planes, in return for which **McDonnell Douglas reportedly would guarantee a firm unit price of $5.8 million.** The figure compares with estimated unit costs of about $5.5 million for the lightweight fighter. Though **the Air Force reaction is described as having been "noncommittal to cool,"** the service is computing life cycle cost advantages of having to train pilots, technicians, and maintain a parts inventory for one instead of two planes. **Weighing against Air Force adoption of the plan is Pentagon enthusiasm for the lightweight fighter and its potential for sales to U. S. allies.**

POS equipment, automated tellers to get Federal boost?

If the U.S. Controller of the Currency makes a full-blown regulation out of his recent proposal to **permit national banks to operate automated terminals in retail stores,** he will be sued by independent bankers. According to one spokesman, the independents are having "apoplexy" over the prospect of competing with larger banks anxious to unite with retailers in point-of-sale/automated-terminal combinations. Meanwhile, savings and loan institutions are "applying like mad" for perfunctory Federal approval to install such systems.

Washington commentary

CBO: bureaucracy's new challenge

When the nation was swimming this summer in Watergate, trying to keep its political system afloat, most of its citizens failed to notice that Congress was overhauling the Federal budget process. The legislation that became law in July is "the most significant in 20 years," claims Pentagon budgeteer James L. Vance. Richard Nixon, while still President, didn't go quite that far, although he did call the bill "the most significant reform of budget procedures since Congress began." That is one of his few observations with which no one in Washington disagrees.

Nevertheless, many within the electronics industries who count on Government contracts are still ignorant of the law that established the Congressional Budget Office and altered the Federal budget cycle. Among other things, the act has slipped the beginning of the Government's fiscal year to Oct. 1 from July 1, effective with the start of fiscal 1977 in calendar 1976. And, beginning with President Ford's fiscal 1976 budget that goes to Congress next January, all agencies will have to account not only for their spending plans in that year, but will be required to submit two-year plans for all new spending initiatives as well as a five-year budget forecast.

As DOD's Vance put it to a somewhat surprised IEEE audience in Washington recently, "Those of you who don't have your fiscal 1977 proposals for new initiatives in now are in trouble." Vance, who addressed the Electronics and Aerospace Systems Conference, is director of resource allocations in the office of the assistant secretary of defense (intelligence).

Justifying $93 billion

Vance is just one of hundreds of military spending specialists who will continue shaping next year's defense budget priorities during the next two months. He is also one who concedes that the upcoming Pentagon budget will set a new record, although he disagrees with those of his colleagues who see it topping $100 billion (see p. 36). What the military would like comes out to $101 billion, but Vance suggests $93 billion is more likely on the basis of current "administrative guidance" from the top.

Program justifications are going to be much tougher for DOD budget planners with the establishment of the Congressional Budget Office, which is expected eventually to have as many as 100 professionals reporting to the two new budget committees in the Senate and House. Respective chairmen are Sen. Edmund S. Muskie (Dem., Maine) and Rep. Al Ullman (Dem., Ore.). Compared to the half-dozen professionals on most congressional committees, the proposed CBO staff represents a major break with tradition.

If the CBO and the new budget committees can wield as much authority as their charter allows, they are certain to become one of the most influential organizations in the Government. The CBO, for example, could give new meaning to the constitution's mandate to the Congress to be responsible for all spending. Until now, the Congress has had to react largely within the framework of the Executive's budget presentation, unable to effect major changes in the President's priorities. With the CBO able to analyze the presidential budget—along with a 24-month plan for new spending initiatives—there will be room for Congress to take independent action.

After getting CBO recommendations for spending alternatives and options, the budget committees will draft a tentative budget of their own, setting targets for 14 areas of spending as well as matching revenues. When the existing appropriations committees then act on specific spending bills, Congress will take a second look at the budget and, if necessary, modify it in an attempt to reconcile income and outlays.

The Pentagon's problem

DOD's Vance believes that the concept is a good one even though it will increase paperwork and overhead generally for the Pentagon and its contractors to come up with program justifications. "It has got to be good," he muses. "It can't get any worse, right?" But there undoubtedly will be problems, particularly in the beginning as the new budget process shakes down. The most obvious one will come when Congress finds that the new layer of authority and responsibility in the budget committees prolongs the passage of spending bills beyond the Oct. 1 beginning of the new fiscal year.

For defense electronics suppliers, Vance says the new system will preclude "any more buying in." Cost estimates are going to have to be better, he warns, as will technological performance since Congress is going to be watching much more closely than it ever has. Though Vance and others leave it unsaid, DOD is concerned that the new Congress is going to be watching through eyes that may not be as friendly to military programs as those of the chairmen of the Senate and House Armed Services Committees.

—Ray Connolly

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Electronics may account for 25% of superspeed-train costs

West Germany has a head start in developing high-speed mass-transportation systems. While other countries are working with other types of suspension systems, the Germans are relying on electromagnetic levitation to attain speeds in excess of 300 miles per hour. Such suspension is necessary, experts say, because conventional wheel-on-rail or road vehicles can't travel much faster than 200 miles an hour.

But whatever suspension systems are adopted—and they are likely to be different in different countries—they will have to be controlled by computers and other electronic gear. The fallout for electronic manufacturers is now small, compared with what's being spent for purely electrical systems. "But it could be substantial in the future," says Stefan H. Hedrich, former manager of magnetic-suspension projects for West Germany's Krauss-Maffei AG and now director of the company. Hedrich figures that when vehicles are controlled and monitored by a central computer, the electronics share will amount to 20% to 25% of total systems cost.

Harri Brauer, who is in charge of testing a vehicle built by a consortium called the Magnetic Levitation Project Group, puts the electronic-equipment share used in the vehicle and for remotely controlling and monitoring it at 15% to 20% of the project's total cost of $5.3 million. This percentage does not include such power-electronic devices as thyristors. The group is composed at AEG-Telefunken, Brown Boveri Cie, and Siemens AG.

Head start. As early as 1969, Munich-based Krauss-Maffei demonstrated a mobile model with a magnetic support and guidance system and propelled by linear motors. Now the company is readying its Transrapid 04, which it hopes will reach 200 mph on a 2.5-kilometer track some time next year.

Last year, Krauss-Maffei completed a test facility that has electronically operated track switches for magnetically supported vehicles. These switches no longer contain any moving parts, either on the track or on the vehicle. Besides insensitivity and absence of wear, they have microsecond switching times and high reliability.

Two different principles of magnetic suspension are being followed. Both Krauss-Maffei and Messerschmitt-Bölkow-Blohm GmbH (MBB) are using electromagnetic systems, but the AEG-BBC-Siemens group is taking the electrodynamic route. The two groups' near-term goal is 300-mph vehicles that will be tried out in competitive endurance tests on looped 42-mile tracks the government is planning for 1976 or 1977 in Bavaria.

The electromagnetic system uses attraction between electromagnets installed on the undercarriage and armature rails along the track to suspend the vehicles no more than 0.5 inch above the rails. The electrodynamic system uses superconducting magnets in the vehicle's undercarriage to induce eddy currents in reaction rails. This opposing field suspends the vehicle 2.5 to 5 inches above the rails.

MBB, an aerospace firm in Munich, in 1971 demonstrated a six-ton vehicle, powered by a linear motor, which attained 40 mph [*Electronics*, June 7, 1971], and, in subsequent tests that year, it reached 56 mph. In 1973, MBB started levitation tests with a digital controller for magnetic support and guidance systems. This year, MBB and Krauss-Maffei agreed to continue joint programs.

The long haul. Envisioned for the long term are 300-mph trains that in two hours could traverse from Hamburg in the north to Munich in the south, passing through the major cities along the route. A government-sponsored study says work on this system could be started during the late 1980s or early 1990s. Implementing it would call for investments of more than $6.5 billion, at the current rate of exchange and based on 1972 prices.

From the late 1960s through 1974, the Bonn Ministry of Research and Technology will have transport techniques, funding as much as 80% of some individual projects. For 1975, the ministry has earmarked about $25 million, of which $10.3 million is pegged for electromagnetic systems and roughly $6 million for electrodynamic systems. □

Japan

1-k static RAM fits microprocessors

An experimental high-speed static 1,024-bit random-access memory compatible with microprocessors has been fabricated by engineers at the Research and Development Center of Toshiba (Tokyo Shibaura Electric Co.). The capability to operate with a single power supply without timing circuits qualifies this n-channel device especially for use with microprocessors with relatively small memories.

The experimental memory, made by a new silicon-gate technology, is designed around enhancement/depletion circuits. The depletion-voltage level of the load transistors differs from those in the memory cells and in the peripheral circuits. A new decoder circuit has also been developed for stable high-speed accessing of stored information. Typical access time is 300 nanoseconds, read/write cycle time is 600 ns, and

the power-input requirement is 250 milliwatts. The device is compatible with transistor-transistor logic.

The memory-cell size of 65 by 75 micrometers is considerably smaller than that of other devices. The chip size is 3.2 by 3.5 millimeters, which is smaller than commercially available chips configured as 1,024 words by 1 bit, such as the Intel device. However the Toshiba RAM, arranged as 256 words by 4 bits, requires more peripheral circuits.

Configuration. By using 4 bits and fewer words per chip, memories of smaller capacity can be economically assembled. So Toshiba expects to offer chip sizes of both one word and four words.

The self-alignment of silicon-gate MOS decreases the chip size because it eliminates the need for mask-alignment tolerances, and higher speed is obtained from the resulting decrease in overlap of gates over sources and drains. Enhancement/depletion inverters give full power-supply output-voltage swing, constant-current-load characteristics, and small ratio of driver-to-load channel widths.

The static-RAM circuit is standard—two cross-coupled driver transistors, two depletion-type load transistors, and two transfer gates connected to digit lines. Because memory cells account for the lion's share of total memory size and power dissipation, the bulk of the design effort is concentrated on reducing these two factors.

The Toshiba design, like that of many other static RAMs, uses depletion-type load transistors between the power supply and the digit lines to precharge them. These and other peripheral-circuit depletion-load transistors must be operated at higher currents than memory-cell depletion-load transistors because both conductance and switching speed fall as current is decreased.

Two thresholds. Toshiba engineers designed their memory with different threshold-voltage values for the peripheral-circuit and memory-cell depletion-load transistors. The peripheral-load transistors have a threshold of −2.8 volts. Because the depletion-load transistors are normally operated with the gate connected to the source, the gate voltage, at 0 V, is 2.8 V above the threshold voltage, and both drain current and conductance are comparatively high, which increases operating speed. Since the memory-cell depletion transistors have a threshold of −1.2 V, gate voltage is a much smaller value above the threshold voltage, and drain current is held to a low value without increasing channel length.

These RAMs are fabricated by a relatively simple process. Thermal oxide about 1,000 angstroms thick is grown on the wafers, and boron is implanted over the entire surface of the p-type wafer. The boron concentration is maximum at the interface of the silicon and silicon dioxide. Then a field oxide about 7,000 Å thick is deposited over the wafer.

The windows for transistor gates are opened, and then a gate oxide 1,000 Å thick is grown. Phosphorus ions are implanted into the channels of the two types of depletion transistors in two steps using the same 170-kilovolt accelerating voltage, but in different doses. Photoresist is used for masking, and conventional techniques are used for polycrystalline-silicon deposition, phosphorus diffusion of source and drain, and aluminum metalization.

Another innovation is the use of a depletion-transistor transfer gate in the decoder as a form of delay, with different characteristics for negative- and positive-going signals. The differentiation between the signals prevents sneak paths caused by the momentary simultaneous selection of several digit lines due to the overlapping outputs of the decoder-circuit. □

Around the world

System automates analysis of tumors

A London doctor has developed an automated system for radio-immunoassay, a method of analyzing tumors by measuring the quantity of their isotope-tagged antibodies. These are made to react with the patient's cells in measured amounts of reagents. The system allows a hospital laboratory to run 1,500 samples during a day shift, compared with about 200 by manual methods. The inventor, Dr. K.D. Bagshawe, consultant physician and director of the Medical Oncology department, Charing Cross Hospital, adds that the system increases reliability and accuracy. The Digico Automated Radio-Immunoassay Analytical System (Darias) is built around the 16-bit minicomputer made by Digico Ltd. The first $71,250 production unit will soon be delivered.

TV monitor checks multiple channels

Britain's Independent Broadcasting Authority (IBA) has introduced a precision tunable uhf receiver and demodulator unit covering 452 to 470 megahertz as the first of a family of equipment for economically checking network performance. As a receiver, the unit can find faults in distant stations by sequentially switching, possibly under the control of automatic direction finders, to each signal, or it can access signal quality at particular locations. As a demodulator, it can perform acceptance testing of transmitters at a manufacturer's plant and measure the incidental phase modulation and frequencies of video transmitters.

Automatic system monitors telecasts

Marconi Instruments Ltd. has introduced the last part of its Television Automatic Monitoring System, the TK 2916 data selector, which ties the system together. The system continuously monitors a television network's transmission quality, reports faults, and switches to the best transmission channels—all remotely and under either automatic or manual control. The video signal is monitored all the way from the camera to the transmitter, and conditions are reported by way of displays or teletypewriters to a central location.

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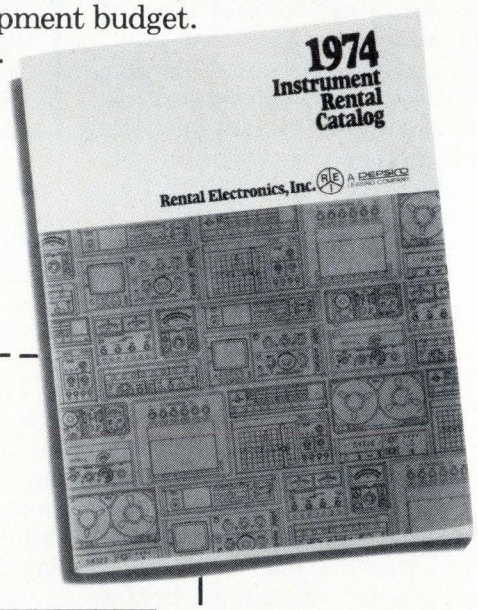

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Bonn gives green light—funds—to fighter project

The British-German-Italian-developed Multi-Role Combat Aircraft has received a welcome boost **now that Bonn's defense ministry has advocated spending nearly $500 million for its final development phase.** Though some members of the opposition party still have reservations about the project, approval of the additional outlay by the West German parliament seems assured. Thus far, the three partners have spent well over $1 billion on the project, but even so much of the onboard equipment, including some electronics gear, has not been proved out.

Spanish likely to tap Fujitsu for computer aid

Japan's Fujitsu Ltd. apparently has the inside track to be named the minority foreign partner in the "national" computer company that the Spanish government wants to set up to build medium-size computers. Although government planners in Madrid haven't tipped their hand, insiders say that Fujitsu people have been particularly visible since the government published a decree last month singling out the electronics industries as a "preference" sector and laying down the conditions for a native computer company. **The government holding company Instituto Nacional de Industria and the Barcelona computer company Telesincro SA are the most likely Spanish partners for the venture.**

Under the decree, the Spanish national computer project will get a substantial array of fiscal benefits, like tax relief and export aids. And, presumably, the new company would become the preferred supplier to government agencies. **In return, the government has stipulated that the new company reach an output of some $18 million yearly** within five years after startup and export 30% of its output. Also, the company would have to guarantee spending of **nearly $2 million yearly for R&D** in hardware and software.

TRW ends venture with Mitsubishi

TRW will pick up its marbles and leave Japan. It is reclaiming its capital from its joint venture with Mitsubishi Electric. **One cause is Mitsubishi's switch to joint effort with Philco-Ford for Japanese satellite work.** The original joint venture according to TRW spokesmen, was established in 1962 to help support the emerging Japanese satellite/aerospace industry. But the company knew then that the Japanese government would take over an increasing amount of the business, including software and equipment for the Japanese commercial-satellite effort. And the government is doing just that. An earlier tie-up in computers was dissolved when TRW left the computer business, and a semiconductor joint venture didn't pan out.

ICL set to announce new computer range

In deciding when to announce its "new range" of computers, ICL was caught between an uncertain economic climate and a design approach which might get stale if it waited too long, says one executive. But, the newly rejuvenated company finally chose October 24 to launch the long-awaited line of computers designed to give the company a better edge in the domestic and international marketplace. Expected to be based on several major models, **the 2900 line is an attempt to put the UK company into the burgeoning communications-oriented scientific**

and business markets with more flexible machines as well as the traditional larger number crunchers. Last year, ICL introduced the 2903, a fairly small machine that the company describes as a "bridge" between its old line and the new, but which may be the lower middle model of the so-called "new range."

Siemens hopeful on its rail-car identification system

Insiders at Siemens AG say that the company's railroad-car identification system will be adopted on a Europe-wide basis. And, **since the system is built around semiconductor microwave components, its introduction would open one of the first mass non-military markets for such devices.** Sicarid—for Siemens car identification—keeps tabs on the movements of freight and passenger cars by automatically reading 12-digit code numbers assigned to them and sending the data via trackside processing equipment to a central computer for further processing.

The payoff that Sicarid could bring to the West German company is enormous. In all of Europe, nearly 2 million rail cars and coaches are in operation. Each would require identification-number encoding equipment on its under-carriage. Then come the thousands of gigahertz-range transmitter and receiver units between the tracks for code reading. Introduction of the system on a Europe-wide scale could come between 1978 and 1980. One Siemens man, who recently talked with Soviet rail officials in Moscow, speculates that the Russians might be the first to adopt the system. **The reason: the Soviet Union's rail network is a closed one because its track gauge differs from that in the rest of Europe.** Thus, the country can introduce the system on its own.

ICs show up in more cameras

Photokina 74, the big photographic equipment show that just closed in Cologne, pointed up **a strong trend toward integrated-circuit applications in more-expensive cameras.** Simple ICs for shutter control are already being widely applied in low-priced mass-produced compact or pocket cameras. Now, more-sophisticated ICs for both shutter and aperture control are showing up inside reflex and movie cameras because they have become low enough in price to be attractive even in limited-volume, expensive equipment. Among the prime European contenders for the camera IC market are Siemens AG, with both MOS and bipolar devices, and Intermetall GmbH, a member of the ITT semiconductor group, with bipolar versions only. Siemen's chief customer is AGFA, **which introduced the first movie camera using MOS circuitry at this year's Photokina.**

Addenda

The British Post Office is starting a trial facsimile mail service **linking 10 cities. Called Postfax, the system uses Plessey KD 111 facsimile machines to link post offices, to which documents must be taken, although messenger service is available. . . . After recently announcing that it was licensing Lockheed's System 3 in order to battle IBM for the U.K. small-computer market,** Aardvark Business Computers Ltd. now is tackling the low-cost OEM terminal market, as well. **It has introduced Comet, a data-entry and retrieval terminal, tagged at less than $1,000, based on a system it developed for Thos. Cook and Son Ltd.'s foreign exchange system.**

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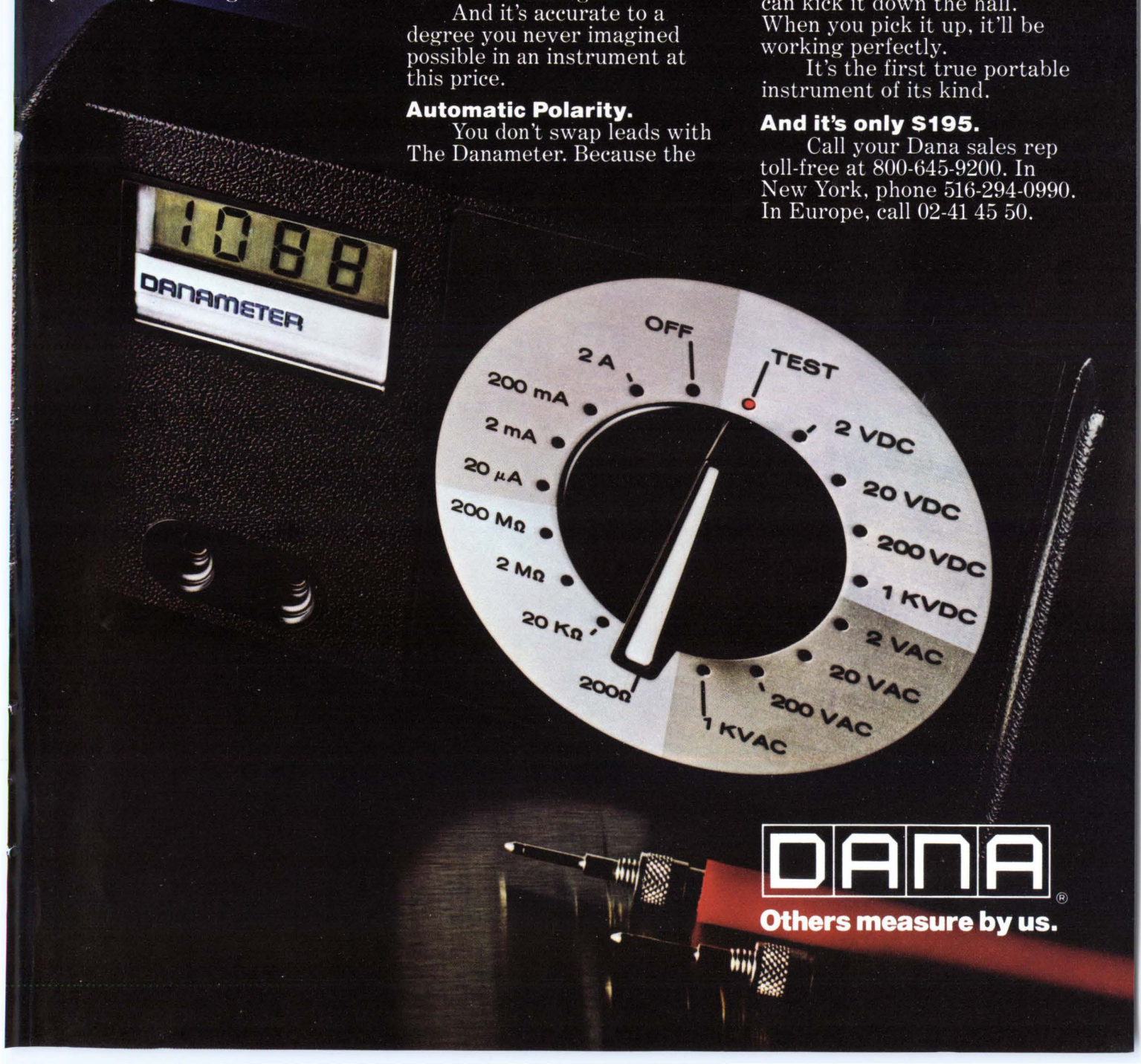

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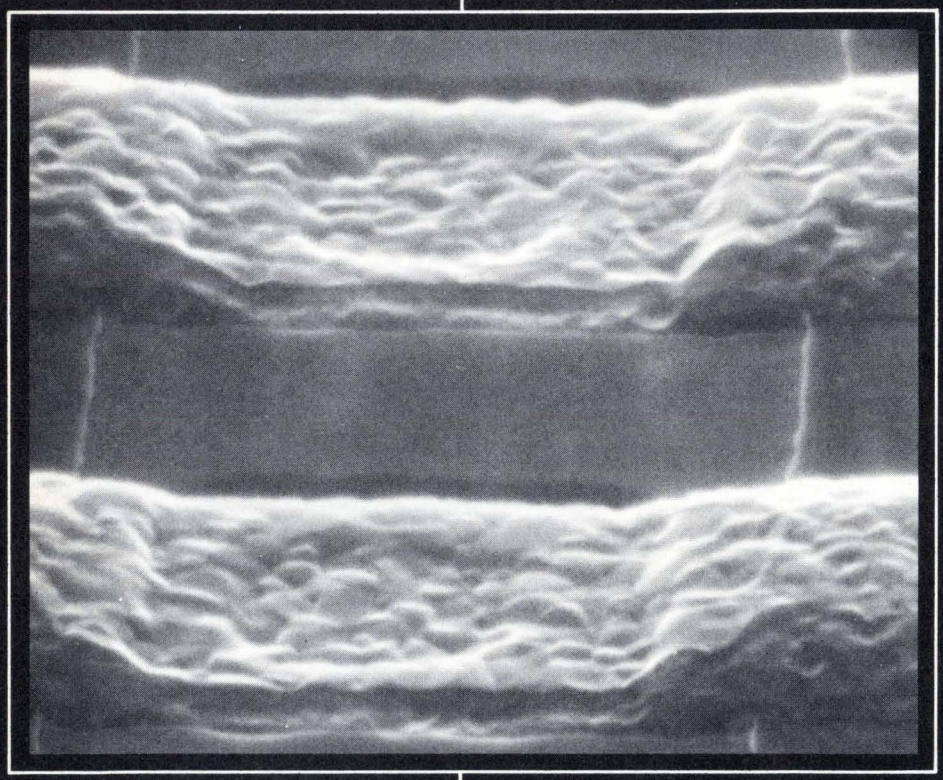


* AIM is Intersil's Avalanche-Induced Migration process, U.S. patent no. 3,742,592

AIM programing takes place entirely beneath the surface of the P/ROM. Compare the fully programed diode junction (top) with an unprogramed junction (bottom) in this unretouched 5000X photomicrograph of an Intersil IM5603A 1024-bit P/ROM. Note that there is no metal rupture or change of any kind in the appearance of the surface of the metal. Bit programing has taken place well below the surface, protected from any effect of environmental degradation.

100% reliable and faster to program.

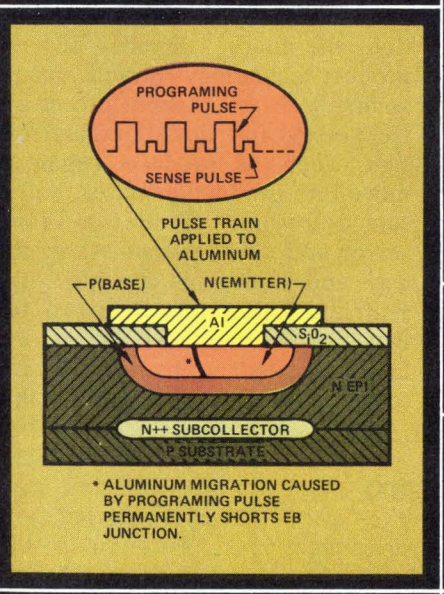
Intersil means memory

Programability

Intersil's Avalanche-Induced Migration technology gives superior reliability, faster programing and a better programing yield than fusible-link methods. AIM has been in use almost 4 years. It has created more than 1 billion memory bits without a single bit failure. And it lets you fully program a 2048-bit P/ROM in less than one second.

Technology

We apply a constant-current programing pulse to two back-to-back diodes. The reverse diode avalanches and shorts, leaving a single forward-biased diode. We then apply a sense pulse and determine the ohmic quality of the programed short; if it's not within specifications we immediately program it again until it is. Our pulse-sense programing sequence allows



us to measure and control the quality of the programed short, whereas it's impossible to measure a programed "open" to a quality level that assures reliability.

Intersil P/ROMs in full volume production undergo a battery of static, dynamic and temperature checks before shipment to customers and distributors for off-the-shelf delivery.

Reliability

Once a short is formed, it's totally beneath the surface of the silicon, typically 1½ microns deep. It's covered by a natural passivation layer of silicon dioxide, aluminum and vapox — inherently hermetic and protected from any degrading effects of the environment. And there is no metallic debris to migrate or "grow back" with continued use of the memory at a later date.

Availability

Type	Capacity	Output	Access Time (Max)		Pd (mW)	Price (100-999)	
			Read (nSec)	C/S (nSec)		0 to +75°C	−55 to +125°C
IM5600	256 bit (32x8)	OC	50	50	350	$ 6.00	$ 9.50
IM5610	256 bit (32x8)	TS	50	50	350	6.00	9.50
IM5603A	1024 bit (256x4)	OC	60	30	450	22.00	44.00
IM5623A	1024 bit (256x4)	TS	60	30	450	22.00	44.00
IM5604	2048 bit (512x4)	OC	70	30	550	45.00	80.00
IM5624	2048 bit (512x4)	TS	70	30	550	45.00	80.00

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1974 AWARD FOR ACHIEVEMENT

Gordon E. Moore

☐ One evening in 1956, a young chemical physicist was called to his office phone at the Applied Physics Laboratory of Johns Hopkins University. On the other end was William L. Shockley, co-inventor of the transistor and later a Nobel prize winner in physics. Shockley wanted to know whether the young man would join him in his newly formed Shockley Semiconductor Laboratory to work on chemical problems associated with the fabrication of transistors.

Had Gordon E. Moore not accepted Shockley's offer, the course along which the semiconductor industry would have developed might have been far different. The fact is, he did join Shockley and the consequences of that decision include the evolution of *two* $100 million corporate giants and technical achievements responsible for more than a little of the $3 billion semiconductor industry as we know it today.

Moore, who had been looking for a new job in his native California, had been interviewed at the Radiation Laboratories in Livermore, but decided to turn down their offer when it came. Shockley had received permission from the labs to go through their files for names of applicants who had not joined the labs, and came up with Moore's.

Moore, who didn't even know what a transistor was at the time, accepted the offer because, "it was in Palo Alto, and it sounded like an exciting field to get into." But before Moore headed West, Shockley arranged for him to get together with another new enlistee, a young physicist named Robert N. Noyce, who already had been working on semiconductors at Philco. That was the beginning of an 18-year association that has been responsible for a steady flow of major innovations in electronics.

Ironically, however, the Shockley organization benefited little from the creative abilities of Moore and Noyce. After a year and a half, Shockley's managerial shortcomings had so alienated them and six of their associates that they decided to leave and form their own company.

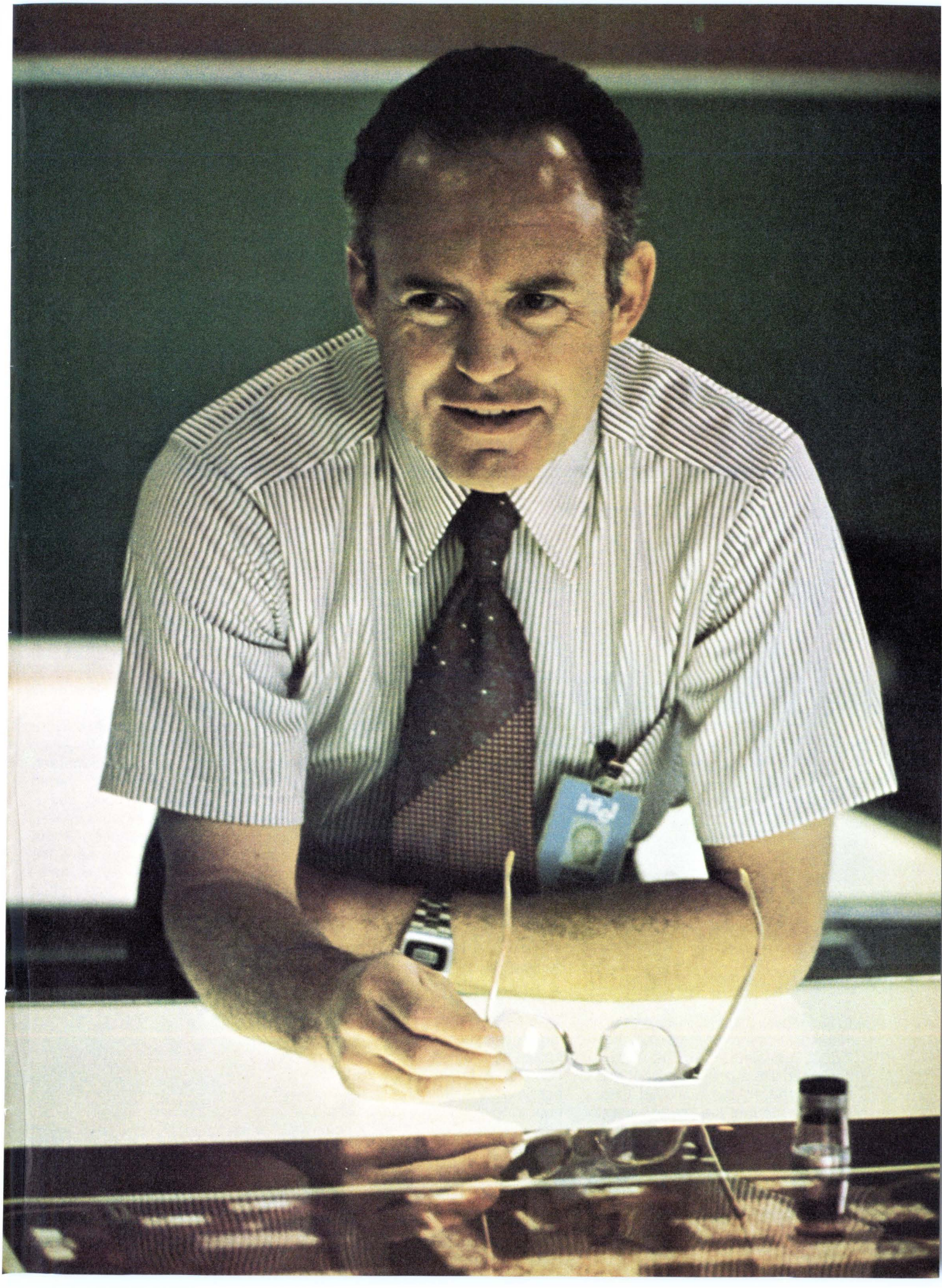
The founding of Fairchild Semiconductor is an oft-repeated story. In 11 years Fairchild became a $150 million operation. Noyce's charismatic qualities, coupled with his considerable managerial skill, impelled him toward the general manager's title and a group vice presidency of the over-all Fairchild organization. Moore—whose managerial tastes still run toward handling the internal direction of new-product technology—busied himself at first with establishing processing technology and initial product design. Then, as products began to move into production status, he assumed the post of director of research and development. Along the way and under his direction, the Fairchild Laboratory achieved the first planar integrated circuit, the first stable MOS transistor, the first complementary-MOS circuit, the first dielectrically isolated IC, and the first practical two-layer-metal IC.

But in 1968, Noyce and Moore became dissatisfied with the state of affairs at Fairchild. Noyce grew uncomfortable with his general manager's role as the Fairchild organization became huge.

The 1974 Achievement Award

For his distinctive and important contributions to electronics technology, and particularly for his leadership in organizing the technical staff at Intel Corp., the editors of *Electronics* have chosen Gordon E. Moore to be the recipient of the magazine's 1974 Achievement Award. The award will become an annual means of recognizing the people behind significant developments in electronics technology.

Largely by virtue of Moore's unique ability to assess new technology, Intel has created such product milestones as the 1103 1,024-bit RAM, the MCS-4 microprocessor chip set, followed by the 8080 8-bit family, the more-powerful n-channel 8080, and, most recently, the Schottky-bipolar 3000 microprocessor family.



He longed for the more intimate associations he enjoyed in the startup phase.

Moore, too, became restless, although he says he had the best job in the industry then, with a big budget and hordes of top scientists on his payroll. He saw changes coming when the board of directors began looking for a new president—changes he didn't think he would like. Furthermore, he began to see that his lab was becoming "a kind of dinosaur," too big and too slow. That opinion was borne out, he says, within two years after he left Fairchild, by which time the lab had been drastically reduced.

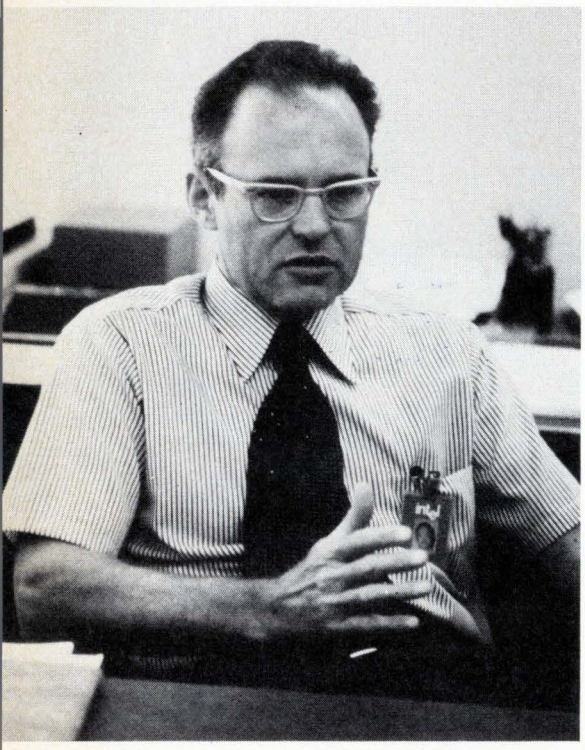
Moore decided to join Noyce in a new enterprise, now known as Intel Corp. Deciding on a strategy for the new company, Moore and Noyce looked for a product that was technically complex and had the potential for selling in large quantities. This would be their ticket to beating the big companies before the big ones could get turned around. The semiconductor memory became the target. Not only did that meet the strategic criteria, but it opened up the possibility of entirely displacing another technology—core memories—within a relatively short time.

The company's goal was to reach $100 million in sales within 10 years. This objective was achieved in six, as first-half 1974 sales totaled $66 million. And during those six years, Intel's technological track record has been outstanding. Such seminal contributions as perfecting silicon-gate MOS and Schottky-bipolar technologies, the introduction of the now-classic 1103 1,024-bit RAM, the microprocessor concept, and a line of successively more powerful microprocessors, all have been spun out of the Intel philosophy.

In their wake, computer design has taken a new direction. Entirely new computer applications have become economically feasible, and the power of the microprocessor is making a bid to change and dominate the traditional methodology of system design.

Today, Moore no longer gets involved directly in technology, in the sense that he neither designs experi-

Gordon Moore's viewpoint



"One thing that Shockley was interested in doing was making the 5-cent transistor. At the time, it seemed like a goal so distant that it might never be achieved. Many people thought the dollar transistor wasn't in the cards. And now we sell transistors as part of an IC at a very small fraction of a cent—probably 1/100 of a cent."

"Silicon on sapphire is the closest thing around to something that's a significant step. But the longer it takes SOS to become commercially significant, the smaller the advantages appear. Some of the things that are being done now in single-polarity MOS are approaching SOS in performance. And as we get completely committed to making dynamic circuitry in the MOS we're doing, for example, we would have to give up all of that to go to SOS. I'm not sure SOS will ever fit in."

"Just seeing the technology evolve and working on some of the details has been immensely gratifying. I'd like to think we're the real revolutionaries in the world. Things are being revolutionized a lot more by electronics technology than by some political things going on."

"I've been known to say 'let sleeping organizations lie.' Stirring things up for its own sake is something I don't like to do. In this business, the pessimist is nearly always right on how long it takes to do anything. Maybe the optimist will get it going, but he's seldom right on how long it's going to take. So I guess I do tend to be conservative."

"We don't do anything very formal in the way of research to tell us if a product idea will be successful. Sometimes it comes from the contact with our customers and their problems. With the microprocessor, though, our feeling for it developed principally from our key technical people telling us it will be a great gadget if we can make it. It wasn't something our customers were coming around asking for—they didn't realize it could be done yet. One of the guys on our staff started out looking at the complex calculator and saw that we could make a general-purpose computer of about the same complexity and have the flexibility to do a variety of functions. We made the first one on that basis. And once you get the first olive out of the bottle—the rest flows pretty easily."

ments nor supervises specific projects. But he admits to still getting a big kick out of "making a technical suggestion that works." One associate, Andrew S. Grove, the company's vice president of operations, says Moore's contribution to Intel's success, and for that matter to Fairchild's, is considerably more profound than that.

"Gordon is absolutely the most quietly brilliant man I've ever known," says Grove. "Although he does make technical suggestions—and they are good ones—that's a cheap way of assessing his value to the company. His major contribution is his technical understanding of the future. For example, he'll understand the relative significance of something like the 4-k RAM to the market sooner and better than anyone else in the world. I'll implicitly trust his judgment because time after time his understanding of how some basic technological discovery can be utilized to attack some market segment, and how we can approach it, and the ultimate capability of that technology, turns out to be far better than anyone else's."

This assessment is confirmed by Noyce, president of Intel. "In terms of forecasting technology, Gordon's knowledge is amazing," he says. "He has a gut feel for how to do a job. Although he rarely makes a technical contribution any more—no management does—Gordon's entire history spells out a feel for the flow of technology and how to push it faster."

Another important attribute of Moore's, says Noyce, is his management style. "Gordon is an excellent planner and organizer. More than that, he has the ability to recognize good ideas and good people. One reason that he hasn't received more recognition is that he's always giving credit to others. He gives people their head—with creative people you've got to do this."

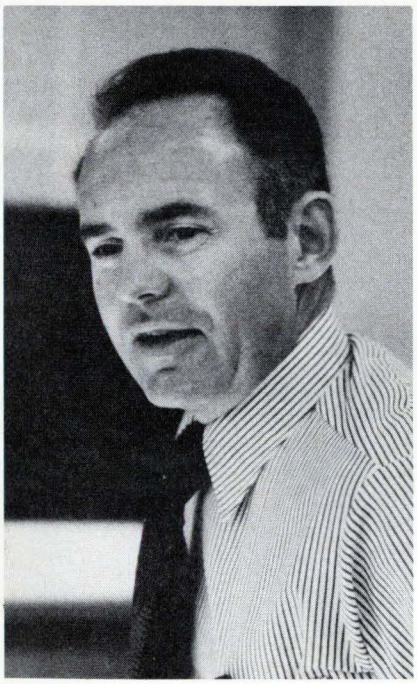
At the same time, he's strict on defining and tracking objectives, Noyce continues. "At Intel, we have very few bootleg projects. Here a development job is not done until a profitable product is established. Under a methodology developed by Gordon, we've become good at forecasting economics of new products. Product planning is done on the basis of an *economic* impact analysis after technical analysis. That's one reason product planning has been so successful at Intel."

Noyce and Grove admire Moore's ability to calmly assess all the alternatives of a decision and make his opinion felt without pushing his weight around. He does get annoyed and angry, but you have to know him well to perceive it. The giveaway, say Noyce and Grove, is a quivering lower lip.

"I've maintained from the beginning that the real force and strength and the one who really runs Intel is Gordon Moore," says Grove.

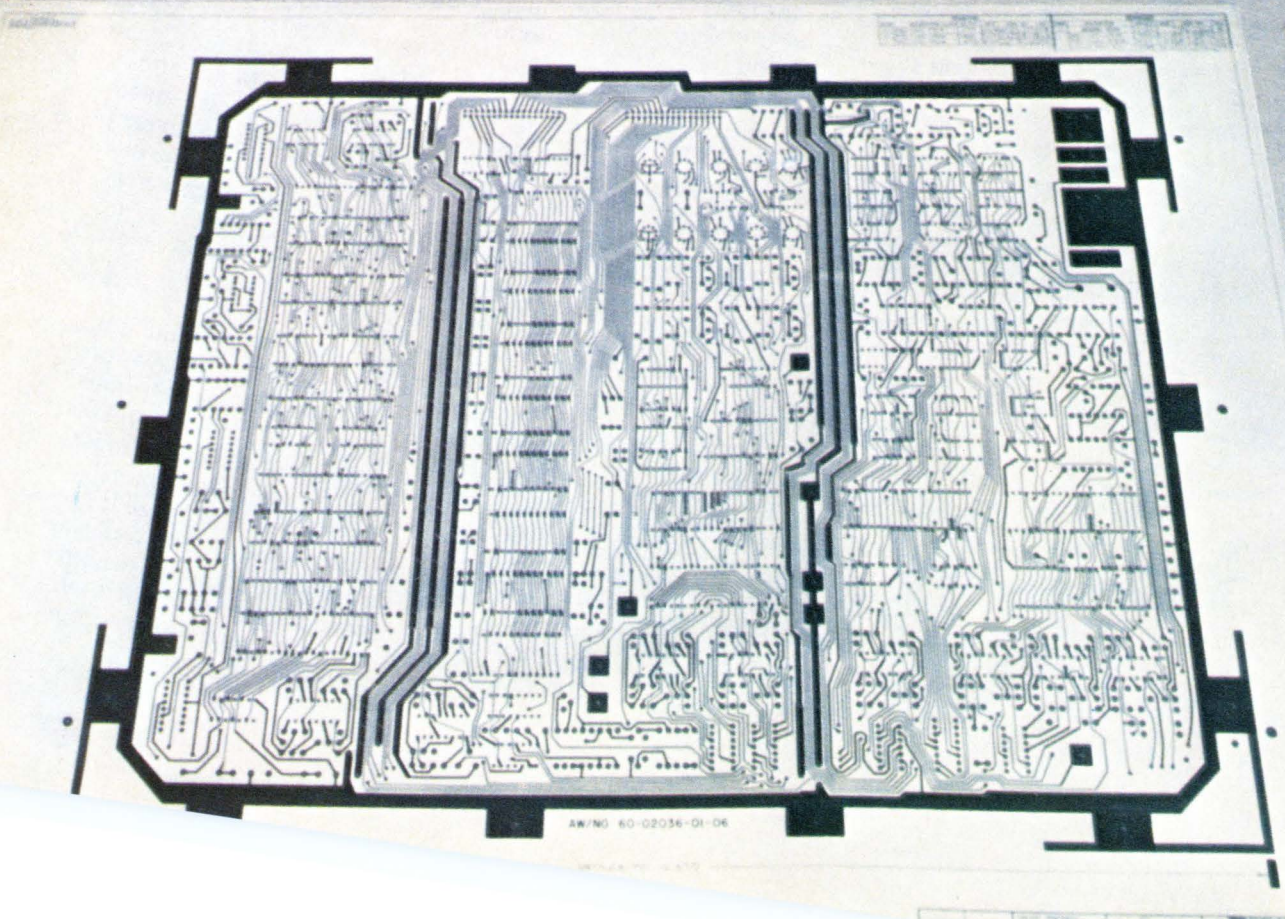
At 45, Moore could pass for seven or eight years younger. In an industry where management is much given to flamboyance and hyperbole, Moore fairly exudes conservatism. And, although he comes across as quiet and introversive, according to Noyce, he has a marvelous sense of humor, usually manifested in outrageous puns.

With his wife Betty, and sons Ken, 19, and Steve, 14, Moore makes his home in Los Altos Hills. From there, he frequently embarks on his favorite nontechnological avocation: fishing. He claims to have fished all over the world, but he's partial to Mexico. Salt water or fresh, worm or dry fly, it makes little difference to Moore: "I'm not a purist about it. I'll do anything to outwit them." □



"I don't look for dramatic changes in technology in the future. I think we get more product fanout from small changes in technology these days. There must be fifty different MOS processes around now that, every other month it seems, one or the other is touted as going to wipe out everything else. Frankly, when you put them all together and look at the tradeoffs, they're really very close together. You end up taking the compromises that are appropriate for one set of applications and others for another set. But nothing coming along will have a wipeout capability."

"CCD is just another MOS device. Neglecting the imaging application, the whole question in memories is whether CCD gives enough of a cost advantage over what you can do with RAMs. Every time you learn to do something with CCDs, it gives us another idea for what you can do with RAMs. For the same cost, the RAM is generally a more powerful function. They're not the same cost yet—the CCD is about a factor of two ahead of the RAM. So the question is—is that enough? I personally think CCD could be an important memory technology, but wouldn't stake my company on it."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"Design flexibility is important. With copper-additive, it's easy to design extra circuitry into our boards. When we want to switch our typewriters from mag card to tape cassette, or switch from editing to communications, we just change a few chips.

"Because we're working with one standard board, assembly is much easier and less costly. Stocking of parts and documentation is simplified. Personnel need a lot less training. And of course, field repair and modification are much easier. In fact, in many cases, I can send my customer a bag of chips and instructions on how to plug them in and test them out.

"All these benefits of the 'mother board' concept would just be wishful thinking, if we couldn't get the density and reliability of photoprinted additive process. So with the help of Photocircuits, I like to think we're one step closer to being number one in word-processing systems."

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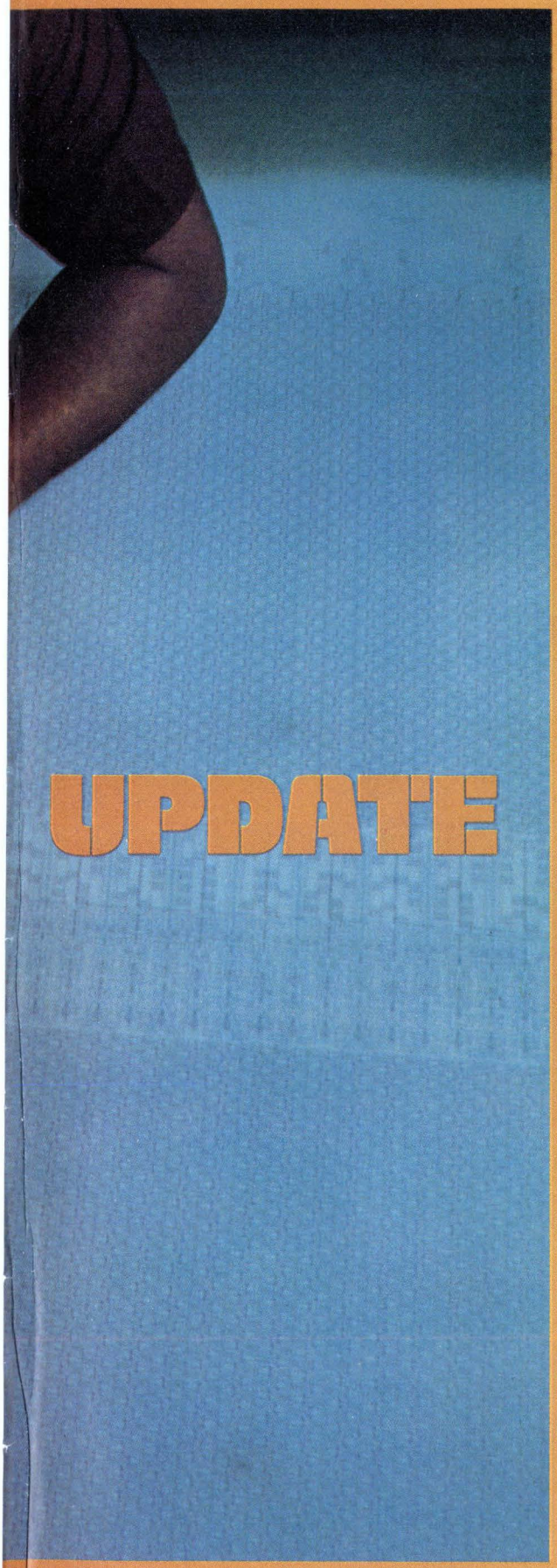


UPDATE

Many of the crucial decisions on how to apply electronics technology are made by the electronic-equipment designer as he faces fundamental choices. Bipolar vs MOS. Microprocessors vs minicomputers. Hard-wired controls vs programable computers. Millimeter-waves vs optical links. Discrete components vs passive networks. Hybrid vs all-solid-state TV. Just gathering the data to make those decisions intelligently can be almost a full-time task.

Yet the dynamic technologies that fuel the growth of the electronics industries just won't stand still. 1974 has yielded a host of important advances in solid state, consumer, and commercial electronics, components, computers, and instruments. These developments herald many changes in product mix, engineering technique, and profit opportunity.

Pinpointing these trends—separating the really significant from the merely novel, sorting out the trade-offs, putting technology into perspective—is one of the hardest jobs facing the engineer today. But that kind of insight can spell the difference between success in the marketplace or obsolescence.

For a technology to succeed, the cost must be right, and above all, the timing must be right. The following pages are devoted to those technologies whose time has come.

COMPUTERS


RUN
STATE
STATUS
AC
MD
MQ
BUS
START
ADDR LOAD
EXTD ADDR LOAD
TOP

Culmination of two fast-growing technologies—computers and solid state—the microprocessor is bringing automation to altogether new applications and is also being used to further boost the performance of minicomputers. Computer networks are putting pressure on the developers of mass-storage systems, and a major attempt is under way to systematize numerous varied software approaches.

☐ The computer industry is growing rapidly on several fronts, but easily the biggest new force for change is the arrival of the microprocessor. Already expanding into wholly new computing applications, it may soon take over some lesser minicomputer jobs. Meanwhile, minicomputer performance is also being boosted by a newly feasible microprogramability, IBM is working on System 370's successor, and computer networks are beginning to provide a range of service unimaginable just a few years back.

- Microprocessors. Combining a microprocessor with other large-scale and medium-scale integrated circuits forms a complete microcomputer on a single printed-circuit board at very low cost. So far, these devices have been limited in performance, and hence in applications, but faster versions with larger instruction sets are becoming available.
- Minicomputers. LSI's most revolutionary benefit here is to make microprograming practicable as the means of internal control—and often accessible to the user, who can thus tailor his machine to his application. Next biggest impact of LSI on minis derives from the new 4,096-bit memory chips, which by now rival the traditional ferrite-core memories even in terms of cost per bit.
- Medium and large computers. The world awaits IBM's next step—its Future System—though recently announced improvements to the System 370 indicate that the FS schedule may have slipped. In the meantime, Honeywell has consolidated its own line of computers with the line purchased from General Electric; Sperry Univac is extending its series 90; and Burroughs has replaced several models in the 700 series with multiprocessing versions claimed to be twice as fast (the central processing and input-output functions are divided between at least two machines).
- Networks. Unquestionably the shape of computing services to come, networks will mostly take the form of value-added systems based on Arpanet's packet-switching concept. At least three commercial value-added networks are under way for the U.S. alone.
- Peripherals. New computational capabilities are putting the pressure on development of mass-storage systems, the most promising technologies in this area being charge-coupled devices, electron-beam storage, optoelectronics, and magnetic bubbles. As for other peripheral equipment, magnetic-tape density is now up to 6,250 bits per inch, and the trend to building small, inexpensive peripheral-equipment controllers right into a main computer's processor is only possible because of the progress in LSI.
- Software. IBM is reportedly working on a totally new System Q that's intended to rationalize and replace IBM's profusion of software lines, and presumably to smooth the transition from System 370 to FS. Q may even achieve that utopian ideal—definition of an application- or price-oriented computing system before assembly of the hardware and software need to turn it into a computer.

by Wallace B. Riley, *Computers Editor*

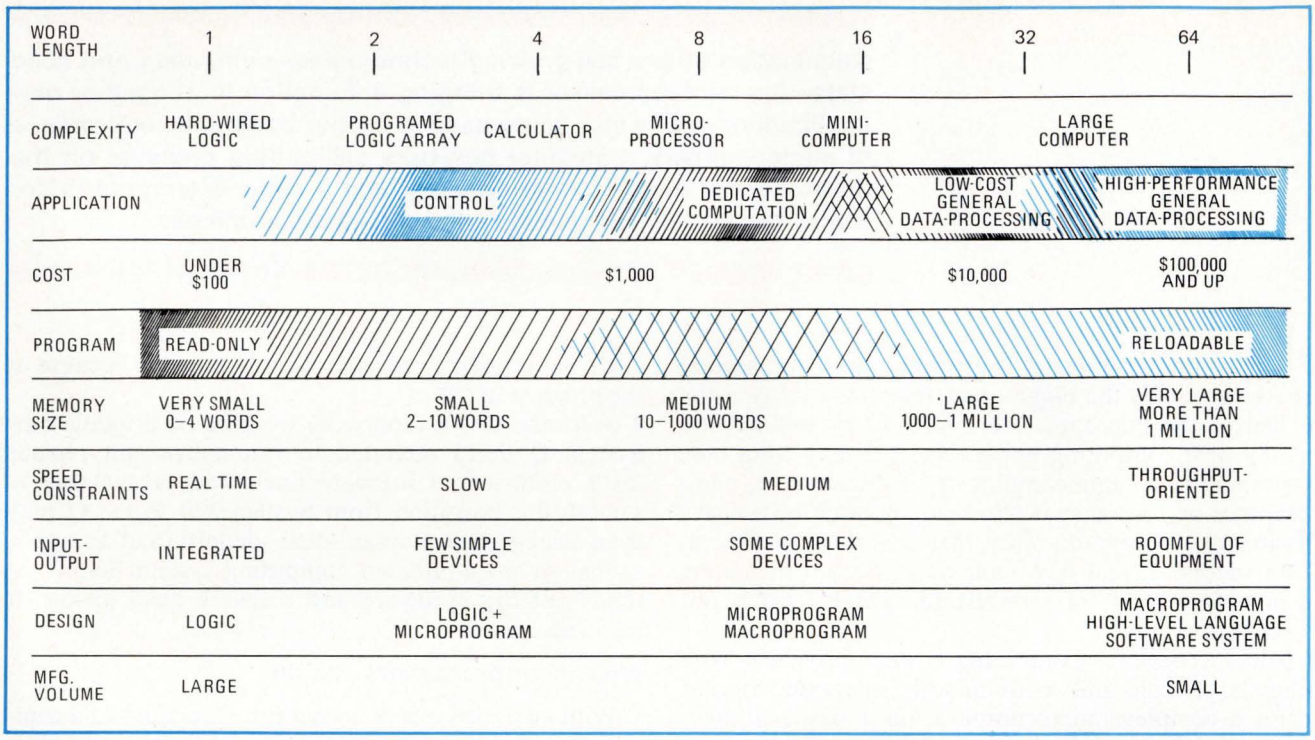
What microprocessors can do

With microprocessors, most of the functions of a computer's central processing unit, which previously were implemented with small-scale and medium-scale integration, have been packed onto one or a few large-scale ICs. This chip (or chips) gives the system designer a new building block for both new and old applications, at low cost and with a lot of processing power. At present, most of them need external memories, registers, and multiplexers, but these functions are already moving onto the chip and before long will all fit on one substrate little or no larger than today's conventional sizes.

Most microprocessors currently available handle either 4 or 8 bits in parallel. The 4-bit units differ from single-chip calculators mainly in being programable (though some fancier calculators do use very simple programs). Because 4 bits can represent a decimal digit, these devices can do decimal arithmetic in serial mode as well as binary arithmetic in parallel mode.

The 8-bit devices can handle both binary and alphabetic data encoded in either 7- or 8-bit form. They were, in fact, originally designed for use in "intelligent" terminals, where the 8-bit format would be very important for alphanumeric processing of the quasi-standard character codes—whether IBM's extended binary-coded decimal interchange code (EBCDIC) or the American Standard Code for Information Interchange (Ascii). The later 8-bit microprocessors are much faster, thanks to their use of n-channel MOS and complementary-MOS technology (see page 138).

Microprocessors designed for alphanumeric processing cannot easily be linked in parallel to handle longer words. The "bit slice" approach, on the other hand, by providing specific data and control inputs and outputs, does allow a single microprocessor to interact with its neighbors, in the same way that adjacent bits interact within it. For example, the overflow from the high-order end of one chip serves as an input carry or other signal to the low-order end of the next. By this means



Spectrum. This depiction of shades of computer-equipment complexity shows room for growth at 2- to 4-bit word lengths. National Semiconductor's new IMP-4 exploits this area; Intel may soon update its trail-breaking 4004 here. (Chart is based on Pro-Log Corp. material).

microprocessors can handle words of more or less indefinite length.

The new 3002 microprocessor from Intel Corp., Santa Clara, Calif., is a 2-bit slice device, and last winter's model 6701 from Monolithic Memories Inc., Sunnyvale, Calif. [*Electronics*, March 7, p. 159] is a 4-bit slice microprocessor. Some microprocessors billed as capable of working with more than 8 bits are, in fact, simply sets of parallel units like these—but some are true single-chip units.

Numeric and alphanumeric processing by 4- and 8-bit microprocessors calls for instructions adapted to handling the 4- and 8-bit data entities as units. But process control, a wide-open area of application for microprocessors, calls for 1-bit processing, which requires a different set of instructions.

The most flexible solution is to adapt the instruction set to the application, by using a microprogram instead of random logic to control the microprocessor, and by making this microprogram alterable by the user. These characteristics need not be self-contradictory—the microprogram can be stored in an external programable read-only memory, feeding control signals in through additional pins in the microprocessor package.

This same approach permits microcomputers to emulate one another or even larger minicomputers. Emulation, in fact, is one way of overcoming a major difficulty with today's microprocessors—that is, that few are compatible, in terms of instruction set and programability or pin numbers and assignments.

Clearly, even today's microprocessors and related devices offer a range of capabilities, and the list of their present and potential applications is almost limitless. Already they're either in active use or under serious consideration for many diverse functions, ranging from programable manipulators in factories to pinball machines [*Electronics*, July 11, p. 81].

Microprocessors have two major advantages: they permit design changes to be made simply by changing the program, and they require fewer parts in a given application than an equivalent hard-wired design.

Whether the program change tweaks up a design or completely alters the system, it's done simply by plugging in a new read-only memory. Any difficulties in writing the new program are on paper only—nothing else need be torn apart. Fewer components, of course, cost less to assemble, can fit on smaller printed-circuit cards, and dissipate less power, contributing in turn to more savings in physical packaging of a system.

Microprocessors differ from hard-wired logic in their design approach, but the difference is mostly cosmetic. Hard-wired logic depends on long-established basic design techniques; but when the engineer graduates to microprocessors, he must implement the fundamental logic in terms of sequences of program steps.

In design terms, this distinction is not basic, requiring only that the logical ideas be viewed as a sequence of steps rather than a combination of conditions. What is radically affected, though, is system performance. Though a microprocessor can execute any desired functions through a sequence of program steps, its limited instruction set makes that sequence long, and its long instruction cycle time makes execution slow. Even when the same circuit family is involved, hard-wired logic is faster.

But the speeds of the more recent microprocessors are rapidly improving. For instance, Intel Corp.'s 8080 is an order of magnitude faster than its predecessor, the 8008.

Motorola Semiconductor Products division makes an n-channel MOS microprocessor, the 6800, in its Phoenix, Ariz., plant that is comparable to the Intel 8080. Meanwhile, Intel has announced a bipolar microprocessor that is 15 times faster than even the 8080. And, early next year, a complementary-MOS silicon-on-sapphire unit almost as fast as the bipolar device is expected from Inselek Corp., Princeton, N.J. [*Electronics*, April 18, pp. 95 and 88; Sept. 5, p. 89; and June 13, p. 35, respectively].

A second problem with microprocessors arises from the common practice of keeping their control instructions in ROMs. The development of prototype designs is slowed by the need to send to the factory for new ROM masks for every program change. The solution is the sort of assembly offered recently by National Semiconductor Corp. of Santa Clara, Calif. Called a field-alterable control element or FACE [*Electronics*, Aug. 22, p. 34], it puts those obdurate control instructions in a programable ROM that can be updated in the field and committed to a permanent masked program only when all debugging is complete.

International Business Machines Corp., Armonk, N.Y., has so far made no move toward using microprocessors, as some minicomputer manufacturers have done. However, it has been suggested that microprocessor technology might well replace some software functions in one of IBM's future products—perhaps the FS computer that's expected in 1975 or 1976. If and when IBM does start building the devices, production will probably be in small quantities at its plant in Manassas, Va., where it now builds large and complex special-purpose devices for specific products such as point-of-sale terminals. The giant factory in East Fishkill, N.Y., is dedicated to simpler ICs for general use in all IBM products.

Mini makers react to micros

The increasing capabilities of microprocessors have not gone unnoticed by the minicomputer industry. This is demonstrated by the addition of a microprocessor module to the line of logic modules made by Digital Equipment Corp., Maynard, Mass. by DEC's rumored plans to introduce a microprocessor version of its PDP-11 computer, and by the use of microprocessors in recent LSI computers by General Automation, Inc., Anaheim, Calif.

Furthermore, as LSI technology develops, the top of the microprocessor market will surely move upward into the area now served by such bottom-of-the-line minicomputers as DEC's PDP-8/A. If so, prudence may put pressure on some minicomputer houses to extend their lines or their levels of service upward—as DEC, Data General Corp., Southboro, Mass., and Interdata Corp., Oceanport, N.J., have already done with their respective PDP-11/45, Eclipse series (see p. 189) and 7/32 computers.

Those minicomputer makers who have not yet made the transition to microprocessors are moving in that direction. LSI circuitry comparable to microprocessors in complexity is a feature of: two versions of the Naked Mini LSI, recently announced by Computer Automation, Irvine, Calif.; a British machine intended to compete with the Naked Mini, called the "Streaker" and made by Computer Electronics Ltd., Saffron Walden, Essex; and the "Micro One" computer from Microdata Corp., Irvine, Calif., that is compatible with the company's older 800 and 1600 computers.

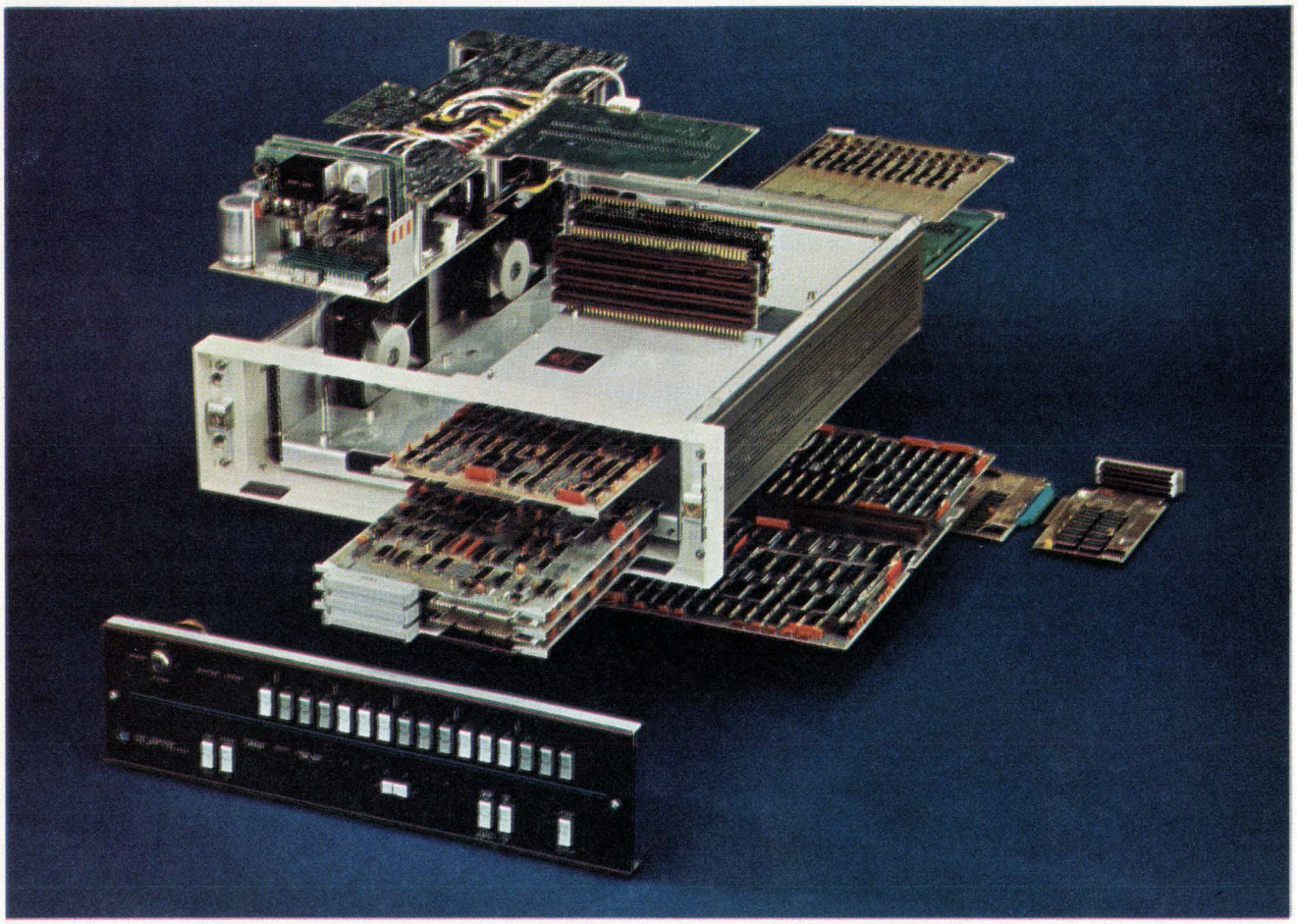
Of special significance in the move to LSI are the large single-chip read-only memories. These ROMs make microprograming practical for control in minicomputers, and microprograming in turn both reduces costs and increases performance—to such an extent that the higher-performance minis today are almost equivalent to some larger general-purpose systems in everything except price.

Furthermore, thanks to the availability of programable ROMs, reprogramable ROMs, and even wholly read/write memories at reasonable costs, users are often given access to microprograms, freeing them to define their own instruction sets to a certain extent. This access was once frowned upon because it threatened to introduce serious bugs into the system. But many users are experienced enough now for that danger to be quite remote—and where the danger still exists, the users are quite capable of exterminating these bugs without outside help.

The outlook, therefore, is for more and more microprogramed minicomputers to appear, with increasing definition by the user of his machine's instruction set and hence its capabilities. He may, for example, choose to include the power to multiply two 16-bit numbers together with a single external instruction in the application program (by suitably encoding a set of microinstructions to react to that external instruction) and decide to dispense with the ability to process strings of bytes, a requirement that a different user with a text-editing application would prize very highly.

The memory function is where LSI is by now having its greatest impact on minicomputer technology. With the advent of the 4,096-bit semiconductor memory chip, the cost per bit has been reduced at least to the same

Large-scale system. One of four models at the top of Honeywell's new Series 60 computer family is this 66/80, the most powerful at level 66. Its maximum memory capacity is over a million words.



Modular. The new 21MX minicomputer series from Hewlett-Packard Co. is designed for simple assembly and easy maintenance. The entire processor is on one board (bottom), while the power supply packs 300 watts at eight voltages on only two main boards and three small ones.

level as that of ferrite-core memories, and perhaps below that level. Intel, in fact, recently announced a 4-kilobit chip for $12—less than ⅓¢ a bit. Hewlett-Packard Co., Cupertino, Calif., was among the first to utilize the 4-kilobit chip in its models 2105 and 2108 [*Electronics*, May 2, p. 87] while Texas Instruments in Dallas has upgraded its model 980 in the same way.

The big prospects

In the area of medium- and large-scale general-purpose computers, the most pregnant question is, "What will IBM do?" IBM, like most large corporations, usually plays its hand of future product announcement plans very close to the chest, but during last year's trial of the antitrust suit brought by Telex Corp., Tulsa, Okla., certain internal IBM documents were made public and revealed plans for a new line of computers dubbed FS (for Future System). These machines were to have been announced beginning in 1975, but some of IBM's recent improvements to current models of System 370 imply that the schedule may have slipped.

Among these improvements is greatly enlarged real memory capacity on several models. The improvements increase the usefulness of the machine for a customer whose needs are growing, so that he's more likely to hang onto it until IBM can begin trying to sell him a new one.

Some observers have inferred from these increased capacities that FS, when it appears, will not have the virtual storage IBM announced with great hoopla only two years ago. Virtual storage, by coupling an external auxiliary memory to a relatively small main memory, provides a computer user with as much memory as he wants, but with reduced performance. The larger the ratio of auxiliary to main memory capacity, the more often must a block of data be transferred from the auxiliary to the main memory. But throughput is kept high only when these block transfers are minimized by having a large main memory and a relatively small auxiliary memory. A study by Datapro Research Corp., Delran, N.J., shows the maximum throughput for a given hardware cost is obtained when the auxiliary memory capacity is no more than one and a half to four times that of the main memory.

This limitation on the usefulness of virtual storage is one basis for the inference that it may not be in FS. Another factor is the huge operating system (software) needed to support virtual storage—and needing, in turn, lots of real memory and lots of overhead time. And, since the trend in memory technology is to bigger and cheaper real memories, the advantages of virtual storage may just not be worth all the floundering.

On the other hand, FS is to have a new operating system called Q. The software is said to be huge and, if so,

Big computer, small package. Two new Interdata machines, the 7/16 (top) and 7/32, are 16-bit machines internally, but the 7/32's organization makes it look to a programer like a 32-bit machine. Its instruction format, in fact, resembles that of the IBM System 370.

Omen. Hewlett-Packard's 2108A is among the first commercial systems to use 4,096-bit MOS memory chips. These chips now have a per-bit cost equal to or less than that of ferrite cores.

will need plenty of auxiliary storage, suggesting the need for automatically relocating its modules in the main memory—and relocatable memory is almost the same as virtual memory.

The Bunch

But IBM is not the entire computer industry. There's also the Bunch (an acronym for Burroughs-Univac-NCR-Controldata-Honeywell), which among them have somewhere between a quarter and a third of the market and whose plans will also affect the outlook for computer technology.

Honeywell Information Systems Inc., for example, with its introduction of the Series 60 last spring [*Electronics*, May 2, p. 81], has brought together its own line of computers and the former General Electric line, acquired in 1970. However, the new line still has a gap, in which the company's next model in this series will presumably go.

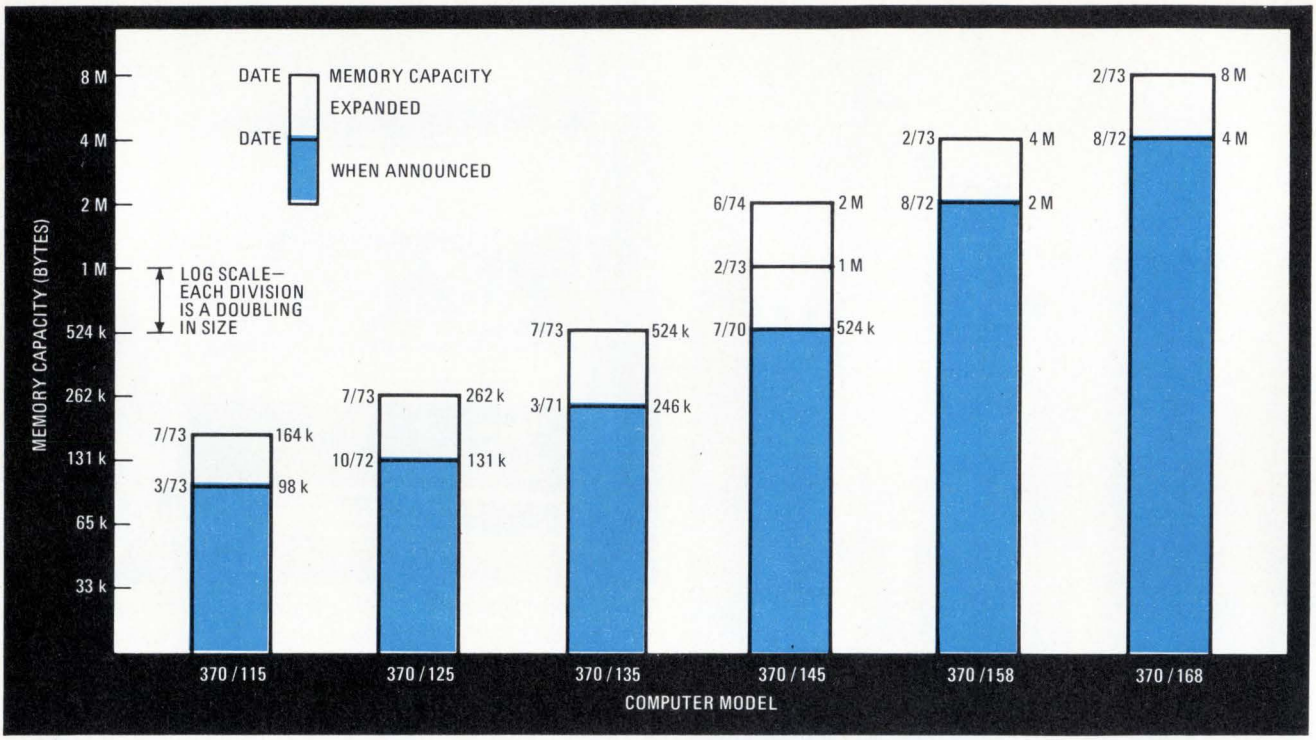
By the end of the year, Sperry Univac, Blue Bell, Pa., may well have a fourth model in its Series 90 line, which is remarkable for spanning the performance spectrum of all other machines on the market, if Univac's claims are correct. In particular, the 90/30, newest and smallest of the series, matches much of its competition in performance but beats all of it in price.

Recently Burroughs Corp., Detroit, Mich., began upgrading its four-year-old 700 series with new models of the top-of-the-line 7700 and the medium-size 4700. Various combinations of central and input-output processors at both levels make up extensive and powerful multiprocessing systems, with twice the throughput of the earlier versions. A straw in the wind is Burroughs' use of what it calls a "bipolar local memory" in front of the main memory in the 7700—essentially the same functionally as IBM's "high-speed buffer memory," which is widely known as a "cache memory." IBM has been using the technique in its largest machines since 1968, but was only recently joined by Honeywell in the Series 60 and now by Burroughs.

More and bigger networks

Mushrooming development of networks and communications services is under way and will surely continue. Already, for example, Control Data Corp., Minneapolis, Minn., operates a dozen or so separate computer networks, and has even brought out a new line of computers, the Cyber 170, with which it plans to consolidate its position and eventually to combine all its service operations into one network. Telenet Communications Corp., of Washington, D.C., the commercial spinoff of the Arpanet, the network of the U.S. Department of Defense's Advanced Research Projects Agency, says it is proceeding on schedule with its plans to have a seven-city network operating by January, and 18 cities connected by the end of 1975. Packet Communications Inc., Waltham, Mass., the similar venture started shortly before Telenet by former employees of Bolt Beranek and Newman Inc., is making progress but admits its target of 18 cities by next summer may not be reached, because venture capital is scarce. Plans for the similar Cyclades and Hermes packet-switching networks in Europe have been announced and construction is under way [*Electronics*, Feb. 21, p. 56, and March 7, p. 52].

Meanwhile, although IBM's specific intent is not yet



Growing, growing . . . In IBM's System/370 computers, memory capacities have all consistently increased, some recently and to very impressive levels. They make the machine more useful and may portend a delayed introduction of IBM's next computer family.

public, the company disclosed plans to get into the communications satellite business by joining Comsat Corp. in a joint subsidiary [*Electronics*, July 11, p. 26].

But, to get back to the large individual machine, large-scale integration is simplifying its design, too. Integrated controllers for peripheral equipment are in growing use and are so small that they can be built right into the mainframe along with the central processor. IBM, for example, has incorporated integrated controllers in several System 370 models, while other manufacturers now also use the technique—notably Honeywell, in some models of its new Series 60, and Univac in the System 90/30. Since the practice also saves dollars, it will unquestionably continue and grow.

Whatever IBM does or does not do about virtual storage, the need for mass storage continues to grow. And now, after years of fits and starts in various technologies, real mass storage may finally arrive.

A mass-storage unit may be defined as anything that can store a trillion (10^{12}) or so bits, accessible (perhaps slowly) in large blocks that, once located, can be transferred into a local memory fast and at a cost of thousandth of a cent or less per bit. Even a much smaller 50-billion-bit unit would still have 10 times the capacity of the largest configuration of the IBM 3330 disk unit. But any mass-storage system would probably have a high initial cost, so that capacities much below 50 billion bits would have a cost per bit too high to be practical.

Although past attempts to build mass-storage systems have basically been mechanical amplifications of conventional storage techniques, the greatest promise for truly inexpensive (per bit) and truly massive memories is in electronic and other non-mechanical technologies. These include charge-coupled devices [*Electronics*, Aug. 8, p. 91]; electron-beam memories, which scan semiconductor devices with electron beams for both reading and writing [*Electronics*, Oct. 3, p. 44]; magnetic bubbles, and the related but distinctly different domain-tip propagation. (Only Cambridge Memories Inc., Concord, Mass., is currently developing the domain-tip technology, and it has one unit in a customer's facility for testing).

The interest shown a few years ago in laser holographic memories has largely died out, because of optical and materials problems and the cost of suitably powerful lasers. Nevertheless, the laser is the basis of the Unicon, which was recently rejuvenated by Precision Instrument Co., Santa Clara, Calif., after a long and difficult development-redevelopment period [*Electronics*, July 25, p. 30]. The company claims to have several orders already for its new version, which it will begin installing before the end of 1974.

International Data Corp., Newtonville, Mass., points out that the whole mass-storage concept may yet suffer a substantial delay, because IBM has not recently expressed much interest in it. IBM apparently plans to stay with rotating disks for the time being, perhaps at storage densities higher than today's.

High-density tape

The storage density of magnetic tape happens also to be an area being heavily researched. By now it's possible to pack 6,250 characters into a single inch of tape and to run the tape at 200 inches per second, producing a data transfer rate of 1¼ million characters per second. Only IBM and Storage Technology Corp., Louisville, Colo., have such equipment in production, although

several other companies have said that they are investigating it.

Achieving such a high density requires the format of the data recorded on the tape to be radically different from the format in which it emerges from the central processors. But when the data is read, it is unscrambled so that what goes back to the central processor is identical to what came out, more reliably, IBM says, than ever before with magnetic tape.

Is such a high-density tape system really useful? Doubtless some special applications can profit from it—for example, research in nuclear physics, which already demands the largest and fastest computing equipment available and requires vast quantities of data to be recorded in a very short time. For such applications a density of 20,000 b/in. is said to be not only feasible but necessary, and will probably be developed within a few years, in a unit that writes fast and reads slowly. High-density magnetic tape also has certain advantages because it is physically compact.

But it has its disadvantages, too. It's of little or no value for multiple data sets, which must be kept on separate reels for independent access. Though useful in making long records more readily available, it's much less important than a reduced inter-block gap for shorter records. And a shorter gap can be achieved only through mechanical innovation.

Furthermore, in the many applications of magnetic tape that require lower speeds, high density is not an advantage. So, whether more high-density magnetic tape appears soon depends on how tightly the independent manufacturers hold to IBM compatibility.

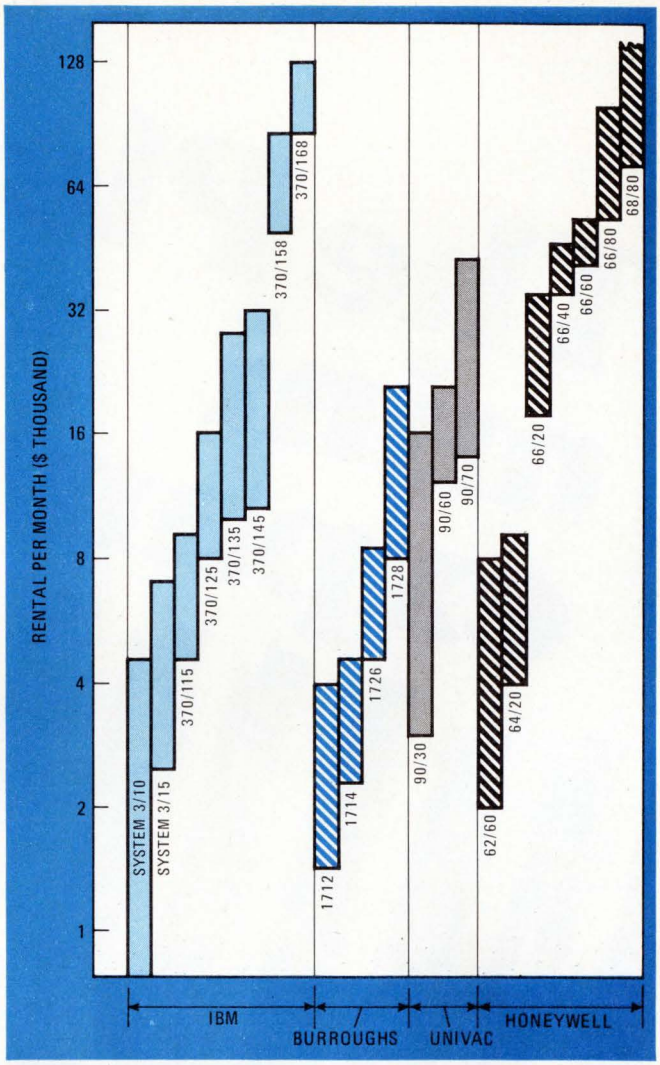
Software outlook

The next big step in software development will be IBM's operating system Q. According to some estimates, Q may be announced late in 1974 or early in 1975. One of Q's purposes is to smooth the transition from System 370 to IBM's next hardware family, FS, another development that came out during the Telex antitrust suit.

Computers today depend on operating system software to keep them running. But with a multitude of different systems for large computers, small computers, multi-processing, virtual storage, and a variety of other special cases, IBM faces a software problem very much like the hardware problem it had 10 years ago, before the 360 announcement. It faces a proliferation of different lines, with lots of overlapping and confusion as to which software package is best for a particular application. IBM hopes Q will rationalize things.

IBM probably expects Q to meet the requirements of the marketplace for 10 years or more, as it did the 360 in its day. But the 360 lasted only six years before being eclipsed by the 370; and now 370, after perhaps five or six years, may yield to FS. Will Q fare any better?

Q will render all previous IBM operating systems obsolete, just as 360 obsoleted the hardware that IBM had been selling previously. But unlike 360, Q will not obsolete the programs written to run under the old system. Its hallmarks will be utility by the nonprofessional user, availability, opacity (so that the casual user knows only that his problem is being solved, not how or where), and



Families. Wide range of equipment is available from major computer manufacturers. Comparison reveals that lines built by Honeywell and IBM have gaps, which, however, are likely to be filled soon.

across-the-board applicability to all FS computers, both large and small.

One characteristic of Q will be what system designers have been shouting about for years but have never quite attained—the design of hardware *after* the software has been put together with an eye to what the market needs. This may result in an FS assembled in a series of price levels—a $1,000 system, a $10,000 system, a $100,000 system, and so on—with hardware boxes and software modules chosen for each specific application.

If and when Q does show up, if these prognoses are even slightly accurate, it'll have a substantial effect on at least some parts of the computer industry. The software industry may not be seriously affected, because most software houses don't produce operating systems—the manufacturers provide them without charge, so there's no percentage in it for the software houses. If FS is organized differently from system 370 to get the most benefit from Q, the independent peripheral manufacturers and those whose business is interconnecting IBM computers with front-end minis may find themselves in a new ball game. □

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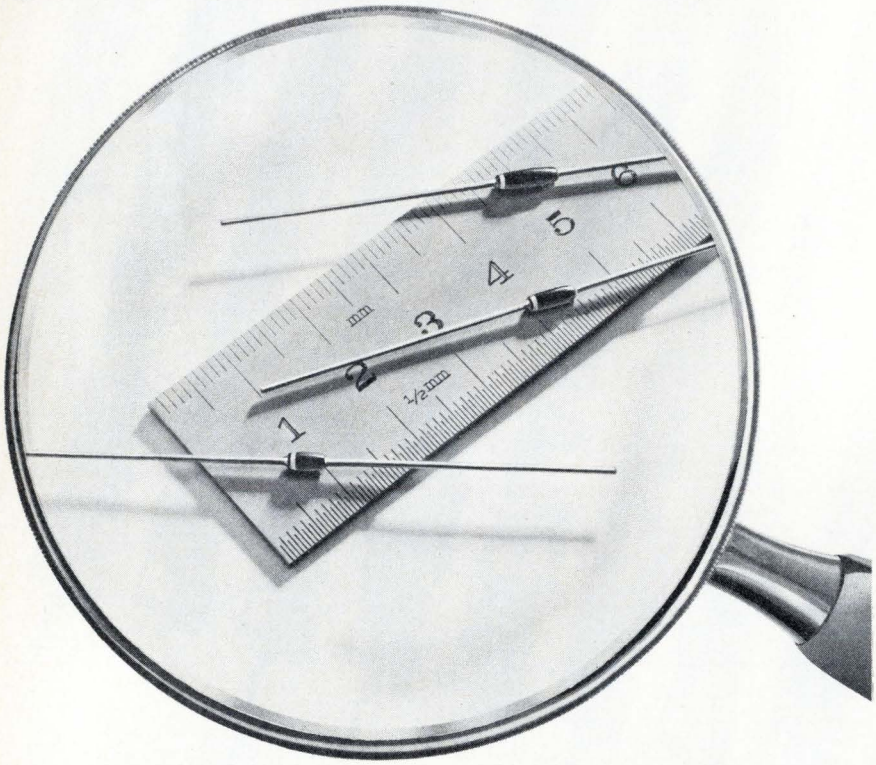

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COMMUNICATIONS

To counter the threat of overcrowded communications channels, at least two millimeter-waveguide systems are now being installed, and experimental wide-bandwidth fiber-optic systems are already under construction, since the attenuation problem is nearly solved. To lower costs, there are moves towards digital communications and the use of satellites as broadcast terminals with continent coverage.

☐ Domsat, an acronym used to describe domestic satellites, could just as well represent four words describing the leading edges of communications technology: digital, optics, millimeter waves, and satellites. More messages—both voice and data—are being carried in digital format because of the cleaner signals resulting from complete regeneration at repeater locations, and because the cost of digital integrated circuits has been brought lower than equivalent analog circuits. Optical communications are on the verge of fulfilling their long-heralded promise of providing broader bandwidths to handle greater amounts of information in a transmission channel. Millimeter waves are being exploited to relieve spectrum crowding at the lower microwave frequencies, as well as for large bandwidth. And satellites are coming into use as lower-cost alternatives to long-distance terrestrial links, and as broadcast terminals covering wide areas of the earth.

Traditionally, things have changed slowly in the communications field. The Federal Communications Commission has always moved deliberately because of the far-reaching and sometimes unclear implications of its decisions. Common carriers have installed equipment with planned lifetimes up to 40 years or more, and seldom have committed equipment far ahead of a real need in the market place.

The pace of change is quickening, however. Specialized common carriers, including the proprietors of the new domestic communications satellites, are now coming on line with their service offerings. The military, always a goad to improving technology, is adding an extra measure of stimuli to optical communications and higher powered solid-state microwave devices. Finally, the problems of communications technology have still another boundary—the electromagnetic spectrum. Frequencies below about 10 GHz are crowded today. In the next few years, there will be much happening in the open spaces up to 30 GHz and even beyond. But there is simultaneously a move to leapfrog the intervening frequencies all the way to the optical range.

Through the fibers

In the optical range, just as Morse's telegraph wire preceded Marconi's wireless radio, fiber-optic cables will precede through-the-air transmission of optical communications signals.

Fiber optics is not a new technology, but developments in recent years have placed it at the forefront of new communications systems. Fiber attenuation has dropped dramatically—from thousands of decibels per kilometer to tens of decibels, and recently even lower, to about 2 dB/km at some optical wavelengths. Attenuation has been decreased to such a point, in fact, that some designers are now becoming more concerned with how the fiber distorts the signal.

In terms of operation, fiber-optics technology now is at the "test-bed" stage. Many electronics R&D facilities have assembled experimental fiber-optics systems to study what the tradeoffs might be.

The military is also playing an important role in advancing this technology. Besides the large bandwidth, what makes fiber optics attractive for military applications is its immunity to electromagnetic interference. Probably the leading military establishment in the fiberoptics field is the Naval Electronics Laboratory Center in San Diego, which earlier this year installed a voice-band communications system on a ship [*Electronics*, Feb. 21 p. 36]. The Air Force also has test-flown multiplexed data systems using fiber optics. Next year, an aircraft will be equipped with fiber optics to carry navigation and weapons delivery signals to the cockpit [*Electronics*, Aug. 22, p. 69].

Corning Glass is experimenting with single-mode fibers with losses down to 2.1 dB/km at a wavelength of 1.05 μm. Bell Laboratories recently announced it had developed fibers with losses as low as 0.85 dB/km at 1.06 μm. The losses in the Bell Labs cable rise steeply to 10 or 12 dB/km at the hydroxyl-ion absorption peak at 0.95 μm, but then drop off to about 2.3 to 2.8 dB/km at about 0.85 μm. The Bell Labs fibers are made with a chemical vapor deposition method using a pure silica core with borosilicate cladding. The core diameter is in the 30 to 40 μm range (about 1.2 to 1.6 mils).

The size of the bundle is directly related to the size of the light-emitting diode that drives it, and LEDs are now larger than the bundles. There's also a relationship between fiber attenuation and the solid angle in which it accepts light. A low loss fiber cable with losses of about 30 dB/km has an input half angle of about 8 degrees. However, a higher loss fiber, such as one in the neighborhood of 400 dB/km, has half angles of about 41 degrees. Thus, for short lengths (say less than 100 feet) it may be better to use the higher loss cable because it picks up more light to begin with.

Earlier this year, incidentally, Corning developed a device to couple several terminals to one source [*Electronics*, March 21, p. 34]. Called the Star Coupler, it uses a cavity with a mirrored end-face to fit over the

by Stephen E. Scrupski, *Communications & Microwave Editor*

Microprocessor controls. International Communications Corp.'s new 40-plus data terminal uses a microprocessor to control all functions and also allows quick redesigns to fit customer needs.

ends of several optical fibers. Light from one fiber is reflected evenly to all the others. The coupler was recently test-flown in an Air Force plane as part of an on-board data multiplex system.

One of the most unusual systems being studied is a program at Rome Air Development Center. It involves a fiber-optics system to carry radar data to the ground from a balloon tethered at a height of 12,000 feet (about 4 kilometers). According to RADC engineer Allen Clough, the Air Force uses microwaves for communications between balloon-borne radar systems and ground equipment. The trouble is the microwave equipment is heavy, consumes much power, could cause interference with nearby systems, and is less secure than a wired connection. Also, since the microwave transmitter gets its power from an on-board gasoline generator, if the transmitter could be eliminated, the balloon could go for longer periods before it must be brought to the ground for refueling.

RADC therefore is considering testing the concept of a 4-km fiber-optic cable dangling to earth and carrying the radar data. According to Clough, fibers with about 10 dB/km losses might be acceptable.

Millimeter waves breaking

The Bell System has begun installing what it feels will be the long-distance medium of the '80s—a millimeter-wave waveguide system. A test installation, composed of 20 miles of waveguide, is now being installed in northern New Jersey. Actual tests will begin next year on the 2.5-inch circular waveguide, which Bell says will eventually have a capacity of 500,000 conversations in a frequency band from 40 to 110 GHz. (By comparison, the newest frequency-division multiplex coaxial cable system, the L-5, carries 108,000 conversations in 20 coaxial tubes in a frequency range from 1.6 to 69 MHz and has repeaters at 1-mile intervals).

A waveguide system is being planned in Germany between Heidelburg and Darmstadt by the German Post Office over a 26-mile link [*Electronics*, Feb. 21, p. 55]. Using a waveguide with a diameter of about 2.75 inches (7 centimeters), the link will also carry up to about 500,000 conversations and require no repeaters in the entire length.

A millimeter-wave short-haul system for intracity hops from building to building was introduced earlier this year by Norden division of United Aircraft [*Electronics*, April 18, p. 30]. The units are undergoing type testing by the FCC, although a few sets are now being used under a developmental license. The company expects to upgrade the system by extending the range from 3.5 miles to about 6 miles. They also are hoping for more operational experience in rain to develop statistics on the reliability of the link.

First approach

Norden had been waiting until the FCC issued its docket number 19311 before sending in its equipment for type testing. Docket 19311, issued late last month [*Electronics*, Oct. 3, p. 63], covers digital modulation at microwave frequencies. This is the first time the FCC has approached the problem. It sets standards on out-of-band emissions, frequency stability, etc. for all frequencies in the microwave range, although it is less stringent for equipment operating above 15 GHz than below (because there are many analog systems at the lower frequencies).

Although the long wait for the final decision on 19311 may have held back some designs, most companies felt confident enough about the outcome to go ahead and design equipment.

Raytheon Data Systems recently introduced a digital transmitter for the 12-GHz band that uses an Impatt amplifier produced by Raytheon's special microwave devices operation (formerly Microstate). The amplifier uses a four-stage Impatt diode amplifier as the output device and delivers up to 2 W at about 12 GHz. The components are mounted on a ferrite substrate, which also provides the active material for the circulators and isolators.

The Bell System announced its Dataphone Digital Service (DDS) earlier this year to provide end-to-end digital service at rates up to 56 kilobits per second [*Electronics*, April 4, p. 75]. The system uses data-under-voice techniques for microwave transmission of digital information. The FCC has asked AT&T to delay system operation until it completes its studies, since the rates that Bell set have been contested by the specialized common carriers.

One of the specialized common carriers, Data Transmission Co. (Datran), Vienna, Va., announced that it would add time-division-multiplex switching capability to its network early next year to allow any computer on the network to contact any other computer in less than one-half second. The switch also will allow Datran to bill customers only for the time they use to transmit

Buried waveguide. AT&T is installing a 20-mile test link of cylindrical millimeter waveguide in northern New Jersey. The waveguide eventually will carry up to 500,000 telephone conversations in a frequency range from 40 to 110 MHz. Actual operation will begin in the 1980s.

Gale has moved to California.

THE REASON:

Excellon Automation acquired Gale Wave Soldering Systems and will make them in Torrance.

With Gale now one of its products, Excellon Automation continues to offer the finest equipment to the p.c. board industry.

Sometimes referred to as U.S. Patent No. 3,589,590, the unique Gale oil intermix design is the heart of the Gale wave soldering system. No fussy valves, no metering, no oil waste, no splash.

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Intermix is controlled directly by pump speed . . . no valve to clog.

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Gale foam fluxers provide optimum wetting with gentle bubbles that coat deep holes and eyelets evenly.

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Solid PVC construction is impervious to corrosive fluxes. Contamination-free.

Anti-drip brush prevents excess flux from dripping onto preheater, and is easily removed for cleaning.

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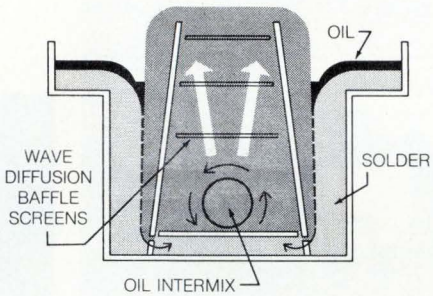
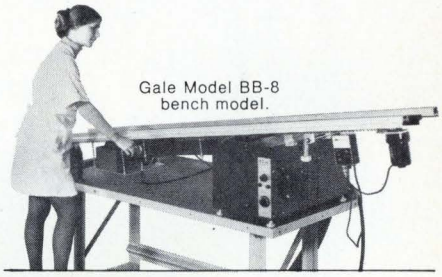


Preheaters

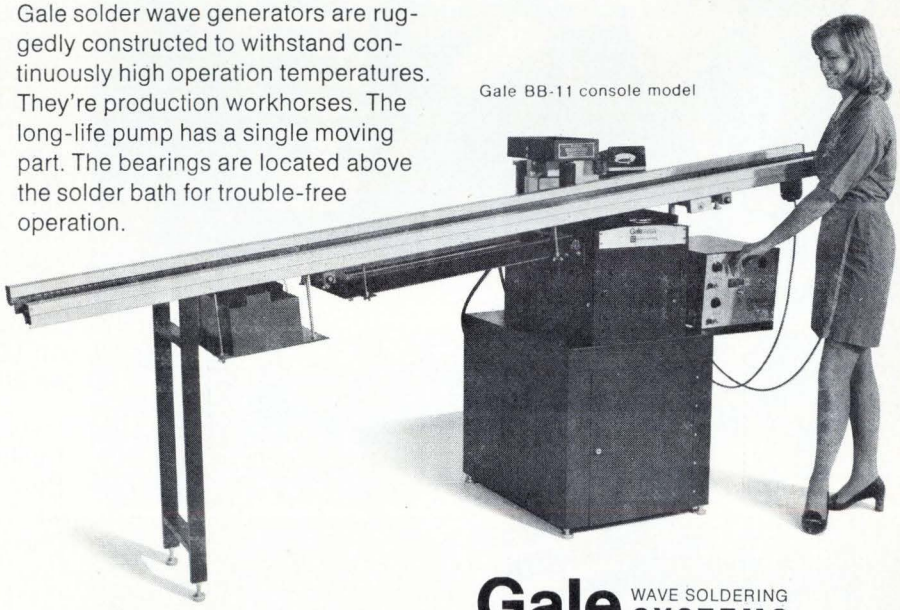
Gale's 30-inch long preheaters are full width of conveyor, allowing faster conveyor speeds for increased production rates. Infinitely variable heat control, adjustable height and hinged for safe and easy cleaning, even while elements are hot.

Wave Generator

Gale solder wave generators are ruggedly constructed to withstand continuously high operation temperatures. They're production workhorses. The long-life pump has a single moving part. The bearings are located above the solder bath for trouble-free operation.



Gale Model BB-8 bench model.



Gale BB-11 console model

Conveyors

Palletless or pallet operation . . . the Gale system is equally versatile. No tooling or special fixtures are required. Simultaneous pallet and palletless operation, with various board sizes, double row setup permits side by side running of different size pallets. Result: Total flexibility regardless of board size and shape variation.

The Gale wave soldering system is most impressive. That's why Excellon Automation brought it into its family of quality products. It's a good move.

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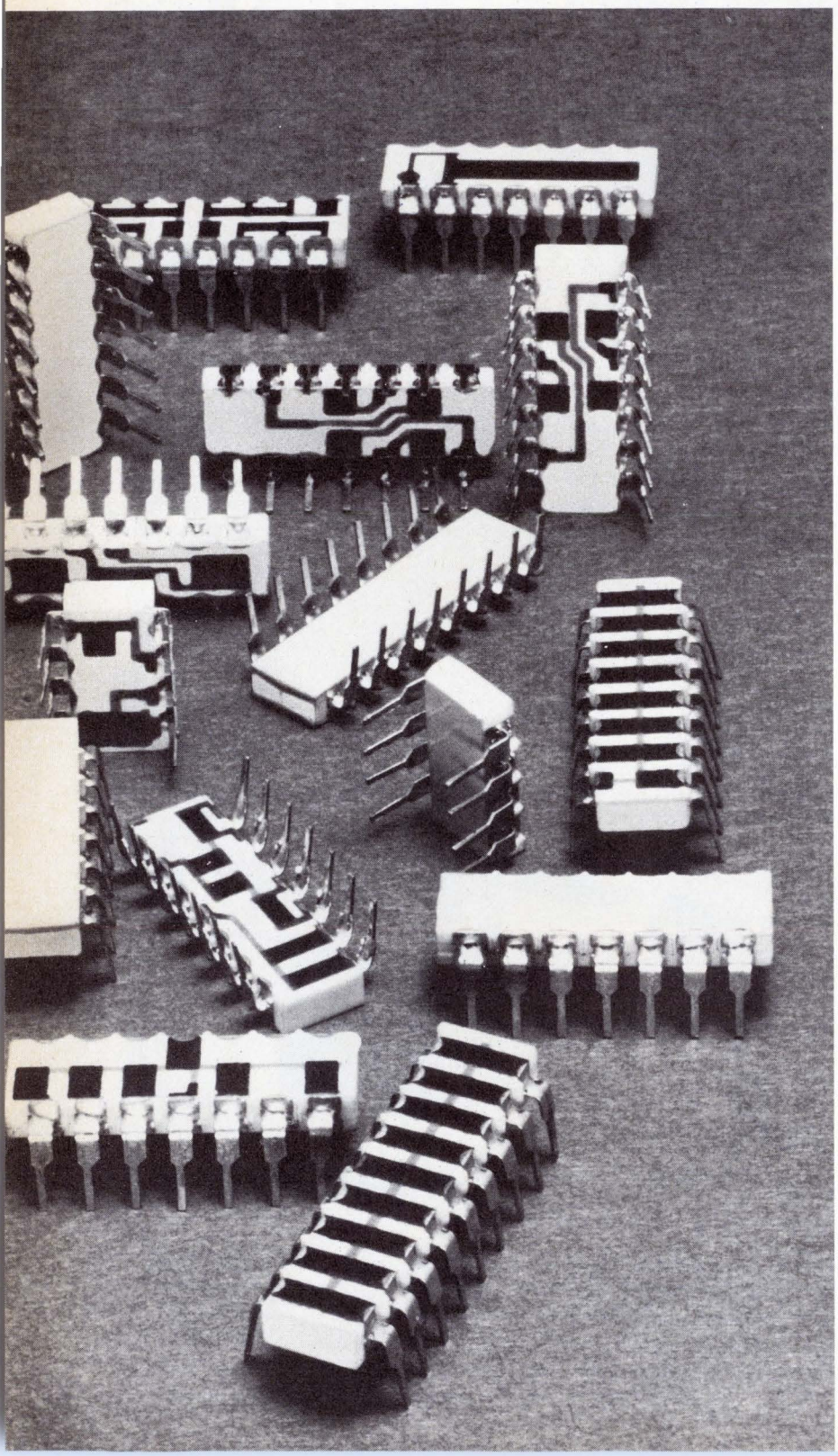

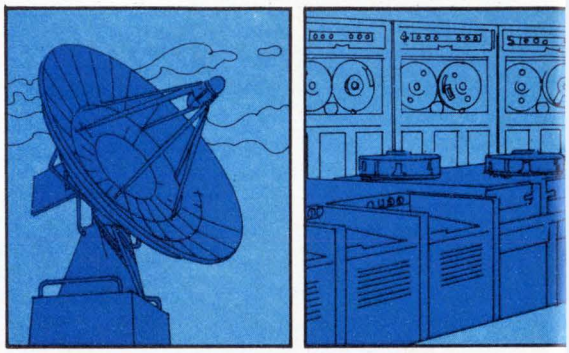

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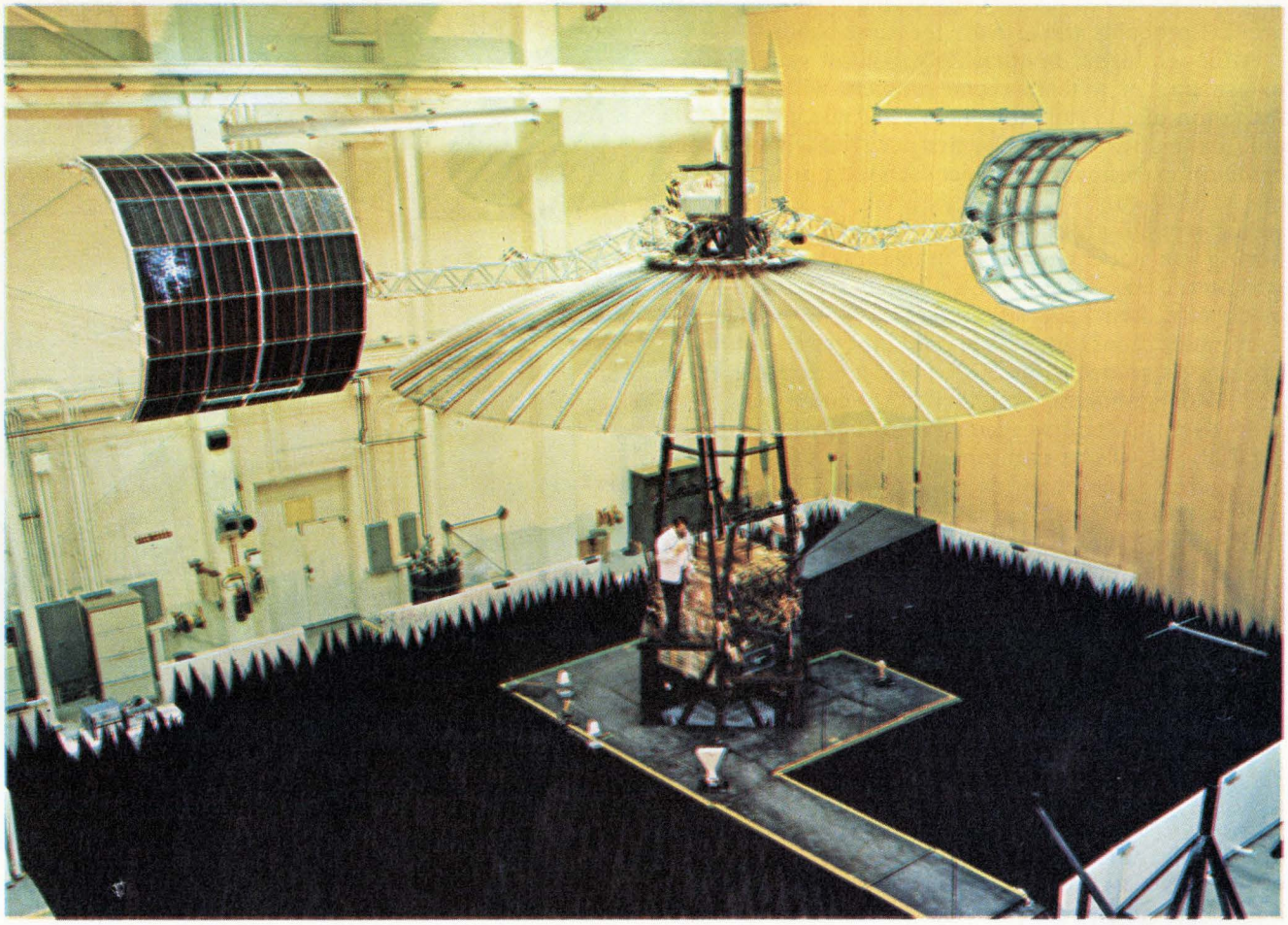

The way it was. NASA's ATS-F satellite undergoes tests before launch last May. Now in orbit, the satellite is being used to test such concepts as maritime navigation and educational-television broadcasting to remote areas in Appalachia and the Rocky Mountain states.

data. The company says that the switch will serve more than 10,000 customers and can handle up to 80,000 non-blocking calls per hour.

In space, meanwhile

There are now two satellite systems serving North America—Telesat Canada's Anik satellites and Western Union's Westar. Both operate in the 4 and 6 GHz bands. Next year, RCA Global Communications and its subsidiary, RCA Alaska Communications Inc., plan to launch their own satellite. In the meantime, they have leased channel space on Anik II and now are serving customers. Similarly, American Satellite Corp. has leased channel space on Westar I and is also selling time to customers [*Electronics,* Oct. 3, p. 95].

Communications satellite technology is about to move into a second generation, using cross-polarized signals to double system capacity, digital modulation, and higher frequencies.

The Intelsat 4-A, which will be launched in mid-1975, will use two separate beams, each operating at the same frequencies, aimed at the eastern and western regions of the North Atlantic. They will thus "reuse" the same 500 MHz bandwidths at 4 and 6 GHz, since neither beam will interfere with the other. The antenna, now being built by Hughes Aircraft, will "probably be the most complex antenna ever built," according to Hughes's Ralph Mitchell. It will have about 100 feeds (by comparison, Western Union's Westar I has four feeds—three combine to cover North America, while one shoots a spot beam to Hawaii).

The AT&T/GSAT satellite, planned for launch in 1977 (pending FCC approval), also will reuse frequencies, but with a cross-polarization system. The antenna uses two reflectors, one for each polarization, horizontal and vertical. The spatial coverage for each reflector overlaps the other, so the satellite can provide 1,000-MHz bandwidth up and 1,000 MHz down, from the basic 500 MHz for each reflector.

The move toward higher frequencies is being stimulated by the crowded conditions in the 4- and 6-GHz bands, which satellites share with terrestrial microwave links in the U.S. The Communications Technology Satellite, a joint U.S.-Canadian project to be launched next year, will include equipment to transmit in the 12-GHz band and receive in the 14-GHz band. General Electric is developing a satellite that will be used to broadcast television signals in Japan in the same band, and the European satellite that will be eventually launched to provide telephone communications in Europe will probably use the same bands.

Even higher frequencies are in the offing. AT&T is considering the 18 and 30-GHz bands in its second generation of satellites, and the Japanese communications

satellite probably will also use the same bands.

Although higher frequencies will allow earth stations to use smaller antennas, one problem will be the attenuation due to rainfall. There's not much data available in this respect, so the first AT&T satellite will include an experiment to collect such data at frequencies of 19 and 28 GHz.

For satellite ground stations, work continues on reducing the noise figures for transistor amplifiers. For parametric amplifiers, there's a steady trend away from cryogenics. Len Lazarus, marketing manager for LNR Communications, Inc., explains, "there is not much pressure to go below the 50-K noise temperature of the uncooled parametric amplifier." Antennas may get a little larger to improve gain, Lazarus says, but the increased cost will be more than offset by the savings of not having to maintain a cryognics system. He points out that three-fourths of all the amplifiers that LNR makes, which are all parametric, are already non-cryogenic. "It won't be long before that's 100%," he says.

Mobile systems static

Until the FCC settles the disputes over its decision on new spectrum space for land-mobile use, there will probably be few new developments in this field.

In May, the FCC opened 115 MHz, between 806 and 947 MHz (26 MHz in that band remained for industrial, medical, and scientific uses), giving 40 MHz to the wireline common carriers, 30 MHz to private users, and keeping the remaining 45 MHz in reserve.

The radio common carriers (RCCs), which offer paging and radiotelephone services in the lower land-mobile bands, and who were "left out in the cold," according to one observer, have asked the FCC to reconsider. Their main objection is that equipment suppliers, such as Motorola Communications division, Schaumburg, Ill., and General Electric Communications Products department, Lynchburg, Va., will be able to offer services in competition with the RCCs, but will be unregulated under the new rules. Industry insiders, however, expect the commission to revise the rules, although no one seems sure just what the changes might be. They point out that two new commissioners have joined the FCC since the May decisions.

AT&T also has asked the FCC to reconsider its decision. AT&T says that its cellular mobile-radio system was designed on the basis of a 64-MHz band and the 40 MHz that the FCC has assigned them will result in a 50% cost increase and a 40% drop in capacity. Until the FCC responds to this, AT&T probably will not begin the trial runs in a 12-MHz band that the commission originally asked the company to perform.

However, Motorola is going ahead with its Dynatac hand-held radio telephone. Martin J. Cooper, director for systems operations, says, "We will have conventional mobile radios in 900 MHz within the next year, and we will be creating a new concept, called multi-user dispatch systems, that will encompass from 5 to 20 two-way radios and give shared access to many users."

With the advent of the microprocessor, the designs of communications terminal equipment, from data modems to police-car radios, has begun to change. Moving hand-in-hand with the growth of digital communications, microprocessors are taking over many of the routine message-handling chores that previously were done with wired logic, or, as in a communications base station, by a minicomputer.

Ship talk. Marisat, the maritime satellite, will be launched next year for communications to merchant and naval ships.

In a new data display unit built by International Communications Corp., Miami, Fla., an Intel 8008 microprocessor directs all the terminal operations. It allows an operator great flexibility in editing messages before transmission and also allows the company to tailor each system for each specific customer.

Using microprocessors requires more than reading the manufacturer's spec sheets, however. As John Scott, director of engineering for computer products at International Communications, puts it, it was his group's own experimentation with the Intel chip that accounts for the flexibility built into the display unit. "We have taken advantage of a number of things that we found out about the device in 'playing around' with it," he says. "The significant point is that we have succeeded in making it the heart of the system and of combining every control function in the memory."

Motorola Communications division is using a microprocessor in the base station of a police radio system and, according to Motorola's Martin Cooper, each car will have a microprocessor in its terminal by next year. Cooper says the use of computers as an adjunct to communications, while not brand new, has become more critical in satisfying the customer. "Our first major computer effort was three years ago, when we used redundant computers to manage our Los Angeles paging sys-

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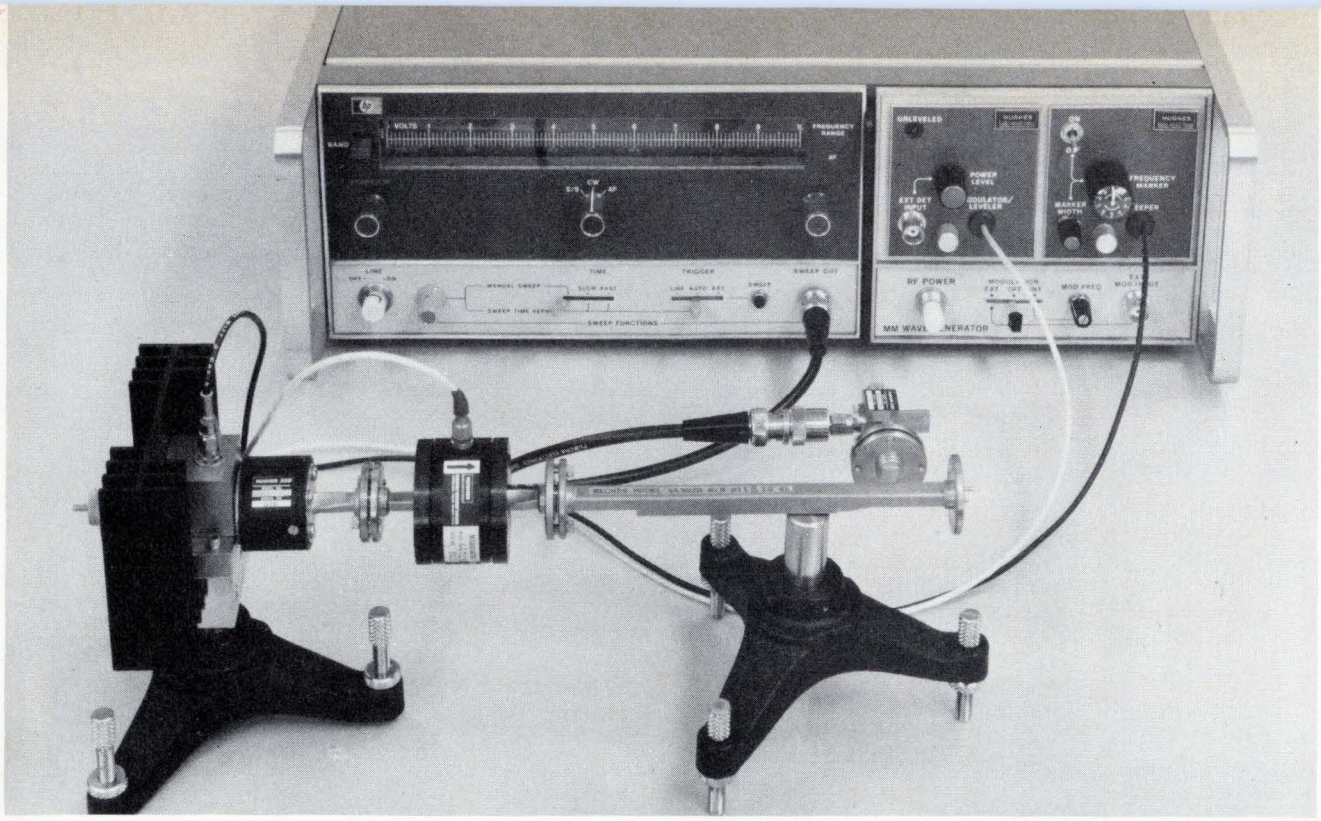
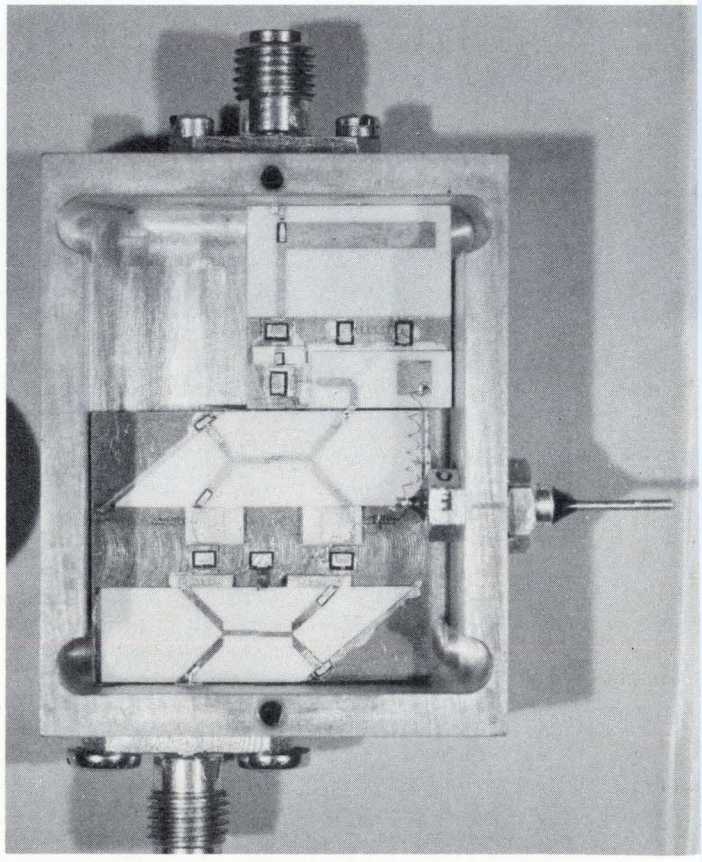
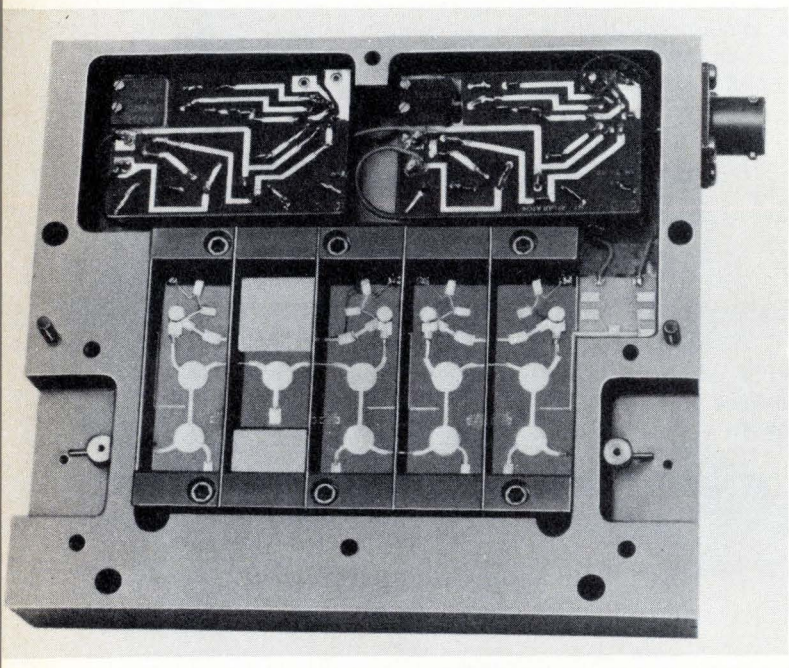


Clean sweep. Hughes Aircraft's Electron Dynamics division has produced an Impatt oscillator controlled by bias-current variations to sweep a 10-GHz band between 40 and 90 GHz.



GaAs amp. Gallium-arsenide field-effect transistors are used in power amplifiers at RCA David Sarnoff Research Center. This three-stage unit gives 25-dB gain at 4 to 5 GHz with 154-mW output.

Solid power. Raytheon's Special Microwave-Device Operation is building a four-stage power amplifier using Impatt diodes on a ferrite substrate. It delivers 1 watt in the 7.1- to 8.8-GHz band.



tem, and more recently, we have been using them for computer-aided dispatch for our police communications systems."

Martin Marietta, Orlando, Fla., is building a computer-controlled mobile telephone system for use in the 150- and 450-MHz mobile-radio bands. It could also be used in 900-MHz mobile band since only the rf portions would have to be changed. The system features message accounting, call billing, trunk-level access to telephone networks, dual processors for redundancy, and built-in diagnostics to provide a self-contained performance and monitoring capability.

Silicon still ahead

In solid-state microwave power technology, it's generally true that silicon is still ahead of gallium arsenide, despite all the advances in GaAs for such large applications as light emitting diodes. For LEDs, the starting substrate can have a higher impurity level than would be required for microwave devices. According to John Eshbach, GE R&D lab, Schenectady, N.Y., the diodes in microwave sources require low impurity levels and the impurities must not diffuse into the epitaxial regions of the diodes. These problems have been pretty well solved with epitaxial layers that shield the active device layers from the substrate, but silicon still benefits from the greater weight of experience.

In another area—impact avalanche transit time (Impatt)—Eshbach figures "it's a stand-off between silicon and gallium arsenide." GaAs offers better performance, but silicon, as before, has the heavier background of materials development.

For Gunn diodes, there was a time when the major efforts were aimed at improving power and frequency, but the main interest now, according to Eshbach, is in low-noise, lower power applications, like doppler radars, microwave intrusion alarms, and other specialized motion detectors. For short distances, 100-milliwatt outputs are adequate, and for doppler-type radars, low noise is necessary since the system is working close to the center frequency.

Workers at RCA David Sarnoff Research Center, Princeton, N.J. report that they recently achieved 1 kilowatt at 2 GHz from a stack of three Trapatt (trapped-plasma avalanche transit-time) diodes. The assembly worked at a 0.5% duty cycle, and had an efficiency of 25%. Trapatt diodes are now being sold in "moderate quantities," according to RCA's Fred Sterzer, director of the Microwave Technology Center in Princeton. Single diodes generating more than 400 W in the 1 to 2 GHz range are being built. Eventually, according to Sterzer, it appears that several kilowatts from stacked diodes should be achieved.

One new type of Impatt has been developed at GE. Instead of having uniform doping profiles that usually give about 1 W at 10% efficiency in X band, GE's device uses a narrow peak of doping near the junction—a so-called delta function of charge—to increase the efficiency to more than 20% at 3–5 watts power output. This delta function reduces the electric field in the drift region and thus the losses.

In high-power microwave transistors, RCA researchers are working on GaAs field-effect transistors that now give about 1 to 2 watts at 10 GHz. Sterzer says they expect to achieve 10 watts at 10 GHz in about two years. In fact, Sterzer says he expects such power transistors eventually to replace Impatt sources up to 6 MHz.

The problem of getting higher powers out of microwave bipolar transistors seems to revolve around getting finer and finer geometries. But that game "gets tougher and tougher," according to GE's Eshbach. The company, therefore, is developing a device called the controlled avalanche transit time device (CATT), which is an Impatt with a third terminal to inject carriers into the avalanche region. It looks like a transistor, with an emitter that injects a current that is multiplied by avalanche operation. Eshbach says the CATT operates at low avalanche multiplication factors, and noise does not appear to be a problem.

The Watkins-Johnson Co., Palo Alto, Calif., reports some improvement in electron-bombarded semiconductor devices. In these, a high energy electron beam is modulated by an rf signal and amplifies the signal by controlling a diode current. David Bates of Watkins-Johnson says his company has recently achieved 500 watts of peak pulse power at 1,550 MHz, also 25 W of continuous wave power at 245 to 460 MHz, and 50 W cw at 320 to 370 MHz.

Switching with semis

Semiconductors are also moving into telephone switching systems. Manufacturers are bringing out more solid-state crosspoint switches to replace the traditional crossbar switches or reed relays. RCA Solid-State division, Somerville, N.J., has built a 4-line switch using eight air-isolated SCRs for use in a PABX made by an Italian manufacturer, Telletra. Raytheon Semiconductor, Mountain View, Calif., is developing a standard series of SCR crosspoint-switch circuits. The company is planning to introduce soon a 2 by 3 by 2 (six line-pairs—the maximum number that will go into a 16-lead package) balanced switch as a standard item, and will also offer 4 by 6 by 1, 4 by 5 by 1 and 4 by 4 by 1 single-ended switches as standards.

Motorola Semiconductor says it will introduce two crosspoint switch circuits in the third or fourth quarter of 1975, using SCRs and dielectric isolation.

Siliconix is building crosspoints devices using C-MOS logic driving junction field-effect transistor (JFET) switches [*Electronics*, Mar. 21, p. 32]. The company says the switches are now catalog devices. The major advantage of C-MOS-JFET switches, according to a company spokesman, is that they don't require the holding current and don't have the offset voltage inherent in SCR switches. Volume production is still waiting for a first large customer, however. Texas Instruments also is making dielectrically isolated SCR switches. The company says it is producing some custom devices for specific programs, and also has two standard products—8 by 1 by 1 and a 4 by 2 by 1. TI, however, doesn't consider these to be completely suitable for volume usage, but rather as evaluation vehicles with which users can experiment. Next year, the company says it will be ready with the standard products. □

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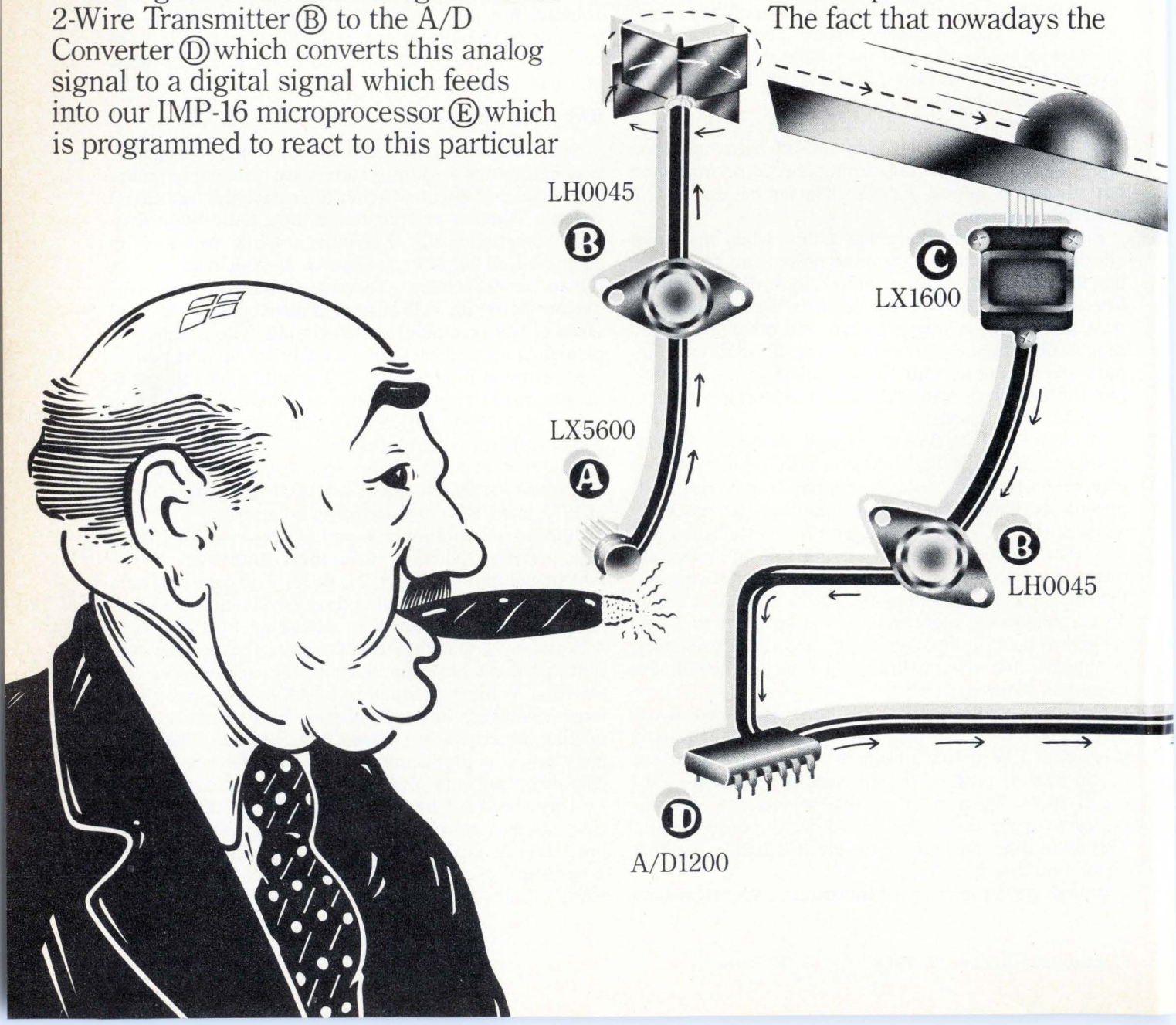

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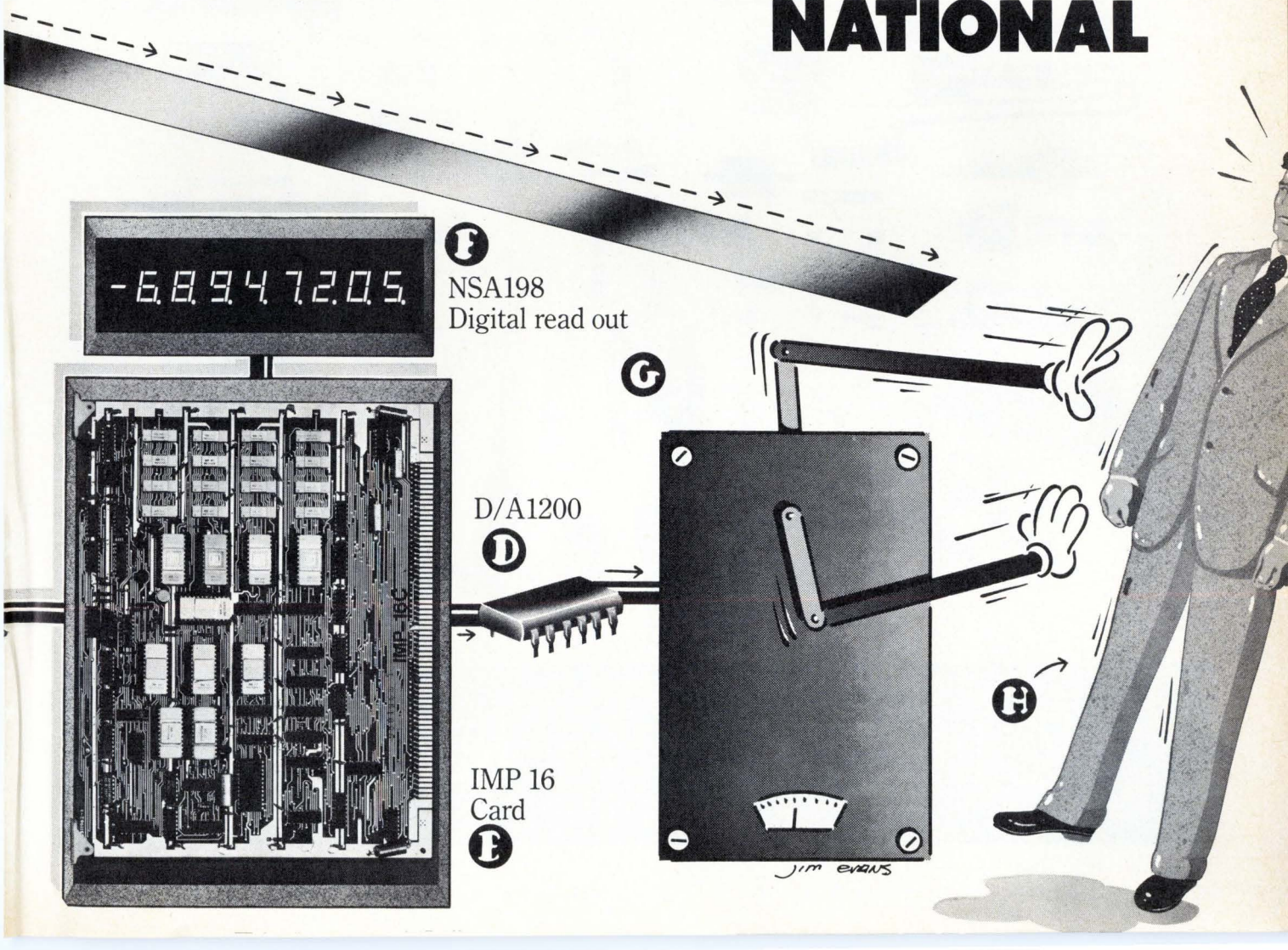

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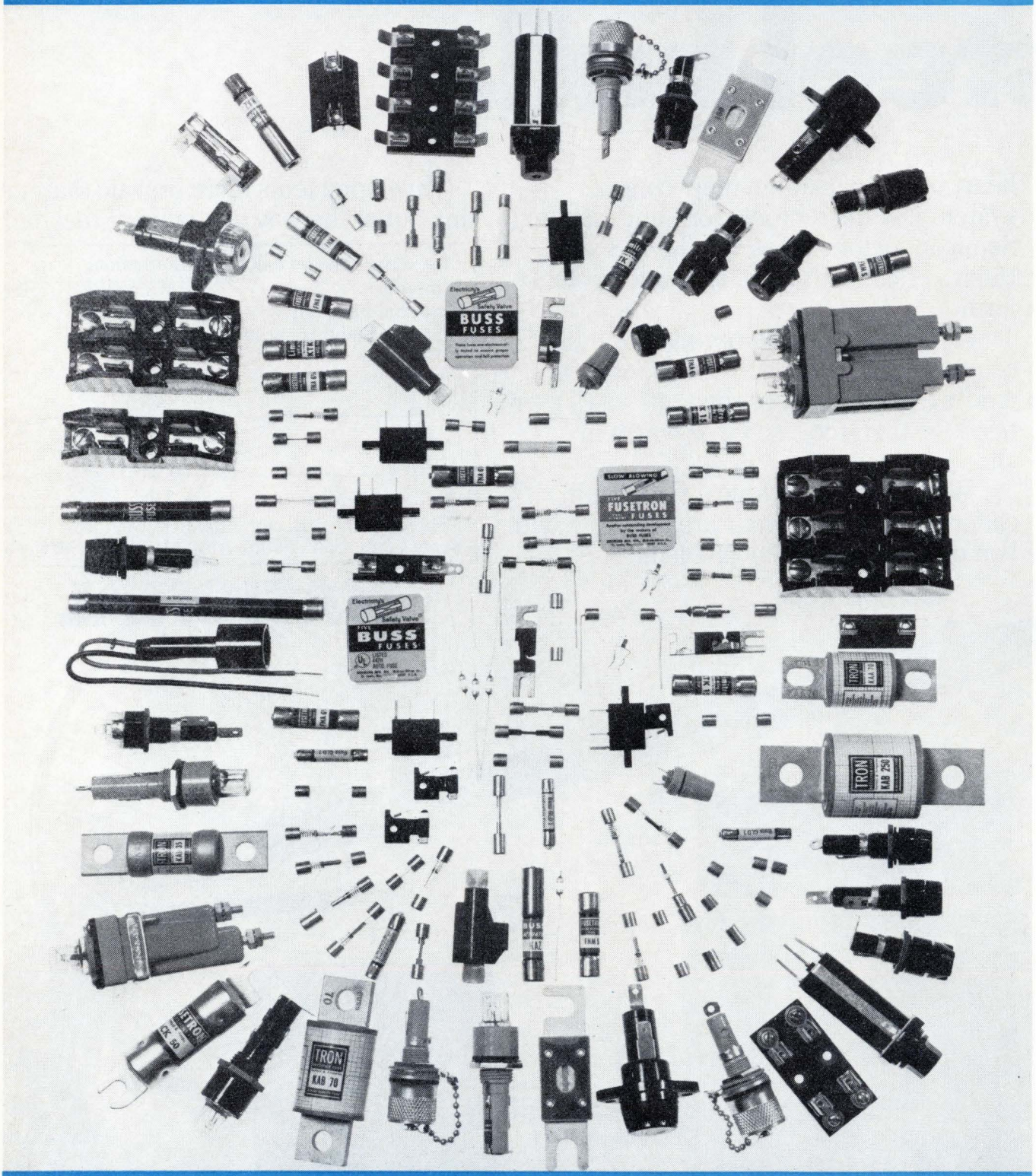

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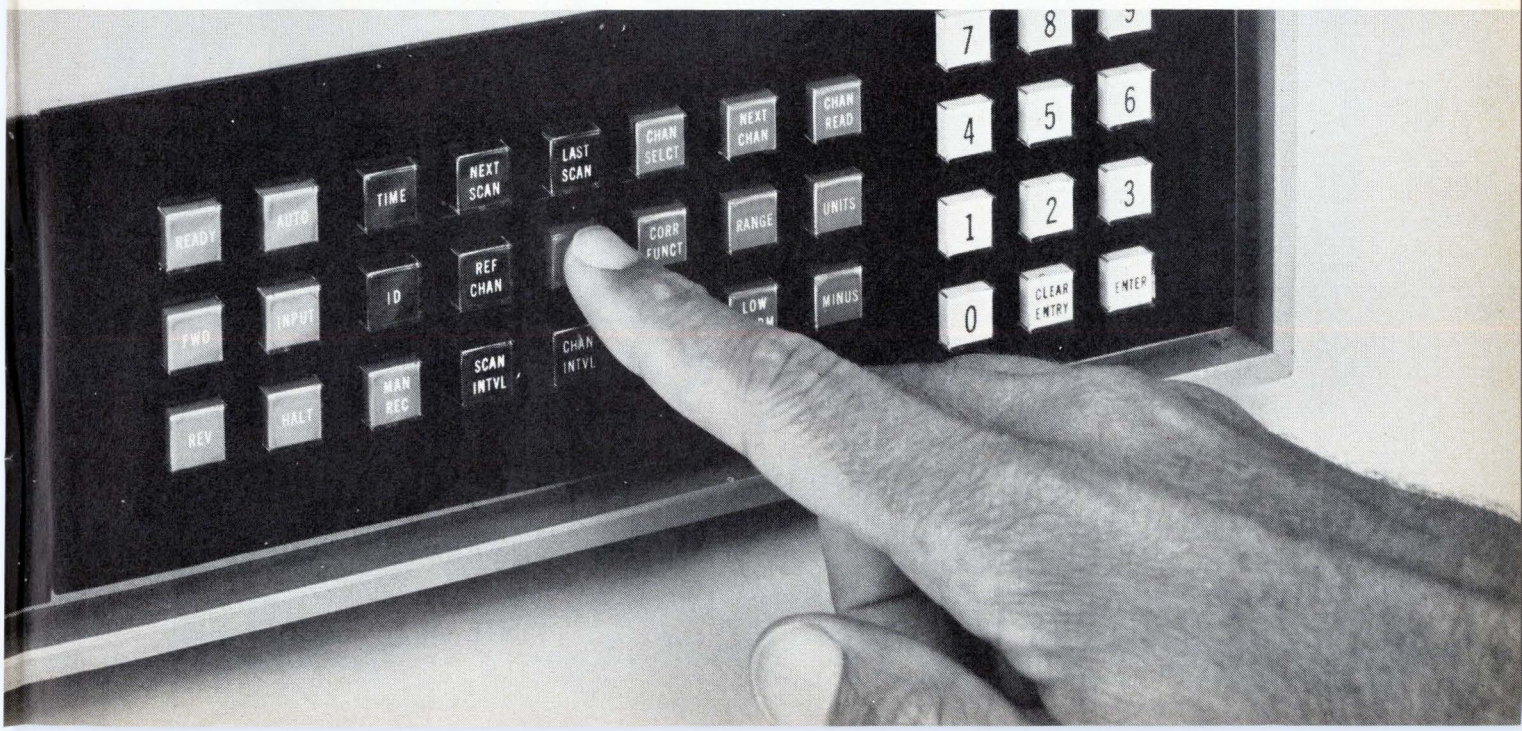


INSTRUMENTS

The entry of large-scale integration into instrumentation is by now simplifying test and measurement procedures for all users, from the design engineer to production-line personnel. Instruments will 'get smart' increasingly as their manufacturers learn to take advantage of microprocessor chips. Automated networks controlling entire plants will spread rapidly as soon as a standard data bus can be agreed on.

☐ The manual labor, tedious calculations, and often the sheer guesswork involved in many testing and measurement tasks are dwindling under the impact of large-scale integration. Instrument manufacturers are now faced with the problem of testing those same complex LSI devices that help them build their compact, simple-to-use, yet highly sophisticated equipment. Oscilloscopes are acquiring new capabilities. Digital synthesizers are providing cleaner test stimuli. Also, a tentative agreement on a standardized data bus for all instruments may yet simplify the job of interconnecting instruments into systems.

- "Smart" instrumentation. Microprocessors are already beginning to take over measurement control and to add new self-test and computational abilities to such instruments as a self-testing IC tester and an oscilloscope that computes several waveform parameters. The chip processors are also being used at the interface with minicomputers.
- Bench-top instruments. By harnessing the digital display to LSI circuitry, these units have lowered their error from the former typical 3% and 5% of full scale for dc and ac analog-type volt-ohm-milliammeters (VOMs) respectively to less than 1% for 3½-digit instruments and well below 0.01% for 5½-digit equipment. The use of LSI to replace large numbers of discrete components in timing and counting circuits increases reliability and reduces assembly costs. Moreover, LSI's small size enables several instruments to be put into a single multifunction package.
- Digital synthesizers. This means of producing precisely defined complex test stimuli will spread more widely when the costs of computer-based systems drop and the frequency limitations of low-cost digital-to-analog converters are overcome.
- Waveform display. Device rise times have climbed so rapidly that oscilloscope bandwidths have had to increase, too. And to meet the need to examine multiple binary channels, a variant on the traditional scope—the logic analyzer—stores and then simultaneously displays several waveforms in an actualized timing diagram.
- Standardized data bus. A worldwide attempt is under way to standardize on an interface [*Electronics*, Sept. 19, p. 67] that will enable any manufacturer's instrument to communicate with any other over a simple cable connection.
- Fault diagnosis. Growing in popularity is the computerized system in which test programs are based on simulation of the assemblies to be tested. Costs are high, but they may come down considerably as microprocessors take over this function.

by Stephen E. Grossman, *Instrumentation Editor*

Enter the microprocessor

Almost any test or measuring instrument today is fair game for redesign around microprocessors, which now are available in sufficient variety and quantity for cost-effective use. One example is Hewlett Packard Co.'s model 1722A oscilloscope, which shows not only voltage magnitudes on its digital display but also time-interval and frequency measurements, as well as several other parameters—all computed with the aid of a microprocessor. Another instance is the Qualifier 901 IC tester, built by Fairchild Systems Technology, Palo Alto, Calif., which runs through a thorough self-test routine, under microprocessor guidance, whenever a program is loaded into it.

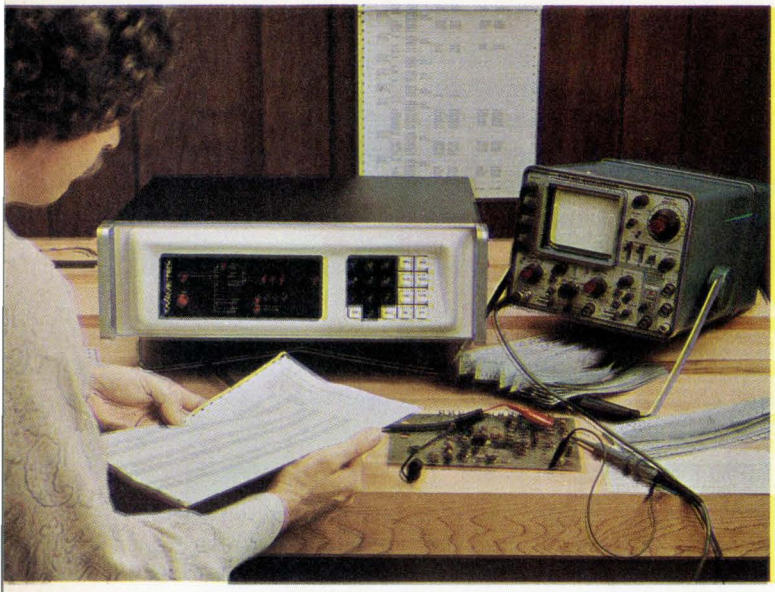
In the words of Marco Negrete, former manager of Hewlett-Packard Co.'s Loveland (Colo.) Instruments division and now general manager of the Microwave division, Palo Alto, Calif., microprocessors make a lot of things possible that "we wanted to do for some time but haven't done for technological and economic reasons, such as add more diagnostics to products without paying a large dollar penalty for it." Or, for that matter, paying a large size penalty.

This size and cost reduction in measurement instrumentation is due to the centralization of both signal processing and the input/output control logic in the microprocessor. In such a design, the analog-to-digital converter is well up front, digitizing the input as soon as it has been amplified. In contrast, in some present digital meters, an a-d converter digitizes the signal only after it has been processed in analog form and just prior to the measurement's appearance on the digital display.

Precisely how the devices are used will vary mainly with the price level of the instrument. At the low end of the price scale there are the $100 to $500 mass-produced instruments, where a $25–$30 microprocessor chip is a major contributor to cost. If volume is large enough, the designer will look at the possibilities of some of the more specialized microprocessor designs cut close to the specific applications.

In the middle range and up—instruments priced at $1,500 or more—chip sets, including supporting memories and input/output circuitry that costs in the $300–$500 range, will replace what has hitherto been put in other forms.

Some highly proprietary microprocessor designs are



Programable. Wavetek's model 152 function generator can be programed by a remote data bus, making it a natural for automated test applications, or by the push buttons shown on the front panel.

expected to emerge, in which the instruction sets are adapted to specialized instrumentation problems, such as linearization of the scales, limit testing, and I/O interface capabilities. Moreover, expanding the capacity of a basic design by, say, increasing interface capability does not require additional digital circuits. All that is necessary with microprocessors is to add a subroutine by adding to the firmware.

Microprocessors, of course, require a whole new generation of instruments to test them, and these instruments are still in their infancy. William J. Mandl, director of product planning at Macrodata Co., Woodland Hills, Calif., says, "It will take some work to learn to test microprocessors properly because of their complexity and size. Because of their applications, the testing will have to be more thorough than for calculators."

The hardware is not the big limitation. "The test pattern—that's where we run into the worst problems," says Mandl. "We have a lot of knowledge about testing memories, but this knowledge isn't developed yet for microprocessors."

Like memories, microprocessors are pattern-sensitive; that is, operation of the device can be affected by the sequence in which the instructions are programed into it. To test for pattern-related problems, Macrodata favors checking instructions by executing them in different, but given, sequences. As many of these failures can be subtle, the tester has to be capable. Macrodata offers two approaches. One is emulation of the hardware with the MD-104, which itself is a sophisticated microcomputer microprogramed to match the device under test and using lookup tables for those operations beyond its powers. The other way is to use a tester with a very large mass memory. Macrodata's version contains up to 32,000 words, operating to 10 megahertz. It can store many instructions or compress them into algorithmic form.

Another new area of solid-state technology that is putting new pressure on the tester manufacturer is the charge-coupled device. Basically big shift-registers, CCDs can complicate the test procedure by their ability to store analog values. Here, too, Macrodata has been busy, having demonstrated a CCD tester that includes special interface circuitry and, in one case, a light source for data. Still, "a lot of problems remain in learning to test CCDs properly," concludes Mandl.

Designing bench-top digitals

The trend in digital bench-top instruments is to slash the component count by using custom LSI for both digital and analog circuitry. The result is more functions in smaller, lower-cost packages.

Up to two years ago, digital-instrument houses were using medium-scale integration. But to remain competitive, they were adding to instrument functions, expanding ranges, and increasing accuracy, all of which caused component density to climb to the point where heat dissipation and reliability became problems. "Even with the MSI approach, this meant paying too much for what we were putting inside," says Robert Berry, marketing manager for Fluke Manufacturing Co.'s digital multimeter product line.

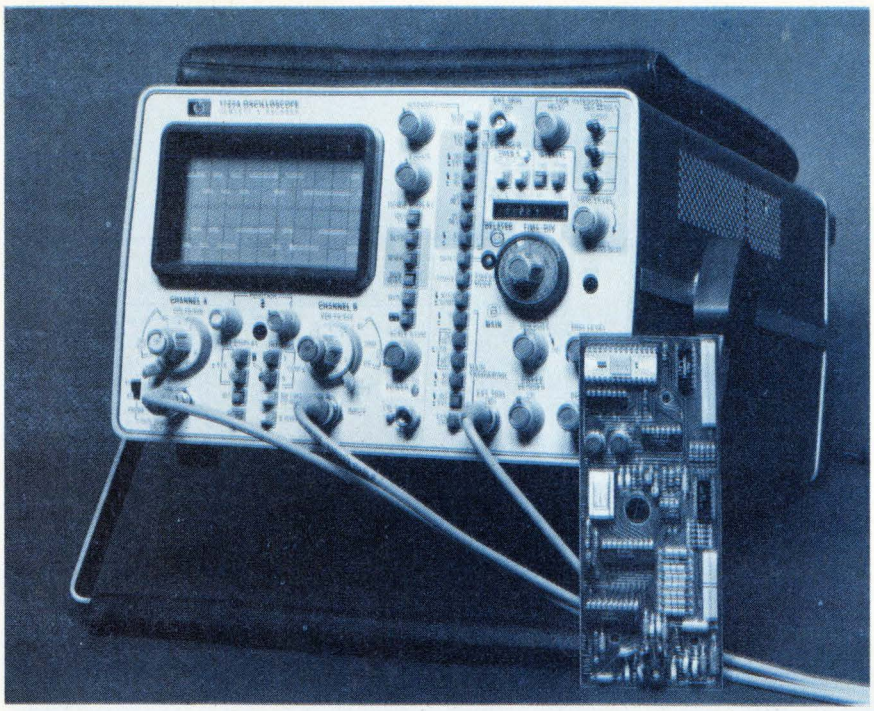
The Seattle, Wash., firm ventured away from the MSI approach in 1972, with its well-known model 8000A. Manually ranged, with 3½-digits, it was Fluke's first effort in the low-priced high-quality field. The targeted accuracy—to within 0.1%—was attained by the use of two custom LSI chips. The analog chip incorporated p-channel MOSFETs, npn and pnp bipolars, and Schottky diodes, while in the digital chip, the designers employed conventional p-channel MOS LSI processes throughout.

The result, priced at $299, was a commercial and technical success. The more-than-30,000 units sold in the last two years account for about half the market in 3½-digit multimeters.

Last May, Fluke followed up by introducing the automatic-ranging 8600A and 8800A digital multimeters. All the digital functions were packed into a custom LSI C-MOS 40-pin device. Because of the accuracy requirements (the 4½-digit 8600A delivers accuracy to 0.02%, and the 5½-digit 8800A, to 0.005%), the two models use LSI only in their digital side. On the analog side, LSI still cannot be built with the necessary accuracy except at low yields and therefore high prices. Even so, the two new DMMs are half the size of previous instruments, and their power requirements are said to be reduced at least 1,000-fold, with a corresponding diminution in heating problems.

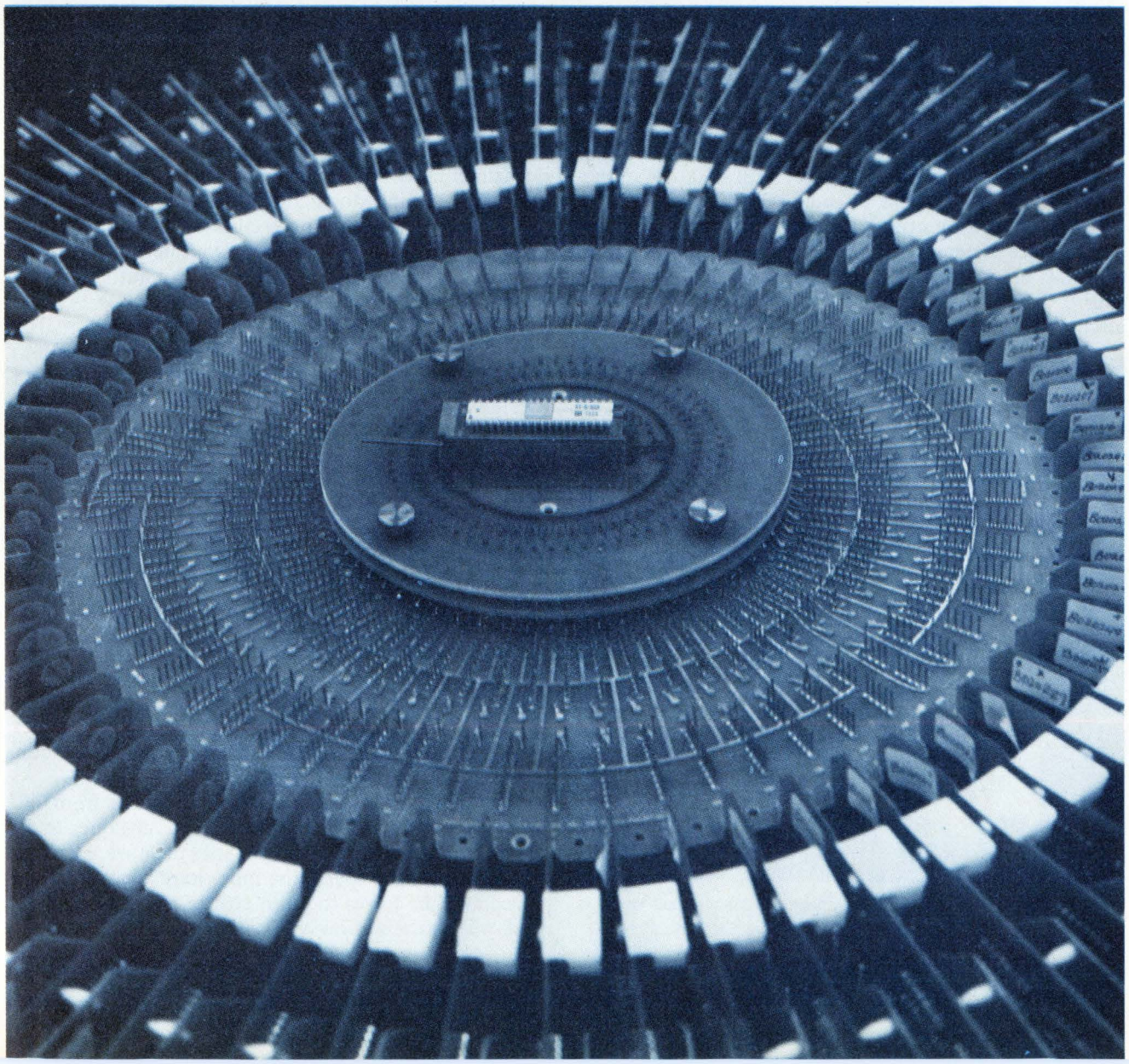
The principal obstacle to an industry-wide shift to LSI in bench-top instruments is the low yields of the LSI processes. At present, because of cost, yield, and volume factors, the LSI makers prefer to deal in quantities of 10,000 and 100,000. But instrument houses seldom deal in such large quantities in a particular product run, and the price for smaller lots goes up much too high.

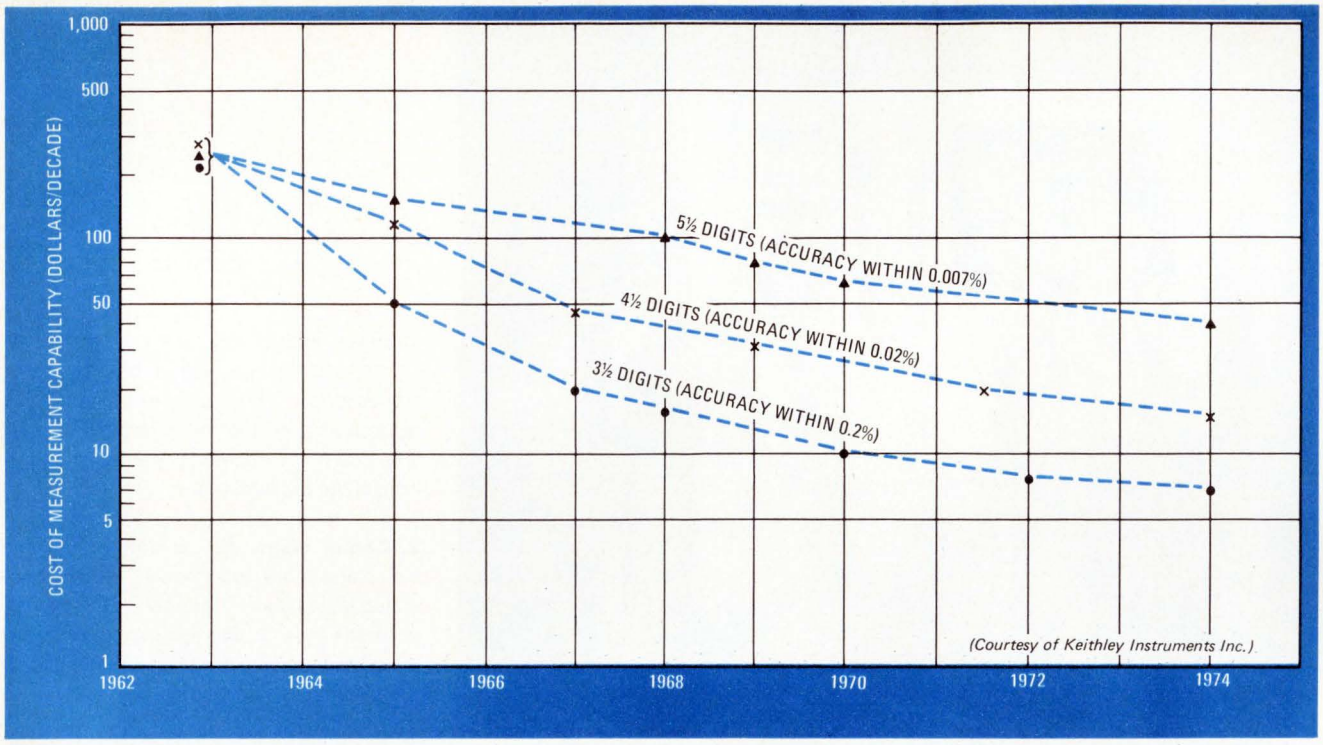
Instrument designers are also zeroing in on high reliability in the form of long-term stability and long life. Users are expected to become more alert to total life-cycle costs and to want less frequent calibration,



1. Smart scope. Hewlett-Packard's model 1722A oscilloscope with a built-in microprocessor and LED display has direct digital readout of a number of waveform parameters. The microprocessor board is shown in front of the oscilloscope.

2. Center stage. As LSI devices become faster and more sophisticated, so do automated test systems. Pictured are the 64 sector cards (one for each pin) surrounding an LSI device under test in this 1803 test station of a Tektronix S-3260 automatic test system.



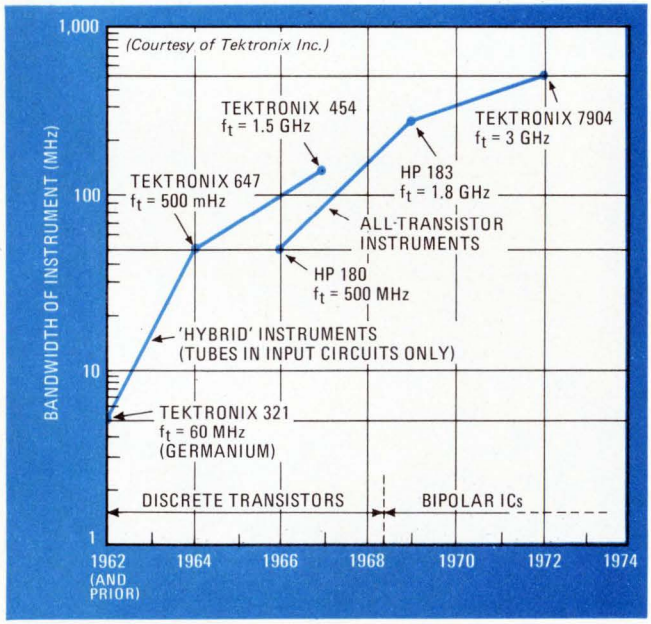


3. Dollars per decade. The price per decade for digital-multimeter measuring capability is on the decline. Plot shows that the 3½-digit instrument has improved by more than two orders of magnitude in 10 years.

says William Nichols, who is in charge of new product development at Keithley Instruments Inc., Cleveland, Ohio. The company is a major contender in the high-volume digital multimeter market with its autoranging model 168 3½-digit DMM, priced at $299.

Other upcoming trends in DMMs, as perceived by Nichols, are increased programability and increased use of DMMs in systems. This latter development is also, of course, being given impetus by the current worldwide attempt to agree on an internationally standard data bus for linking instruments into operating systems.

Once instruments become easy to interconnect, it will also be easy to set up systems that eliminate the interdepartmental communications barriers in a plant. For example, tracking down the source of defects in final tests would be more easily facilitated if manufacturing and design engineers were kept routinely informed of them by a daily analysis produced by an automated test setup.



4. Bandwidth bonanza. Oscilloscope performance has risen as bipolar ICs have supplanted discrete transistors.

Digital synthesizers

Digital techniques are assuming a new role in instrumentation in yet another way—by synthesizing various complex waveforms to serve as test stimuli.

Observes Thomas Carver, manager of automatic test-equipment program operations at RCA's Government Communications and Automated Systems division in Burlington, Mass., "Previously a separate audio-radio-frequency generator had to be used with every test system, but high cost, reliability, and calibration were serious problems." However, spurred on by the emergence of low-cost, high-speed digital-to-analog converters and a desire to enhance automated test systems, RCA and other companies pioneered the digital technique, using a computer to do the waveform synthesis. The waveform is recirculated through a shift register, then smoothed in a high-speed d-a analog converter.

Right now, RCA's system can deliver signals from 0.01 hertz to 6 megahertz. In the future, Carver hopes to extend the top frequency to 20–30 MHz or more. He notes that the higher the speed, the more hardware can be replaced and the lower the unit cost of a test system. Indeed, when RCA originally turned to software for the al-

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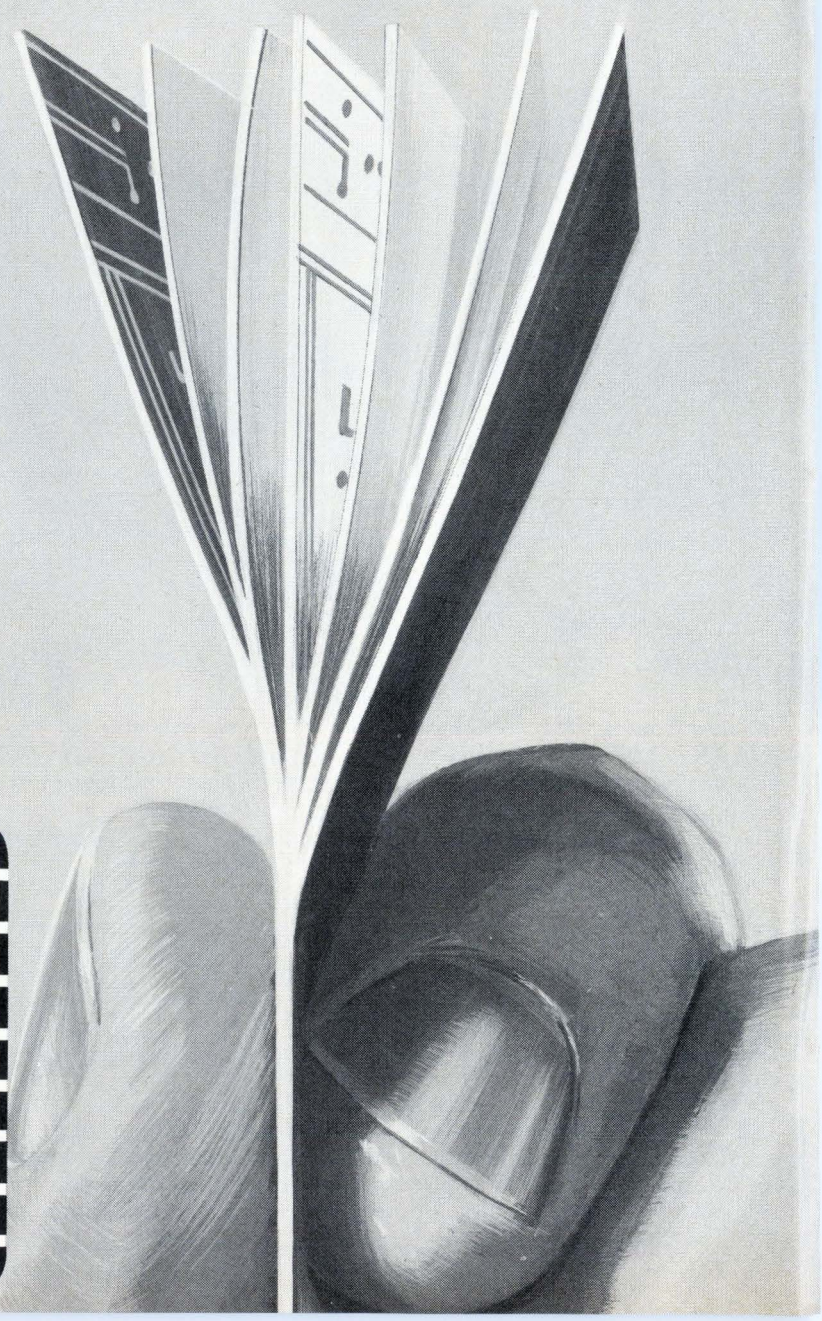

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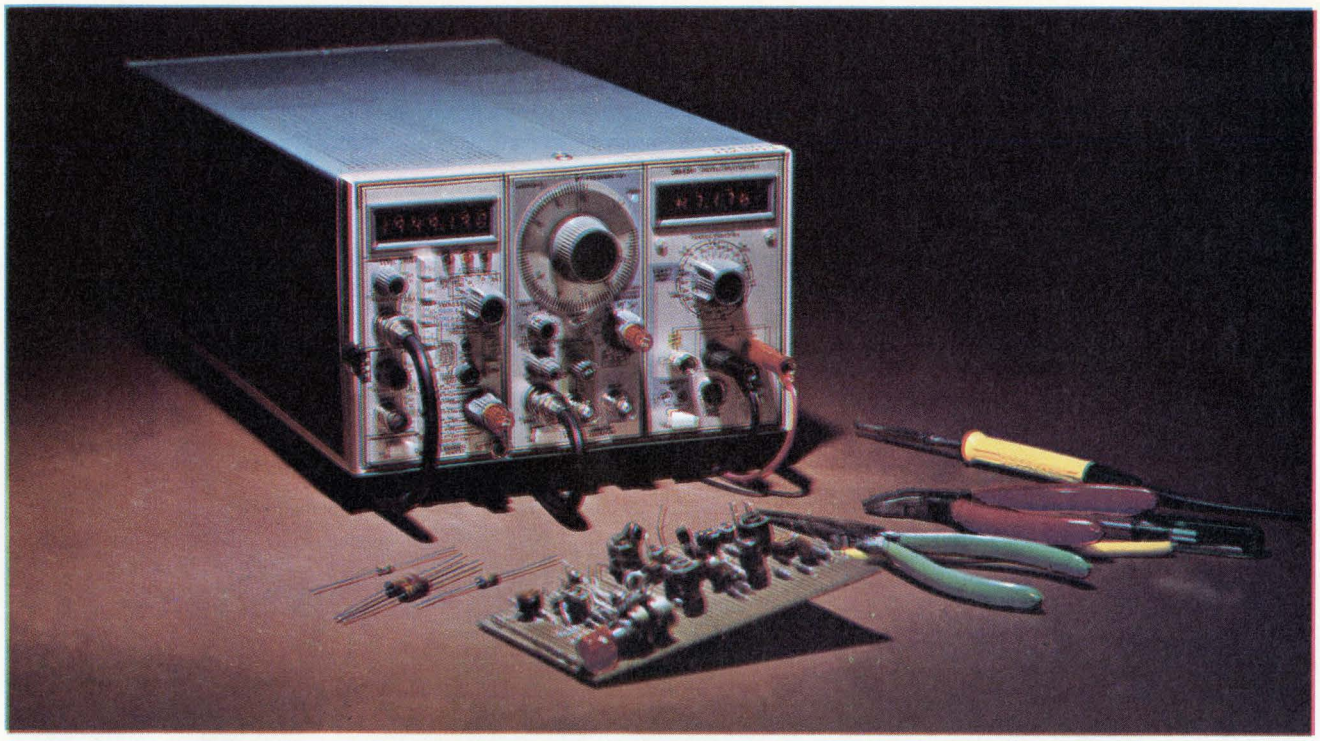


Pint-sized package. Housed in a mainframe only 8.7 inches wide, 6 in. high, and 15.3 in. deep are two of about three dozen instruments in Tektronix's TM-500 series. Left to right are a 100-MHz frequency counter, a 0.004-Hz—1-MHz function generator, and a 4½-digit multimeter.

gorithms that create the waveform's digital equivalent, the amount of hardware was reduced by 50% to 60%. The approach is claimed to have great flexibility. "The ability of the test system to generate waveforms is limited only by the imagination of the software designer," says Carver.

So far, systems based on a Nova 800 minicomputer with a 32-kiloword memory have been sold to the Army Electronics Command for testing airborne communications, receivers, and servo amplifiers. But Carver is confident that the technique will dominate in the commercial sphere within only two or three more years. At present, it's about half the price of a system that uses other forms of frequency synthesizers and now costs anywhere from $60,000 to $500,000.

Carver sees RCA's approach as modifying the way items are tested because "you can program more exotic waveforms to get effective test signals." Waveform-generation systems could also be used in measurement applications to perform high-speed sampling, with the computer providing spectrum and waveform-distortion analysis. The principal change necessary would be to switch from a d-a to an a-d converter.

Off-the-shelf direct digital synthesizers, such as the model 5100 manufactured by Rockland Systems, West Nyack, N.Y., are limited to about 2 MHz due to the current state of the art of d-a converters costing $150 or less. (Direct synthesis avoids the phase-locked loops of the indirect approach and is claimed to have finer resolution, faster switching and spectrally purer output than indirect synthesis.) Above 2 MHz, the low-cost d-a converters develop excessive phase noise due to their settling characteristics.

Propagation delay, which is dependent on the bit pattern, also becomes a problem. "Data can be spaced no closer than 125 nanoseconds with some 25 ns spent in settling time with the discrete bipolar d-a converters available today," says Rodger Hosking, manager of engineering at Rockland Systems. "What's needed to raise the frequency limit of direct-synthesis generators is a breakthrough in semiconductor technology."

Oscilloscopes stay ahead

As for signal output, engineers will probably want to go on examining just what is happening with the familiar real-time oscilloscope. As Oliver Dalton, manager of Tektronix Inc.'s laboratory for oscilloscope engineering in Beaverton, Ore., sees it, "It's simply that an engineer thinks he knows what he is going to see, but he wants to check it to make sure."

The race between rise times and scope bandwidths has already spurred the production of oscilloscopes with bandwidths to 400 MHz [*Electronics*, Aug. 8, p. 42]. But the demands on the designer of these instruments continue to grow. His circuits must deliver speeds that are several times higher and distortion that is several times lower than in the circuits his customer wants to test. But since he has access to essentially the same off-the-shelf ICs and other hardware, his only recourse is to develop special ways around those limitations.

That he generally succeeds is proven by Fig. 4, which plots the ever-increasing bandwidth of various oscilloscopes through the years. Note that the unity current-transfer gain (f_t) of the devices used by the oscilloscope designers to implement each instrument are approximately an order of magnitude higher than the deliverable bandwidth of the instrument.

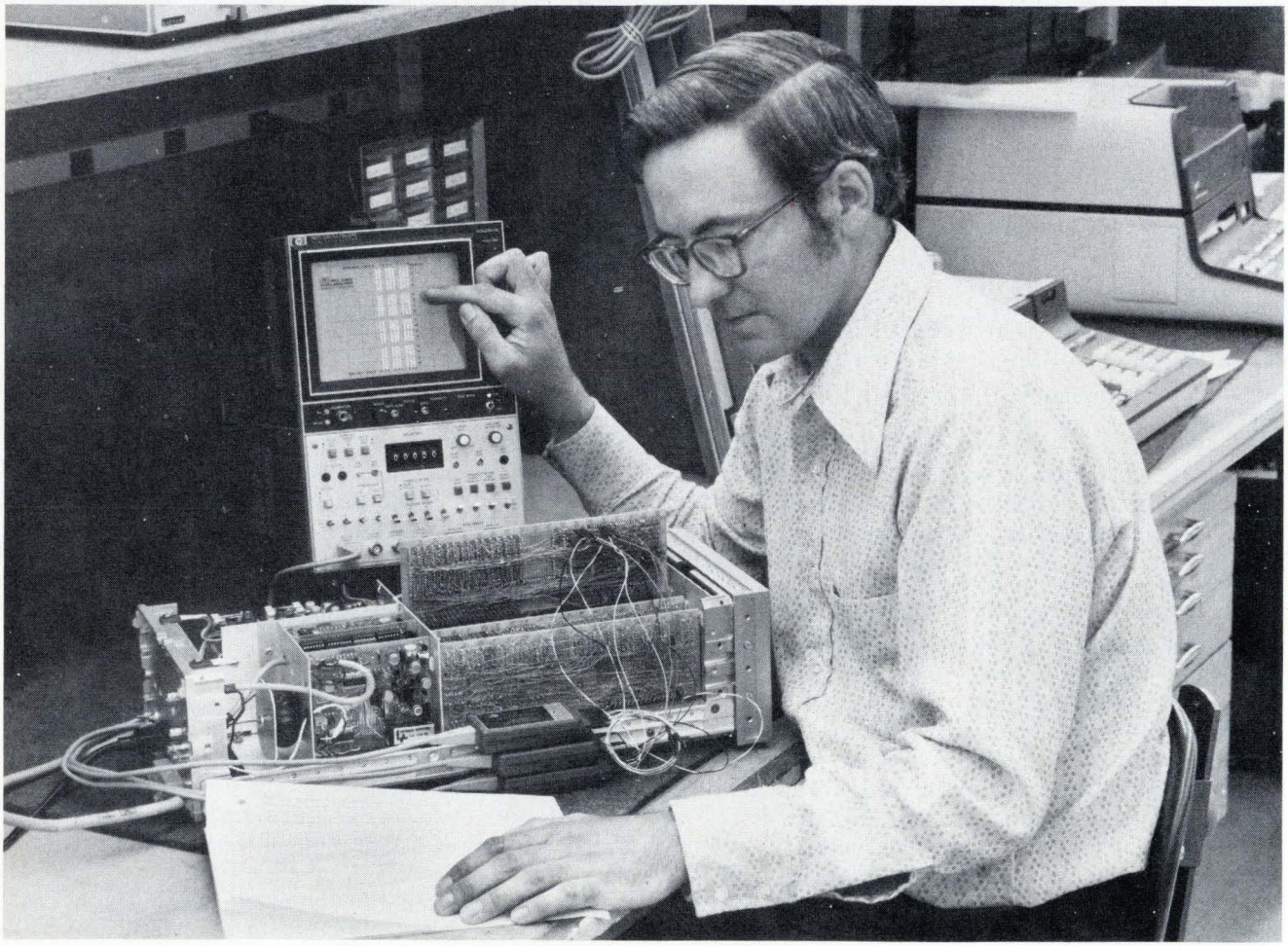
A new species of instruments derived from the analog

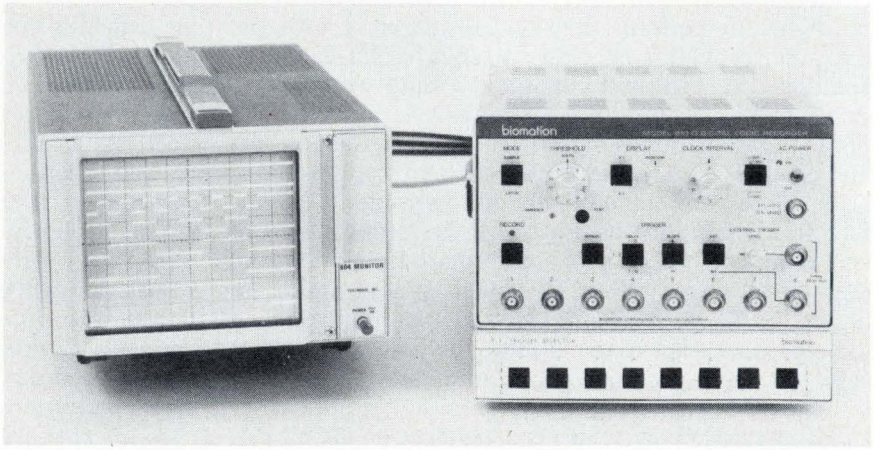
scope is known generally as logic scopes [*Electronics*, Oct. 3, p. 119]. Two basic kinds are emerging. The logic-state analyzer, such as the 1601L made by Hewlett-Packard Co., Palo Alto, Calif., (Fig. 5a) which measures a circuit's functional status. It indicates in the form of numerals (0 and 1) the states of various registers, and it helps the designer tell whether the logic flow chart is at fault or if there's an electrical problem. The other kind is the logic-timing analyzers, such as those produced by E-H Research Labs Inc., Oakland, Calif., or Biomation Corp., Palo Alto, Calif. (Fig. 5b). Most of these produce a standard timing diagram of up to 12 of a device's input and output waveforms on a single CRT display.

Rising labor costs make it more urgent to fix faults fast, just when increasing system complexity makes it harder to find them, whether in the field or plant. The answer clearly is automated testing [*Electronics*, Sept. 19, p. 95].

Demand for diagnostics

At the assembly level, edge-connector testers can test printed-circuit boards and attempt to diagnose the cause of failures. Particularly potent are the in-circuit component testers, like the model FF101 made by





5. All at once. A new species of binary instrument enables the engineer to examine a number of binary channels simultaneously. Hewlett-Packard's 1601 logic-state analyzer (above) presents to a viewer as many as 12 channels of logic state as 0s and 1s. Biomation's 810 digital logic recorder (right) can detect eight-digit signals and display them on an oscilloscope in the form of a timing diagram.

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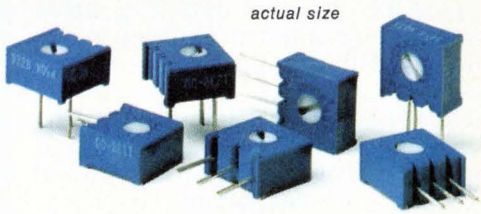

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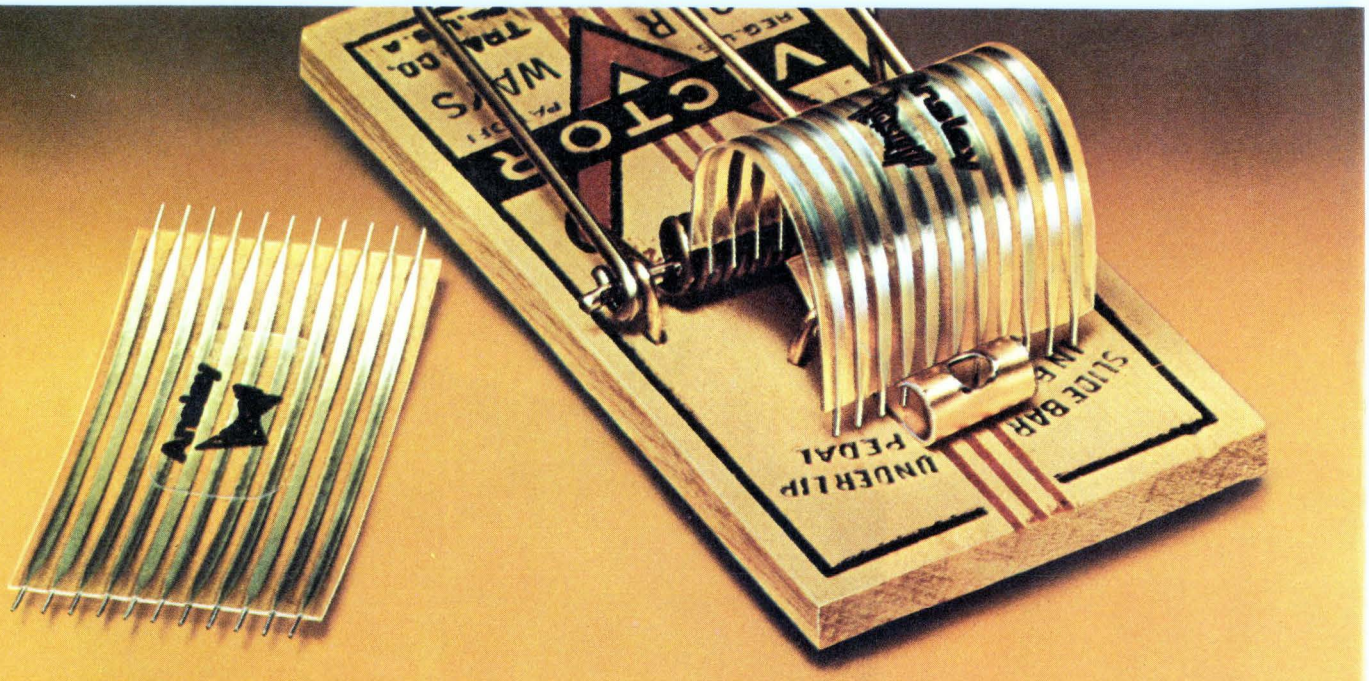

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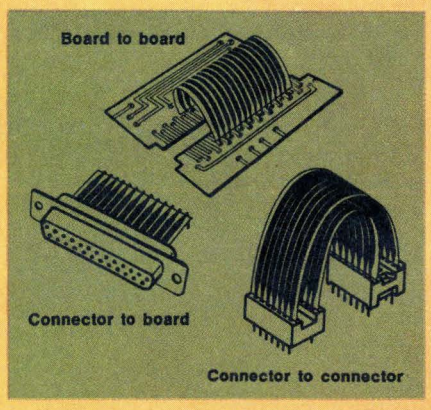

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6. Debug the board. Automated test systems, such as the one made by Computer Automation Inc., Irvine, Calif., are becoming vital for testing and diagnosing faults in complex printed-circuit boards, thereby speeding production and chopping cost of manufacture.

Faultfinders Inc., Latham, N.Y., which press pins against the soldered nodes of the circuit components and use circuit-isolation techniques to check components individually.

Software is enlarging its grasp, particularly in testing digital devices and pc boards, both for test-pattern generation and diagnostic capability. The ideal test program would identify every fault that could occur on the board or IC, and the ideal diagnostic program would trace each fault to a single circuit defect, instead of giving the test-set operator a list of possible faults.

A recent software development in digital testing is a simulator to assist the programer in designing better test programs for logic cards. Models for simulating digital-logic cards were first run by large computers in the late 1960s, when they were used as design and circuit-analysis tools. General Radio Co., Concord, Mass., claims it was the first to run a simulator on a mini-based system designed for production-line testing—and the company has recently announced a second-generation system capable of handling hybrid boards, which mix analog and digital circuitry.

The new system simulates the digital sections and models the analog sections, enabling the tester to work around any analog circuit that interrupts its progress in tracking down a defect. However, using simulation to test the analog circuit itself is still a long way off.

According to Eric L. Mudama, a marketing manager at General Radio, such a simulator system now costs perhaps $100,000, but a trend toward lower prices is beginning as the cost of computers and mass storage gets lower. As microprocessors become faster, they also could impact price.

As a postscript, it's worth noting that, though most automated test systems are aimed at device testing, printed-circuit-card testing, and system testing, some highly dedicated testers are entering the market. As an example, Zehntel Inc., Concord, Calif., says it is breadboarding an electronic-watch tester, derived from its experience with calculator-board testers. The system uses programable read-only memories to program the system and C-MOS circuitry for taking measurements. The tester will check for logic malfunctions that would cause a time error and for malfunctions in the LSI chip that could cause an excessive power drain on the battery. Actually, the tester is a classifier in that it sorts out the watches in terms of "good," "fails logically to drive the display," and "passes logic test but fails current test." □

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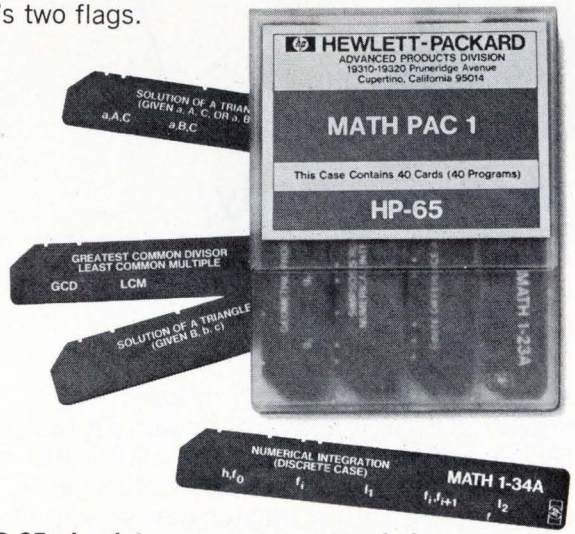

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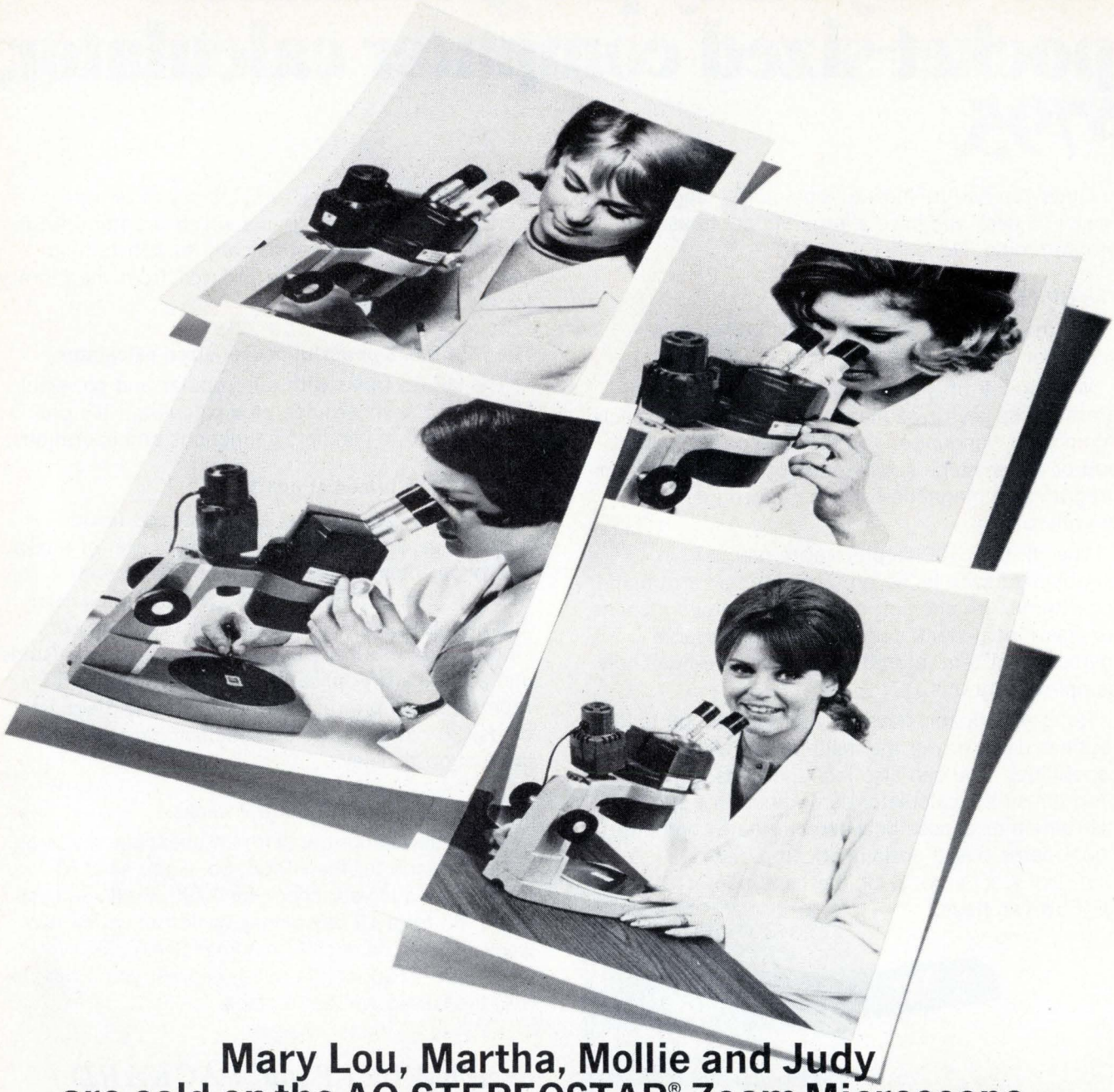

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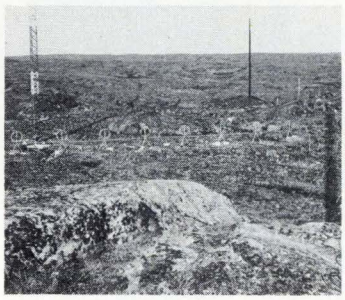

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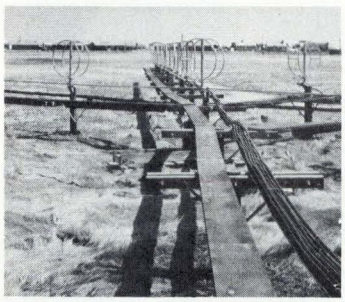

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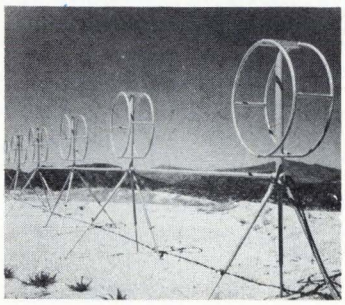

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The energy crisis is stimulating an electronic takeover in industrial plants, where shortages plus soaring costs are dictating maximum efficiency and automation. Microprocessors, besides slashing the cost of computer control, will join with solid-state sensors and LED displays in boosting the reliability of industrial systems. Buildings could be heated and cooled more efficiently with electronic controls.

□ Impelled by inflationary pressures and the need to increase productivity, the installation of electronic controls in factories is accelerating. The increased acceptance of electronics in industry is also being spurred by the energy crisis, which is creating an unprecedented demand for controls to maximize the efficiency with which energy is produced, converted, and consumed. What's more, the proven reliability of recently introduced electronic transducers, controls, and displays is doing much to overcome the distrust created by early equipment failures.

And, although minicomputers are having their effectiveness increased dramatically by development of specialized hardware and software, microprocessors can be expected to penetrate and pervade every industrial-electronics application. Reliability and low cost are probably more important than enhanced capabilities as reasons that microprocessors will probably replace most minicomputers and hard-wired controllers.

Reliability enhances controls

The microprocessor may well prove to be the greatest boost that industrial electronics has had since its beginning about 30 years ago. Designers of industrial equipment welcome microprocessors because they can buy chip sets and then design circuit boards, systems, and packaging themselves. This flexibility, plus the inherent reliability that comes from using a small number of ICs, makes engineers confident that they can design microprocessor-based systems with the ruggedness needed to survive in the industrial environment.

What's more, microprocessors offer the all-important advantage of enhanced reliability. For this reason alone, microprocessors may be expected to play an important role in controlling machine tools. And reliability is the reason given by General Electric Co., Waynesboro, Va., the leading producer of numerical controls, for development of its new Mark Century 1050 line of microprocessor-based N/C equipment. GE is thus far the only company to use microprocessors in large (up to six-axis) controls, although other companies have used them in small units [*Electronics*, Sept. 19, p. 31].

Microprocessors seem to be ideal for the vast middle ground of industrial applications. The control of a large oil refinery still requires the use of one or more minicomputers, and the control of a simple N/C lathe probably is best served by some fairly simple hard-wired logic. But the microcomputer will save both money and annoyance in controlling smaller chemical operations and complex N/C tools, as well as many climate, traffic, water, and waste systems.

The application of microcomputers to industrial controls has not been too extensive yet, but their widespread use is inevitable. Some big process-control houses are known to be working closely with semiconductor manufacturers to develop as-yet-unidentified special-purpose devices. And at least some resistance to installation of microprocessor controls is attributable to the rapid pace of continuing developments that quickly make installed equipment obsolete.

Even in applications where a minicomputer is clearly needed, microprocessors can be beneficial as local controllers, both to cut the communications burden on the minicomputer and to continue to run the system at a high level of efficiency when the minicomputer is out of service for any reason.

A typical large computer-controlled chemical plant, for example, has a minicomputer handling 3,000 control loops. When a computer is down, the usual procedure is to have each of the loops revert to some form of local control. Some critical pressures and temperatures are automatically maintained at the last setpoints dictated by the computer, while others are brought to preset known safe values, and still others are turned over completely to manual control.

Although these procedures are quite safe, they can also be quite inefficient. Shutting down the flow of fuel to a furnace while turning the flow of cooling water up to maximum is a good way to prevent an explosion, but it can also ruin a lot of material.

Microprocessors can be a big help in such situations if several of them are used—each to control a small group of closely interactive loops. The microprocessors in turn, would operate under the supervision of the master computer. A failure of the master computer would be far less serious than if the microcomputers were not in the system, since groups of tightly interactive processes would continue to be controlled by a single microprocessor.

Transducers: the source of knowledge

Solid-state transducers are making their mark by reliable, accurate sensing of data in all kinds of industrial environments. The monolithic integrated silicon pressure transducer, pioneered by Kulite Semiconductor Products Inc., Ridgefield, N.J., and popularized by National Semiconductor Corp., Santa Clara, Calif., is probably the best known of these new solid-state sen-

by Michael J. Riezenman, *Industrial Editor*

Powerhouse. Control console for computer-controlled boiler system at Buick Motor division's Flint, Mich., plant logs boiler data every hour and alerts operator any time conditions become unsafe.

sors. Working in a fashion similar to the older metal-foil strain-gages, the new units exploit the piezoresistivity of single-crystal silicon.

Although variations exist, the main idea is to make the entire pressure-sensing diaphragm out of a single piece of silicon with a four-element resistive bridge diffused into it. Since this method involves no bonding, all problems asosciated with cementing tiny strain elements into place are avoided. All of the resistors in the bridge are in intimate thermal contact with each other, thus minimizing the temperature-sensitivity problems that plagued some early users of strain gages made of discrete semiconductors. And because the entire manufacturing process is photolithographic, much of the expensive hand labor associated with previous designs is eliminated.

Solid-state technology is also getting into the temperature-measuring field. Here, the basic idea is to exploit the strong temperature dependence of the base-emitter voltage drop of a transistor.

Although Relco Products Inc., Denver, Colo., has been making expensive special devices for military-aerospace applications for several years, only within the past year have both Relco and National Semiconductor introduced low-cost, rugged devices that can compete economically in the industrial marketplace. The two companies use rather different methods for exploiting the temperature dependence of a transistor's V_{BE}, but both offer the user compact packages in which the output voltage is a linear function of the absolute temperature. Typically, the units have a sensitivity of 10 mV/°C, which means that they need no preamplifiers to condition their outputs for system use.

The big disadvantage of these solid-state temperature sensors is their limited temperature range. At best, they span from −100°C to +150°C, but a range of −55°C to +125°C is more typical. While these temperature extremes cover a broad range of temperature-measurement and control applications, including photographic, pharmaceutical, some chemical-process controls environmental controls, undersea temperature studies, and various medical and other biological needs, they are clearly not applicable for cryogenic applications, furnace controls, or most metal-refining environments.

Displaying control information

After industrial data has been sensed and processed, it must be displayed so that the operator can make value judgments. Because of their reliability, light-emitting diodes are favored for use as simple status indicators. And the traditional cathode-ray-tube display is extremely useful for displaying complex outputs from data-processing equipment, especially when it is teamed with a local refresh memory.

An excellent example is the computer-driven Videotrend color-television display from Leeds & Northrup Co., North Wales, Pa. The Videotrend, which can be considered a replacement for a four-channel strip-chart recorder, provides traces in four different colors that can be labeled in the same color and displayed against time-scale grids that can be varied.

The unit's memory can store 240 data points for each of the four channels. To dramatize deviations from established norms, shading can be extended from each of the traces to its respective baseline.

It is fortunate that two fairly recent solid-state developments are making solid contributions to the overriding need for reliability. These are the LED and the optoisolator. The LED, from the industrial viewpoint, is simply an indicating lamp that can be trusted.

Optoisolators increase reliability by fighting noise. In the noisy industrial environment, optoisolators can enhance system reliability by breaking ground loops and keeping the ever-present noise from propagating throughout the entire system. It is becoming increasingly common for instrument makers to include optical isolation on the digital inputs and outputs of various measuring devices to prevent interference with the measurements being made at the analog front end.

Saving energy

Of great immediate value to the cause of energy conservation is the contribution that electronics can make in the areas of residential, commercial, and industrial climate-control equipment. Low-cost heat and humidity sensors, reliable logic circuitry, and SCRs or triacs can be

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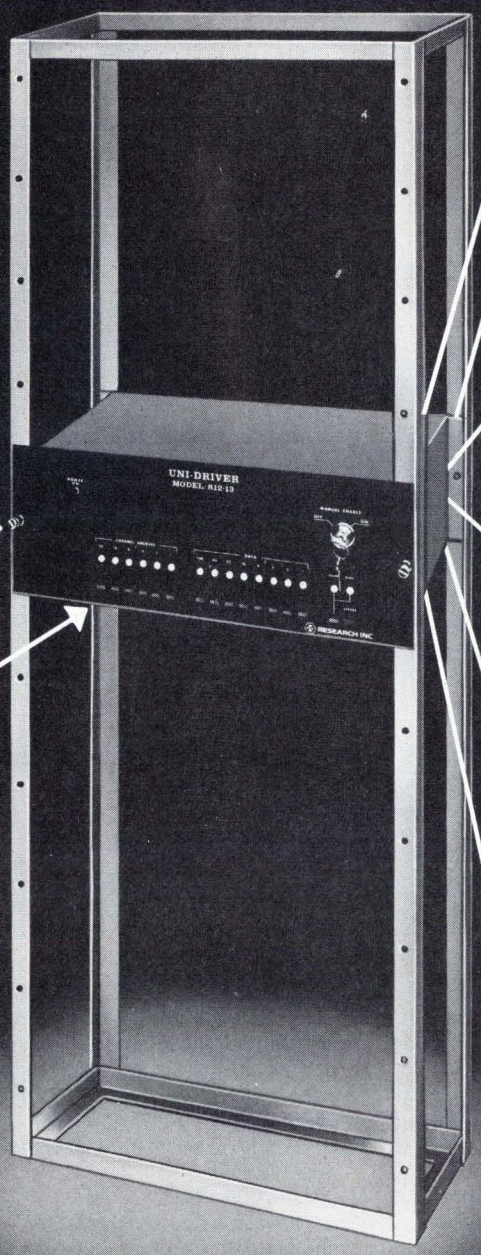

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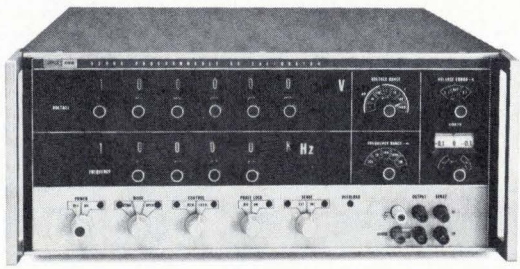

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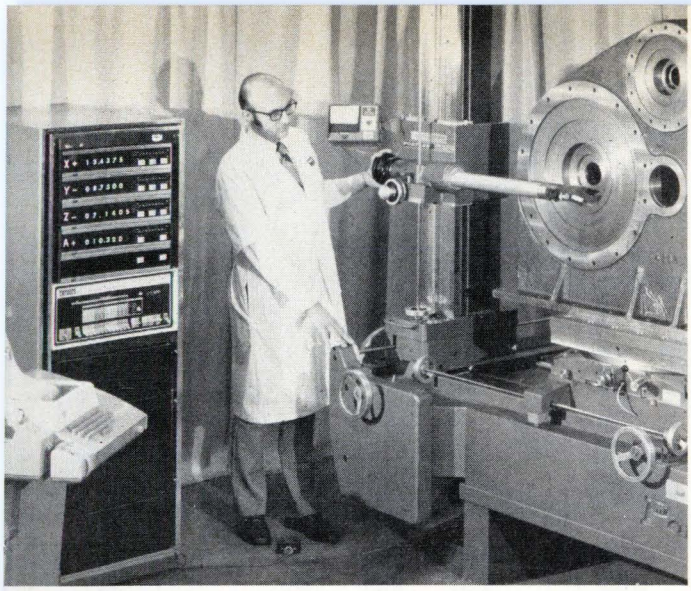
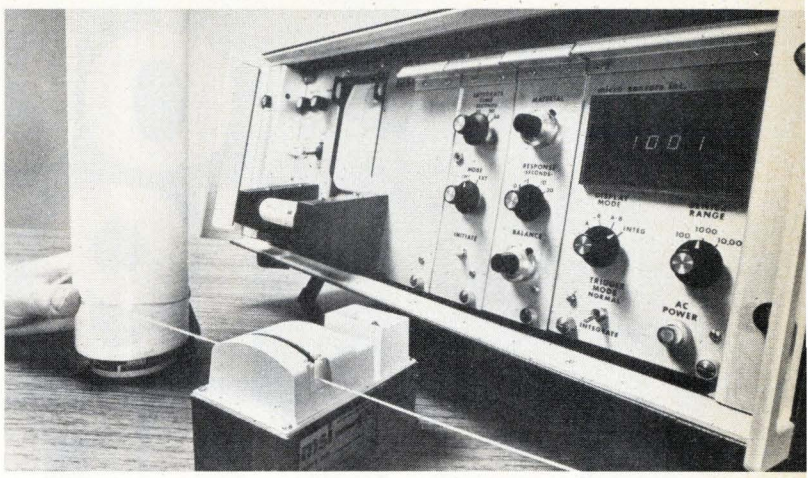


Inspector. Four-axis automatic inspection machine provides digital readout of linear dimensions plus hole diameter. Unit uses moiré-fringe approach and integrated circuitry to get 0.0001-in. resolution.



Transducer trends. New capacitive transducer measures the denier—mass per unit length—of thread as it is manufactured. Device capacitance varies with mass of material between its plates.

combined to make proportional controllers for furnaces and air conditioners that are usually operated in a wasteful on/off mode. But intelligently designed climate-control equipment not only can save energy, it can make for more comfortable living, as well.

Fancy proportional controllers for air conditioners aren't worth much if buildings are poorly insulated, or if doors and windows are left open. Automatic timers to shut off the lights in unoccupied portions of office buildings are sometimes worse than worthless if the light's heat output was meant to be an important part of the building's heating system.

In some buildings designed during the cheap-energy era, it is not uncommon during the winter for furnaces to be heating the peripheral areas of the building at the same time that air conditioners are cooling its control core. Even the fanciest high-speed miniature solid-state electronic controls are helpless against this kind of built-in inefficiency. But if energy conservation is regarded as a big system problem, electronics can play an important role in making the system work.

And, although solar energy and laser-induced thermonuclear fusion may well prove to be our main sources of energy several decades from now, for the next few years, fossil fuels, fission reactors, and hydroelectric plants—in that order—will remain our only important sources of energy. There remains little scope, therefore, for any significantly increased use of electronics in the actual production of energy.

In conversion, the outlook is a little brighter. Since, from a control viewpoint, a fossil-fueled electricity generating plant is, after all, no different from a chemical plant or an oil refinery, it can also take advantage of all advances in process control—microprocessors, improved transducers, and all the rest.

Aiding energy transmission

A particular application in which electronic components are destined to have ever increasing impact is in the long-distance transmission of electricity. Direct-current transmission seems certain to become increasingly important in the immediate future.

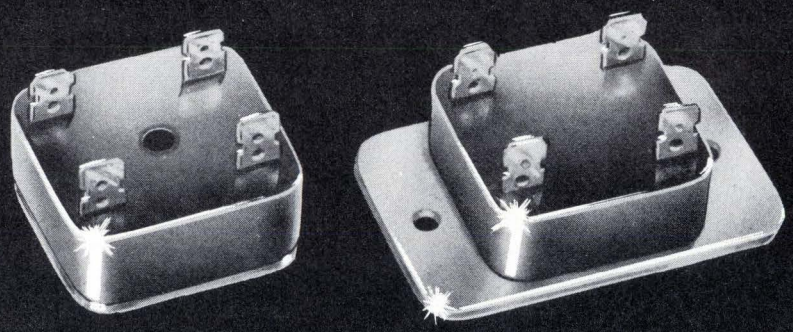
The reasons are fourfold. First of all, there is less loss in dc transmission than ac, particularly at the extremely high voltages being contemplated for long-haul systems. Second, dc is transmitted over two-wire systems; the high and increasing costs of copper and aluminum make this fact alone important, since ac systems are typically three-phase and require more conductors. Third, since dc systems are not sensitive to the dielectric absorption properties of insulators, cheaper materials can be used to insulate their cables. And finally, dc links allow the asynchronous transmission of electricity between power grids. They make it unnecessary to worry about matching frequency and phase before connecting two grids together.

Transmission of dc electricity is important to the electronic community because the current state of the art calls for solid-state ac-to-dc and dc-to-ac converters. The total number of devices involved will not, of course, compare with the number of transistors being produced on LSI chips, but these huge power devices may require enormous tonnages of silicon. At the very least, the increased use of dc transmission will increase both the quantity and quality of high-power solid-state rectifiers and switches.

Finally, if buildings now on the drawing board are designed to be as efficient as possible in their use of energy and materials, elaborate integrated control and communications systems can be economically included in them. Widespread multiplexing could minimize the amount of copper needed for such functions as climate control, lighting control, intercomunications, data communications, and voice communications.

Microprocessors and/or minicomputers could direct the flow of heat from areas where it exists in abundance to areas where more is needed. Data for these computers would not simply consist of temperature measurements, but would include measurement of the humidity and number of people in a room as well as wind velocity and irradiance from the sun on the building's exterior. Anticipatory control could be introduced, and heat pumps would make it unnecessary and unthinkable to air-condition part of a building during the winter. □

our 1975 economy compact models



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CONSUMER

Reliability now ranks very close to low cost in the eyes of consumer and commercial electronic-equipment manufacturers. As the best route to both goals, solid-state technology, up to and including large-scale integration, is gaining ground in everything from television sets, video projectors and playback systems, and four-channel audio equipment to appliances and electronic funds-transfer systems.

☐ The all-solid-state color-television chassis reached maturity this year, but the event was virtually unnoticed by consumers. Although it's been about five years since the first models were designed, this was the first year that the number of solid-state models in product lines exceeded the number of so-called hybrids. What's more, RCA announced in March that it would produce its last hybrid chassis in April, and others have since acknowledged that by next year, there probably won't be a hybrid set in production. The Japanese have long since phased out hybrid sets in their domestic market.

While the consumer may see no difference in the picture on the all-solid-state models, set reliability should show up in a dramatic reduction in expensive service calls. In the TV industry, however, the impact has been felt. For some time, there had been discussion of when the solid-state chassis would become less expensive than the hybrid, which has tubes, passive components, discrete semiconductors, and ICs mixed together. There has been no cross-over point because nobody has been able to make a valid comparison between the two types of chassis. The all-solid-state models cost more than the hybrids, but they also perform better and are more reliable.

In other entertainment products, efforts have been increased this year to develop low-cost, reliable, video-disk players, while video projectors have arrived as a consumer product. However, development of cable-television equipment has actually slipped backward from the grand plan for interactive two-way CATV to more down-to-earth one-way premium television programing. Four-channel stereo products seem to have slipped into a stage of tweaking to higher levels of performance both the discrete four-channel and four-two-four matrix encoding systems.

In personal electronics, the buzz-word has been cost. The cost of calculator chips and finished products has continued downward, while functions per dollar have increased. Solid-state watch makers have concentrated on digital displays, including the use of field-effect liquid-crystal types. But again, the key is cost, with "under $100" being the target these days.

As for commercial equipment that directly affects consumers, much effort to upgrade point-of-sale terminals has been concentrated on recognition devices that can read coded labels. In banking systems, communications is the key to electronic-funds transfer, which the industry has been dreaming about since it invented the term "cashless society." Now new parts of electronic-funds-transfer systems are emerging among some savings banks, credit-card companies, retailers, and banks.

by Gerald M. Walker, *Consumers Editor*

What's on television?

Top engineers in the TV industry agree that the all-solid-state chassis is the most significant development in the last couple of years (Fig. 1). The application of integrated circuits has also been a major advance. As expected, the trend has been toward more complex ICs than were in the first-generation receivers, and as a result, more functions are being combined on each chip. One manufacturer, Zenith Radio Corp., Chicago, has reduced the three ICs performing chroma functions to two, and will probably eventually squeeze all of these functions onto one IC.

Worldwide, all TV manufacturers are taking this consolidation route as the costs of ICs come down, and as capabilities and reliability are also improved. Low-level functions of the receiver that are amenable to integration include the i-f stage, chroma, audio, sync separation, and automatic gain control.

Thanks to the spur provided by the Federal Communications Commission's requirement that uhf and vhf tuning be compatible, electronic tuners will come on strong in TV sets. With it, says Karl H. Horn, senior vice president for engineering and research at Zenith, "there will be a proliferation of channel-number displays on-screen, LEDs, incandescent bulbs, neons, liquid crystals, and even fiber optics. Which ones get the most use depends on reliability and economics."

Giant steps in the U.S. toward use of digital ICs in tuners have been taken by Magnavox Consumer Electronics Corp., Fort Wayne, Ind., now controlled by North American Philips, and kit-maker Heath Corp., Benton Harbor, Mich. Both manufacturers are offering push-button channel selection and display of the number of the channel being viewed on the screen.

These are catch-up developments, since Japanese designers had previously introduced digital tuners based on MOS ICs. But the U.S. products offer the additional qualities inherent in more recent IC improvements. The Magnavox version, introduced last spring, uses an ion-implanted p-channel chip from Mostek to replace all potentiometers in the tuning circuitry.

Remote control is an integral part of the system, and the ultrasonic signals are decoded on the chip, instead of in banks of tuned circuits. Also on the chip is a frequency synthesizer for controlling varactor tuners, and a character generator provides the on-screen channel

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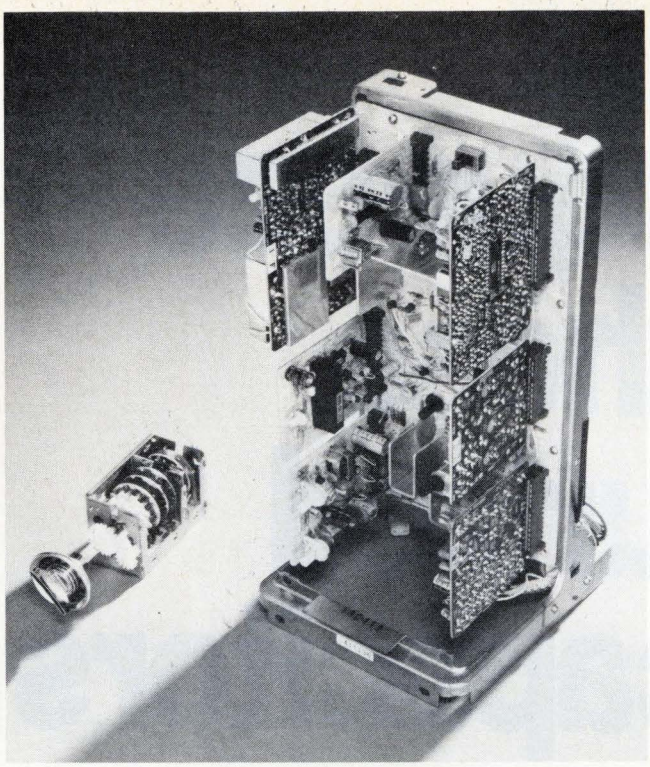
Circle 124 on reader service card



1. Solid-state economy. TV makers have not only gone over to solid-state chassis, but have economized in design. This Sharp 18-inch model consumes 79 W, compared to 140 W previously, and it has a 57-contact tuner (left) compared to 117 contacts previously.

display. This type of tuner is being referred to as a frequency synthesizer.

The one vacuum tube left in the TV receiver, of course, is the picture tube. Already common in Japan and virtually the only type used in Europe, the 110° deflection tube is now on its way into some American receivers. Until now, set designers have been loath to go to 110° because of the added effort and cost involved in the deflection circuits, correction of pin-cushion effects, and the power supply. In addition, the tube costs $7.50 to $10 more to manufacture than the 90° version.

But the development of the in-line, simplified convergence tube has altered the picture by providing a saving in manufacturing costs to offset the premium on the 110° tube. Essentially the 110° in-line tube, like the large versions recently developed by Philips in Europe, cut requirements for dynamic tolerance-compensation in half. What's more, the tube eliminates the need for dynamic convergence units on the tube neck.

Flat screen is elusive

Some observers are skeptical and others are enthusiastic about the potential for the flat-panel display (Fig. 2). "It seems that every five years, the practical, flat, wall-size TV is 10 years away," chides David E. Daly, division vice president for RCA consumer-electronics-product planning. "It needs a breakthrough to solve cost, brightness, and resolution."

Comments Dr. Robert Adler, vice president and director of research for Zenith, "Our company president has said that there will not be a wall-size TV receiver in his office during his lifetime, but we're trying to prove him wrong. We are hopeful that it will be perfected in somebody's lab in three to five years. It will take three more years to get out of the lab and three to four more to become commercially attractive. In the mid-'80s the flat screen should be available as the 'Cadillac' of consumer products."

The all-digital receiver appears remote today. Although digital technology would benefit signal-processing, the need to convert analog signals to digital and then back again for display is a deterrent. Nevertheless, Dr. Donald S. McCoy, division vice president for development engineering at RCA Consumer Electronics, Indianapolis, points out that a digital terminal for the home could be used for other information-processing services, such as transmission of printed material. Circuits would not be needed in this terminal to convert the signal form, but this would not be a true TV set.

Although efforts to develop video-disk players are continuing full-tilt in Europe, Japan, and the U.S., mass-produced, consumer-priced products remain only fond hopes. The joint Telefunken-Decca venture, called the Teldec TED player, had actually reached production stage in January, but the firm held it up because of a problem with its disk-handling arrangement. However, despite the delay, Teldec will probably still be the first to offer a consumer product using a stylus playing head on a rigid disk that spins at 1,800 revolutions per minute.

On the other hand, the optical type of player is offering competition, and developments have gained considerable momentum. Philips has displayed an optical type employing a laser that reads through a transparent plastic protective coating. In the U.S., a couple of video unknowns, MCA and I/OMetrics, have developed systems as well. The MCA offering is like the Philips model, and the I/OMetrics player uses an unusual film-based disk.

Others work on video players

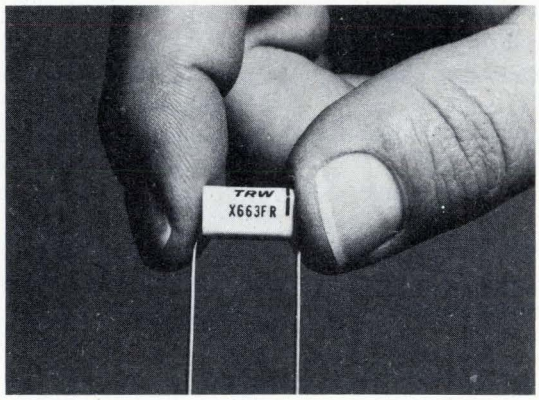
Among the major electronics manufacturers, RCA, and Zenith have made no secret of their efforts. Zenith, working on an optical floppy disk (Fig. 3) has collaborated with Thomson-CSF in France. RCA is pinning its hopes on a capacitance approach similar in concept to the stylus playing head for audio and is working hand-in-hand with the company's record division. Meanwhile, Sony Corp., always likely to do the unexpected in technology, has come up with a video card-player, called Mavica, for Magnetic Video Card (Fig. 4).

These developers can show pictures of various qualities on what are admittedly laboratory-built players or rough prototypes. But reaching the present level of development has been quite a challenge.

"It's important to understand that there are two costs involved—the player and the disk or software," Zenith's Adler points out. "We want a system that has a picture quality no less than NTSC [U.S. television] standard and a disk that can be made cheaply and quickly."

Zenith's laboratory model produces pictures close to target with some "dropouts" that are only distracting when the player is matched against the same program broadcast to a standard receiver. Best results have been

Fight chassis squeeze with these miniaturized "flat oval" capacitors



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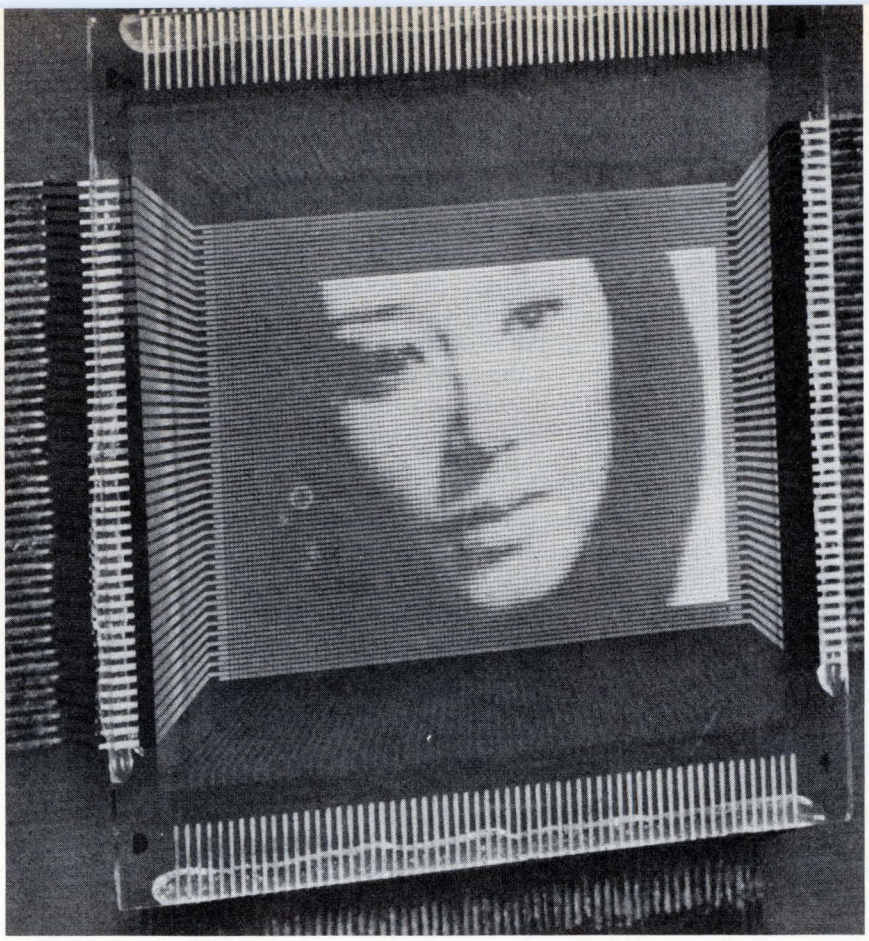

2. Flat. Development of flat-panel displays is progressing in Japan. Sony has demonstrated a colored-gas-discharge type, and Sharp has built a monochrome electroluminescent version (above).

achieved with the help of a time-base correction, but ideally, the mass-produced player should not have the added cost of this circuit.

The development team is also trying to increase the density of the information grooves on the disk up to 900 tracks per millimeter to lengthen playing time and to find a way to record on both sides of the disk to double total playing time. Adler says that the frequency of the fm carrier for luminance and chroma (the video components of an NTSC signal) has still not been firmly settled. However, distortions caused by nonuniform disks can be avoided if the fm carrier frequency is twice as high as the highest video frequency of 4.2 MHz.

Zenith set the synchronizing pulse at 6 megahertz, the black level at 6.5 MHz, and the white level at 8 MHz. This protects luminance frequencies as high as 3.25 MHz. Adler explains: "We have reduced the chroma subcarrier frequency in such a way that the entire chroma band fits within the luminance band, making sure, however, that the sidebands of luminance and chroma remain interleaved. In the decoder, we use a comb filter to separate luminance and chroma cleanly from each other."

System can freeze frames

MCA Disco-Vision Inc., Torrance, Calif., has also demonstrated a good picture on a prototype player that can freeze by repeat scanning of a single record groove. Being optical, it does not wear the record. Measurements of the playback signal-to-noise ratio reveals that the noise floor is determined by photon-shot effects, thermal effects, laser noise, and preamplifier noise. Thermal and preamplifier noise, which dominate, are about equal. The MCA video signal-to-noise ratio is now better than 40 dB in playback.

In its Mavica system (Fig. 4), Sony increased recording density by narrowing the width of the recording track and dispensing with a guard band. However, in order to eliminate adjacent-band interference, Mavica employs a phase-modulation method in which the central phase of the carrier in one track coincides with that of the carrier in the adjacent track. Because signals that are overlapped in playback are merely a combination of the signals in the two tracks, no beat is generated.

In Sony's skip-field technique, the video signal is recorded with the frame period aligned on the card, which also increases the recording density. Playing time is 10 minutes for the 6.25-in.-by-8.5-in. card.

Little detail has been revealed concerning the RCA capacitance-disk system, primarily because the firm has been burned twice by premature announcements. The first was a hologram-tape system that languished in the lab, and second was a VTR player that has been delayed a couple of times. The rigid RCA disk, coated with conductance and dielectric layers to facilitate capacitive pick-up, rotates at 450 revolutions per minute and can be recorded on both sides for an hour of playing time.

In response to criticism that this system causes wear on the record and stylus, RCA's McCoy contends that wear is about the same as it is in audio systems—about 500 plays before wear is noticeable with a sapphire stylus and about 75 plays of the disk before the noise

3. Floppy TV. Zenith's video disk comes off the press at the company's research lab for display on a laser-type optical player.

level increases. Time-base-correction circuits are necessary, and it's extremely important that they be built into the player, says McCoy, because it would be next to impossible to modify television receivers in the field.

Video projectors make a play

All of a sudden, four large-screen color-TV projection systems are available. Of these, three are nearly consumer-affordable—Sony's at $3,000, Advent Corp.'s at $2,500, and Shannon Communications' recent offering at less than $1,000. The fourth, General Electric's PJ5000 projector, at $44,000, is still very much an educational system.

Sony gets diagonal picture size of 50 inches by using a specially developed Trinitron tube that triples normal image intensity. Advent Corp., Cambridge, Mass., has designed its VideoBeam around three LightGuide projection tubes that transmit an 87-in. diagonal picture. The tubes use a Schmidt optical system. The electron beam is projected over a 15° angle onto a 3 in. curved aluminum target coated with a single phosphor for the desired color. The image is reflected back into the tube to a 6 in. curved mirror behind the phosphor, which, in turn, reflects the image forward onto the screen through a corrector lens. Because the optical elements are fixed in the tubes, the projection distance must be 8 ft., with 1 inch of tolerance.

The Shannon system is basically a lens arrangement that attaches to the front of a standard TV receiver, which is why the cost is much lower than that of the other two systems. The only electronics consists of a double-pole, double-throw inverter switch interposed in the vertical-deflection circuit of the picture tube to reverse the mirror image from the tube so that it is projected in the proper orientation for viewing the image reflected from the screen. There is also a "zoom circuit" available to shrink the size of the raster scan projection of a large-screen set down to the size of the Shannon projection lens.

The Shannon-adapted receiver can be focused by moving the lens back and forth to provide a picture of the desired screen size. For example, the standard model, designed for a tube measuring 12 in. on the diagonal, can be viewed on screens having diagonals of 50 in. to 120 in. Screen brightness for this system is 4 to 15 foot lamberts on this range of screens, compared to more than 10 ft L on a 50-in screen for the Sony system and more than 20 ft L on axis for Advent's equipment.

Getting set for pay-TV

Hope generated by all the communications services for interactive television in the "wired nation" just about went down the drain this year as cable-TV operators reefed their investment sails to sit out a rather serious financial storm. This was a clear case of how the cost of money and the inflationary economy directly affects the development of technology.

But it did not bring CATV technology to a halt. Cable operators have found in premium pay-TV a potentially profitable service with much less investment than the elaborate two-way systems require. In the meantime, hardware development is suspended in sort of a holding pattern. Design efforts are being devoted to equipment to scramble, unscramble, and control pay-TV cablecasting. The challenge is to develop essentially interactive control on standard one-way cable nets, but keep the costs down.

The approach of Jerrold Electronics Corp., Horsham, Pa., for its Scramble-Descramble Systems (SDS) is to provide three levels of service—single programs, multiservice for subscription-type monthly billing, and individually addressed pay-per-program TV. The latter, SDS-AN is the most elaborate of the three. One-way addressing is provided by a system consisting of a minicomputer, an address/service encoder, a channel scrambler/modulator, and an order-entry encoder.

A set-top descrambler is installed in the home, separate from the standard converter issued by the cable operator. All of the information needed to authorize a per-program order is carried on one dedicated channel.

The SDS-AN system would not have been possible without MOS LSI for the home descrambler, observes Andrew Barnhardt, manager of R&D for Jerrold. To get the address coding and error-correcting logic required in an electrically noisy environment would have taken 30 or so transistor-transistor-logic ICs, he adds, whereas the task is handled with one MOS LSI device.

Audio quietly innovates

Advances in semiconductor design have given audio engineers increased freedom in the design of voltage and power-amplifier circuits for use in hi-fi equipment. Entire driver stages have been reduced to IC form, making electrical design more predictable and consistent and mechanical design less demanding. For example, packaged Darlington configurations, designed to replace discrete driver and output stages in comple-

mentary audio-amplifier applications, are available at sufficient power levels for use in hi-fi amplifiers.

The fm and a-m reception sections of receivers have benefited as well. Besides electronic tuners, phase-locked-loop ICs are gaining wide use as multiplex demodulators in fm receivers. Shottky barrier diodes are now used as rf mixers, i-f filters are now available in frequency-aligned packages, and quadrature detectors are being used more frequently in receivers.

Tape-cassette decks have benefited from IC-logic systems for transport control to ensure accurate and safe shuttling of tape. Speakers have not changed much, but designers are experimenting with devices like the Heil air-motion transformer, inverted-cone designs claimed to maintain accurate phase relationship, and systems in which the discrete drivers are arranged to optimize propagation interfaces.

Four-channel stereo has also undergone intensive refinements, particularly with the development of IC decoder chips for both the discrete four-channel technique, CD-4, and the matrix two-four-two technique, SQ. "One of the problems," remarks Frank Krauser, chief engineer for Fisher Radio, Long Island City, N.Y., "is we need discrete four-channel fm broadcasts on the air to spur interest in consumers. In engineering, we have devoted considerable time to eliminating distortion and noise of the discrete CD-4 system and in increasing channel separation in the matrix-SQ system."

As for the future, some audio engineers are revaluating the traditional goal for hi-fi equipment of absolute fidelity in reproduction. "Traditional thought would dictate that the material on the disk—music and noise—be played back as accurately as possible," comments a spokesman for Harman/Kardon. "Now, we believe that the noise should in some way be eliminated without damaging the musical material in any way. So the charge given the engineer is no longer to build an accurate piece of equipment, but to build a piece of equipment that is capable of delivering the sound of the original, despite the limitations of the recording material. This would be more aptly called recovery equipment than reproducing equipment."

Audio developments are muted

Engineers are already experimenting with noncontact playback of recordings that are similar in concept to the optical video disk. Optical circuits offering most of the capabilities of electronic predecessors may eventually be designed into hi-fi audio equipment. But unlike the typical audio-equipment showroom, where sound levels reach the threshold of pain, technical developments in audio equipment have been muted, but significant, this year. These innovations include:

- Digital-tuning additions. H.H. Scott Inc., Maynard, Mass., has come out with a second-generation digital frequency-synthesis tuner. The digital logic is standard high-speed TTL and ECL that reaches 120 MHz. Coverage extends from 87.5 to 107.9 MHz in 100-kHz. stages, so that the tuner will work both in the U.S. and Europe.
- Software processing. Dbx Inc., Weston, Mass., has developed a new audio-disk recording and coding technique for noise reduction. The disk would be decoded at the point of playback, either by an add-on decoder or by decode circuitry built into consumer preamplifiers and receivers, much like the Dolby-B system for tapes. Using a patented linear decibel-compression and expansion scheme, the decoder eliminates the inherent surface noise of the record and substantially reduces the loudness of random clicks and pops in playback.
- Turntable. Rabco division of Jervis Corp., Plainview, N. Y., is bringing out a horizontal-travel tone arm on a turntable that tracks record grooves in a straight line, which is not possible with standard pivoted arms. The entire arm tracks the disk in a continuous lateral motion so that the arm's position at any point is parallel to its former positions, so long as the density of the grooves remains constant. The arm is driven by a chain drive connected to a servo motor.

All-electronic. The home will gradually become a terminal site for video and audio information, as well as entertainment.

Developments dominate where cost is king

Solid-state technology has dominated electronic developments in personal and home products for some years now, and 1974 was no exception. The extent of penetration has depended on the differences in cost structure for such products as calculators, watches, and appliances. Personal electronic calculators are now ubiquitous, electronic watches are reaching popular price levels, and electronics is being only tentatively built into home appliances.

It's common to refer to the hand-held calculator business as chaotic. But from an engineering viewpoint, a certain orderliness has become clearer this year. Despite the unruliness of the marketplace, the consumer calculator has followed a pattern fairly well-recognized in the semiconductor industry. Simply put, prices have come down, and functions have been increased.

Despite the steadily growing number of companies

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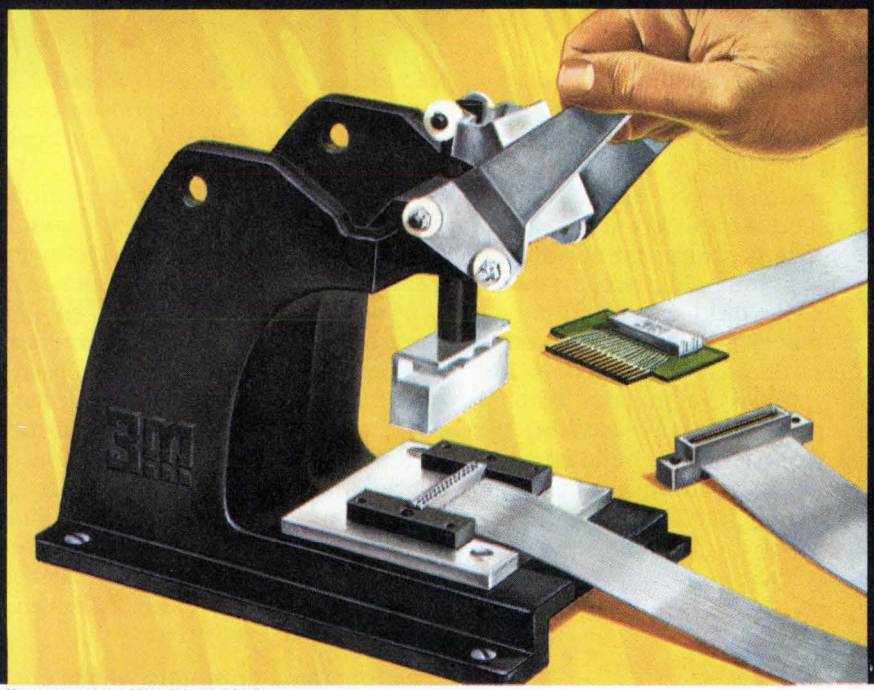

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4. Square peg? The Sony video-disk entry is actually a magnetic card, called Mavicard, inserted in a VTR-like player. The player has two magnetic reading heads, and playing time of disk is about 10 minutes. Sony has not priced the system yet.

developing solid-state watches, designs of this personal electronic product are still undergoing significant revisions—in the counter-chip circuits and the displays.

A switch to field-effect liquid crystals from the dynamic scattering types has achieved better visibility and perhaps longer life to displays. Field-effect displays, which absorb light through polarizers, present dark characters against a diffused white background and require less power than dynamic scattering types.

The problem with LED watch displays is the need for on-demand push-button switches to conserve battery life by lighting the digits only when needed. Manufacturers are attacking the problem in two ways: cutting the power consumption of LEDs with new materials that offer higher brightness with lower currents than today's devices and using more efficient driving circuits.

The C-MOS counter chips for watches are also being modified. For example, Intel Corp., Santa Clara, Calif., has cut the number of watch-circuit components from 50 to 25 and will probably have it reduced to 10 before long. American Microsystems Inc., also of Santa Clara, has made a dramatic change in watch chips between the model hours/minutes module (HMM) and the recently announced compact watch module (CWM). Component count has been decreased from 45 to 23, thickness from 0.358 in. to 0.250 in., and power from 5–7 V to 3 V.

Penetration of appliances is slow

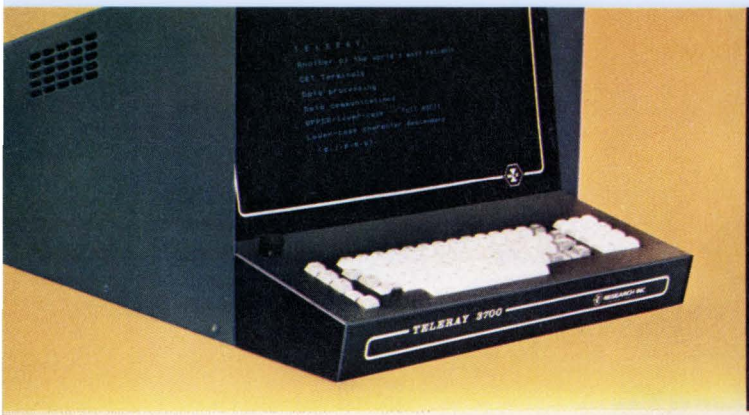
Appliance manufacturers don't have an intrinsic dislike for electronics, but they do have an intrinsic appreciation for cost. Thus far, the solid-state invasion has barely crossed the borders of appliance-land, because the cost has not been right. Clothes still get clean and dry, and food can be prepared efficiently without benefit of semiconductors. Air conditioners, however, have provided an opening for solid-state controls because of a desire to conserve energy and maintain performance during and after brown-outs and intermittant outages.

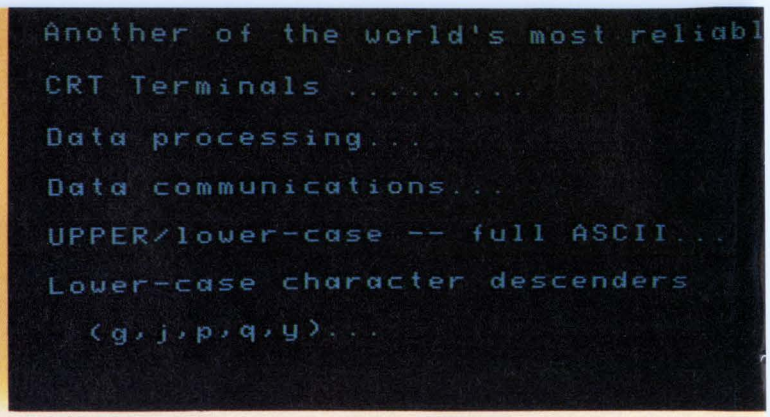
Electronics has firmly planted a foot in the doorway with a line of ranges and ovens introduced by Frigidaire. Following a kitchen range that uses four MOS ICs, the company has added two built-in ranges—a ceramic-top stove, and an oven containing the same electronics package, plus a gas-discharge digital display (Fig. 5).

The follow-on units are important because they will probably be imitated by other appliance manufacturers. However, the next generation will probably gain even more flexibility by using microprogramable devices, rather than being hard-wired.

The veil of secrecy that typically covers household-appliance developments has been lifted from another development that has reached the market. Sears, Roebuck & Co. has announced an automatic clothes dryer, manufactured by Whirlpool, that contains an MOS chip for timing and logic control. A high-threshold metal-gate p-channel MOS chip is fed by a moisture sensor. The chip operates relays that drive the heating coils and motors for the tumble drum and fan. Transistor buffers drive the relays. The machine has a cool-down cycle, and to prevent wrinkles, a buzzer signals when the clothes are dry.

Electronics has started the penetration of air conditioners. How far will be revealed in detail later this year as new lines are announced. For instance, Heil-Quaker Corp., Nashville, Tenn., majority-owned by Whirlpool Corp., has concentrated on applying electronics to





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The diagnostics system will warn the homeowner to take care of some of the minor maintenance chores, such as cleaning the filter, that a service man used to do. The next level of diagnostics also indicates to the homeowner when he should call for help. This system will require a combination of linear and digital circuits, but again, the cost has to be right.

"The problem with a sophisticated diagnostics system," states Robert W. Ramsey, senior development engineer in advanced-product development for Heil-Quaker, "is that it has to be offered as an option at a higher price because only certain groups of consumers will immediately understand its value in total maintenance costs. That's the difference between adding electronic functional controls to an air conditioner, and being required to add safety controls, as in the automobile industry. We can't enjoy the economy of numbers when the electronic controls are offered as top-of-the line options."

Consumer meets terminal

The next year will be critical for manufacturers of point-of-sale terminals. During this time, standards for marking and reading tags in both retail and supermarket products will go into effect, and hardware producers must be ready with fast, dependable readers. To complicate the design effort, retailers have selected different coding standards from those of the supermarket operators and food processors.

Although the supermarket industry was first to establish the Universal Product Code, UPC is considered by retailers to be too narrow to cover the wide variety of items handled in department stores. As a result, the POS technology these days is centered around recognition devices—not only laser scanners already designed into supermarket UPC readers, but also photodiode arrays and charge-coupled devices.

A second development is needed for what's called distributive processing, which amounts to beefing up the terminal to do memory tasks in conjunction with an in-store minicomputer. This has led to the application of microprocessors in POS terminals.

Funds-transfer faces a crisis

The switch to electronic systems in supermarkets and retail stores will be based largely on choice and economics, but the nationwide or worldwide electronic transfer of funds is rapidly approaching a state of necessity. Experts estimate that in about 10 years, the present checking system will bury American banks in paper. And electronic transfer of funds would relieve the mails and bill-payers of a heavy burden.

Communications constitutes both an economic and technical challenge to electronic funds transfer. And communications also draws the Federal government into the electronic transfer of funds, because, to make a nationwide system work, the banking institutions will need a general-purpose communications net that does not yet exist, but will require Uncle Sam's blessing. Also, if the financial and retail communities actually create an electronic currency system, the Federal Government must be heavily involved because it controls paper currency.

5. Hot item. More manufacturers will probably follow the lead set by Frigidaire in programable cooking, controlled by MOS ICs.

Development of electronic funds-transfer systems (EFTS) is in an even greater state of flux than POS systems. Equipment includes simple credit-checking terminals, cash dispensers, automated tellers, and ganglia of data-communications nets, together with minicomputers and large-scale computers. These are operated by different institutions, including banks, credit-card issuing firms, savings institutions and various retail merchants. As one industry observer puts it, "It's a very messy business."

The technology has been developed, but the applications have not. Pinpointing the crucial aspect of electronic funds-transfer systems, C.F. Rench, vice president of R&D for NCR, Dayton, Ohio, observes, "The economics of communications is working against paper-check handling. It comes to the difference between the cost of check transfer—meaning transmission of an image of a single paper check on the one hand and electronic funds transfer on the other. On this basis, the paper check would appear to be more costly and far slower to handle than electronic funds transfer."

The ultimate system

Although various concerns have gone about EFTS piecemeal, buying terminals and establishing communications subsystems linking a specific number of stores and banks together, no complete electronic funds-transfer is in operation yet. The ultimate, blue-sky system will be national in scope and cover automated payroll, preauthorized payments, on-line financial services, remote inquiry terminals, remote transfer terminals, and remote retailer terminals. Electronically transferred payrolls would eliminate 3 billion checks per year. Bill payment is the largest single category of check transfers, and well over half—57%—of all checks mailed are for credit-card bills. □

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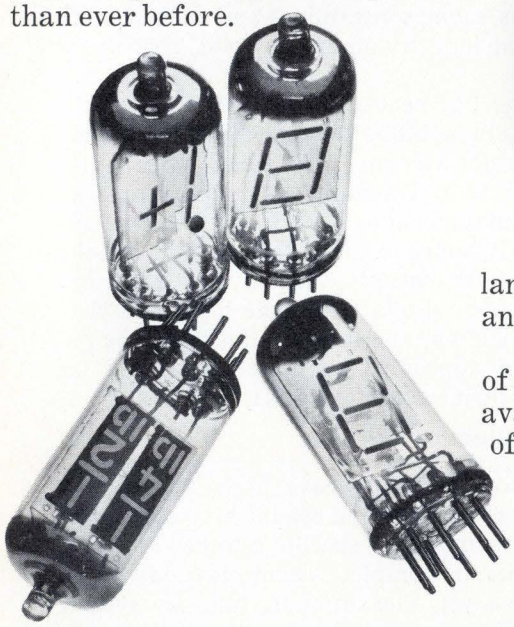

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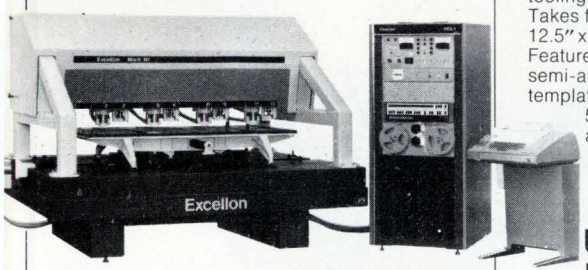

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A Programming option is available for the XL-2 which allows the machine to be used in a tape preparation mode of operation . . . performing both programming and drilling functions.

Drill hit rates up to 300/min. with 3 stacks. Spindle motor speeds: 20,000 - 60,000 with Excellon Quiet-Drill Model 700. Liquid-cooled & variable speed.

QUAD-DRILL™ 1218. For short-to-medium runs.

This quality Excellon 4-spindle drilling machine mass produces holes with minimum tooling investment. Takes four stacks of 12.5" x 18.5" boards. Features an adjustable, semi-automatic drilling cycle by a template-following stylus. Hit rate to 55/min. Highly accurate, dimensionally stable granite working surface.

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This single-spindle drill takes a stack of boards, pinned to either template or negative. Drill cycles upward from below when conical stylus centers in template or, with negative, centers in optional projection scope. Production rates of more than 250,000 holes/day.

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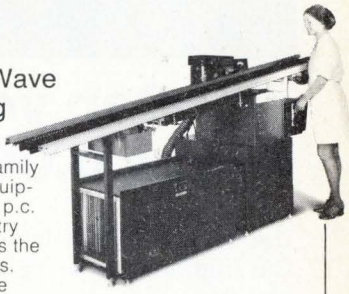
GALE Wave soldering systems.



Excellon's family of quality equipment for the p.c. board industry now includes the Gale systems. Featuring the unique oil intermix design (U.S. Pat. No. 3,589,590), Gale is the only wave soldering system with a single infinitely variable, stepless control dial to adjust both wave height and oil intermix ratios.

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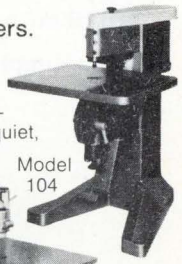
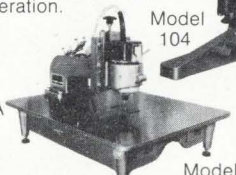
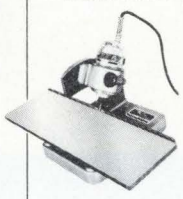


Manual pneumatic (Model 103) spindle lift pin router for internal and external routing of p.c. boards. Belt-driven (Model 104) offers quiet, long-life operation.

Model 104



Model 202A



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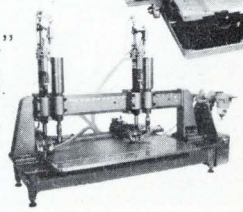

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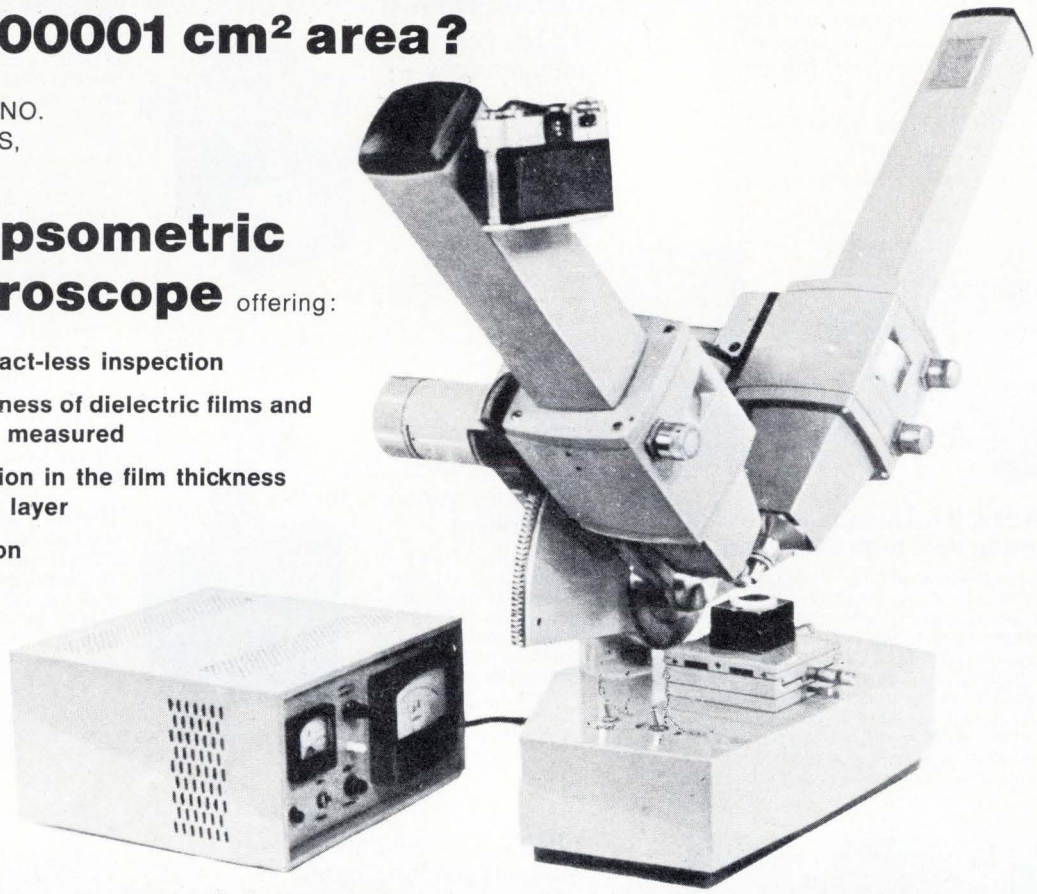

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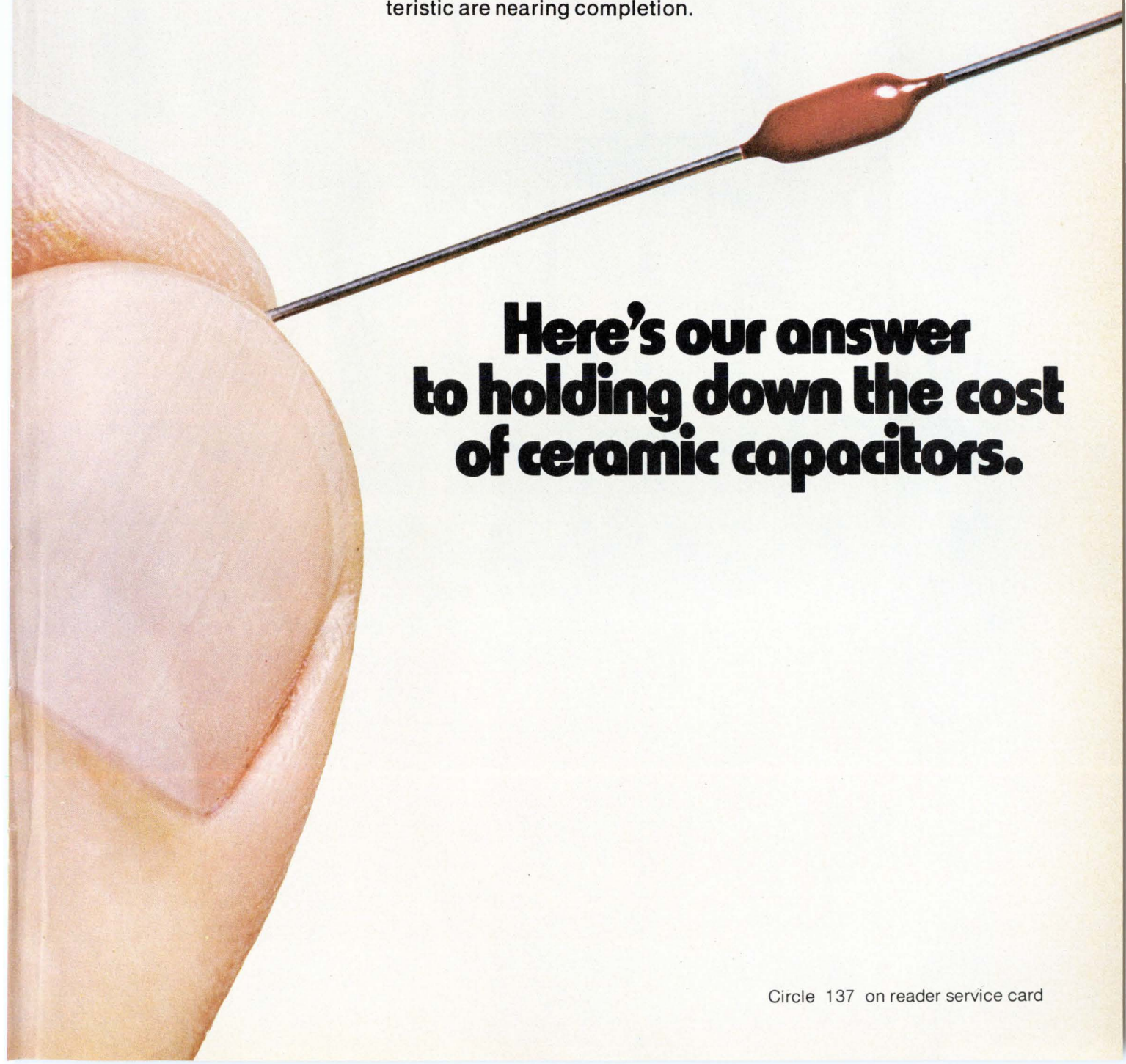

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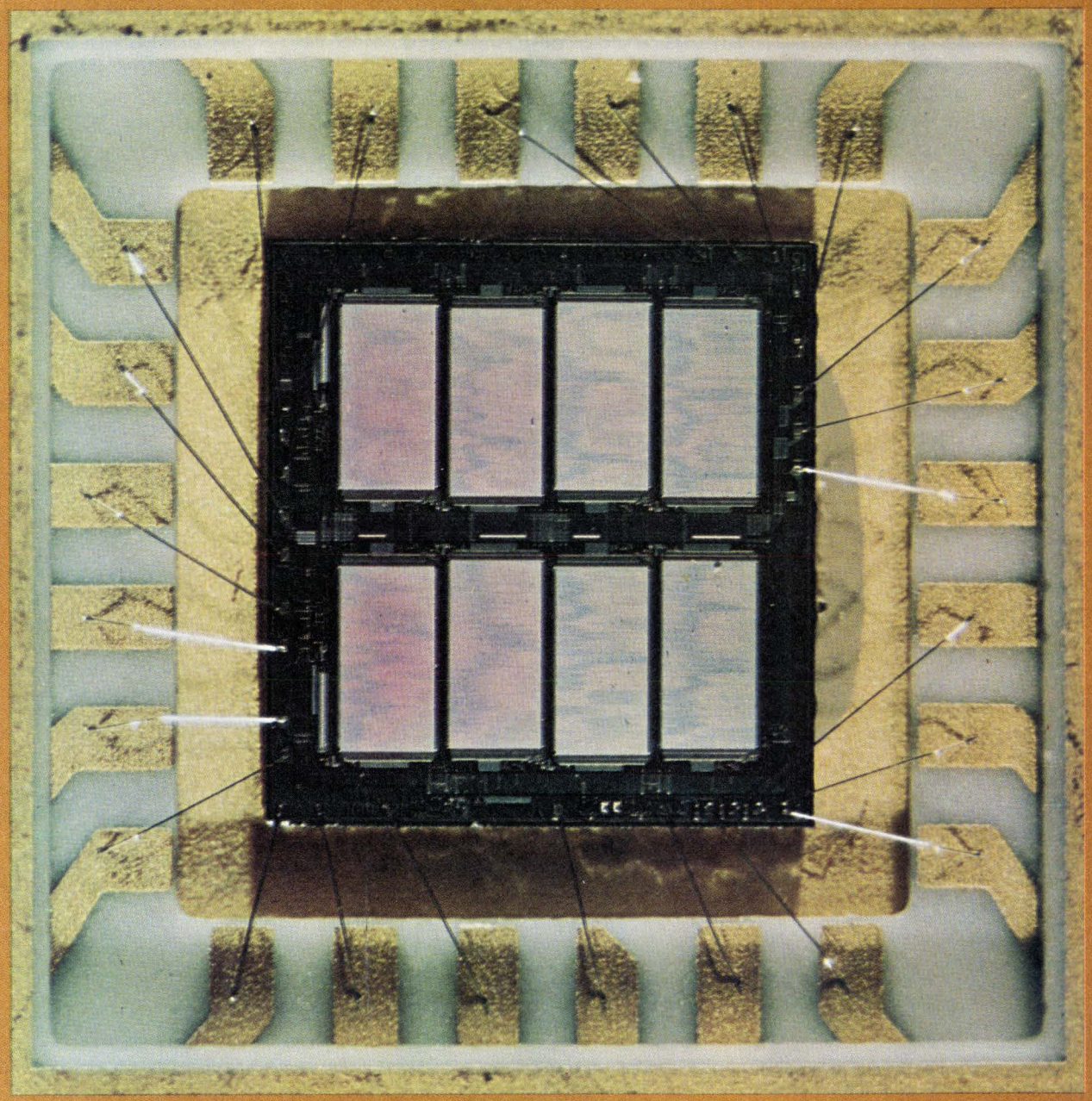


An increasingly subtle understanding of semiconductor processing techniques, plus a willingness to experiment with new layouts and materials, has brought the solid-state industry to the sophisticated heights of 8-bit microprocessors, 4,096-bit memories, 16,384-bit charge-coupled devices, and linear large-scale integration. What's more, performance and bit densities promise to go right on climbing.

☐ Semiconductor technology has been developed into a formidable arsenal of fast, reliable, IC devices that can be deployed to perform nearly any system function. LSI digital technology, using improved n-channel and complementary-MOS processing techniques on the one hand, and revamped high-density bipolar techniques on the other, are teaming with new linear-MOS capabilities to provide increasingly more-powerful design options and create unprecedented equipment performance.

Here are the highlights:

- Memories. Fast 1,024-bit and 4,096-bit dynamic n-channel random-access memories are going into volume production, and static n-channel devices with speedy 300-nanosecond access times are becoming widely available. Bipolar RAMs are moving in two directions: very fast 256-bit and 1,024-bit emitter-coupled-logic devices with access times typically as low as 20 ns for the fastest cache and scratch-pad applications and low-power versions of the 1,024-bit transistor-transistor-logic devices for heavy-duty mainframe subsystems. Complementary-MOS structures, in addition to their well-known logic capabilities, are being teamed with silicon-on-sapphire substrates to create a new class of low-power, high-density, memory devices for power-stingy industrial and aerospace systems. Finally, charge-coupled memory devices that can replace moving disks and drums have arrived. The first 16-kilobit and 32-kilobit CCD chips are expected by the end of the year.
- LSI processors. This year's 8-bit n-channel microprocessors offer the versatility of 70 to 90 instructions at 1- to 2-microsecond speeds. These bus-oriented CPU designs can be interfaced with matched input/output chips, such as modems and data-acquisition circuits, to provide an ever widening range of programable computer-control applications. Soon to arrive are 16-bit microprocessors built with improved n- and p-channel processes on single low-cost chips that will deliver the economy and performance required in such tough industrial applications as numerical controllers, data-acquisition systems, and monitoring car-engine parameters.

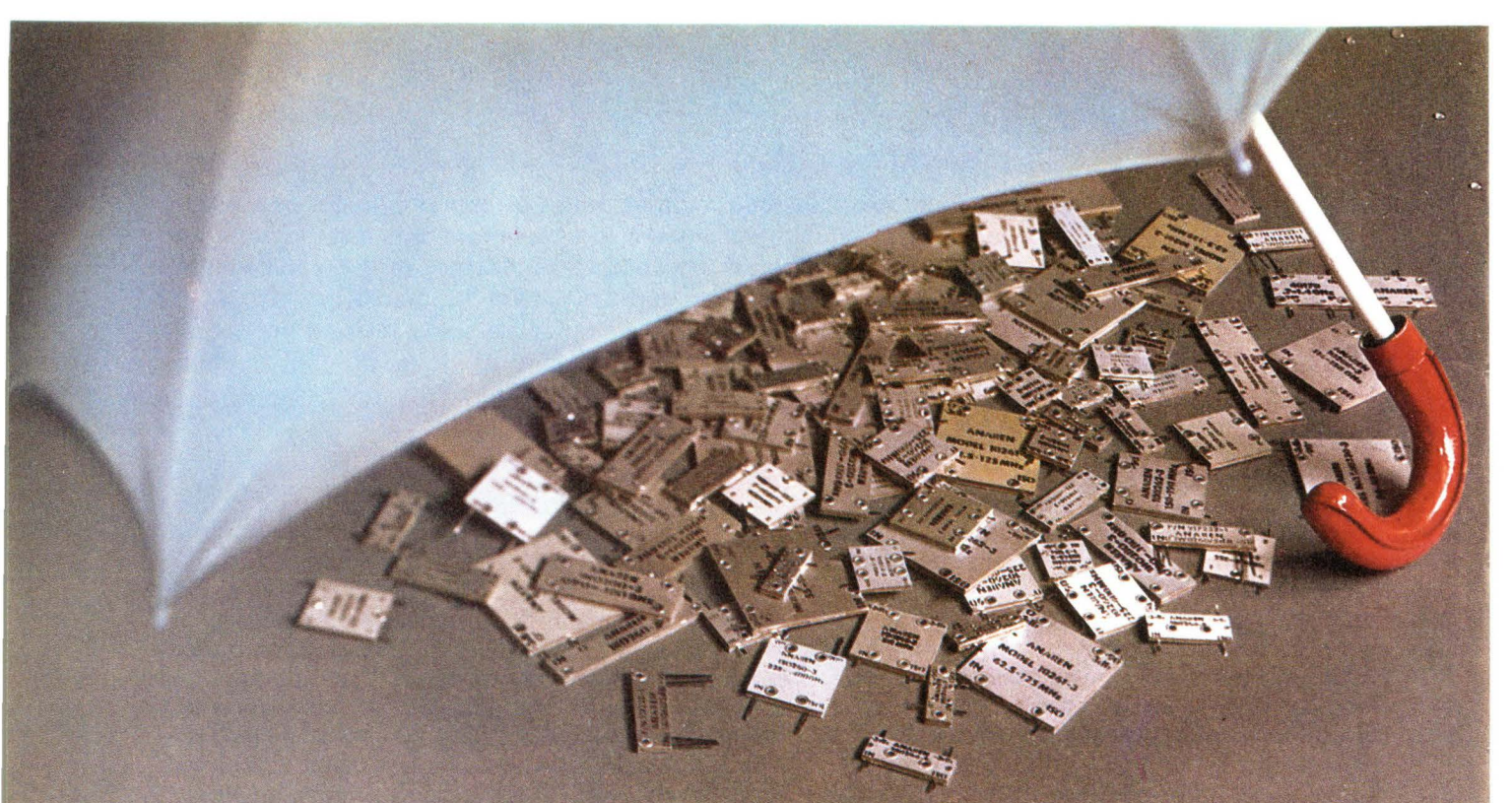
Most recently, TTL LSI processors have emerged in families of computer components to add minicomputer-control performance to industrial and computer-system designs. Finally, a new bipolar technique called integrated injection logic (I^2L) is being developed for 8-bit and 16-bit single-chip bipolar processors that promise to give designers a strong alternative to today's n-channel and TTL devices.

- Standard logic families. LSI-circuit techniques are being applied to standard logic, which is being rapidly upgraded to perform the fastest and most demanding jobs in mainframe controllers, megabit communications terminals, gigahertz counter circuits, and military- and industrial-computer equipment of all kinds. Schottky TTL and low-powered Schottky are now standard families. Complementary-MOS families, some built with space-saving dielectric and oxide-isolation processing techniques, can pack more functions onto smaller chips, and silicon-on-sapphire substrates are boosting C-MOS speed into the TTL range.
- Bipolar LSI. Here the direction is to high-performance bipolar capability on large chips at reduced cost. Many consider integrated injection logic to be an ideal technique in this respect. I^2L chips being readied at laboratories throughout the world may contain as many as 3,000 gates operating at speeds faster than 10 nanoseconds and dissipate only 1 nanowatt of power. Equally significant, long-abandoned logic forms, such as resistor-transistor logic, have received new life from such new LSI-processing techniques as implanted transistor elements and passive isolation.
- Linear devices. Again, I^2L structures are emerging in the first LSI linear devices, such as analog-to-digital-converter chips, digital tuners, and tone controls. Mixed processing techniques are now packaging single- and double-channel MOS structures on conventional bipolar chips to significantly boost the performance of operational amplifiers, digital-to-analog converters, comparators, and integrators. The successful integration of interdigitated p-MOS input structures, bipolar gain stages, and a C-MOS output already has produced a general-purpose operational amplifier capable of 5-picoampere input currents, 2-millivolt offset voltages, and slew rates of 5 volts per microsecond at a typical bandwidth of 15 megahertz.

Memory options proliferate

Although microprocessors have been making the headlines, no segment of semiconductor technology has moved faster in the last few years than semiconductor memories. Semiconductor-memory types now span the spectrum of applications from the microsecond and micropower requirements of today's terminals and portable memory equipment through 100- to 500-nanosecond mainframe and peripheral-controller applications, right down to the faster 20-nanosecond com-

by Laurence Altman, *Solid State Editor*



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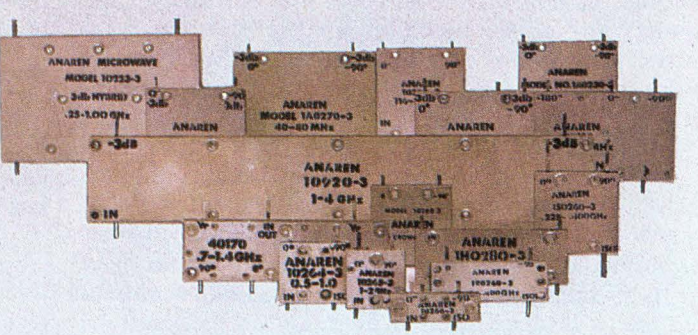

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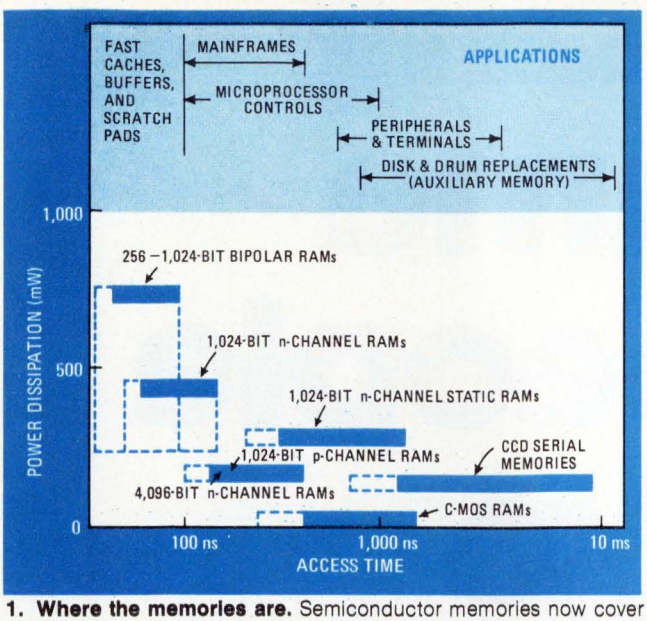


1. Where the memories are. Semiconductor memories now cover the spectrum—from the fastest cache and buffers to the slowest mass auxiliary memories. Dotted lines indicate performance trend.

puter-buffer and scratch-pad functions.

Figure 1 shows the speed-power performance of today's semiconductor RAMs. The dotted lines indicate how device performance will be improved over the next 12 months.

Four performance ranges can be discerned:

- Static bipolar and dynamic n-channel 1,024-bit RAMs are being increasingly used for high-speed scratch-pads, buffers, and mainframe memories. The trend is to higher speed and lower power requirements. Low-power versions of today's 1,024-bit bipolar chips—dissipating 200 milliwatts of power at 80-nanosecond speed—will shortly become available from Fairchild Semiconductor Components group, Mountain View, Calif., for example, to compete more favorably with the n-channel devices.
- The venerable 1,024-bit dynamic p-channel RAMs, which have recently become faster and cheaper, with access times of less than 150 ns, and the new 4,096-bit dynamic n-channel RAMs, are now in full production for medium-speed main memories and for peripheral, terminal, and microprocessor applications.
- Demand for 1,024-bit n-channel static RAM MOS chips has suddenly exploded for small peripheral and terminal applications. The new 256- and 1,024-bit complementary-MOS devices are now emerging in quantity for terminal designs needing low power dissipation but not high speed.
- Finally, charge-coupled devices are being built in 16- and 32-kilobit chips as replacements for mechanical and tape auxiliary-memory systems.

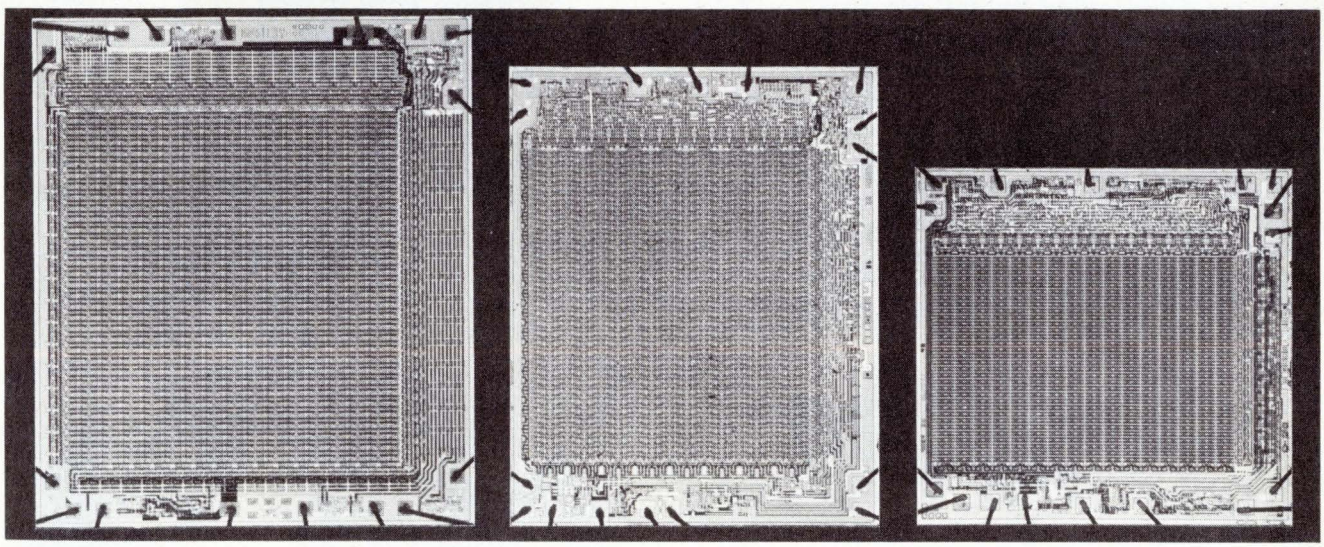
Designing mainframe memories

Potentially the cheapest way of satisfying the needs of medium-speed mainframes and large peripheral controllers is to apply the capabilities of the 4,096-bit n-channel RAM, which offers four times as much memory on the same-size chip and operate at about the same speed as the 1,024-bit p-channel devices.

Although availability is likely to be spotty till early 1975, 4-kilobit RAM prices now range from $15 to $25 for the 300-ns part and $10 to $15 for the 500-ns part. Three design types are vying for industry dominance:

- The 22-pin package, first announced by Intel Corp., Santa Clara, Calif., and Texas Instruments, Dallas, requires only one high-voltage clock level and three power supplies.
- The 22-pin package from Motorola Semiconductor Products Inc., Phoenix, Ariz., and American Microsystems Inc., Santa Clara, Calif., has an extra reset pin that is addressed when the device is first energized.
- The 16-pin package from Mostek Corp., Carrollton, Texas, is now also being supplied by Fairchild. It takes up less space than the other two designs, but may add system complexity because some pins do double duty, and the device must be multiplexed.

System designs are finally catching on to the virtues of the 1,024-bit n-channel MOS RAM. Introduced by In-



2. Bipolar memory:—faster and smaller. The 1,024-bit bipolar RAMs are getting smaller on the one hand and faster on the other. This Fairchild 1,024-bit device is shown as it has progressed over the last three years. Today's 45-ns device (right) is 20% smaller than first (left).

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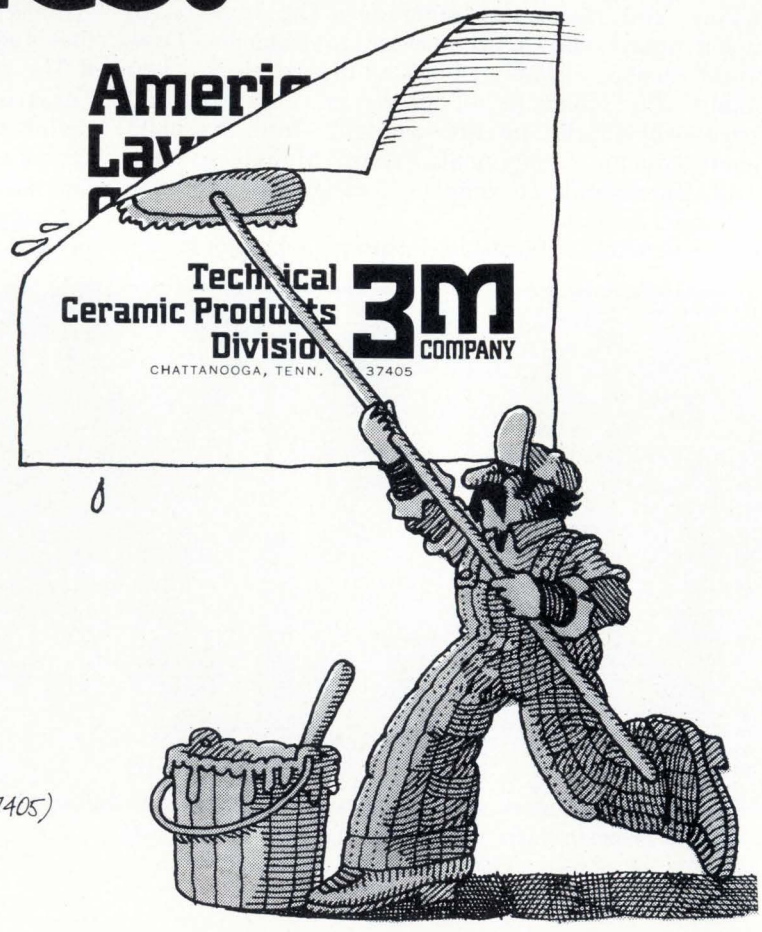

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They've involved our Purchasing Department by asking them to locate new sources of supply. Searching throughout the world, if necessary, to find additional qualified and dependable vendors. And working closely with our long-term suppliers to insure their meeting our production needs.

Our engineers have kept in close contact with their customer counterparts. Keeping them informed of materials to be avoided because of scarcity, or suggesting possible substitutes. Helping them to write new wire and cable specs around available materials so that the products can be delivered in a reasonable time.

All told, we think our engineers are meeting the challenge. But then, so are our other employees who say, "Yes we can." That's the goal. We think their efforts are helping you. And we think they've made us a better company.

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tel two years ago, it is now supplied by a host of manufacturers, and 20 to 30 million units could well be used next year.

The interest has been spurred by capabilities of the 1,024-bit statics, which operate from single 5-V supplies, are directly compatible with bipolar logic, and dissipate relatively low power when operating, although their dc-power drain is fairly high. Most significant, the latest designs are getting faster—speed has been increased from 1 microsecond to 500 ns, although some remain as low as 300 ns, increasing the device's penetration into some small mainframe designs, where low speed is acceptable.

RAMs built with C-MOS techniques are finally available in volume. Now at the 256-bit level, by year's end, they will have reached the 1,024-bit level. Having low standby power dissipation, high noise immunity, and high power-supply tolerance, they are particularly useful in industrial and portable memory equipment.

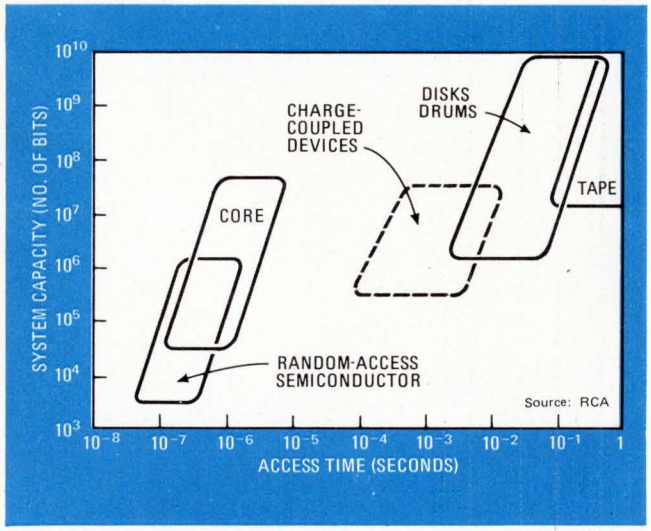
Moreover, many predict that C-MOS RAMs will proliferate throughout the computer-memory hierarchy as they're improved by such measures as use of insulating substrates like sapphire, which boost speed, shrink cell size, and increase chip-packing density. Intriguing indeed is the prospect of power-supply-tolerant, noise-immune, 1,024-bit and 4,096-bit static C-MOS-on-sapphire RAMs, operating off 5 V at speeds below 100 ns.

What's more, memory-component manufacturers will be ready to use their established n-channel processes in combination with SOS substrates in what could be the next high-density memory technology—an awesome 16-kilobit memory chip capable of 300-nanosecond access time.

Fast-memory options abound

Although the spate of semiconductor memories now available with overlapping performance characteristics can be confusing for some applications, for the designer of high-speed buffer and cache memories, the choice is clear: the bipolar RAM with access time of less than 50 ns. However, for many buffer and cache memories, the 50- to 80-ns access times of n-channel dynamic MOS devices is fast enough. The trouble is that their cycle time, which is three times as long as the access time, may slow up over-all system speed.

Moreover, new bipolar-memory processes now going into production will make these devices even more attractive during the next few months. For example, Fairchild is preparing two new oxide-isolated 1-kilobit devices Fig. 2—a 200-milliwatt version of its 1,024-bit devices, and a high-speed (30-ns) 500-mW unit. And on



3. CCDs fit in. Charge-coupled devices will fill the gap between the fastest semiconductor RAMs and the slowest tapes and drums.

TABLE 1: MICROPROCESSOR CHARACTERISTICS SUMMARY

Technology	p-MOS	n-MOS	C-MOS and C-MOS on sapphire	Bipolar
Word length	4, 8, 16	8, 16	8, 12, 16	16
Cycle time, μs	1 – 5	0.5 – 2.5	0.3 – 3	0.1
Instruction time, μs	4 – 20	1.5 – 5.0	0.3 – 6	0.6
No. of chips	1 – 5	1	1 – 2	7

Judging the microprocessor race

To get a foothold in the burgeoning microprocessor business, manufacturing activity has been feverish. Intel and Motorola began this year's n-channel parade with upgraded second-generation processors—Intel's 8080 and Motorola's 6800 [*Electronics*, April 18, p. 81]. These were followed recently by n-MOS chips from Signetics, Fairchild, and Western Digital—their first microprocessor entries.

Rockwell stayed on the p-channel route, updating its PPS-4 system with an 8-bit CPU chip [*Electronics*, April 4, p. 35] as has National by issuing 8- and 4-bit versions of its popular p-MOS IMP-16 system. National is also readying a single-chip 16-bit p-channel device for entry early next year, Intel has upgraded its MSC-4 system with a more flexible 4040 chip, and General Instrument is preparing its 16-bit n-MOS entry [*Electronics*, June 17, p. 29]. Others staying with p-channel are Mostek with an 8-bit unit and Microsystems International with a 4-bit device, while Electronic Arrays is planning an 8-bit n-channel design similar in scope to the other n-channel entries.

RCA exploited its C-MOS capability with a two-chip 8-bit device [*Electronics*, March 7, p. 30], which it's planning to offer as a single-chip product on a sapphire substrate. Inselek also has a C-MOS/SOS chip in the works—an 8-bit slice—while Intersil works on a C-MOS device on bulk silicon—a 12-bit unit that is compatible with existing Digital Equipment Corp.'s 12-bit PDP software.

On the bipolar front, Intel has already introduced a family of Schottky-TTL LSI processor chips [*Electronics*, Sept. 27, 1973 p. 33] that offers many minicomputer design capabilities in 2-bit increments. This followed Monolithic Memories' early entry into the bipolar-processor field with its 6701 series 4-bit microcontroller slice. Finally, TI, still formally silent on its LSI processor plans, now appears ready to introduce a single-chip 8- or 16-bit bipolar processor built with integrated injection logic [*Electronics*, Aug. 30, 1973, p. 143] that promises still higher performance.

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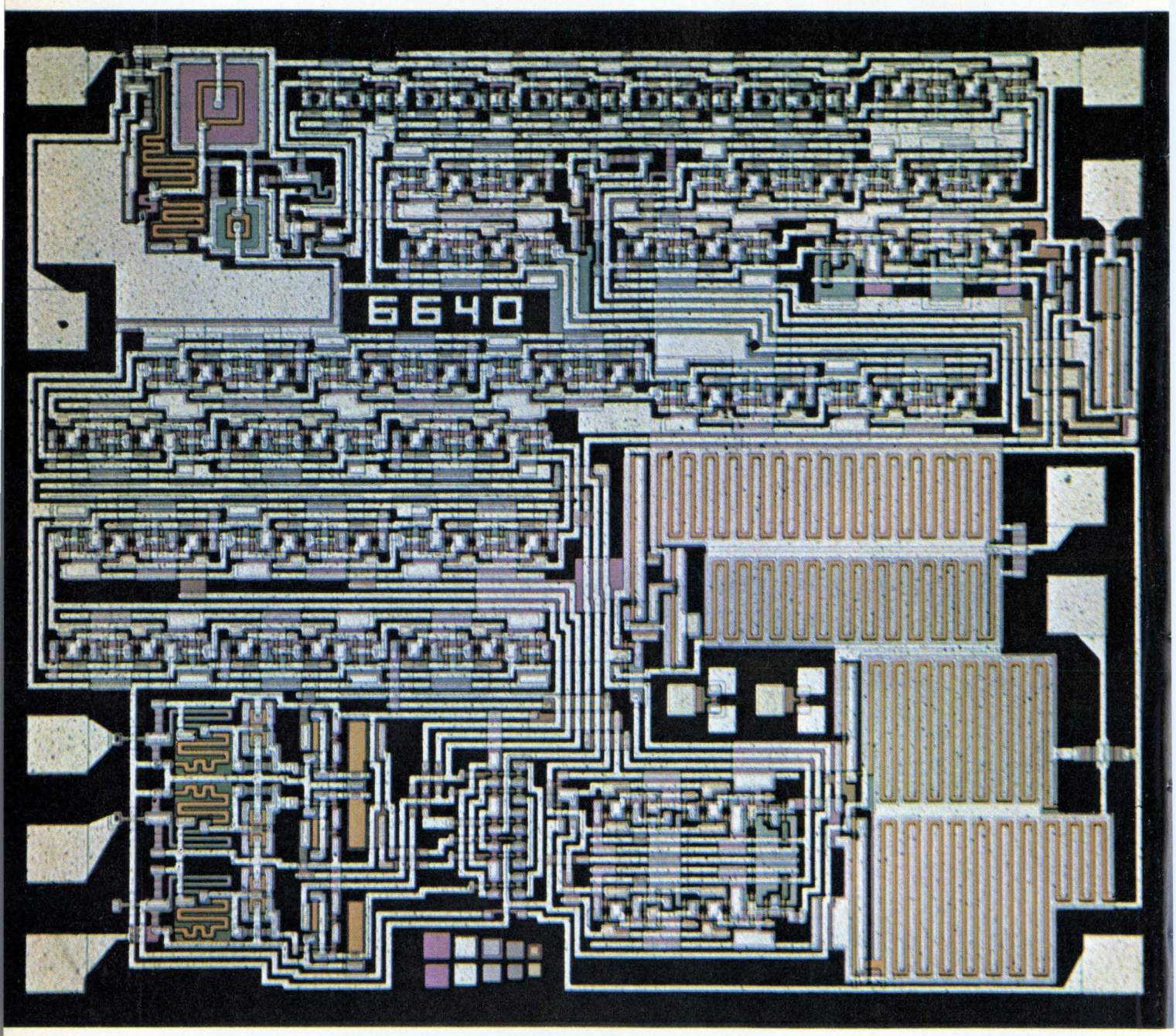
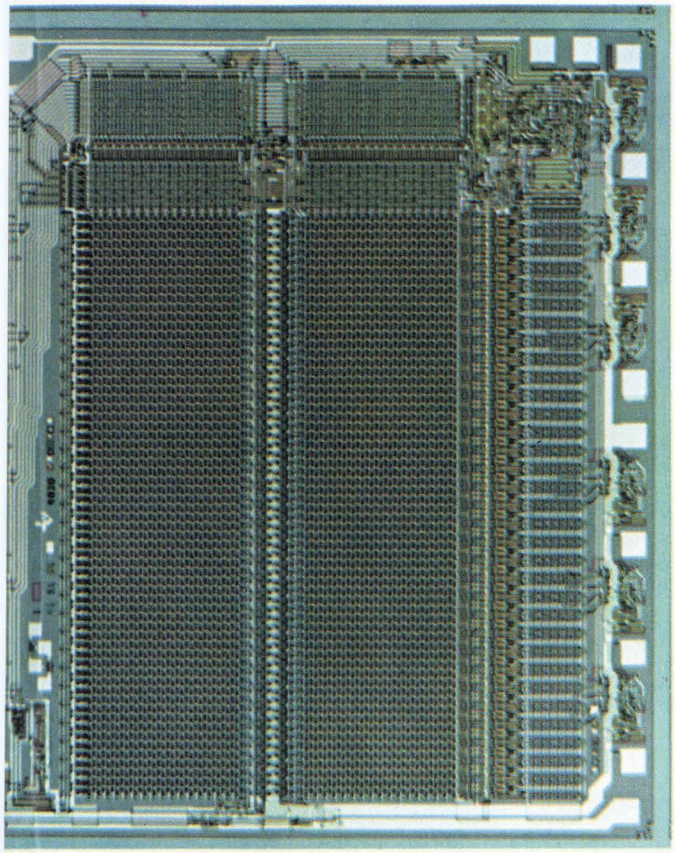
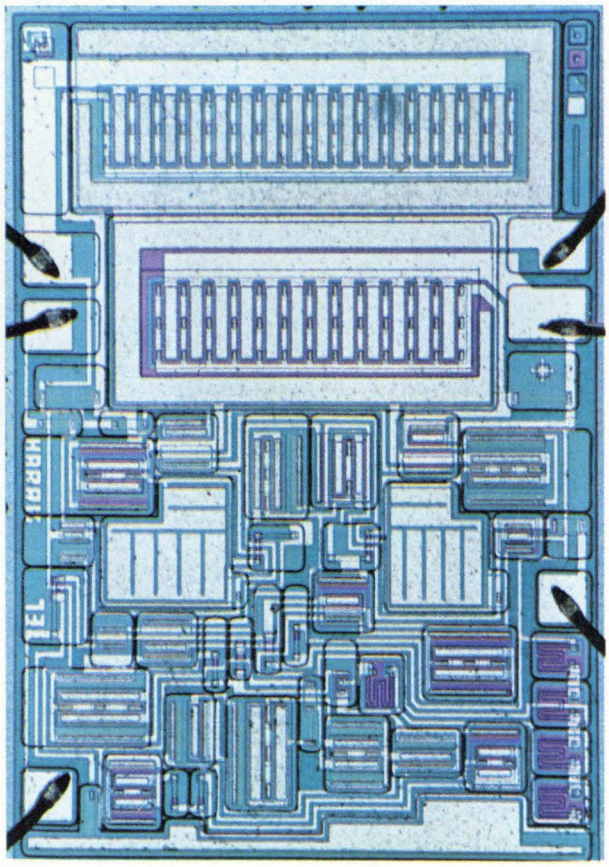
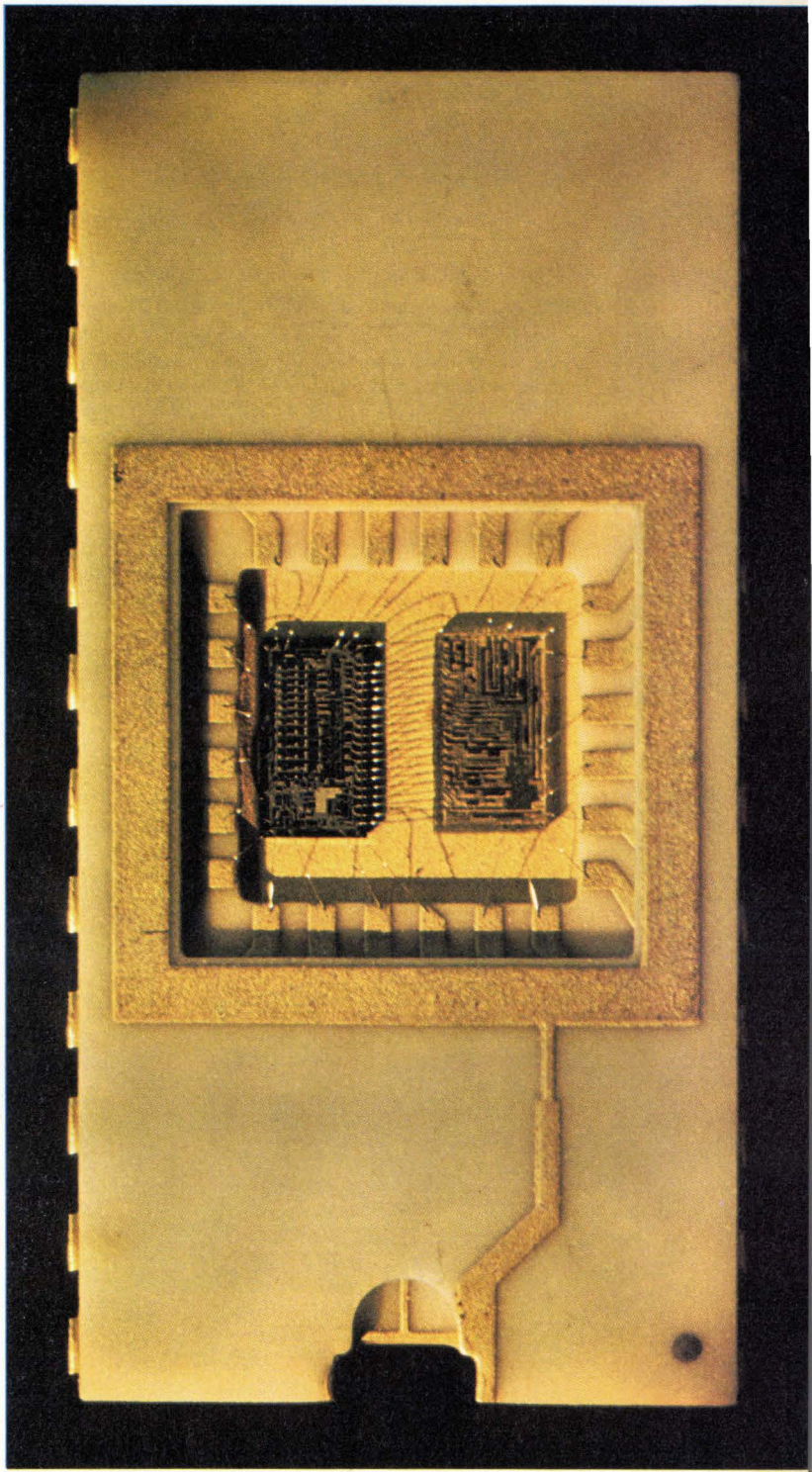


Pushing limits. There's more to semiconductor developments than microprocessors, as shown by these devices, which are typical of products that are extending operating limits and challenging designers. RCA's low-power complementary-MOS switch (top, left) is built on a sapphire substrate to get more elements that operate faster on a single chip. Sapphire-based circuits are being applied for watches, where high crystal frequency means smaller lower-power circuits, and for microprocessors where n-channel and C-MOS team up with sapphire to push single-chip performance into the 16-bit, 50- to 100-nanosecond minicomputer range. The maturing 4,096-bit RAM (top, center) means more memory for less money. This standard 300-ns part from TI, for example, could sell for less than $10 by the end of next year, bringing the cost of high-performance semiconductor memory well below today's core prices. New linear-MOS processes are being combined with improved bipolar techniques to boost analog-chip performance. Two examples: a 600-milliampere current booster, built with combined bipolar and MOS technology by Harris (bottom, center), and two-chip IC converter (right) featuring 12-bit resolution in a standard dual in-line package from Analog Devices.







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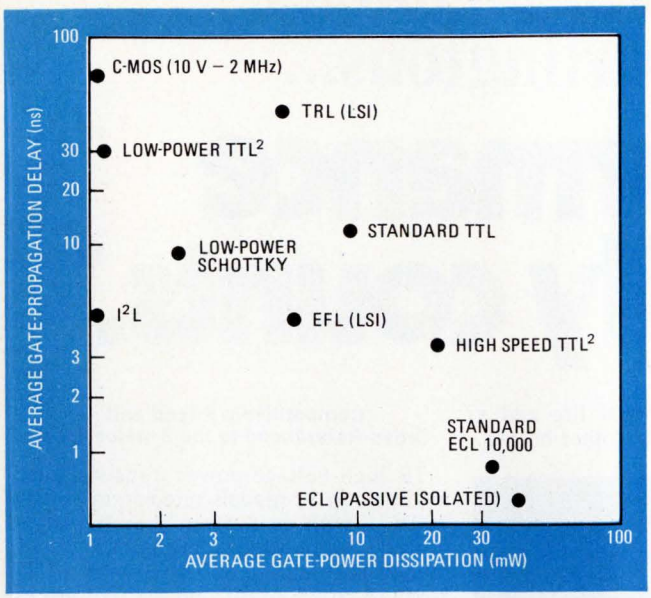

4. Logic boom. There's now a logic family for every circuit need, and competing types are extending designers' options.

another track, many semiconductor laboratories are applying the Schottky-TTL process in a 1-kilobit format, so that already a host of new, easily manufacturable bipolar-memory devices are available in that size from Signetics, Intel, and Intersil.

Memory-system designers are now attempting to determine how best to utilize the newly emerging 16- and 32-kilobit CCD serial-memory chips. Figure 3 shows where the CCDs will fit into the memory spectrum—most likely as replacements for block-oriented mechanical disk, drum, and tape drives. Compared to drums, a CCD equivalent will have four to eight times faster access time, occupy almost 1/10 the volume, weigh ⅛ as much, and operate at 1/60 the power.

LSI processors keep pace

Keeping pace with the rapid developments in memories is an increasingly powerful array of single-chip processors (Table 1). These serve as the hearts of the new low-cost microcomputers, minicomputer controllers, and data-processing systems. New 8-bit n-channel microprocessors offer the versatility of 70 to 90 instructions each and operate at less than 2-microsecond speed.

Soon to arrive will be 12-bit and 16-bit n- and p-channel microprocessors that offer minicomputer-processor capability on single low-cost LSI chips. This is the technology needed for the complex real-time control jobs, such as automobile-engine monitoring, cockpit-panel control, high-speed chemical processors, and the like. The technology is moving to tighter n-channel designs, combined with such process innovations as using insulating substrates of sapphire and spinel to boost processing speed and lower power consumption.

Capping this processor activity are the newly available bipolar LSI circuits that go to the heart of minicomputer-control applications. Now becoming available in families of matched computer components, such as Intel's 3000 family or the 6701 device from Monolithic Memories, Sunnyvale, Calif., these LSI processor chips enable designers to emulate most of today's 16-bit minicomputers, as well as to build into their equipment sophisticated microprogramable control capabilities. Typical cycle times of 70 ns and capacity of 120 and more instructions in a set make LSI bipolar-processor technology for the first time suitable for medium-scale computing applications—both for traditional minicomputer manufacturers and for independent designers of control systems.

Standard logic is upgraded

Under pressure from programable LSI logic chips, standard logic families are being upgraded rapidly so that they can perform the fastest and most demanding jobs. These families have been greatly enlarged, both in types and performance, during the past year. Indeed, a dozen or so logic families are now available with overlapping specifications (Fig. 4), giving the designer of standard logic more and more freedom to specify his exact circuit requirements.

Standard TTL still dominates main-line logic applications—all the timing, processing, and controlling that make up the bulk of instrument and computer-mainframe and peripheral logic. Here, a moderate price for moderate speed is generally the key. For LSI designs, new and revived bipolar circuits of integrated injection logic, resistor-transistor logic, and emitter-follower logic are making their impact. High-speed technology is still dominated by ECL designs, though they may encounter some competition from Schottky TTLs. Finally, for the industrial environment, where noise immunity and protection from power-supply variations are the chief considerations, but high speed is rarely needed, C-MOS is still the best bet.

I²L sets performance marks

Of all the various kinds of bipolar LSI available, the newest, integrated injection logic, is catching the imagination of logic designers throughout the world with its high-density and its high performance—nanosecond delays and microwatt power dissipation. Conceived almost simultaneously by researchers at Philips Gloeilampenfabrieken in Eindhoven, the Netherlands, and IBM Deutschland in Boeblingen, Germany, I²L circuits will be appearing in a multitude of old and new applications: single-chip digital data processors, LSI logic arrays, watch chips, digital voltmeter circuits, high-frequency counters, digital tuners, read-only memories, shift registers, converters of all kinds, control logic for complex calculators, frequency dividers for electronic organs, and linear circuits for radio and television. Commercial production of 8-and 16-bit microprocessors and high-frequency watch circuits is beginning. Touch-control circuits for radio and TV tuning and circuits for telephone tone-dialing systems are also on the way.

The ultimate source of all the excitement is I²L's elegant gate layout, from which the space- and power-consuming current sources and TTL load resistors are eliminated, reducing a gate to a single pair of complementary transistors. A vertical npn transistor with multiple collectors operates as an inverter, a lateral pnp transistor serves both as current source and load, and no

IR's new glass passivated, high voltage Power Transistors and Darlingtons...

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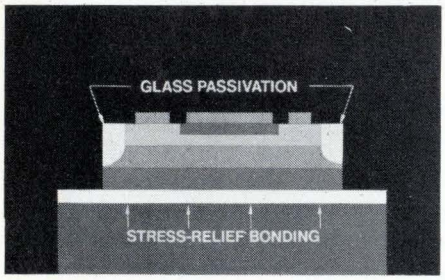
The three other largest selling high voltage power transistor lines of today offer you good characteristics. But while a specific device may excel in specs for one parameter, it may be marginal in other equally important characteristics. Not so with IR's new high voltage power transistors. They easily meet or exceed all established specifications. Now you can design a better, more efficient circuit without compromising.

*** High Voltage and High Gain in the same transistor.**

Most others offer you either high voltage or high gain. They can't give you both in the same device. We can. For example: rated to 700V_{CBO} with an I_C from 7 to 10 Amps (pulse), we provide a gain of 30 - 90 at 1 Amp.



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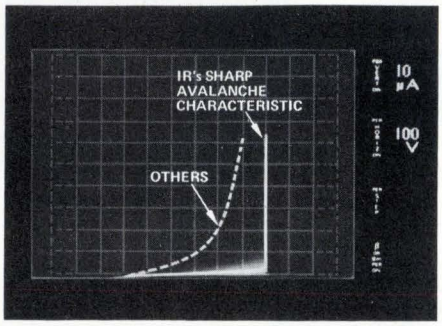
IR triple-diffused, NPN mesa structures are the first and only high voltage power transistors with glass passivated junctions. You'll get longer life and a stability unequalled by the other brands.



The avalanche curve pictured shows our "sharp" curve and the "soft" curve of the others. Convincing evidence of better junctions that you can operate at full rated specs without a worry.

*** Lower Saturation Voltage for better efficiency.**

IR saturation voltage is lower than the others. Higher efficiency, less power loss, reduced power consumption and system operation at lower power levels are your new advantages. And you won't have to sacrifice switching speeds or voltage capability.

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IR's "Stress-Relief" bonding between the chip and mounting surface gives better protection from thermal cycling, gives you an extra margin of safety in thermal design considerations, with a broad safe-area that is more than adequate for any application.

Competitively Priced and Cross-Referenced to the 3 major lines.

IR high voltage power transistors are available in 12 models rated from 300 to 700V_{CBO} with an I_C from 7 to 10 Amps (pulse). Monolithic Darlingtons in 15 models are rated to 600V_{CBO} with an I_C from 15 to 25 Amps (pulse). All are in the standard TO-3 package.

Find IR's equivalent to the devices you're now using, then ask your local IR salesman, Rep or Distributor for complete specs and a test evaluation sample. When you've put it to the test, we think you'll agree. It's better — everywhere that counts.

IR P/N	Delco P/N	RCA P/N	Motorola P/N
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IR402	DTS 402 2N3902		MJ3028 MJ3030 2N3788 2N3902
IR403	DTS 403		
IR409	DTS 409		
IR410	DTS 410	RCA410	MJ410
IR411	DTS 411	RCA411 2N5838 2N5839	MJ411 MJ1800 MJ3029 MJ3430
IR413	DTS 413	RCA413 2N5840	MJ413
IR423	DTS 423	RCA423	MJ423
IR424	DTS 424		MJ424
IR425	DTS 425		MJ425
IR430	DTS 430	2N5239 2N5240	MJ430
IR431	DTS 431	RCA431 2N5240	MJ431 2N5241
Monolithic Power Darlingtons			
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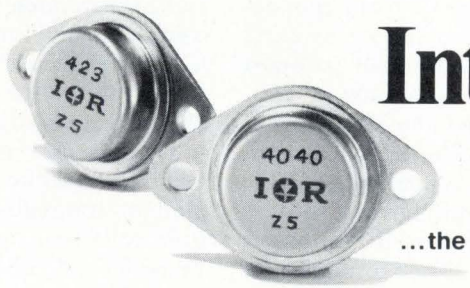

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TABLE 2: COMPARISON OF OP AMP PARAMETERS

		Open-loop gain V/V (min., −55 to +125°C)	Unity-gain bandwidth MHz (typ., +25°C)	Unity-gain slew rate V/μs (typ., +25°C)	Input offset current nA (max., −55 to +125°C)	Input offset voltage mV (max., −55 to +125°C)	Offset voltage drift μV/°C (typ., −55 to +125°C)
Standards	741 Fairchild	2.5×10^4	1.0	0.5	500	6.0	15
	108A National	4×10^4	0.5	0.25	0.4	1.0	5 (1)
Bipolar	monoOP-07A Precision Monolithics	2×10^5	1.2	0.25	4.0	0.06	0.2
	LH0044A National	1×10^6	0.4	0.06	4.0 (2)	0.05 (2)	0.2
FET-Input	740 Fairchild	2.5×10^4	3.0	6	0.15 (2)	30	
	8007AM Intersil	1.5×10^4	1.0	6	0.0002 (2,3)	30 (2)	50 (1)
	AD523L Analog Devices (4)	2.0×10^4	0.5	5	0.00025 (2)	20 (2)	25
Mixed Processes	2900 Harris	1×10^6	3.0	2.5	0.5	0.05	0.3
	SN62088 Texas Instruments (6)	1×10^5	3.0	25	10	0.10	0.6
	3130 RCA	5×10^4	15	10	0.01 (2)	2.0 (2)	15 (1)
	2530 Harris	1×10^5	70	320 (5)	20	3.0	5

(1) Maximum; (2) At 25°C; (3) Typical; (4) Specified over 0 to 70°C; (5) With external compensation when gain is set under 5 V/V; (6) −25 to 85°C.

ohmic resistors are required for either the source or load function. In contrast, a typical TTL gate needs six or eight transistors, plus source and load components.

Linear processing boosts op-amp performance

Although the technological advances in memories, microprocessors, and other digital circuits have held the limelight during the past few years, linear circuits—especially high-volume, low-priced operational amplifiers—are experiencing a renaissance of their own. A combination of MOS and bipolar processing has boosted their performance considerably (Table 2).

Texas Instruments started the latest round of op-amp improvements with its single-package chopper-stabilized unit, the 088 [*Electronics*, Aug. 16, 1973, p. 85]. With MOS circuitry on one chip and bipolar junction-FET components on a second, the TI design is an interim one, to be followed soon by a monolithic version.

A monolithic chopper is already available from Harris Semiconductor, Melbourne, Fla. Its HA-2900 not only contains mixed MOS and bipolar elements, but also uses Harris' dielectric-isolation process, which is said to result in smaller chips with higher yields. Harris, which is capitalizing on a dielectric-isolation, high-frequency, process has already introduced a series of op amps that achieve extremely high slew rates. The HA-2530, for example, has typical rate of 320 V/μs and minimum of 280 V/μs]*Electronics*, Sept. 27, 1973, p. 145].

Adding p-channel MOSFETs to Harris' n-channel/bipolar mix yields RCA's C-MOS bipolar process [*Electronics*, Oct. 3, p. 103]. The first commercial product using that technique, the CA3130 op amp [*Electronics*, Sept. 19, p. 133] offers the input capabilities of MOS, the voltage gain and speed of a bipolar-C-MOS stage, and the output advantage of C-MOS.

Higher performance and more functions per dollar can also be achieved by improving the standard of bipolar linear process, a technique used by National, Motorola and Precision Monolithics Inc., Santa Clara, Calif. Precision Monolithics, for example, has introduced a bipolar-input op amp, the mono OP-07, which was designed as an alternate to chopper-stabilized units in microvolt and high-stability applications [Electronics, July 25, p. 147]. An on-chip trimming technique reduces the cost of providing a high level of performance, including low offset voltage and drift.

Other manufacturers have also introduced bipolar products designed to compete with mixed-process chopper-stabilized op amps. The LM121-series preamplifiers from National Semiconductor Corp., Santa Clara, Calif., in conjunction with standard LM108 op amps, perform as well as the choppers. Finally, Motorola and National are leading another trend: the use of multiple op amps on single chips—duals, triples, and quads, for low-cost general-purpose applications.

Converters: more accurate monolithics

The battle between IC and modular a-d and d-a converters continues. True, in most cases modular devices still offer better specs than ICs, but complex linear LSI chips, working as matched sets in standard IC packages, offer the same high modular performance in a cheaper, easier-to-use format.

For example, Analog Devices Semiconductor, Wilmington, Mass., uses matched chips for what it calls "compound monolithic integration." Two or more custom-designed IC chips are interconnected in a single package, much like the TI 088 op amp. Its first product is the AD562 12-bit IC d-a converter with two chips, a bipolar switch circuit measuring 100 by 190 mils, and a network chip 100 by 180 mils that uses a proprietary silicon-chromium thin-film resistor technology.

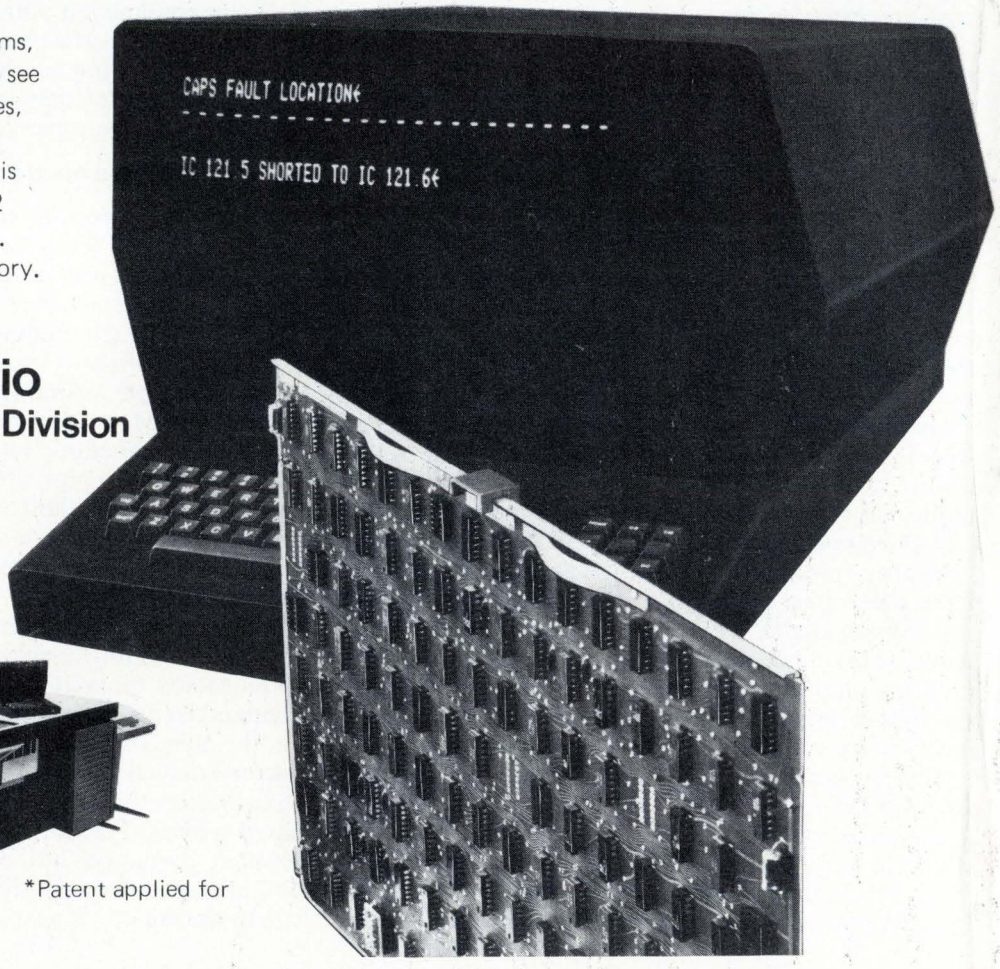
Other monolithic converters include Analog Devices' 10-bit C-MOS monolithic converter and Precision Monolithics' complete 10-bit plus sign bipolar d-a converter, the monoDAC-02. Designers at Motorola Semiconductor Products division detect a trend toward making IC converters that are compatible with microprocessor-based systems. For the instrument market, for example, 3½-digit resolution a-d converters, which require 10 bits, are scheduled to be fabricated on chips of the right size by the middle of next year. □

Testing boards is one thing. Troubleshooting them is quite another.

As boards become more complex, and the production quantities increase, automatic testing becomes a necessity. In fact, it is relatively easy to justify the cost of a system for testing PC boards when you consider what your alternatives are. However, what many who look into test systems fail to realize is that with the typical automatic test system at least 50% of the **total** operating costs are attributable to troubleshooting time. It appears, then, that the system that minimizes troubleshooting time and expense will probably prove to be the least expensive system over its lifetime.

The GR1792 Logic-Circuit Test System, with its incomparable CAPS software package, removes the human element from troubleshooting as much as possible. In its automatic-fault-location (AFL)* mode, CAPS literally removes the operator from the troubleshooting procedure. Within seconds after a fail signal appears, the CRT displays a series of messages that resolve not only **what** the fault is but **where** it is located. It accomplishes this by an on-line simulation technique that provides a complete I/O pin comparison, thus investigating **all** failure possibilities that could produce the symptom.

If you are in the process of investigating PC board test systems, look beyond the testing scene to see the whole picture. As time passes, most of your expense will be in board troubleshooting, and that is the point on which the GR 1792 and CAPS really pay off for you. Call or write for the complete story.



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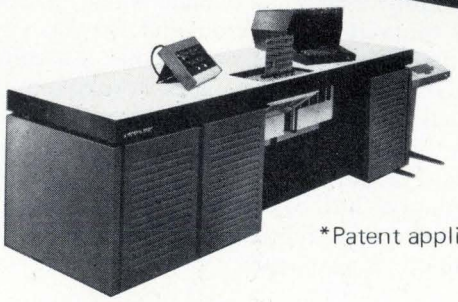
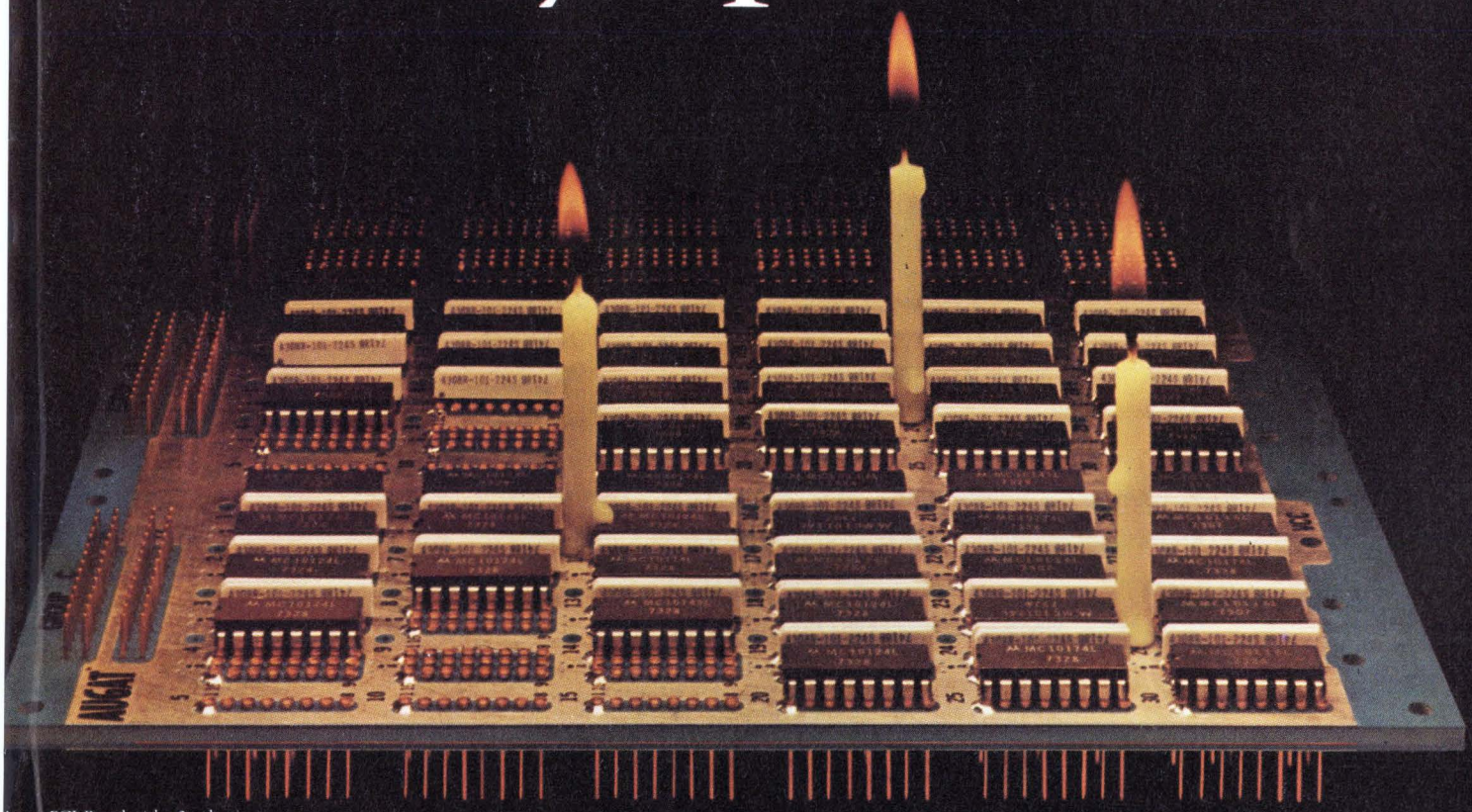


*Patent applied for

ECL design just became a three-layer piece of cake.



Augat ECL Board with −2 volt bus for terminating single in-line package (SIP) resistor network.

Compared to methods of the past, the Augat series of socket, Wire-Wrap® ECL boards makes ECL design a piece of cake. Even for circuits in the 125 to 500+ MHZ range.

They can save you 90 percent or more in breadboarding and prototyping time. Tens of thousands of dollars in start-up costs. And many costly hours in field maintainability.

With this proven advance in three-layer interconnection technology you don't have to design in controlled impedance interconnections, mess around with transmission lines, or commit power connections for different ECL logic modules. All of which frees you to concentrate on the partitioning of logic functions and the preparation of a wiring list.

And unlike a multi-layer P.C. board, there is no loss in planar density. Two 16-pin ECL and associated pull down and decoupling components fit into one square inch on every Augat ECL board.

The nice thing, too, is that Augat ECL boards are standard catalog items available in any quantity at any time from Augat distributors around the world. You can contact them directly or write Augat, Inc., 33 Perry Avenue, Attleboro, Mass. 02703. Tel. 617-222-2202. TWX 710-391-0644.

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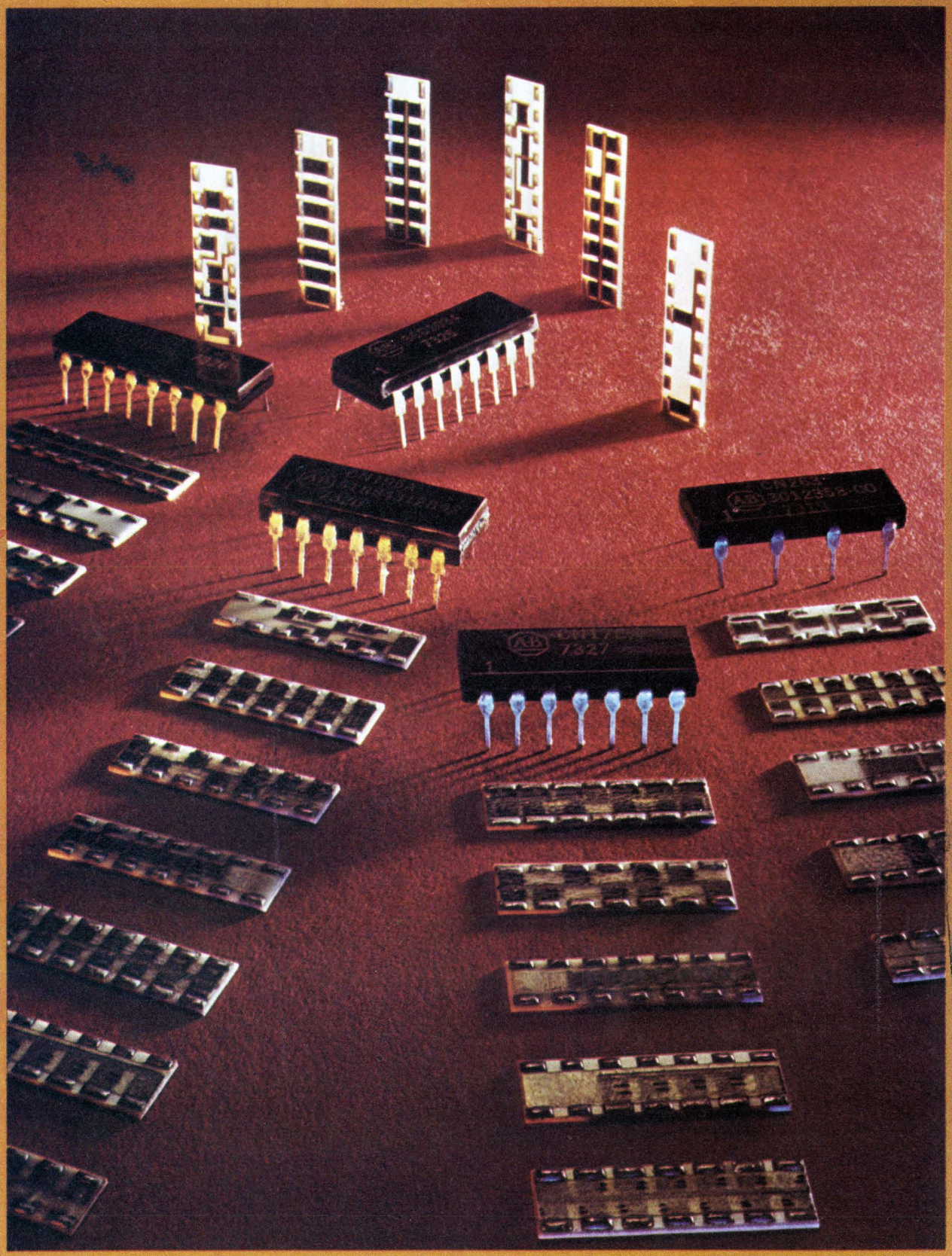
COMPONENTS



Ever-improving IC parameters set the pace for just about all the changes in other components. Resistor and capacitor networks now turn up in dual in-line packages that fit easily on a printed-circuit board side by side with ICs. Switches and relays are smaller. Digital displays are overcoming old limitations on efficiency or lifetime to conform to the requirements of LSI-based calculators and watches.

☐ The need for compatibility with integrated circuitry continues to affect the design, materials, and packaging of passive components, power semiconductors, switches, relays, and displays. The use of dual in-line packaging is spreading. Hand-held calculators and point-of-sale terminals are influencing the design of keyboard switches. Power semiconductors are offering greater reliability and better performance than ever before. Displays are in some cases efficient enough to be driven directly by MOS circuits.

Some of the more prevalent trends are:

- Resistor and capacitor networks. Now readily available, these networks are being put in both dual and single in-line packages for easy handling by automatic-insertion equipment.
- New materials and designs. Passive components are smaller, have improved characteristics, and cost less than or no more than their predecessors. These changes result from innovations in materials, combinations of technologies, and breaks with traditional design.
- Switches and relays. Generally, to complement IC requirements, smaller units are handling higher current levels at higher speeds than in the past.
- Power semiconductors. Modern processing technologies and a heavy emphasis on reliability engineering are boosting the ratings of power devices while shrinking the size of their packages.
- Brighter displays. Light-emitting diodes now come in many colors, the efficiencies of gas-discharge and vacuum-fluorescent devices are improving, and liquid-crystal displays are now claimed to last 10 years, rather than one or less.

For the most part, dual in-line and single in-line resistor and capacitor networks are intended to complement both linear and digital ICs. They are used to terminate logic lines, provide logic pull-up or pull-down functions, or for decoupling purposes. Some of the newer suppliers of these networks are offering different designs, instead of simply second-sourcing existing product lines.

For example, the Electronic Components division of Stackpole Carbon Co., St. Marys, Pa., is making thick-film resistor networks that can be operated at up to ½ watt, although they are specified at ⅛ and ¼ W. The higher power rating is possible because the resistor elements are shaped like top hats, rather than the more conventional rectangles, permitting them to be laser-trimmed without creating hot spots.

by Lucinda Mattera, *Components Editor*

There's also an increasing demand for thin-film-resistor networks in dual in-line form for such applications as instrumentation and analog-to-digital and digital-to-analog converters. As a rule, thin films offer better temperature characteristics than thick films, as well as tighter resistance tolerances. The dual in-line thin-film resistor networks introduced this year by Allen-Bradley Co. of Milwaukee have a resistance tolerance as low as ±0.01% and a standard temperature coefficient of ±25 ppm/°C. These networks are made from integrated films of chromium cobalt, vacuum-deposited on special glass substrates.

Even tantalum capacitors can be bought in network form. Sprague Electric Co. of North Adams, Mass., for instance, has a complete family of dual in-line capacitor networks that can contain only tantalum chips, only ceramic chips, or a combination of the two. One of the company's newest offerings is a four-lead dual in-line tantalum capacitor that can be wired in a four-terminal feedthrough-like mode for high-frequency operation.

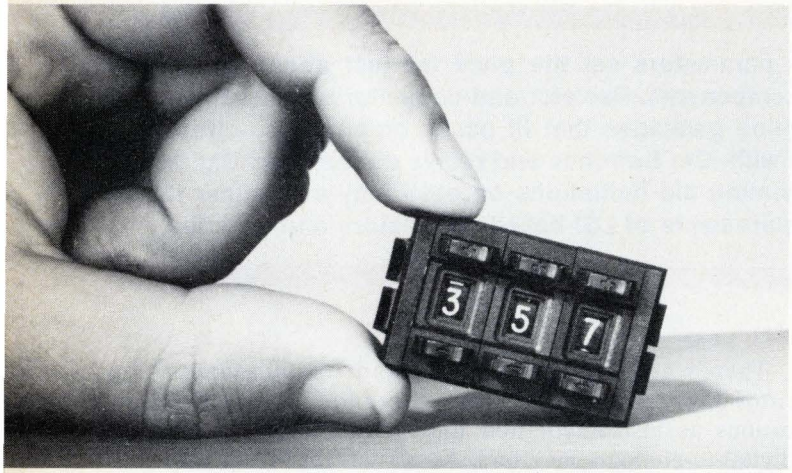
As always, new materials are an important part of the technology behind resistors and capacitors. Centralab Electronics division of Globe-Union Inc., Milwaukee, for example, has a new carbon-resistor ink for its series PEC thick-film hybrid circuits. The new ink provides an improved temperature coefficient of –75 ppm/°C at no increase in cost to the user. (Typically, carbon has a coefficient of about –1,700 ppm/°C.)

Similarly, a family of disk capacitors from Erie Technological Corp. of Erie, Pa., are made with a high-K ceramic, which was developed jointly by Erie and Siemens AG, Munich, Germany. The new material has a dielectric constant of approximately 50,000, permitting capacitance to be increased by a factor of five or so with no increase in device cost or size.

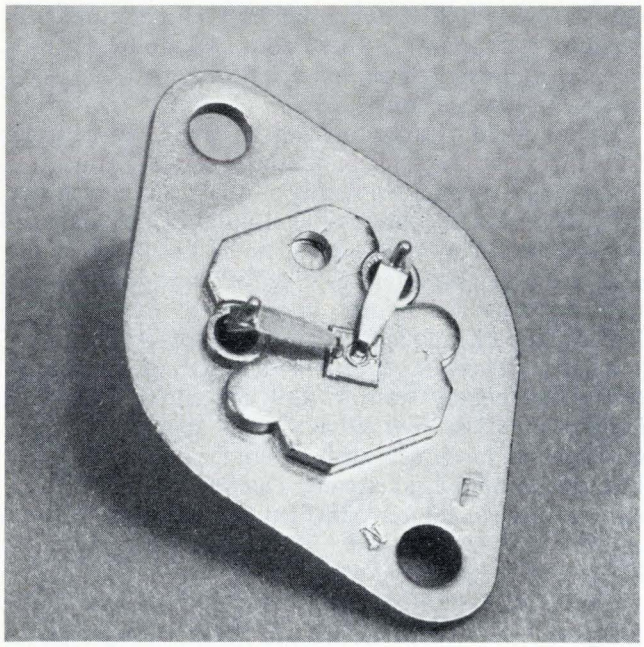
Special capacitors are also making news these days. There will be quite a few of the four-lead variety—the ones that are used for switching-type power supplies. And Sprague is offering a new line of polypropylene capacitors specifically developed for high-frequency ac applications, like television and SCR circuits.

New designs are coming on line

Variable resistors and capacitors are getting better, too. Trimmer resistors are going to open-construction (unsealed) configurations to keep costs down, while trimmer capacitors are sporting new designs. Mepco/Electra Inc. of Morristown, N.J., has a new trimmer capacitor in which thin sheets of the film dielectric alternate with the rotor and stator plates. This



Hybrid form. Push-button potentiometer from Bourns combines several component technologies. It contains special thick-film resistor networks and employs an unusual ratchet switching mechanism.



Under the cap. This power Darlington carries around its own heat sink inside its TO-3 metal can. The capless RCA unit shown here can handle up to 10 amperes continuously with no external heat sink.

interleaved design makes possible a broad capacitance-tuning range of better than 15:1. Additionally, Erie Technological is making a low-profile ceramic trimmer capacitor, which is primarily intended for the watch industry. One of this trimmer's electrodes is embedded to minimize the device's height.

Some components are beginning to evolve in a hybrid form, making use of two or more component technologies. The Helipot division of Beckman Instruments in Fullerton, Calif., is offering a 10-turn ⅞-inch-diameter potentiometer that contains a plastic-coated wire-wound resistive element. With this combination, the potentiometer costs a bit more than a purely wire-wound unit, but it offers the good temperature coefficient, low noise, and infinite resolution of its conductive plastic.

Another hybrid component was introduced this year by Bourns Inc. of Riverside, Calif.—a push-button potentiometer having a digital readout. The standard version of this product is a three-decade unit. Each decade has two push buttons: one advances the reading, and the other reduces it. Inside the potentimeter, there's a special 10-element cermet-resistor network for each decade and a special ratchet mechanism for each decade's contact system.

Relays and switches holding their own

Electromechanical devices are fighting the inroads of semiconductors, and, for many applications, they can still outperform their all-electronic counterparts. Although quite a few relay and switch designs are becoming obsolescent, new models are needed to complement ICs for system functions and to switch power and current levels that are too large for ICs to handle. The new units are also smaller than their predecessors.

Reed relays, for example, are improving. Nowadays, they are housed in either dual in-line packages or tiny axial-lead configurations, giving them greater utility in IC systems. Switching levels have fallen from several volts to tens of millivolts. And some reeds can switch in a fraction of a millisecond, handling currents on the order of several amperes.

In solid-state relays, the trend is to all-solid-state units that contain optical isolators, replacing older devices that used reed relays to trigger their solid-state output circuit. Other relay products even include an indicator to display their state or some related condition.

Mechanical switches are also being influenced by ICs, with respect to both performance and packaging. Electronic calculators and such growing markets as point-of-sale systems and computer peripherals are spurring developments in keyboards. Spring-loaded mechanical keyboard movements are being replaced by the less expensive, low-pressure, clicker-type touch mechanisms and capacitive-coupled switches. And keyboards are getting thinner in response to the hand-held market.

More and more switches are being put into dual in-line packages, allowing them to be stuffed on a pc board just like an IC. Even traditional switch styles are changing. For instance, a small rotary switch from Stackpole Components Co. of Raleigh, N.C. has a square shape to provide maximum support for its mounting pins.

Power devices keep pace

Only a few years ago, power semiconductors were still struggling to overcome their poor reliability record. But today's power devices are a safe and sound bet, and embarrassing failures are now comfortably a matter of past history. What's more, those problems that can't be designed out are being eliminated through testing. Reliability is of such major concern that some manufacturers of power semiconductors put almost one third of their engineering effort into improving it.

Nowadays, most power packages are multiple-device affairs representing an optimal combination of functions. For instance, a Darlington stage may be used for a high-gain function, a transistor stage for an amplifier function, and a diode stage for a speed-up function. As a result, power Darlingtons can now handle as much as

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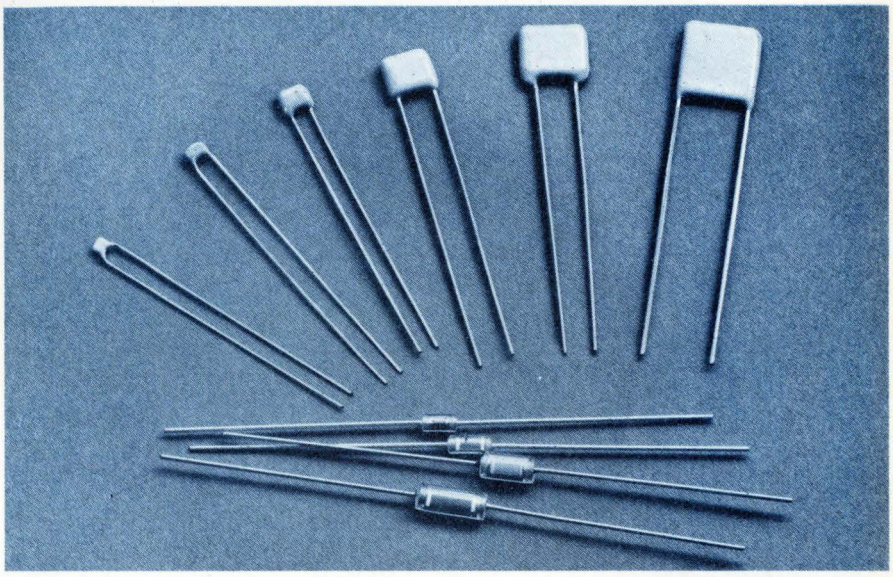

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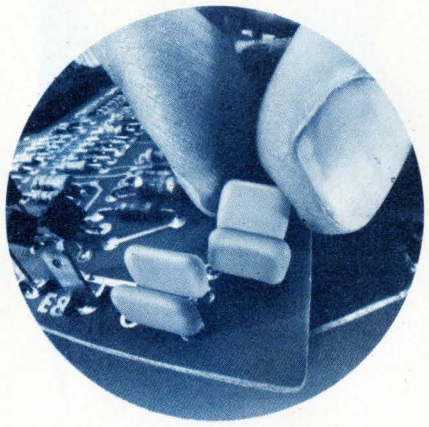

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MONO-GLASS axials are glass encapsulated, designed for automatic PCB insertion; furnished reel-packed for high volume applications. They're available in 50 and 100 WVDC from .01 to 1.0Mfd.; three dielectrics: COG, X7R and Y5V.

Our basic materials research gives you the best in monolithic technology; our productivity engineering guarantees competitive prices and best delivery.

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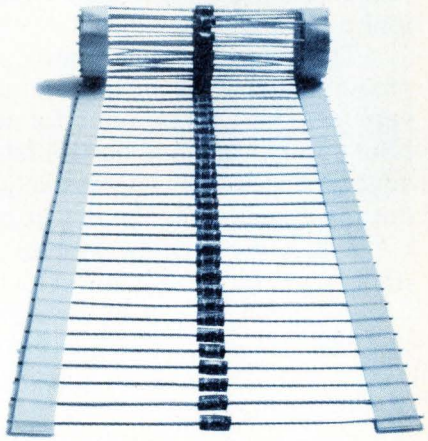

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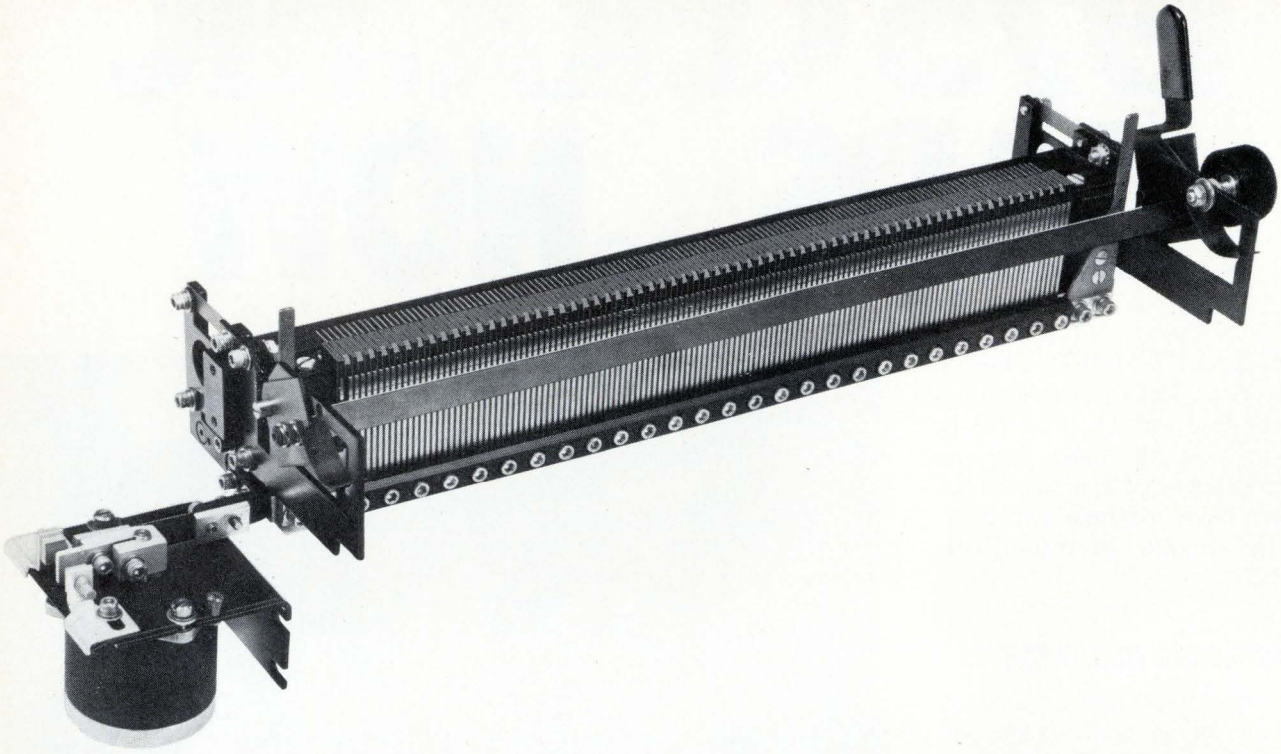

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One look at the Tally print mechanism readily reveals the reason behind Tally's reliable hardware performance and consistent print quality.

The patented comb matrix printing technique minimizes moving parts. And the two elements that do move . . . don't move very far. There's a hammer for each position. The one-piece Tally print comb prints one horizontal dot row at a time. The paper advance assembly progressively steps the paper vertically one dot row to complete the matrix character.

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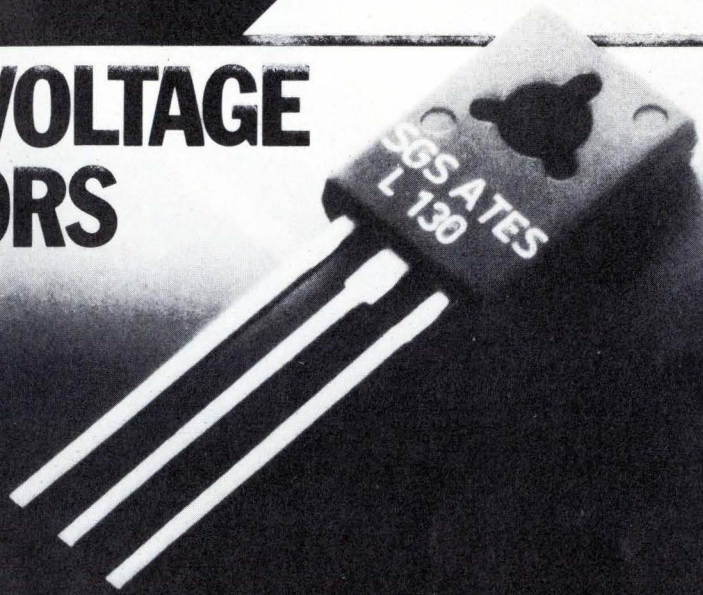
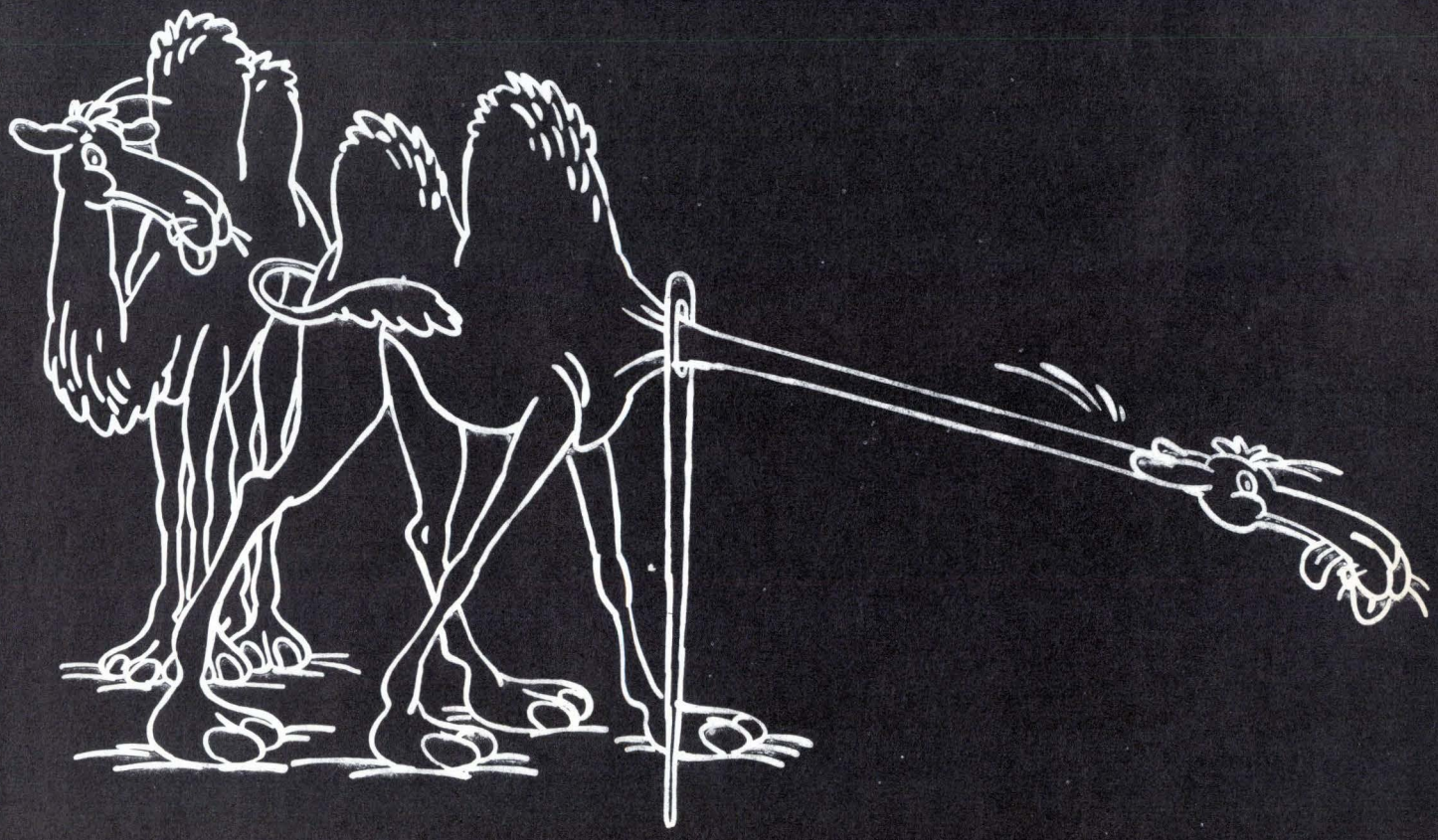
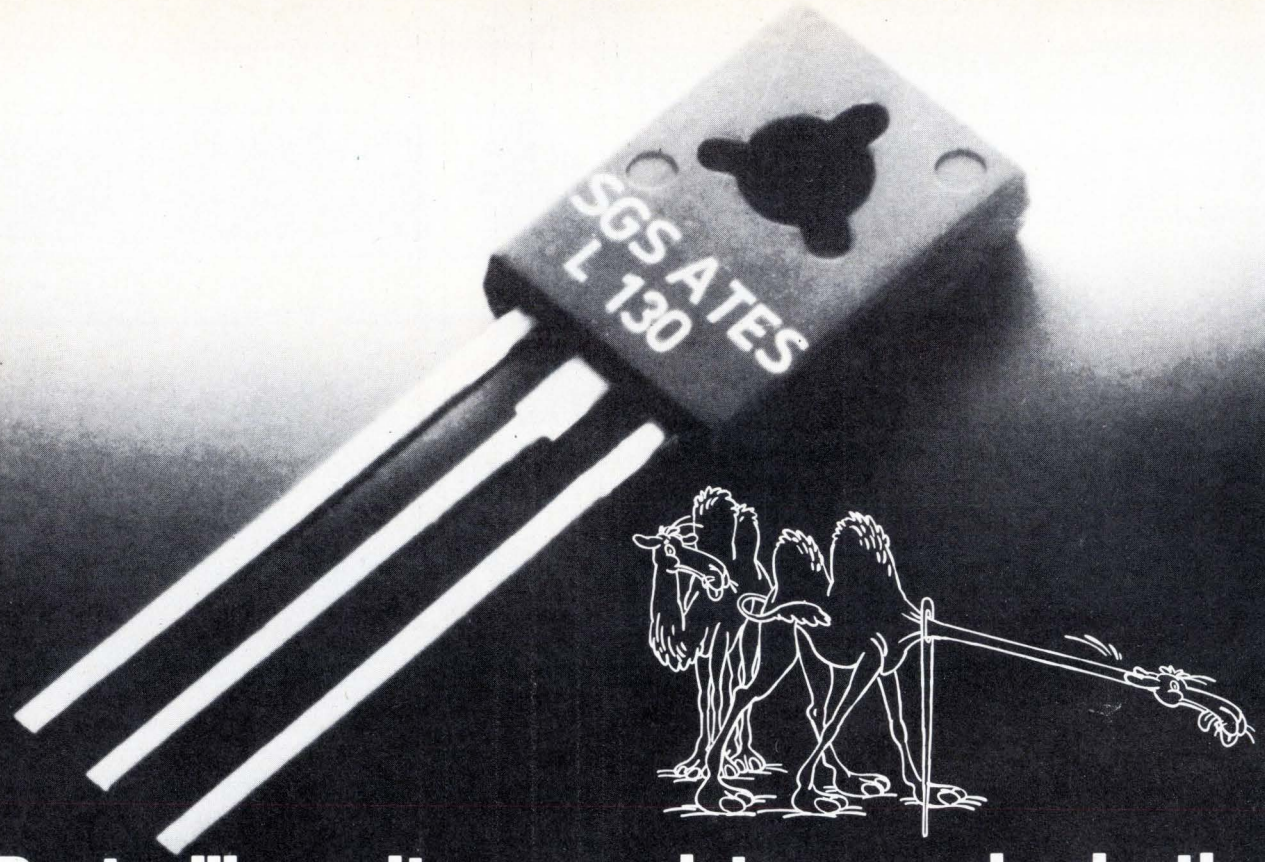


A regular and constant output



whatever the input



Bestselling voltage regulators now in plastic

Following the sweeping success of SGS-ATES' integrated fixed voltage regulators in TO-3 metal can, these circuits are now also available, ex stock, in SOT 32 plastic package.
Designated L129, L130 and L131, they are suitable for low cost applications in professional, industrial and consumer equipment requiring compact components with low/medium output current, such as

- desk calculators
- video displays
- computer peripherals
- touch tuning and remote control for TV sets
- TV subsystems, such as video IF, sound IF, sync and chroma stages

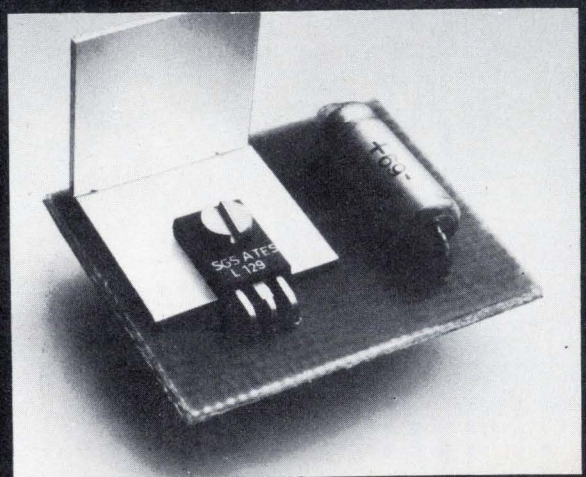
A particularly interesting area of application is in local regulation systems. The main advantages of this circuit technique over traditional single point regulation are the reduction in common ground and inter-circuit coupling, high noise immunity and the elimination of problems due to line voltage drops.

Special features of the circuits include

- tight tolerance on the output voltage
- load regulation less than 1%
- ripple rejection 60 dB typical
- internal overload protection
- short circuit protection

The L129, L130 and L131 are designed to operate in the -20 °C to +85 °C temperature range. For the standard operating temperature range, 0 °C to +70 °C, these plastic voltage regulators are available with type numbers TDA1405, 1412 and 1415.

-20° to +85 °C	V_o	I_o reg. typical	0° to +70 °C
L 129	**5V**	**850 mA**	**TDA 1405**
L 130	**12V**	**720 mA**	**TDA 1412**
L 131	**15V**	**600 mA**	**TDA 1415**



SGS ATES

10 or 12 amperes—a considerable improvement over earlier ratings of 1 to 2 A—and operate at breakdown voltages on the order of 400 to 600 V. Ratings for power transistors have been improved, too, and single devices go as high as 60 A and 1,600 V. Additionally, packages are smaller than they used to be, and some even include integral heat sinks.

Improved processing technologies are also behind the upgraded performance and reliability of power semiconductors. Substrates are no longer of the old silicon-alloy variety—manufacturers are now using epitaxial bases and multilayer epitaxial techniques. Moreover, the advances in power technology will continue. Within the next few years, MOS and bipolar technologies will be combined on the same substrates, taking advantage of the power-handling capability of bipolar devices and the good linearity and coupling of MOS devices.

The display picture

Display technology is still dominated by red-light-emitting diodes and planar gas-discharge devices, although different colored LEDs are coming on strong, and field-effect liquid crystals have been making progress in combatting their temperature and life problems.

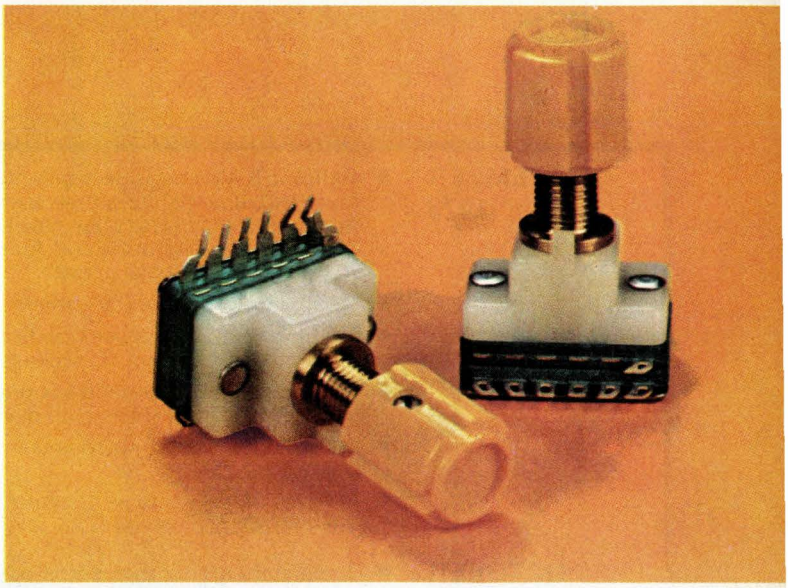
The single most exciting development in the LED area has been the introduction of different colored displays and indicators in production quantities. Yellow, green, and high-brightness red lamps and small (0.3-inch high) digits have been available for months now, and orange devices are just coming on stream in large quantities.

The technology behind these advances is the use of nitrogen-doped epitaxial gallium arsenide phosphide (GaAsP) grown on a gallium-phosphide (GaP) substrate. This Monsanto-patented process combines the high quantum efficiency and color flexibility of nitrogen doping with the low optical transmission losses of the GaP substrate to achieve both increased efficiency and a variety of colors. What's more, since the GaAsP epitaxial layer is not grown by the tricky liquid-phase process normally used to grow epitaxial gallium phosphide, cost-savings are realized as well.

The new high-brightness red LEDs generate a wavelength of about 6,350 angstroms, compared with 6,500 to 6,600 Å for the older GaAsP or GaAs devices. Although the color difference is minor—a slight shift toward the orange—the brightness change, when expressed in photometric units, is profound. The human eye is four to five times more sensitive to light at 6,350 Å than it is to light at 6,600 Å.

With this materials system, the new yellow and green devices are also brighter than their predecessors, although the increase is attributable more to increased quantum efficiency than to photometric good fortune. The higher brightness—about 20 times for the yellow units, and eight times for the green—means that small LEDs and LED displays can, in many cases, be driven easily by MOS circuitry without buffer drivers. As a result, such items as calculators and small, portable instruments have lower parts counts and longer battery life than before.

Aware of the significance of these developments, the makers of planar-gas-discharge devices and vacuum-fluorescent diplays are also striving to improve efficiencies. The gas-discharge units are already low-current devices, so the effort is directed at lowering their driving voltage, while the opposite is true for fluorescent units.



Shaped for the job. Traditionally, rotary switches are round, but this pc-board rotary made by Stackpole is square, providing maximum support for its mounting pins and a flush fit to the board.

Efforts to reduce the voltages of planar gas-discharge displays are taking two major directions: the design of electrode structures that can initiate and maintain ionization at lower potentials, and the use of phosphor coatings on the inside of the packages.

The phosphors respond to otherwise-wasted ultraviolet radiation to produce visible light—in much the same manner as the common fluroescent lamp operates. In addition to providing increased brightness, these phosphors make multicolor operation possible. With the right mixture of gas and phosphor, the phosphor color could predominate at one voltage, the gas color could predominate at another, and a color blend could be obtained at intermediate voltages.

In liquid-crystal technology, reduced voltages and lengthened life are the big news, as dynamic-scattering displays are displaced by field-effect devices. Only a couple of years ago, manufacturers were claiming 10,000-hour life spans; now, they are talking 10 years (over 80,000 hours). Proof of these claims will clearly be some time in coming, but it is evident that the glass-sealing problems that have plagued the manufacturers of liquid-crystal displays have largely been solved.

Materials improvements have dropped the voltages needed to operate field-effect display devices from the region of about 7.5 V a few years ago to about 3.0 V today. Operating temperature ranges are also being extended, although to some degree, the definition of the temperature range of a field-effect device is a matter of opinion. At low temperatures, the device doesn't suddenly stop working, it merely gets very slow. The lower usable temperature limit, then, depends on how much patience the viewer has. □

CHRONOLOGY

SEPTEMBER 1973

- 4-kilobit RAMs begin to reach marketplace in small production quantities: Intel's and Texas Instruments' 22-pin packages and Mostek's 16-pin device vie to become the industry standard *Sept. 13, 1973, pp. 116–121*
  (In November, Motorola and American Microsystems Inc. introduce their own 22-pin versions *Nov. 22, 1973, p. 148*)
- Toshiba unveils color TV camera with single tube to sell for under $800 *Sept. 13, 1973, p. 62*
- First monolithic chopper-stabilized op amp from Harris Semiconductor challenges Texas Instruments' two-chip IC package *Sept. 27, 1973, pp. 110–114*
- 16-bit custom n-channel microprocessor from General Instrument promises minicomputer performance from single-chip devices *Sept. 27, 1973, p. 33*
- Fairchild's charge-coupled area-image device becomes the first solid-state video camera *Sept. 27, 1973, pp. 33–34*
- American Microsystems designs microprocessor chip for control of electric kitchen ranges *Sept. 27, 1973, pp. 35–36*

OCTOBER 1973

- Completely monolithic digital-panel-meter chip from Integrated Photomatrix of Mountainside, N.J., could halve DPM prices *Oct. 11, 1973, p. 44*
- Three-in-one instrument called Testclip introduced by Fluke/Trendar for troubleshooting ICs *Oct. 25, 1973, p. 211 and Nov. 8, 1973, pp. 89–93*

NOVEMBER 1973

- To combat the fast-rising price of gold, Metalized Ceramics of Providence, R.I., develops selective plating technique for ceramic LSI packages *Nov. 8, 1973, pp. 30–31*
- The first 8-k charge-coupled shift register from Bell Northern is compatible with the PDP-11 systems made by Digital Equipment Corp. *Nov. 22, 1973, p. 25*
- Digital multimeter, designed to really compete with analog volt-ohmmeters in terms of performance and price, announced by Dana Laboratories *Nov. 22, 1973, p. 146 and Dec. 6, 1973, pp. 99–102*
- Ultrasonic medical device for noninvasively measuring the thickness of such tissues as blood-vessel walls developed at Massachusetts Institute of Technology *Nov. 22, 1973, p. 34*

DECEMBER 1973

- 10-bit monolithic digital-to-analog converter from Analog Devices is first to use C-MOS processing *Dec. 6, 1973, p. 35*
- First space-saving oxide-isolation MOS memory (1103 type) arrives from Fairchild *Dec. 6, 1973, pp. 35–36*
  (The company follows shortly with an Isoplanar C-MOS memory *Dec. 20, 1973, p. 25*)
- Sapphire process from Rockwell used for first time in building a single-chip 8-bit microprocessor, a custom circuit for General Automation's LSI series 12/16 computers *Dec. 6, 1973, pp. 34–40*
- SCR having 2,500-ampere current rating released by International Rectifier *Dec. 6, 1973, p. 164*
- Monolithic op amp trimmed via diode shorting introduced by Intersil *Dec. 20, 1973, p. 128*
- Artificial eye that stimulates brain's visual cortex through electronic camera embedded in eye socket is developed by Institute of Biomedical Engineering, University of Utah *Dec. 20, 1973, pp. 23–30 and Jan. 24, 1974, pp. 81–86*
- Advent begins sales of Videobeam projector for large-screen TV *Dec. 20, 1973, pp. 38–42*

JANUARY 1974

- Heath develops color-TV digital tuner with on-screen channel-number display and electronic clock *Jan. 10, 1974, pp. 36–38*
- Most-powerful programable pocket calculator announced by Hewlett-Packard *Jan. 24, 1974, pp. 74–78*
- Conductive elastomers gain ground as alternative to metal-contact connector systems through technique developed by Chomerics Inc. of Woburn, Mass. *Jan. 24, 1974, pp. 32–34*

FEBRUARY 1974

- Integrated injection logic becomes a new bipolar LSI technique for digital and linear circuits, as disclosed by Philips and IBM *Feb. 7, 1974, pp. 46–47*
- Signetics 1,024-bit Schottky-TTL RAM is first to use conventional processing in 1-k memory chip *Feb. 7, 1974, p. 35*
- First C-MOS microprocessor, an 8-bit unit from RCA, is intended for low-power industrial and consumer applications *Feb. 21, 1974, p. 25*
  (Intersil follows with its own 12-bit C-MOS device *April 4, 1974, p. 35*)
- First bipolar LSI microcontroller from Monolithic Memories built with Schottky TTL has gate equivalence of 1,000 *Feb. 21, 1974, p. 25*
- Philips announces I^2L products – a digital tuner, a telephone tone control, and a frequency divider/amplifier *Feb. 21, 1974, pp. 25–26*

Significant advances in electronic technology reported over the past year in *Electronics*

MARCH 1974

- Bell Laboratories and the RCA David Sarnoff Research Center develop methods to modulate light at rates that could exceed 1 GHz, bringing practical fiber-optic communications systems one step closer *March 7, 1974, pp. 36–38*
- Burroughs develops the first gas-discharge analog bar-graph display *March 7, 1974, pp. 89–93*
- Fast logic scope, a 200-MHz unit, announced by Biomation Corp. *March 7, 1974, pp. 150–151*
- First 12-bit microprocessor built with p-MOS comes from Toshiba *March 21, 1974, pp. 111–116*
- RCA develops first 525-line charge-coupled-device TV camera *March 21, 1974, pp. 29–30*

APRIL 1974

- Low-cost monolithic temperature transducer introduced by National Semiconductor for commercial applications *April 4, 1974, pp. 178–180*
- Fastest storage scope with a writing speed of 1,350 centimeters per microsecond announced by Tektronix *April 4, 1974, pp. 46–47*
- 8-bit n-channel microprocessor chips from Intel and Motorola usher in the high-performance era for microprocessors *April 18, 1974, pp. 88–95*
- Double-junction light-emitting diode, made by Siemens, glows red, yellow, or green *April 18, 1974, pp. 29–30*
- Norden division of United Aircraft Corp. introduces the first commercial millimeter-wave communications system to use the newly opened 22- and 39-GHz bands for short-haul intra-city data and voice messages *April 18, 1974, pp. 30–31*

MAY 1974

- ATS-F satellite, which uses solid-state transmitters to achieve the highest transmitted power in space, will perform many communications experiments after being launched on May 30th *May 2, 1974, pp. 69–70*
- Honeywell announces fastest-commercial electrostatic printer, having output rate of 18,000 lines per minute *May 2, 1974, pp. 35–36*
- 0.5-megabit bubble memory from Bell Labs challenges disks in cost and performance *May 16, 1974, pp. 30–31*
- Thomson-Brandt readies color video-disk recorder employing optical technology *May 30, 1974, pp. 3E–6E*

JUNE 1974

- Sony displays gas-discharge panel for use in flat-screen TV *June 13, 1974, pp. 10E–12E*
- C-MOS on sapphire used by Inselek for standard logic circuits, and by RCA for custom LSI processor circuits for the Air Force *June 27, 1974, pp. 35–36*
- MOS chip made by Mostek for TV tuners features memory and on-screen channel-number display *June 27, 1974, pp. 34–35*

JULY 1974

- First wave of fast static n-MOS RAMs (access times of 300 to 500 nanoseconds) begin arriving from Intel, Signetics, Motorola, Mostek, and Electronic Memories *July 11, 1974, p. 143*
- Service starts on Western Union's Westar I, the first commercial U.S. domestic communications satellite *July 25, 1974, p. 42*
- Bipolar op amp, offering the performance of chopper-stabilized mixed-process devices, bows from Precision Monolithics *July 25, 1974, pp. 147–149*
- Ohmtec of Burlington, Mass. develops a conductive ink for silk-screening conductor patterns on printed-circuit boards *July 25, 1974, pp. 33–34*

AUGUST 1974

- Field-alterable control element (FACE) introduced by National Semiconductor simplifies development of microprocessor-based systems *Aug. 22, 1974, pp. 34–38*
- Variable taped speech control from Cambridge Research and Development Group permits high-speed playback without distortion *Aug. 22, 1974, pp. 87–94*
- RCA's 16-k charge-coupled memories begin replacing disk and drums *Aug. 22, 1974, p. 26*

SEPTEMBER 1974

- Intel's Schottky bipolar family of LSI processor chips brings high performance to microprocessor-based computer systems *Sept. 5, 1974, pp. 89–96*
- First op amp with C-MOS output built by RCA with new mixed linear processing *Sept. 19, 1974, pp. 133–135*
- International Electrotechnical Commission moves to establish world-wide instrument-bus standardization *Sept. 19, 1974, pp. 67–68*

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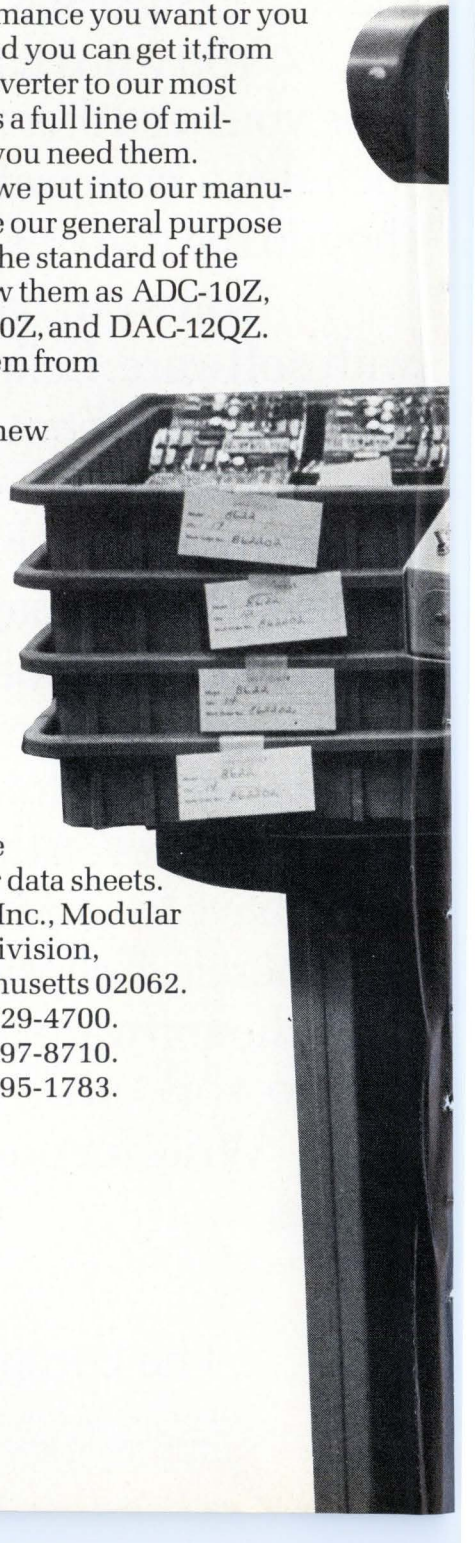
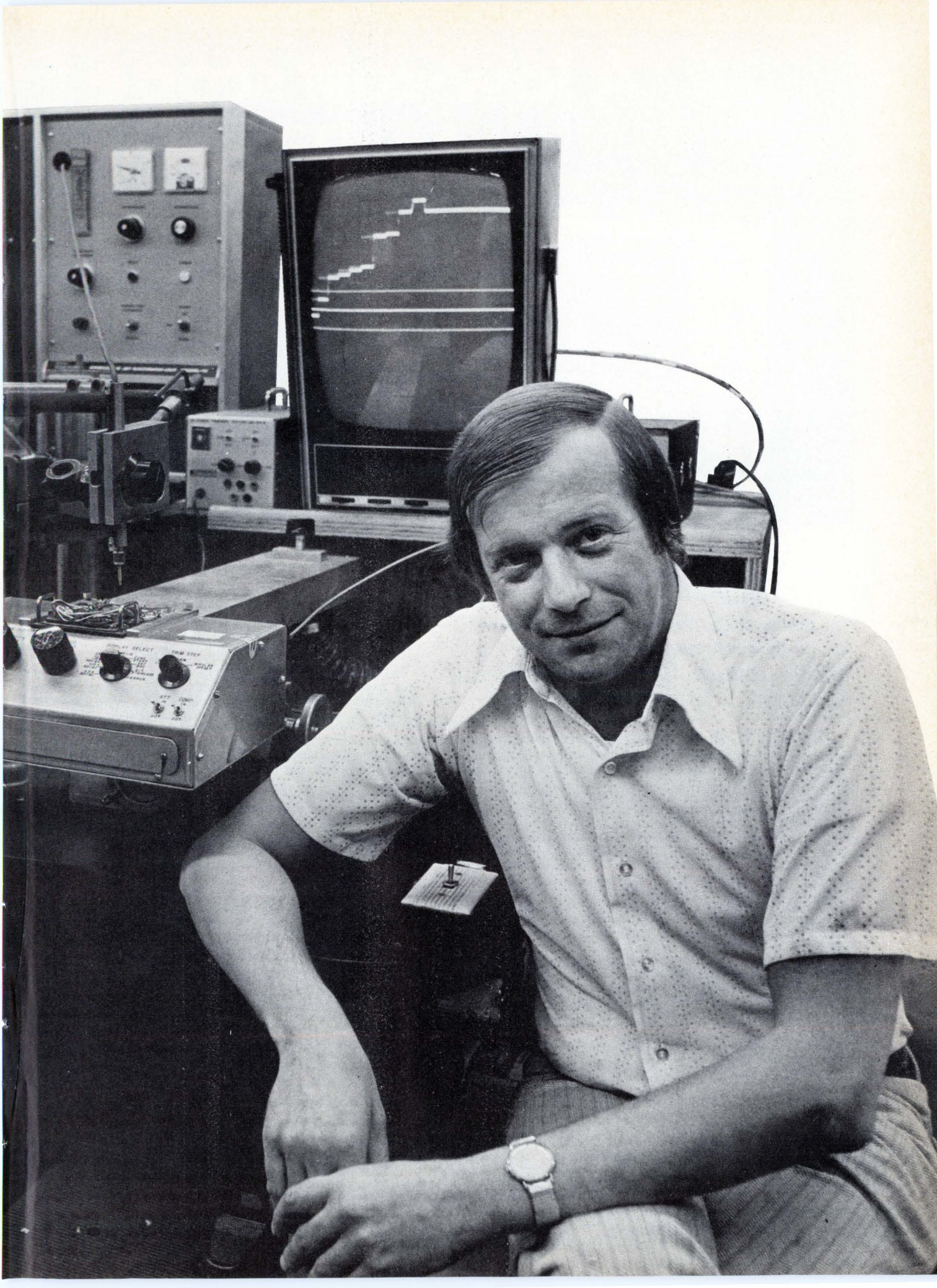
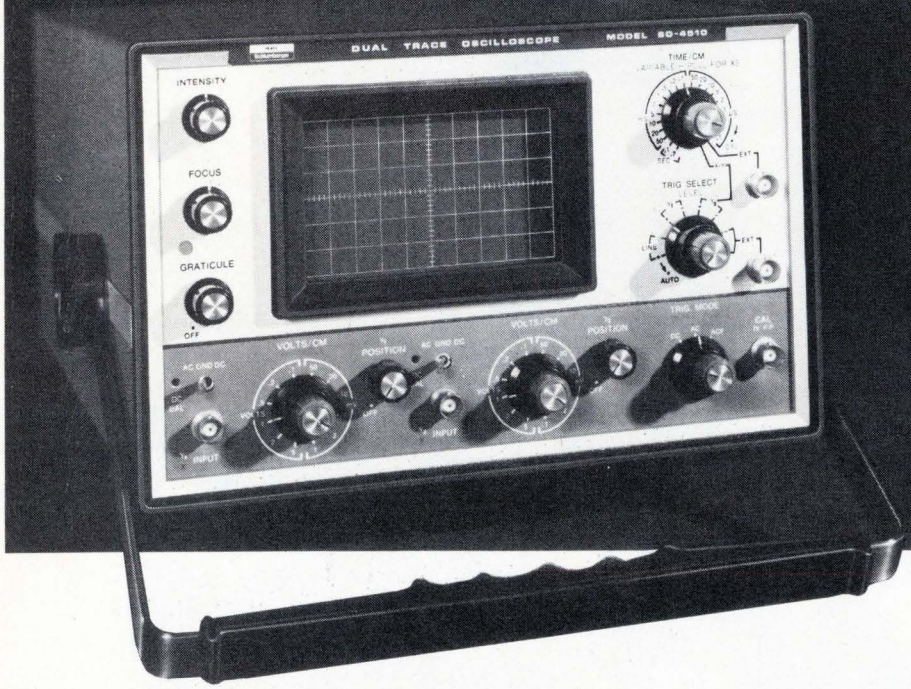


ANALOG DEVICES

Circle 166 on reader service card



A low-cost scope should offer more than a low price.



The new Heath/Schlumberger dual-trace SO-4510 has DC-15 MHz bandwidth, 1 mV sensitivity, post-deflection accelerated CRT, vertical amplifier delay lines & more . . . for only $750*.

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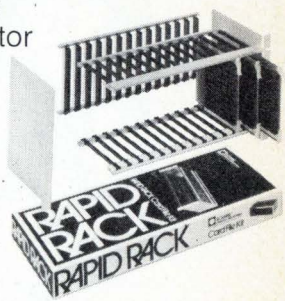

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GOVERNMENT

Although anyone who wants to sell to the Federal Government can still dazzle the customer with speed, power, range, and the like, the bottom line in Washington these days reads: "How much does it cost?" Even the Pentagon, with its $2 billion budget, is asking that, and the civilian agencies, which have considerably less to spend, are proving even tighter with their dollars than they were last year.

☐ Purveyors of electronic systems and subsystems who moved through the muggy streets of Washington from one Federal agency to another this summer encountered a new mood. It was characterized by the question, "How much will it cost?" instead of "What will it do?

Putting price above performance—indeed, even encouraging the tradeoff of performance and lower costs—is a trend that predates Gerald R. Ford's move into the White House. But the trend is expected to accelerate as the President strives to limit Federal spending in an effort to control raging inflation. New technology is getting hard looks everywhere as cost-conscious bureaucrats push for what they like to call "proven technology."

The Department of Defense is no exception, although the enormous size of its budget (now about $82 billion annually) leaves the military much more room to maneuver than, say, the Federal Aviation Administration with its $1.7 billion. So it is that DOD maintains its position as the principal source of Federal funds for advancing the state of electronic arts. For the foreseeable future, it is a position that will be enhanced relative to other agencies as President Ford continues to stress the need for a strong defense establishment.

Design-to-price—the Government's low price—is the chief bugaboo for engineers anxious to deploy their latest innovations throughout the military establishment. "If they can't prove the costs to build and maintain, and guarantee its reliability, we don't want it," says one specialist in the Directorate of Defense Research and Engineering (DDR&E).

But inflation isn't providing the only pressure on prices. The Pentagon is reassessing the complexity of its weaponry and its costs following last year's October war in the Middle East. Heavy Israeli weapons losses early in the fighting staggered the Pentagon, which is now showing itself more disposed to trade off some quality features for larger quantities. There is, says DDR&E chief Malcolm R. Currie, "a premium on plentiful, 'affordable' weapons."

In this context, the Congress sees some programs like the Air Force B-1 strategic bomber now being developed by Rockwell International as less and less affordable. Projected unit costs have run up to $60 million so far even though the first flight test is not scheduled until late this year. Still, however shaky the long-term future of the B-1 may be, it is helping to refine airborne radar technology—even if it is doing it for a price.

Typical of the cost-consciousness affecting military electronics people is what's happening on the Air Force's Electronically Agile Radar (EAR) program at the Westinghouse Defense and Electronic Systems Center outside Baltimore. After an extended competition that narrowed down to Westinghouse and Hughes Aircraft when Goodyear Aerospace and Raytheon both were dropped, the Air Force Avionics Laboratory picked Westinghouse to design, build, and test the first four of the multimode EAR systems. The two-year contract is for units for use in the B-1 as well as in the FB-111 and B-52 bombers, and the F-4J model phantom.

Westinghouse won, says the company's EAR program manager Wayne Fegely, "because we listened. The Air Force meant tradeoffs, they wanted tradeoffs, so we began trading off." For example, one Westinghouse design "that has a very high reliability also had a life cycle cost of only 10% to 12% of acquisition cost, whereas system costs run five to 10 times higher than that. Yet it would have cost us too much to develop it, so we juggled our maintainability with reliability so that our life-cycle costs are higher, but our development costs are lower." The original design, Fegely says, "would have required us to go very much with large-scale integration and beam-lead technology, which is coming very slowly with R&D funds today."

The digital radar, which will operate at X band, is being designed to allow essentially simultaneous fine-resolution terrain mapping and all-weather, terrain-following flight—overcoming a handicap of the FB-111's present Ku-band system, which is limited by bad weather. Moreover, the EAR will also provide doppler ground-speed measurement and precision position information for accurate weapons delivery.

For all this—plus nuclear survivability and a system with its "works-in-a-drawer," including large- and medium-scale-integrated line-replaceable modules—Fegely says the 1978 production price for 200 systems has a unit cost target of just over $500,000. That figure is expressed in 1970 dollars, however.

Typical of the rush to exploit LSI technology for military applications is the Defense Communications Agency's request late this summer for proposals to study LSI uses in a voice processor of the "linear predictive coder" type. The need for secure voice communications is considered crucial throughout DOD, and DDR&E's Currie says this year will bring implementation of an interim system known as Autosecvocom Phase 2 to accelerate the switch within the military from

by Ray Connolly, *Washington bureau manager,*
and Larry Marion, *Washington bureau*

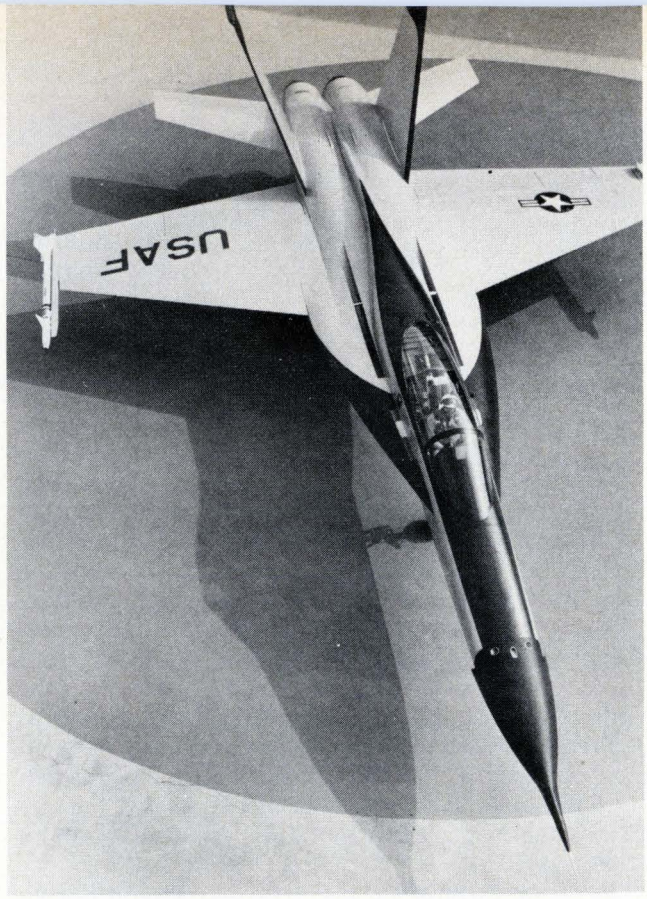
analog to digital voice communications at the strategic level.

In defense R&D the emphasis has shifted heavily to development since the U.S. pullout from Vietnam. Funding for basic research, as DDR&E's Currie euphemistically puts it, "is stable" overall. Refining established technologies, such as airborne radar, or adapting concepts like packet communications switching to broader applications for both tactical ground and strategic space systems, are among the highest-priority elements in the DOD program.

Areas of technology getting exceptional increases in DDR&E funding this year and probably next, are high-energy lasers, where officials say the jump in fiscal '75 money—nearly 40% to $23.4 million—suggests that "there have been more advances than money available." The Pentagon is also pushing for automatic programing of computers with an expenditure of $3.56 million, a 32% increase over last year; space object identification with $18.2 million, up 15%; acoustic-array signal processing for antisubmarine warfare and nuclear monitoring, up 35% to $5.3 million; and, on the tactical side, target acquisition and identification, up 16% to $14.9 million.

Other significant technologies with reasonably bright futures in DDR&E's view include:

- Laser materials. Within three years, when it's hoped that a six-year effort will have produced an X-ray laser, an estimated $28 million will have been spent. New money to improve ultraviolet laser materials and mirrors will come in fiscal '76. Simulated field tests on a new erbium laser material will go ahead this year. Small carbon-dioxide lasers and sodium-vapor lasers are also being funded.
- Photoelectronic materials. With a 47% funding increase to $7.6 million this year, the program, with an estimated $58 million total cost, has a number of goals: radiation detection from ultraviolet to acoustic wavelengths; integrated optical circuits for communications links insensitive to electromagnetic interference or pulses; transistor and IC reliability improvements through better control of fabrication techniques; new techniques for characterizing individual submicron particles; new materials for surface-acoustic-wave devices, and semiconductor applications such as computer memories of silicon chips modified by dopants.
- Helium lasers. The importance of the rapid advances in this area are reflected in last year's formation of the High Energy Laser Review Group within the Advanced Research Projects Agency to coordinate extensive efforts by DOD and the services. The highly classified effort to develop powerful, reliable weapons for ground-to-air and ground-to-ground use is funded principally through five service labs and six contractors. Included are Avco-Everett Research Laboratory, United Aircraft, MIT's Lincoln Laboratory, Hughes Aircraft, TRW, and Northrop Corp.
- Target acquisition. With an estimated $74 million outlay in six fiscal years through fiscal '79, this represents one of the biggest tactical development programs and revolves largely around remotely piloted vehicles (RPVs) and their subsystem requirements. It is still an area sensitive to interservice in-fighting as the Army and Air Force continue to battle for control of the RPV.
- Packet switching. By pooling a communications satellite's bandwidth and dynamically allocating it to ground stations as needed—rather than assigning fixed channels between station pairs—the Defense Department has found that a satellite's usage can be expanded by factors of 10 to 100 for more flexible, economic operation. Moreover, rapid and automatic reallocation of capacity to a crisis area can be accomplished.
- Antisubmarine warfare. ASW remains near the top of the Navy's electronic requirements, along with secure communications. In the latter area, the service is determined to develop its controversial, extremely-low-frequency (ELF) system, known as Sanguine—this despite its inability to find a suitable site for the large buried antenna grid. Already rejected in Wisconsin and Texas, stubborn Sanguine proponents are looking for new sites, although they have reportedly rejected one prime location in the upper Michigan peninsula—President Ford's home territory. Nevertheless, site location and ELF technology are being pursued with more than $13 million in new money so that ICBM attack submarines can remain invulnerable by not having to deploy a surface antenna to receive command signals.



Winner's circle. The Northrop YF-17, rolled out last spring, represents 1.6 million engineering man-hours and more than 10,000 hours of wind-tunnel testing and flight simulation.

The civilian markets

Compared with the military, the Government's civilian agencies are penny-pinchers when it comes to functioning as a financial force behind advancing the state of the art. Even once-proud NASA ended fiscal 1974 this

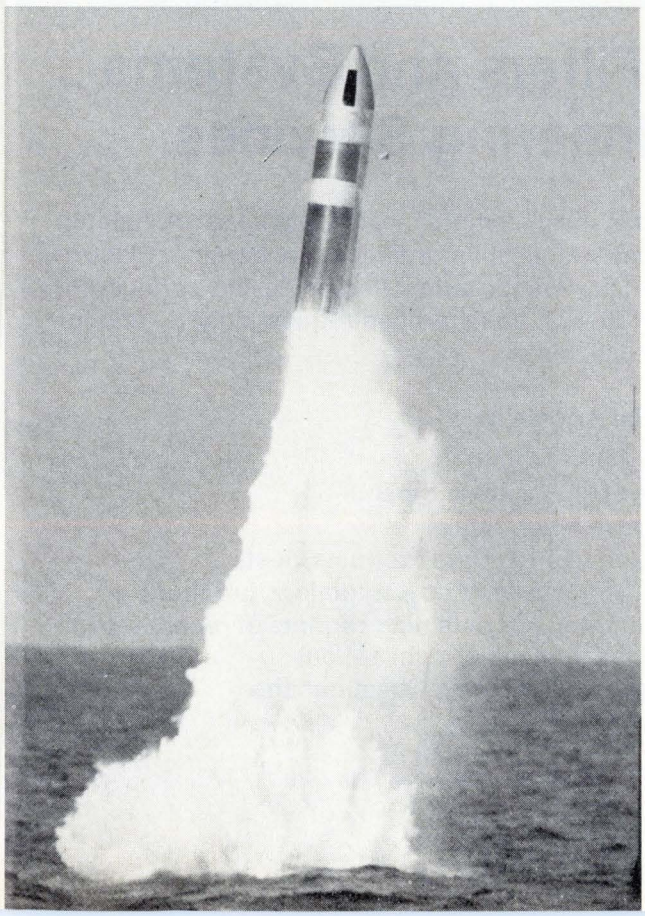
summer with an award of no more than $2.18 million in study contracts for the space tug and shuttle system, and that money was split among eight contractors. Typical of those awards was $286,000 to General Dynamics Corp.'s San Diego facility for space-tug avionics definition.

In light of President Ford's call for reduced Federal spending in just about every area except defense, the shuttle program could be vulnerable. "Unfortunately for us, it would be an easy one to cut," sighs one California congressional aide. "The program's in its early stages and wouldn't mean the loss of too many jobs compared to what DOD's spending on big jobs like the B-1."

Last year's energy crisis cut two ways in the electronics field. One, it appears to have dealt a body blow to the once-promising market for pollution sensors and monitoring networks as energy needs nudged aside concern for pollution control. "Concern for pollution has gone the way of Richard Nixon and Watergate," says a communications engineer who recently left the Federal Communications Commission. "And it has just about as much chance of making a comeback." Later, however, as the sense of urgency over the energy crisis receded, areas of low-power electronics R&D, which once appeared to be natural beneficiaries of the crisis, also lost ground. One exception may be solar-cell technology for direct conversion of solar energy into electrical energy, but even here, the funding is relatively insignificant.

Inflation has also robbed the Department of Transportation, a prime civilian sponsor of Federal electronics programs, of funds. So the use of electronics to improve transportation safety and efficiency is stymied.

Out of the deep. Navy's submarine-launched Poseidon missile breaks the surface in firing test. Companies selling weapons systems to the Pentagon are finding a more cost-conscious customer.



In mass transit, the DOT, wary after the Morgantown, W Va., people-mover debacle, has $2 million earmarked for advanced magnetic gravitation research. A prototype system is not expected before 1980. Meanwhile, private industry, including General Motors, has begun development of computerized pallet highways (in which vehicles park on moving highway sections) and other concepts. However, Federal support is inadequate for full-scale development.

Development of air-traffic-control systems has proved to be a turbulent route for another DOT agency, the Federal Aviation Administration. New equipment must interface with old, making introduction of such innovations as microwave landing systems a problem. Electronics is the backbone of the FAA's operations, but "we really don't get into state-of-the-art equipment," says David R. Israel, who's in line to be associate administrator for engineering and development. Still, the FAA wants to spend $250 million in fiscal 1975 to equip airports, plus another $96 million for R&D—the largest single R&D budget in the DOT.

A big procurement coming up for the FAA will center around the "flight service station" concept. Unmanned computer terminals at small airports around the country would be used by general aviation to submit flight plans and receive weather data. Israel estimates that up to 3,500 terminals will be required in 2,500 locations.

Other big-ticket expenditures by the FAA will include automated radar terminals for medium-sized airports; addition of computer memory to operating radar equipment; and upgrading of the present third-generation air-traffic control.

About 10 years ago there was a great deal of excitement about computer-aided instruction, but the concept never made much headway in public-school systems. Now, however, minicomputers and hand-held calculators may prove that there is a place in schools for electronics, says the National Institute of Education. For example, a trend that could develop slowly would see a minicomputer for each school to replace on-line terminals. But the calculator revolution should be more immediate, and even might have an effect on the teaching of math itself, because students who own the ubiquitous machines can solve more complex problems than their unequipped peers.

Over at the Commerce and Justice Departments, two agencies have been quietly increasing their contributions to electronics R&D. Commerce's National Oceanic and Atmospheric Administration (NOAA) continues to have weather and environmental satellites launched almost monthly, representing an expenditure of more than $50 million a year. NOAA has also ordered remote weather systems for deserts and mountaintops and sophisticated data buoys for the seas.

A smaller but still significant effort is under way at Justice's Law Enforcement Assistance Administration. There, work is being funded on personal alarm systems and improved police communications, and police around the country are buying fingerprint systems developed under LEAA auspices. □

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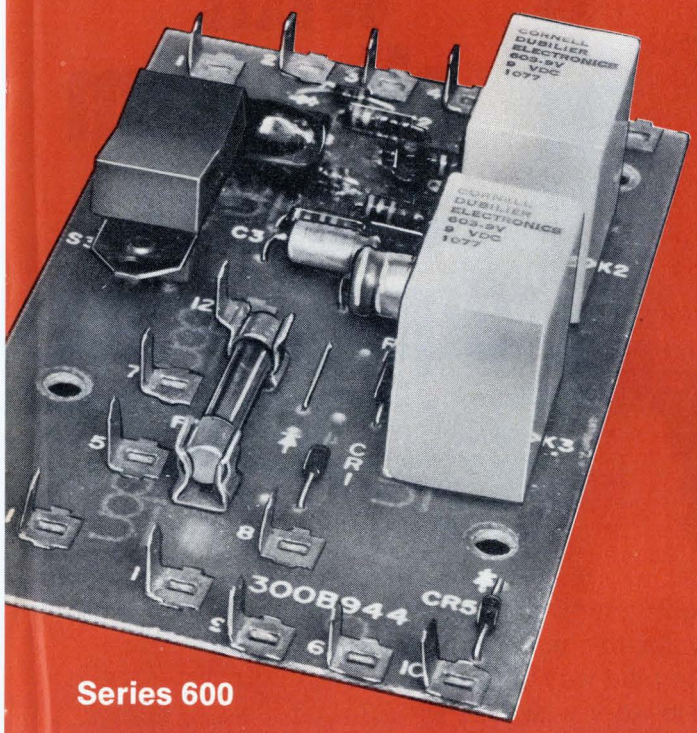

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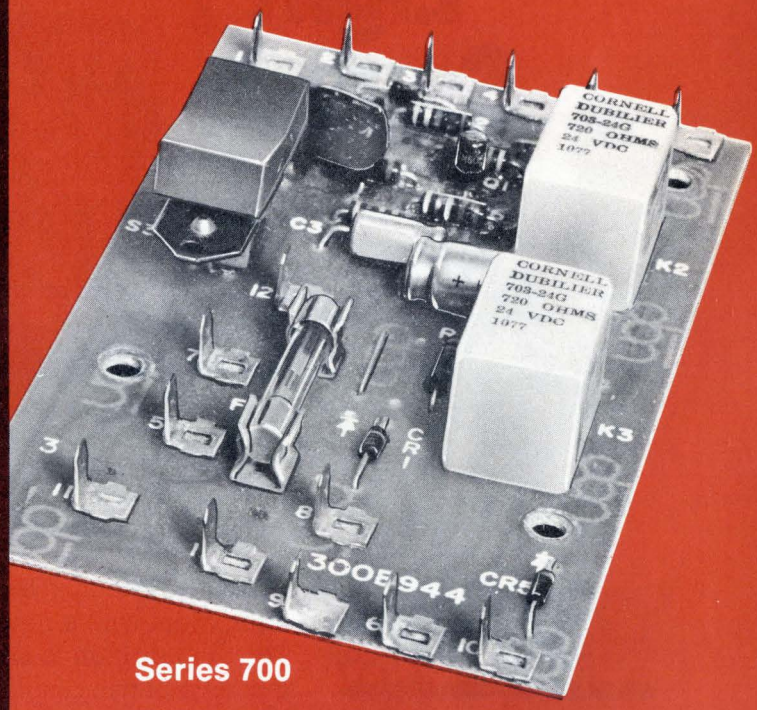

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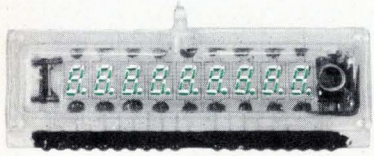

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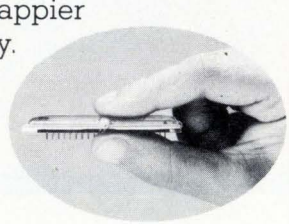
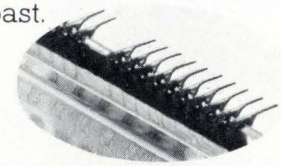
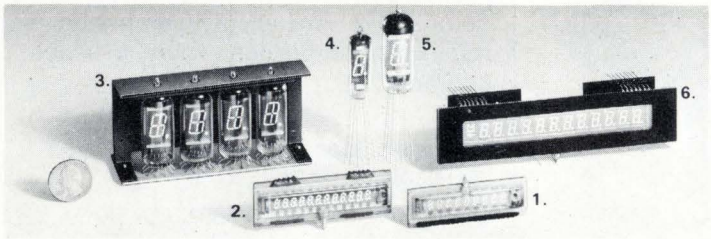


Digits on〈FG〉models measure a mini 5mm high to help you be as small in your thinking as you want. Both new displays are glass-enclosed all around. And have easy-mounting pin connectors. But mounting isn't the only thing that comes easy with these trimmed-down displays. Reading the indication they give comes easy, also. Because Ise keeps with the past. Gives these new multi-displays the same eye-easy green glow and planer construction that make their forerunners so popular. In addition, they also give you low-voltage advantages for direct LSI drive.



If you've been holding back on a headful of ideas simply because the right multi-digit display wasn't available, it's time to stop.



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R&D

Blame it on a soft economy or tight money, but today's research and development establishments are being forced to think of themselves as businesses. No one expects R&D to show direct profit, but just about everyone now expects researchers to pursue new technologies or improve old ones with one thing in mind—applications. That holds true for nonprofit university facilities and company laboratories.

☐ It all starts with research and development. And at R&D establishments—ranging from the big corporate and university centers all the way to the smaller, less formally structured installations—the money crunch is forcing the focus away from blue-sky projects to applications that will take the form of products—and profits.

As the physicists, chemists, metallurgists, and electrical engineers in the laboratories find themselves thinking more and more of filling spaces in product lines, their superiors are thinking more and more of organizing their R&D efforts along the lines of profit centers. In some places, such thinking already has resulted in a crisp, somewhat more businesslike R&D organization.

This thinking will be encountered at a cross section of laboratories across the U. S. But in California's Silicon Valley, south of San Francisco, three companies might serve as classic examples. Although they have more differences than similarities, Hewlett-Packard Co., Fairchild Semiconductor, and Intel Corp. have at least three strong R&D characteristics in common:

- They all consistently plow back at least 10% of their annual sales revenue into R&D.
- They all support fairly large R&D groups in relation to their size. H-P, with about 28,000 employees, has 1,900 in R&D; Intel, with 2,000 in its work force, has 200 of them in R&D; Fairchild's numbers are 800 out of 27,000.
- They all write off R&D very conservatively, subtracting outlays from the net income for the year they occur rather than when a resulting new product begins to make money.

At H-P, Dan Lansden, administrator of the corporate laboratories, says that R&D is highly product-oriented and aimed at the practical application of theoretical ideas rather than at extending the theory. To this end, H-P keeps 270 researchers at corporate H-P labs in Palo Alto, while the other 85% are scattered among the product-development groups that are a part of each of the company's 20 divisions.

The interface is effected this way: programs in the operating divisions are designed almost exclusively for development of specific new products or improvement of existing products. The corporate laboratories' primary mission, says Lansden, is to give technical support to those efforts, chiefly through exploration and application of new technologies.

At the divisional level, development work is performed by small project teams, consisting typically of electronic and mechanical engineers and an industrial designer. But throughout the course of a project, the team gets help and insight from manufacturing engineers and marketing personnel. An important factor is early involvement of these experts.

The division's engineering manager and general manager decide whether to take a product to advanced development or production. They act after receiving a preliminary feasibility study made at the direction of the section manager for a particular line. The decision on a product's feasibility is based on an assessment of its total R&D cost, probable market, target price, sales per month, profit per year, the number of years it will make money, and the total net profit.

Back at Palo Alto, says Lansden, things are a bit less formal. "For one thing, we call what we do 'investigations' rather than 'projects.' " The objectives are a bit more free-form, but the investigation must ultimately appear to have some chance of getting to market. And where the time scale for a divisional research project is about three years from idea to product, the scale in the H-P Labs is two to five years from concept to prototype product feasibility.

As a rule, Palo Alto takes new-technology investigations only to the point of feasibility; they then must be sold to a particular division that would carry on to the prototype and new-product stages. "But the division general manager is under no obligation to buy the results of a particular investigation," Lansden explains. This places the H-P labs in the position of making sure that what they do is applicable by their "customers."

The $10,000 ceiling

Decisions on how far to carry an investigation depend on scale. The departmental research manager alone can allocate up to $10,000 on any particular project. Anything over that must be approved by Bernard Oliver, director of corporate R&D. "This gives us a little more flexibility," says Lansden. "For one thing, it allows the investigator and the department manager to do a little preliminary study on a particular technology before recommending any big allocations. For another, it gives the departmental people a chance to prove a particular technology worth pursuing if there are doubts within the labs as to its practicality."

The same sort of split between central and divisional R&D is practiced at Fairchild, except that there is a little more centralized control. Some 50 to 75 researchers at corporate headquarters in Mountain View investigate technology that the corporate officers believe will result

by Howard Wolff, *Associate Editor*

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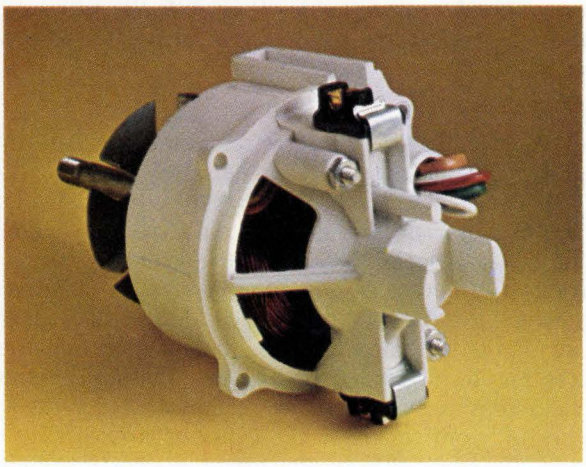

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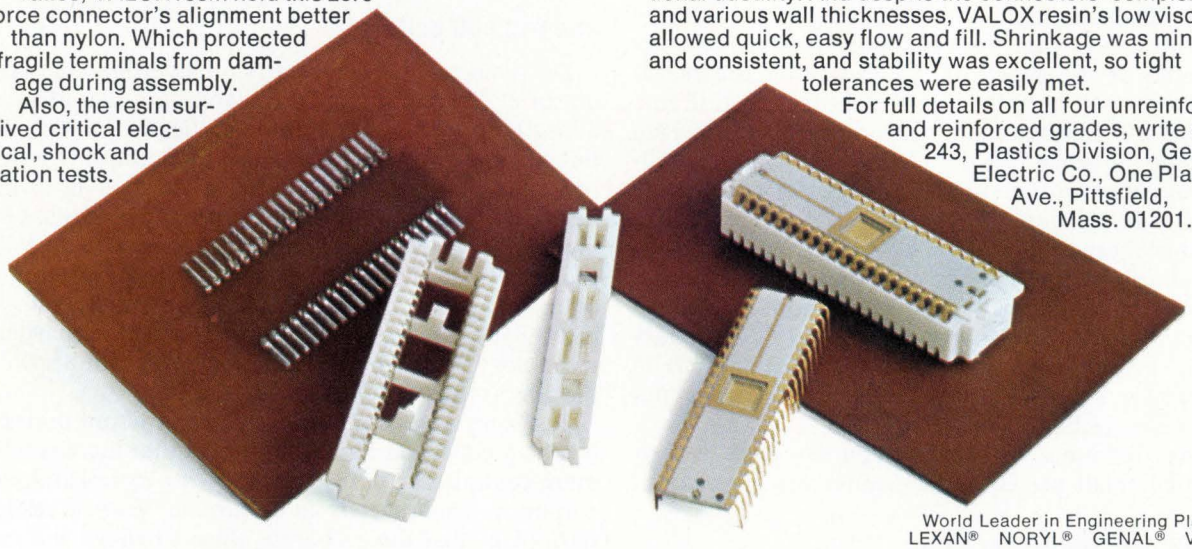

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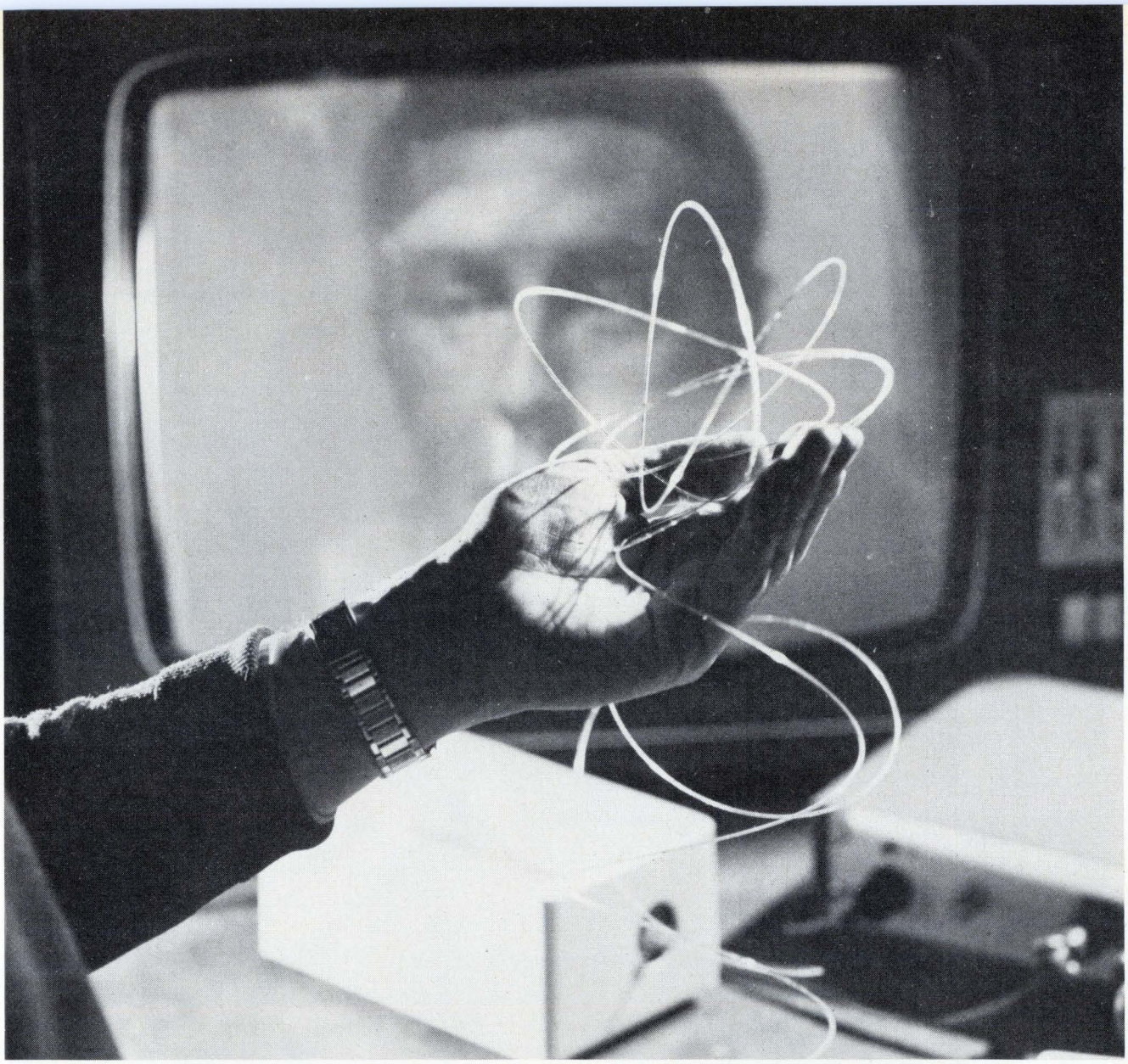

Bright picture. Scientist at an ITT research laboratory holds optical fiber being used to transmit television picture (background). With applications-oriented R&D the rule, such investigations of new communications technology are still being widely funded.

in either new products or the enhancement of old ones. Thomas Longo, who is vice president and general manager of the Digital Products division, says, "The ideas for which way to go are all over. What it comes down to in the long run is separating technical feasibility from economic feasibility."

That decision is made on the corporate level by Longo and James Early, director of corporate research. At the division level the decision is made by the general manager, with his research manager and Early and Longo as consultants. As for pilot lines, separate production facilities are maintained for the corporate research group. When production feasibility is proved, the project is either transferred into a division's production lines (as with Isoplanar) for further work by divisional researchers on yield improvement, or a separate division or group is set up around the pilot line (as happened with C-MOS).

At Intel in Santa Clara, the story is quite different. One reason is that the company specializes in semiconductor memories, unlike broad-based IC maker Fairchild or instrument maker H-P. Another is that most of Intel's corporate executives are scientists with doctorates in a number of disciplines who came from companies with separate pilot and production.

So at Intel there are no pilot lines, says Andrew S. Grove, vice president for operations, and no development labs. His explanation: "For years I worked for a company that was a technological leader, but could not translate that leadership to the production line. When I came here [*Electronics*, Oct. 5, p. 86], I resolved that one place we were not going to screw up was in translating technology into production." For this, production workers must understand the needs of researchers, who in turn must understand the needs of production. The best way to achieve that mutual understanding, says Grove, is to have them share facilities.

"When visitors ask me where we do our production-feasibility studies," says Grove, "I show them our 'invisible' pilot lines scattered in bits and pieces all over the

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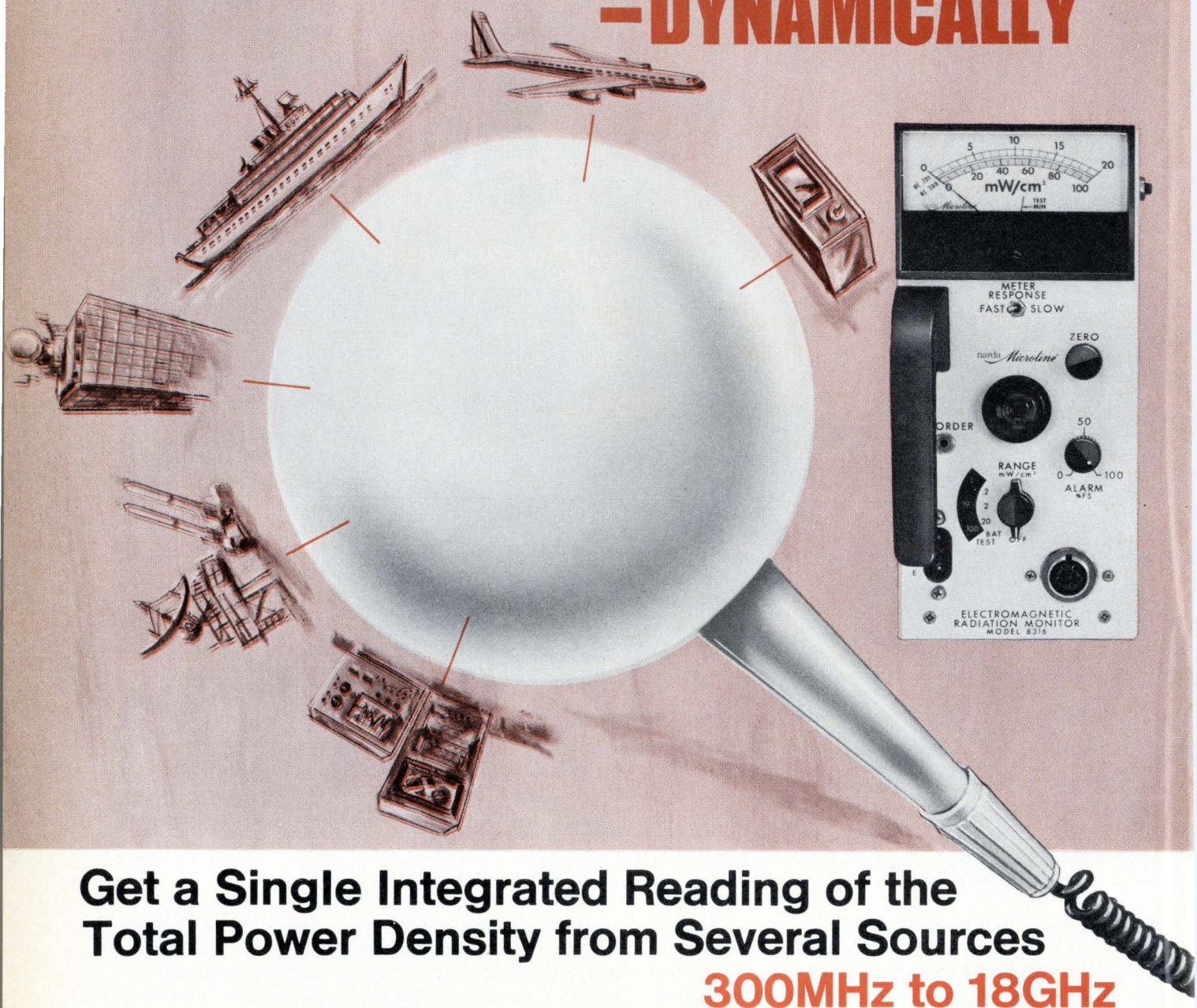

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plant on equipment that isn't being used for production at a given moment." And those invisible pilot lines may shift around depending on where the necessary equipment is available.

"Over the short term it's inconvenient to both production and research people," admits Grove, "causing all sorts of glitches in their schedules. But over the long term it's meant terrific savings in dollars and in the amount of time it takes to move along the learning curve. So any temporary setbacks at the beginning are offset by the tremendous gains we make at the end."

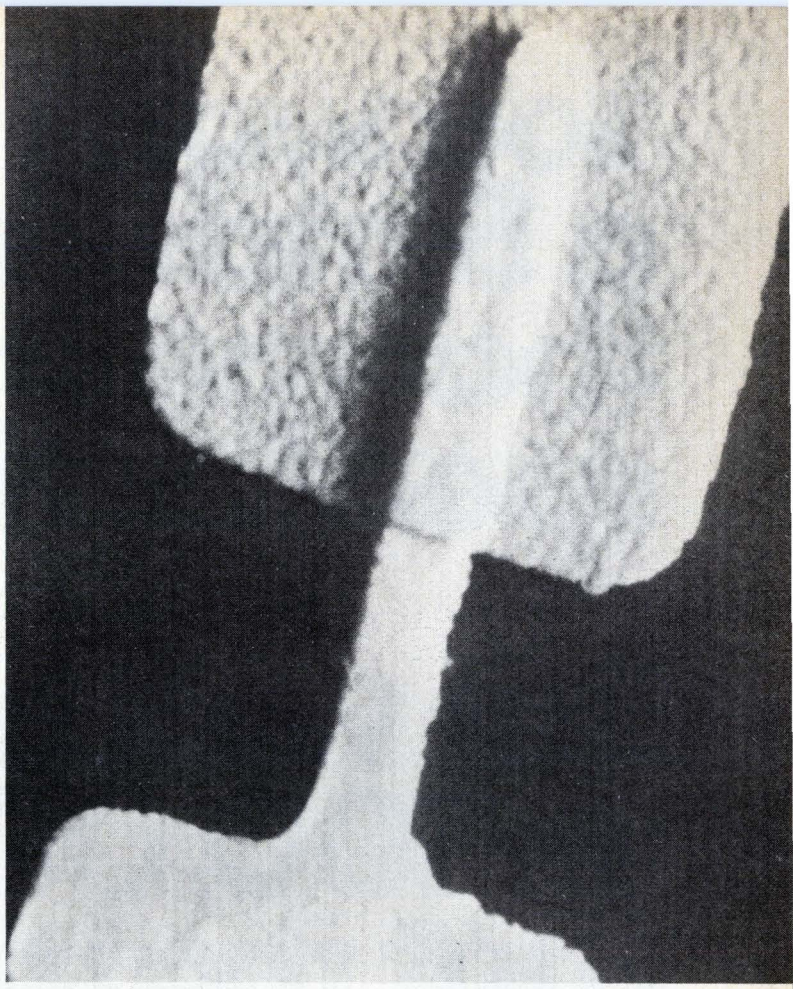
In some companies, the research group also serves as a technical consulting service for the rest of the company's divisions. That's the case at Control Data Corp. in Minneapolis, even though the central research facility is primarily charged with looking into new areas of opportunity for the mainframe maker. John Baird, senior vice president for research and development, says that, as a result, "We've gotten the company into several other lines of business—semiconductors and plasma displays, for example."

The way R&D is organized at Control Data, explains Baird, "We take a technical idea and develop the technology through what we call applied research until it is in a position to be transferred to an operating group. We'll carry it as far as necessary to make sure the transfer doesn't fall through a crack. This, in some cases, involves production of prototypes, and in some cases the production of considerable product. But ultimately we want to transfer it out of research because we don't want to become an operating division."

Control Data has another unique method of keeping technology from falling through a crack. When a project moves from the lab to an operating division, the entire group working on it often is also transferred. In the past year, this occurred twice. The first time, 14 researchers went to the Aerospace division with their plasma display. "It went there because it's being sold to the military; we'll develop about $2 million in orders for that product this year," says Baird. The initial product was developed entirely in R&D and, because "that was an area where we had a lot of trouble getting anybody in the company interested in the product," the research division even sold displays outside Control Data.

The second transfer came when 26 employees were moved lock, stock, and image-comparison system into the Military division. While most of the project is classified, the system automatically compares pairs of photo or radar images and prints out the differences between the two. "We've also done some work with this technique in chest X rays," says Baird. "By comparing two taken a year apart, we can print out a photograph of the differences to show if any cancerous growth has occurred."

Control Data's operating divisions do relatively little research. But since they're charged with keeping product lines up to date and with developing new products, they do some. They follow the same general procedure as the central facility for funding: the division's chief engineer proposes projects for review by his general manager. Then it is bucked up the line to the group chief in peripherals, systems and services, or marketing.



Meeting point. Scanning electron micrograph shows Josephson junction measuring 1.3 by 7 micrometers. Fabricated at IBM's Zurich Research Laboratory, it switches in less than 10 picoseconds.

Research expenses are written off each year. "The only R&D we defer," says Baird, "is that part of the development on a new product which corresponds to that part which is leased—and written off over the lease period. On a new computer system, for example, we might lease 40%, so 40% of the development cost is deferred and written off over the lease period. The same thing happens with marketing expenses."

The company's central research activity derives 30% to 40% of its support from corporate funding; the rest is split between outside R&D funded predominantly by the Government, and interdivisional work orders. Control Data spent about $164 million in 1973 for what it calls total technical effort—exploring advances in technology for new products and services, as well as applications of computer technology. Of that, R&D expenditures came altogether to $48.1 million. "So far as I know," says Baird, "I've never been stopped from funding anything I want to fund."

Business is business

It's easy to conclude that corporate R&D groups are focused sharply on saleable products—but what about institutional research organizations? The answer, says Sid Bass, director of electronic research at Chicago's IITRI, is that while it's usually run on a not-for-profit basis, institutional R&D is a competitive business. "We seek our business competitively, and we get paid for it,"

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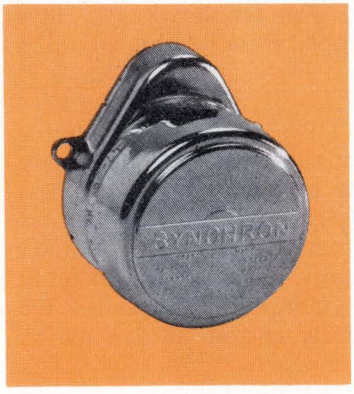

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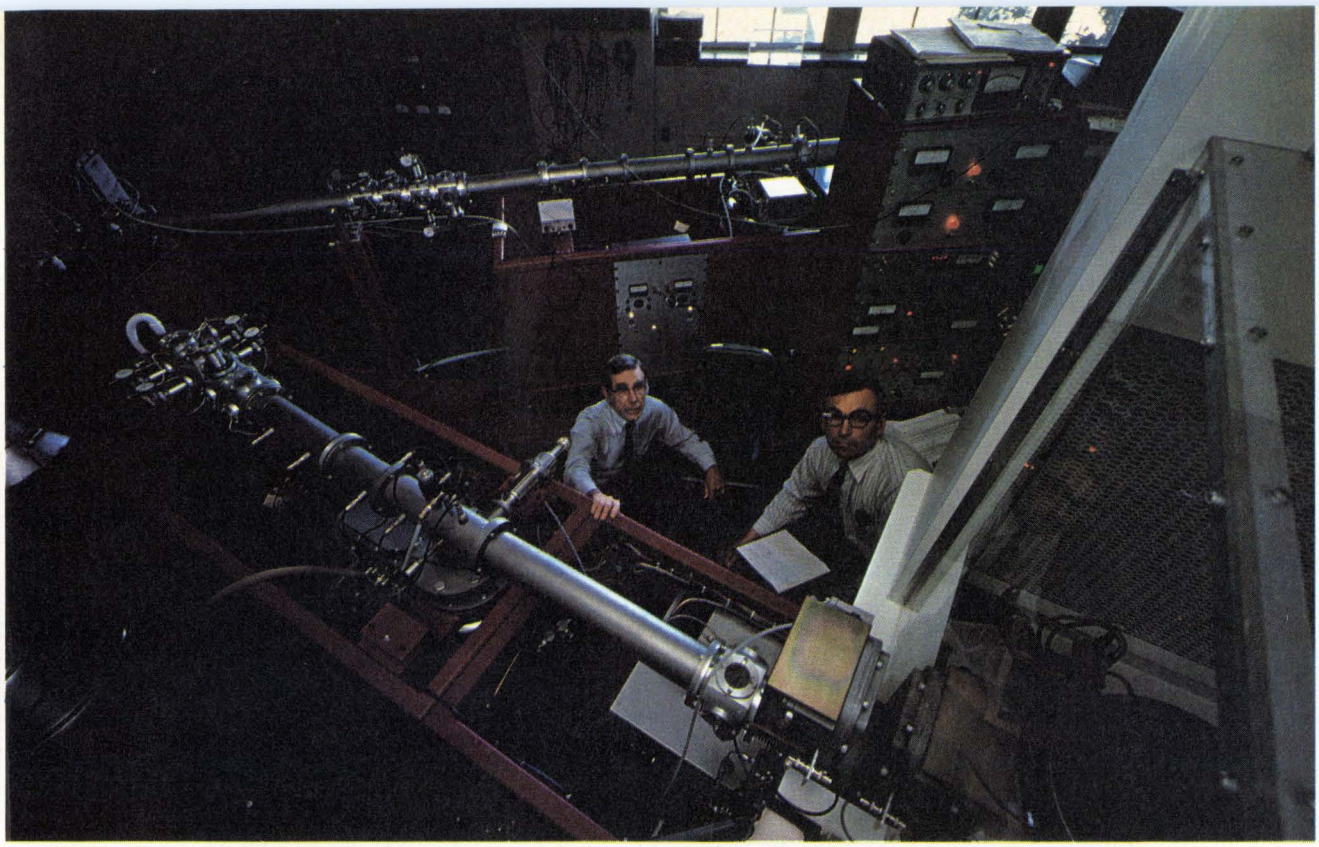

Pipes connected to tomorrow. Researchers at RCA Corp.'s Solid State Technology Center have put together this dual-line ion implanter for experimentation and production of more sophisticated silicon technologies. Despite the advent of newer materials, R&D budgets still include a good deal of money for work on improving fabrication and density of silicon devices.

says Bass. "And as any business should, we start in the market, the R&D market. We determine what the needs are—and they may be services, not products, that have their origins in some policy or national goal," he says. "We look at where the needs lie, and who intends to spend the money." That's why the biggest customer at the Illinois Institute of Technology Research Institute's division is the Government, which supplies 80% of the contracts—65% of IITRI's business is from the Pentagon, 15% is from nondefense agencies. Industrial firms provide the rest.

Bass's division is finding more and more of the needs it seeks to fill in what he calls services: performance prediction of devices or systems, experimental and analytical evaluation of competing products, and comparing and reviewing specifications, to name a few. A full two thirds of the division's work is now service-oriented; the remainder consists of pursuing conceptual developments toward hardware itself.

"The electronics industry in this country serves its own industrial needs internally," says Bass. "There are very few secret processes that are proprietary and protectable, so the engineering that goes on is short-term, usually aimed at the next product cycle. And if I owned a company, I'd want to keep that kind of work inside." As a result, says Bass, most of the IITRI division's commercial research work is for non-electronics firms: "Electromechanical companies find themselves having to deal with a new technology on a transient or peripheral basis. Our work for them is generally on specific problems."

Things were not always thus for IITRI. It has invented, conceived, and developed hardware, such as its pioneer work in magnetic recording 30 years ago. "That development was second only to the transistor and atomic bomb in terms of impact, and it was invented here," says Bass. But recent attempts have seen IITRI outstripped by electronics firms. "The lifetime of a preeminent position, even if it arises, is too short," sighs Bass.

He gives this example of the inappropriateness of conducting basic research at an R&D institution: in the late 1960s, IITRI went all out in its work with surface-wave technology. "We invested heavily in facilities to make devices and succeeded only minimally in selling our research," recalls Bass. "For as soon as the technology payoff was apparent, the companies that felt they could get a product yield overwhelmed us. They invested more in a few months than we could afford to spend over three or four years.

"Research, even in the applied form, is increasingly hard to sell," he continues. "More and more of it is being done in the product-development labs of commercial firms. And there's so little market for basic research that we don't even bother to look for it."

That gloomy picture is not repeated in another university-sponsored R&D operation, the one at Massachusetts Institute of Technology in Cambridge, Mass. There, says Albert G. Hill, vice president of research, every faculty member is expected to do research in his field, either independently or as a part of a team. And it is the faculty member, most often, who decides what his research will be. About 90% of the funding is from the outside—mostly the Government, but also from individuals, foundations, and industry.

About $70 million worth of research is on the MIT campus, about $25 million of it with a strong electronics

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orientation (though Hill says it's difficult to determine where electronics research ends and where research that uses electronics begins). In addition, about $70 million worth of electronics-related research is going on at MIT's Lincoln Laboratory, which, unlike the campus centers, is permitted by university rules to handle classified work for the Defense Department.

But on the whole, the atmosphere at MIT seems to be one of individual initiative—even extending to funding. Hill explains that "we aid faculty in getting research support since we know where the foundations and Government agencies are." However, over a period of time a professor will develop his own contacts among supporters, so most of the work in preparing research proposals is done by individual faculty members. MIT funds some research directly, but more often the individual researcher or group helps get its own funding. An Office of Sponsored Programs represents the MIT administration in processing proposals, negotiating contracts, and making sure a contract is not overspent.

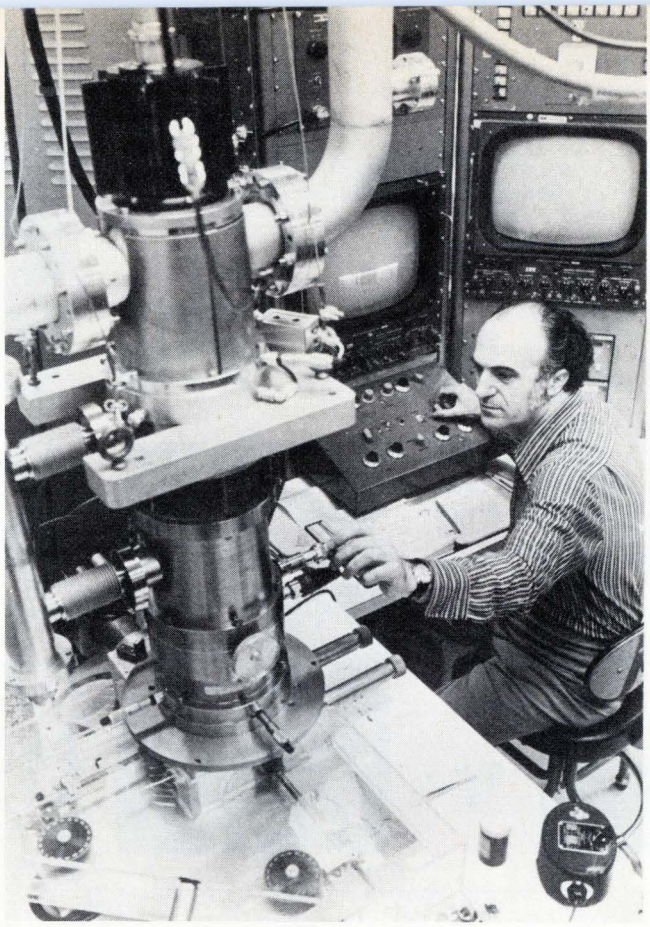
Recently, the university played its direct-support role with the new energy laboratory. In this case, the idea came from the administration, with Hill instrumental in formulating it, when the energy crisis struck. MIT felt that there should be a lab devoted to over-all energy policy, says Hill. And since it's difficult to determine just which Government agencies are responsible for energy action and which industries are hardest hit, MIT has yet to find a patron for the lab. It simply dipped into its own general funds to set up the facility. Hill points out that perhaps $4 million worth of research on the MIT campus is related to energy, but that work is splintered among many contracts with no cohesion. It would take $5 million a year to fund a central energy lab that could pick its own projects with appropriate reviews.

It would seem that the only R&D rule at MIT is to do your own thing, but that is not quite the case. Besides the stricture against classified and proprietary research—except at Lincoln Lab—there are other rules. The work must be state of the art or pushing it; the researcher and the university must have the capabilities required to do the work; and MIT, as a nonprofit institution, must not guarantee anything, such as performance parameters.

It's also expected that research will include student participation. Although that is not a strict rule, promotion, tenure, and salary increases depend in part on the number of students a professor has, so the pressure to include them is strong. Hill says that he has been forced several times to return proposals that have not been related to education.

Once a research project is under way, its results, interest, and value are "pretty much judged by the faculty member's peers," says Hill, rather than by the university. If a department has one of its members doing something routine, MIT wouldn't take a strong stand against the work if it were funded from outside. But if it burdens the university it would be discouraged.

While most research is done by individuals, Hill says, "Our people follow the news and we have a marketplace too, though it is less obvious than in industry. We are related more than we want to believe to the outside world." And there is interaction between researchers: a member of the nutrition department might have an idea for an instrument needed in his work and, with the help of a colleague in the EE department, develop it.



Making them smaller. Michael Hatzakis of IBM's Thomas J. Watson Research Center works at an electron-beam-fabrication apparatus used to make ultra-small devices for the firm's products.

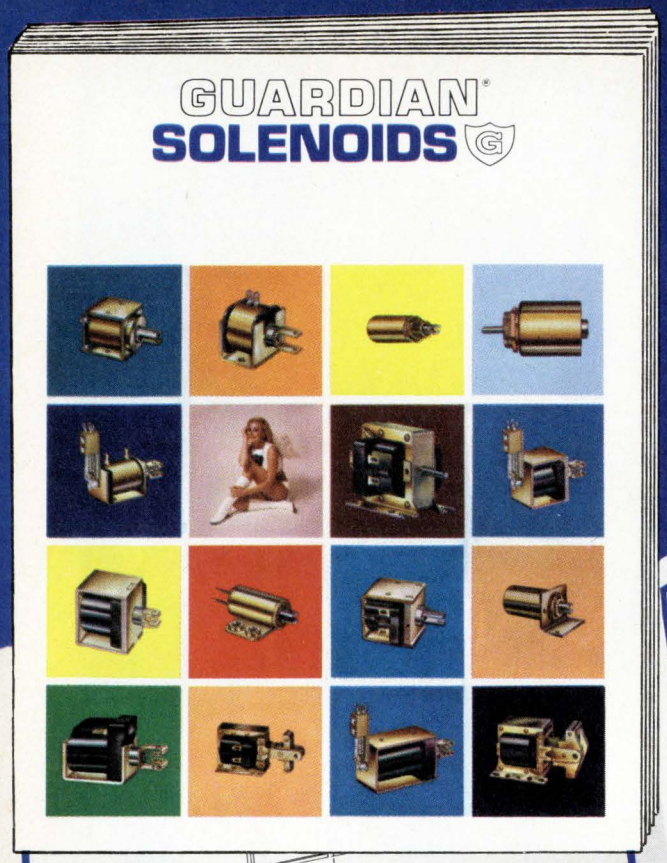
Once an MIT research project is finished, the results are generally published in a research journal—MIT does no development. If the research has led to a potential product, the researcher might obtain a patent or a business might be established around it. This work is handled by the MIT Development Foundation Inc.

A crack at Bell

If there is still any doubt that R&D is going in new directions, consider what might be in the future for mighty Bell Laboratories. On file with the Federal Communications Commission are two internal reports on the operation of the labs. While lauding the work done there—with its $500 million-a-year budget, Bell Labs averages two and a half patents per working day, says an AT&T staff study—both the AT&T staff study and one done by Bell System operating company officials are unhappy about supervision of the labs' work. The staff study recommends tighter direct control by AT&T.

Saying that R&D decisions are reached through "compromise and concession," the report recommends giving AT&T officials authority to make R&D decisions, and also wants to let the marketing department have some role.

The times, as both studies point out, are changing. □



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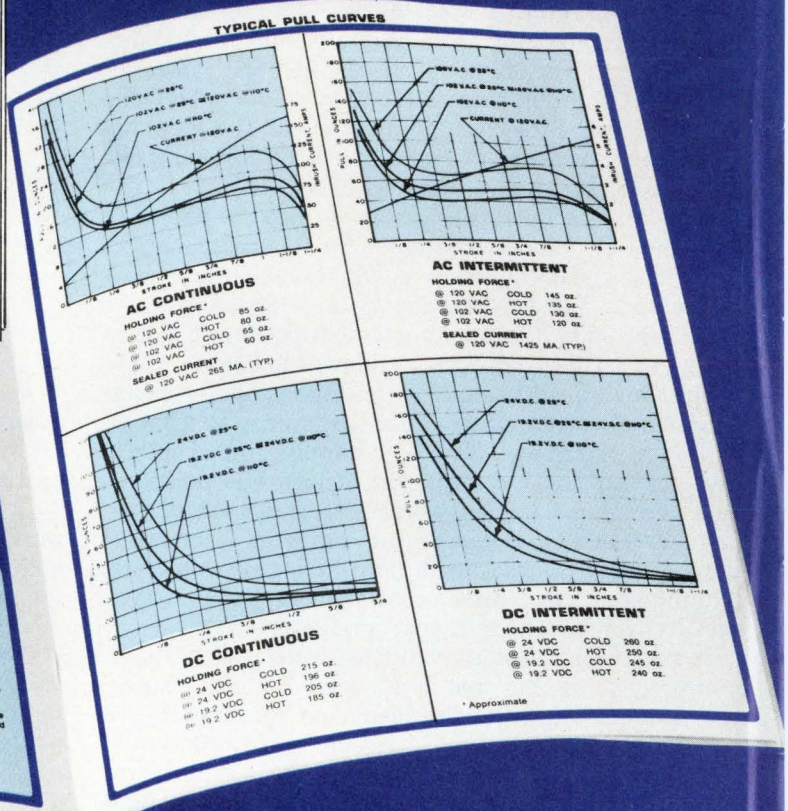

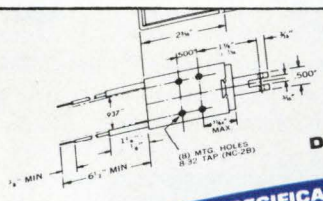

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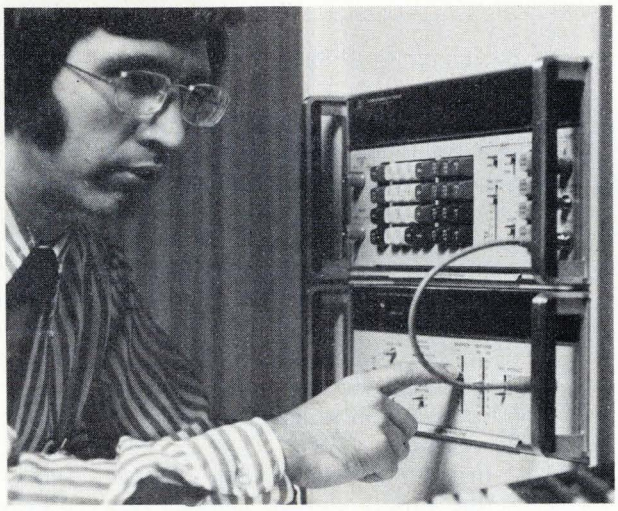
Spectrum analyzer is upgraded

H-P adds a programable calculator to provide automatic control as well as increase speed and accuracy of measurements

Adding a programable calculator to a spectrum analyzer not only provides automatic control, but also increases speed and accuracy. Hewlett-Packard's model 3045A is an automatic programable system covering 10 hertz to 13 megahertz that has a high-resolution synthesizer and is offered with a choice of three different programable calculators. This system is supplied with software for various general measurements and programing instructions for more specific measurements.



Time saver. Calculator-controlled spectrum analyzer promises engineers high accuracy without time-consuming knob twiddling.

Traditional spectrum-analysis applications often involve tedious frequency tuning and sweeping to check for distortion products and spurious responses of the device under test. The accuracy of these measurements—both in amplitude and in frequency—is usually limited by the cathode-ray-tube display of the spectrum analyzer. Further, the measurements require a fair amount of manipulation to get a meaningful display on the CRT. Rf and i-f gains, offsets, i-f bandwidths, sweep widths, and sweep speeds must all be taken into account in interpreting the display. But the autoranging and scaling provided by the calculator plots frequency responses over the analyzer's entire measurement range.

Programability opens up other test opportunities. For example, total harmonic distortion (THD) measurements are usually made by notching out the fundamental signal and reading the remaining total-signal level, including noise and spurious signals. Under calculator control, the fundamental and a predetermined number of harmonics can be measured and THD calculated as the square root of the sum of the squares far more accurately and just as rapidly as with the conventional approach.

Calculator control is particularly useful on the production line because the resulting high speed and the ease of operation can boost production rates and yield lower unit costs than manual systems. The calculator can compute results, make decisions, manipulate data, and store data for a series of tests. Measurement results can be printed on a calculator's self-contained printer or recorded on magnetic cards or cassettes for future use. Results can also be plotted on X-Y recorders, typed, or stored in a bulk-storage cassette memory. Amplitude-response measurements can be made under control of the calculator, with the aid of the read-only memories built into the synthesizer and detector.

The model 3045A automatic spectrum analyzer consists of a model 3330B automatic synthesizer as a source, a model 3571A spectrum analyzer and a model 9820A, 9821A, or 9830 desktop calculator. The link between the instruments and the calculator is the new H-P 16-line interface bus, consisting of eight control lines and eight data lines. [*Electronics*, Sept. 19, p. 67]. Codes and data are transmitted as 8-bit parallel Ascii words.

The heart of the system is H-P's new model 3571A spectrum analyzer, which tracks the frequency of the source and measures amplitude response with a wide choice of bandwidths. The selective filters are optimized for swept spectral analysis with a shape factor of 11:1. The 80-dB dynamic range and 150-dB measurement range provide a wide latitude for signal analysis.

The amplitude range is 150 dB (3 V to 100 nanovolts), resolution is 0.01 dB, and dynamic range is 80 dB. Selectivity is 3 Hz to 10 kHz in a 1, 3, 10 sequence. Internal distortion response is greater than 80 dB below full scale, and internal spurious response is more than 70 dB below full scale. Price for the 3045A ranges from $22,400 to $30,000, depending on options.

Hewlett-Packard Co., 1501 Page Mill Rd., Palo Alto, Calif. 94304 [339]

FIFO memory speed boosted tenfold

Schottky-bipolar processing overcomes MOS speed limitations on single chip

by Bernard Cole, San Francisco bureau manager

A FIFO (first-in, first-out) serial memory, fabricated by advanced Schottky-bipolar processing, promises to be nearly an order of magnitude faster than other single-chip FIFOs now on the market. The device, from Monolithic Memories Inc. of Sunnyvale, Calif., is capable of in/out shift rates as high as 10 megahertz. The company plans to introduce it in sample quantities in November.

In a FIFO memory, data entered at the inputs automatically propagates toward the output terminals without clocking. When data is removed from the outputs by a shift-out signal, other data in the FIFO memory moves down the line automatically to fill up the vacant locations.

A typical application for the device would be as an input or output buffer between a keyboard and a central-processing unit or between a CPU and a printer. Information can be entered into the FIFO at keyboard speed, which saves valuable computer time. Similarly, data can be fed to the FIFO at computer speed and then transferred to a printer at the slower printout speed.

An extremely important feature of the FIFO memory is its ability to perform read and write operations simultaneously and independently. This allows a machine to write new data into the memory at the same time that another machine is reading data from the memory without requiring any kind of synchronization between the two.

FIFOs can also be used to advantage in data-communications systems. Here, if the received data is being strobed by a fixed-rate clock and the transmitter and receiver clocks are not set to precisely the same frequency, a FIFO can act as an elastic buffer store that keeps the system from losing data. Of course, the system will need resynchronization eventually, when the FIFO either gets completely filled or emptied, but the period between synchronizations is much longer than if the FIFO were not used.

The FIFO buffer concept is not new, and, in fact, random-access memories have been used with counters to generate the read and write functions. A multiplexer selects the appropriate address counter for a read or write, and the counter is incremented at the end of the cycle, so that the next read and write will occur at the next counter address. Since the location of the next read and write are held in independent counters, reading and writing can be randomly intermixed. However, using an ordinary RAM, only one operation can be performed during a given cycle, since only one address can be selected at a time.

If the RAM is very fast, relative to the machines using it, then the control logic can be designed to receive read and write requests independently and to execute them so quickly that the FIFO buffers appear to operate completely asynchronously.

The problem of handling read and write operations simultaneously

How did Fabri-Tek come up with the most powerful, reliable, economical off-the-shelf microprocessor on the market?

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That's right. While other manufacturers have been loudly introducing microprocessors using all kinds of whiz-bang technology, Fabri-Tek pulled a fast one. We designed the MP12, and we're manufacturing it in volume — right now. The MP12 puts us — and you — way ahead of the field, because the MP12 takes advantage of tested, field-proved technology. TTL components... core memory... solid, workable logic design. And since we've been experts in these areas for many years, we cleverly packaged the whole thing to sell at just $990 in quantities of 100, or $1340 for one.

What's In It For You? With the MP12 you get the kind of performance, reliability, and economy that other microprocessors won't deliver for a long time. It's a ready-to-go 4K processor with all the electronics necessary to plug into any application: industrial control; laboratory automation; communications; data acquisition; point-of-sale. Important features include PDP-8 compatible instruction set, console, complete supporting software. You not only get a lot more, you get it a lot quicker. Your order puts a system on an airplane the next day.

Give Us A Try. We've taken such advantage of computer technology that it's almost unfair. But we think you'll forgive us when you see what the MP12 can do. Write or call today to arrange a demonstration in your office or plant.

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New products

is eased if a two-port RAM is used. Such a device has two independent sets of address inputs—one for reading and one for writing. Unfortunately, two-port RAMs have limited capacity. Therefore, says Dale Williams, marketing director, they're fairly expensive to use in a FIFO of reasonable size.

Within the past year or so, a number of companies (among them Fairchild Semiconductor and Advanced Micro Devices) have introduced MOS FIFOs integrating all these functions onto one chip.

"But the problem has been that the speed limitations inherent in MOS have limited the shift-in, shift-out rates of such FIFOs to 1 or 2 megahertz," says Williams. "This meant that one-chip FIFOs could be used as buffers on peripherals, which have an upper-end speed of 1 or 2 megahertz, but not on most processors or large CPUs where the input speeds vary between 5 and 10 MHz. Most of these latter buffer applications are still handled by random-access memories."

Monolithic Memories' 16-pin bipolar FIFO, with a capacity of 64 four-bit words, can shift information in and out at rates up to 10 MHz because of the speed afforded by Schottky technology. This means, says Williams, that it can handle all buffer functions previously handled by either MOS one-chip FIFOs or RAMs.

It has the additional advantage, he says, in that it already has TTL inputs and outputs, whereas MOS devices require special input circuits to provide complete TTL compatability.

Available in either a ceramic or a plastic package, the 6741 uses a power supply with voltages ranging up to 7 volts and supply current of 100 milliamperes.

Although exact pricing has not yet been set on the 6741, says Williams, it should be available in November in lots of 100 to 1,000 at a price of $35 each. Volume quantities should be available in the first quarter of 1975.

Monolithic Memories Inc., 1165 E. Arques Ave., Sunnyvale, Calif. 94086 [338]

Centralab perspectives

FOR USERS OF ELECTRONIC COMPONENTS

CENTRALAB
Electronics Division
GLOBE-UNION INC.
5757 NORTH GREEN BAY AVENUE
MILWAUKEE, WISCONSIN 53201

A new concept in thick film hybrid circuits lowers cost and broadens applications.

New resistor paints, automated production and laser trimming aren't the only reasons that the NEW PEC™ circuits from Centralab are the high quality performers engineers demand.

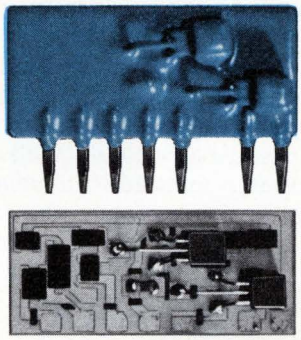
It's not surprising that the announcement of a breakthrough in thick film hybrid technology should come from Centralab. The product of a totally new concept in automated production, NEW PEC employs specially developed resistor paints that give these thick film circuits improved tolerance, better TCR, reduced noise and greater stability during load life. They offer unmatched reliability, through laser trimming and computerized pretest and final testing. Automation means increased production capacity for high volume orders and faster delivery. Complete processing time — from substrate to finished circuit — has been reduced from several days to a matter of hours. Yet, with all these improvements, NEW PEC is price competitive with discrete components.

Ever since 1945, when Centralab pioneered thick film microcircuitry, they have continued to make major contributions to the technology and have been a leading supplier of thick film hybrid circuits. With the announcement of the NEW PEC system, they can now meet the increasing demands of present high-volume users and have extended the use of thick film hybrids to a whole new range of applications.

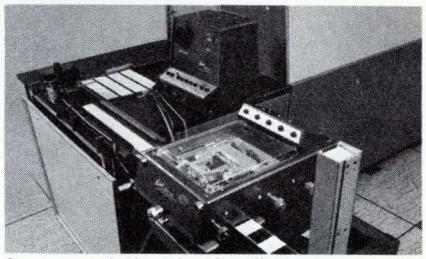
The automated production equipment recently developed by Centralab engineers brings a new degree of sophistication to the art of thick film hybrid microcircuitry. Advanced features like these can help you apply NEW PEC thick film hybrids:

- **TCR reduced from −1700 ppm/°C to −375 ppm/°C.**
- **Resistor tolerance improved from ±10% to ±5%.**
- **Noise reduced from 15 db to 9 db.**
- **Resistor stability improved 35%.**
- **Alumina and steatite substrates for greater strength and better heat sinking for mounting active devices.**
- **Automatic screen printing insures precise metallization and resistor patterns.**
- **Mechanized component and lead attachment improves reliability 86%.**
- **Computer controlled laser pretest and adjustment. No problems of over-adjustment, abraded metallizing or contamination from sand abrasion.**
- **All circuits tested before and after encapsulation.**

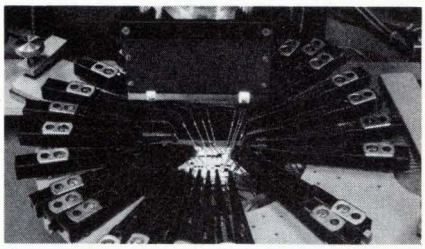
Centralab's NEW PEC opens new vistas for the user of thick film hybrids. For full details on how they can meet the needs of your application write Centralab for Catalog 1547.



Centralab's NEW PEC is low-cost, high-quality thick film circuitry for a wide range of applications. Automotive electronics, copiers, point-of-sale terminals, peripheral computer equipment, instrumentation and process control are just a few.



Screen printing is the first step in the NEW PEC automated process. Substrates are automatically fed through the printer where precise metallization patterns are deposited before firing.



Computer controlled laser equipment provides pretest to insure proper screening and curing and precise adjustment of resistors. Resistor trimming is shown in this view of the laser head.

Data handling

Pertec terminal is aimed at OEMs

Microprocessor provides flexibility for CRT unit, built for business systems

By using a microprocessor instead of hard-wired logic as the heart of its model 7100 terminal, Pertec has come up with a machine flexible enough to serve a variety of OEM users. Pertec's first cathode-ray-tube terminal is designed primarily for remote data entry through data-communications lines, although it can also be used locally with a direct computer interface. In small and large business systems the terminal is expected to perform a wide variety of functions, such as word processing, credit verification, and inquiry response.

"Almost every terminal function is determined by ROM control-memory programing, rather than by using hard-wired logic as do most other low-cost terminals on the market," says Dick Kontrimas, marketing manager of the company's Business Systems division. He adds, "It is Pertec's goal to offer system manufacturers an alternative to in-house production by supplying a unit with the flexibility to be adapted to a very wide range of applications."

In the 7100, all keyboard, special-control-key, and communications-protocol functions can be readily changed simply by changing a read-only memory. During customer development, erasable ROMs can be used; later on—in production—mask-programed units would be used because of their lower cost.

The keyboard is detachable so that the device can be easily operated in any position. Keystroke acknowledge, electronic keyboard-locking transmission, and a flashing position indicator make the terminal easy to operate.

The terminal's standard character set is 64 Ascii characters (96 with lower case), but the character set can be modified by ROM reprograming. Several international character sets are available as options. The 7100 has a display area of 5.5 by 8.25 inches, with a capacity of 80 7-by-9-dot-matrix characters per line. A 12-line display is the standard configuration, but a 24-line option is available at additional cost. Both page and scroll-display modes are standard with the terminal.

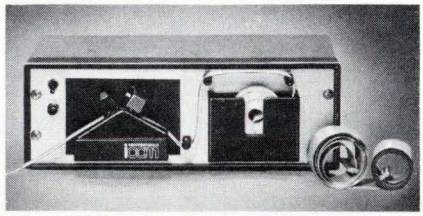
Synchronous and asynchronous data communications at rates as high as 9,600 bits per second are available as options, as are direct computer interfaces. The interfaces also permit serial or line printers to be connected to the terminal, and the communications-modem adapter enables several terminals to be daisy-chained. The microprocessor also makes it easy to interface other peripheral equipment with the terminal, the company points out.

The 7100 is approximately 18 in. wide, 13 in. high, and 19 in. deep. The detachable keyboard measures 18 by 3 by 8 in. Prices for the terminal start at $2,025 in lots of 100.

Pertec Corporation, Business Systems Division, 17112 Armstrong Avenue, Santa Ana, Calif. 92705 [361]

Paper-tape reader feeds into National microcomputers

A high-speed paper-tape reader, model R8016P, is designed for direct interface with National Semiconductor's IMP-8P and IMP-16P microcomputers. Features include plug-compatibility with the card reader interface on the IMP-8P and

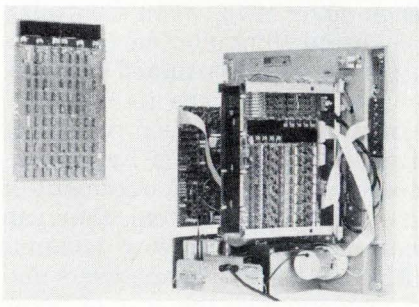


IMP-16P; assembler-program loading in less than 120 seconds; use of photoelectric character detector; and a 40-line ribbon cable that directly interfaces with the National unit. Price of the paper-tape reader is $995.

iCOM Inc., 6741 Variel Ave., Canoga Park, Calif. 91303 [365]

Formatter records, reads up to 45 inches per second

Designed to mount directly inside tape drives, and contained on a single 9¼-by-14-inch printed-circuit board, a standard formatter and its dc power supply combine for simple drive mounting, eliminating the cost and space requirements of separate



Centralab perspectives

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spice

VARIETY IN PUSHBUTTON SWITCH SELECTION. That's how Centralab can help put a little more spice in your work-a-day life. Because nobody else can give you all the up-to-date features and functions that let you design the way you want to. Start with the basic module . . . then select the options you want, and every functional and appearance specification suddenly becomes reality.

Maybe you'll select Centralab pushbutton switches* because they require so little space. That's important when you also consider that up to 29 modules can be ganged on a single bracket with horizontal or vertical mounting, rear or back-to-back coupling.

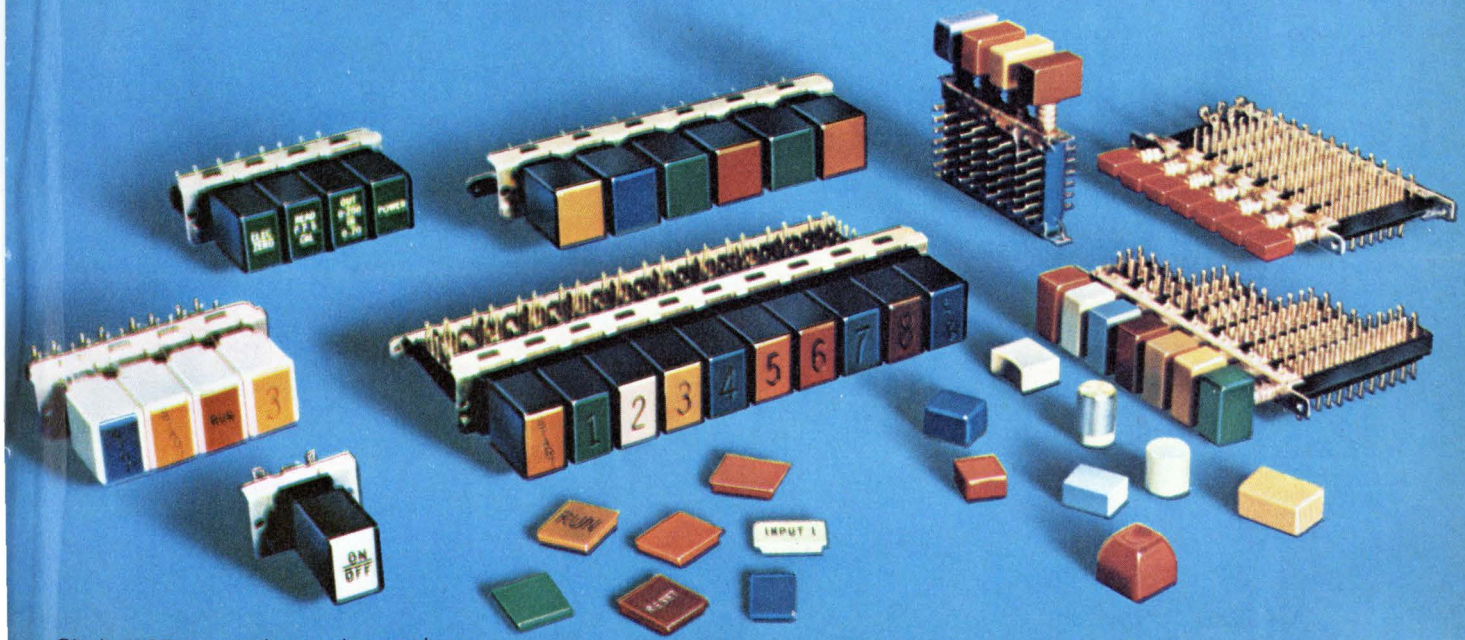
Or, you may want the flexibility that 5 different center-to-center spacings offer you. You can have 10, 12.5, 15, 17.5 or 20 mm in non-lighted switches. Lighted pushbutton switches are available in 15 or 20 mm. For interlock and lockout functions, Centralab is your clear choice. We not only offer you momentary, push-push and interlocking action switches, but four types of lockout as well.

You'll find some of the brightest benefits in our lighted pushbutton switches. First, we supply both white and black lamp housings with a variety of filters and lenses for the precise control of light output over a wide range of ambient light conditions. And the snap-in lens permits relamping through a front panel. Our shock-mounted filament lamps are designed for low maintenance and long life.

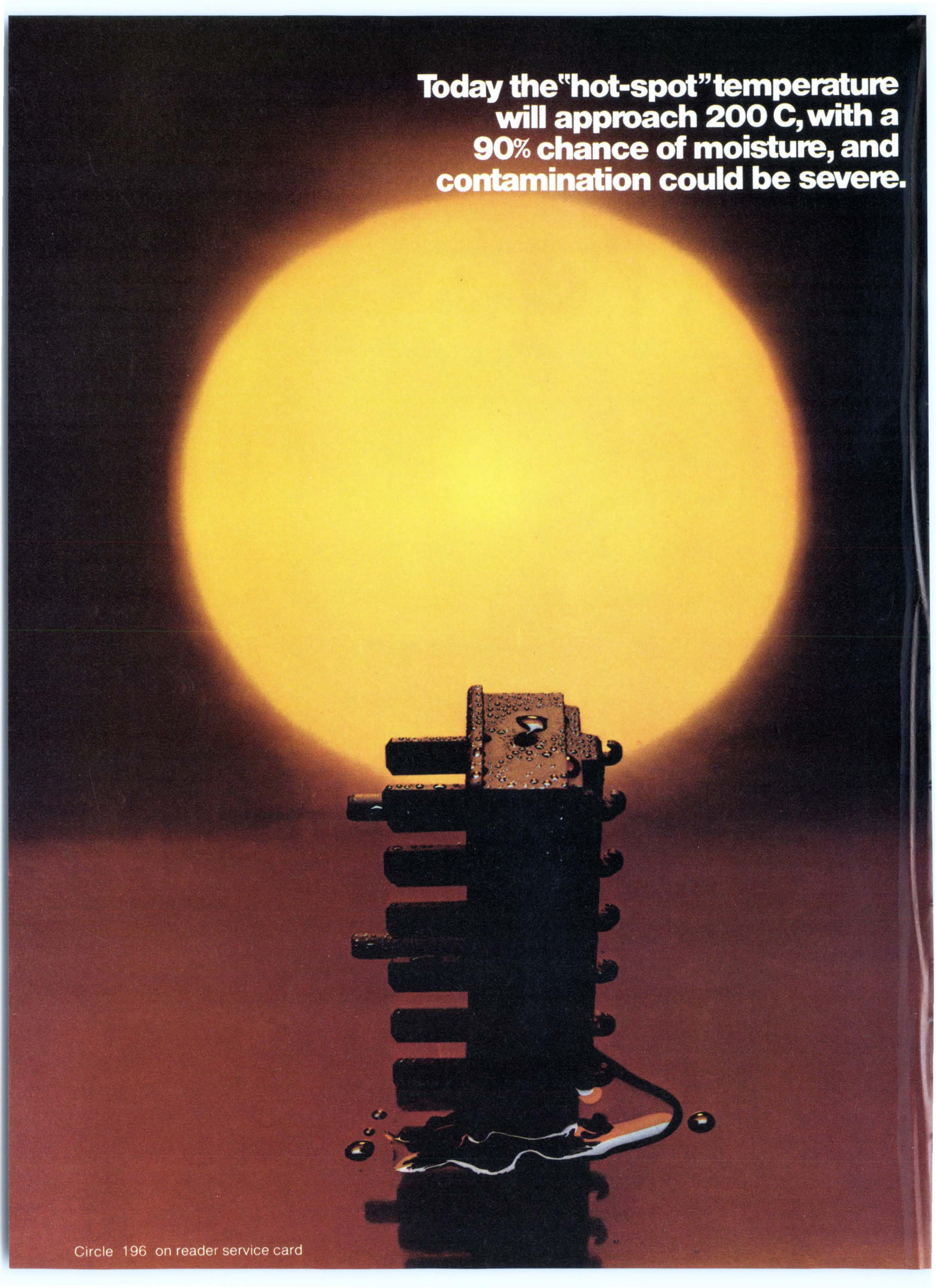
The lamp circuit can be integral or separate from the pushbutton switch circuit. Where it's integral, lamp and switch circuits are in the same terminal plane and can be flow soldered simultaneously for easier installation and service.

If you're looking for the boundless variety that means true design flexibility, we've got your kind of pushbutton switch. We'd like you to know about our epoxy sealed terminals, selective pin cutting, wrap-around support bracket, dust-seal covers, line switch and 25 button styles in 18 colors. And how we can furnish legends for buttons, filters or lenses. We've put it all in a new 24 page catalog that includes complete specifications, dimensional drawings and ordering data. It's yours for the asking. Just circle the information service card or write Centralab for Catalog 1550P. Put some spice in your life.

*Isostat licensed



Circle 195 on reader service card



New products

rack mounting. Microdata's model 6920 records and reads NRZI IBM-compatible ½-inch nine-track tapes, with speeds from 12.5 to 45 inches per second at 800 bits per inch, and serves as a direct replacement for any standard industry formatter. Price, in OEM quantities, is $640 each. Delivery time is 30 days.

Microdata Corp., 17481 Red Hill Ave., Irvine, Calif. 92705 [368]

Add-on memory system set for MAC-16 mini

An add-on memory system for the MAC-16 minicomputer is called ExpandaMac-16. It is available in increments of 8,192 16-bit words, up to a maximum of 64 kilowords. Using one ExpandaMac enclosure, MAC-16 users can install a memory system in a few hours and upgrade thereafter. ExpandaMac-16 duplicates the operating performance of standard MAC-16 minicomputer hardware. It uses magnetic-core-memory-storage elements on plug-in memory boards. Cycle time is 1 microsecond. Parity bits and memory protection features are optional. Price for the first 8-kiloword module is $4,225. This includes an ExpandaMac enclosure capable of accommodating additional 8-kiloword modules up to the maximum 64-kiloword capacity. Additional 8-kiloword modules are $1,650 each.

Cambridge Memories Inc., 12 Crosby Dr., Bedford, Mass. 01730 [363]

Core-memory module made for Varian Computer

A 16,384-word core-memory module for Varian's V70-series computers is a single-port, asynchronous memory with low-drive core. Memory cycle time is 1.2 microseconds, and effective cycle time is 0.9 μs, using an asynchronous bus with optional odd-even address interleaving. Price of the 16-kiloword-by-16-bit memory module is $3,250. Price for the V72 computer with 16 kilowords is $10,250. With 32 kilowords, the V72 computer sells for $13,500.

Varian Data Machines, 2722 Michelson Dr., P.O. Box e, Irvine, Calif. 92664 [366]

Video terminal displays up to 1,728 characters

A large-screen video terminal, model 4011, has a display capacity of 1,728 characters (27 lines at 64 characters per line) and comes with both a standard typewriter keyboard and a numerical-key cluster. Also featured is automatic right-justification of numeric entries. The terminal can be located up to 2,000 feet from a computer or can operate remotely via a standard data-communications interface. Price is $5,950.

Qantel Corp., 3474 Investment Blvd., Hayward, Calif. 94545 [364]

Typewriter terminal is HP-9800-series compatible

A typewriter terminal, for use with the Hewlett-Packard 9800 series electronic calculators, is offered by Tycom Corp. The unit consists of an IBM Selectric 15-inch typewriter

with a buffered Ascii converter. An HP 11202A interface adapter with self-test capability must be provided by the customer. Automatic tab-set/tab-clear, operated under calculator control, is standard. The system provides input (optional) and output multiple hard copies at 15 characters per second. Price is $1,900 for

New products

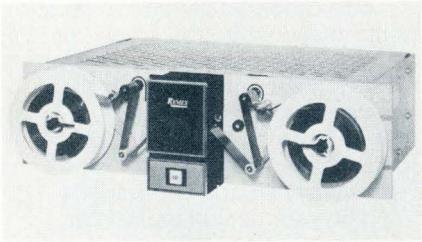
the buffered Ascii-output writer.
Tycom Corp., 26 Just Road, Fairfield, N.J. 07006 [369]

Remote data terminal scans IBM-3275 market

A remote data-entry terminal, designed to vie with the IBM-3275 information-display system, performs on-line data entry and processing tasks at remote terminal locations. Designated the SPD-325 series and available in single- or dual-station configurations, three models are offered. Models 1 and 2 offer 480- and 1,920-character screens, respectively, with formats identical to the IBM 3275. The SPD 325 model 3 offers a 960-character screen in an 80-column-by-12-line format. The model 2 sells for $3,400, or leases for $80/month for five years.
Incoterm Corp., 6 Strathmore Rd., Natick, Mass 01760 [367]

Reader/spooler reads up to 300 characters/s

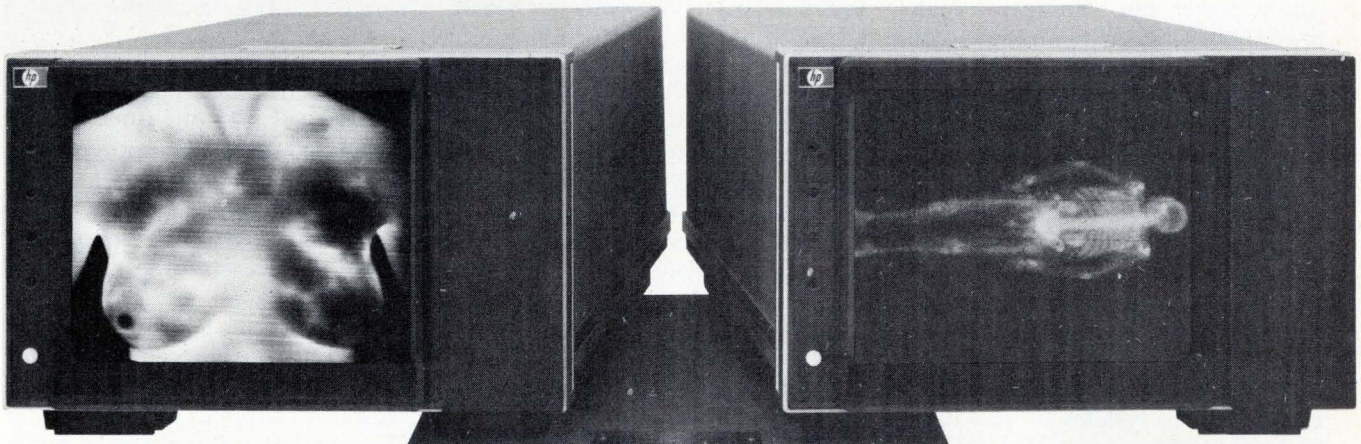
A punched-tape reader/spooler for minicomputer and automatic test applications reads up to 300 characters per second asynchronously and stops on a desired character. The unit can rewind a 5¼-inch spool at 1,200 c/s. DTL- or TTL-compatible at the interface, the bidirectional,



photoelectric reader will accept tape of five to eight levels, including advance-feed tape, with infrared transmissivities to 57%. Price is $1,295, with OEM discounts available. Delivery time is 90 days.
Remex, 1733 Alton St., Santa Ana, Calif. 92705 [370]

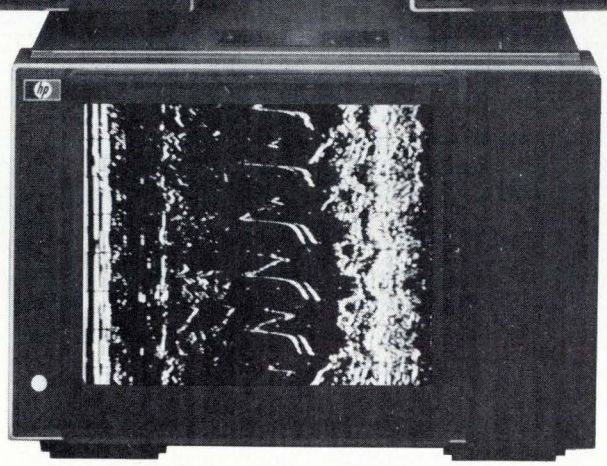
When a life depends on the display you choose...

depend on HP's new 1332A. This improved display gives you the superior picture quality you must have when life is in the balance. It answers your need for higher resolution, better stability, more uniform light-output. And it meets the stringent UL Listing for electronic equipment used in patient care. The 1332A provides a combination of high performance and easy system integration to give OEMs a better display solution for demanding medical-instrument applications. For example:



Thermographic breast scan for cancer. Courtesy of Dorex Inc., Los Angeles, CA.

Gamma camera provides full body bone scan for early detection of cancer. Courtesy of Penrose Cancer Hospital, Colorado Springs, CO.



Ultrasound determines dynamic blood flow through the heart. Courtesy of Metrix, Denver, CO.

In Thermography Equipment, HP's 1332A delivers the stable light-output required for making long scans or taking display photographs. Regulated CRT filaments prevent power-line surges from interfering with picture quality. And the 22.5 kV CRT allows more grey shades and assures a bright picture, even at low refresh rates typical in this application.

For Radioisotope Cameras, the 1332A provides superior light-output uniformity for more accurate analysis. Exceptional CRT design maintains the unit's extremely high resolution regardless of intensity level or beam deflection. This, combined with a fast z-axis rise-time means you get sharp pictures that reflect your system's true performance capability.

In Medical Ultrasound Units, where crisp, clear pictures are essential, the 1332A gives sharp focus at all intensity levels, with any degree of beam deflection. As a result, you get the sharp, high-resolution pictures you need—at high or low intensity, over the entire viewing area. With this display, you get the picture quality needed for accurate diagnoses.

In addition to high performance, the 1332A offers easy system integration. Over 40 standard options, such as phosphor selection, digital blanking, gamma correction, choice of z-axis rise-time, x- and y-axis deflection factor, control location and more, let you tailor the display to your system's needs. You also get the quality, product safety and after-sales support you expect from a leader in CRT technology. To get more information about the new 1332A Display, just contact your local HP field engineer. Or, write to Hewlett-Packard.

084/7

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1501 Page Mill Road, Palo Alto, California 94304

Actual photos taken from these systems in use.

Semiconductors

High-speed 1-k RAMs developed

Available with either tristate or open-collector outputs, devices are rated at 30 ns

For users who don't have to worry about power, but who need a high-speed 1,024-by-1-bit random-access memory for scratchpad or main-memory applications, Signetics Corp. has introduced two 30-nanosecond Schottky bipolar RAMs.

The RAMs, one with an open-corrector output and the other with a tristate output structure, are designated the 82S10 and 82S11, respectively. The latter, says Napoleon Cavlan, Signetics applications manager for high-speed memories, will "satisfy the speed requirements of bus-organized systems by providing active bus drive for both high and low logic levels, without additional buffering."

While it is 30–60 ns faster than most 1-kilobit RAMs announced to date, its power dissipation when in operation is 840 milliwatts—about 90 to 185 mW higher than that of competitors—and it has no low-power mode of operation. In comparison, Fairchild's FSC 94515 is a 1-kilobit ECL unit rated at 65 ns; American Memory Systems' AMS 7001, an MOS type, is rated at 60 ns.

Surprisingly, the new RAMs achieve their speed and packing density through conventional Schottky processing, in conjunction with dual-layer metalization, to encompass both the cell matrix and the device's peripheral circuitry.

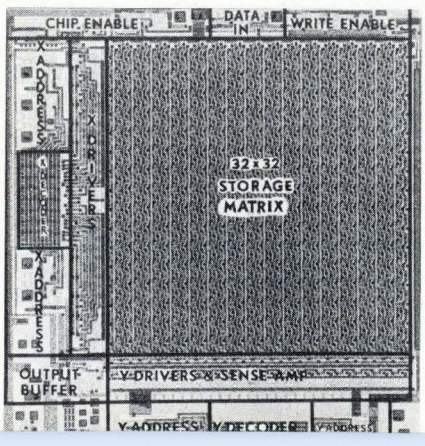
Both devices are supplied in 16-pin dual in-line packages, and have identical pin-outs. They are also compatible with Signetics' already announced 82S08, a slower 1-kilobit RAM at 85 ns, an operating power dissipation rating of 600 mW and dissipation in low-power mode of 375 mW.

An important advantage of using conventional processing techniques, says Cavlan, is that both the 82S10 and 82S11 are fully TTL-compatible, and require only a single 5-volt power supply. They have a pnp structure on all inputs, which reduces the logic-0 input current to a typical value of 10 microamperes. "The dramatic reduction in fan-in translates into considerable savings at the memory-board level," he says, "by enabling a single TTL gate to drive a considerable number of device address and control inputs in parallel, beyond the normal fan-out factor of 10."

Other key device specifications, maintained from 0°C to 75°C with ±5% supply-voltage variation, are 45-ns maximum address-access time, 30-ns chip-enable-access time, 50-ns maximum read or write cycle, and 160-mA maximum supply current.

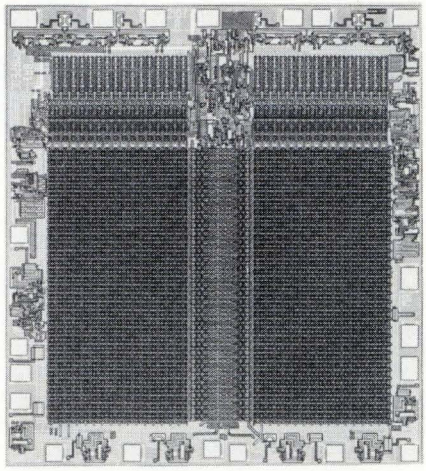
Signetics is delivering the 82S10/11 in preproduction quantities and will begin volume shipments during the fourth quarter of this year. The initial price of the 82S10 and the 82S11 is $65.20 each when purchased singly or in sample quantities.

Signetics Corp., 811 E. Argues Ave., Sunnyvale, Calif. 94086



4-k n-channel RAM costs only $12 in hundreds

A 4,096-bit random-access memory priced at only $12 in 100-up quantity is a silicon-gate n-channel device designed for use in systems that require high-density, low-power



memories with cycle times in the microsecond range. The 2107A-8 is packaged in a 22-pin DIP with the industry-standard pin configuration for 4,096-bit dynamic MOS RAMs. It has a maximum access time of 420 nanoseconds, read cycle time of 690 ns, and write cycle time of 970 ns. Like other faster RAMs in Intel's 2107A family, the 2107A-8 is a fully decoded, single-clocked, TTL-compatible design that operates on standard power supplies of +5, −5, and +12 volts. Standby power dissipation is 2 mW and active power is 11 mW. The low standby power allows a typical storage array of 32 kilobytes to operate with an average power dissipation of about 4 watts. A special low-power data-retention option, which reduces current and power requirements approximately 80%, is available.

Intel Corp., 3065 Bowers Ave., Santa Clara, Calif. 95051 [413]

Rf power transistors span 40 to 110 MHz

Designed for the 40–110-MHz midband international radio market, five rf power transistors have output power ratings of 1.5, 3.5, 7.5, 15, and 25 watts. To maintain stable operation over the entire frequency range, the gains of the devices are kept within the 10-dB range. Operation at VSWRs of up to 30:1, at any phase angle, can be tolerated. 100-piece prices vary from $1.75 for the

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Powertec, Inc.,
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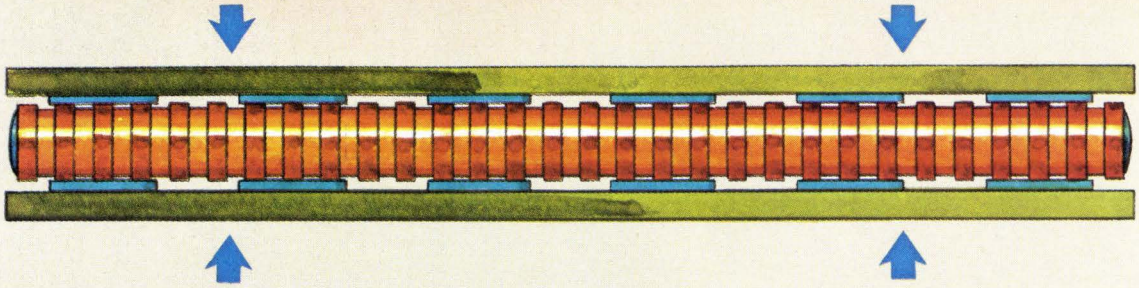
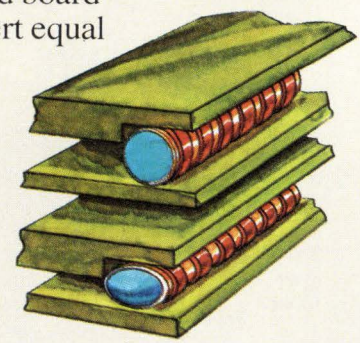
Circle 201 on reader service card

POWERTEC

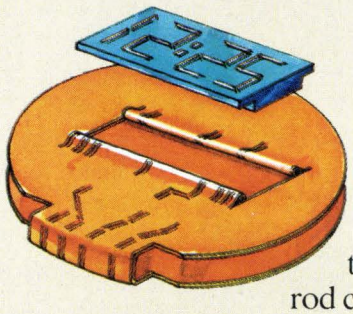


Our new micrometallized connectors. We made them work under pressure.

By combining micro-circuitry with an elastomer. Then the whole innovative package is placed between parallel planes of any hard board circuitry. So the elastomer can exert equal pressure along its entire length.

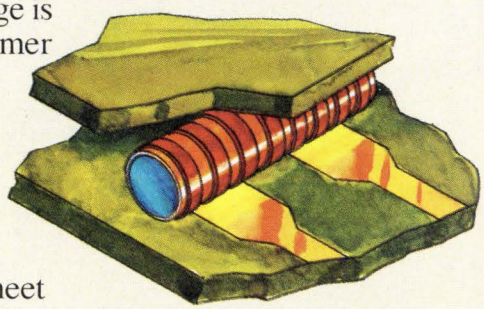


That's our extraordinary elastomer interconnection system. It's ideal for liquid-crystal displays in electronic watches. And for other products that demand advanced connection techniques.



Circuit paths are isolated from one another, and since we offer extremely fine resolution, multiple redundancy to the interconnected components is certain.

Another advantage is the fact that the elastomer rod can "float" within the micrometallized circuitry for unmatched resistance to shock and vibration. For easy handling and precise location, tabs and sprocket holes are available.



You can also be assured that AMP can meet your microelectronic interconnection needs: AMP Elastomate comes in a wide variety of cross-sections, lengths and circuit-path widths. But best of all, it doesn't take much pressure to make it work efficiently and economically for you. Just call (717) 564-0100. Or write AMP Incorporated, Harrisburg, Pa. 17105.

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Circle 202 on reader service card

New products

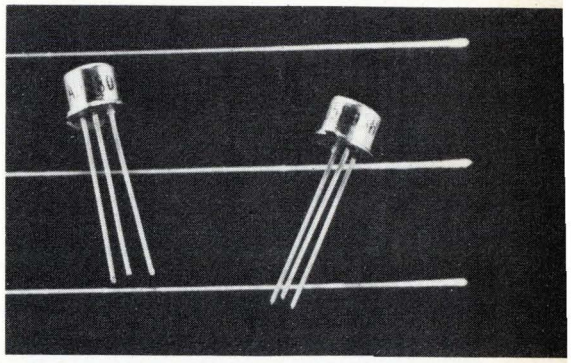
1.5-W drivers to $14.95 for the 25-W output amplifiers.
Motorola Semiconductor Products Inc., P.O. Box 20924, Phoenix, Ariz. 85036 [417]

Hometaxial power transistors put out up to 75 W

Three series of single-diffused hometaxial-base power transistors are intended for a wide variety of medium-power switching and amplifier applications. Supplied in the JEDEC TO-220AB package, the transistors are expected to be used as series and shunt regulators and as drivers and output stages of high-fidelity amplifiers. The devices come with breakdown-voltage ratings of 40, 60, 80, and 100 volts, and power dissipation ratings of 36, 50, and 75 W. Not every combination of voltage and power rating is available. 1,000-unit prices range from 47 cents for a 36-W, 40-V unit, to 85 cents for a 75-W, 80-V transistor. Delivery is from stock.
RCA Solid State Division, Route 202, P.O. Box 3200, Somerville, N.J. 08876 [416]

Voltage reference drifts less than 25 μV per month

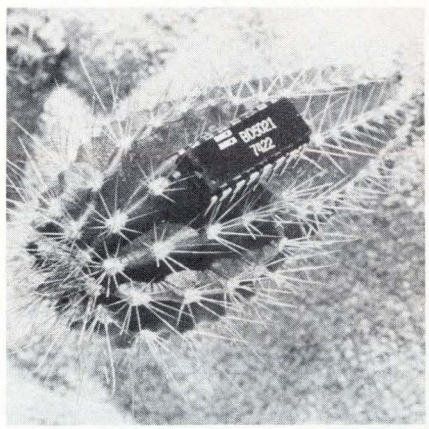
A temperature-compensated voltage reference that is stable to 40 ppm/°C and 25 microvolts per month provides a fixed 2.5 V ±2% output for inputs between 4.5 V and 30 V without any external components. The AD580 is priced as low as $2 in hundreds. The device finds applications in eight- and 10-bit digital-to-analog converters that require an external reference. With a wide input range that allows it to be powered by 5-V logic supplies, the reference is an excellent choice for use in digital panel meters. Its 1.5-mA maximum quiescent current drain is a clear advantage over classical zener techniques. The AD580 is available in three versions: the AD580J with 80 ppm/°C temperature drift, 0 to 70°C operating range, and $3 small-quantity price; the



AD580K with 40 ppm/°C stability, 0 to 70°C operating range, and $6 price; and the AD580S with 40 ppm/°C drift, −55°C to 125°C operating range, and $11.25 price. All versions come in T0-52 packages and are available from stock.
Analog Devices Inc., P.O. Box 280, Norwood, Mass. 02062 [415]

Hex LED digit driver sinks up to 320 mA

Aimed at the digital-clock and calculator markets, a high-efficiency LED digit driver offers increased battery life and improved noise margins in multiplexed display applications. Designated the BD5021 hex digit driver, the bipolar IC consists of six MOS-compatible digit drivers with each driver capable of sinking up to 320 milliamperes. A separate pin is provided on the BD5021 for drive-current input. This allows the use of an external resistor to set the input current for the best tradeoff between display brightness and battery life. A low saturation voltage



decreases the required operating voltage and further extends battery life. The 1,000-piece price for the BD5021 in a 16-pin dual in-line plastic package is $1.20. Delivery is from stock.

Bowmar Arizona Inc., 2355 W. Williams Field Rd., Chandler, Ariz. 85224 [418]

MOS shift registers work up to 1.5 MHz

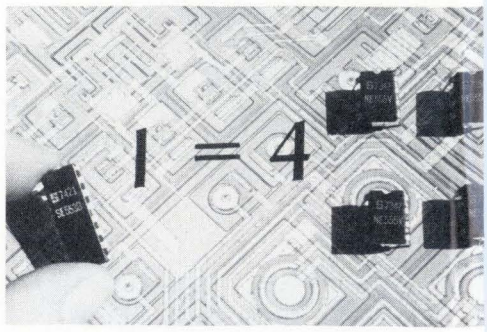
The first three members of a family of p-channel, silicon-gate, MOS shift registers from AMD are pin-compatible with like-numbered devices originally offered by National Semiconductor Corp. The devices—a 512-bit, a dual 256-bit, and a quad 128-bit shift register—are guaranteed to operate up to 1.5 MHz. Prices for 100-up quantities vary from $4.80 for a molded DIP with a temperature range of 0 to 70°C, up to $9.20 for an hermetically sealed DIP with a temperature range of −55 to +125°C.

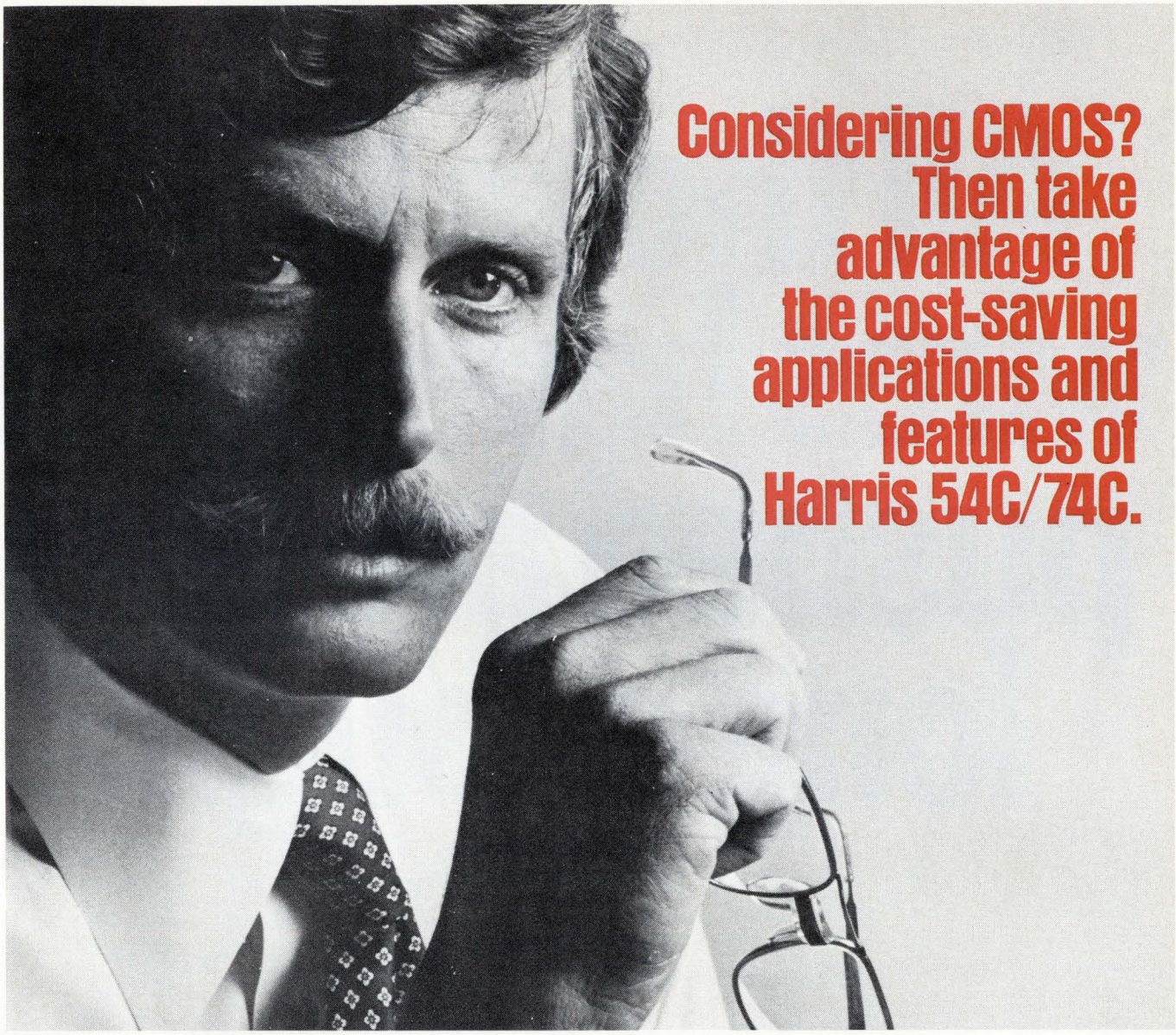
Advanced Micro Devices Inc., 901 Thompson Place, Sunnyvale, Calif. 94086 [419]

Quad timers can be oscillators or time delays

Two monolithic quad timers which can be used to produce four entirely independent timing functions are general-purpose controllers that can be used in a monostable (one-shot) mode to produce accurate time delays from microseconds to hours. Astable (free-running) operation requires the use of two of the four timer sections. Both the time delay in the monostable mode and the frequency in the astable mode are determined by external resistors and capacitors. The NE/SE 553 output sinks current, whereas the NE/SE 554 acts as a current source. Both timers are edge-triggered. When connected in tandem for sequential timing applications, they require no coupling capacitors. The units can operate from any supply voltage from 4.5 to 16 V, and have maximum output currents of 100 mA. In quantities of 100, both quad timer models sell for $1.86 each.

Signetics Corp., 811 East Arques Ave., Sunnyvale, Calif. 94086





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Harris supplies the identical 54C/74C devices that National does. And our product line is complete. We have 23 in the family now, and 14 more on the way. Specifications are written for the system designer and are consistent across the line. Units in quantity are available from distributors, and constitute a complete compatible family. The software you need to design 54C/74C into your system is available now.

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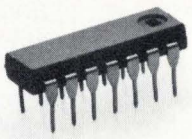
All those little wires have been pushed around long enough.



Until now, all those wires have been at the mercy of packaging materials that expand when things get hot.

So we developed new Dow Corning® 480 semiconductor molding compound.

Dow Corning 480 has a low coefficient of thermal expansion.

So it virtually eliminates the hot intermittent open. And moisture penetration.

Which means that an integrated circuit stays integrated. Through all sorts of temperature and atmospheric extremes.

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Dow Corning 480 semiconductor molding compound is the kind of improved product you can expect to keep getting from Dow Corning. Our Technical Service and Development Department has more manpower and greater technical facilities than any other in the industry.

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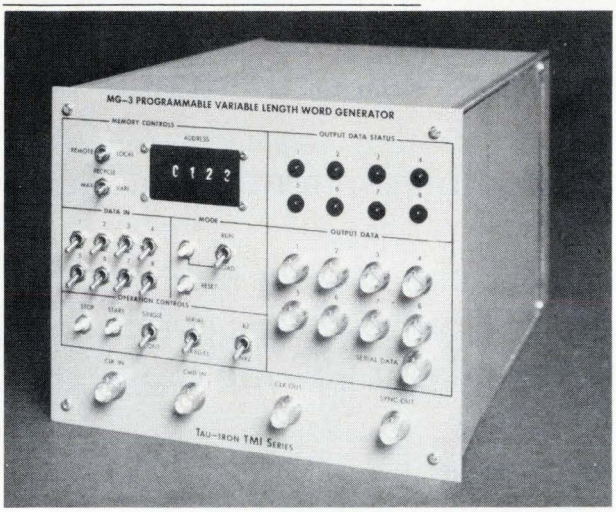
DOW CORNING

Instruments

Word generator reaches 50 MHz

Programable unit puts out variable-length words for testing circuits and systems



Aimed at applications ranging from the testing of digital logic circuits and data-communications systems to the routine recording of data on magnetic tape, a programable, variable-length word generator can store and produce up to 128 8-bit words. The generator, which can operate at clock rates of up to 50 megahertz, provides both serial and parallel outputs.

The Tau-Tron model MG-3 uses a semiconductor random-access memory to store a matrix of up to 1,024 bits in a 128-by-8 format. In its parallel mode of operation, the MG-3 uses its eight output-data ports to read out one 8-bit word at a time. In its serial mode, a built-in parallel-to-serial converter converts the same data to serial form and puts it out through a single port.

Front-panel controls allow the user to set the number of words to be read, to stop the generator at any point, to restart it at that point, to reset it to the beginning of the word matrix, and to tell the machine either to run through the matrix once, or to keep repeating until ordered to stop. The output-data rate is determined by an external clock which can run at any speed up to 50 MHz.

The memory can be loaded manually by selecting a memory address with a front-panel three-digit thumbwheel switch, setting up an 8-bit word with a set of toggle switches, and pushing the load button. A faster way to program the generator is to let a computer or paper or magnetic tape do it by means of a remote-loading option. With this option, the generator can be programed at a rate of 250 kilobytes per second, which means that the whole word matrix can be programed in 0.5 millisecond.

With the remote programing option, the stop, start, and reset functions can also be controlled remotely. This allows the instrument to be used as part of a computer-controlled test system in which input and output words are compared. When a discrepancy occurs, the interactive controls would allow the computer to stop the generator and start a diagnostic procedure.

Price of the MG-3 is $4,000 without the remote programing option. Delivery is six to eight weeks.

Tau-Tron Inc., 11 Esquire Rd., North Billerica, Mass. 08162 [351]

Floppy-disk-head tester handles IBM 3740 devices

A tester for testing any floppy-disk (diskette) head used in the IBM 3740-type data-entry devices tests all dynamic electrical parameters of the head. In addition, it can be interfaced to standard diskette drives. The unit displays track location and head position in ¼-track increments. Other displays show write current, tunnel erase current and head engagement. Write test is performed for 1-f at 125 kHz, and 2-f at 250 kHz, with or without tunnel erase. Write current climbs from 0 to 15 mA in 1-mA steps, while the tunnel erase current ascends in 10-mA steps from 10 to 80 mA.

Infomag, 5743 Thornwood Dr., Goleta, Calif. 93017 [353]

Function generator distorts less than 0.5%

The model 5800 function generator provides sine, square and triangle waveforms and features distortion less than 0.5%; a frequency range of 0.2 Hz to 2 MHz; 50-ohm output with 15 V peak to peak, and push-button operation. In addition, the 1,000:1 tuning dial covers the entire audio range in one turn of the dial

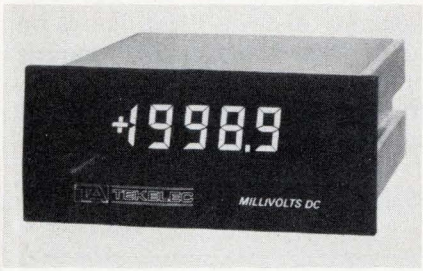
with no multiplier adjustments required. Its price of $245 makes the 5800 attractive for hobbyists, schools, and repair shops, as well as in the design and testing laboratory.

Krohn-Hite Corp., 580 Massachusetts Ave., Cambridge, Mass. 02139 [355]

'Logic-powered' DPM pulls only 200 mA

An optional 5-volt power input, which brings with it the advantages of transformer isolation, is now

available for the series TA 300 3½- and 4½-digit, liquid-crystal-display panel meters. The new option permits operation of the panel meters in the field with the low battery drain of only 200 milliamperes, and



therefore extended battery life. The reflective liquid-crystal displays—which require no power-consuming bulbs—draw only a few nanoamperes. The digits are 0.5 inch high and can be read from a wide range of viewing angles. The meters provide transformer isolation between signal and power ground and automatic polarity indication on all ranges. The optional 5-v transformer costs $5 per meter.

Tekelec Inc., 2623 Saddle Drive, Oxnard, Calif. 93030 [356]

Gaussmeters measure up to 100 kilogauss

Two wide-range, analog and digital gaussmeters measure permanent magnets, direct-current fields or alternating-current fields to 800 Hz from a few milligauss to 100 kilogauss. Both transverse and axial fields are measured, depending upon choice of probe. All probes are based on the Hall-effect principle. The analog model 750A gives pre-

New products

cise indications from 0.1 gauss, full scale, to 50,000 gauss, full scale, in 18 ranges. Model 750D, the digital instrument, uses a seven-segment, four-digit display with ranges of 10, 100, 1,000, 10,000 and 100,000 gauss. Overrange provides full-scale capability of twice these figures on the four lower ranges. Both models indicate polarity of fields measured. Price of the model 750A is $865, and the model 750D is $1,180.

RFL Industries Inc., Boonton, N.J. 07005 [357]

3½-digit multimeter has maximum dc error of 0.5%

The model 282 3½-digit multimeter features a maximum dc error of 0.5% and also offers automatic polarity and automatically positioned decimal point; positive out-of-range indication; 100% overrange capability on all ranges; 1-mV resolution;

10 megohms input impedance on both ac volts and dc volts; full overload protection on all ranges, and 100% solid-state circuitry. The unit reads dc and ac volts, to 1,000 V; dc and ac current to 1,000 mA, and resistance to 10 megohms. Resolution is 1 mV. Price is $200.

Dynascan Corp., 1801 W. Belle Plaine Ave., Chicago, Ill. 60613 [358]

HTL logic checker handles V_{cc}s from 11 to 18 V

An HTL logic checker, model A23-2087, supplements the company's DTL/TTL version for monitoring positive logic HTL ICs with V_{cc} be-

Our advanced hi-speed CRT's now available with color.

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New products

tween +11 V and +18 V. The logic checker automatically locates the V_{cc}, ground and unused pins, and can be clipped either way onto ICs with up to 16 pins. Logic states are instantly shown on the LED arrays with 'lamp on' indicating the logic state 1, open circuit or unused pins, and 'lamp off' indicating logic state O or ground. Price is $120.

Jermyn, 712 Montgomery St., San Francisco, Calif. 9411 [359]

Spectrum analyzer covers 1 Hz to 5 kHz

The model 304-A low-frequency wave and spectrum analyzer covers the frequency range of 1 Hz to 5 kHz in one continuous range with three selectable bandwidths of 1, 10 and 100 Hz. The instrument has 0.1-Hz resolution from 1 Hz to 5 kHz and features electronic tuning and automatic electronic sweep. Readout is a

five-digit LED display of the actual tuned frequency. The instrument has selectable time constants of 0.1, 1.0, 10 and 100 seconds, an input voltage range of 30 μV to 100 V full scale and a dynamic amplitude range of better than 70 dB.

Quan-Tech Division, Scientific-Atlanta Inc., Randolph Park West, Route #10, Randolph Township, N.J. 07801 [360]

1.2 GHz

PLESSEY announces the world's fastest decade prescaler.

Now you can reach TACAN frequencies with integrated circuits. And greatly increase the reliability and cost-effectiveness of your design. The new high-frequency mobile communications market is yours now as well.

The revolutionary new Plessey SP8667 prescaler (÷10 at 1.2 GHz) is available for immediate delivery in the standard dual in-line package. Also available are the SP8666 (1.1 GHz) and SP8665 (1.0 GHz). All three of these new circuits feature a guaranteed temperature range of 0-70°C, input sensitivity of 600 mv peak-to-peak, 600 mw of power dissipation, and enough output to drive MECL 10K.

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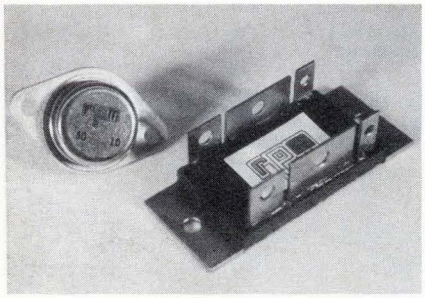
Components

Darlington switch is high-powered

200-A, 100-V device aims at replacing resistive and SCR controls in electric vehicles

Increasing interest in electrically powered vehicles is also increasing interest in efficient controls for them. Electric golfcarts are in wide use, and electric motorcycles, bicycles, and even light cars are now



becoming available. But many are still controlled by primitive resistive controllers that waste power.

One manufacturer of controllers has found the resistive route so inadequate that it has begun production of high-power transistors for the units it sells to vehicle manufacturers. The company is RPM Industries, the research group kept by Robert P. McCullough when he sold his tool interests to Black & Decker Manufacturing Co. RPM discarded SCR controls because of their high forward-voltage drops and the difficulty of turning them off in direct-current applications. But in settling on transistor controls, it found no attractive devices on the market, says engineering manager Stephen H. Smith, and therefore decided to set up its own specialized production line to make transistors for customers as well as for its own use. The parts should also find jobs in other high-power switching applications.

Of the various devices being offered by RPM, the most interesting is a 200-ampere, 100-volt Darlington with a current gain of 1,600 at 200 A, a collector-emitter saturation voltage of only 1.8 V at 200 A, and a forced beta of 400. The monolithic Darlington chip also contains two base-emitter resistors and sits alongside a 200-A commutating diode, intended for inductive loads, in a special large package. This package has a large copper heat sink inside it and is designed for use with bolt-on terminals, the most practical approach for most high-power vehicular applications. Sealing is plastic.

In relation to the voltage-current capability of the transistor, switching times are impressive. Rise time at 60 amperes is 60 nanoseconds, fall time is 200 ns, and storage time is 400 ns. Collector breakdown voltages are 120 V at 1 milliampere.

Price on the RSH-901 is approximately $120 in the sample quantity range, with 90- to 120-day availability.

The company is also readying other high-power devices, including a 100-A, 400-V Darlington, and a 450-V transistor that has a constant beta of about 10 all the way up to 20 A, with a saturation voltage under 0.3 V at 20 A.

RPM Industries, 6334 Arizona Place, Los Angeles, Calif. 90045 [341]

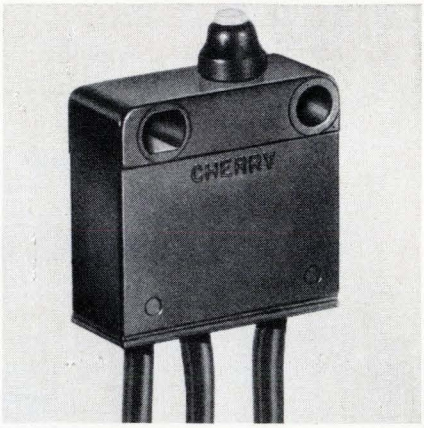
Pressure transducers have silicon diaphragms

Miniature threaded pressure transducer series XT-190 and XT-1-190 have 10-32 UNF threaded bodies, with hexagonal heads and "O" rings, making them easy to mount. The sensing element for these transducers is the company's integrated sensor, consisting of a silicon diaphragm into which a Wheatstone bridge has been diffused. The XT-190 series transducers have 5/16-inch hexagonal heads and the compensation modules in the lead wires, while the XT-1-190 transducers are ruggedized and have ⅜-inch hexagonal heads that house the temperature-compensation circuits. A four-conductor shielded cable with strain relief completes the external connections.

Kulite Semiconductor Products Inc., 1039 Hoyt Ave., Ridgefield, N.J. 07657 [343]

Sealed snap-action switch takes dunking, dampness

A new sealed snap-action switch is immune to moisture and even to complete immersion in water. Designated model E72-40A, the unit is



rated at 10.1 A, ¼ hp, and 115/250 V ac. Its maximum operating force is 230 grams. The switch, which comes with 10-inch leads, measures 0.37 in. wide by ⅞ in. high by 0.92 in. long. The low-quantity price is $2.96, dropping to $1.36 for 2,000-unit lots.

Cherry Electrical Products Corp., P.O. Box 718, Waukegan, Ill. 60085 [342]

Conductive panel control has 1 to 100 kilohm range

The ¼-inch thin space-saver panel control, available in a conductive plastic element, offers the following specifications: resistance range of

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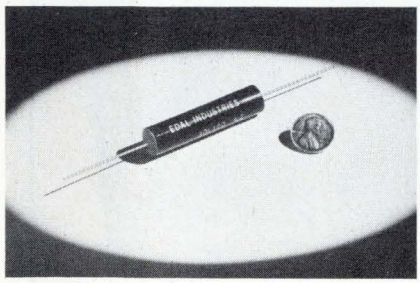
1,000 to 100,000 ohms; power dissipation of 1 watt at 70°C; resistance tolerance of ±20% or ±10%; and independent linearity of ±10%. A typical price in 500 lots is 80 cents each.
Bourns Trimpot Products Inc., 1200 Columbia Ave., Riverside, Calif. 92507 [345]

Stable, deposited carbon-film resistor is rated at ⅛ watt

A ⅛-watt deposited carbon-film resistor offering near-metal-oxide performance at low cost is mechanically interchangeable with all composition and most metal-oxide resistors of the same power rating. The model CF-⅛ has a resistance range of 2.2 ohms to 220 kilohms, a maximum continuous working voltage of 250 v, a maximum resistance error of 5%, an operating temperature range of −250 to +125°C, and a maximum voltage coefficient of −0.01%/v.
Airco Speer Electronics, Bradford, Pa. 16701 [346]

Silicon rectifiers eliminate need to solder many diodes

Series L high-voltage silicon rectifiers are designed for applications requiring minimum size and maximum power. The half-wave configuration consists of matched pretested, preselected double-diffused avalanche rectifiers with inherent protection against voltage transients. The L series offers long life and has axial leads for point-to-point circuit soldering. Because their high voltage ratings eliminate the need to solder many diodes in



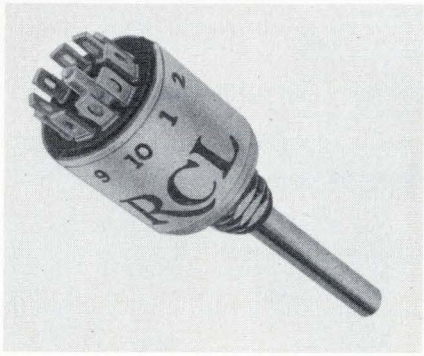
New products

series, the rectifier circuits make faster assembly possible. Half-wave circuits are available in ratings from 1,500 to 30,000 v peak-inverse voltage and currents from 20 milliamperes to 1 ampere. Special types are also available.

Edal Industries Inc., 4 Short Beach Rd., East Haven, Conn. 06512 [347]

Miniature rotary switch needs little behind-panel depth

A 10-position miniature rotary switch, for critical applications where behind-panel depth is at a minimum, has an over-all depth of 0.431 inch for the body and 0.560 in. over the terminals. Manufactured in a one-deck version with terminals



projecting from the rear of the switch, it is 0.5 inch in diameter, has one through four poles and as many as 10 positions, shorting or nonshorting. The series FF has a contact resistance of 10 milliohms maximum initial, an insulation resistance of 50,000 megohms initial, and 10,000 megohms minimum between mutually insulated parts.

RCL Electronics Inc., 700 S. 21st St., Irvington, N.J. 07081 [348]

Square rotary switch design strengthens outer pins

A square rotary switch in subminiature size, 9/16 inch across the body and 13/16 inch maximum width across terminals, is engineered particularly for printed-cir-

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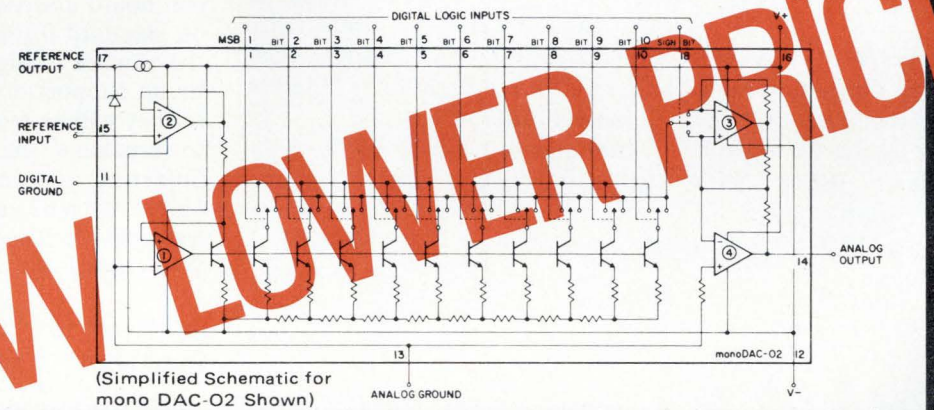

(Simplified Schematic for mono DAC-02 Shown)

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monoDAC-02BCU1	10-bits + sign	9-bits	$30.00
monoDAC-02ACU1	10-bits + sign	10-bits	$60.00

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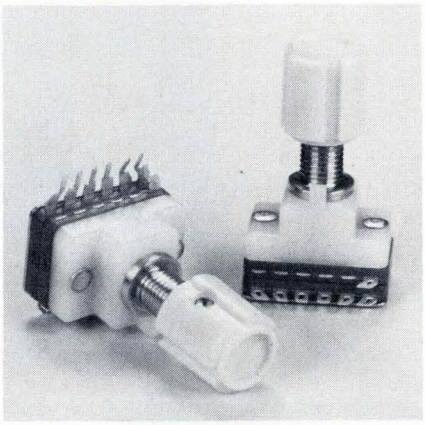
Circle 219 on reader service card

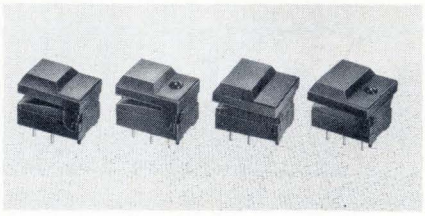
New products



cuit board insertion. The pc pins are on standard 0.100-inch centers, and the square design provides maximum support of the outer pc pins, so they will be much less susceptible to breakage than round designs. Solder-lug terminals are also available. Price is $2 each in 1,000 lots.
Stackpole Components Co., P.O. Box 14466, Raleigh, N.C. 27610 [349]

Push-button switch cuts need for two-sided pc boards

Digitast is a push-button switch for use with dual in-line packages. The inner construction eliminates more costly and troublesome conductor-plate-sandwiched switches. Included in the contact arrangement is a busing contact, eliminating the need for double-sided printed-circuit boards in most applications. The modular design allows plug-in capability, including two pc-board-locator pins and four pc-board stand-offs for flush-parallel mounting. A spring-loaded, vibration-free inner contact arrangement is also used. Two standard button sizes are available: the 12.3-mm and 17.3-mm widths, with or without light-emitting diodes.
Schadow America Inc., 8081 Wallace Rd., Eden Prairie, Minn. 55343 [350]



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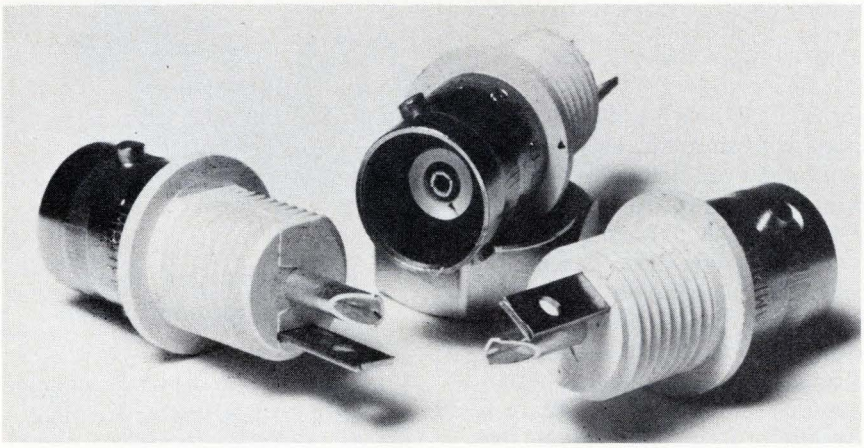


Traditionally, if a design made it necessary to keep the shield of a coaxial cable isolated from chassis ground where the coaxial cable was connected to a BNC jack, insulating washers had to be used to isolate the jack from the chassis. The cable shield then had to be formed into a pigtail and soldered to a metal washer which was electrically connected to the jack's outer contact.

The Amphenol RF Division has eliminated the need to handle extra piece-parts, and to cut nonstandard oversize holes with its fully insulated model P/N 31-010 isolated BNC receptacle. Interchangeable with the popular UG-1094/U connectors, the new connector has a one-piece thermoplastic body. For added convenience, it has an extra contact in the form of a braid-mounting tab molded into the body as a simple means for securing the cable shield directly to the connector's outer conductor.

The P/N 31-010 has a peak-voltage rating of 500V, and a non-constant impedance. The connector complies with MIL-STD-202 specifications for shock, moisture resistance, vibration, and corrosion. It has an operating temperature range of −50 to +250°C.

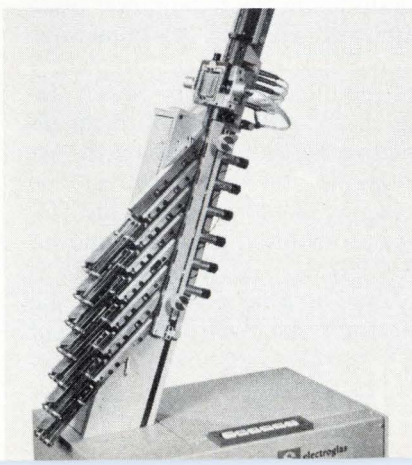
To maintain the receptacle's finish even in harsh industrial environments, a proprietary finish (trademarked ASTROplate) is used on all metal parts except for the center contact and the braid-mounting tab. These latter parts are silver plated to make them easier to solder to.

Pricing on the BNC connectors is 80¢ each in 100-piece quantities, and 61¢ in 1,000-piece lots. Delivery is from stock.

Amphenol RF Division, 33 East Franklin Street, Danbury, Conn. 06810 [391]

Handlers work with 8–18- and 24–40-pin DIPs

The series 5000 component test handlers consist of two basic, tabletop types for final and incoming tests of 8- to 18-lead and 24- to 40-lead dual in-line component packages. Models are available with three to seven



New products

outputs for 300-mil center-line DIPs and three to five outputs for 600-mil center-line DIPs and include an optional ac contactor head. Tube outputs can be programed to any class combination or in any sequence a user desires. Series 5000 prices range from $5,950 to $9,450.
Electroglas, 2901 Coronado Dr., Santa Clara, Calif. 95050 [394]

Solderless connectors handle 50-conductor flat cables

A series of pc-board transition connectors will simultaneously terminate up to 50-conductor flat cable to a printed-circuit board. The solderless Blue Streak flat-cable connectors are of a one-piece design for quick cable installation, and their pin lengths accommodate pc-board thicknesses of 0.031 to 0.094 inch. In addition, a "tulip" contact design increases reliability by providing a maximum of four contact points per conductor, while for terminations in hostile environments, a strain relief is built into the individual contact as well as the connector body. The connectors are made of UL-rated 94 VE-0 glass-filled nylon, the contacts of hardened beryllium copper. The connectors have a temperature rating of 105°C, a current rating of 1 A, and dielectric strength of 1,500 Vdc.
Ansley Electronics Corp., 3208 Humboldt St., Los Angeles, Calif. 90031 [393]

Beryllia insulator ups power of TO-39 package

A beryllia-insulated die-mounting technique improves the power dissipation and gain of a TO-39 package and enables a designer to replace a stud-mounted, medium-power device in rf applications with an alternative costing half as much, according to the manufacturer. The packaging technique allows the TO-39 can to be used at medium-power levels. When the transistor die is mounted on a beryllia insulator, the collector is electrically insulated, yet

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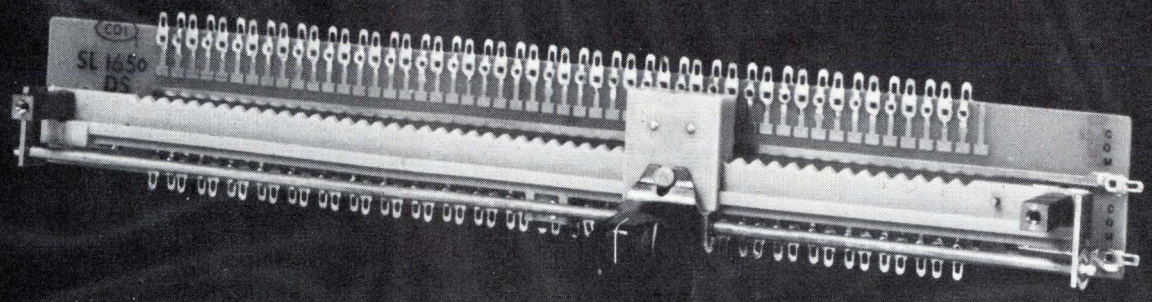

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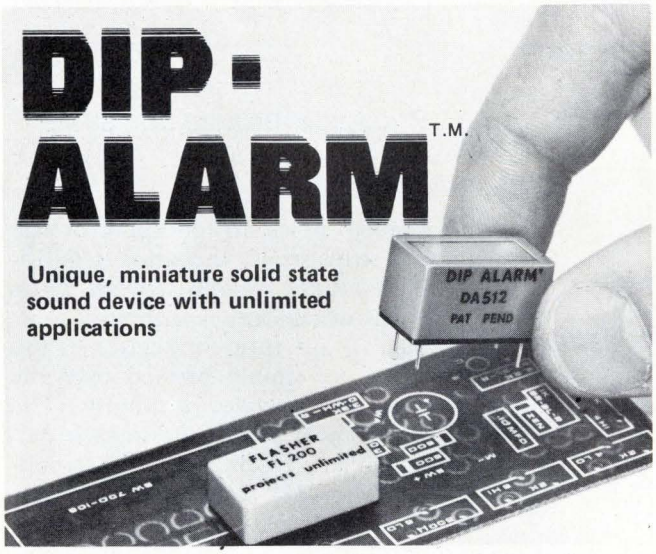

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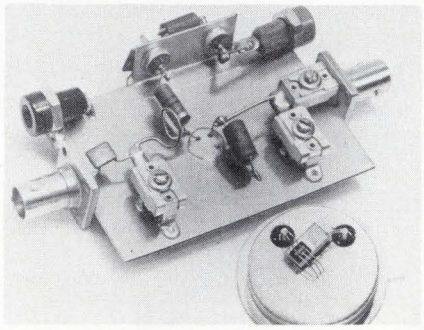

heat is conducted to the case header. The emitter is connected directly to the case, which is soldered to circuit ground; this reduces emitter inductance and thus reduces parasitics in the common-emitter configuration, the company points out.

In a typical installation, the device is mounted directly to a heat sink or the equipment case. The price of the MRF227 uhf driver, which uses the technique, is $2.50, and in quantities of more than 100, the price starts at $2 each.

Motorola Inc., Semiconductor Products Division, P.O. Box 20924 Phoenix, Ariz. 85036 [395]

Phosphor-bronze bus strips need no soldering

Barbed holes in phosphor-bronze bus strips secure the strips to 0.025-inch-square wrapped-wire posts without initial soldering. For busing or interconnections, the strips are simply pressed over the posts to provide continuity. The square hole orients the strips in 90° increments to prevent mispositioning. The T112 series bus links come in 12 in. lengths with hole spacings of 0.1 in., 0.2 in., and 0.3 in., and as 0.2-in.-and 0.3-in.-long tabs with 0.1-in.-apart holes. The long strips may be laid over 0.025-in.-square posts and cut off for the length needed. The tabs serve as convenient interconnections between wrap posts and circuit paths or pads. Strips and tabs are rated at 5 amperes. The 12-inch strips with 0.1-in.-spaced holes sell for $12.75 per package of 10, with 0.2-in.-spaced holes for $7.45, and with 0.3-in.-

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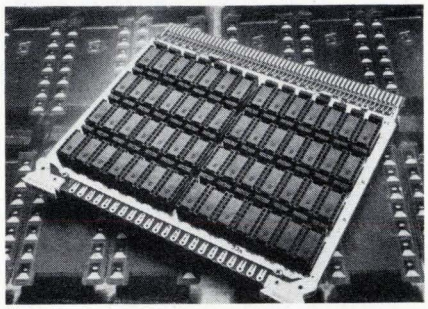
Circle 227 on reader service card

New products

spaced holes for $5.69. The 0.2-in and 0.3-in. tabs sell for $1.20 and $1.50 respectively in packages of 50.
Vector Electronic Co., 12460 Gladstone Ave., Sylmar, Calif. 91342 [396]

Built-in capacitors keep socket card quiet

One ceramic by-pass capacitor for each of its 56 14-pin DIP sockets, plus two low-frequency decoupling capacitors per card, help cut circuit

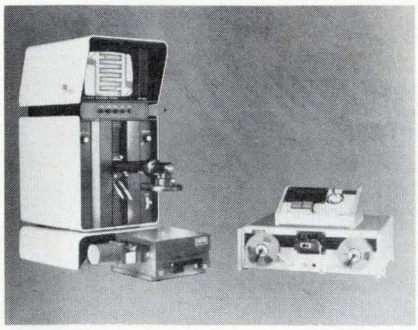


noise on socket card 3D2013. The card is available with 120-pin etched-connector fingers or with 106-pin two-piece connectors and with either two-level or three-level wrapped-wire pins. V_{cc} or ground is bused to any pin by wire loops. Price is $160.
EECO 1441 E. Chestnut Ave., Santa Ana, Calif. 92701 [397]

Color-TV-microscope system magnifies up to 3,000 ×

The MV 9400 color-microvideo system magnifies complex circuitry between four and 3,000 times. This integrated closed-circuit-television-and-microscope system shows the magnified image in full color on the television screen for inspection, training, and repair operations. All the components needed for color viewing are contained in a single console that occupies less than 1.5 square feet of bench space, including: a high-resolution color camera, solid-state monitor, power-focus-camera platform, and a fiber-optic illumination system. The color microvideo system is suitable for a

New products

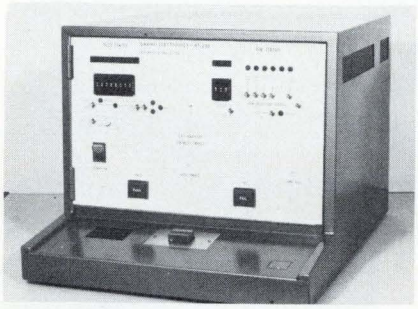


wide variety of tasks in inspection and production.

Circon Corp., 749 Ward Dr., Santa Barbara, Calif. 93111 [398]

Tester checks out ICs and logic assemblies

The model AT 200 test system will check digital ICs including MOS, C-MOS, TTL, DTL, and tristate, as well as complete logic assemblies. The AT200 is a system which contains



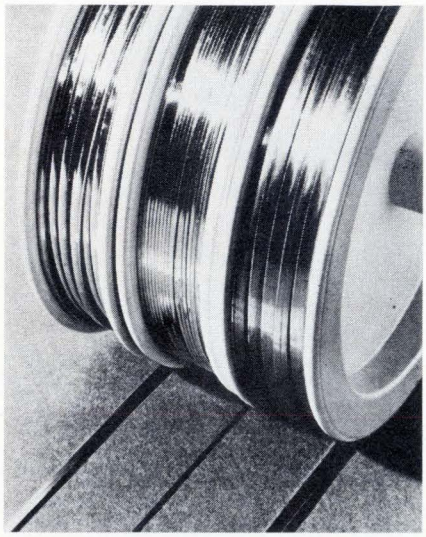
function-board modules for practically all logic types. It can be built up into either a complete or partial test station and will interface with other test equipment. In the latter case, the AT200 can form the heart of a generalized test system with a wide range of capabilities.

Davian Ltd., 52 Cardigan Street, Luton, England [399]

Contact tapes minimize use of precious metals

A series of electrical contact tapes aid automatic production of switches, relays, signal flashers, and other electrical and electronic prod-

ucts. The tapes reduce costs by combining almost any ductile contact material—almost always a precious metal—with any of a variety of base-metal backings such as nickel, cupro-nickel and nickel silver. Typical contact materials provided in-



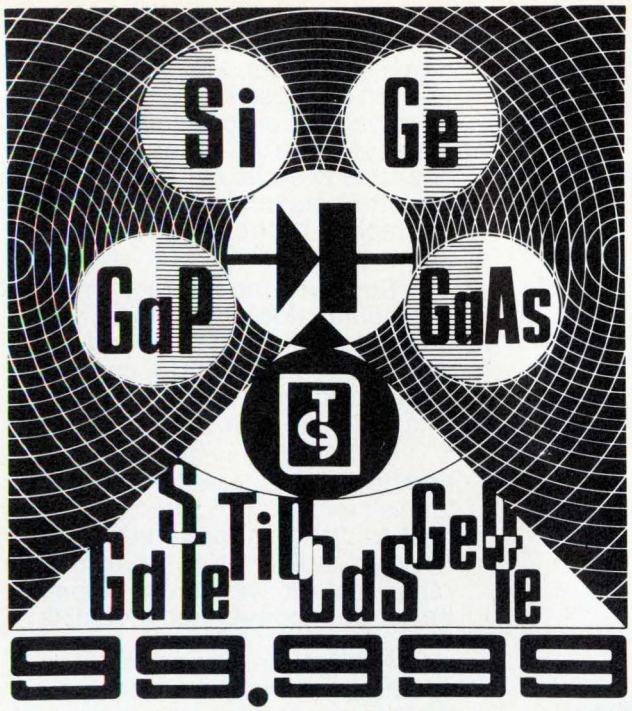
clude gold, silver, platinum, palladium, and alloys of these metals. Tapes of solid material are also available. The tapes can also be produced to close tolerances in an almost unlimited variety of cross-section configurations to meet specific requirements, eliminating the need for design compromises.

Matthey Bishop Inc., Malvern, Pa. [400]

Ion-implantation system processes 200 wafers/hour

The model 100-BP production ion-implantation system for semiconductor processing is specifically designed to provide good reliability. The system can dope semiconductors at energies between 20 kiloelectronvolts and 100 keV with common dopant ions. The equipment is compact (81 inches long, 48 in. wide and 72 in. high) and will process more than 200 3-in. wafers per hour in a fully automatic mode. Price is less than $80,000.

Eltek Corp., 2620 Longhorn Blvd., Austin, Texas 78758 [401]



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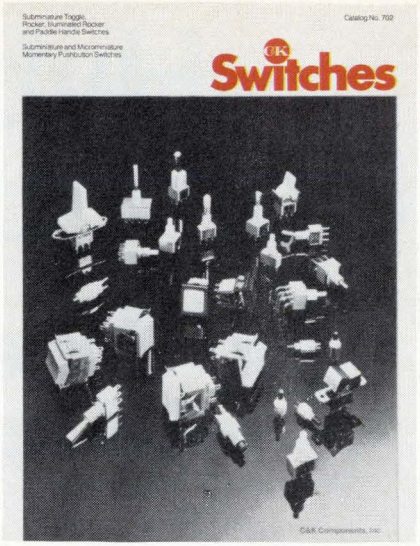

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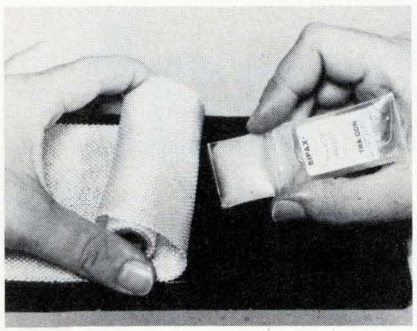
New products/materials



An epoxy adhesive, good for dip or brush coating of printed-circuit boards, is a solventless two-part system that mixes to a smooth, medium-viscosity fluid. Called Tra-Bond 2101, the material is said to have good flow and wet-out properties, curing at room temperature to a resilient solid that adheres to a broad range of materials. Tra-Bond 2101 is available in a variety of predispensed packages.

Tra-Con Inc., Resin Systems Division, 55 North St., Medford, Mass. 02155 [476]

DuHesive 300 can be used to assemble, maintain and repair control and instrumentation systems, and particularly to fasten diodes and resistors to printed-circuit boards, metal dial gears to shafts, and windows to instrument cases. The material bonds with strength up to 4,000 pounds per square inch. No premixing or heating are required. The material is colorless and resistant to chemicals and in addition, meets military specification MIL-A-46050.

DuBois Chemicals division, Chemed Corp., DuBois Tower, 11th Fl., Cincinnati, Ohio 45202 [477]

A material that drives out moisture from the pores of metals, WD-40 cleans contacts without running the risk of corroding them. As a nonconductor, the material can also be used on motors, generators, alternators, wiring and connectors, as well as TV tuners, amplifiers, potentiometers, printed circuits, and other precision electronic components. Since the material provides a moisture barrier, it also helps stop short circuits and power failures.

WD-40 Co., 1061 Cudahy Pl., San Diego, Calif. 92110 [478]

A pourable, silicone-rubber-based, potting compound for electronics applications is fast-curing. The two-part system, called RTV-627 compound, has a temperature range from -65° to 400°F. Curing is at between 150° and 350°F, and at room temperature the compound sets in less than 24 hours. A 22-pound kit is priced at $3.92/lb, the 100-lb kit at $3.27/lb, and a 1,000-lb kit at $2.93/lb.

Silicone Products department, General Electric Co., Waterford, N.Y. 12188 [479]

Eccofoam SH is a polyurethane foam which remains rigid even at temperatures as high as 235°F. Main use is in electronic applications as a high-temperature structural member or thermal barrier. The foam is available in bulk densities having a range from 2 to 14 lb/ft.^{3} For continuous use, the temperature range is from -94° to 235°F. Sheet size is 12 by 24 inches, and thicknesses range from 1 to 4 inches. Price per sheet is from $12 to $151. Delivery of the material is from stock.

Emerson and Cuming Inc., Canton, Mass. 02021 [480]

An electroless process for depositing nickel directly on aluminum is intended to replace conventional electroplating methods. The process operates from 80° to 95° C at a rate of 2,000 angstroms/minute. Electroless nickel for aluminum is available from stock and is priced at $10 per gallon.

Transene Co. Inc., Route One, Rowley, Mass. 01969 [371]

A light-control film for luminous displays is said to improve readability in moderate to intense light environments. Primarily intended for readout and alphanumeric displays using liquid crystals, LEDs, and cathode-ray tubes, the film may also be used for strip lighting and optical systems such as rear screen projection in microfilm readers. Maximum transmission angle of the film is 45°.

3M Co., Visual Products division, Dept. VP4-28, Box 33686, St. Paul, Minn. 55133 [372]

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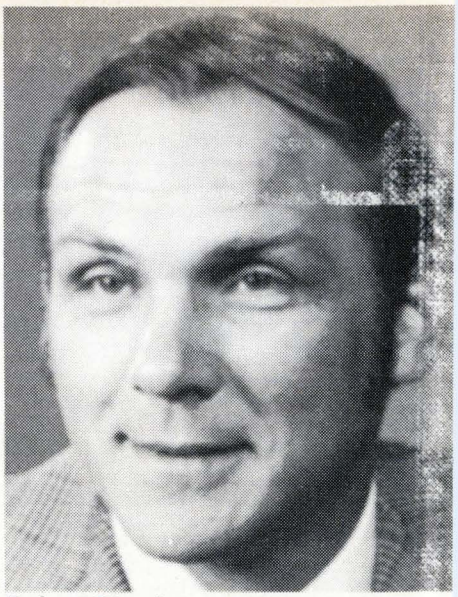

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VS—50A	5 MHz to 500 MHz	500 kHz to 500 MHz	$1,150.00
VS—60B	5 MHz to 1000MHz	100 kHz to 1000 MHz	$1,795.00
VS—80	1 MHz to 1200 MHz	50 kHz to 400 MHz	$1,450.00

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VS—340	3.6 GHz to 4.3 GHz 5.8 GHz to 6.5 GHz	500 kHz to 700 MHz	$4,650.00
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New literature

Thick-film resistors. TRW/IRC Resistors, 401 N. Broad St., Philadelphia, Pa. 19108 has published a 24-page handbook for users of thick-film discrete resistors. The manual gives product descriptions, applications and design information. Circle 421 on reader service card.

Capacitors. An eight-page brochure describing capacitance ranges, specifications and physical characteristics of ceramic chip capacitors is available from GTI/Tensor Electronics Inc., 11558 Sorrento Valley Rd., San Diego, Calif. 92121. [422]

Tape transport. A six-page bulletin available from Microdata Corp., 17481 Red Hill Ave., Irvine, Calif. 92705 describes the series 6000 magnetic tape transports that are IBM-compatible and use 10.5-inch reels. [423]

Dc power supplies. Computer Products Inc., 1400 NW 70th St., Ft. Lauderdale, Fla. 33307. A two-page specification sheet describes the PM 300 series chassis-mount version of the company's regulated dc power supplies. [424]

Disk drives. A six-page brochure describing the FD400 flexible disk drive is available from Pertec Corp., 9600 Irondale Ave., Chatsworth, Calif. 91311. Interface requirements are included, along with descriptions of all interface signals. [425]

Mechanical components. A handbook in German, French, and English describes mechanical components for applications in industrial electronics. It is available from Zeissler, D 521 Troisdorf, POB 1147, Köln, Germany. [426]

Simulators. McFadden Electronics Co., 8953 Atlantic Blvd., South Gate, Calif. 90280, has published a catalog describing cockpit simulation equipment, including control loaders, instruments, dc power amplifiers, and motion simulators. [427]

Chip-sorter. A two-page technical

New literature

data sheet from GTI/Dix Engineering, 1399 Logan Ave., Costa Mesa, Calif., 92626 describes capabilities and physical characteristics of a capacitor chip-sorter. [428]

Tubular capacitors. Cornell-Dubilier, 150 Avenue L, Newark, N.J. 07101, has released a data sheet on its type WMF film-encased tubular capacitors with polyester film dielectric. [429]

Transient recorder. A four-page data sheet on the model 610B transient recorder is available from Biomation, 10411 Bubb Rd., Cupertino, Calif. 95014. A block diagram and technical specifications are included. [430]

Troubleshooting. A digital troubleshooting system called FACT (failure analysis by color tracing) is described in a four-page brochure from Kurz-Kasch Inc., Electronics Division, 2876 Culver Ave., Dayton, Ohio 45429. Diagrams and features of the system are included. [431]

Fasteners. A four-page brochure highlighting a line of fasteners and fastening systems is available from Townsend/TRS Division, Townsend Co., Box 71, Ellwood City, Pa. 16117. Photographs and machine characteristics are included. [432]

Screen printers. Bulletin 3135, describing the feed-ejector system for a line of screen printers, is available from Aremco Products Inc., Box 429, Ossining, N.Y. 10562. [433]

Communications package. Granger Associates, 120 Independence Dr., Menlo Park, Calif. 94025. A two-page data sheet covering the model 6010 communications package is offered. [434]

Thermocouples. Love Controls Corp., 1714 S. Wolf Rd., Wheeling, Ill. 60090, has published a 12-page catalog that describes a line of thermocouples for plastics and other industries. [435]

Power supplies. Catalog 1974-1975

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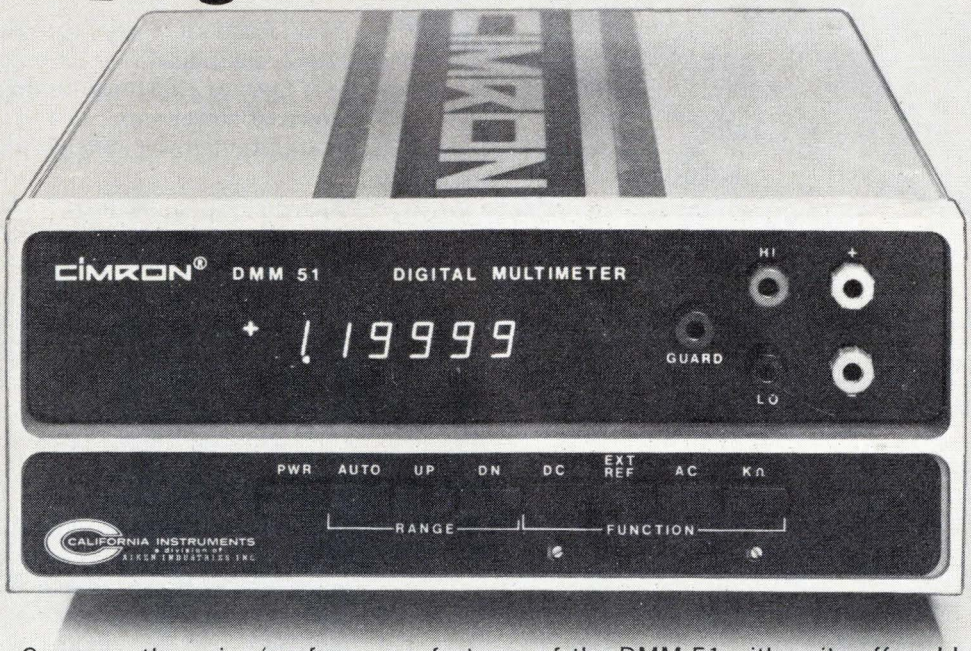

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For more information on DMM 51 circle 93 on reader service card.

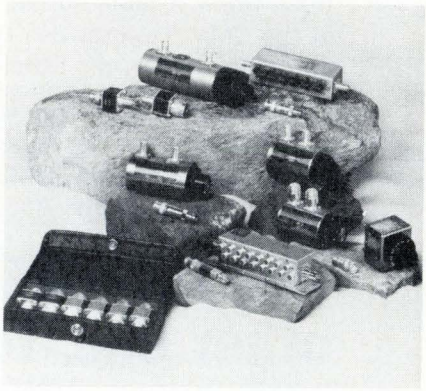
For more information on DMM 50 circle 237 on reader service card.

New literature

from Acopian Corp., Easton, Pa. 18042, contains 48 pages describing new lines of chassis-mounting miniaturized power supplies and redundant-output power systems. [436]

Op amps. An applications note dealing with the design criteria for FET-input operational amplifiers has been published by Siliconix Inc., 2201 Laurelwood Rd., Santa Clara, Calif. 95054. The 18-page brochure compares FET-input stages to bipolar stages and discusses the behavior of JFET preamplifiers. [437]

Microwave products. Alan Industries Inc., Box 1203, Columbus, Ind. A 32-page catalog helps the design engineer select and match the correct attenuator, precision load, matching pad, terminator or other



microwave product to the application. The catalog covers specifications, applications, diagrams, and ordering information. [438]

Pulse transformer circuits, Technitrol Inc., 1952 E. Allegheny Ave., Philadelphia, Pa. 19134, has issued an eight-page bulletin as a design aid for pulse transformer circuits. Among the topics discussed are methods for measuring turns ratio and common-mode rejection [439]

Oscilloscope. Nicolet Instrument Corp., 5225 Verona Rd., Madison, Wis. 53711, has issued a 12-page brochure describing the features of the model 1090 digital oscilloscope and its plug-ins. [440]

Card frames. A catalog available

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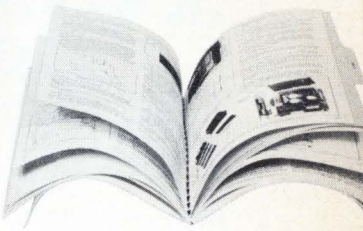

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New literature

from Vero Electronics Inc., 171 Bridge Rd., Hauppauge, N.Y. 11787, gives dimensional information on card frames, plus summary descriptions of other product lines, including circuit boards, connectors and various related accessories. [374]

Capacitors. A four page brochure provides data on a line of Super-Cap low-voltage ceramic capacitors manufactured by Murata Corp. of America, Rockmart Industrial Park, Rockmart, Ga. 30153. Bulletin 49-06 gives dimensions, temperature characteristic curves, and performance specifications. [375]

Heat sinks. A short-form catalog of a line of heat sinks/dissipators includes dimensions and performance curves. IERC, 135 W. Magnolia Blvd., Burbank, Calif. 91502. [376]

Counting system. A data sheet for the ECS-175 counting system has been published by Intec Inc., 416 Vosseler Ave., Bound Brook, N.J. 08805. Features and photographs of the system are included. [377]

Uhf power amp. A bulletin from Henry Radio 11240 West Olympic Blvd., Los Angeles, Ca. 90064, gives specifications and diagrams for its line of uhf power amplifiers. [378]

Transducers. A catalog of pressure and temperature transducers has been published by National Semiconductor Corp., 2900 Semiconductor Dr., Santa Clara, Calif. 95051. Besides specifications, the 160-page book goes into design theory, options, and applications. Tables and a glossary are included.

Connectors. The Flattac series of connectors is described in a four-page brochure from Elco Corp., Willow Grove, Pa. 19090. The brochure describes contacts, insulators and toolings available for simultaneously terminating up to 35 conductors in one cycle of semiautomatic fabrication of cable-to-post or cable-to-printed-circuit-board connections. [379]

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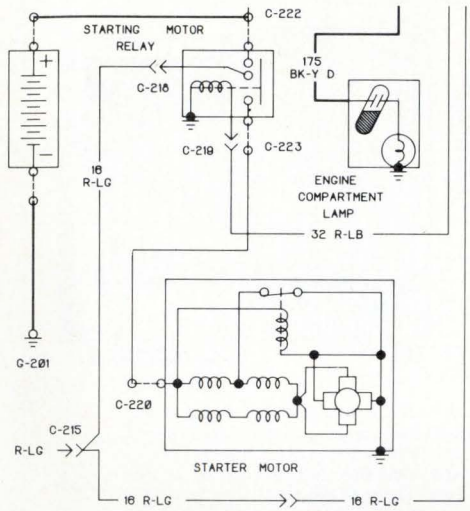

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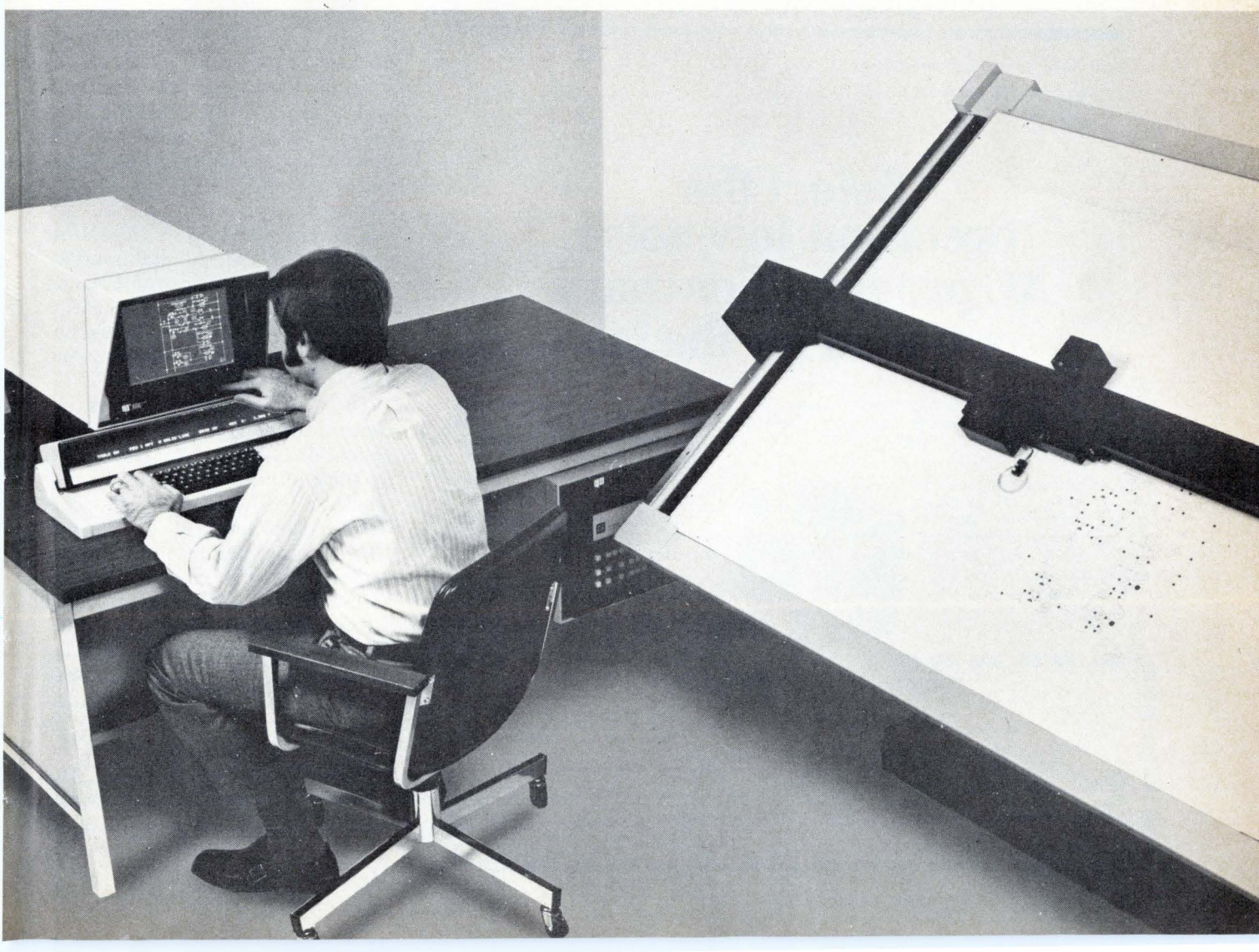

New books

Manual of Linear Integrated Circuits: Operational Amplifiers and Analog ICs, Sol D. Prensky, Reston Publishing Co. (Prentice-Hall Corp.), 289 pp., $16.95

This book will not make you an expert in any of the multitude of circuit types discussed, but it will give you a running start on analyzing a manufacturer's data sheet or talking with a semiconductor manufacturer's applications engineer. Author Prensky, an associate professor of electronic engineering at Fairleigh Dickinson University, Teaneck, N.J., has done an admirable job of explaining, at the junior to senior college level, the operation and applications of nearly every type of linear IC.

It's also an unusual, but pleasant, surprise to find a book from academia that discusses its subject in terms of what's available on the market. Prensky appears to be well tuned in to who's making what.

After a couple of general, introductory chapters, he discusses differential amplifiers; the characteristics, applications, testing and breadboarding of operational amplifiers; power amplifiers; consumer and communications circuits, including fm stereo multiplex circuits and phase-locked loops; regulators and control circuits; digital interface circuits; precision-instrumentation op amps, and specialized linear-IC applications, including current sources, active filters, gyrators, and sample-and-hold circuits.

The author, however, does not concern himself with process innovations that have been responsible for some of the new devices. For example, in his section on chopper-stabilized op amps, the author discusses circuit operation but without describing how the MOS and bipolar processes can be used together on the same chip.

Some useful appendices are included. One lists commercially available linear ICs by manufacturer's type number and gives references back to discussions of the devices in the text. Another lists manufacturers and their addresses.

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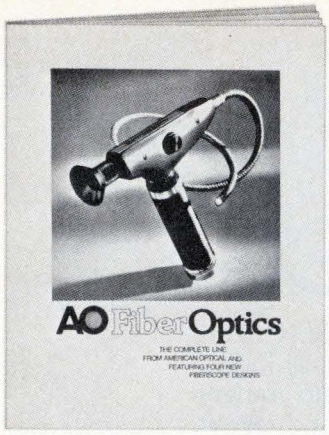

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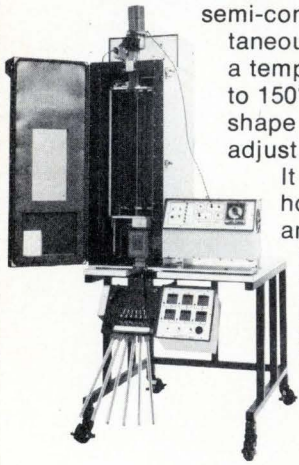

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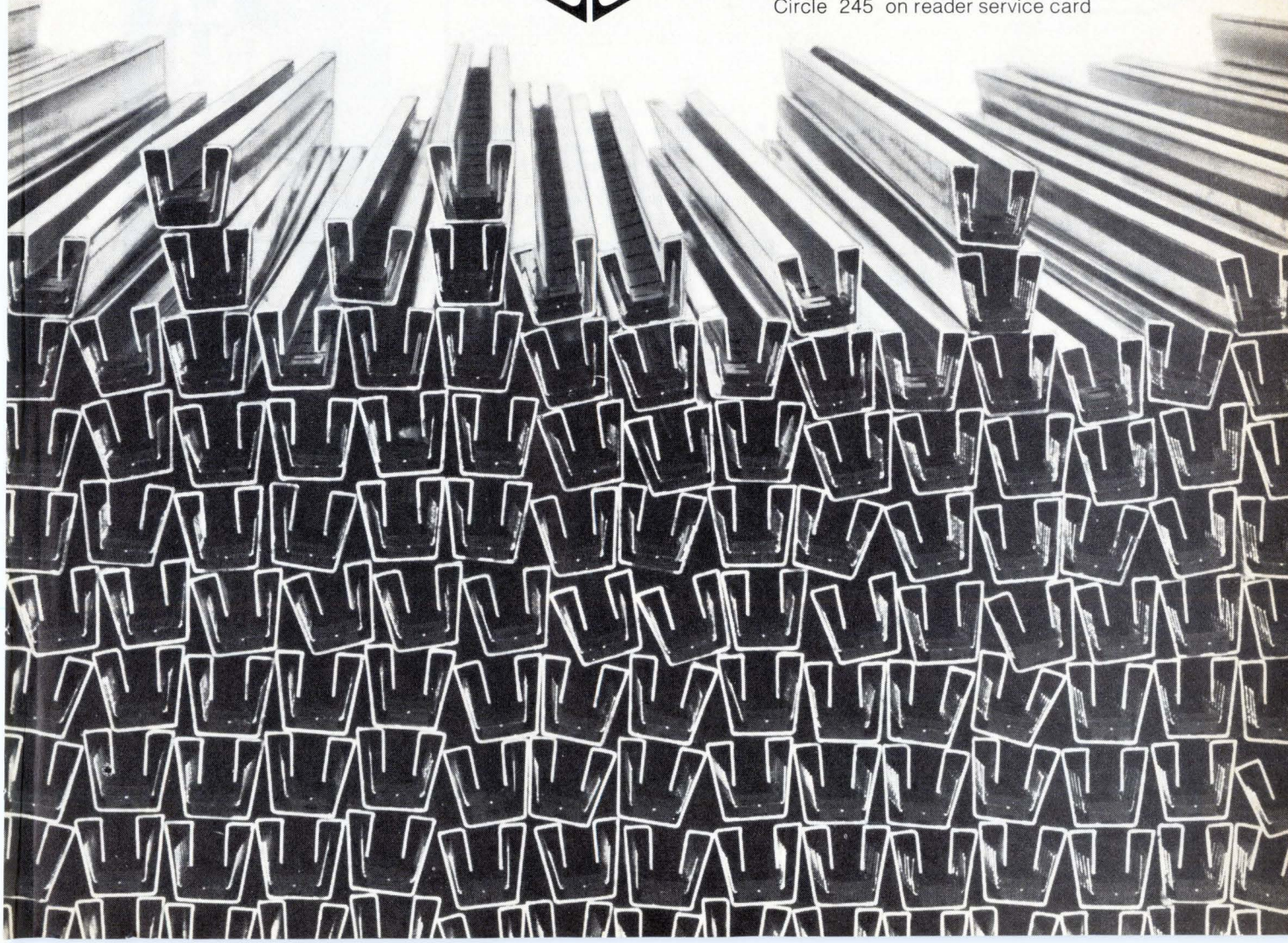

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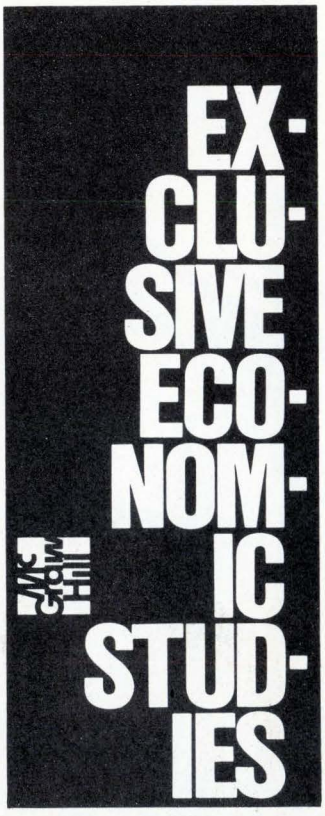

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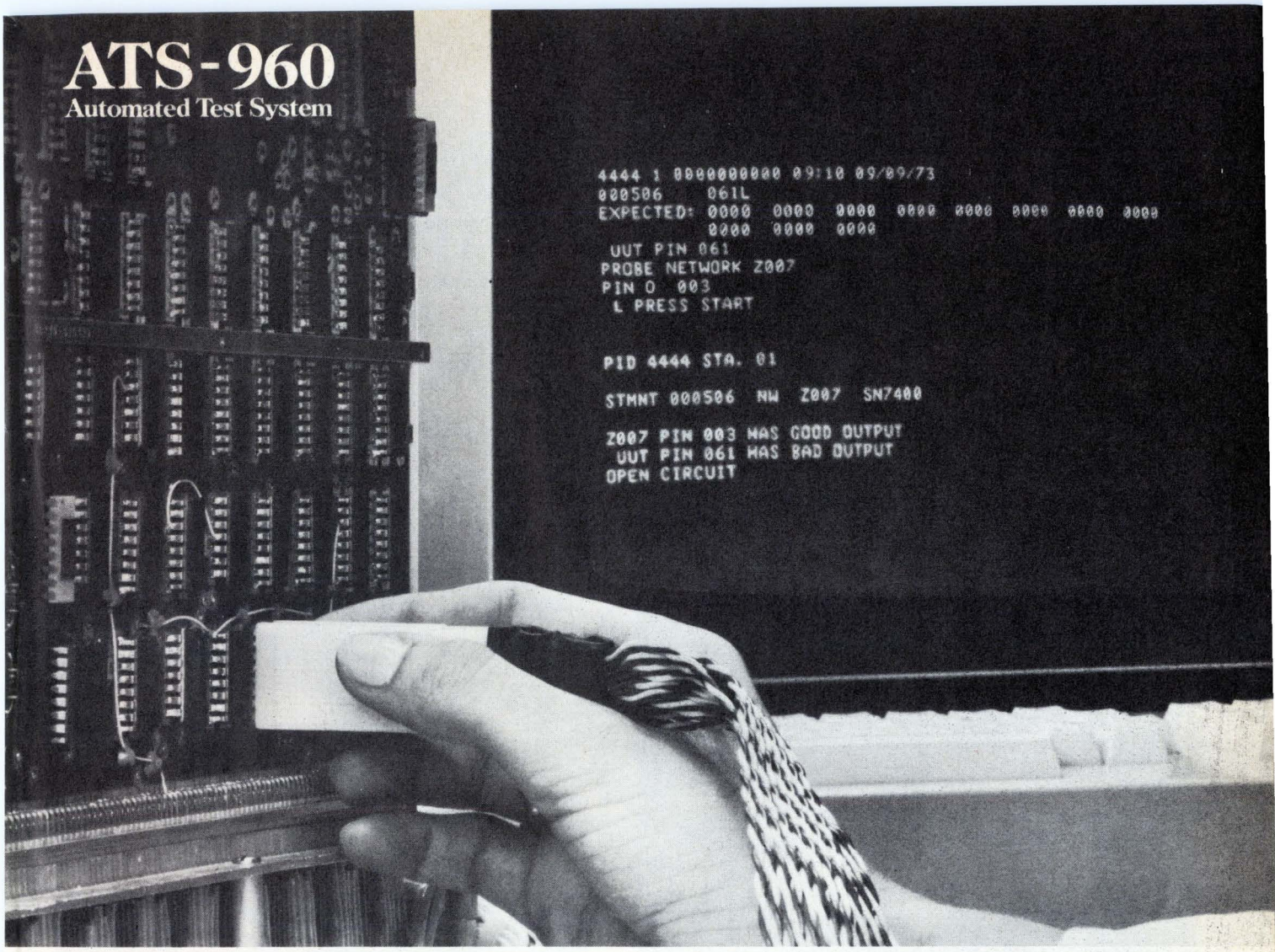

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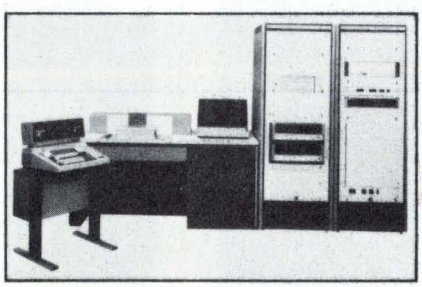

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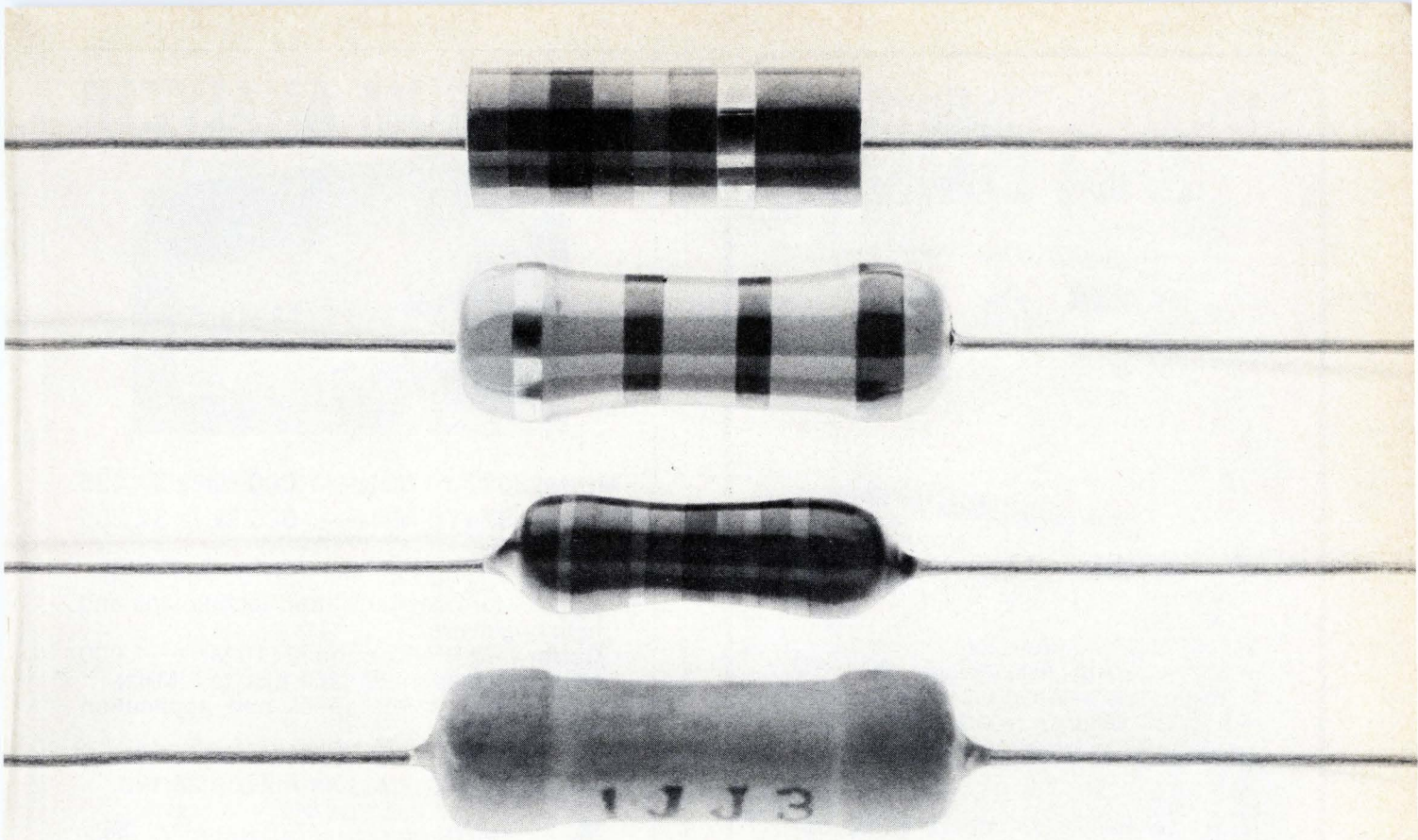

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