OCTOBER 26, 1978

ANNUAL TECHNOLOGY UPDATE ISSUE

The era of very large-scale integration begins as 64-kilobit RAMs and 16-bit microcomputers come on stream/ 110

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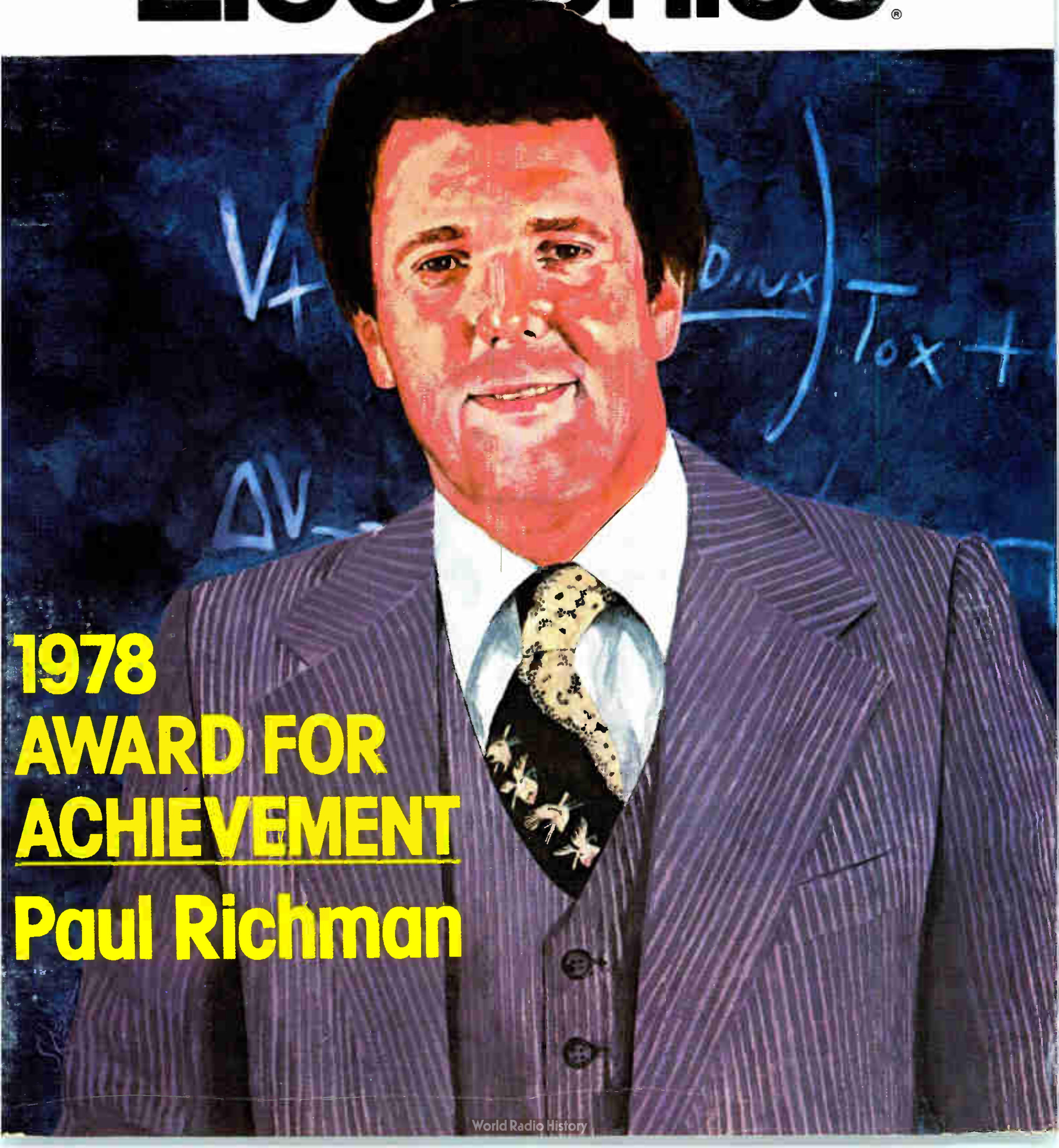

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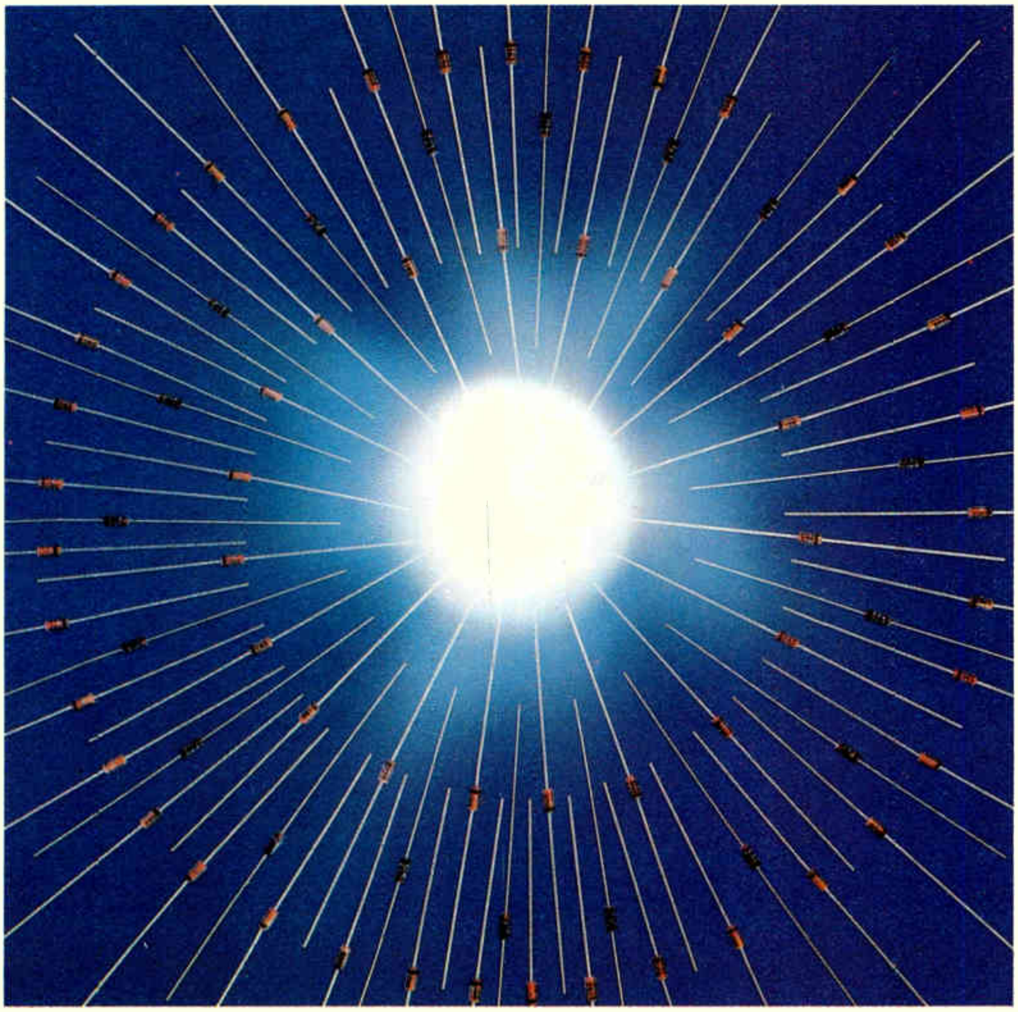

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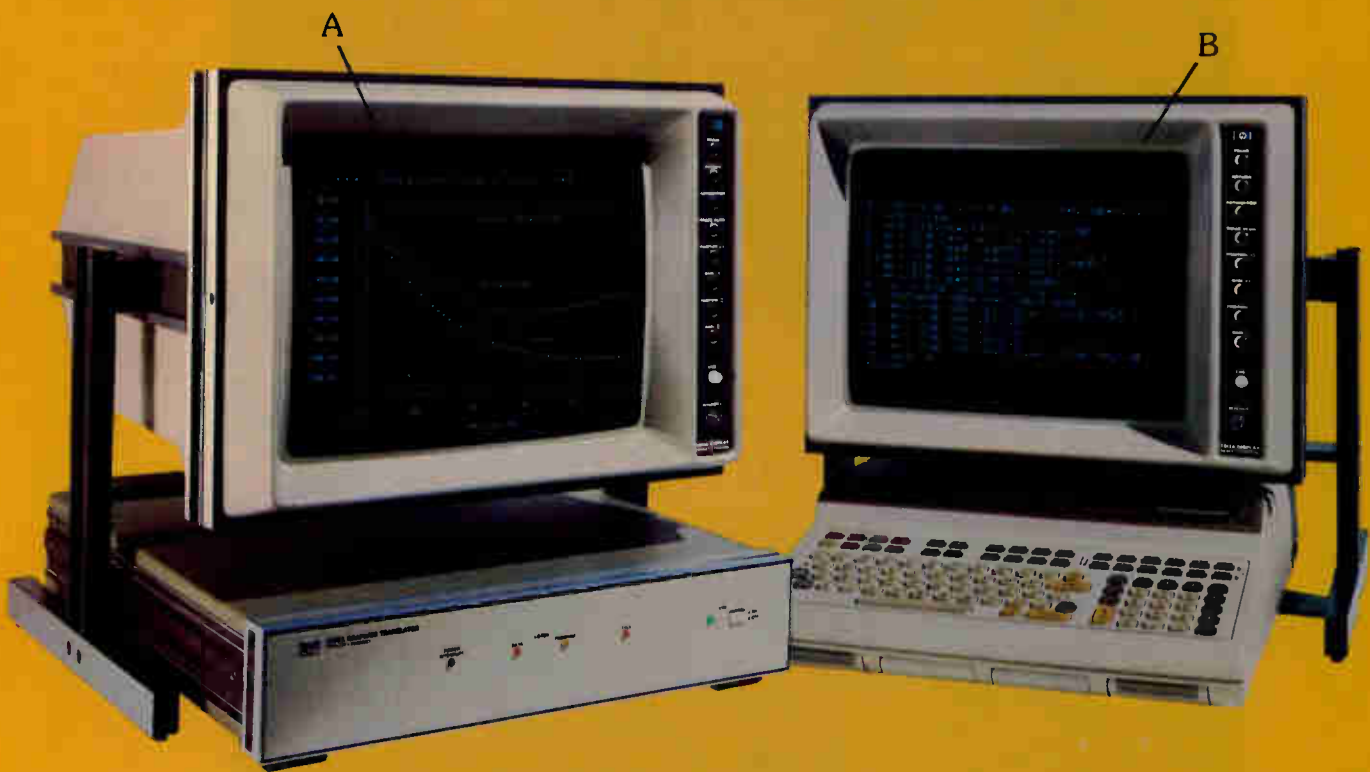

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Electronics

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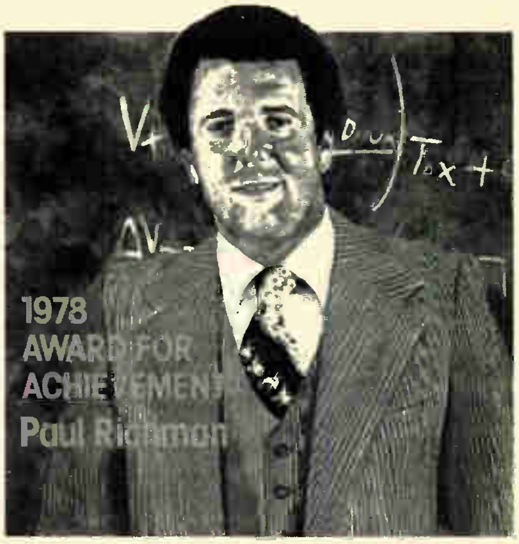

Cover: Award goes to process innovator, 100
For his leadership in developing the Coplamos and Clasp device-fabrication techniques, *Electronics* salutes Paul Richman, president of Standard Microsystems Corp., Hauppauge, N. Y.

Cover is by Art Director Fred Sklenar.

TECHNOLOGY UPDATE, 110
The past year marked the semiconductor industry's entry into the era of very large-scale integration. Moreover, VLSI's effects are already being felt in the computers, communications, and instruments industries and are spreading to other areas.

Semiconductors, 112: Very large-scale integration spurs developments in many processes.
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And in the next issue . . .
X-ray lithography breaks the 1-μm barrier . . . designing optical-fiber systems: first of a series.

Each year for the last five years, the editors of *Electronics* have faced the intriguing task of worldwide technological stock-taking in order to produce our annual Technology Update issue (p. 110). The challenge for each editor is to define and analyze the many distinctive yet overlapping developments that emerge over a year's time, and then to put these developments into some kind of perspective. It requires an all-out effort by the entire staff.

"Not the least of the problems facing the editors for this issue is the selection of the winner of our annual Award for Achievement," comments Executive Editor Sam Weber, whose job was to oversee the project.

The award goes to the person who exemplifies leadership in electronics technology or, through activity in government, business, or the academic world, exerts leadership in promoting the welfare of the electronics industries.

"If you think about it, this selection takes not only insight and understanding about technology, but a lot of guts to designate one from among the many 'stars' who have contributed to the advancement of electronics technology," Sam adds.

This year's award winner, Paul Richman of Standard Microsystems, was an entry in a field of great quality. Yet he was originally nominated by several editors and was an overwhelming choice in the final balloting. For his extraordinary contributions to the improvement of MOS performance through innovative structure design, we think he is fully worthy of our Achievement Award. A profile on Richman and his contribution starts on page 100.

It's often called "The Battle of Cherry Hill," in humorous reference to the fireworks that take place at the Annual Test Conference held for the last eight years at Cherry Hill, N. J. The ninth conference, which starts Oct. 31, should be no exception.

Even the theme is provocative—can complex LSI continue to be tested effectively at both the component and board levels? The reason for the battle is that the conference brings together component users, test equipment producers, and component manufacturers, each with differing views.

"This is perhaps one of the most immediately relevant meetings of the year," comments New York bureau manager Bruce LeBoss, who put together the preview story with instruments editor Al Shackil (p. 81). "Unlike a number of conferences that emphasize components three to four years from actual applications, this meeting stresses the real world of testing today's devices or anticipating problems in testing devices that are soon to be used in high volume." That's another reason for the conflicts—the focus is on pressing problems that have a strong impact on current LSI applications.

Essentially, the difficulties are the same, only at increasingly higher levels of complexity. "Yesterday's 4-K problems are today's 16-K problems," Bruce concludes.

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Readers' comments

Cooperation is seen as key

To the Editor: As a candidate for executive vice president of the Institute of Electrical and Electronics Engineers, I am concerned about who would be my "boss" next year. As you have stated of the two candidates for president, "many of their objectives are the same" [Editorial, Aug. 31, p. 24]. The question is: who is likely to deliver?

The IEEE is controlled by the board of directors, led by the executive committee, which is headed by the president. The president must be able to work with the board, just as the president of the United States must be able to work with Congress. Jerry Suran will be better able to enlist the board's cooperation, which is essential for translating brave words into meaningful deeds.

A final word, to reformers who wish to make the institute more responsive to the members' needs. Consider two possible reforms that make a lot of sense: election by all IEEE voters of some members of the nominations and appointments committee, and similar election of an independent council to govern the institute's forum publications (those that go to all members).

Leo Young
Washington, D. C.

Solutions for the real world

To the Editor: I read with disbelief the comments of Eugene Swystun ["Swystun likes what he sees in I^2L and n-channel codecs," Sept. 14, p. 14] about power considerations for telephony coder-decoders.

According to the article, "The low power advantage of C-MOS is useless because telecommunications systems still have a lot of transformers and transistor-transistor-logic parts." Quoting him directly: "Why reduce power when you have all that *junk* still hanging around there?" I italicize the word "junk" to emphasize a void between the theorist and the realist.

Yes, that "junk" is still there, but in most cases the current drains that are associated with conventional telephony components like relays and battery-feed transformers are traffic-dependent and not steady-state power demands.

The added cost Mr. Swystun emphasizes for complementary-MOS designs versus that of other technologies is a one-time item. It is far less than the continuing cost of power required to support less efficient logic forms.

Current electromechanical switching systems have power requirements that vary with user demand. For instance, a 2,000-line electromechanical exchange may vary from a midnight power demand of 1,500 watts or less to a busy-hour demand of nearly 8,000 W, with an average 24-hour power drain of under 4,000 W. Today's digital telephone exchange of similar size will have a power drain of over 5,000 W with very little shift in drain between peak and quiet hours.

Also, the unused capacity in the new electronic switchers exacts a power-cost penalty. Existing electromechanical and some stored-program-control exchanges are engineered and installed with a two- to four-year growth capacity. This spare equipment draws very little power until activated. But spare equipment in the new digital systems will draw power at a fairly constant rate whether activated or not. These drains translate into larger power plants, greater battery reserves, larger emergency power plants, higher BTU loads on the building air-conditioning system, and most significantly, higher power bills for the entire life of the switching system.

As to size differential between C-MOS and other technologies, the impact of chip design on final codec size will have little effect on a telephone switching system's overall floor-space requirement.

We users of the new technology in telephony are looking for a practical marriage of technology and the real world of telecommunications. Exotic state-of-the-art designs that do not address the whole problem are unacceptable.

C. Keith Cheshire
Mid-Continent Telephone
Service Corp.
Matthews, N. C.

News update

■ The Suez Canal is expected to handle more and larger vessels more efficiently when its new traffic-management system becomes operational in 1980. Cutler-Hammer Inc.'s AILtech division in Ronkonkoma, N.Y., which had a letter of intent from the canal authorities [*Electronics*, Jan. 19, p. 14], now has a $17.8 million contract to design, manufacture, and install the system.

AILtech will subcontract the project to a three-company team: Cutler-Hammer's AIL division in Deer Park, N.Y.; Megapulse Inc. of Bedford, Mass.; and General Electric Co.'s Mobile Radio department in Lynchburg, Va. AIL will provide overall system engineering management, the radar subsystem, and computer-assisted display and control systems. Megapulse will supply a miniature Loran-C position-fixing system, and GE a series of voice and data radio networks.

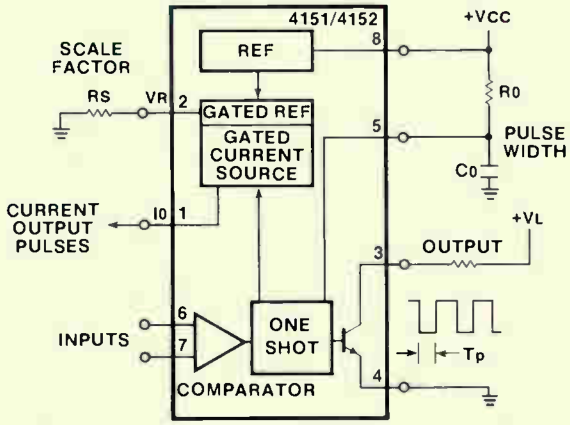
With the new system a ship entering the canal will be detected by radar and visually presented on a digitally scan-converted display system located in a harbor control office. This data will also be sent to a main computer to be displayed and color-keyed by direction.

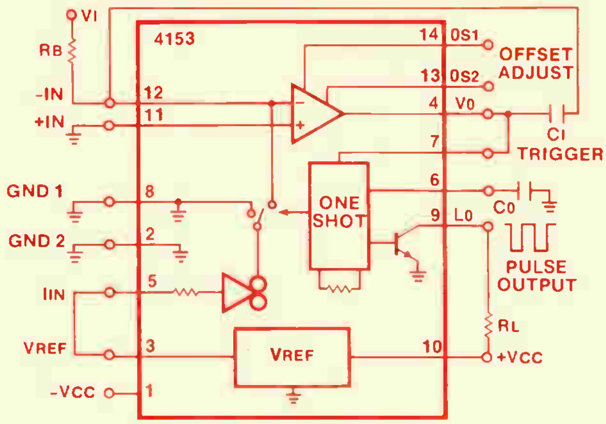
Bruce LeBoss

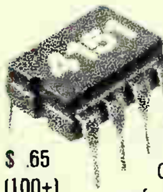
■ A little more than a year after its introduction, an optical step-and-repeat camera that directly exposes semiconductor patterns on silicon wafers is going great guns. More than 40 of GCA Corp.'s so-called Mann DSW (for direct step-and-repeat on wafer) photorepeaters [*Electronics*, Aug. 4, 1977, p. 115] have been sold at an average price of $450,000 each. In announcing the camera, officials of the Bedford, Mass., company said at the time that there was plenty of room for improvement in optical photolithography before electron-beam lithography becomes a widespread production reality for direct wafer exposure, as opposed to mask making. The response to the DSW appears to bear them out, with Japanese semiconductor makers the leading customers.

Lawrence Curran

VFC's . . . We've done one better, better.







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The 4151 was the first multi-function VFC offered by Raytheon. It's a low-cost accurate means of converting an analog signal to a pulse train of proportional frequency.

The 4151 gives you the option of connecting it up the way you need. Make a VFC, FVC, or a voltage-controlled pulse generator. Combined with a little external logic, the possibilities are endless.

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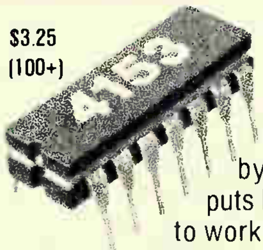
(100+)

The 4152 was the next generation of VFC to come from Raytheon. It's a 4151 and more. It has a linearity capability of ±1% max. Both current source and voltage references have guaranteed maximum temperature coefficients of ±100ppm/°C and a maximum one-shot stability rated at ±50ppm/°C. Add an external op amp and you get linearity of ±0.05% max. and a total gain T.C. of ±150ppm/°C.

The 4152 has a wide bandwidth of greater than 100 kHz, and is DTL, TTL and CMOS compatible, making it an economical answer to your data conversion needs.

$3.25
(100+)



The 4153 is the latest improvement on VFC's offered by Raytheon. It puts LSI technology to work for you. It has a high linearity capability of ±0.01% max. at 10 kHz operation and is high speed, 250 kHz min. All you need to make it work are 2 resistors and 2 capacitors. It has fully contained buried zener reference and on chip op amp.

The 4153 has a total gain T.C. of ±150ppm/°C (including reference, one-shot and current source T.C.'s). The 4153 now makes precision analog-to-digital interfacing an economic reality.

See for yourself. Use the handy coupon, or give us a call today. We'll do the rest. Raytheon Company, Semiconductor Division, 350 Ellis Street, Mountain View, CA 94042, (415) 968-9211.

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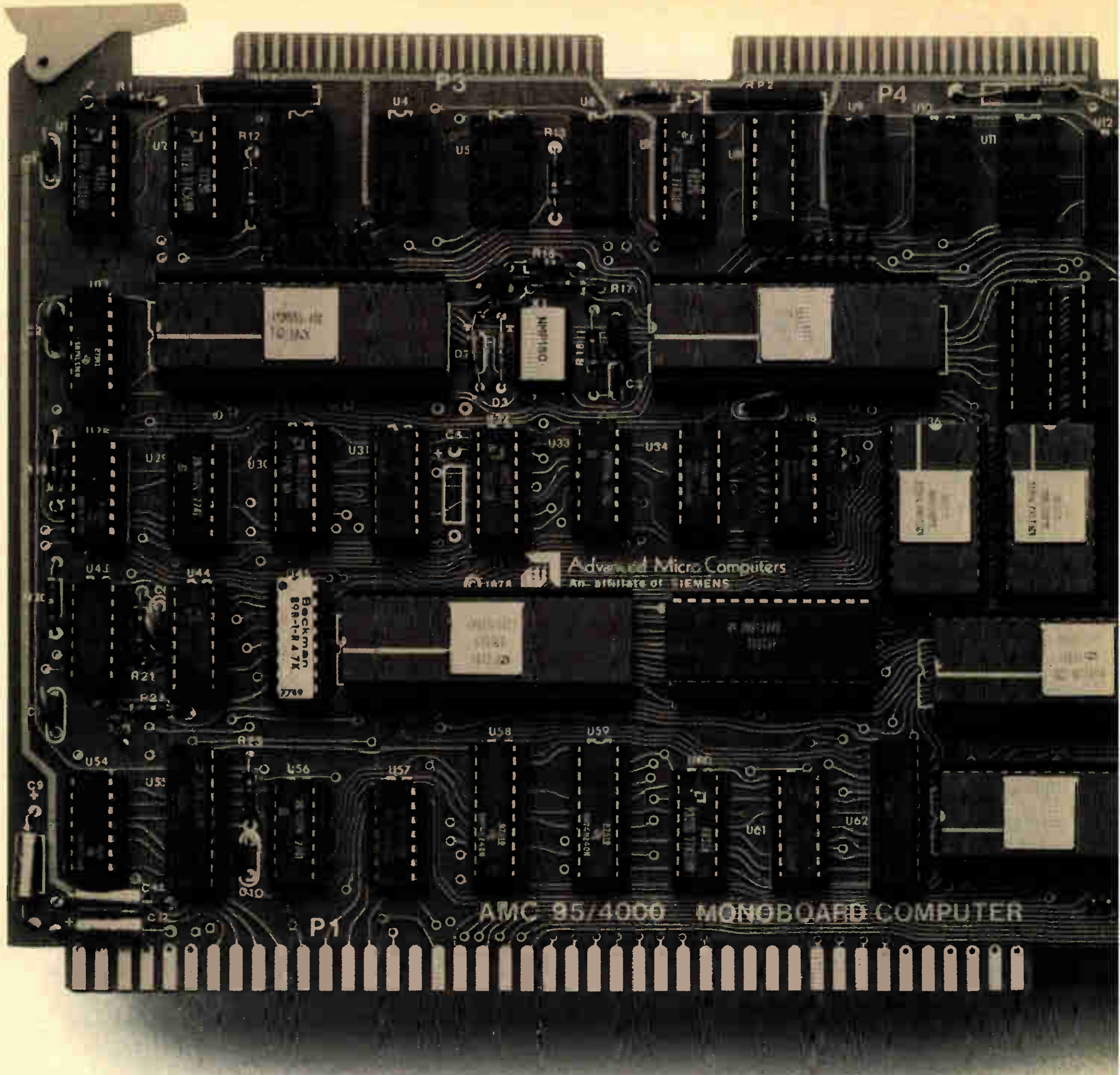
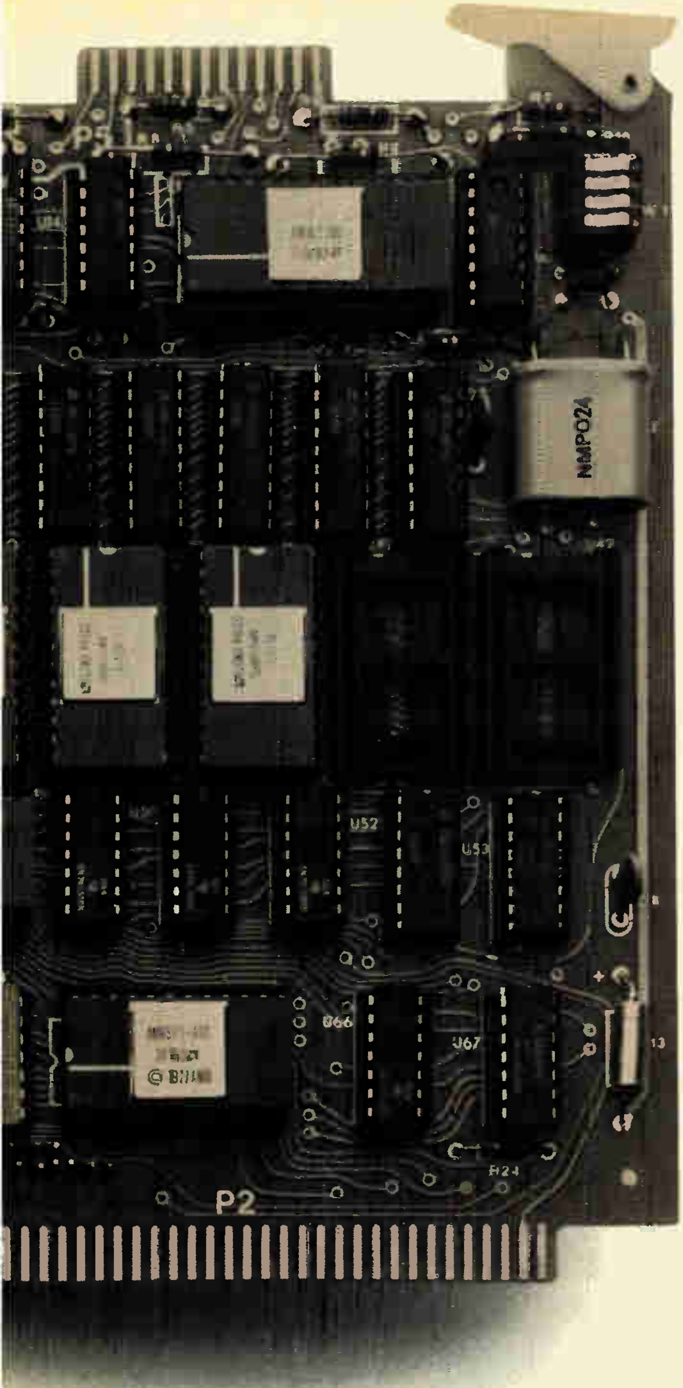


THE CHAIRMAN OF THE BOARD.



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AMC's Monoboard, the AMC95/4000, is the new boss of microcomputer boards. It performs complex math at twice the speed of any other board. And it can process data at clock rates of 2MHz or more.

The Monoboard really has what it takes to be a leader. It performs both floating-point and fixed-point math operations in the blink of an LED. It can do 16- and 32-bit two's complement arithmetic (add, subtract, multiply and divide), 32-bit floating-point operations, plus transcendental and data-manipulation functions.

But those aren't the only reasons the Monoboard is taking over. It also has four independent DMA channels, 4K bytes of RAM, space for up to 12K bytes of ROM/E-PROM, a serial I/O port, and 48 programmable I/O lines.

And the Monoboard has the same physical configuration as the SBC-80 card family. So anyone now using SBC-80's can pack more power in their systems by simply plugging in the Monoboard.

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Assembly and process-related faults account for 70% to 80% of PC-board faults. By detecting and repairing these faults early in the production cycle, troubleshooting bottlenecks during functional testing are minimized and a cost saving increase in production throughput occurs. The GR 2270 In-Circuit/Functional Test System with automatic program generation software keeps program costs low. Identifies multiple faults in a single pass and prints a board repair message in simple English. Eliminate subjective visual inspection. Fast, accurate and cost effective.

The low cost, computer-controlled, bench-top GR 2230-I provides automatic high-volume in-circuit testing of small PC boards and modules. English-language macro-instruction keyboard for easy user programming. Rapid testing with 64-pin scanner, expandable to 128. Flexible interfacing to bed-of-nails or probe fixtures. Automatically prints out faults.

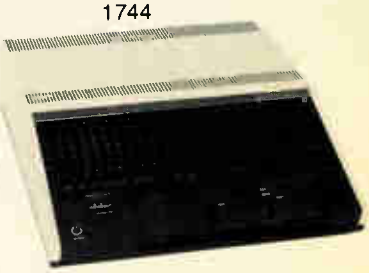
2270


2230-I

IC Testers

Users find GenRad digital (1742, 1744) and linear (1740) IC testers easy to setup and operate to provide low-cost testing with faster IC throughput. Complete testing to vendor specifications assures you of a good IC and vendor correlation. The resultant reduction in board failures will often pay for the tester in months. Interfaces are also available to a variety of popular handlers.


1742

1744


1740


Portable Field-Service Tester

Reduce your field service costs. The GR 2225 digital PC-board test system with automatic guided-probe diagnostics provides your field service engineer with on-site test and repair similar to that of your factory's production test department. Language translators convert your factory board test system programs to keep programming costs low. This shortening of the repair pipeline results in a dramatic reduction of large spare board inventories.

circuits, modules, or PC boards... functional testing... or in the field...

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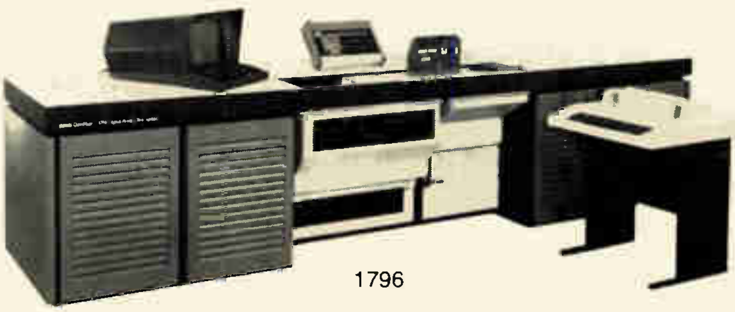
Functional Testers

The GR 1796 Dynamic Digital/Analog Test System for parametric, high-speed digital and analog testing is designed to diagnose your most complex state-of-the-art PC boards. Like digital boards using LSI chips such as microprocessors, RAMs, ROMs and UARTs. High speed driver/sensors (dc to over 1.5 MHz), sophisticated analog stimulus and measure ment modules, and a flexible switching matrix and PCB interface capability are just a few technical highlights that this verstile system provides.

The GR 1799 Digital/Analog Test System is a fully integrated system in the medium-price range for functional testing of digital, analog and hybrid PC boards.

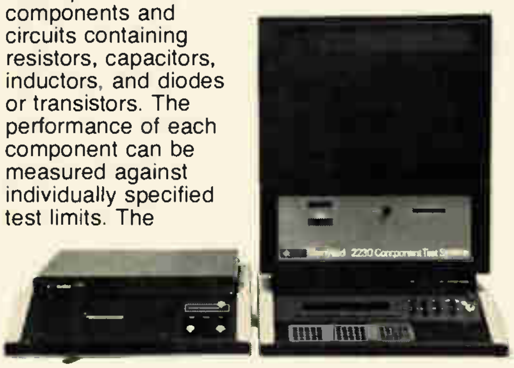
Composed of specially designed and selected modules and system components, this combination, integrated into one total system, provides faster testing and operation, easier programming and greater expandability.

The low cost GR 1795-HD and -FD Logic-Circuit Test Systems are ideal for the smaller manufacturing operation or for operations requiring additional production capacity for testing digital PC boards. With automatic program-generation and complete diagnostic capabilities, you can realize a new cost effectiveness as provided by this computer-controlled, simulator-based system.



Component Testers

The GR 2230 is a fully automated, user programmable, bench-top system which reduces the time and cost of testing components, networks and modules. Its flexibility permits rapid mixed measurements on sequenced reeled components and circuits containing resistors, capacitors, inductors, and diodes or transistors. The performance of each component can be measured against individually specified test limits. The versatility of the system is being realized in a broad range of applications from component manufacturers in production test to component users in incoming inspection departments.



Measuring impedance of passive components such as capacitors, resistors and inductors is fast and simple with a low-cost, high performance micro-processor-based Digibridge™. The GR 1657 and 1658 offer measurement of R, L, C, D and Q at test frequencies of 1 KHz and 120 Hz. The 1-MHz GR 1687 measures Ls & Q, Cs & D, Cs & Rs, Cp & Gp. The 1658 and 1687 keyboard models feature ten automatic limit comparison bins for sorting and selectable test speeds plus an optional IEEE 488 bus/handler interface.

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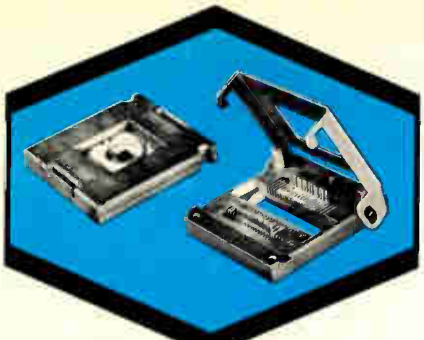
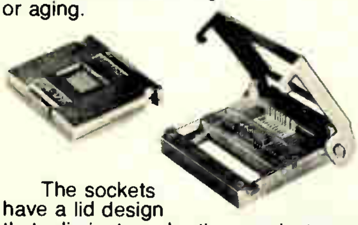




People

Zschau takes the helm at the AEA

Getting the Government to reduce the paperwork that plagues electronics companies engulfed in a morass of Federal regulations is a high priority of the American Electronics Association. So says its new chairman, Edwin V. W. Zschau.

Zschau, who is also chairman of Systems Industries Inc., Sunnyvale, Calif., a minicomputer equipment maker he founded in 1968, knows the problems firsthand. "My own company has fewer than 300 employees, yet we spent weeks the last two years working on a two-inch-thick affirmative-action manual," he relates.

The form of forms. "The concern of this regulatory activity is not with what we're actually doing in hiring minority and disadvantaged employees but with the form of the manual," he continues. Part of the problem was that a new inspector did not like the manual approved by the previous inspector. Such Government red tape consumes an incredible amount of time, especially for small companies whose only other choice is to ignore Federal contracts entirely, Zschau contends.

He wants the association, headquartered in Palo Alto, Calif., to identify the areas where regulations are not fulfilling their purpose and work to eliminate them. The AEA will also continue to lobby for legislation it considers vital, as it did in testifying in favor of legislation to reduce the capital gains tax and to ease customs procedures.

Effective. Zschau believes the electronics industry is perceived as being a responsible and effective lobbyist. He attributes this effectiveness to having "done our homework and to relying on executives who have the perspective to discuss issues with elected officials."

Other issues likely to involve the AEA are the legislative efforts to reform the Communications Act—"we're pushing for more open competition" with AT&T, he says—and to change cost-accounting procedures

Opposed. People should speak out against Government red tape, says Edwin Zchau.

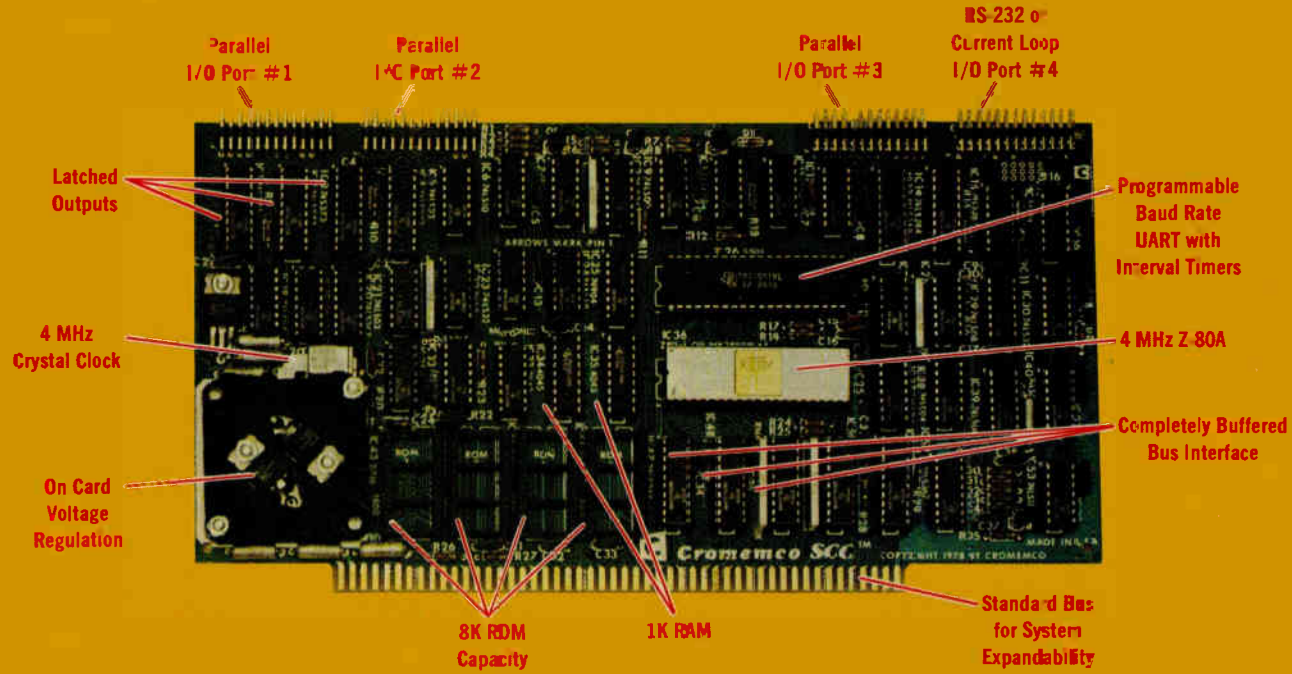
applied to Government procurement contracts. On trade matters, Zschau promises that the association will also be heard from.

Besides lobbying, "the other purpose of the association is helping companies build successful businesses," Zschau points out. More than two thirds of the AEA's 1,000-plus member companies have fewer than 200 employees. When his term ends in November 1979, he says, he would like to look back and see that the association not only provided leadership on the state and Federal level, "but also helped member companies become successful, particularly the small ones."

Third World will want photovoltaics: Varian's Maget

Look for the first large markets for photovoltaic solar cells to start opening up in developing areas of the world, rather than in the United States, says Henri J. R. Maget, recently appointed to the new position of corporate director of solar energy at Varian Associates, Palo Alto, Calif. Lacking an established electrical grid, countries in places like Central Africa and the Middle East will be eager to apply solar arrays, he says.

Eventually, solar energy will furnish about 2% to 3% of U. S. energy requirements, he believes, representing "a multibillion-dollar business in which the investment will be



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COMPLETE COMPUTER

In this advanced card you get a professional quality computer that meets today's engineering needs. And it's one that's complete. It lets you be up and running fast. All you need is a power supply and your ROM software.

The computer itself is super. Fast 4 MHz operation. Capacity for 8K bytes of ROM (uses 2716 PROMs which can be programmed by our new 32K BYTESAVER® PROM card). There's also 1K of on-board static RAM. Further, you get straightforward interfacing through an RS-232 serial interface with ultra-fast speed of up to 76,800 baud — software programmable.

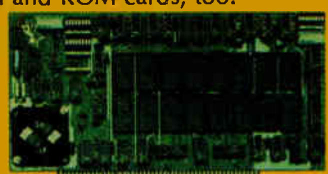
Other features include 24 bits of bi-directional parallel I/O and five on-board programmable timers.

Add to that vectored interrupts.

ENORMOUS EXPANDABILITY

Besides all these features the Cromemco single card computer gives you enormous expandability if you ever need it. And it's easy to expand. First, you can expand with the new Cromemco 32K BYTESAVER PROM card mentioned above. Then there's Cromemco's broad line of S100-bus-compatible memory and I/O interface cards. Cards with features such as relay interface, analog interface, graphics interface, opto-isolator input, and A/D and D/A conversion. RAM and ROM cards, too.

Card Cage



32K BYTESAVER PROM card

EASY TO USE

Another convenience that makes the Model SCC computer easy to use is our Z-80 monitor and 3K Control BASIC (in two ROMs). With this optional software you're ready to go. The monitor gives you 12 commands. The BASIC, with 36 commands/functions, will directly access I/O ports and memory locations — and call machine language subroutines.

Finally, to simplify things to the ultimate, we even have convenient card cages. Rugged card cages. They hold cards firmly. No jiggling out of sockets.

AVAILABLE NOW/LOW PRICE

The Cromemco Model SCC is available now at a low price of only $450 factory assembled ($395 kit).

So act today. Get this high-capability computer working for you right away.

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Circle 15 on reader service card

People

New cell. Henri Maget is counting on photovoltaic cells made of gallium arsenide.

large." And he adds, "We're talking about a breakthrough in costs by the end of the 1980s."

Slow but sure. In the meantime, "you don't want to force the technology in the near term to meet criteria that can't be done economically and create a credibility problem with the public," continues the French-born holder of a Ph.D. degree in chemistry. You don't want oversell."

For Varian, success will come when the overall cost of the supporting system hardware is reduced enough to offset the cost of the more expensive but more efficient aluminum-gallium-arsenide cells it will be using [*Electronics*, July 20, p. 42]. The company believes it can hit cost goals by packing the cells more densely and by more effective systems design. Varian is the only one of more than 15 companies in the Department of Energy's solar concentrator program to pursue gallium-arsenide cells.

Maget, previously manager of business development at United Technologies Inc.'s Chemical Systems division in Sunnyvale, Calif., likens the present state of the photovoltaic business to the situation during much of the 11 years he spent helping develop fuel cells in General Electric Co.'s direct energy conversion operation. Both programs seek better energy conversion, but fuel cells had a big cost problem because of the expensive electrode material. With solar energy, though, "you don't have the materials problem, so you don't need the same kind of breakthrough," he says. □

SSR UPDATE

AC Solid State Relays: We have more answers than you have questions.

Whatever your AC solid state relay switching problem, the odds are we have the answer sitting on our shelf. With more than 90 different models ready to meet your needs, you have to look long and hard to find a problem we can't answer.

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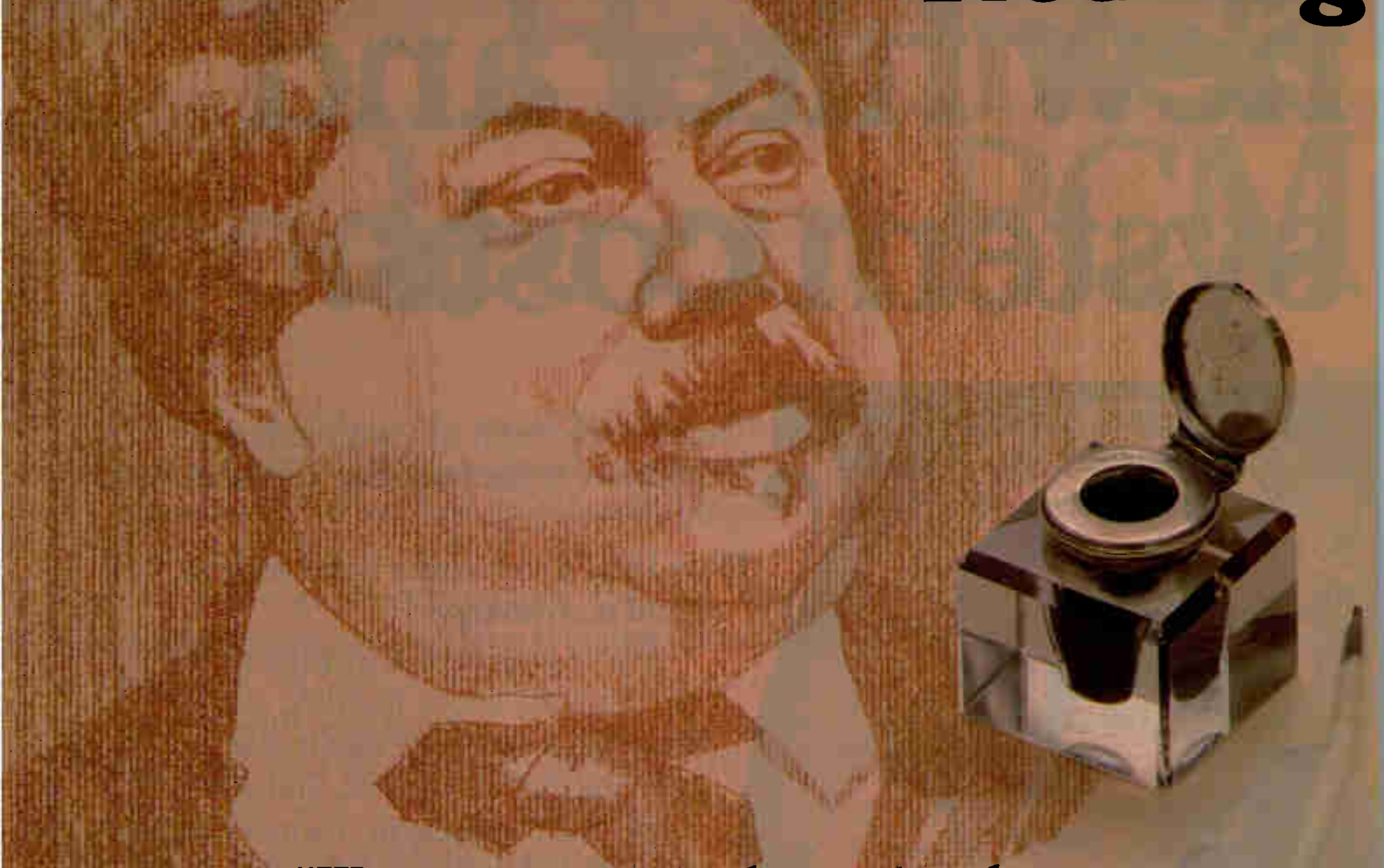
Circle 17 on reader service card

"Nothing



"We measure success by semiconductor memory systems delivered. 2 billion bytes."

As the largest independent supplier of semiconductor add-on and add-in memory in the United States, Intersil has delivered over 2 billion bytes of semiconductor memory. Both systems and modules. Many people think of us as leaders in semiconductor technology. And they're right. Today, as a result of the 1976 merger between Intersil and Advanced Memory Systems, Intersil is one of the largest forward integrated semiconductor firms in the U.S.A. That means we can offer both advanced semiconductor devices and a full range of memory systems. IBM compatible add-on memory systems. Other large scale mainframe memory systems. General purpose memory modules. Core Replacement modules. Add-in memory. Plus, custom memory products. 2 billion bytes delivered to date.

OEM SYSTEMS.

Intersil's standard and custom OEM memory systems product applications range from terminals and cash registers to medical systems and large, general purpose computers. And, from single memory cards to entire memory systems.

Intersil Modular Memory Systems (IMM): Designed for medium to large systems applications, the systems offer from 64K to 4096K bytes of rack mountable memory complete with power and chassis. Modular memory systems are available with numerous options to facilitate their use in a wide variety of applications.

RAMSTAK:™ General Purpose Memory Cards that offer storage capacity from 16K × 20 to 128K × 24. Designed for small to medium scale systems applications, the cards are compatible with industry standard core memory cards. Timing and control are self-contained. RAMSTAK cards are available using 4K, 8K, and, will soon be offered with 16K Dynamic RAMs.

CMOS Power Saver™ Memory Cards: Dissipating only 2.5 watts at 5V, Power Saver cards offer 16K × 8 MOS memory on a single 7″ × 14″ card. 300ns access. TTL compatible. And, Power Saver Memory Cards include on-board battery backup.

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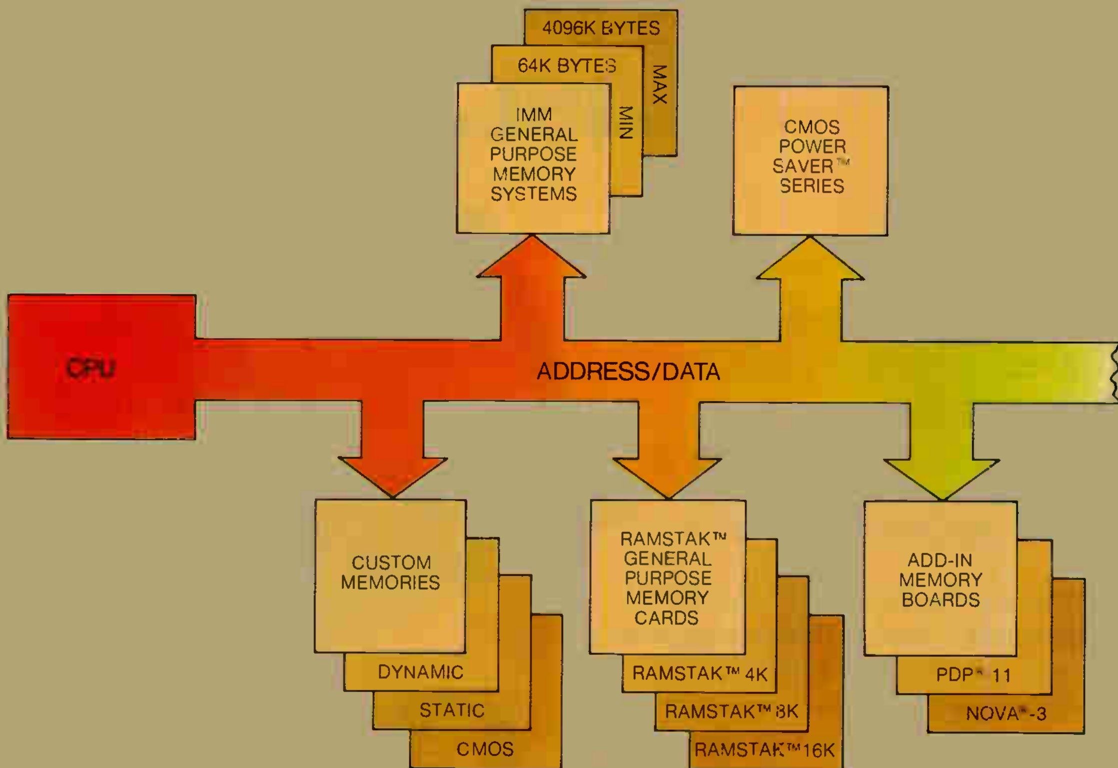
1802-1870



General Nova*-3 families of minicomputers. Naturally, both systems are totally hardware and software compatible with their host computers.

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Our standard products offer answers to most memory requirements. But many customers have unique requirements. For 10 years, we've specialized in the design and development of custom memories. Tested them. Burned them in. And delivered them. In volume. On time. With proven reliability.

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First it was mainframe memory. Then general purpose modular memory systems and CMOS memory cards. Next, system compatible add-in memory for the PDP*-11 and Nova*-3 minicomputer families. And from there, to even more cost effective memory systems. Because nothing succeeds like success.

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The more you know about our product, the less time you'll spend on yours.

Editorial

Trade with Japan and other misunderstandings

During the visit to Japan earlier this month by the 138-member U. S. export development mission, it was disconcerting to witness the apparent lack of communication between Japanese officials and the American leaders—Secretary of Commerce Juanita Kreps, mission leader Mark Shephard Jr. of Texas Instruments Inc., and Frank A. Weil, assistant commerce secretary.

For example, the Americans repeatedly stated that the Japanese must remove nontariff barriers in order to permit more participation in their markets by U. S. manufacturers. But the Japanese either refused to recognize the problem or else insisted that matters such as complex distribution systems and unfamiliar safety standards were simply part of the complicated task of doing business in Japan.

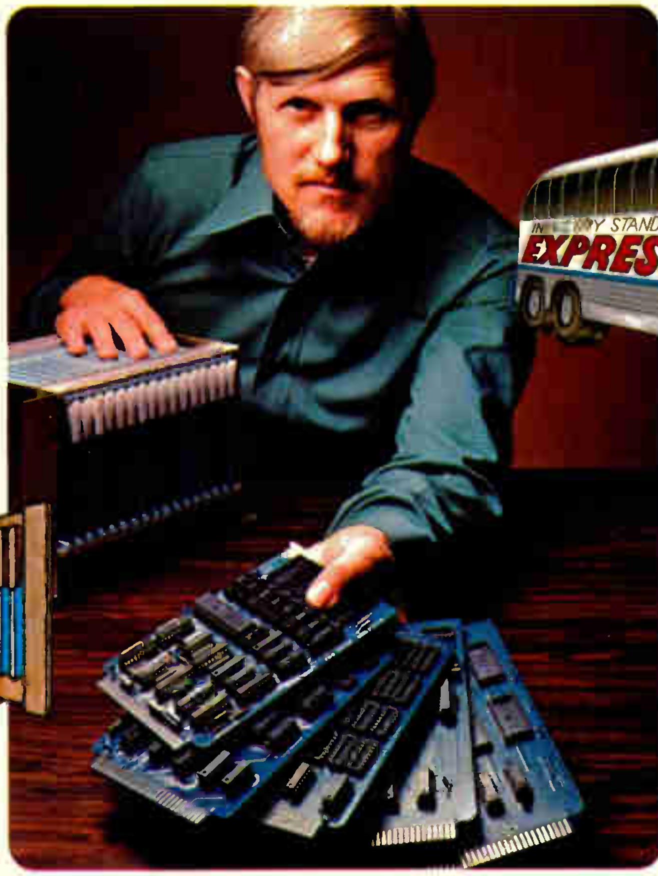
Japan pointed to its International Balance of Payments Countermeasures headquarters, now called simply Reduce-the-Surplus headquarters, as a sign of good faith. This group has a supplementary budget of 45 billion yen ($243 million at current exchange rates) to spend in America for medical equipment and aircraft. However, this fund is nowhere near the multibillion dollar procurements of the Nippon Telegraph and Telephone Public Corp. and the Japan National Railways that are "closed" to foreigners. Instead, these public corporations have "families" of domestic suppliers that get the business. Indeed, American computer companies in particular would love to get a piece of NTT's procurement pie, but chances are rather slim since the Japanese government claims to have no influence over the telephone company. This response is somewhat hard to believe since the government approves NTT's annual budget.

Nevertheless, the dozen or so electronics companies that participated in the trade mission should not feel discouraged. Perhaps arriving in a group is not the best way to open business with Japanese companies, but it's a first step.

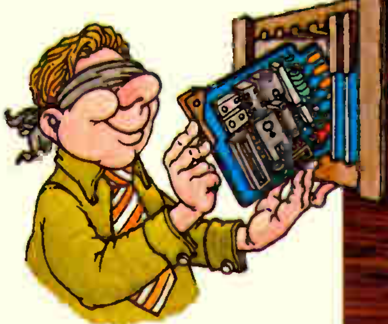
More important, there are Japanese companies that want to see what the Americans have to sell, and the publicity the mission attracted was good. One major business-machines producer, for instance, is considering buying computer terminals and modems from the U. S., an about-face from the days when American consumer electronics firms were purchasing OEM, private-label goods made in Japan. The arrival of the mission provided an opportunity to explore this interest. Now that the initial fact-finding contacts have been made, there is more hard work ahead. One very real trade barrier is Japanese doubt about American quality control. Another problem is establishing a presence in Japan.

The need for full commitment was quite apparent at the Japan Electronics Show this month. What the American trade delegates who attended saw was a sparse crowd in the hall set aside for foreign booths, where firms such as National Semiconductor, GenRad, Mostek, and Fluke got tiny spaces in their sales reps' exhibits. But they saw large crowds at the Texas Instruments booth, located in the hall for domestic components companies. And, if they had their business antennas carefully aligned in the domestic halls, they would have met Japanese ready and eager to "buy American" for specific products. If nothing else, the trade mission has come away with information on what the Japanese want to buy; next is to figure out how best to sell it. As TI's Shephard aptly pointed out, "the best way to become an export-oriented nation is to increase dramatically the number of exporting firms." Then he cautioned that the Japanese market is tough. "It is not a vacuum waiting for U. S. products."

PRO-LOG makes it easy to board the STD BUS.



Introducing the STD BUS, the simplest bused microprocessor system ever made. STD means Simple To Debug, Simple To Develop, Swift To Deliver.
The new STD BUS—8-bit microprocessor systems built around a standard bused motherboard which allows any card to work in any slot. Thus you can change the function of your system, the memory type, even the



microprocessor type by simply exchanging one card for any other. The STD BUS is 56 lines wide and is compatible with Pro-Log's standard 4½-inch by 6½-inch edge-connected cards.

It's supported by both Pro-Log and MOSTEK and freely available to the industry.

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Z-80 PROCESSOR ● 8085 PROCESSOR
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Computer Security Conference and Exhibition, Computer Security Institute (Hudson, Mass.), Statler Hilton, New York, Nov. 6–8.

Chicago Fall Conference on Consumer Electronics, IEEE, Ramada O'Hare Inn, Rosemont, Ill., Nov. 6–8.

12th Annual Asilomar Conference on Circuits, Systems, and Computers, IEEE, Asilomar Hotel, Pacific Grove, Calif., Nov. 6–8.

Electronica 78—The Eighth International Trade Fair for Components and Assemblies in Electronics, Munich Fair Association, Fairgrounds, Munich, West Germany, Nov. 9–15.

Eighth International Congress on Microelectronics, IEEE, Fairgrounds Congress Hall, Munich, Nov. 13–15.

CompSac 78—Second International Computer Software and Applications Conference, IEEE, The Palmer House, Chicago, Nov. 13–16.

Gomac-78—Government Microcircuit Applications Conference, U. S. Department of Defense (for information, contact Robert D. Larson, Wright-Patterson Air Force Base, Ohio), Del Monte Hyatt House, Monterey, Calif., Nov. 14–16.

24th Conference on Magnetism and Magnetic Materials, IEEE, Stouffer's Inn, Cleveland, Nov. 14–17.

Annual Assembly, Radio Technical Commission for Aeronautics, Sheraton National Motor Hotel, Arlington, Va., Nov. 16–17.

Symposium on Computer-Aided Design of Digital Electronic Circuits and Systems, The Commission of the European Communities (for information, contact Keness Belgium Congress SA, Brussels), Hilton Hotel, Brussels, Nov. 27–29.

Autotestcon 78, International Automatic Testing Conference, IEEE, Hilton Mission Bay Hotel, San Diego, Calif., Nov. 28–30.

How you can get Z80 power for $171.

Mostek's MD Series™ lets you control system functions and cost.

Design Z80 systems fast and economically with Mostek's MD Series of OEM microcomputer boards. Choose either MD stand-alone boards or expandable MDX boards—both on compact 4.5″ x 6.5″ cards.

Mostek's Micro Design Series

MDX Module	Price*	MDX Module	Price*
CPU1	$171.00	SIO	$171.00
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16K DRAM	223.00	EPROM/UART	148.00
32K DRAM	410.00		
		MD-SBC1	194.00

*100 lot quantities

The MDX boards are modularized by function. This reduces system cost since you buy only the functional modules you need. And you can use any combination of MDX cards because all MDX cards are STD BUS compatible.

The STD BUS is a unique second-sourced motherboard interconnect system designed to handle any MDX card in any card slot. This reduces hardware design time letting you concentrate on application software.

The MD stand-alone microcomputer boards are also Z80-based. The MD-SBC1 features 8K x 8 EPROM; 2K x 8 RAM; two 8-bit input ports; three 8-bit output ports; two interrupt inputs; and single +5 Volt power supply.

For more information, call or write Mostek, 1215 W. Crosby Rd., Carrollton, TX 75006; phone 214/242-0444. In Europe, contact Mostek Brussels; phone (32) 02/660.25.68.

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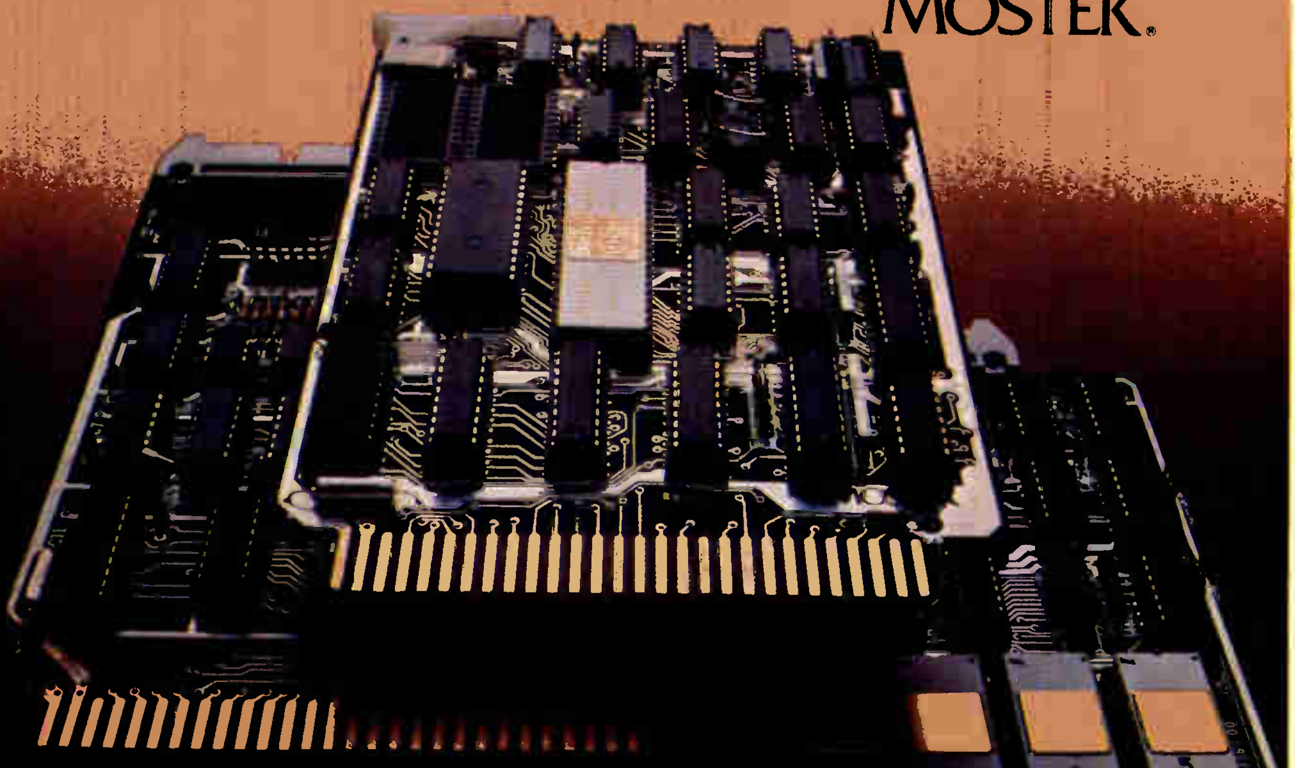

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Plus you only need one development system, Mostek's AID-80F™, to develop and debug software for Mostek's entire product line. BASIC and FORTRAN are also available for use on the AID-80F.

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MOSTEK

How to tell a clad connector

It's easy to think of connectors as all being pretty much the same. But actually, there are significant differences between ordinary connectors and clad connectors.

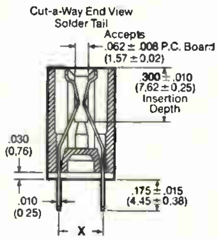
For example, the shortcomings of connectors with monometal contacts have long been known.

Alloys, though more versatile than monometals, haven't been able to provide the range of characteristics demanded by today's applications.

And most gold platings, such as flash gold, are too thin for any kind of durability. They tend to be porous and vulnerable to abrasion and intermittencies. And they're wasteful and costly, because you really need gold only at the point of contact.

The optimum solution, then, would be a combination of metals that provide the exact characteristics required for the specific application. As of today, there is only one way to produce such a combination.

Cross section of a 3-layer pressure-bonded composite metal.



It's a bonding process pioneered and developed by Texas Instruments. And it's called cladding.

The clad difference.

Basically, a clad metal is two or more metals bonded at the molecular level into a composite. There's no need for intermediate adhesives or brazing alloys. It's simple, it's clean and it's permanent.

In TI connectors, a strip of metal – the "contact" metal, usually gold – is bonded as a *50 to 75 micro-inch* inlay to a base "spring" metal.

When the connector is fabricated, the gold inlay appears at the point of contact, the only place it's needed. So even though it's non-porous, much thicker and far more reliable than gold plating, we can almost always offer our clad connectors for less than you'd pay for an ordinary connector.

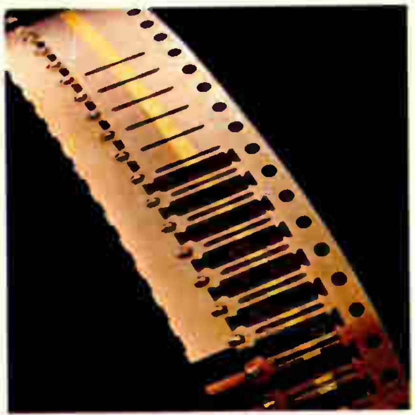
And because we manufacture our connectors from start to finish at a single site, you not only get a *low priced* connector, but a *high quality* connector, too.

Our toughest customer.

The technique of bonding one metal to another is simple in concept but difficult to execute. This probably explains why there are so few manufacturers of clad metal. Of these manufacturers, TI is far and away the

Clad metal strip material

from an ordinary connector.



Clad metal strips are stamped into contacts by high speed presses.

largest in the world.

We are also the largest semiconductor manufacturer, which gives us an intimate knowledge of connectors and their electrical requirements. So as we developed our clad metal capability, we were able to apply it intelligently and immediately to our connectors.

And since we use our own connectors in many of the products we make, we get direct and rapid feedback from one of the most exacting manufacturers in the electronics industry.

In short, we're our own toughest customer. Which is why our connectors have to be the best.

Cross Section of H4 Series Edgeboard Connector

Custom features, standard prices.

TI's gold inlay is easy to spot. But there are other features, usually associated with customized connectors, that aren't so easily seen. These features come with all standard TI connectors and sockets, along with off-the-shelf availability. They include the following:

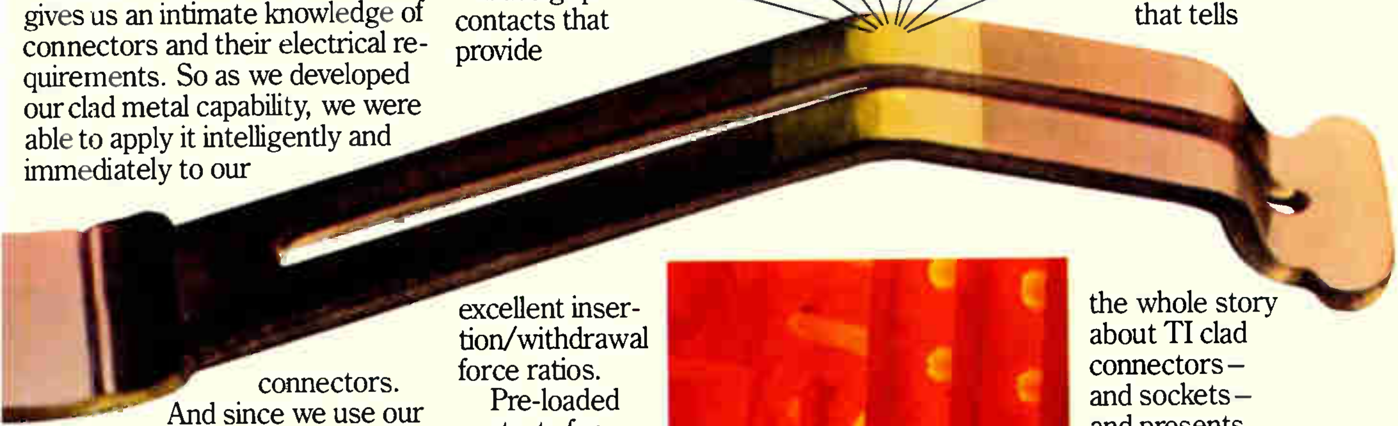
A special edge grip contact design that maximizes contact pressure and permits fast, positive insertion.

Face grip contacts that provide excellent insertion/withdrawal force ratios.

Pre-loaded contacts for faster, easier production insertion of IC's.

And individually replaceable contacts which can be changed without removing an entire socket from its mounting.

In most cases you'll be able to find the connector you need among our standard offerings. But if you have a complex or unusual application that calls for a custom-designed connector, tell us about it. We've helped hundreds of customers with such problems. And chances are, we can help you, too.



Fire assay helps Texas Instruments metallurgists determine precious metal purity, fundamental to achieving high reliability.

H4 Series Edgeboard Connector

Ask for our catalog. It's beautiful and it's free.

Now that you know there's a big difference between clad connectors and ordinary connectors, you'll probably want to see what we have to offer. We have a fascinating catalog – "The Texas Connection" – that tells the whole story about TI clad connectors – and sockets – and presents the products in detail with accompanying descriptions, illustrations and specifications.

For a copy, just call or write Texas Instruments Incorporated, Connector Systems Department, Mail Station 2-16, Attleboro, Massachusetts 02703. Telephone (617) 222-2800, extension 268, 269 or 7327.

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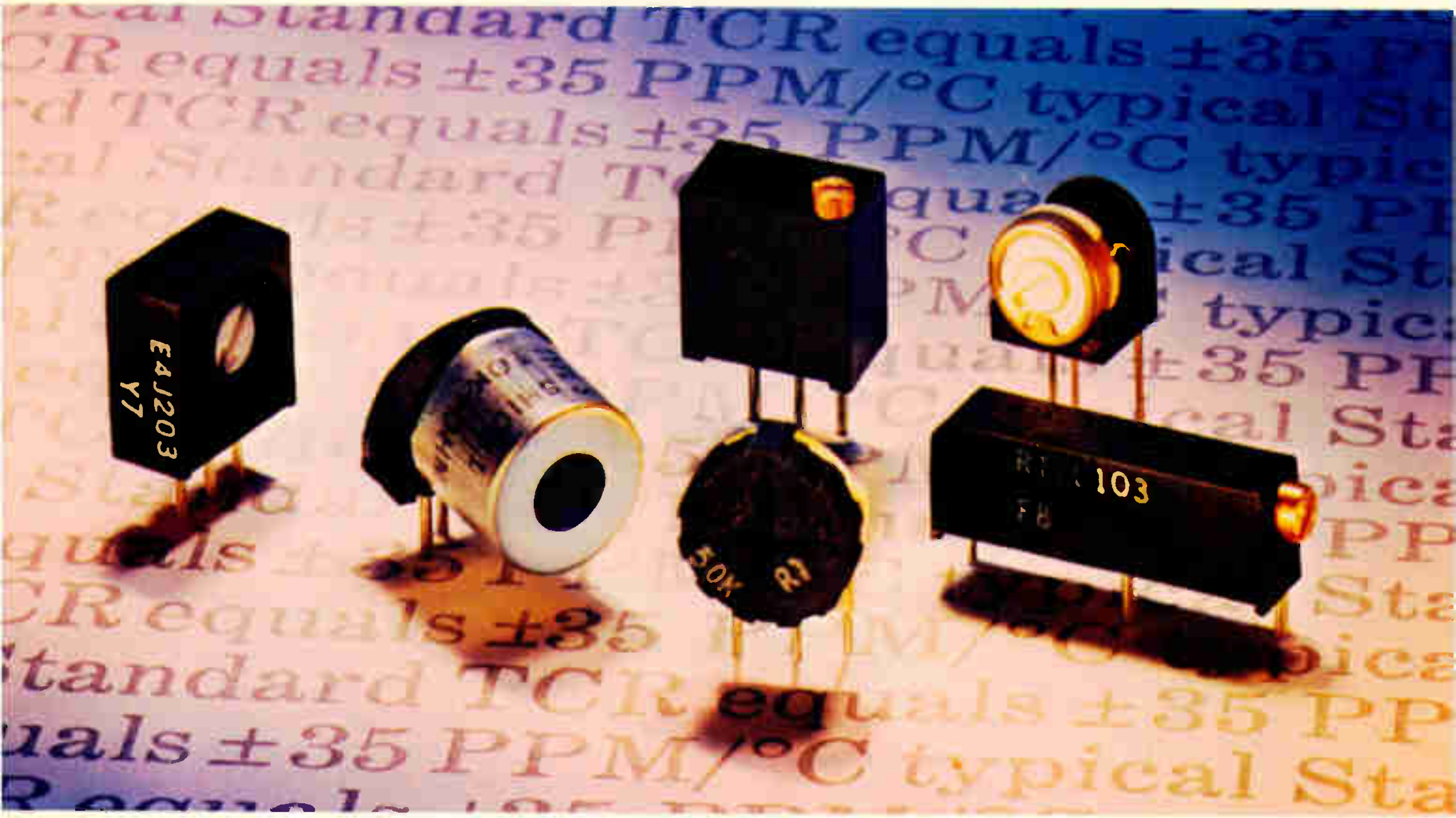
TYPE	TCR LESS THAN 500 OHMS	RESISTANCE RANGE AND TOLERANCE	POWER RATINGS	OPERATING TEMPERATURE RANGE	PUBLICATION NUMBER
A	ALL ±35PPM/°C TYPICAL	10 ohms to 2.5 megs ±10%	0.5 W @ 85°C	−55°C to +150°C	5238
D		10 ohms to 2.5 megs ±20%	0.5 W @ 70°C	−55°C to +125°C	5240
E		10 ohms to 2.5 megs ±10%	0.5 W @ 70°C	−55°C to +125°C	5219A
S		50 ohms to 1 meg ±10%	0.5 W @ 85°C	−65°C to +150°C	5208
*MT		100 ohms to 2.5 megs ±20%	0.5 W @ 70°C	−55°C to +125°C	5241
*RT		10 ohms to 2.5 megs ±10%	1.0 W @ 40°C	−55°C to +125°C	5237

*20 turns nominal. All others single turn.



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Circle 32 on reader service card

Electronics newsletter

Japanese mission seeks to assuage semiconductor houses

While the United States government is organizing missions to Japan to promote exports, Japan is about to send a mission to the U. S. in hopes of easing the tension caused by its aggressiveness in American semiconductor markets. To this end, the chief executives of major Japanese semiconductor firms are holding **seminars in Palo Alto on Nov. 14 and in New York on Nov. 16.** Manufacturers involved are Hitachi, Fujitsu, Nippon Electric Co., Matsushita Electronics, Toshiba, Mitsubishi Electric, Tokyo Sanyo Electric Co., and Sharp.

In Palo Alto, mission head Toshihiko Kubo, executive vice president and director of Hitachi, will lead off the proceedings, followed by Robert Noyce, chairman of Intel Corp., who will present the American point of view. Talks will also be given by Charles Sporck, president of National Semiconductor Corp., and by deputy mission head Shoichi Akazawa, vice president and director of Fujitsu Ltd.

Wyle's Spiegel sees signs of double ordering

Is "double ordering" of some electronic components from multibranch distributors, often the first sign of overheated business conditions, starting? At least one distributor executive believes it may be. **"Our bookings for memories are double our shipping rate,"** observes Sidney L. Spiegel, group vice president of western-based Wyle Distributors Group. He and other distributors keep close tabs on double ordering, which overstates demand and skews business projections. It reached record levels preceding the 1974–75 recession, but in today's confusing marketplace, it's still not clear whether the memory shortage is repeating history, he admits.

Motorola to talk about 6800 at Munich

With samples scheduled for 1979's first quarter, Motorola Inc. is going ahead with plans to reveal additional details on the MC 6800 at the big Electronica show in Munich, Nov.8–10. **Billed as the first 16-bit microprocessor to offer various 32-bit capabilities,** the 6800 won't be available in large-volume quantities until the second half of 1979.

32-digit LCD on one substrate coming from Crystaloid

The first liquid-crystal display to hold 32 alphanumeric digits (0.284 inch high) on a single substrate has been introduced by Crystaloid Electronics Co. of Hudson, Ohio. Arranged in a multiplexed 5-by-7-dot matrix scheme, all of the unit's **control and drive circuitry is on a board mounted in back of the 7.5-in.-long display.** The complete unit sells for $395, while the LCD without circuitry goes for $75. Meanwhile, Static Systems Corp., New York, N. Y., has announced a 64-character LCD for $95, built to its specifications by Crystaloid. Both displays are slated to displace light-emitting-diode and plasma-discharge displays in word-processor terminals.

Xincom tester aims at high-speed ICs

Joining the firms offering systems to test the new generations of high-speed semiconductor memories (see p. 171), Fairchild Camera & Instrument Corp.'s Xincom Systems division is about to take the wraps off a 25-MHz memory tester. Designated the 5582, the system will be unveiled at next week's Annual Test Conference in Cherry Hill, N. J. It is designed **to test new emitter-coupled logic and high-performance MOS static random-access and read-only memories** requiring cycle times down to 40 ns and pulse widths of less than 10 ns, with fast rise and fall times.

Electronics newsletter

System attains 1-μm lines with through-lens feature

Printing LSI circuits with lines down to 1-μm wide in a mass-production environment will be possible with a step-and-repeat lithographic system soon to be unveiled by Electromask Inc., Woodlands Hills, Calif. The model 700 "wafer stepper" attains its high resolution with a design that allows alignment directly through the lens on the wafer, without external reference targets, according to the company. **It provides layer-to-layer registration of 0.25 μm** and handles 3-, 4-, or 5-inch wafers.

8-bit converter has interfacing logic on chip

Eyeing potential markets in home computer, instrumentation, and low-end process control applications, National Semiconductor Corp. is about to spring the first monolithic 8-bit analog-to-digital converter to have all microprocessor-interfacing logic on chip. **It takes no additional components to interface the Naked-8 with Intel 8080-class microprocessors,** including the Zilog Z80, and only one additional component for the Motorola 6800. Called the ADP 0801, the chip features a 65-μs conversion time, 0.5% accuracy, and a low price: $3 or less.

Schottky TTL from TI aims at speed, low power

Whether an application calls for blinding speed or super-low-power consumption, it will be covered by one of two new Schottky TTL families expected soon from Texas Instruments Inc. One line of parts will feature speed: gate delays below 3 ns are anticipated, though power dissipation may run to slightly more than 20 mw per gate. **But a second line is expected to offer typical power dissipation of 1 mw per gate**—half that of currently available low-power Schottky parts—with gate delays of about 5 ns. Fairchild Camera & Instrument Corp. recently began shipping samples of a new Schottky TTL family with typical 3-ns gate delays and 4-mw typical power consumption per gate.

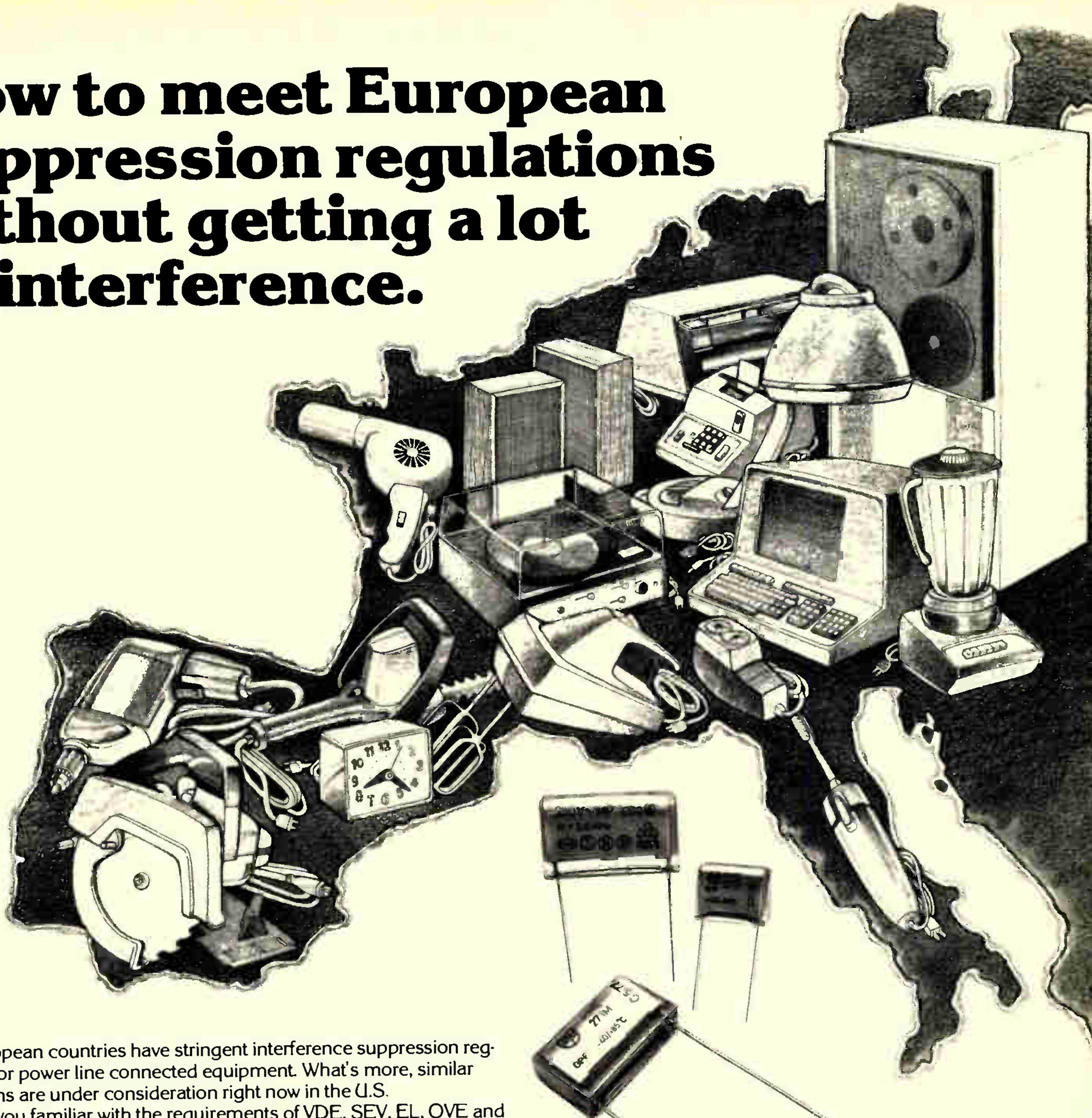
Fairchild plans 9445 follow-on on 16-bit chip

A key part of Fairchild Camera & Instrument Corp.'s suit against Data General Corp. (p. 55) is the upcoming 9445, a follow-on to the 9440 16-bit microprocessor [*Electronics*, Jan. 5, p. 56] that will emulate Data General's Nova 3 computer, including its stack instruction features. Due in the second quarter of 1979, **the 9445 will have higher instruction speeds because of a full 16-bit-wide internal data path,** compared with the 9440's four 4-bit nibbles, and a very fast on-chip hardware multiply-and-divide circuitry, according to Thomas A. Longo, vice president and chief operating officer.

Addenda

Three former Mostek engineers who left to join the British-government-backed Inmos Ltd. **have now left to start their own firm in Dallas,** Micron Technology Inc., which will do engineering and graphics consulting. The three are Ward D. Parkinson, Dennis R. Wilson, and Douglas R. Pitman. . . . In another attempt to develop an electronic system for keeping track of railroad freight cars, **researchers are turning to fiber optics.** Union Pacific Railroad is trying a system from General Cable Corp. and Corning Glass Works. . . . Western Electric International Inc. of Greensboro, N. C. is negotiating to sell its latest digital toll switch, ESS-4, to Taiwan. . . . By 1983, the U. S. military and aerospace market for display systems will be $1.8 billion, **nearly double last year's $921 million,** says Frost & Sullivan Inc. of New York.

How to meet European suppression regulations without getting a lot of interference.



PME 271 SERIES interference suppressor capacitors shown actual size.

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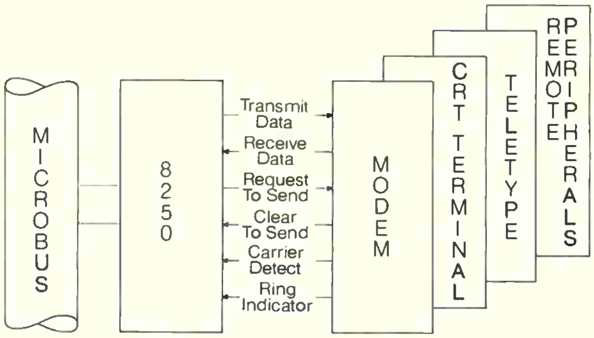

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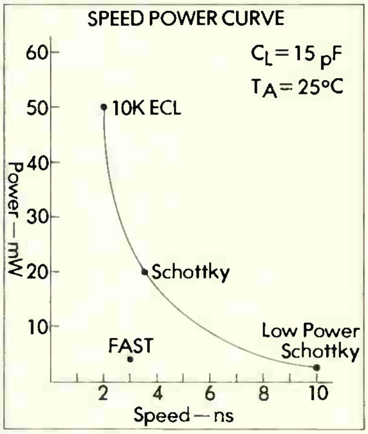

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Air Force working on single language for its computers

Jovial-based language will be used for weapons R&D and support; goal is to cut software costs drastically

Air Force developers of weapons-system computers and the commands that must support them are developing a single software language based on Jovial. The effort is described by Gen. Alton D. Slay, head of Air Force Systems Command, as "a frontal attack with our R&D dollars" designed "to cut our software costs radically."

Leading the development is Col. Robert F. Ziernicki, assistant deputy chief of staff/development plans. He is responsible for software systems architecture and integration.

How radically can software costs be cut without affecting system performance? Gen. Slay calls the savings potential "perhaps greater than any other single effort we can undertake." Col. Ziernicki concurs, noting that the cost of a single line of debugged software is now $300 and that the operational flight program for a single system like the Precision Location/Strike System contains some 500,000 lines.

Under development. The ground-based PLSS, now being developed by Lockheed Missiles & Space Co., uses a Control Data Corp. AN/UYK-25 computer to process intercepted electromagnetic emissions received from enemy tactical air-defense radars for air-strike planning [*Electronics*, Oct. 27, 1977, p. 57].

Working with Col. Ziernicki at Systems Command, which oversees development of aircraft, missiles and electronic systems, is the Air Force Logistics Command headed by Gen. Bryce Poe II at Ohio's Wright-Patterson Air Force Base, which is responsible for supporting more than 40,000 computer systems. If AFSC and AFLC can successfully use a single Jovial-based language for both weapons development and support, Gen. Slay sees the program spreading "across broad system classes like avionics, C³ [command/control/communications], space, and armaments." It also "opens the possibility of sharing development and support networks, conserving scarce personnel skills, and even reusing software programs across systems."

Also heavily involved in the development of the single language called J-73/I, says Col. Ziernicki, are New York's Rome Air Development Center and Ohio's Air Force Avionics Laboratory. The first is working on the language itself, the second on the evolving language's instruction set on the AN/AYK-16A computer used in the Digital Avionics Information System for cockpits of the future, now in development [*Electronics*, Feb. 6, 1975, p. 76].

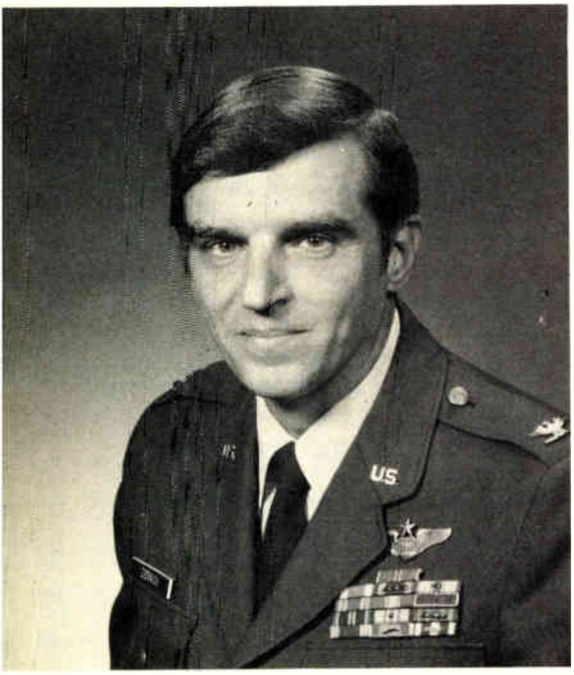
Timetable. J-73/I, as a first-stage derivative of Jovial, will serve as "an interim language," says Ziernicki, until the Defense Department is able to implement its standard triservice language known as DOD-1 [*Electronics*, June 10, 1976, p. 45]. Present estimates are that this will take another five to six years. In the meantime, the joint AFSC/AFLC project is proceeding with J-73/I since it will give Air Force users experience with "proper programming requirements" and "development and sup-

Can Jovial spell DOD-1?

Jovial is a 20-year-old computer language developed for Air Force command-and-control applications by Systems Development Corp.'s Jules Schwartz. A block-structured programming language like predecessor Algol, Jovial derives its acronym from the name of its developer: Jules' Own Version of the International Algebraic Language. It is regarded as the first general-purpose programming language by its Air Force advocates.

Jovial was the Air Force entry in the Pentagon competition to come up with DOD-1, a planned single tactical-systems language that will be used by all three services. It seemed to have lost that competition, which is aimed at putting the brakes on escalating military software-hardware cost ratios that now stand near 9:1.

Now, with the disclosure of the joint Air Force Systems Command/Logistics Command single-language program, Jovial seems less like a loser, even though the language is supposed only to hold the fort until DOD-1 is fully developed years from now. "DOD-1 has been kicking around [in the Pentagon] for more than a year now," notes one corporate representative in Washington familiar with the developments in software. "I've got to wonder if the initial plan for DOD-1 is not really the loser after all, or if the plan has just bogged down. Either way, I feel we haven't heard the end of Jovial."



Director. Col. Robert F. Ziernicki is leading the Air Force's software effort, which teams Systems and Logistics Commands.

port perspectives" transferrable later to DOD-1, Ziernicki explains.

Softech Inc., as developer of the J-73/I compiler, is the principal corporate beneficiary of the project thus far. The Waltham, Mass., company—a losing finalist in the DOD-1 competition—has delivered five of the compilers, including one at RADC, which is using it in its language effort called Jocit, for Jovial compiler and implementation tool set.

Three other compilers are being used by AF system contractors, including Boeing Co. on the space shuttle's upper-stage launch vehicle, Martin Marietta on its single-seat attack fighter development, and Westinghouse on the military program known as EAR, for electrically agile radar.

Studies. Before beginning development in October 1979 of two prototype J-73/I standard software support and development facilities, however, much remains to be done, Col. Zeirnicki points out. Over the next 60 to 90 days, three parallel studies will identify program costs, the software system's capacity and layout, and project system requirements. These will be followed by a six-month analysis phase involving the Logistics Command's five centers and System Command's four product divisions "to look at what is out there and also at what should be out there," Ziernicki says. The analysis will identify what Gen. Slay calls "critical paths, nodes, and redundancies" that will lead to a standard architecture for weapons software support. Testing of the two prototypes should get under way in the summer of 1980, Ziernicki says. □

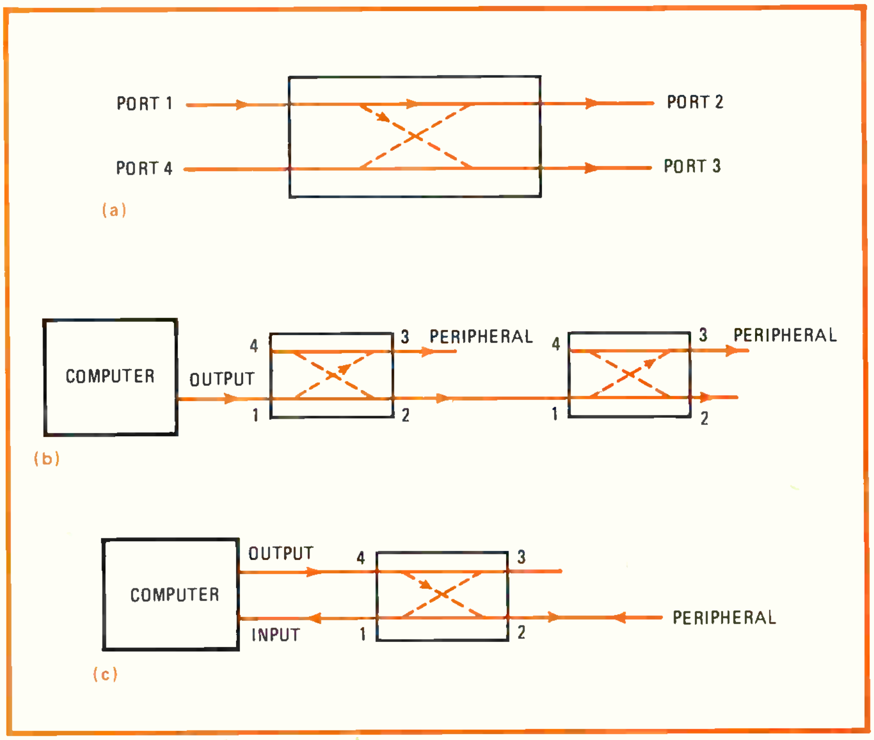
Fiber optics

Directional coupler from Canadian firm can be tailored to light-wave systems

Need a directional coupler for microwave frequencies? Generally, all you need do is select one from a catalog to meet your requirements of insertion loss, directivity, and coupling coefficient.

Need a directional coupler for a fiber-optic light system? Well, it isn't nearly that easy. The few makers of the devices operate as people did back in the late 1940s and early 1950s in the early days of microwave couplers: it might be possible to pick one parameter—coupling, for example—but that would mean learning to live with whatever other two parameters the manufacturer is able to obtain.

No one fully understands how to design the fiber-optic coupler. At least, this had been the situation until a small Canadian development company, Canstar Communications Ltd. of Scarborough, Ontario, tackled the problem. For two years, Canstar has investigated the mechanisms that govern coupling and insertion loss within the fiber-optic couplers. And, according to applied physicist Alexander Lightstone, who



Versatile. Canstar's coupler (a) can be used to couple two or more peripherals to a computer (b), with the decoupled port usually terminated. The coupler can also be used in a duplex mode (c) that carries information to and from a computer and a peripheral.

is components group leader at Canstar, it now knows enough about how the couplers operate to offer coupling up to 40% with insertion losses below 1 decibel along with 40-dB directivity. Moreover, at $200 each without connectors, the couplers are priced comparably to microwave directional couplers.

Four ports. Like their microwave counterparts, the couplers themselves are four-port devices with combinations of ports chosen to yield either taps or feeds. Used as a tap, the coupler takes optical power from a single channel and distributes it among one or more secondary channels. This would allow several computer terminals, for example, to be attached to a single data bus. Used as a feed, the coupler conveys signals from one channel to another or meshes channels into or out of an optical source.

Light is handled in the Canstar coupler much as microwaves are in a conventional directional coupler. For example, light entering through port 1 couples to ports 2 and 3 with none going to port 4, as shown in part a of the figure on page 40. The port 4 fiber is, ideally, totally uncoupled—coupler directivity could be infinite, but above 40 dB is typical.

The coupler insertion loss—a measure of the optical power lost in the device—is well below 1 dB. Perhaps most important, the actual coupling between ports 1 and 3 can be chosen as required from close to zero percent on up. Moreover, a major advantage of Canstar design procedure is that it is applicable to couplers for a wide variety of glass-clad graded- or step-index fiber as well as plastic-clad fiber.

Applications. A major application of these devices is interfacing peripherals to a main computer. As shown in part b of the figure, a typical setup, each peripheral has its own coupler; the couplers, in turn, are connected in line with the main computer output. If the coupler were not available and a single fiber were used to hook up the peripherals, repeaters would have to be included because of excessive insertion loss.

The high directivity of the coupler also allows the system designer to hook peripherals to the computer in a duplex mode. In this case, port 3 is terminated so that any light reaching it is absorbed. A laser or light-emitting diode of part c of the figure, which acts as the data output of the computer, feeds light into port 4.

This light leaves port 2, proceeding away from the coupler to the peripheral. Light signals sent from the peripheral arrive at the computer through port 1 which is connected to the computer input detector—a p-i-n diode or avalanche photodetector. The high directivity of the coupler causes light signals to stay in their transmission paths; no false inputs are given the computer. □

Making the coupler

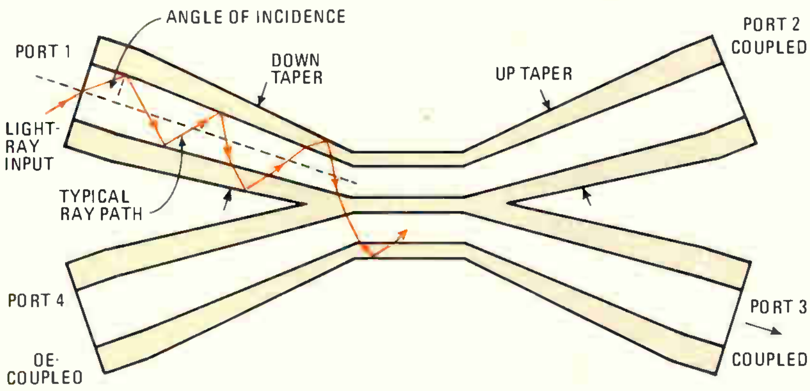
The fact that light could be coupled from one optical fiber to another was first noticed by users of the cystoscope—a medical device. This instrument had many fibers fused into an array for image transmission. Unfortunately for the cystoscope user, image degradation occurred because light would leak or couple from one fiber to another in close proximity. This discovery led to the first fiber-optic directional coupler, in which fibers were purposely fused together so that light would leak from one to another.

In principle, the fused fiber couples light from the fiber cladding rather than the fiber core. Some light always exists in the cladding, because the core-cladding interface never reflects all the light back into the core.

Couplers made using this fusing technique have a coupling coefficient of only a few percent. It turns out, however, that more light can be forced into the cladding and the coupling coefficient increased by adding a taper to the fiber—this is Canstar's approach.

In Canstar's tapered fiber, light is forced into the cladding by decreasing the angle of incidence at the cladding-core interface as a light ray proceeds down the taper, as shown in the figure. Ultimately, the angle is too small for the ray to be totally reflected and substantial light enters the cladding. This is reversed—but not completely—in the "up" taper portion following the interaction region.

The taper angles, proximity of the coupled cables, interaction length, kinds of materials, and their dimensions are all variables that Canstar has reduced to a series of design equations in order to tailor-make its coupler.



Light adds reliability to drafting system

The very expensive computer-aided drafting and mechanical-design system installed at Grumman Aerospace Corp. in Bethpage, N. Y., works very well—except during the summer and fall. Then, ground currents induced by the frequent lightning storms in the area may destroy the quality of information transmitted in underground cables that connect the central computer to remote drafting sites.

"Even though the circuits are protected in cable and conduit, we

Cable hits 53 km without repeaters

The attenuation of fiber-optic cable continues to drop and the latest result—a mere 0.66 decibel per kilometer from Nippon Telegraph and Telephone Public Corp.—has allowed a working pulse-code-modulation system over lines 53 km long with no repeaters. As if this weren't enough, NTT expects to be able to go to 70-km spacing by boosting the 1.27-micrometer operating wavelength into the 1.4-to-1.7-μm region.

Such spacing is two to eight times better than current systems. It is done with a graded-index 60-μm-core, 150-μm-clad multimode fiber propagating 32-megabit-per-second return-to-zero pulses.

The secret of the Japanese firm's success is probably the extreme dimensional precision of the high-silica fiber at a 1.27-μm wavelength. The more perfect the fiber's cylindrical shape, the less the loss of the energy traveling down the line. The key questions of course are: can this cable be produced in quantity? and what will it cost? It is too early for the answers, however.

The researchers at the company's Electrical Communication Laboratory in Yokosuka point out that the long repeater spacings will contribute heavily to the practicality of fiber-optic communications systems. They expect such practical results as siting repeaters in offices instead of in manholes, so that system operating costs will drop considerably.

To make the 53.3-km cable, NTT spliced 22 2.4-km-long pieces by fusing the fiber ends. The total loss, including the splices, was 35 dB at 1.27 μm, with an overall equivalent transmission bandwidth of 17 megahertz. This somewhat low bandwidth will have to be increased for the proposed 70-km system: too narrow a bandwidth tends to distort the transmitted pulses and cause reception errors. The system has a bit-error rate of 10^{-9} with a received power of -43.1 dB per meter, acceptable for long-distance PCM systems.

may get garbage instead of pictures when there is a lightning strike to ground," says Grumman's John J. Mooney. He is an engineering specialist in the engineering and manufacturing systems group that is helping to solve the problem by designing and installing fiber-optic data links between the computer and the cathode-ray-tube displays and precision plotters at the remote work stations.

Although the new system has not yet been installed, its hardware has been checked out and, says Mooney, it is clear it will work properly and prove more reliable. "Actually pulling the cable through the existing conduits shouldn't cause any problems," he says. "All our tests were done through the length of cable that will be used while [the cable] was still rolled on its drum.

"We expect to hook up about seven locations over the next couple of years," he continues. Bandwidth will not be a problem. "The system can handle up to 100 megabits per second and one remote site uses only about 4% of that."

Mooney points out that the system, which generates, maintains, and updates engineering drawings and other graphics and which supplies hard-copy output, will be one of the most sophisticated applications yet for fiber optics. It will also allow Grumman to use far fewer repeaters. The present coaxial-cable system requires expensive and difficult-to-maintain repeaters about every 700 meters, while the new fiber-optic cable will carry signals for 2 kilometers without a repeater.

Grumman is installing the first part of the system using MGO-5 graded-index cable with less than 6-decibel/km attenuation made by Valtec Corp. The cable will join an IBM/370 computer at Grumman's headquarters to an interactive Versatec plotter/display terminal made by Xerox Corp. in a building more than 3 km away with one repeater. Two-way transmission over the cable is controlled by Valtec TTK-D 1/A data links—at the computer, at the remote site, and at the repeater.

Each data link is compatible with transistor-transistor logic and con-

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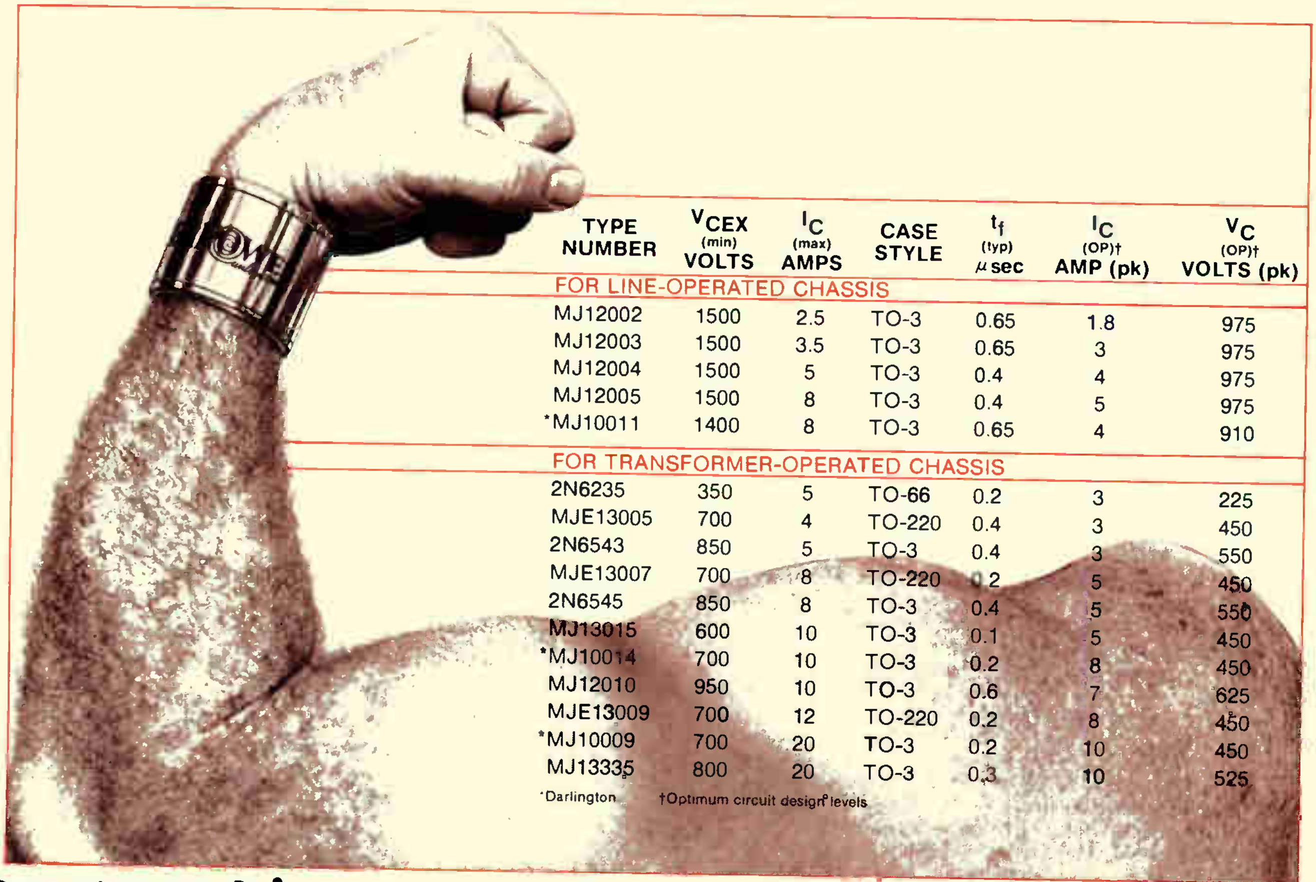

TYPE NUMBER	V_{CEX} (min) VOLTS	I_C (max) AMPS	CASE STYLE	t_f (typ) μsec	I_C (OP)† AMP (pk)	V_C (OP)† VOLTS (pk)
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MJ12003	1500	3.5	TO-3	0.65	3	975
MJ12004	1500	5	TO-3	0.4	4	975
MJ12005	1500	8	TO-3	0.4	5	975
*MJ10011	1400	8	TO-3	0.65	4	910
FOR TRANSFORMER-OPERATED CHASSIS						
2N6235	350	5	TO-66	0.2	3	225
MJE13005	700	4	TO-220	0.4	3	450
2N6543	850	5	TO-3	0.4	3	550
MJE13007	700	8	TO-220	0.2	5	450
2N6545	850	8	TO-3	0.4	5	550
MJ13015	600	10	TO-3	0.1	5	450
*MJ10014	700	10	TO-3	0.2	8	450
MJ12010	950	10	TO-3	0.6	7	625
MJE13009	700	12	TO-220	0.2	8	450
*MJ10009	700	20	TO-3	0.2	10	450
MJ13335	800	20	TO-3	0.3	10	525

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nects to an interface designed by Grumman—actually a data formatter that converts 1.056-megabit-per-second parallel data coming from the Versatec controller at the computer center to a 4.224-Mb/s serial stream that is transmitted over the data link. The formatter at the remote location reconstructs the serial data into parallel data for controlling the Versatec unit.

The formatter also handles parity checks and provides idle data transmission for the system's standby mode and retransmission in the event of a missed handshake signal. An overall error rate of less than 1 part in 10^9 is maintained in a nonreturn-to-zero format. □

Standards

IEEE-488 bus to get face-lift

Things are happening to the IEEE-488 interface specification, the document adopted in 1975 by the Institute of Electrical and Electronics Engineers to spell out how test and peripheral instruments may communicate over a standard bus. Apparently, the spelling out first time round was not done carefully enough, according to Don Loughry, secretary of the IEEE subcommittee on instrument/computer interfaces.

The IEEE is finishing up a new version of the specification to clear up the textual ambiguities of the original—its unclear writing, as Loughry puts it. In addition, a brand new document is being drafted that will recommend code and format conventions for messages being sent on the bus—how many bits to use for a value of voltage, for example. Such recommendations were purposely excluded from the original specification, which details electrical, mechanical, and functional characteristics of the 16-line interface bus, because it would have taken too long to consider all the alternatives, says Loughry.

"We would still be without the bus standard itself if we had attempted to tackle the code and format conventions in the original specification," explains Loughry, who is also an interface engineer in the Computer Systems group of Hewlett-Packard Co. in Cupertino, Calif. Hewlett-Packard originally developed the specification for its own use before it was adopted by IEEE.

Compatibility. Defining how the messages should look on the interface bus will not be easy. "We will try to be general enough in our suggestions for message formats that the greatest number of device manufacturers will be able to conform," Loughry says. "And we will also provide code and format alternatives for solving a given message problem for the same reason."

Loughry is also quick to point out that IEEE-488 bus users need not fret about the new version of the spec. "Most of the changes will be editorial in nature, and all will be compatible with what has gone on before," he says. "Present users won't be left out in the cold."

As an example of what is being done, he cites the way the document at present defines procedures for data-transfer rates. These can be as high as a megabyte per second over limited distances, but there simply is not enough detail, he says. "Part of the rewrite will explain more fully just what the system designer need do to attain this high speed."

And, although there will be technical changes, the changes will not negate old information. "For example, the low level for transistor-transistor-logic drivers is currently 0.4 volt," Loughry continues. "But the new Schottky devices can't get down to that level, so that value will be increased to 0.5 V—which really represents a broadening of the specification to allow for integrated circuits introduced over the last three years."

Future bus. The future of the IEEE-488 interface looks bright. As many designers have discovered, its use is certainly not limited to instruments. In fact, some are calling it the microcomputer bus of the future. As microcomputer architectures mature to include sophisticated distrib-

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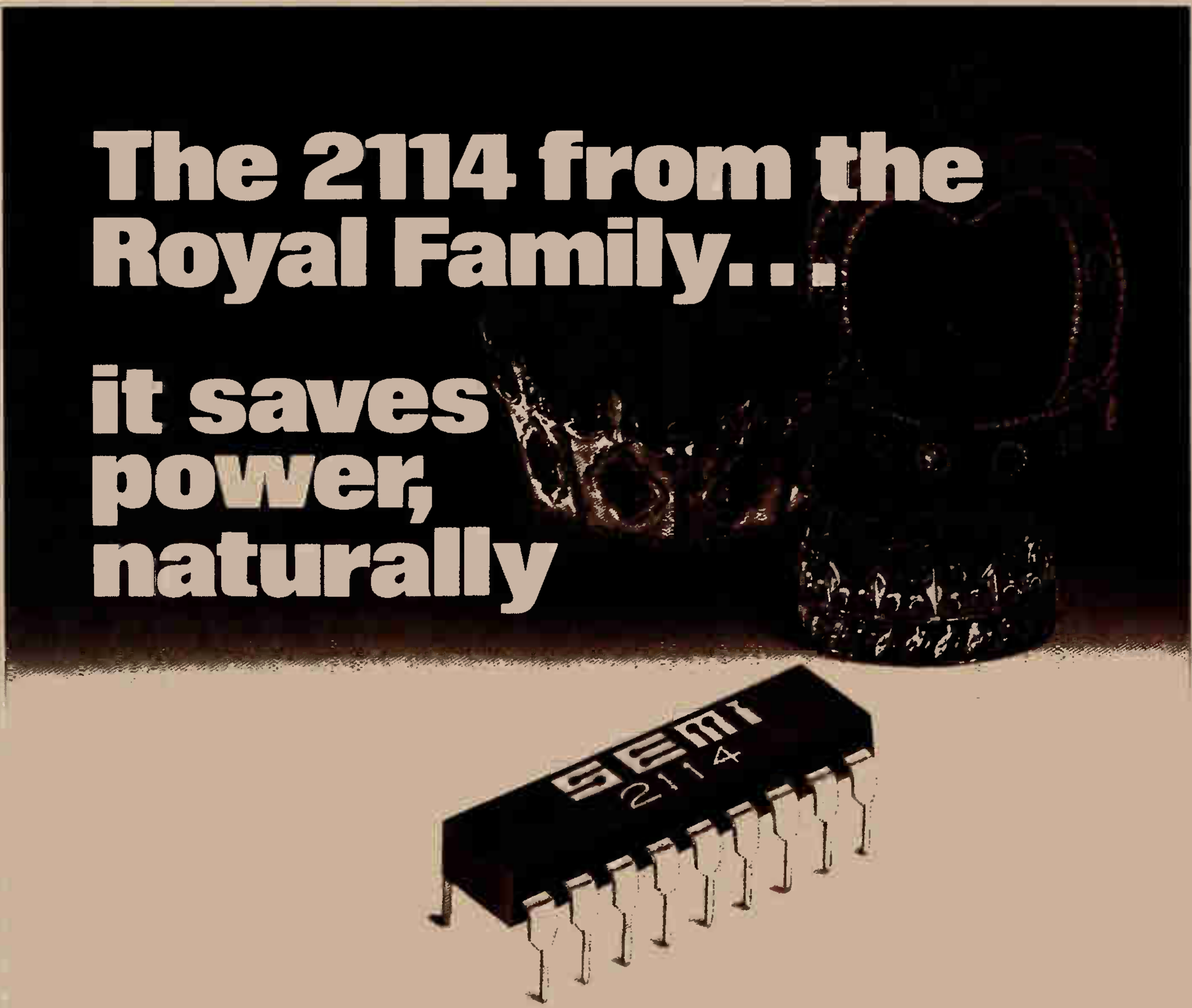

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Before a standard receives full blessing from the IEEE, it must pass an arduous review. First, a committee creates the document. Then, other groups vote on the standard. This balloting is more than the familiar casting of yeas and nays, however. The negative points must be reconciled, before the document is approved, says Loughry.

The revised IEEE-488, for example, has been reviewed by Loughry's subcommittee, the IEEE technical committee, and the IEEE standards board. It is now an official standard awaiting printing and distribution, which should occur by the end of this month. The new document that contains recommendations for code and format conventions for the bus will "hopefully be in the balloting process by the end of the year," says Loughry. □

Solid state

LED hits fiber's loss low point

While some companies struggle to achieve long-lived lasers for the emerging long-distance telecommunications market, others, espying a large near-term business in shorter-range communications, are developing light-emitting diodes as fiber-optic light sources. But while LEDs are simpler to use than lasers, they do not emit the 1.27-micrometer wavelength optimum for most silica fiber strands.

By adding phosphorus to the mix of ingredients, Varian Associates has come up with a new indium-gallium-arsenide-phosphide structure for an LED that emits at the 1.27-μm wavelength. This is where the silica used in fiber-optic cables has an attenuation minimum. Moreover, Varian, which describes the LED late this month at the Third International Conference of Electroluminescent Devices in San Francisco, says it can tailor the emission to any wavelength between 1.05 and 1.35 μm simply by varying the doping in the active layer of the InGaAsP diode. This tailoring could be extremely useful for meeting the requirements of various combinations of distance, cable, and receiver characteristics says Varian senior scientist George Antypas at the central research facility in Palo Alto, Calif. Essentially, more gallium in a device means a shorter wavelength, and more arsenic a longer one.

Samples. Now being offered in sample quantities, the diode is billed by Varian as the first to be available commercially at a wavelength above 1 μm. It has a typical output power of 0.5 milliwatt at 50-mA forward current. It can be modulated at rates up to 50 megahertz, which covers most pulse-code-modulation and digital communications applications.

The importance of the phosphorus is that it improves the lattice matching between the device and the substrate to provide "for a defect-free interface devoid of electron traps," Antypas explains. This lowers the defect density and improves the quality of the substrate so the LED can generate more light.

In making the LED, Varian capitalized on its experience in producing InGaAsP photomultiplier tubes and indium-phosphide substrates for semiconductor lasers, microwave devices, and other products. It makes the high-radiance Burrus-type LED by successively depositing, on an indium-phosphide substrate, a 1-to-3-μm n-type InP layer, a 1-to-3-μm InGaAsP pn junction, a 1-to-2-μm n-type InP layer, and a final 0.5-to-1-μm InGaAsP layer that provides lower resistance with the contact layer than would a p-type InP layer, Antypas says. Then, so that the LED can connect directly to a fiber, a well 1 mil deep by 8 mils wide is etched into the substrate side of the device. Conventional photolithographic techniques form the con-

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tact windows. The LED measures 15 mils on a side and is 2 mils thick.

Varian targets the patented devices for telecommunications in local traffic operations, high-speed data communications for computer networks, and military applications, such as on-board vehicle control systems and wire-guided missiles. As for lifetime, Varian tests at temperatures of 25°C show negligible degradation over several thousand hours, says engineer Philip Wright.

He points out that experiments elsewhere show tens of thousands of hours of life for InGaAsP lasers, a factor he believes applicable to Varian's diode. Varian also is working on an InGaAsP detector to match the 1.27-μm wavelength. It would replace noisy germanium photodiodes or bulky photomultipliers. □

Computers

Powerful desktop systems offer small-business users wide choice

Although industry pundits think sales of microcomputer systems to small businesses won't take off until the 1980s, the competition among manufacturers is already heating up. At the center of the battle are systems small enough to fit atop a desk that are sold, rather than leased, with standard peripherals and software.

The importance of this self-contained approach will be underscored by Pertec Computer Corp. early next month, when it joins the fray with its PCC 2000 desktop unit. Selling for about $13,000, the computer, from the company's Microsystems division in Chatsworth, Calif., is based on an Intel 8085A microprocessor and has 64 kilobytes of main memory, two double-density floppy-disk drives, a 12-inch video-display monitor, and a detachable 63-character alphanumeric keyboard.

Los Angeles–based Pertec is aiming the new PCC 2000 at small businesses with between $250,000 and $5 million annual sales, says B. Allan Lay, senior vice president for systems. This is the market Pertec has been aiming at since it acquired personal computer manufacturer MITS Inc., Albuquerque, N. M., early in 1977. Apparently Pertec has not had the success it hoped for with the "mix-and-match" catalog of computer components offered by

Business type. Pertec's new desktop unit sells for $13,000. Built around an Intel 8085A microprocessor, it comes with a pair of double-density floppy-disk drives.

MITS. So Pertec's new unit is "already configured to the market, not in bits and pieces that have to be assembled," Lay says.

Not so new. Desktop computers have been around since the days of Hewlett-Packard Co.'s 9830 "programmable calculators," introduced by what is now the Desktop Computer division, Santa Clara, Calif., in 1972. Wang Laboratories Inc., Lowell, Mass., entered with its 2200 in 1973, and IBM Corp.'s General Systems division, Atlanta, unveiled its portable 5100 in 1975. But now competition is increasing.

Wang's Personal Computer System, or PCS-II, introduced last year, is priced at $10,600 with 32 kilobytes of memory, whereas HP's latest, the 9835, starts at $9,900 with 64 kilobytes of memory [*Electronics*, Sept. 14, p. 241]. IBM's newest 5110 offers two to three times the power of the 5100 [*Electronics*, Jan. 19, p. 50] and ranges in price from $9,875 to $32,925. Datapoint Corp., San Antonio, Texas, entered a year ago with its 1500 system priced at $5,950, with 32 kilobytes of memory and dual floppy-diskette drives.

Pertec plays down the importance of flashy computer performance, "because the latest one out with the newest components is likely to be best," Lay says. What will determine the staying power of these small computers, as he and most others see it, is the quality of software and maintenance and service support. Pertec has a variety of software applications packages, plans to sell its PCC 2000 through a nationwide network of dealers, and has its own service company. □

Is there magic in a name? SDS debuts again, with new business computer

Chiming in with another desktop microcomputer with production slated for November is a brand new company with an old name that most should recognize: Scientific Data Systems Inc.

SDS is bringing out its model 420 to fill a product void, according to its president, Jack M. Mitchell. Present systems "have largely cornered the small-business market by virtue of the absence of equipment designed

LSI pares unit to 65 pounds with printer

By building on the latest large-scale integrated chips, tiny Durango Systems Inc., offers a desktop small-business computer that is performance-compatible with an IBM 5110 but would cost at least $5,000 less—and also weighs only 65 pounds. The Cupertino, Calif., company is the brainchild of another familiar computer name, George E. Comstock, founder and former president of Diablo Systems Inc., now a printer-making subsidiary of Xerox Corp.

Called the F-85, the computer contains a matrix printer, cathode-ray-tube display, and keyboard in one package. The use of high-powered LSI parts means that the system needs only four printed-circuit boards plus a motherboard, according to engineering vice president Charles Waggoner.

The processor board, for example, contains two 3-megahertz Intel 8085 microprocessors, all the input/output support chips, including a direct-memory-access device and an interrupt controller, 64 kilobytes of random-access memory composed of 16-K dynamic packages, and up to 8 kilobytes of read-only memory.

The diskette controller board is designed around a Western Digital 1781 chip; on the third board, another 8085 drives the printer circuitry. An Intel 8275 ROM character-generator chip sparkplugs the CRT, and the fourth board handles the motor drives for the analog printer. Waggoner says that instrumental in reducing weight was use of a 250-watt Boschert switching power supply that weighs only 4 pounds [*Electronics*, Oct. 12, p. 14]. □

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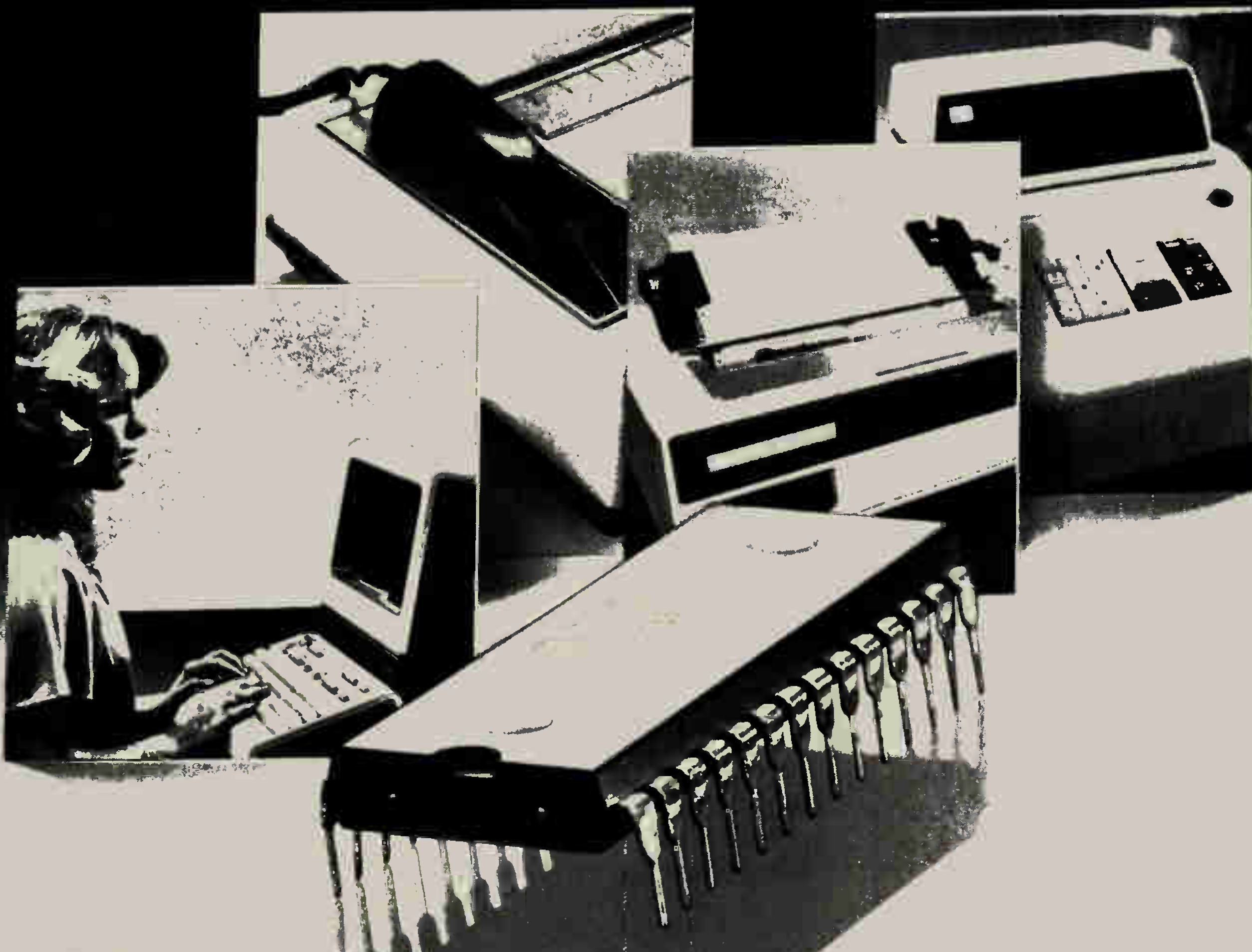

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specifically for small-business applications," he says. He believes systems selling for under $10,000 will create a big new market.

As may be remembered, computer entrepreneur Max Palevsky founded the original SDS in the early 1960s and sold it to Xerox Corp. in 1969 for nearly $1 billion in stock. Xerox changed the name to Xerox Data Systems, encountered troubles, then folded the company [*Electronics*, Aug. 7, 1975, p. 45].

Organizers of the new Scientific Data Systems picked up the name for a $200 fee from the California Corporations Commission after it entered the public domain when Xerox did not actively use it.

Low price. Mitchell's 420, which he designed, comes in with a $7,700 tab. Superior processing speed stems from employing a 6502 chip set from Rockwell International, which he believes is faster than other processors. Instruction times of the SDS 420 run from 1 to 3.5 microseconds, compared with the Pertec 2000's 1.6 and 6.0 μs. Basic memory is a 32-kilobyte static random-access unit, expandable to 56 kilobytes, with dual-disk drive providing 1.2 megabytes of storage. A separable keyboard and 12-inch video display complete the unit, which weighs 65 pounds and is in a cabinet 13 in. high, 20½ in. wide, and 25 in. deep.

The company has already built and tested six preproduction units, along with a software disk operating system. Manufacturing is starting in a West Los Angeles location, with deliveries set in six weeks or so.

Believable. Lending credibility to SDS's plans are the people making up the company. Mitchell himself designed the original SDS Sigma series computers. Other officers in the new group also were with SDS. Further, Mitchell says that Max Palevsky is an investor in the private placement that has just been completed, along with investment banker and venture capitalist Arthur Rock.

The firm is starting operations on a comparatively small scale, considering the heavyweight names involved, with less than $500,000. "But it was oversubscribed, and we had to turn people down," Mitchell says.

Mitchell also discovered the advantages of the SDS "old boy network," some of whom are now running competitive computer firms. "Dozens of people helped us out with designs, hardware, and business plans," he says.

If SDS faces a hurdle, it is the common one of how to sell the computers, Mitchell concedes. He plans now to go through the more than 1,000 retail computer stores in the U.S., then develop other marketing channels.

The problem is that few of the stores have personnel competent to sell even the simplest computers without extensive training. Lack of software constitutes a disadvantage, too, but he notes that many application packages written in the Basic language can be easily adapted. □

Peripherals

LSI chip yields next-generation CRT

Just as the latest generation of low-cost cathode-ray-tube terminals is getting off the ground, Perkin-Elmer Corp. is trying to leapfrog its competition. It is doing this with a CRT terminal built around a custom large-scale integrated chip that combines the functions of a microprocessor and a CRT controller.

The competitive terminals also feature LSI chips, but these perform one function or the other, not both. What's more, not only does Perkin-Elmer's new Bantam terminal pack more into its chip, but it costs less: $599 in quantities of 100 or more, about half the price of the older model 1100 from the firm's Randolph, N. J., Terminals division of the Data Systems Group.

Features. Slated for deliveries next month, the new model 550 terminal features upper- and lower-case characters, displays 1,920 characters with a 7-by-10-dot matrix, has a typewriter-style keyboard, and can operate at 11 asynchronous data

Terminal. Perkin-Elmer's David Ratcliffe leans on the Bantam terminal holding the key to its design—an LSI microprocessor-and-controller chip—and the components it replaces.

rates from 110 to 9,600 bits per second. Thanks to the custom chip, the unit has a variety of editing features previously unavailable in this price range: tabbing, full cursor addressing, repeating, backspacing, shift locking, and others.

The n-channel metal-oxide-semiconductor chip uses a single +5-volt power supply, is transistor-transistor-logic-compatible, and comes in a 40-pin dual in-line package. It can operate at either 50- or 60-hertz refresh rates.

One for six. David Ratcliffe, manager of product development for the Terminals division, says the LSI chip replaces a 6-chip board assembly, bringing the terminal's chip count to 19. It also reduces power consumption from 110 volt-amperes in the model 1100 to just 60 VA, he notes.

The chip's front-end microprocessor decodes incoming data to separate displayable characters from control signals, he explains. The back-end CRT controller generates the vertical and horizontal synchronization signals for the monitor. Rather than incorporate the character generator on the custom chip, Perkin-Elmer uses a separate read-only memory to store characters.

James Folts, vice president and general manager of the division, concedes that the custom chip is not as versatile as commercially available CRT controllers nor as powerful as most microprocessors. But by going the custom-design route, he says, Perkin-Elmer was "able to eliminate many unnecessary options found on existing LSI controllers and economically add intelligence instead." Moreover, it saved the expense of using a microprocessor, which he says is "grossly underutilized" in most low-end terminals.

The chip provides the timing signals for four types of displays: 24 lines of 80 characters, with a 5-by-9-dot matrix; the same line format with a 7-by-11-dot character matrix on a 9-by-12 display matrix; the same-size character matrix but with a 25th line added for terminal-status information; or 16 lines of 64 characters with a 7-by-11-dot character matrix on a 9-by-15 field. □

Washington newsletter

Europe, Japan, and U. S. agree on IC, CRT typing

Agreement on a single type-designation system for integrated circuits and cathode-ray tubes for worldwide use has been reached by heads of manufacturers' associations in Europe, Japan, and the U. S. "It represents a real breakthrough," says one participant in the agreement, which now awaits formal ratification by the governing bodies of Pro Electron in Brussels and the Electronic Industries Associations of Japan and the U. S.

If the Jan. 1, 1979, acceptance timetable is met, the single numbering system for CRTs and ICs is expected to go into effect the following June. The system would use a computer conferencing network and data bank provided by Telenet Communications Corp. in Washington and linking terminals in Brussels and Tokyo. Products listed under the new system, which still lacks a name, will be "double branded" as of July 1 next year with both their new international type numbers and their existing domestic designations.

Air Force forecast of computer weapons in year 2000 due

When the Air Force publishes its "Computer Technology Forecast and Weapon System Impact Study" in December, military-computer makers can expect **extensive treatment of multiprocessing, artificial-intelligence, and Josephson-junction technology,** as well as details on such software support systems as text editors, compilers, displays, analyzer/transformers, and supervisory systems. The first 900-page draft, which looks to the year 2000, is now being boiled down by the Systems Command at Andrews Air Force Base, Md. The study began with a two-week Air Force Academy meeting in August that had extensive industry participation. It was followed by a meeting of users of weapons-systems computers.

China negotiating U. S. satcom buy, ıte Department says

The People's Republic of China has begun preliminary government-to-government negotiations for the purchase of communications satellites, says the State Department, confirming an earlier report [*Electronics*, Oct. 12, p. 57]. **The Chinese government is interested in acquiring a satellite with 12 C-band transponders,** like the Westar system built for Western Union by Hughes Aircraft Co. The negotiations are being handled by a group separate from the six-member delegation now completing a tour of 12 U. S. plants of seven manufacturers specializing in earth stations and associated test and measuring equipment.

ıcemeal rewriting o nmunications Act forecast for 1979

When legislation to deregulate U. S. telecommunications in favor of competition is introduced next year in the 96th Congress, it will probably take the form of omnibus amendments to the existing 1934 Communications Act instead of a single, all-purpose bill. That is the estimate of Senate communications subcommittee chairman Ernest Hollings (D., S. C.), following adjournment of the 95th Congress, **which brought with it the death of H. R. 13015, the Communications Act of 1978.** That measure, a 217-page package introduced in June by Rep. Lionel Van Deerlin (D., Calif.), sought to rewrite all the rules for telecommunications and broadcasting in one bill [*Electronics*, June 22, p. 84]. Just before adjournment and following lengthy hearings on his bill, Van Deerlin sharply criticized managers of the nation's independent telephone companies for offering "so little constructive response" to the legislation while at the same time outwardly praising its goals.

Solarex subsidiary to produce cast-Si solar cells . . .

Solarex Corp. says it will set up a new production subsidiary called Semix Inc. near its Rockville, Md., headquarters to begin 1980 production of 10-by-10-cm solar cells cut from cast "semicrystalline silicon bricks" **that already demonstrate terrestrial efficiencies of more than 15%.** The company has filed several patent applications for the process, which Solarex founder Joseph Lindmayer calls " 'semicrystalline,' because the term 'polycrystalline' is too broad and it's used to indicate a charge in Czochralski growth" techniques.

Initial capital for Semix is reported to be about $2 million. Solarex expects to achieve the Department of Energy's production price goal of 50¢ per watt (in 1975 dollars) by the mid-1980s, although its first completed units are expected to sell at $4 to $6 a watt—a figure that Solarex claims will still make photovoltaics competitive in less developed countries with diesel generators.

. . . as DOE negotiates contract support of Solarex process

The Department of Energy is negotiating a development contract with Solarex to support its new process following agency rejection of a company research and development proposal two years ago, says a company official. Why the turnabout? "It apparently sees an outside threat," he answers, in the European program using similar technology that is being pursued by Heliotronic GmbH, the West German company formed by Wacker Chemical and Chemitronic GmbH (see p. 86). **Solarex says it will now accept Government support only if the company's patent rights can be protected.**

Jedec forming transport unit outside SAE

Semiconductor makers are expected to join a new wide-ranging transportation electronics committee to be organized next month by the Joint Electron Device Engineering Council rather than the narrower automotive group operated by the Society of Automotive Engineers. **Fifteen electronics and automotive manufacturers have been invited to the organizational meeting** of the Transportation/Automotive Committee at the Granada Royale Hometel in Phoenix on Nov. 3, immediately following the two-day meeting of Jedec's JC-41 committee on linear integrated circuits. Acting chairmen of the new unit will be National Semiconductor's Thomas Bispo and Ford Motor's Gary Boone. Companies asked to attend include: Analog Devices, Bendix, Fairchild, Intel, Mostek, Motorola, Raytheon, RCA, Rockwell International, Solid State Scientific, Sperry, and United Technologies, as well as American Motors, Chrysler, and General Motor's Delco.

Micro standards to be pursued under NSF grant

Four national associations will take part in a series of conferences via computer to lay the groundwork for developing U. S. microprocessor standards under an 18-month grant from the National Science Foundation. The Joint Electron Device Engineering Council proposed the program early this year [*Electronics*, Jan. 19, p. 57]. In addition to Jedec, participants include the American National Standards Institute, the Electronic Industries Association, and the Institute of Electrical and Electronic Engineeers. **The group also will update MIL-1331,** the military specification for developing tables of parameters for control of integrated circuits, which Jedec says has not been updated since 1970. Consultants for evaluating the $77,000 grant program are Peter and Trudy Johnson-Lenz, a husband-and-wife team based in Lake Oswego, Ore.

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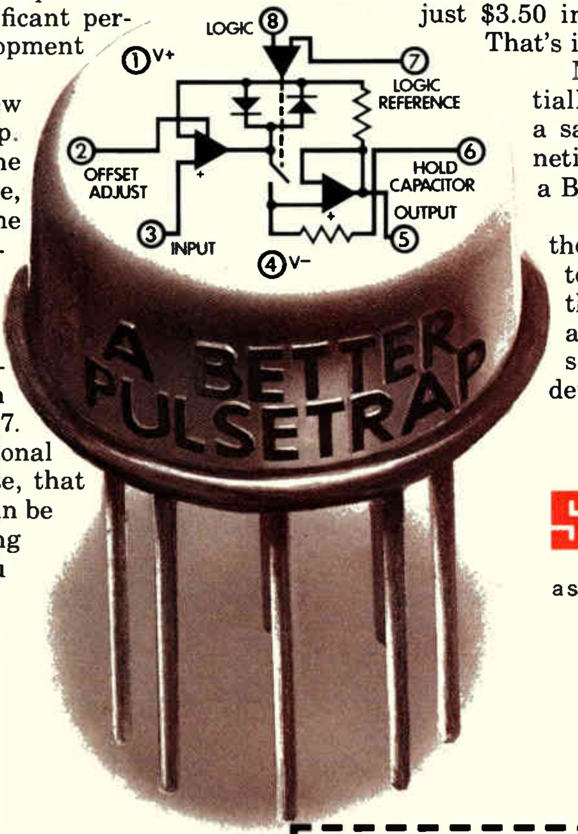

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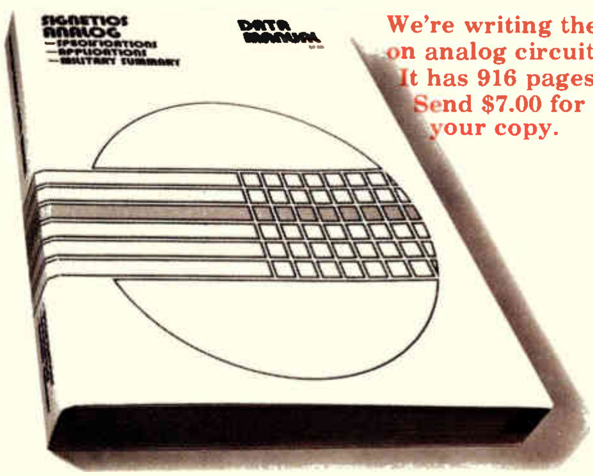

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	μPD 8155	→	
	μPD 8156	→	
μPB 8212	→	→	→
μPB 8214	→	→	→
μPB 8216/26	→	→	→
μPB 8224			
μPB 8228/38			
		μPD 8243	
μPD 8251/A	→	→	→
μPD 8253	→	→	→
μPD 8255/A-5	→	→	→
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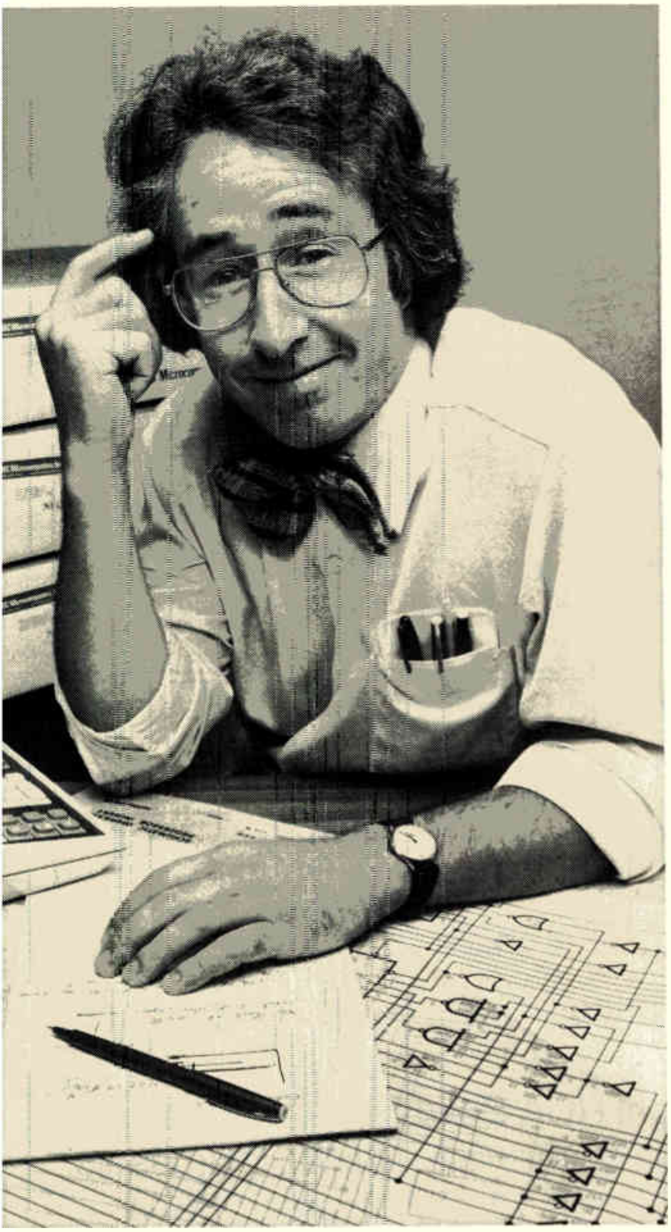

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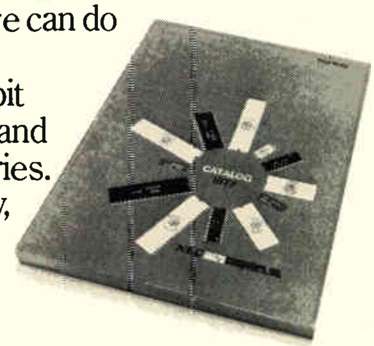

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International newsletter

Only 75-mW dissipation for Hitachi 2147

Now available in samples from Hitachi Ltd. is an extremely low-power version of the 2147 4-K static random-access memory. The NM6147P series mixes three technologies: complementary-MOS sense amplifiers and input/output buffers, cross-coupled n-MOS transistors in the memory cells, and npn bipolar pull-up transistors for low-power operation and a wide voltage margin. **Operating power is 75 mw typical, whereas the best current 2147s are in the 300-mw range;** address and chip-select access times are 50 ns maximum for the HM6147P-3 and 70 ns maximum for the HM6147P. Hitachi is also offering samples of the HN462716 16-K erasable programmable read-only memory, while Nippon Electric Co. is working on a similar 2716-compatible E-PROM and is putting the finishing touches on a 32-K E-PROM. The two Hitachi parts and the NEC 16-K part are to be in volume production in the first quarter of 1979.

Mergers mulled for telecommunications makers in the UK

Britain's National Enterprise board is presiding over industry-rationalization talks among equipment manufacturers that are party to the proposed System X solid-state digital-telecommunications exchange. Spurring the talks is the urgent need to hasten development and marketing of the system, **seen as the UK's last hope of reestablishing itself in the international telecommunications switching market.** Though none of the participants is talking, one strategy known to be under consideration is a merger of Plessey Telecommunications Ltd. and the ITT subsidiary Standard Telephones and Cables Ltd., while GEC Telecommunications Ltd. would go it alone, satisfying the BPO's requirement for dual sourcing.

MITI seeking Japanese-language word processing

Japanese word-processing development projects are more than just a gleam in the eye of the Ministry of International Trade and Industry: MITI is negotiating with the Ministry of Finance for funding for two five-year projects. One would be originating software, chiefly improved operating systems, for the new computers under development in Japan's VLSI project, and high-level software, to improve Japanese programmers' ability to work with established programming languages. The other would be development of high-performance peripheral equipment. **Total outlay would be about $137 million**, and the result would be to move Japanese computers out of their dependence on English-based computer languages.

ICAO ponders German supplement to MLS standard

Early next year the International Civil Aviation Organization will decide whether West Germany's candidate for the international microwave landing system will serve as a complement to **ICAO's recent MLS choice: the U. S.-developed time-reference scanning-beam system.** The Distance-measuring, equipment-supported Azimuth System, which was developed by ITT affiliate Standard Elektrik Lorenz AG, would add 360° localization capability to locate aircraft landing from any direction.

Low-cost actuator responds to pulses as low as 1 μVA

Grenoble-based Laboratoire d'Electronique et d'Automatique Dauphinois has a low-cost actuator even more sensitive than its 100-μVA device introduced earlier this year. Based on the same type of relay, the new actuator responds to pulses as low as 1 μVA. **Low-input energy is accumulated over a time interval and then discharged as a very short but high-energy pulse.** The new actuator will be available in the U. S. and will take inputs from many sorts of transducers. It will be ideally suited to applications where power sources are weak or difficult and expensive to incorporate, the firm says. Cost will be around $3.

Grundig casts eye on American consumer market

Look for West Germany's Grundig AG to jump into the American consumer-electronics market. The move is part of the Nuremburg-based company's plans to recapture overseas markets lost to competition from low-wage areas. Details on a U. S. marketing and product strategy are still to be worked out, Grundig says. **Likely products are high-quality all-bandwave radios and dictating machines—but probably no television sets.** One of the Continent's leading consumer-electronics producers, Grundig pulled in 90% of its 1977 $1.4 billion sales from Europe.

Italian ICs will make organ music

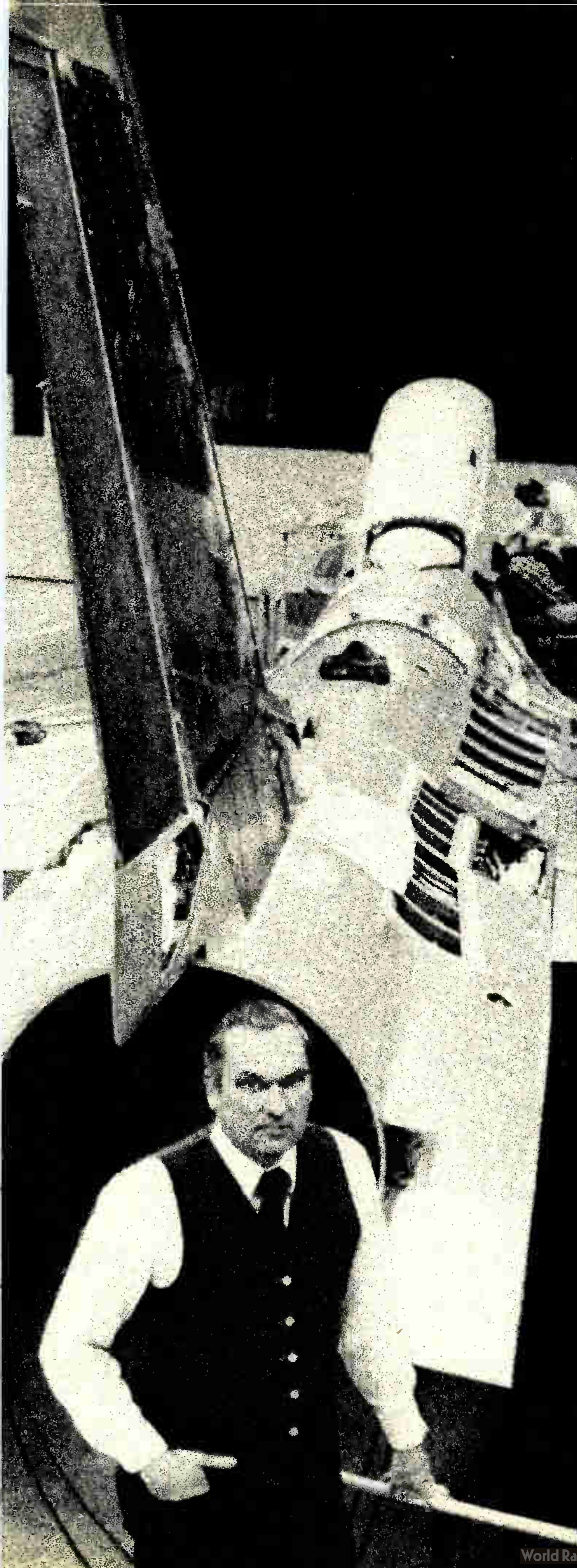
The Italian semiconductor house, SGS-Ates, expects to market a new series of integrated circuits for electronic organs next year. First to come will be a 160-by-160-mil chip carrying the oscillator and frequency dividers for three octaves of notes, a rhythm generator, and two or three pedal controls. At about $8, the price will be low enough for use in a better-grade toy organ, the firm says, and two of the chips can be ganged to get a low-cost six-octave organ. **For the upper end, the company will use a 3870 single-chip microprocessor** for keyboard control paired with a sound chip that can put out up to 16 notes at once over a five-octave range. A second microprocessor and memory could be added so the organ would generate sophisticated accompaniments for players.

8080s give versatility to Telex control

Siemens AG is set to introduce a microprocessor-controlled small private-branch-exchange switching system for Telex communications. The Munich firm's EMX1010 works automatically once the user has written the Telex message and necessary instructions into the system's memory. Under the control of Intel 8080 microprocessors, **the switching system establishes connections among as many as 20 teletypewriters** in an internal network configuration. It repeats calls when a busy signal is received, sends out messages at maximum speed or at times when the rates are lowest, sends the same message to a number of receivers, and handles a host of other Telex-related jobs. It will go on sale in November.

Addenda

The French computer-graphics firm, Benson SA, has signed a preliminary agreement to take over the Graphics division of Varian Associates of Palo Alto, Calif. **In return, the U. S. company will get a share of 20% or so of the French firm.** . . . Plessey Ltd. is reviewing its semiconductor activities, considering such options as a major capital investment to establish high-volume standards capability, possibly with a U. S. license; **a merger with a U. S. firm; or the outright sale of its operation,** reportedly to General Electric Co. Ltd. . . . Watch for Grundig AG soon to introduce **a version of its SUC4004 video cassette recorder for use with the French-developed color-TV transmission standard.** . . . Pye-TMC Ltd. is developing a **modular solid-state private-branch exchange for small business** that will use custom MOS large-scale integrated circuits with Intel 8085 microprocessors. The British Post Office is funding the development.



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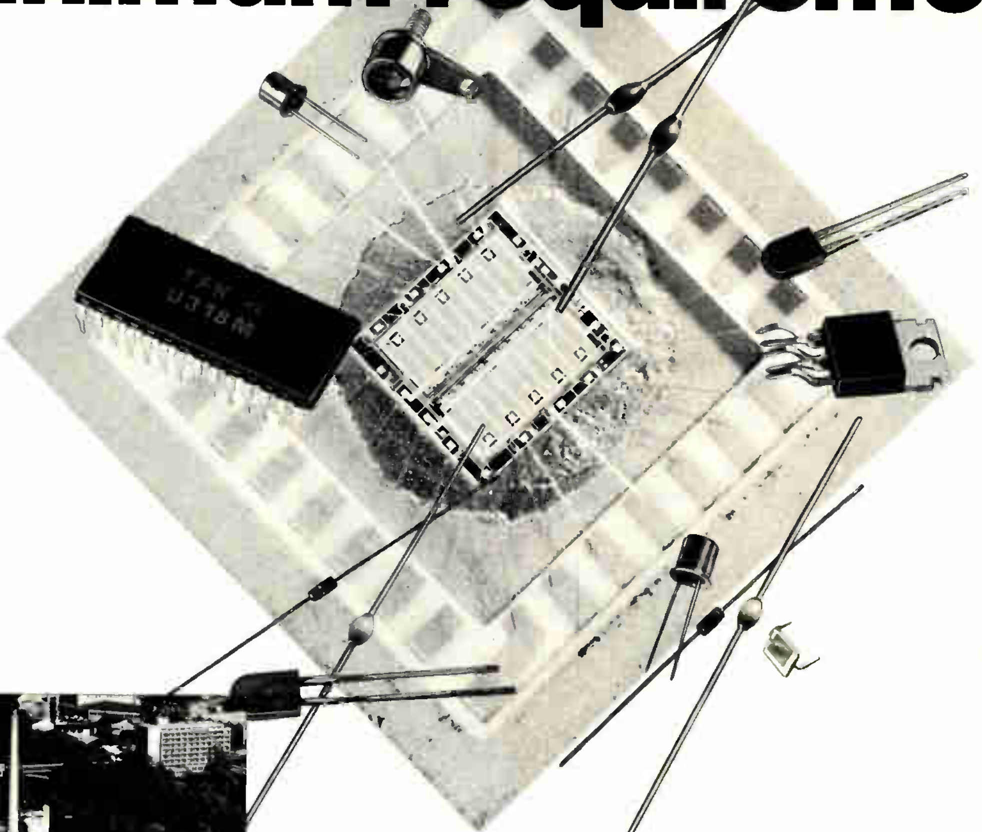

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Stylus glides over grooveless video disk

Capacitive-playback system has wearless random access to tracks, plus other features found in laser-based systems

Engineers pondering the design of video disk systems sometimes reject stylus playback in favor of better performing but more complex and expensive laser playback. The advantages of the latter tack are diminishing, however, now that Victor Company of Japan (JVC) has shown its system that combines the low cost of the stylus approach with performance features found in laser-based systems.

The capacitive-playback system uses a grooveless disk and a stylus with an extremely broad tip that glides over the recorded tracks [*Electronics*, Oct. 12, p. 64]. As well as providing inputs for standard color television sets and commercial video applications, the JVC system can play back digitally recorded ultrahigh-fidelity audio disks.

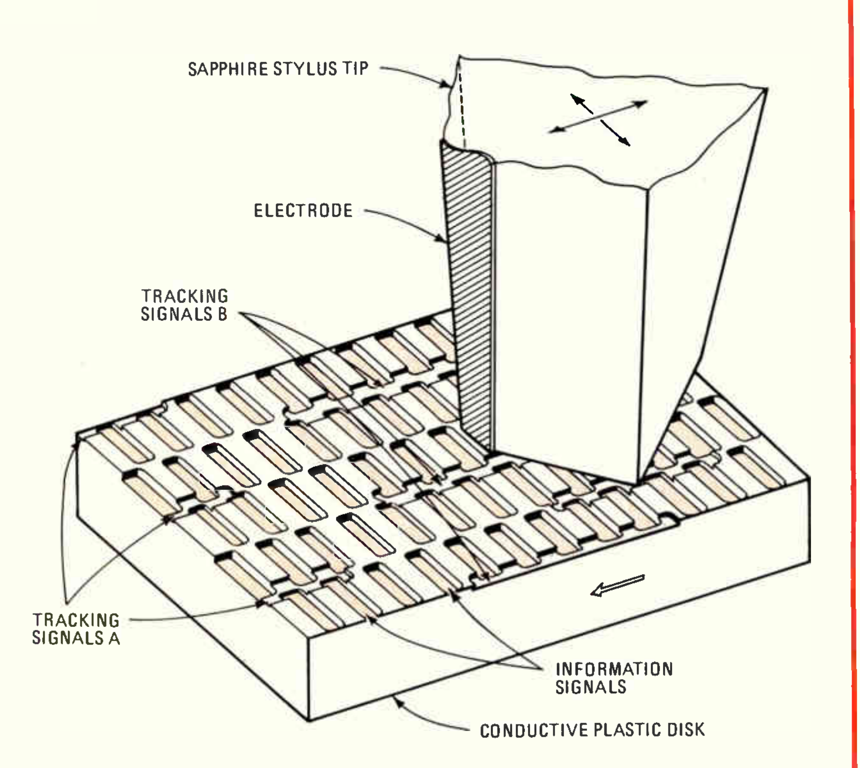
Pickup. Signal pickup is like that pioneered for video disks by RCA Corp., in which capacitance variations between the disk and a flat electrode strip on the rear of the stylus are converted into the output signal. The variation is on the order of 10^{-4} picofarad as the 0.7-to-1-micrometer-wide electrode passes over the pits pressed into the disk's surface to carry the information.

Advantages. Disk and stylus wear will be greatly reduced with the new system, says Victor. More important, thinks the company, is the addition of such features as random access to a track (especially useful for information-retrieval applications), repeatable playback of a TV frame, and variable playback speeds.

Furthermore, the Tokyo firm says the price would be right, because mass-production techniques are already available for all portions of the system. It estimates that the selling price could be half that of a video cassette recorder.

Program materal is carried on Victor's disks as spiral tracks of pits 1.4 μm wide, with a pitch of 1.4 μm (see figure). The narrow track width and relatively low speed of 900 revolutions per minute give a recording time of one hour per side of disk. The TV luminance signal is frequency-modulated on the carrier with an average frequency of 7 megahertz.

Floating. The grooveless design allows the 10-μm-wide blunt stylus tip to appear to float over the tracks, as shown by the negligible wear and the absence of shorts between the electrode and the conductive disk. Consequently the stylus can cut across tracks for quick access to selected tracks, while reproducing information on the intervening tracks for position information, as



No grooves. Video or audio information on JVC's new grooveless disk is recorded in pits, with overlapping tracking pits controlling the stylus's position and a jitter-eliminating mechanism.

laser-based optical pickups also do.

Overlapping the edges of the program tracks are elongated 0.6-μm-wide pits that provide tracking signals. Their relative strengths—512 and 716 kilohertz—control a servomechanism that keeps the stylus electrode over the program track. The tracking signals also control a servo that moves the stylus forward or backwards along track to correct jitter. RCA uses a similar jitter-elimination scheme.

The bandwidth inherent in this system permits it to record ultra-hifi pulse-code-modulated stereo signals in which each sample contains 14 information bits for each channel, and additional error-correction bits. The sampling frequency is 44.056 kHz, for a flat response to 20 kHz.

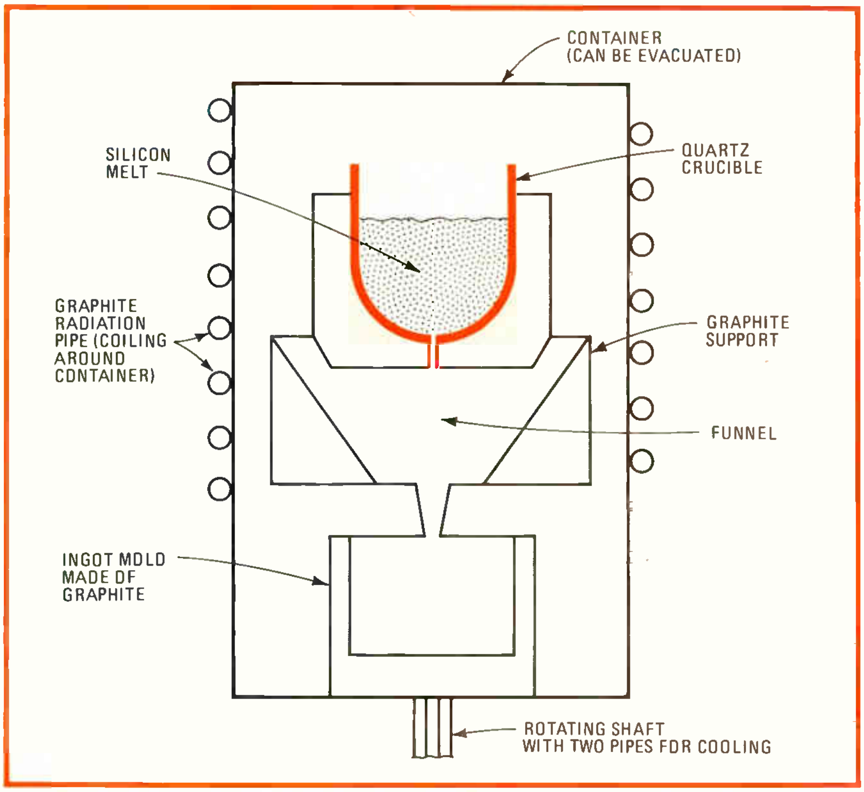
Originals for the disks are fabricated by photolithography, using a laser beam. A single beam is split, modulated at the program- and tracking-signal frequencies, and then recombined for photolithography through a single lens. This tactic maintains the relative positions of program and tracking pits. □

West Germany

Silicon casting promises lower-cost photovoltaic cells

Casting the silicon material for solar cells, rather than growing it by crystal-pulling operations, may clear the way for low-cost energy from the sun. So a West German firm, Heliotronic GmbH, and a U. S. firm, Solarex Corp., are hard at work on casting processes. Both firms think their efforts point the way towards producing photovoltaic power for under 50¢ per watt.

Heliotronic's scientific/technical director, Erhard Sirtl, even predicts 25¢/W in five to eight years. It would be a thirtieth that of present solar-generated electricity.



Casting silicon. By funneling a silicon melt into a mold, crystallization occurs at least 25 times faster than with methods that grow the material by crystal-pulling operations.

The Burghausen subsidiary of Wacker-Chemitronic GmbH [*Electronics*, May 11, p. 44] has reached the sample stage. It has cast material for a 10-by-10-centimeter cell with better than 10% efficiency.

Solarex, of Rockville, Md., reports it has cast polycrystalline silicon bricks for 5-by-5-cm cells with efficiencies above 15%. It plans to be in production within two years of 10-by-10-cm cells at the $4-to-$6/W level, roughly half the present cost.

Polycrystalline. Both firms are producing polycrystalline material, rather than single-crystal silicon. Solarex founder Joseph Lindmayer says that "single-crystal does not have the cost factors required for truly inexpensive silicon material." He points to the high efficiencies his firm is achieving to support his argument that "efficiency does not have to be compromised."

Basically, Heliotronic's process casts silicon melt in blocks that are cut into square slices or in plates that need no cutting because they are of the desired thickness. It also is possible to cast the melt in foils, the company says.

Economical. The casting process is highly economical. It "allows the crystallization of a much higher volume of silicon per unit of time and at a lesser cost for equipment and personnel than conventional techniques like crucible pulling," says Bernhard Authier, inventor of the Heliotronic process.

With the Czochralski crystal-pulling process, he says, the crystallization volume per unit of time is limited by such factors as the pulling velocity, typically 2 millimeters per minute. Casting will give a crystallization velocity that is at least 25 times better for an equivalent block cross section.

What's more, the casting method can be used in production lines and can even be automated, Authier says. These considerations, plus the low-cost materials, are prerequisites for economical power generation by

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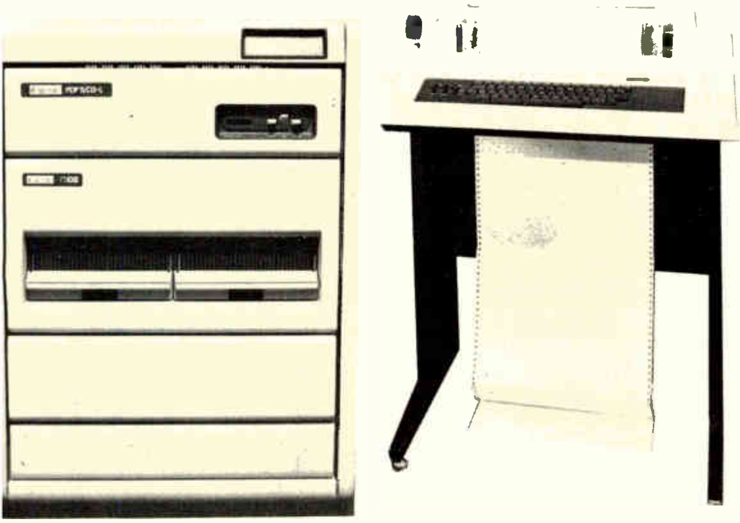

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To be sure, the Heliotronic process is still in the development stage. But samples are being supplied to potential customers.

Heliotronic's pilot system incorporates a container that can be evacuated. Inside it is the casting equipment, which consists of a quartz crucible with a graphite support around it. A graphite-supported funnel feeds the silicon melt from the crucible down into a graphite mold.

The casting equipment is suspended on a rotating shaft that ensures even distribution of heat in the silicon melt. For heating, Heliotronic uses a graphite radiation pipe coiled around the container. For cooling, the rotating shaft has two concentric pipes with cooling water flowing from the inner to the outer one. To get rid of the heat of the crystallization reaction, Heliotronic uses a copper cooling disk.

The reason for the abundant use of graphite is its good heat-conducting properties, much better than those of, say, quartz. It also has the advantage of good workability, Sirtl says, and it has a thermal coefficient close to that of silicon, not to mention good dimensional stability.

Melting. The casting process involves melting silicon of sufficiently high purity in the quartz crucible under a vacuum or inert gas like argon. Flowing through the funnel, the melt enters the mold where it is cast into block or plate form.

The cooling process ensures that the mold wall's interior temperature does not reach the critical point that would allow a reaction between the graphite and the silicon melt before the wall has been covered with a layer of solidified silicon material. The rest of the molten silicon can then be poured, cooled down, and frozen in its own silicon form, supported by the graphite mold.

Precisely controlling the cooling process ensures a temperature gradient in the silicon such that the blocks or plates being cast show the preferred crystal structure—one consisting of oblong areas oriented vertically to the extremely cool bottom portion of the mold. □

Great Britain

TV camera based on ultrasonic energy ready to probe murky water and silt layers

A television camera that uses an ultrasonic imaging system has made the giant leap into practicality, thanks to a breakthrough in tube technology by workers at EMI Ltd.'s central research laboratories. First application for the new tube is an underwater TV system for divers or submersible craft. Ultrasonic energy can penetrate turbid water and even thin layers of silt, conditions that would blind a conventional television camera.

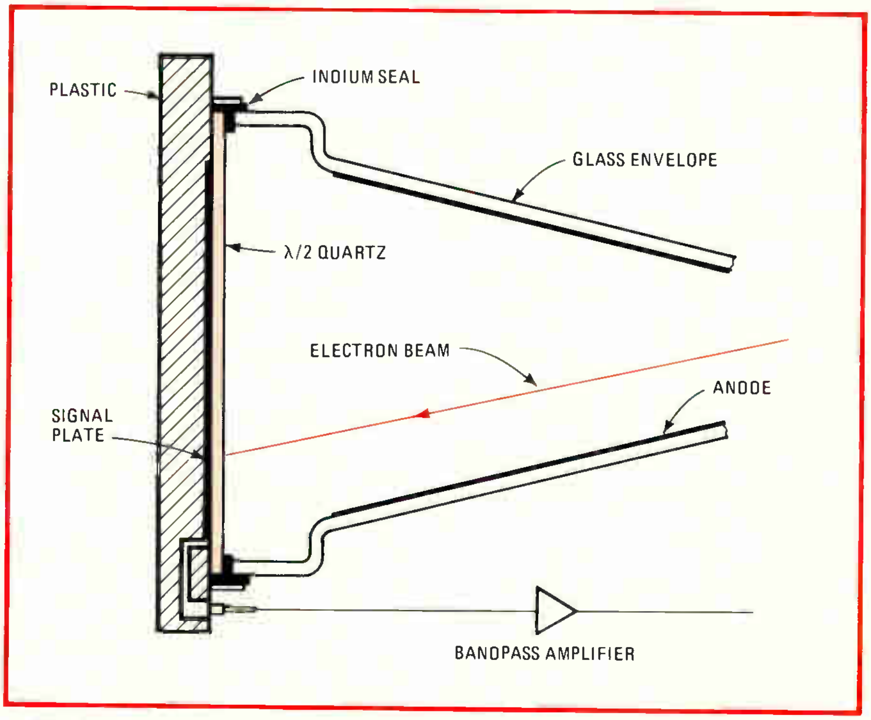
The camera system comes with an array of ultrasonic transducers that irradiate the scene ahead. The resulting reflections are focused onto the converter tube's image plane by a biconcave plastic converging lens.

Large crystal. The scan converter tube (see diagram) has quartz crystal embedded in the faceplate, which translates the ultrasonic-pressure wave pattern into a voltage-distribution pattern. Points of reflected ultrasonic energy are thus translated into equivalent voltage potentials.

The quartz crystal is electronically scanned, and the signal voltage at each point is translated into a capacitive current in the signal plate. This signal is processed by the bandpass amplifier.

The new tube makes possible subsidiary EMI Electronics Ltd.'s high-resolution underwater camera, shown for the first time at the European Offshore Petroleum Conference and Exhibition in London this month. Such a camera has been waiting for a practical image-converter system since the concept was first proposed back in 1936. It took a major research effort by the EMI research labs in Hayes, Middlesex—and some startup government funding—to overcome the problems.

Television pictures created by earlier ultrasonic converters were degraded by the far-from-ideal dimen-



Sound picture. X-cut quartz crystal translates ultrasonic wave pattern into a voltage-distribution pattern, which is electronically scanned and converted into a capacitive current.

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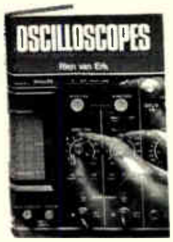

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Circle #70 for literature
Circle #71 for demonstration

sions of the single-quartz-crystal window that forms the faceplate of the vacuum tube. Because quartz is mechanically weak and could fracture when the tube is evacuated, the window's diameter was typically 40 millimeters. Ideally, it should have the largest possible diameter and should be on the order of 1 mm thick. Such dimensions would give a half-wavelength resonance and hence maximum voltage sensitivity in the 2-to-4-megahertz frequency range.

The EMI researchers got around this problem by incorporating a 100-mm-diameter X-cut quartz crystal in a supporting window of epoxy resin. A soft indium-metal gasket seals this composite window to the glass envelope to give a vacuum with a long operation and shelf life. The resin also has an acoustic impedance midway between water and quartz, thus coupling the maximum amount of energy into the image converter.

The resulting tube is robust and can be operated to a depth of 30 meters in water without special relief of the faceplate, says Patrick H. Brown, a member of the labs' development team. With an added pressure window, depths down to 300 meters are possible.

Problems. The development team had to overcome several system problems. The highly coherent ultrasonic radiation used to irradiate the scene produced a speckled effect, similar to that of laser-illuminated scenes. Therefore, to prevent loss of detail, the illuminating ultrasonic transducers are modulated with narrow-bandwidth noise.

Variations in the dynamic range of the received signal can be as high as 80 decibels for a single illuminating transducer. The multiple array of ultrasonic illuminating transducers is used to reduce variations.

To avoid spurious signals being generated by the tube, the scanning electron beam is modulated at high frequencies. By heterodyne mixing of the signals at the tube's target, the ultrasonic information is extracted as a difference frequency by the bandpass amplifier.

The result, says Brown, "is a quite agreeable TV picture." There are 201 lines per frame and 12½ frames per second. At 2 MHz, a range of several meters in very turbid water is possible. The target price, he adds, "is something comparable with conventional TV packages." □

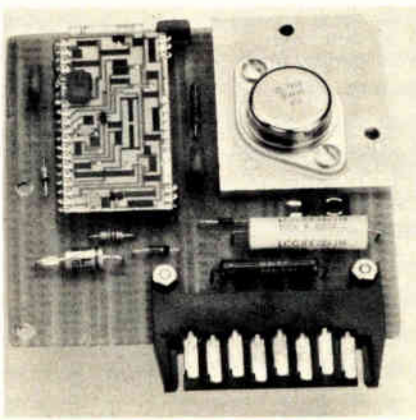
France

Tiny runabout uses electronic ignition

The new Citroen Visa is one of the smallest automobiles in production, but its two-cylinder engine has an all-electronic ignition, a feature confined until now to much larger engines. Thomson-CSF designed its new AEI (for all-electronic ignition) to work on all four-stroke, two- or four-cylinder engines. It can supply high constant voltage to the ignition coil and adjust the spark advance, based on the engine's speed and the intake manifold's compression.

The unit has two synchronization sensors to detect crankshaft position and a sensor to determine vacuum variations in the intake manifold. Their output goes into a processor that works out the spark-advance curves and into a power unit that supplies voltage to the ignition coil. The four-cylinder version has additional sensors for oil and water temperatures and throttle position and outputs for two coils.

Small sparks. Thomson-CSF's all-electronic ignition system is designed for small engines. Citroen's Visa uses a hybrid version but will soon switch to the integrated version shown.



The AEI's processor is a custom monolithic linear circuit. It has three main functions. It computes the engine speed, which Thomson may supply to a tachometer in future versions. At the moment, the data is used to calculate the voltage required for the coils. The processor also works out the spark advance curve and controls the energy output.

Citroen awarded the contract to Thomson only in January, so the company immediately went to work on a version that uses only discrete components. Visas are coming off the production line with a hybrid model, but they will be using the integrated version early in 1979 (see photograph).

Detection. The synchronization sensors detect the passage of a metal stud attached to the engine flywheel. Engine speed and crankshaft position are thus available to the processor for computing the advance curve.

The sensors are basically made up of 1-megahertz oscillators. When the stud passes a sensor, a reference pulse is triggered.

Thomson paid special attention to the radio-frequency interference problems that occur in mounting sensors in an automotive engine. Each sensor has a detection range of 1 millimeter ±0.5 mm to allow it to detect the flywheel-mounted stud without picking up any spurious noise. Also, the pulse generated has a rise time of about 20 microseconds and an amplitude of more than 5 to 7 volts, so it can be detected within the whole range of interference that is encountered in the harsh automobile environment.

The new system is reckoned to achieve 10% economies on the already miserly fuel consumption of the Visa. Other plus points are smooth running even at low revolutions and reliable functioning under extreme operating conditions. Thomson claims that the sensors function even with a dying 6-volt battery or up to 24 v for short periods, as well as under conditions of mechanical abrasion and temperatures from −40°C to +125°C. □

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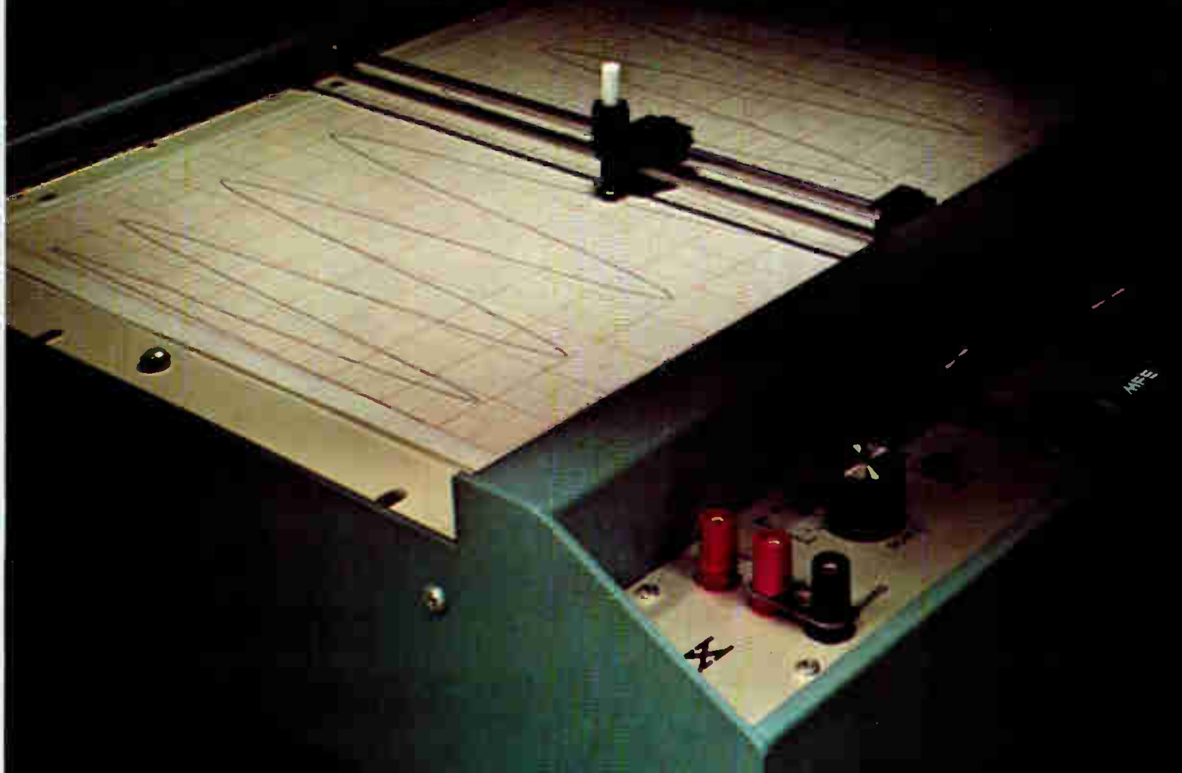

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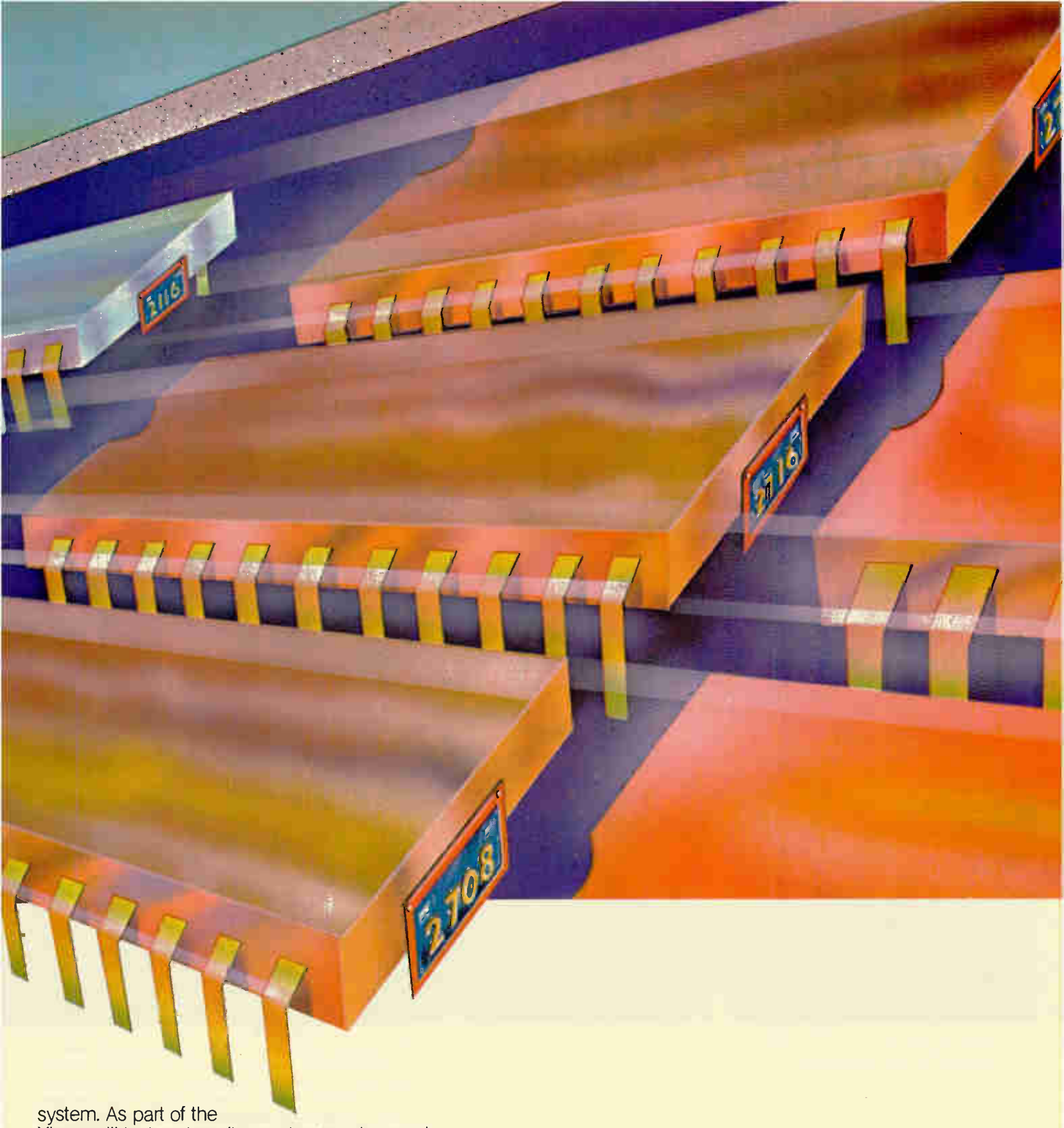

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FAIRCHILD

LSI-board testing bedevils users

Another Battle of Cherry Hill shapes up as annual conference will attract 1,500 device vendors, OEMs, and tester makers

by Bruce LeBoss, New York bureau manager, and Albert F. Shackil, Instrumentation Editor

That many of today's large-scale integrated devices equal yesterday's densely populated printed-circuit boards in performance is a familiar tale. But the other side of the story—the degree to which the increased use of LSI by equipment makers is disrupting the established principles for testing circuit boards—is causing consternation.

In fact, so great are the problems created by the growing use of LSI chips on pc boards that an estimated 1,500 LSI vendors, users, and test-system manufacturers are expected to gather at the 1978 Annual Test Conference next week in Cherry Hill, N. J., to discuss whether complex LSI can be effectively tested at both the component and board levels. Familiarly called the Battle of Cherry Hill because it often has served as an arena for participants to hurl brickbats at one another over testing inadequacies, the three-day conference starts Oct. 31. It will devote more than a third of its technical sessions to issues associated with board-level testing.

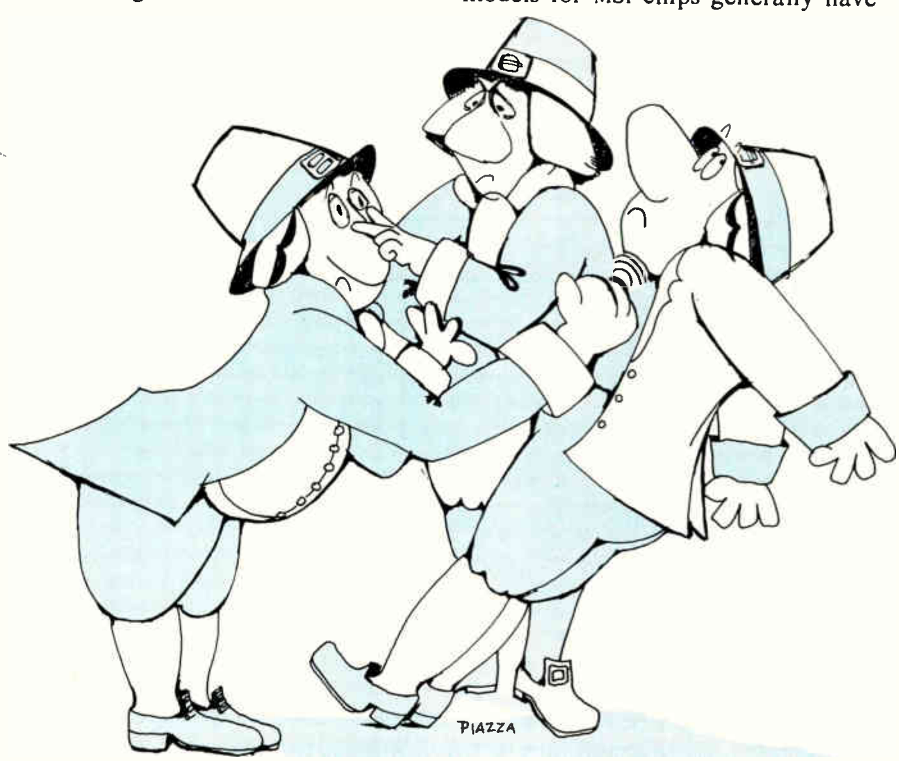
Robert E. Anderson, vice president of Omnicomp Inc. of Phoenix, believes board-level test problems created by the increased use of LSI come in three categories. "The increased complexity has made test sequences for LSI boards harder to generate; the dynamic nature of many LSI chips has required higher-speed test systems; and the bus-structured organization of these boards has made fault isolation more difficult," he says.

Density and pins. According to Anderson, who will chair a panel on board-level test problems, the difficulty in generating test patterns for complex chips is due to the increased functional density relative to the number of edge pins or test pins of the board. "The internal circuits have too many functions, too many states, and too much memory to be tested completely from the edge pins," he says.

Many of the techniques used to test small- and medium-scale integrated-circuit boards "are not suitable for LSI boards," Anderson says. For example, the simulator-aided programming technique, "the most widely used approach for board testing at present, has difficulty keeping pace with the development of new complex LSI chips." The primary problem appears to be the difficulty in modeling such devices.

Richard Albright, manager of advanced test systems at Digital Equipment Corp. in Maynard, Mass., points out just how costly and time-consuming it can be to model these complex LSI chips. "It normally takes from six to eight weeks to model and develop a test program for an MSI board." In contrast, "a board containing about 10 LSI chips will take 20 weeks just to model, and at least an additional 10 weeks to generate test programming for the board." For a single LSI board, "modeling time has increased from a few weeks to six months or even a year."

Also a panelist at the test symposium, Albright further notes that models for MSI chips generally have



been available in the user's or tester-manufacturer's library and were developed from specifications given in the device maker's catalog. However, because of the increased complexity of LSI chips, their specifications are not readily available.

Another part of the problem is the large amount of memory required to simulate a board containing several LSI chips. Modeling such chips "would take up too much core memory and would increase simulation time and costs, even if information were available from device manufacturers," says Robert T. Szpila, test systems marketing manager at GenRad Inc. of Concord, Mass. Also a panelist, Szpila points out that it is just not cost-effective to do a gate-level model of LSI.

Attempts are being made to extend simulators so that they can handle LSI chips on boards. The techniques include functional modeling languages and the use of actual LSI chips to provide a hardware model during simulation. But they "usually model the correct operation of the LSI chips and do not predict faults," Anderson says.

No guarantee. Because LSI devices are complex, GenRad's Szpila notes, "board functions are more complex and it is difficult to evaluate the quality of the test program." As a result, if an operator were to get a green light from his test system, indicating the board is good, "he really does not know if his test was thorough enough to justify that green light."

One way to attack the problem, he says, is to push the state of the art in in-circuit testers that do an internal inspection of LSI devices on the board. "Theoretically, it looks to be a good way to test LSI boards," he adds, because if an operator can get right on the chip itself, he has more control over the test of the IC than if he went through a functional or edge-connection test.

However, a problem arises. "The chip is connected to others through a common node, and when you stimulate the chip you want to test, the other ICs go into an active state. If, when applying power to the IC to be tested, energy is dumped into the other ICs for any length of time, they could burn up."

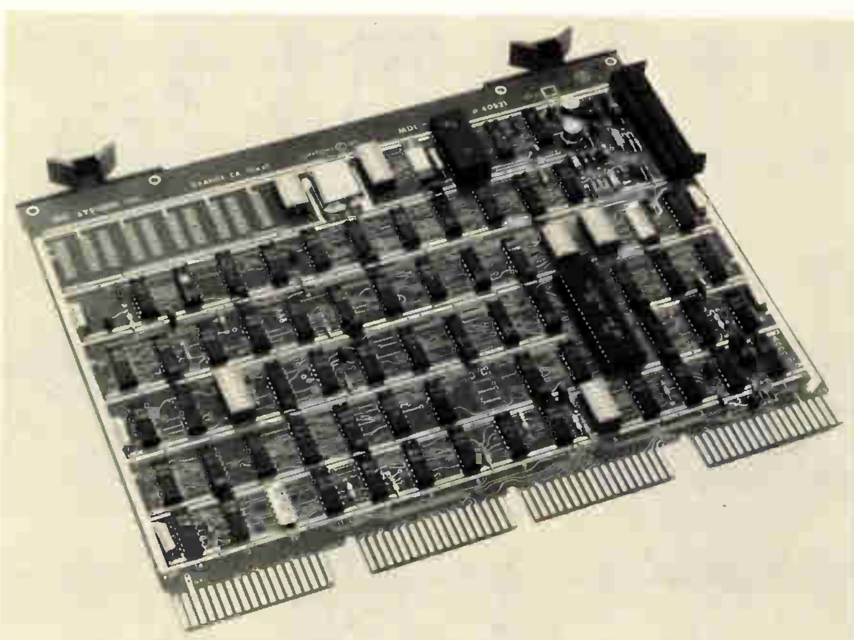
This bus structure of most LSI boards also makes fault isolation more difficult because of the presence of many devices on the same bus, any of which could cause the fault. As a result, "guided-probe testing, the generally accepted way of diagnostic testing, is no longer acceptable when applied to testing LSI boards," says Kemon P. Taschioglou, board-testing-marketing specialist at Teradyne Inc. of Boston. Because the guided-probe method looks at all inputs when a device is failing and because there are many devices hanging on a node, it takes longer to sense all the inputs and to find the path back to the faulty device. As a result, he adds, throughput drops when testing LSI boards.

Furthermore, because the bus is bidirectional, inputs to one device become outputs to another. Thus, says Taschioglou, who will give an overview of LSI board-level testing, "the guided probe gets confused. It thinks it has a feedback loop, and guided-probe diagnostics then become much more challenging."

Largely because of the difficulty in isolating faults on a bus to which many devices are linked, as well as the trend by LSI vendors to put many functions on a chip with a minimum of test points, users now find themselves at the point where they are no longer able to test the devices at the board level, says Walt Luciw, principal advanced-circuits research and development engineer at Sperry Rand Corp.'s Sperry Univac division in Blue Bell, Pa. This situation, he adds, leaves users to assume LSI boards are in working state, only to see them turn up later at a customer's site as faulty boards.

Awesome task. Also a panelist at the Cherry Hill conference, Luciw believes a major contributor to what he calls the escalating problem of isolating or even detecting internal faults involves the learning curve for LSI. "Often, users do not understand the devices fully and without this intimate knowledge, testing an LSI chip alone or in conjunction with other devices on a board becomes an awesome task."

Luciw questions whether LSI vendors themselves know how to thoroughly test their devices. "If the device manufacturers supplied users with schematics, recommended test patterns, and data involving intrinsic device problems, along with a procedure on how to thoroughly test these LSI chips, perhaps 90% of the problems associated with LSI device- and board-level testing would be solved." But, for the most part, Luciw says, "they don't." □



The cause. This board, typical of today's printed-circuit boards jammed with LSI circuits, is the type that causes the annual Cherry Hill finger-pointing by tester makers, users, and OEMs.

Electronics abroad

Taiwan's TV makers getting nervous

While exports of color sets are climbing, threat of U. S. import restrictions and closing of Admiral plant darken picture

by Dan Shapiro, McGraw-Hill World News

With booming export sales and rapid progress toward domestic self-sufficiency in parts and components, Taiwan's color TV industry ordinarily would have much to cheer about.

But any rejoicing is tempered by expectations that the U. S. Government will before long insist on import restrictions on Taiwanese sets similar to the Orderly Marketing Agreement imposed on Japan last year [*Electronics*, Oct. 12, p. 57].

Further complicating the picture is the recent announcement by Rockwell International Corp. that it will shut down its Admiral TV operations in the U. S. and Taiwan. The Admiral plant in Chungho County, outside Taipei, has been Taiwan's largest exporter of finished color sets to the U. S., with an estimated annual volume of 220,000 sets plus 250,000 chassis.

According to figures compiled by Taiwan's Board of Foreign Trade, 496,253 color sets were shipped to the U. S. as of Sept. 9. For all of 1977, in contrast, the total was only 332,563. Taiwanese officials disagree with the contention that this growth has resulted primarily from the limitation on Japanese exports. Trade board director H. K. Shao says, "More important is that the Taiwan product is highly competitive in terms of price and quality."

That competitiveness should grow in the near future as dependence on imported parts decreases. Last month the N.V. Philips Gloeilampenfabrieken subsidiary in Taiwan opened a $55 million plant to produce color picture tubes. Its annual volume of 900,000 units will meet more than 80% of the domestic demand by assemblers selling into the local and export markets.

Philips Taiwan is also awaiting government approval of plans to make deflection yokes and ferrite materials, which it hopes to start producing next year. Another project, being carried out by the government-backed Electronic Industry Research Center with technical cooperation from RCA Corp., is designed to provide domestic capability in linear integrated circuits. Production facilities now under construction are scheduled to go into operation in late 1979.

Purchaser. Only five manufacturers—one American-owned (Admiral), one Japanese, and three domestic—have been engaged in exporting finished color sets to the U. S. (see chart). With Admiral due to close within the next few months, speculation has been rife that its factory may be taken over by another producer. The leading candidate is thought to be Olympic International of the U. S., whose investment application to establish a color TV plant in Taiwan was approved by the government early this year. Formerly a manufacturer, Olympic has been engaged solely in importing in recent years. When its new Taiwan facility is in operation, Olympic plans to make some 100,000 units a year.

Other American-backed TV plants in Taiwan have no current plans to produce complete color sets. Philco-Sylvania makes monochrome sets only, Zenith produces color modules, and RCA began turning out color chassis a year ago and now ships an estimated 600,000 annually to the U. S.

The major role played by Admiral and RCA in the trade is likely to put

TAIWAN'S TV EXPORTS TO THE U.S.

Company	Ownership	Estimated 1978 exports	
		Complete sets	Chassis
Admiral	American	220,000	250,000
Hitachi	Japanese	130,000	–
RCA	American	–	600,000
Sampo	90% local, 10% Japanese	100,000	–
Tatung	90% local, 10% Japanese	150,000	–
United	local	12,000	–

Probing the news

Taiwan in a more favorable negotiating position than Japan was with Washington. In fact, the pressure on Washington to take action against Taiwanese imports is coming less from American industry than from Tokyo, arguing for even-handedness. One result, Taiwan hopes, will be the exemption of chassis from any agreement concluded.

In the meantime, the Taiwanese government has been taking steps to block Japanese companies wanting to use Taiwan as a manufacturing base to circumvent the agreement with the U. S. The policy is aimed at deferring to American restrictions as well as assuring that most export growth is credited to the record of Taiwanese makers.

Reducing reliance on their Japanese partners should not cause great hardship for the Taiwanese companies, since they had already been concentrating on developing their own marketing channels and technical competence. Sets sold by Tatung Co. and Sampo Corp. under their own brands or private labels have been based on their own engineering and design work without Japanese assistance. Tatung has been spending nearly $3 million a year and Sampo $2 million on research and development, extremely large expenditures by Taiwanese standards.

Tatung, whose $200 million in sales last year ranked it as Taiwan's fourth largest private corporation, manufactures a broad range of electrical and electronic consumer and industrial goods. Most sales to the U. S. are channeled through a subsidiary in southern California, the Tatung Corp. of America.

At the end of this year or early next year, after the subsidiary moves to a larger plant in Compton, Calif., it will also begin the assembly of 25-inch color sets using chassis imported from Taiwan and U. S.-made picture tubes and consoles. The production target has been set at 5,000 units for the first year. If the operation goes smoothly, assembly of 19-in. sets will be added as well, leaving only the 13-in. size to be shipped in finished form from Taiwan.

One of Tatung's goals clearly is to shield itself from the impact of any protectionist restrictions. But Chieh Sun, president of Tatung of America, argues that with the rise in ocean freight rates since the energy crisis, assembly in the U. S. is now the most economical way to market products there for the larger models. The chassis, because its production is so labor-intensive, must still be imported from Taiwan, he says.

Sound effort. Of the Taiwanese companies, Tatung has been the most ambitious in its marketing efforts. Seeking to develop a special feature to help its product find a niche in the highly competitive U. S. market, it decided to improve sound quality to appeal to audiophiles. Its "Audiocolor" models incorporate a transmission device for channeling the sound through the consumer's existing stereo system, an innovation that won the product a design and engineering award at the Consumer Electronics Show last year. The styled set has also been made to resemble audio equipment.

Sampo, Taiwan's 10th biggest private company last year, with sales of slightly over $100 million, markets in the U. S. through a branch office in Chicago. It began exporting color sets, in 19- and 13-in. sizes, to the U. S. last December, selling to such customers as K-Mart and the chain stores of the City Products group.

Because of limited production capacity, Sampo does not anticipate a rapid expansion in exports. Although it seriously considered establishing assembly facilities in the U. S. as Tatung is doing, it has tabled the idea, at least until the market situation becomes clearer.

The third and smallest Taiwanese exporter is United Electronics International, which maintains a sales office in New York. Its 1978 exports to the U. S. are expected to come to only 12,000 sets.

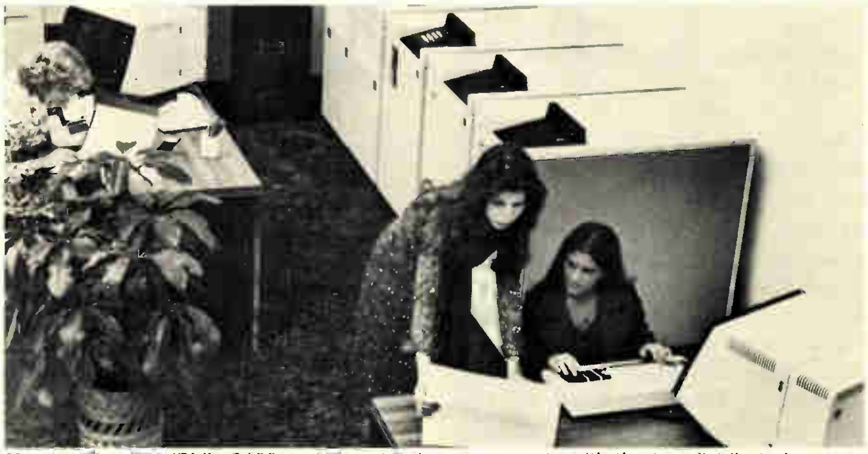
Looking ahead, Taiwanese manufacturers expect their country to surpass Japan as an exporter of color TVs but not to dominate the market as the Japanese formerly did. They anticipate strong competition from South Korea, which can undersell Taiwanese products as a result of even lower wage levels. □

Computers

IBM moves in on distributed processing

New 8100 system will compete with companies already in that arena both technically and in terms of price

by Anthony Durniak, Computers Editor



New contender. IBM's 8100 system not only can compete with the top distributed processors technically, but it sets up a rivalry between mainframe and small-system divisions.

After paying lip service to the concept with its previous machine, IBM has extended its broad umbrella of approval to distributed processing with the introduction of its 8100 Information System. The new entry, unlike its predecessor, stands ready to challenge the heavyweights.

Technical details about the processor, which was unveiled earlier this month [*Electronics*, Oct. 12, p. 33] appear to point to a product that is unique in its configuration and specifications. Because of this, the 8100 is expected to compete with all contestants in the distributed-processing arena. At first blush the 8100 seems to weigh in against such products as Digital Equipment Corp.'s PDP-11/70, Data General Corp.'s latest Eclipse C/350, and Hewlett-Packard Co.'s new 3000 Series 33. Marketed by IBM's mainframe arm, the Data Processing division in White Plains, N. Y., the new computer is even expected to impact other IBM divisions, primarily the General Systems division in Atlanta, as the 8100 appears to overlap its System/34 and aging Series/3. With its stand-alone processing and programming features, the 8100 also obsoletes the Data Processing division's previous distributed-processing unit, the 3790, even though IBM still makes it.

A 32-bit interrupt-driven processor, the 8100 is available in two versions: the 8130, which uses IBM's new 64-K random-access memories and has a memory cycle time of 1,200 nanoseconds, an access time of 975 ns, and a data transfer rate of 930 kilobytes per second; and the 8140, which IBM says uses older 3-K RAMs and thus is some 60% faster with a memory cycle time of 800 ns, access time of 550 ns, and data rate of 1.25 megabytes per second.

Both processors have a machine cycle time of 400 ns, can handle between 256 and 512 megabytes of main storage, and have an instruction set of 112 instructions. IBM will not reveal the type of logic used, claiming it is proprietary. Though IBM does not use the term "microprogrammed," a spokesman says both processors operate under control of read-only memories that are not alterable by the user. Both units contain 4 kilobytes of read-only memory. Eight priority levels are incorporated into the 8100 processors, which also have dynamic addressing to handle up to 4 megabytes of logical address space.

There are two types of registers in the 8100 processors, the 32-bit principal registers and the associated 16-bit adjunct registers. The registers are divided into 64 sets of eight

The 64,000-bit question

In addition to unanswered questions concerning the processing capabilities of the 8100 computer, the industry has been frustrated by a lack of information concerning the new 64-K random-access memory used in it [*Electronics*, Oct. 12, p. 33]. IBM says the chip has arrays of dynamic one-device cells and is fabricated using a new field-effect-transistor process that uses n-channel metal gates. A spokesman says the chips are 0.25 inch square and are packaged four to a 1-in.^{2} module.

Developed at the General Technology division laboratory in Burlington, Vt., the 64-K device has an 18-K brother developed at the IBM World Trade Laboratory in Boeblingen, West Germany. A spokesman at Burlington, where the devices are made, says details will be released later this month.

registers each, of which 48 are general purpose.

Integrated into the 8100 processors is a 1-megabyte, dual-sided, double-density diskette drive and a choice of 29- or 64-megabyte fixed disk drives or 23- or 58-megabyte fixed disk drives with 131 kilobytes of fixed-head storage. Additional input/output devices and disk drives are attached through an 8101 unit. Although IBM says the fixed disk-drive technology is proprietary, the data-transfer rate is 1.043 megabytes per second and the average access time is 27 milliseconds.

In addition to this collection of hardware, IBM introduced some 20 software products to operate with the 8100. In a break with its traditional policy, the software is unbundled—that is, priced separately from the hardware—with licensing fees ranging from $11 to $215 a month. Most important of the products are the two operating systems, the Distributed Processing Control Executive, which emulates IBM's older 3790, and the more powerful Distributed Processing Programming Executive, which allows the 8100 to operate in a stand-alone mode—something the 3790 could not do.

Industry observers caution, however, that before a complete analysis and comparison can be made additional information is needed on the 8100's instruction set, addressing scheme, and Programming Executive capabilities. Moreover, true measurements of its processing throughput will be impossible until production units are available, competitors note.

Although the first 8100s are not scheduled for delivery until the third quarter of 1979, their prices are rather aggressive, and industry observers expect a round of price cutting by competitors. An 8130 processor, for example, with 256 kilobytes of memory and a 28-megabyte disk, starts at $600 a month on a two-year lease or can be purchased for $24,000. The largest 8130, with 512 kilobytes of memory and a 64-megabyte disk, is priced at $29,940 or $780 a month on lease. The 8140 with the same hardware parameters ranges in price from $960 to $1,520 a month on lease or $33,060 to $46,980 purchase. □

Electronics abroad

Components sales up across Europe

Soft spots are few and far between, though two common problems loom as firms gather for Electronica

by John Gosch, Frankfurt bureau manager, and the European editors of Electronics

For the first time in many years, West Europe's multifaceted components markets have something in common: business everywhere is on the upswing. In fact, it is going much better than predicted earlier this year, and the upward trend should continue well into 1979.

Besides good business, they have other aspects in common, but these are less encouraging. There is the problem of declining prices, and there is the erratic world monetary system, as well as the devalued American dollar, which hurts companies doing business where the dollar is the medium of exchange.

Another problem that has the industry on edge are stretched-out deliveries and even shortages for some devices. Usually that's not bad, but this time components people worry that the shortages are the result of inventory ordering.

All in all, though, prospects are good. In the words of Erich Gelder, managing director of Advanced Micro Computer GmbH, a joint venture of Siemens AG and Advanced Micro Devices Inc. of Sunnyvale, Calif., "for all the uncertainties, the positive aspects predominate." It's little wonder, then, that sales and marketing managers from all over Europe will be in a buoyant mood at the Nov. 9–15 Electronica components shown in Munich. And on the stands will be 1,400-plus exhibiting firms.

West Germany. In West Germany, whose 1977 components production value of $2.3 billion makes it the world's third largest producer after the U. S. and Japan, sales started to pick up around the middle of this year. Because business was down by about 2% during the first half of this year compared with the same period last year, 1978 will probably show a gain of 3% for components of all kinds. That is modest, to be sure, but the trend is up.

Aisles of Munich. This scene from last year's Electronica show will be repeated early next month, with sales managers from all countries able to report upswings.

Doing better than the average this year will be innovative components for new applications. These include optoelectronic devices, which should register a 15% gain, and, of course, microprocessors, which are expected to score a hefty 70% sales increase over last year. Overall, semiconductor products should gain "around 10%," says Dirk G. Vogler, manager for marketing administration at Texas Instruments GmbH in Freising, West Germany.

The result may be supply problems, but also price declines for many devices, even for some with long lead times. To Gelder, this is contradictory—a development that he believes stems from "everybody wanting to increase his market share, come what may." He, among others, speculates that at least part of the shortage problem is the result of over-ordering to rebuild stocks.

A big boost is coming from the data-processing industry, and at long last the industrial-equipment sector is coming to the fore as a big customer. Also, after years of keeping its purse strings tight, West Germany's post office is going on a spending spree again: for the next five years, the agency has earmarked about $12.5 billion for telecommunications capital expenditures.

France. At Electronica, the French also will add a dash of optimism about Europe's near-term prospects. As in West Germany, impetus will keep coming from the communications and consumer sectors. Sales

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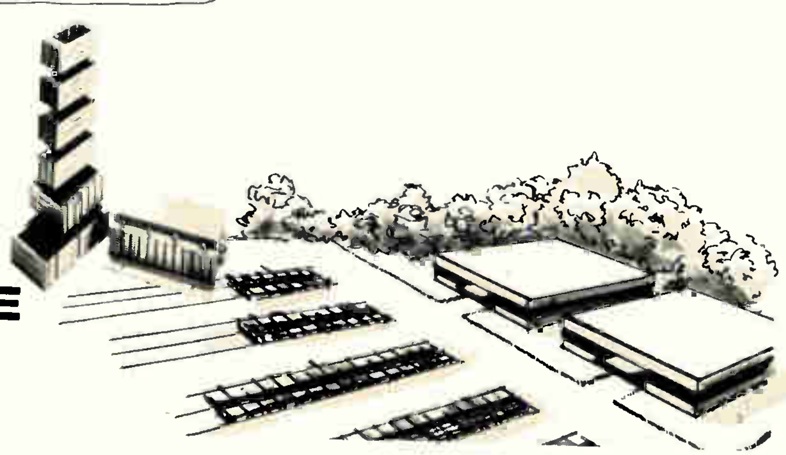

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Circle 91 on reader service card

officials at Motorola France say that telecommunications will lead the way next year with a growth rate of around 14%.

Overall, French electronics markets will be doing well, and so component makers are sanguine about the near-term future. Yves Thorn, marketing manager at Thomson-CSF's Sescosem division, says, "We see a good increase in the IC market in the first half. This will be mainly in metal-oxide-semiconductor and linear circuits for telecommunications."

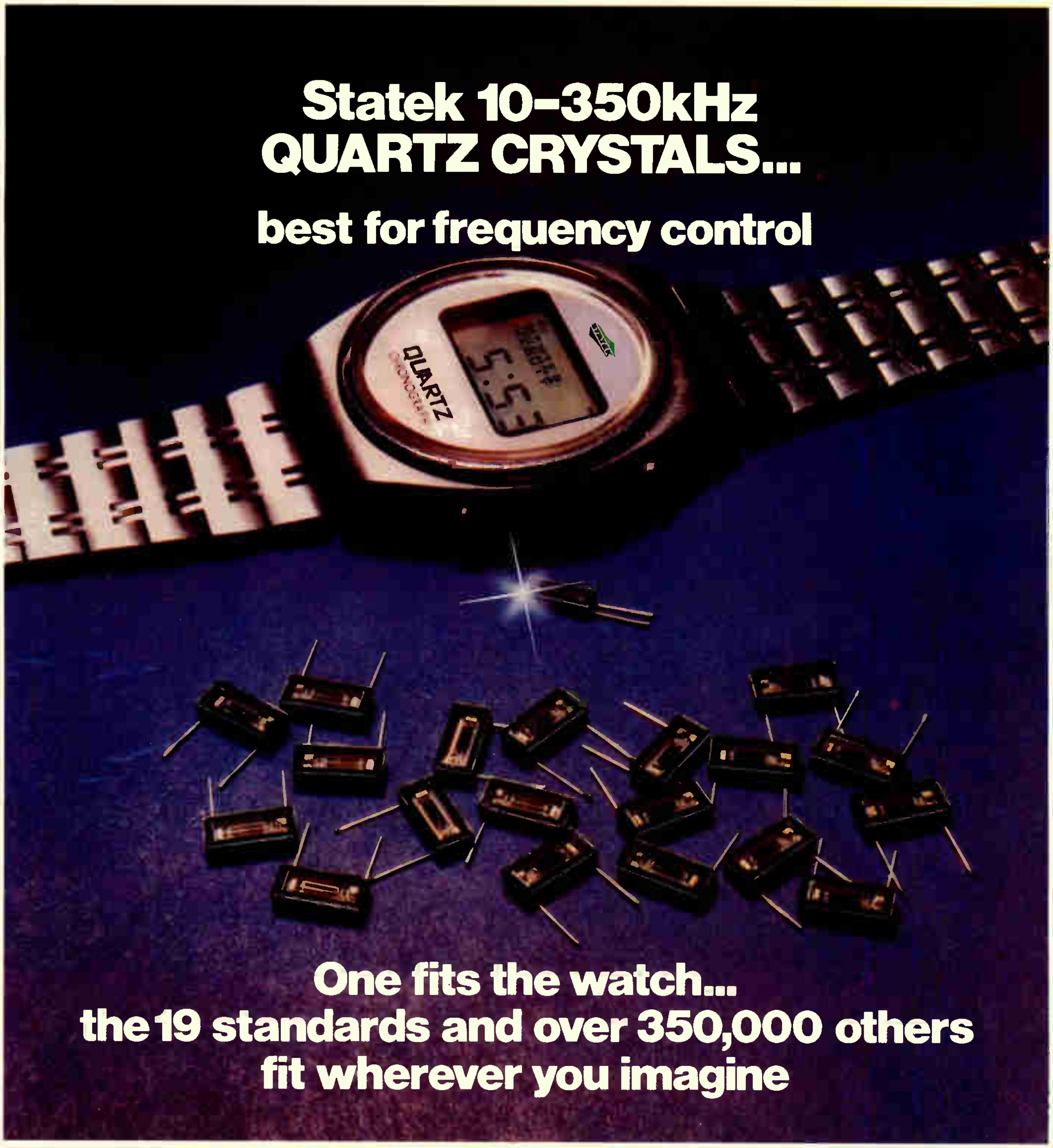
Italy. Italian sales and marketing people also will descend upon Munich in a buoyant mood—and with good reason: Italy's components market is experiencing an upswing that should continue through next year. Though mild right now, the upturn could gain momentum if the Rome government puts into effect its plan to pump some $600 million—$125 million for components—into research and development efforts.

"Overall," says Enrico Villa, marketing manager at the big components producer SGS-Ates, "the semiconductor industry should show a growth rate of between 13% and 15% for 1978 and roughly the same for 1979, with large-scale integrated MOS circuits faring the best."

Britain. The cross-Channel group of marketers from the United Kingdom will head for Electronica with spirits not quite as high as those of their counterparts on the Continent.

To be sure, at present the British economy is enjoying a miniature consumer boom, the result of growing North Sea oil revenues and the relative strength of the pound. However, the consensus is that the boom will have spent itself before the second quarter of 1979, and the depth of the following recession will depend on the unions.

In the components sector, there has been a slowing down of order intake overall, says David Benda, industrial and component market research manager for Mullard Ltd. But high-growth products like memories and microprocessors are holding up better than most other devices. □



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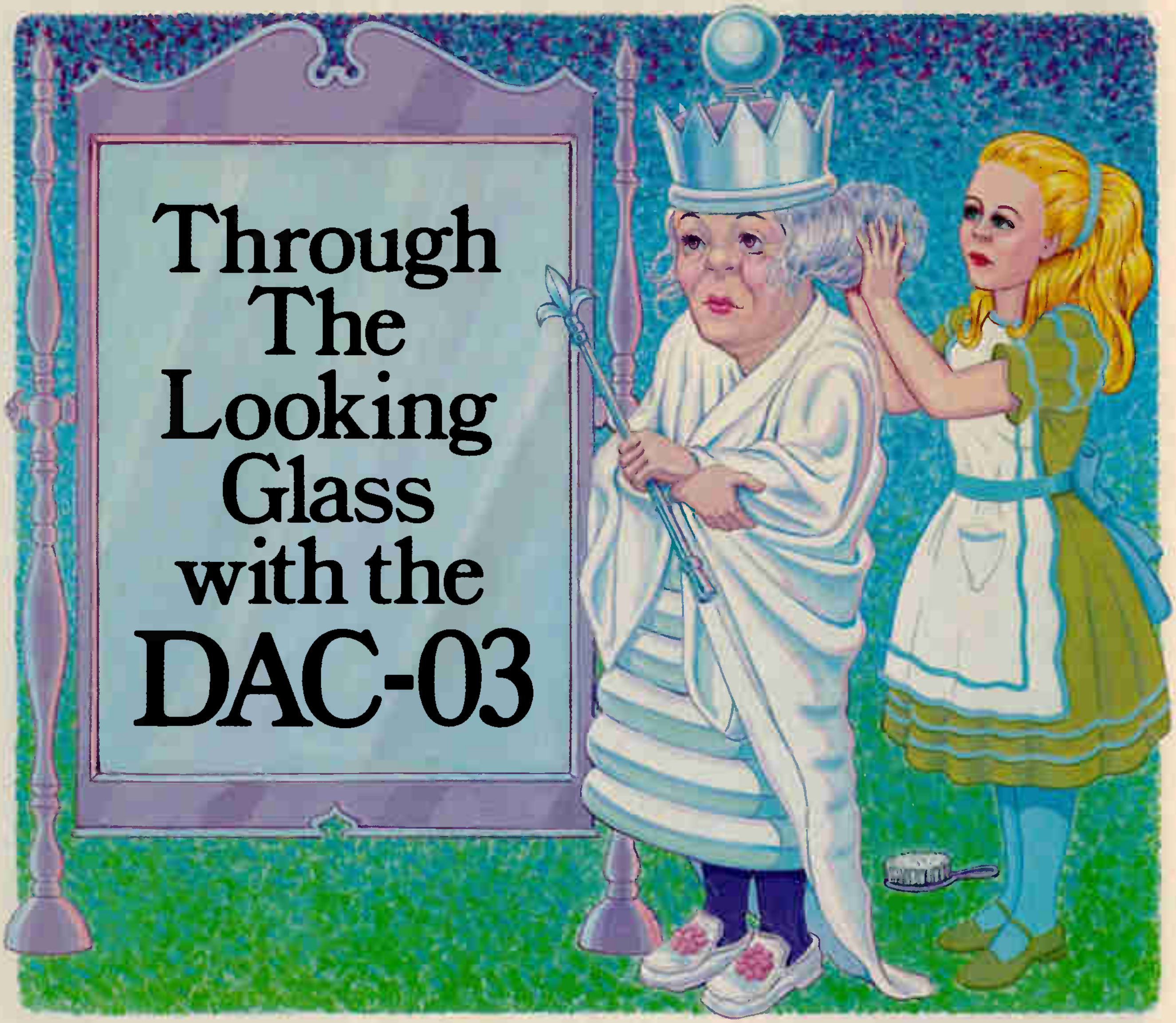


In *Through the Looking Glass,* Lewis Carroll introduced Alice to a mirror-image world where things were never what they seemed. In fact, they were just the reverse of what they should be. Punishment came before the crime; answers came before the questions.

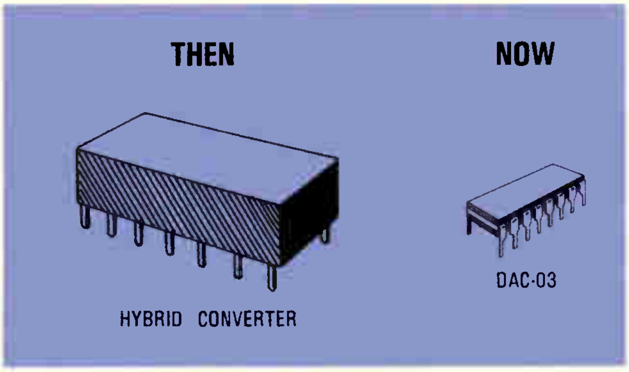
Linear Wonderland is like that sometimes, too. Salesmen spend their commissions before the purchase orders are signed. Marketing departments announce products before engineering develops them.

And at PMI, we try to develop products before anyone else realizes they're needed. We know that in Linear Wonderland, the best products create their own need.

That was how we developed the first truly monolithic D/A converter, the 6-bit DAC-01. At the time, no one thought they needed it because they were "making do" with modules or in-house designs with separate op amps and voltage references. When the DAC-01 (and the 10-bit DAC-02) came along and offered high performance specs with monolithic reliability, a lot of people suddenly found this was *just* what they needed.

PMI has another product we think a lot of engineers need: The DAC-03, a *low cost* 10-bit converter. Like the 10-bit DAC-02, it includes all the elements of a complete DAC on a single chip: precision voltage reference, current steering logic, current sources, diffused resistor ladder network, and high speed internally compensated output op amp.

Unlike the DAC-02, the DAC-03 is perfect for design jobs where the operating ambient is confined near room temperature. That's where our DAC-03's 25°C tested and guaranteed performance and its low, low price should be just what the systems engineer ordered.



The people who haven't needed the DAC-03 (until now) are all those designers who looked at our DAC-02 and decided that their system didn't justify the higher cost of wide temperature range testing.

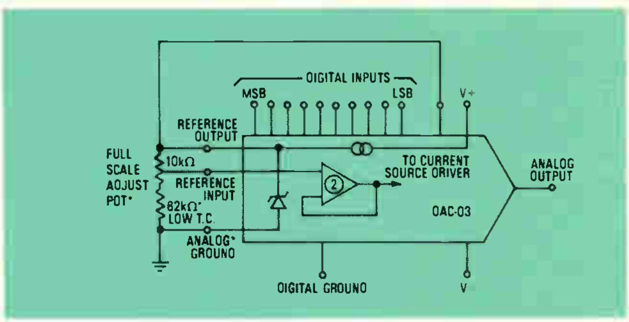
So they turned instead to in-house designs they could build with low-cost components, or to modules and hybrids which gave them the 25°C performance they wanted, but cost dearly in terms of space and power.

Was PMI going to let them go on forever making those trade-offs?

And will those same engineers go on using oversized $50 modules with a 1-watt power requirement and a speed of 5 μsec when they can get a DAC-03 in a chip or DIP package which requires only 350 mW, settles within 1.5 μsec output to ½LSB at a 10V step and costs as little as $7.95?

Even in the sometimes-backward world of Linear Wonderland that's not very likely. As Tweedledee said to Tweedledum:

"Contrariwise! If it was so, it might be; and if it were so, it would be; but as it isn't, it ain't. That's logic!"



Logic could also convince you to be one of the first to stop not needing the DAC-03. You'll quickly develop a need for the DAC-03's guaranteed monotonic performance in four non-linearity grades. We believe you'll need not only the DAC-03's speed and miserly power consumption, but also its ability to use a wide range of power sources, from ±12V to ±18V. And knowing that it's available in either + 5V or + 10V output range versions allows you to develop a need for either. Or both.

One need you'll *never* develop with the DAC-03 are additional devices for interfacing in TTL and DTL applications. Its input is fully TTL/DTL compatible, and only a 4¢ diode is required for full CMOS compatibility. You also won't need a big design budget since the DAC-03 is priced like a monolithic DAC, not like a module.

Sound too good to be true?

"One can't believe impossible things," Alice told the Queen.

"I daresay," replied the Queen, "that's because you haven't had much practice."

Why not practice with the impossible? Just fill in our "WHO NEEDS THE DAC-03?" coupon below and return it to us. Or get them from the guys on the following page. Fill out the coupon and PMI will send you a free sample so you can find out for yourself that in Linear Wonderland the best products are the ones nobody needs.

Until PMI develops them.

Part No.	100 and UP (US OEM)
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DAC-03CDX1 (or X2)	$ 9.95
DAC-03BDX1 (or X2)	$14.00
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1500 Space Park Drive
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Santa Clara, CA 95050

Check which type and voltage:
☐ DAC-03DDX2 (5V) or ☐ X1 (10V) ☐ DAC-03CDX2 (5V) or ☐ X1 (10V)
☐ DAC-03BDX2 (5V) or ☐ X1 (10V) ☐ DAC-03ADX2 (5V) or ☐ X1 (10V)
☐ I don't need samples, just send a data sheet

My name ____________________

Title ____________________

Company ____________________

Dept. ____________________

Address ____________________

City ____________ State ____________ Zip ____________

Phone (______) ____________

10E5006

Sapphire could challenge ECL

Speed and density of C-MOS circuits mount, with military preparing to welcome radiation-hardened versions

by Robert Brownstein, San Francisco regional bureau

The conventional wisdom is that complementary MOS with silicon-on-sapphire technology will find an emerging market when n-channel metal oxide semiconductor begins to run out of steam in the 1980s [*Electronics*, April 27, p. 94]. But with research teams cranking out faster and denser C-MOS on sapphire, the technology is likely instead to wind up competing against speedy emitter-coupled logic.

That's the main view of participants at the fourth IEEE workshop on SOS held earlier this month in Vail, Colo., where the talk more commonly is of skiers sliding down snow-covered slopes than of electrons sliding through n and p channels of devices layered on sapphire substrates.

Speeder. Lockheed's D. Howard Phillips, workshop chairman, talks of SOS speed.

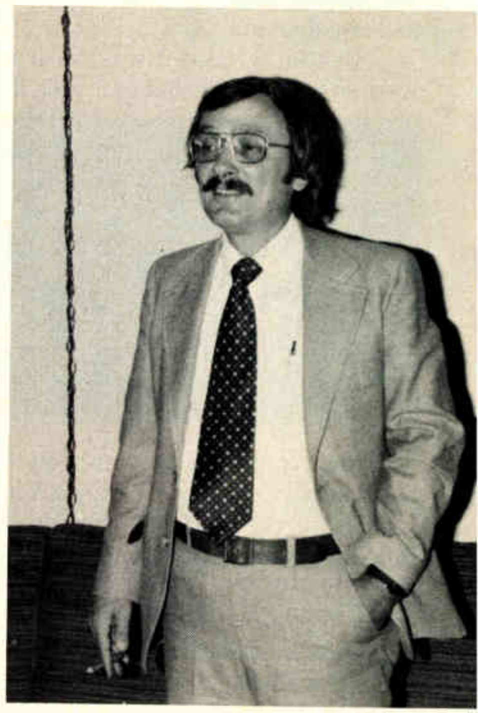
D. Howard Phillips, workshop general chairman and manager of microelectronics at Lockheed Missiles and Space Co., Sunnyvale, Calif., says that C-MOS on sapphire is geared to high-speed or high-performance device development, particularly because of its low-capacitance dielectric substrate, which allows high speed at low power dissipation.

Speed-power is the name of the game, according to Daryl T. Butcher, a research manager at Rockwell International Corp.'s Electronic Group in Anaheim, Calif. He reveals that speeds up to 500 megahertz have been achieved with 2-micrometer channel lengths on prescaler circuits operating at 10 volts. "There has been a lot of publicity about SOS being used in microprocessor and memory applications, but I think it makes more sense to be attacking the Cadillac end—the high-speed, low-power area," Butcher says.

He backs his statement with a comparison of a C-MOS-on-sapphire divide-by-10 or -11 circuit with a functionally equivalent low-power Schottky and ECL circuit. "At 10 MHz and 100 MHz, the ECL circuit dissipates 400 milliwatts and the Schottky part, 93 mw. In contrast, the C-MOS-on-sapphire IC runs at 0.32 mw at 10 MHz and 2.7 mw at 100 MHz," Butcher says. He adds, "At 300 MHz the SOS IC dissipates only 7 mw." The highest dissipation for C-MOS on sapphire is only 0.2 to 0.4 watt per square centimeter, according to Butcher.

The 11 circuits that Rockwell's research and development group experimented with are mostly dividers, counters, and ring oscillators. Each was laid out in two ways: one was a maximum-speed layout with no crossovers; the other was a conventional maximized-density design. To maintain good speeds both on and off the chip, input receivers and output drivers were fabricated on chip to reduce the input-output voltage to less than 1 V and reduce the power by a factor of 25. "At 5-V levels, power would have been the limiting factor for the maximum clock frequency it is practical to use," Butcher explains.

Although Rockwell's achievements bode well for future use of SOS in mainframe processors, SOS radia-



Military. Radiation-hardened SOS will dominate, says RADC's Bobby L. Buchanan.

tion-hardened parts "will be a dominant military technology," predicts Bobby L. Buchanan, chief of Rome Air Development Center's radiation-hardened technology branch at Hanscom Air Force Base, Mass. Buchanan, the workshop's keynote speaker, describes the basic military needs as a technology that is "useful, reproducible, and radiation-resistant." He concludes that "C-MOS on sapphire fills the bill." Buchanan discovered the mechanism responsible for the problem with back-channel leakage that plagued early SOS efforts.

Bumping n-MOS. Furthermore, "10% of the 8080As sold are used in low-level military applications such as avionics and the like. This will grow to 15%, but if there were a C-MOS-on-sapphire version of the 8080A, it would displace the n-MOS part from nearly all of these military projects, plus open up some others," Buchanan projects. The upshot, he believes, is that a C-MOS-on-sapphire 8080A would have a total dollar value twice that of the entire commercial 8080A market.

"SOS has come a long way; we have solved the problems of back-channel leakage, island-edge effect, n-channel kink, hysteresis, and protection circuitry, but there are still two barriers to overcome before it will have wide military use," Buchanan says. One is better test and evaluation data and procedures; the other is a larger materials technology base. There are not enough materials suppliers and "the techniques for qualifying the material are just not there," he says.

RAM figures. Perhaps those barriers can be skirted, especially with life-cycle data like this from RCA Corp.'s David M. Sarnoff Research Laboratories in Princeton, N. J. The CDP 1821, a 1,024-bit C-MOS-on-sapphire random-access memory, had a failure rate of 0.0003% per 1,000 hours, according to the lab's Alex Shevechenko. Of 397 devices tested for a total of 752,130 hours, only one failed functionally, he says. The RAM, which is used in the Tiros weather satellite, has had no failures in 2½ years of space operation, he adds.

RCA Labs has come up with a five-transistor memory cell to replace the conventional six-transistor cell and increase chip density, according to researcher Richard Hollingsworth. A 4,096-bit RAM, the CDP 1825, with a 16-square-millimeter die, is already available and uses 59.7% of the chip area for the memory circuitry. The 2114-like RAM, with more than 22,000 transistors, dissipates 50 microwatts and has an access time of 350 nanoseconds at 5 V, he says.

Pushing for even denser circuitry, RCA has adopted an arrangement of one contact per memory for its five-transistor cells in some experimental designs. "Metal contacts are replaced by buried contacts," Andrew G. F. Dingwall, another researcher, explains. The design goals are for sub-100-ns RAMs. Using 5-μm design rules, RCA has built a 4-K static RAM with a die size of less than 16,000 mil^2. As for the 16-K and 64-K devices, Dingwall projects die sizes of 5 by 6 mm (47,000 mil^2) and 6.2 by 7.5 mm (73,000 mil^2) for these sub-100-ns chips.

An offshoot of Rockwell's high-speed SOS development is a 12-bit analog-to-digital converter. It has developed a chrome-silver resistor technology for the resistive ladder network and used a laser to burn links rather than trim resistors. The approach avoids the need to apply heat to the three-ladder network itself during the resistor trim process, according to Martin M. Spanish, a Rockwell engineer. The experimental part does a full conversion in only 2.5 microseconds and has on-chip comparators and offset-voltage correction circuitry.

If C-MOS on sapphire is so fast, why not use it in bit-slice designs? Raytheon Co., Bedford, Mass., is doing just that, according to Richard P. Lydick, C-MOS design chief. "We're making C-MOS-on-sapphire versions of the 4-bit 2901 and the 2909 sequencer," he says. So far, says Lydick, the 2901 works except that a slight logic error made early in the project caused the designers to omit a latch. The result: "It works fine for the first 20,000 truth table lines, but then it tends to overwrite," Lydick says. He adds, however, that this is no great problem because the designers left a great deal of extra space on the chip for just such corrections. □

MOTOROLA HELPED BRING

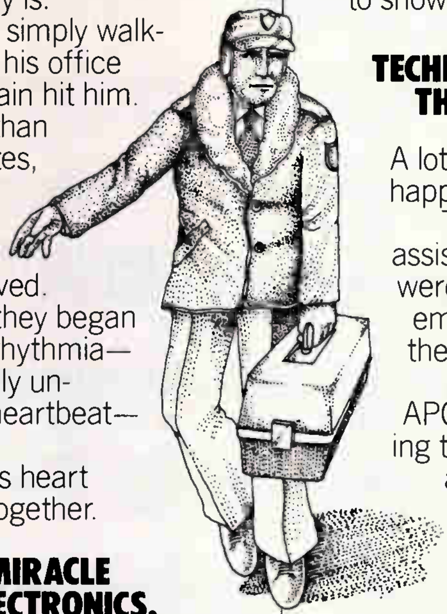
His name isn't important.
His story is.

He was simply walking back to his office when the pain hit him.

In less than three minutes, an ambulance with two paramedics arrived.

But as they began to work, arrhythmia—erratic, wildly uncontrolled heartbeat—set in.

Then his heart stopped altogether.



A MIRACLE OF ELECTRONICS.

Fortunately, the ambulance was equipped with a Motorola APCOR Coronary Observation unit.

It put the paramedics in immediate touch with an emergency physician at the hospital miles away.

Not just by voice communication; that doesn't give a doctor all the information he needs.

But at the very same instant, by Motorola telemetry, an electrocardiogram of the activity of the man's heart was being transmitted.

A miracle of electronics—microelectronics—was about to show what it could do.

TECHNOLOGY DOES THE TALKING.

A lot of things were happening at once.

The medical assistants at the scene were talking to the emergency room at the hospital.

And the Motorola APCOR was also talking to the doctor in a language only a doctor could understand—by transmitting the patient's EKG.

The doctor could then treat the patient almost as if he were on the spot.

In a few minutes, the man's heart began to beat. He was once again on his way to being alive, in every sense of the word.

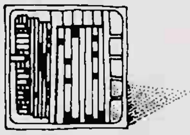
MICROCIRCUITS MAKE IT HAPPEN.

APCOR is made possible by Motorola microcircuits, tiny information processors that transmit both electronic

THIS MAN BACK TO LIFE.

signals and the human voice.

Microcircuitry is also at the heart of the many other kinds of two-way communications equipment we make.



A microcomputer, drawn larger than life.

But communications equipment is only part of what contributes to our nearly two billion dollars a year in sales.

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Thanks to Motorola microelectronics, we create all kinds of remarkable systems that would have been inconceivable not long ago.

A system to help power companies handle peak loads without danger of blackouts.

An electronic car-engine management system that can save gasoline.

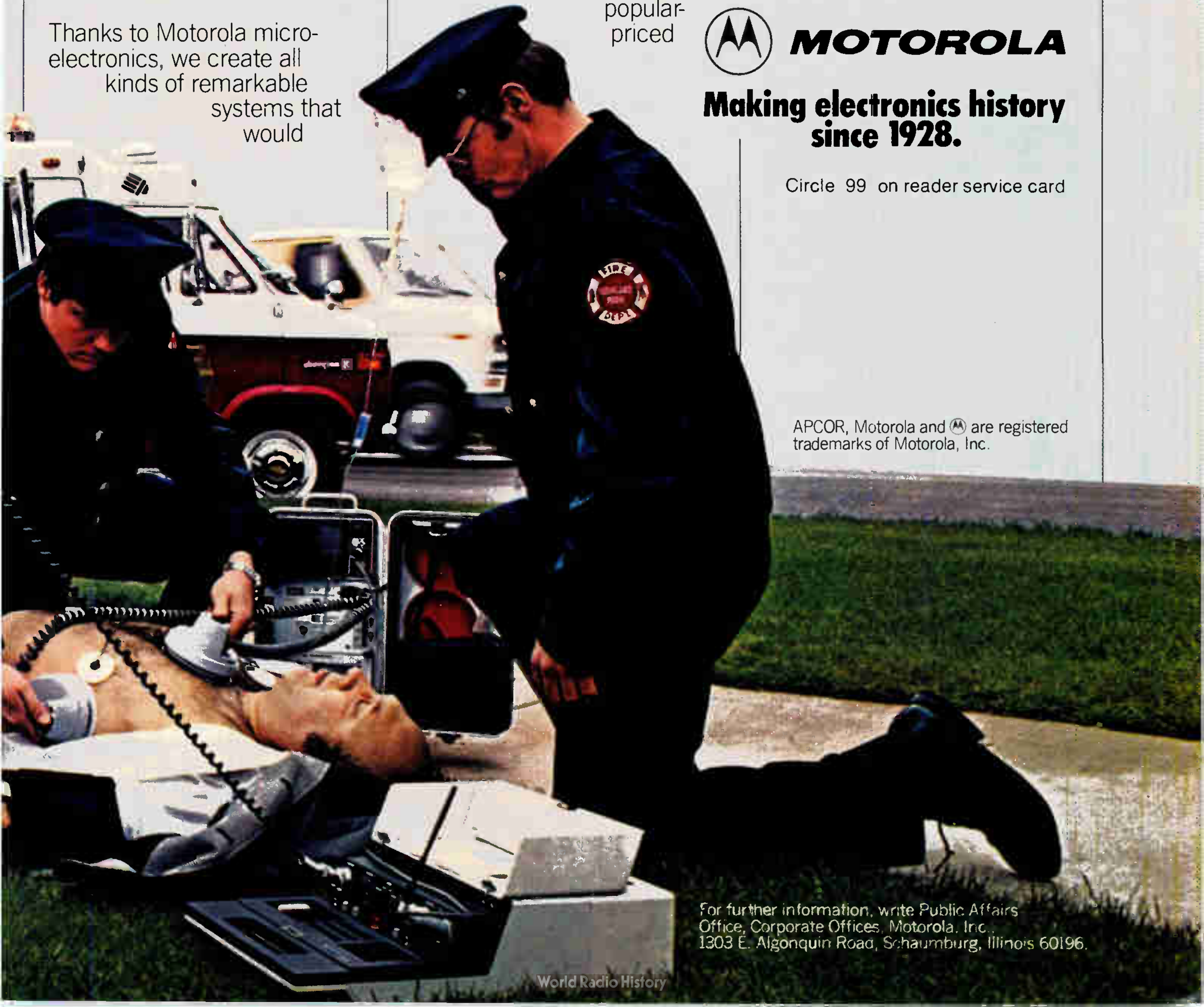
Even a communications system to help probe Mars.

But then, we've come a long way from the time we first made history by putting radios into cars (we went on to put alternators and electronic ignitions into them) and later put popular-priced TV sets into homes (they're a product we don't make here at all anymore).

Today, Motorola is one of the world's largest manufacturers dedicated exclusively to electronics, as well as one of its foremost designers of custom and standard semiconductors.

Many of the things we make are changing people's lives.

Others are actually saving them.



MOTOROLA

Making electronics history since 1928.

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THE 1978 ACHIEVEMENT AWARD

Creator of Coplamos structure cited for contribution to high-speed MOS

by Bruce LeBoss, New York bureau manager

Paul Richman, president of Standard Microsystems Corp., is a great believer in the adage that "necessity is the mother of invention." He says it explains the development by his team of scientists and engineers of fundamental solutions to manufacturing problems foreseen for metal-oxide-semiconductor large-scale ICs in the early 1970s.

Richman's leadership in developing important device-fabrication techniques, embodied in the technologies known as Coplamos and Clasp, is largely responsible for the significantly increased performance capabilities of today's state-of-the-art MOS integrated circuits, particularly random-access memories and microprocessors. These patented techniques and processes are now licensed by many of the world's most prominent semiconductor manufacturers, among them IBM Corp., Texas Instruments Inc., and Western Electric Co.

His preparation for his role in technology development began with a solid grounding in theory at the Massachusetts Institute of Technology, where he received a bachelor's degree in electrical engineering in 1963. Because of his interest in courses like quantum mechanics and semiconductor theory, he chose to do his thesis on insulated-gate, thin-film transistors made of cadmium sulphide. These devices, he recalls, "were forerunners of MOS devices" and their electrical characteristics were "very similar to those of MOS transistors fabricated in bulk silicon."

At Columbia University, where he acquired a master's degree in electrical engineering in 1964, Richman continued to concentrate on courses in solid-state physics and semiconductor theory in both the EE and physics departments. Not surprisingly, when he joined the General Telephone & Electronics Laboratories in 1965, he worked on early MOS device fabrication. His major interest was theoretical: "A lot of theory had to be evolved with respect to MOS transistor device characteristics. In addition, particular attention had to be paid to how those transistors interacted with one another when interconnected in IC form."

At the GT&E labs, he became a senior device research engineer and did work on the control of parasitic, field-aided, space-charge-limited current flow in MOS devices. Some of the considerations associated with that work, such as the use of a reverse-substrate bias, he says, "are particularly important in high-density device-scaling techniques being employed today."

Approached in 1969 to become the vice president for research and development at a small electronics company starting out in the MOS device field, Richman not only accepted, but brought with him several key members of GT&E. The Hauppauge-based company, Solid State Data Sciences Inc., was a spinoff from General Instrument Corp., "and was not well-financed," he says. "Although we had high hopes for the company, they never materialized."

Eventually its assets were taken over by a new firm, Standard Microsystems Corp. With money from a venture-capital outfit, it was founded in 1971 by four people: Richman as vice president R&D, Walter Kmeta (now manufacturing vice president), Walter Zloczower (now manager of organizational and personnel development in the manufacturing department), and another man no longer with the firm.

"When I first started at Standard Microsystems," Richman recalls, "I was

The 1978 Achievement Award

For major innovations in device-fabrication techniques that greatly increase the performance of metal-oxide-semiconductor integrated circuits, the editors of *Electronics* designate Paul Richman, president of Standard Microsystems Corp. in Hauppauge, N. Y., as recipient of the magazine's fifth Achievement Award. He is a key figure in the development of Coplamos and Clasp technologies.

The Coplamos technology involves the use of self-aligned, field-doped, locally oxidized structures for high-speed, high-density n-channel MOS ICs. The structure helps overcome troublesome cross-coupling problems caused by parasitics in n-MOS devices, while also achieving optimum performance in terms of speed and density. Clasp—Coplamos last-stage programmable—is a new type of MOS memory structure that can be programmed during the last step in the manufacturing process.

'We were able to minimize parasitic conduction between neighboring n-channel devices while also maintaining a high avalanche-breakdown voltage'

Like many who have difficulty getting up in the morning, Paul Richman takes long showers to awaken fully. Unlike most of his breed, however, he often spends that time thinking about semiconductor technology or his firm's business. "There's nothing else to do in the shower. Some people sing: I think of new processes and possible second-source agreements," says the 36-year-old president of Standard Microsystems Corp. in Hauppauge, N. Y.

His morning shower is not the only time he has "technological daydreams," as he calls them. A daydream that led to one of his nine patents in the field of semiconductor devices came as he was mowing the lawn.

Richman had no idea what semiconductors were until he went to college. "In high school, I liked technology but had never heard of the word 'semiconductor.' When I went to MIT, I decided to go into electrical engineering and soon found out about semiconductor technology and that I liked it."

His liking for semiconductor technology might be described as "a love affair." At least that's the way it may have appeared to Ellen, his childhood sweetheart and wife of 12 years.

When first married, the couple had an apartment in Bayside, N. Y., two blocks

aware of a very interesting thing happening in the evolution of MOS ICs. The semiconductor industry realized n-channel devices clearly were superior to p-channel devices in terms of speed and density. And indeed most discrete MOS transistors fabricated in the early 1960s were n-channel devices."

However, when ICs first began to be built, they were built as p-channel configurations because neighboring n-channel transistors tended to cross-couple through two mechanisms that occurred in the thick-field oxide regions. There was cross coupling between neighboring devices and between neighboring n^+-diffused regions. "I proposed the Coplamos structure," Richman says, "on the basis of theoretical considerations" and the work on local oxidation done almost simultaneously by Franco Morandi at SGS-Ates in Italy and a team at the laboratories of Philips in the Netherlands.

Richman filed for a patent on Coplamos in 1971 and immediately began fabricating devices. Together with Kmeta, Zloczower, and senior process engineers Olie Hedquist and Jim Hayes, he built the first Coplamos structures in metal-gate technology and subsequently in n-channel silicon-gate.

The Coplamos patent was issued in 1973 and, Richman says, "has been the focal point of Standard Microsystems' patent-licensing program ever since." It has been complemented by a patent covering on-chip reverse-substrate biasing and, most recently, by the issuance of a patent on Clasp technology.

"In all licenses, not only did Standard Microsystems exchange rights to its patent portfolio for the rights to use semiconductor patents of much larger companies, but also money has flowed to us," he notes. In fact, the recent accord with Western Electric was precedent-shattering in that it is believed to be the first time the American Telephone & Telegraph subsidiary has paid another firm for rights to semiconductor technology.

As Richman explains it, the Coplamos patent is on a self-aligned, field-doped, locally oxidized structure for high-speed, high-density n-channel ICs. "The structure enables one to solve parasitic and cross-coupling problems, while achieving optimum performance in terms of speed and density," he says. The characteristics achieved are particularly important for microprocessors and high-speed dynamic and static random-access memories.

Basically, the use of self-aligned field doping, recessed thick oxide, and reverse substrate biasing selectively increases the surface depletion-charge density in the thick-oxide regions of n-MOS devices, he continues. "Thus we were able to minimize parasitic-conduction mechanisms between neighboring n-channel devices, while also maintaining a relatively high avalanche-breakdown voltage." The developments opened the way to higher n-MOS power-supply voltages required for high-speed operation, without encountering parasitic-conduction problems.

A development patented last February, Clasp technology promises great manufacturing benefits of an-from General Telephone & Electronics Laboratories, where Richman began his working career in 1965 as a member of the technical staff. On weekends, he would not think twice about taking a five-minute walk to the labs to check on the progress of an experiment. "I thought of the labs as an extension of my apartment," he says.

With their three children—10-year-old Lee, 6-year-old Alyson, and Daniel, 2—the Richmans live in St. James, on the north shore of Long Island and out of walking range of the Standard Microsystems plant. The eight-room, ranch-style house they have occupied for the past nine years has a wooded back yard and is in a quiet setting that appeals to Richman.

He would love to see his children enter the engineering field, "a great profession." He is especially pleased that his son Lee knows about metal oxide semiconductors and is fascinated by the semiconductor industry. Also Alyson, at her father's 15th class reunion last June, became "so infatuated with MIT that she didn't want to leave."

With a near fanatical desire to document matters, particularly in the technical area, Richman keeps detailed and orderly files. He takes pride in finding quickly any item relating to technology or the firm's day-to-day business. "This ability has come in very handy in the patent-licensing area," he says, contending that he is as orderly at home as he is at work. "Ellen thinks otherwise," he admits, especially when she finds a pair of Richman's sneakers in the center of the bedroom floor.

As well as liking classical music, he is a sports enthusiast. At 6 feet 1 inch and 185 pounds, he likes to play tennis and quarterbacks the company football team. "Almost comparable to some of our licensing pacts," he says, was his firm's 77–56 victory last year over hybrid device maker Circuit Technology Inc. Like the good sport that he is, he notes that CTI avenged that loss and spoiled what would have been an undefeated campaign with a 28–14 victory in the season finale.

The author of many articles published in technical journals around the world, Richman loves to write. He "was pleasantly surprised" when the Russians pirated his 1967 textbook, "Characteristics and Operation of MOS Field-Effect Devices." Another, "MOS Field-Effect Transistors and ICs," was published in 1974. Now he combines his obligations to family and business with teaching, so he cannot see a return to writing soon.

With the title of visiting professor in the Department of Electrical Sciences of the State University of New York at Stony Brook, he has spent one night each week of the past four spring semesters teaching a graduate course in MOS field-effect devices and ICs. For two years before that, he served as an adjunct professor of electrical engineering at the City University of New York.

Why teach with such a busy schedule? "I'm a theoretician," Richman explains. "However, routine management and people problems take much of my time. I feel I have to maintain a theoretical background, or it will be tough to keep up to date. Teaching forces me to stay current and explore and examine some of the assumptions and derivations I've made."

In addition to keeping a link with theory, Richman also is careful to stay in close touch with his firm's employees. All workers have free access to him. Until the firm grew rapidly last year, he knew all employees by their first name. The environment at the company is informal: Richman dresses casually and encourages new employees to doff their jackets and ties. "I hope to emphasize creativity, in a politics-free environment, and I intend to keep it that way."

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other type. Clasp, for Coplamos last-stage programmable, differs from other MOS memory structures in being programmable during the last step in the semiconductor manufacturing process. Wafers can be processed and stored, waiting only for the desired electrical information to be put into them. The approach can eliminate expensive overruns of custom parts, while shortening delivery times dramatically.

The president of Standard Microsystems since 1974, Richman has enjoyed watching the company grow from four employees to its present total of over 180. The firm's business today is a combination of its patent-licensing program and a mix of highly sophisticated standard MOS products for the data-communications, computer-peripherals and terminals markets, as well as a variety of custom devices it builds for manufacturers in the home-entertainment, word-processing and data-communications fields, among others.

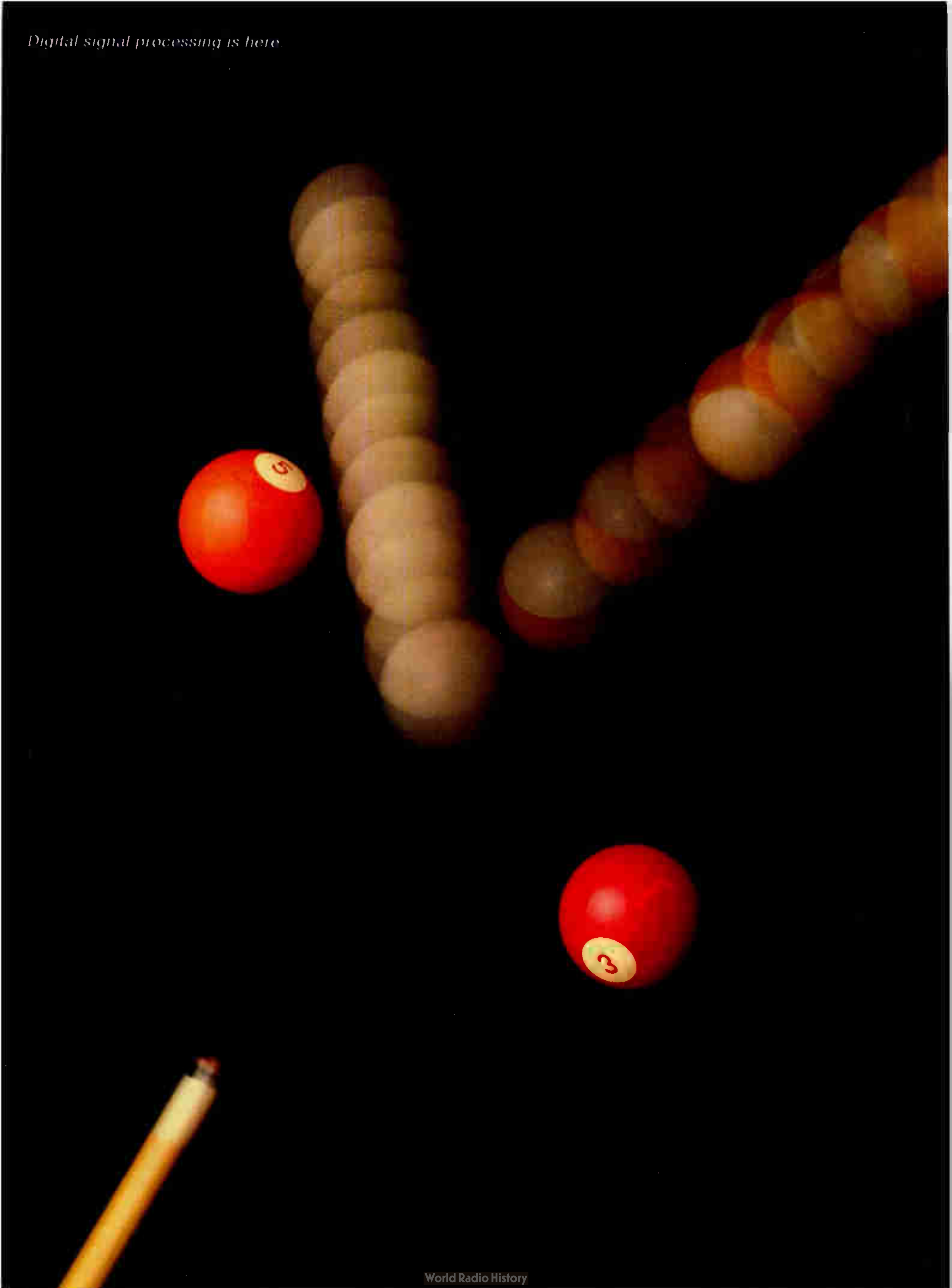
In the fiscal year ending Feb. 28, 1978, Standard Microsystems posted a pretax income of $1.75 million on revenues of $7.5 million, compared with $1 million of pretax profit on $5.1 million in revenues for the prior year. "Although I'm very proud of our patent-licensing program, I'm equally proud of the operations of the company," he says. "Although our volume is relatively low when compared to the giants of our industry, our pretax profits as a percentage of sales rank among the industry's leaders. We hope that trend will continue." He projects a pretax profit in excess of $2.7 million on sales of about $11 million in the current fiscal year.

Richman says he's "having a lot of fun," along with a good crew of people that are "dedicated and top-notch in their technical expertise," in building Standard Microsystems' business. However, he must combine business acumen with technological expertise.

Although he expects sales to grow dramatically over the next few years, he is more interested in seeing profits increase at a faster rate. "One of management's philosophies is 'controlled growth.' We have intentionally resisted high-volume markets that also are very high-risk areas and concentrated on growing slowly with an emphasis on profits."

The firm's volume the past three years has grown about 50% annually, but "we could have grown faster," he says. For example, it could have participated directly in the RAM market, but chose instead to profit from this high-risk field through royaltes from companies such as International Telephone and Telegraph Corp. It licensed ITT in 1976 and helped it get into production of dynamic RAMS.

"More often than not, we've decided not to go into a specific market that would accelerate our sales growth but also severely jeopardize profits," says Richman. "However, we don't allow ourselves to fall behind in technology." He notes the firm has processes oriented toward RAMS and high-speed microprocessors, for example, but has no plans to enter the market segments directly. "I'm a firm believer in another adage, that he who rides the tiger oft winds up inside." □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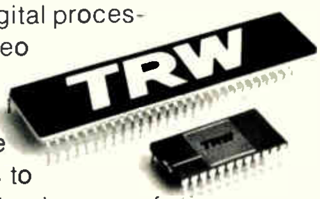

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The 931B is a true RMS differential voltmeter designed for rapid measurements of AC waveforms to within ±0.05% regardless of their shape. Frequency response extends to 2MHz.

1957: Fluke introduces ultra-stable DC calibrator.

Two years after introducing differential voltmeters, we expanded our precision measurement line to include DC calibrators. Now Fluke provides a full range of instruments for all DC calibration needs. Here are three.

The 343A is a seven-dial, 20 ppm DC calibrator that provides parameters of stability, temperature range and response time required by a wide range of applications.

The 382A operates as a combination ±0.01% voltage calibrator and a ±0.02% current calibrator. It offers voltage outputs to 50V and current capabilities to 2A.

The 335D provides 10 ppm accuracy as both a DC voltage standard and a differential voltmeter.

1963: Fluke introduces standards.

We started it all in 1963; now the 540B stands by itself in the industry. It is a primary standard thermal transfer device for NBS traceable measurement and calibration of AC voltage and current. Measurement capability is 0.25V to 1000 Vrms over 14 ranges, with a frequency range from 5 Hz to 1 MHz.

The 510A is a precision fixed-frequency sinewave voltage source suited to calibration or test applications. Outputs are 10 Vrms at 10 mA with available frequencies from 50 Hz to 100 kHz.

The 731B DC transfer standard is an electronic standard cell designed to give metrology people a portable working DC standard. The 731B can be hand-carried anywhere and subjected to severe environmental conditions.

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1966: Fluke introduces DC calibration systems.

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Accuracy to 5 ppm is standard in this DC voltage and ratio calibra-

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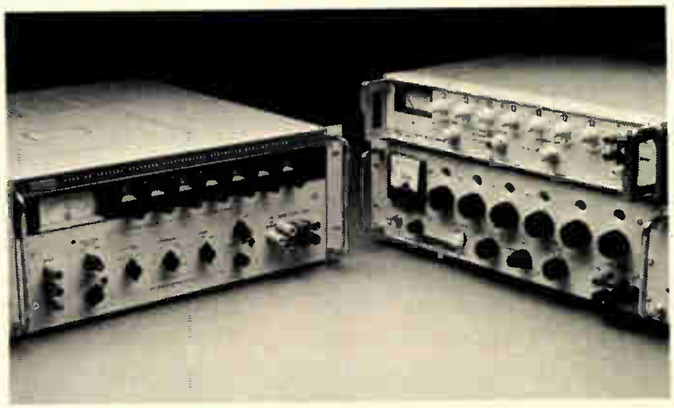

335D, 343A, and 382A DC calibrators.

6110-8005

tion system, with resolution and ratio accuracy to 0.1 ppm.

In a functional self-contained enclosure, the 7105A offers voltmeter and power supply calibration capability, a differential voltmeter, ratio calibrator and a null detector.

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We entered the market with a fully programmable AC calibration setup. Together, the 5200A precision ±0.02% AC calibrator and the 5205A precision power amplifier can calibrate AC devices up to 1200 Vrms. Frequency range is 10 Hz to 1.2 MHz.

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1977: Fluke introduces the cal lab in a box.

In this year, we introduced the first "calibration laboratory in a box."

Our new 5100A/5101A calibrators can calibrate VTVMs, VOMs, 3½- and 4½-digit DMMs in a fraction of the time it takes you now, unless — of course — you're already using one!

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The microprocessor also provides error computation in percent or dB, full scale or fraction of full scale.

1978: Fluke introduces the most advanced DMM.

Our 8502A microprocessor-based DMM, a total systems instrument, has uniquely enhanced bench capability as well.

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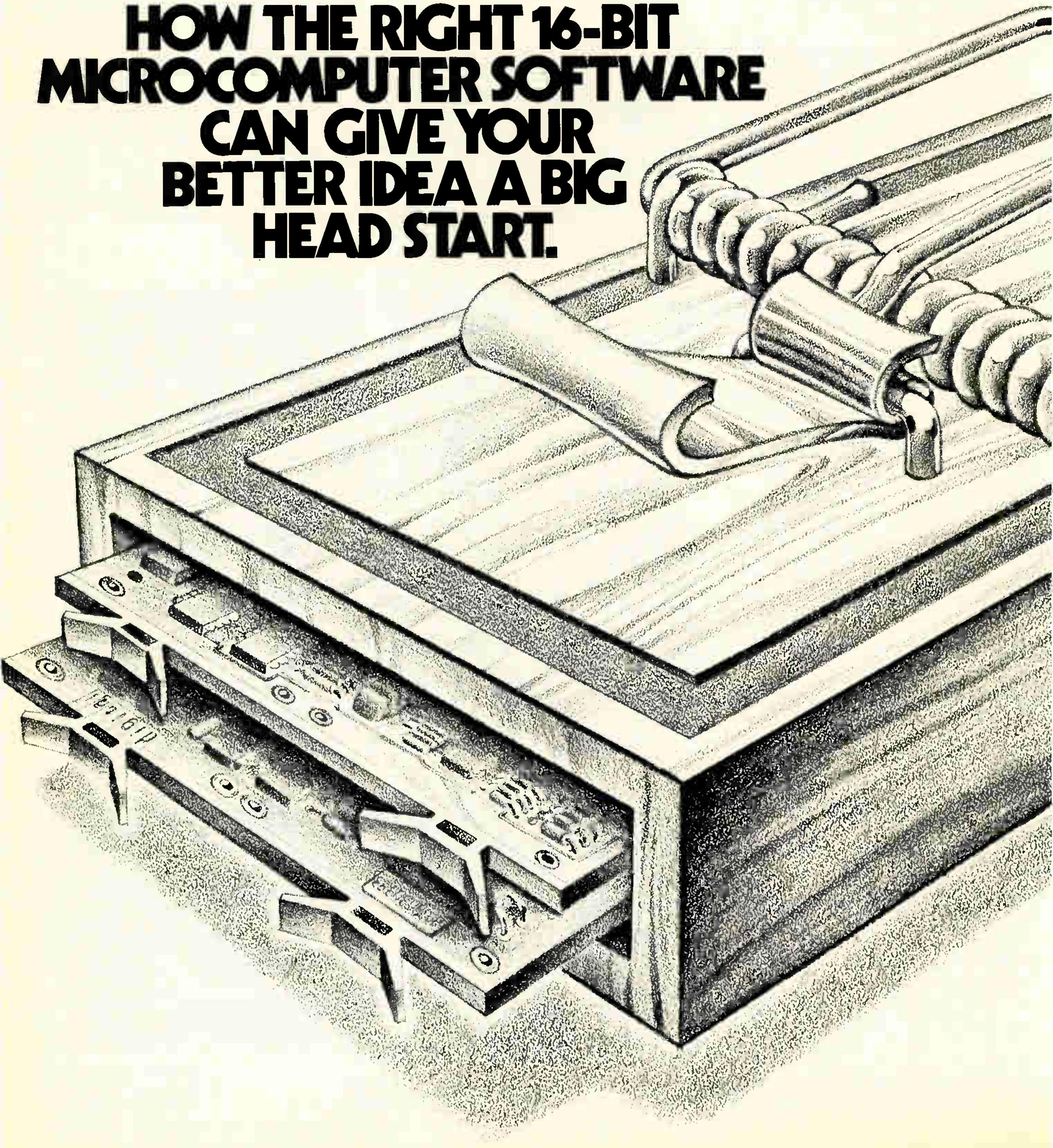

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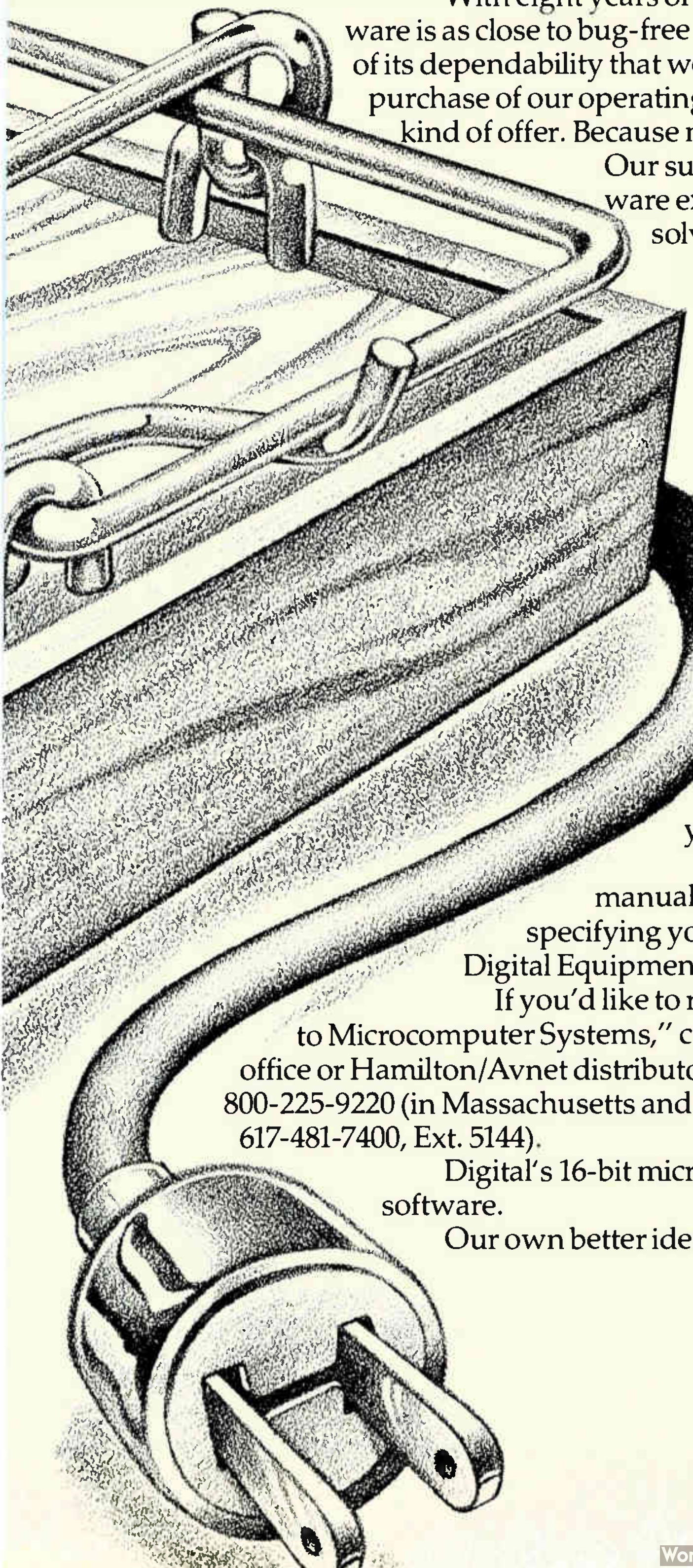

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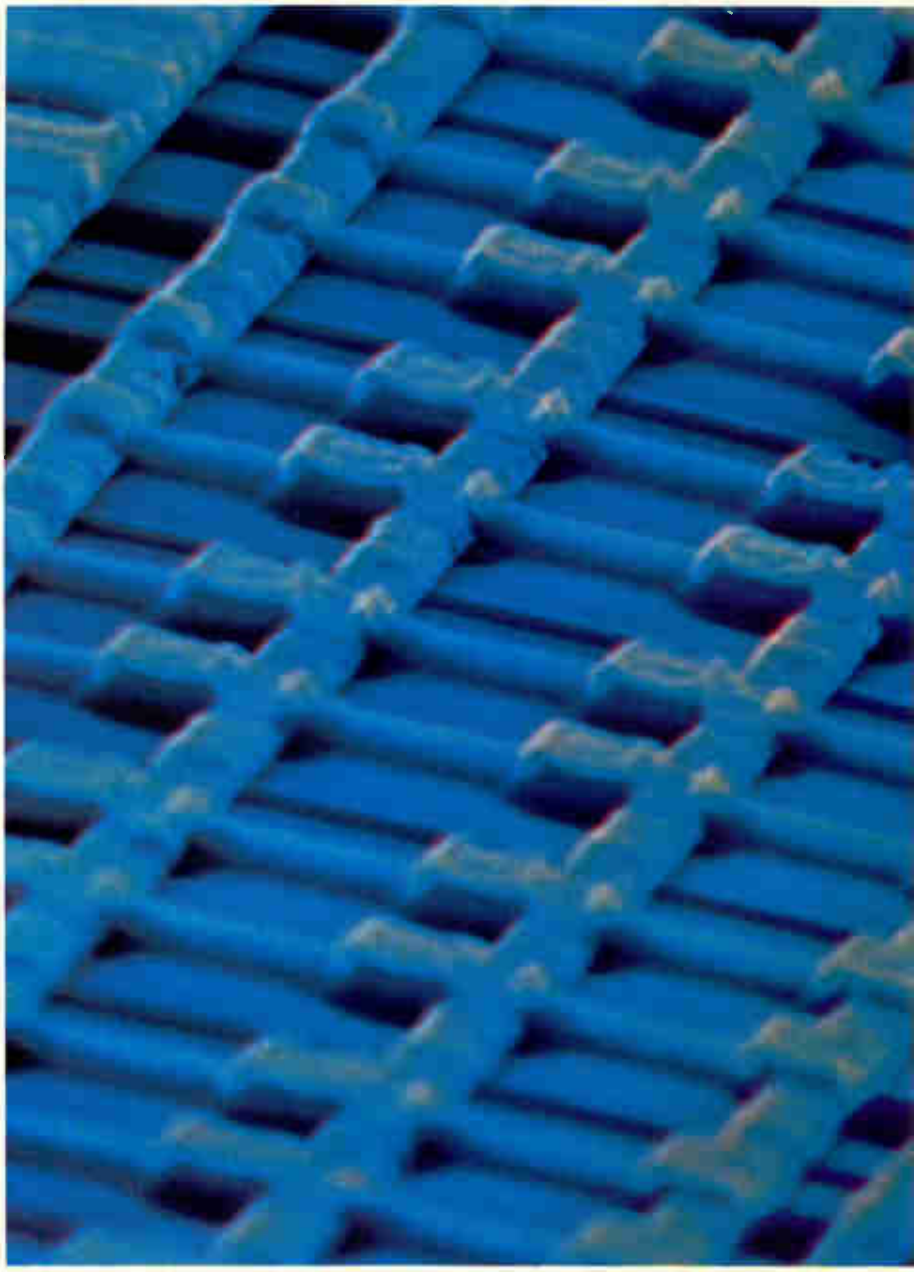
TECHNOLOGY

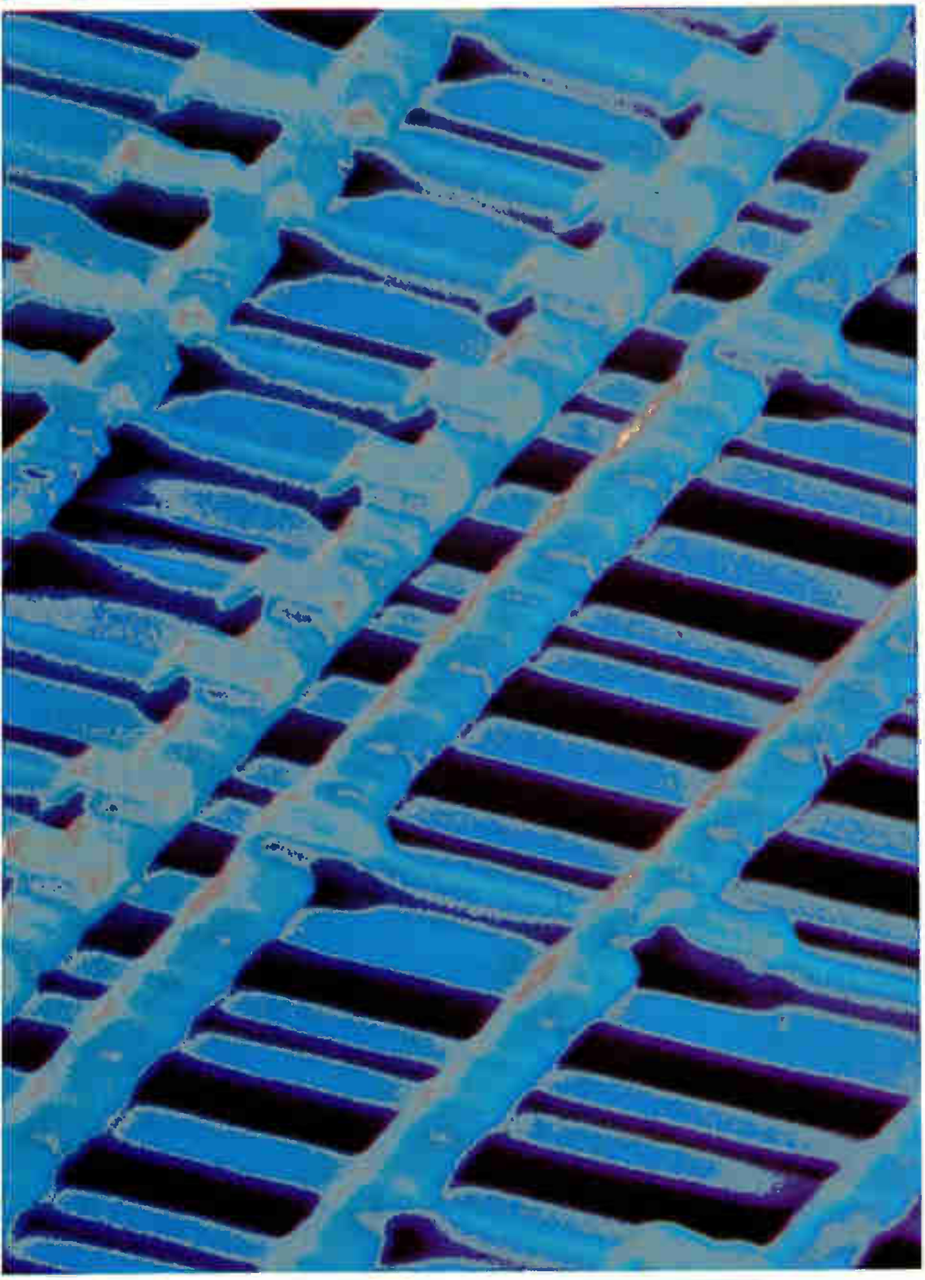
Semiconductor technology continues to be the engine that drives electronics past existing limits. And 1978 has proved no exception, as semiconductor manufacturers pass the threshold of a new era ushered in by very large-scale integration. The announcement of the first 64-K random-access memory and the entry into the 16-bit realm by microcomputer chip families signal the advent of devices with unprecedented density and performance. The ultimate effect stretches the imagination, but already the capabilities afforded by VLSI are breaking new ground as minicomputer manufacturers turn to new architectures built around high-performance chips, as communications engineers plan systems with the growing supply of chip codecs, as instruments that intelligently measure and manipulate signals proliferate, and as talking toys delight and enlighten children. All these presage another remarkable year ahead.

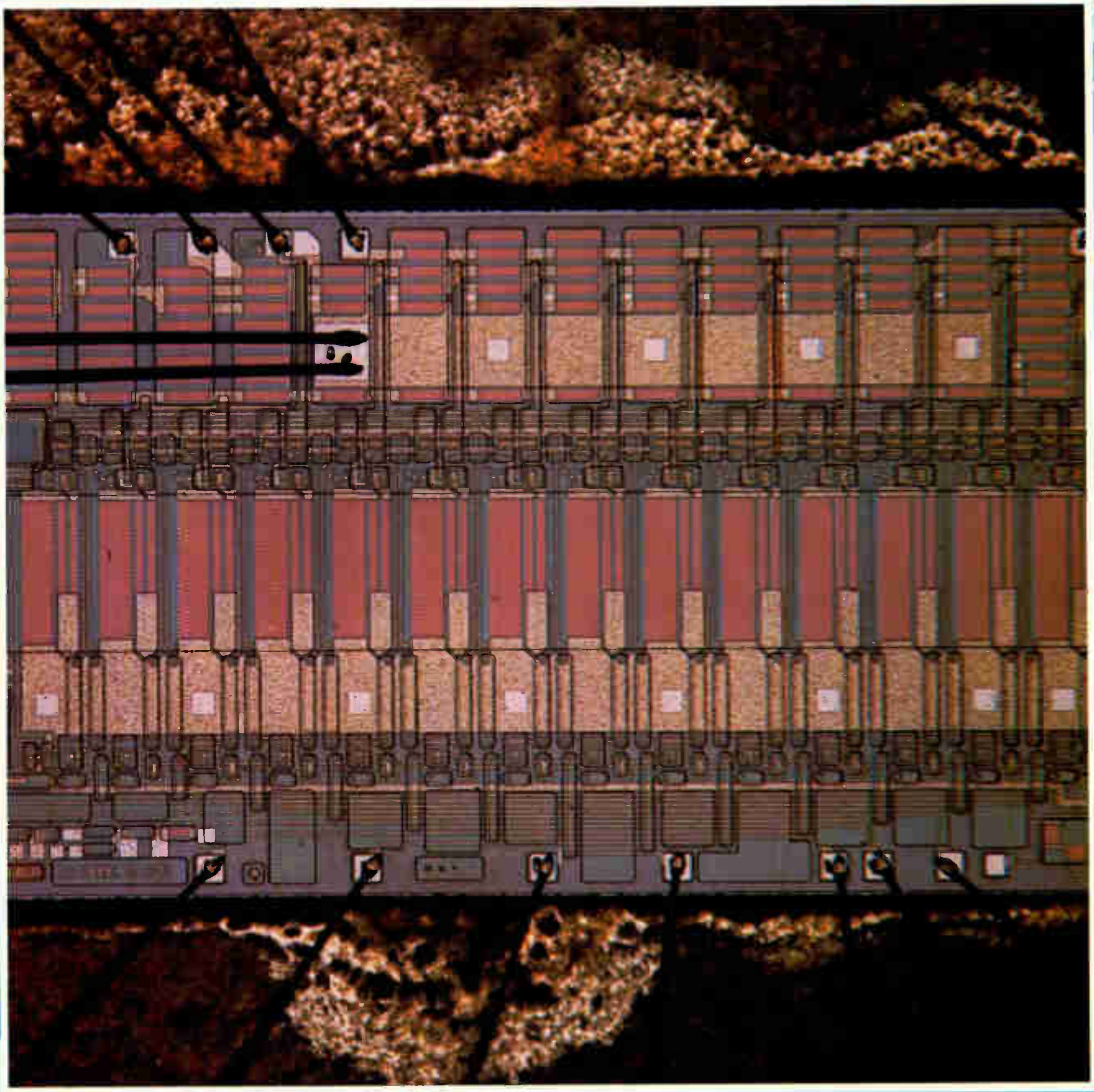


CONTENTS

UPDATE

More is still less. In pursuit of denser circuitry, IBM Corp. used electron-beam lithography to fabricate the 1-μm-wide gates of the logic device shown below left. Improved recording densities are offered by 14-inch platter disks pictured below being assembled at Sperry Univac's ISS division.





SEMICONDUCTORS

by Raymond P. Capece, *Solid State Editor*, and Nicolas Mokhoff, *Components Editor*

☐ *The popularity of silicon-gate n-MOS technology for large-scale integration is due to its familiarity, simplicity, inherent high speed, and still-unmatched density. But whereas n-MOS has enjoyed high-volume production and slid to the flattened region of the learning curve, several other technologies have only just started their journeys down the slope. In particular, two distinctly different techniques—C-MOS, especially on sapphire, and bipolar I^2L—should join silicon-gate n-MOS as leaders for fabricating digital circuits, including the now-emerging VLSI devices. The table compares the current characteristics of the three, as well as their potential for 1980. In the analog area, meanwhile, a growing number of firms are mixing various bipolar and MOS processes and design techniques—notably bi-FET and bi-MOS combinations—to put both analog and digital circuits on the same chip. The result: higher-performance linear subsystems that are packaged as components.*

Because of its strengths, the first very large-scale integrated circuits have been and will continue to be launched with n-channel metal-oxide-semiconductor technology. The coming year will see production of 65,536-bit dynamic random-access memories and 16-bit microprocessors built with more than 50,000 devices, both of which may fairly be considered first-generation VLSI products.

N-MOS is still first

These units are made possible partly because of n-MOS's lead in scaling down transistors. Next year, firms will try tighter geometries than ever before—channel lengths of 2 to 2.5 micrometers and gate-oxide thicknesses of 500 angstroms or less. Such dimensions will knock down the speed-power product of n-MOS gates from about 1 to 0.3 picojoule or less.

This technology is also the first to push the limits of optical lithography for volume-production parts. As late as last year a 2-μm geometry was believed the limit for optical equipment. But the use of light in the deep-ultraviolet range of the spectrum (wavelengths of about 2,500 angstroms), together with methods to improve registration and to counteract diffraction effects, will bring to the production line geometries so small they were once only achievable with electron-beam lithography. Indeed, semiconductor manufacturers now expect optical lithography to yield production ICs with channel lengths as small as 1 μm.

Furthermore, various manipulations of the n-MOS process have boosted speed and cut power. Circuit design tricks, too, are improving devices.

What's more, all n-channel parts are headed toward operation from a single +5-volt supply, and although on-chip circuits have been used to generate the negative voltages MOS circuits need for speed and compatibility with transistor-transistor logic, broader thinking has led to MOS designs that require no negative voltages at all. In the 64-K RAM from Texas Instruments Inc.'s MOS Memory division in Houston, for example, 5-V-only operation is accomplished without the standard charge-pump circuits, and at no sacrifice in speed—in fact, the TMS 4164 is faster than 16-K parts. Others, though, will take a different route and improve the charge pump.

In its new part, TI keeps the substrate at ground but manages to prevent undershoots as low as −1 V from forward-biasing the transistors. It also has elected to isolate internal voltage swings from the standard TTL levels at the RAM's pins, sticking with comfortable MOS levels internally. Such must be the thinking when, in the 1980s, the shorter channels and thinner oxides of scaled-down devices will require reduced drain voltages of 2 or 3 V, since it is folly to assume that computer makers will eagerly embrace a shift from standard TTL levels.

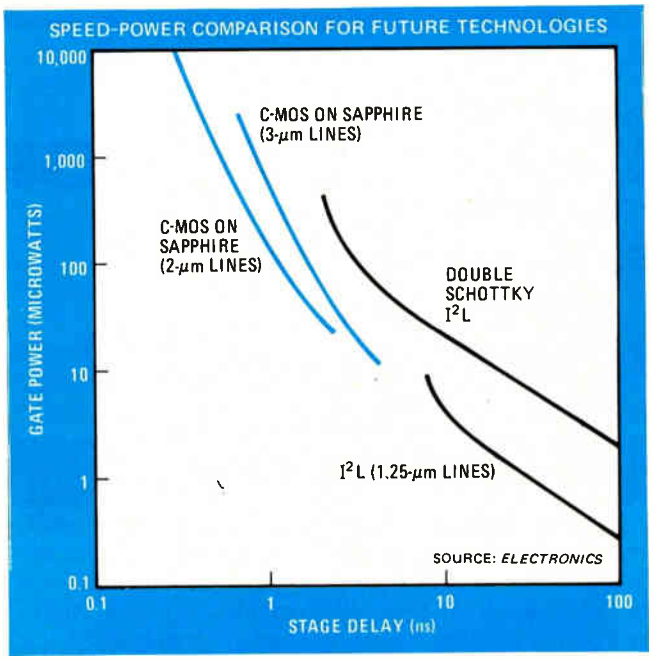
N-channel technology's three-dimensional counterpart, V-groove MOS, developed by American Microsys-

At left is a section of Harris Corp.'s Manchester-encoding circuit, built with self-aligned C-MOS technology.

COMPARISON OF TECHNOLOGIES

	1978			1980		
	n-channel MOS	C-MOS on sapphire	I^2L	n-channel MOS	C-MOS on sapphire	Schottky I^2L
Density (gates/mm^2)	140	110	120	200	200	175
Gate delay (ns)	1	2	0.5	0.5	1	0.2
Power dissipation (mW/gate)	1	0.1	1.5	0.4	0.05	0.6
Speed-power (pJ)	1	0.2	0.75	0.2	0.05	0.12
Mask levels (no.)	6	7	6	6	8	6
Critical dimensions (micrometers)	4	5	5	2	3.5	2
Area of static memory cell (micrometers^2)	2,400	3,300	2,500	1,100	1,000	1,500

SOURCE: *ELECTRONICS*



tems Inc., Santa Clara, Calif., has entered the LSI speed and density race and has already opened up a lead in memory devices, including RAMs and read-only memories—V-MOS dynamic RAM cells are the smallest. Moreover, in next year's 64-K RAM they should hit a new low of 0.15 mil^2 (100 μm^2)—almost half that in n-MOS 64-K RAM designs. However, V-MOS transistors are common-source devices and, since they can only pull down loads, must be mixed with standard n-channel transistors for logic circuits.

The suitability of V-MOS as a broad-based LSI technology will be tested in the coming year by AMI's first nonmemory V-MOS part, an ambitious digital signal processor built with over 34,000 devices on a single chip 200 mils on a side. Called the signal-processing peripheral, the device takes advantage not only of the size of V-MOS transistors but of their speed as well. AMI is squeezing nanosecond gate delays so that its part can multiply two 12-bit numbers in a single 300-ns instruction cycle and can perform a 128-point fast Fourier transform in 11 milliseconds.

Not to be underestimated as a viable LSI and VLSI technology is complementary MOS, especially when built on sapphire substrates. The stereotypes must be dismissed: C-MOS on sapphire will not be restricted to the rich; and standard C-MOS is not limited to digital watches, nor to small- and medium-scale integration, even though in its early state it could not economically attack LSI.

C-MOS: bulk silicon and sapphire

Hewlett-Packard Co. has made a major commitment to C-MOS on sapphire, rapidly implementing its in-house parts, including the processor for its HP-3000 mainframe computer system, with this technology. Meanwhile, Rockwell International Corp., Anaheim, Calif., and RCA Corp.'s Solid State division in Somerville, N. J., in particular are working on developments to offset the high cost of the sapphire substrate. Rockwell, however, is aiming first at high-performance markets that will make the parts worth their princely prices. RCA, on the other hand, claims that within the next few years, its techniques for pulling sapphire ribbons will get the cost down so that it is no more than 25% higher than that of bulk silicon. But more important, improved yields and other factors will ultimately result in reducing the cost of C-MOS-on-sapphire systems to that of those on silicon even without cheaper ribbons.

Though C-MOS on sapphire has some catching up to do with n-MOS in speed and density, its ace is a tenfold advantage in power dissipation—100 microwatts per gate, as against n-channel's 1 milliwatt per gate. Moreover, 1979 should see that figure halved.

The coming year will test the viability of this process in LSI applications. RCA will bring to market memory products—first a 1,024-by-4-bit static RAM—and a C-MOS-on-sapphire version of Intel Corp.'s high-performance 8085 8-bit microprocessor.

Rockwell, too, will be making commercial offerings of its C-MOS-on-sapphire products, which until now were built only for the military. Its first production devices will address the high-performance market, even going after emitter-coupled-logic sockets. Parts like counters and prescalers are likely, since Rockwell has devices running in the 100-to-400-megahertz range that are built with 2-μm-long channels and polysilicon gates. Its divide-by-16 binary counter, for example, dissipates a scant 8 mW from a 5-V supply when running at 300 MHz.

As for C-MOS on silicon, no one is more aware of its potential as a high-density, high-performance VLSI contender than the Japanese. In Hitachi Ltd.'s Central Research Laboratory, engineers have put together what they call HI-C-MOS devices that challenge the speed and density even of n-MOS parts. By scaling down the devices to channel lengths of about 3 μm, and by carefully controlling the impurity concentrations in the wells, Hitachi has realized 0.55-ns gate delays—the same as with n-MOS. The company has even built 4,096-bit RAMs with its process that exhibit access times of 40 ns, also comparable to those of n-MOS. The speed-power product of HI-C-MOS, however, is about 50 femtojoules—less than one tenth that of n-MOS.

Beware the bipolar

Proponents of n-channel MOS as the only viable technology for VLSI had better check the progress of integrated injection logic, as well. Fairchild Camera and Instrument Corp., Mountain View, Calif.; Signetics Corp., in nearby Sunnyvale; and Texas Instruments have spent a lot of time and money on injection logic and have much to show for their efforts. Look at Fairchild's 93483 16,384-by-1-bit RAM built with its Isoplanar I^2L: the chip uses 4½-μm geometries, has an access time of 150 ns, and dissipates less than 500 mW—all on a 25,000-mil^2 die. Fairchild expects that 2-μm geometries will be in

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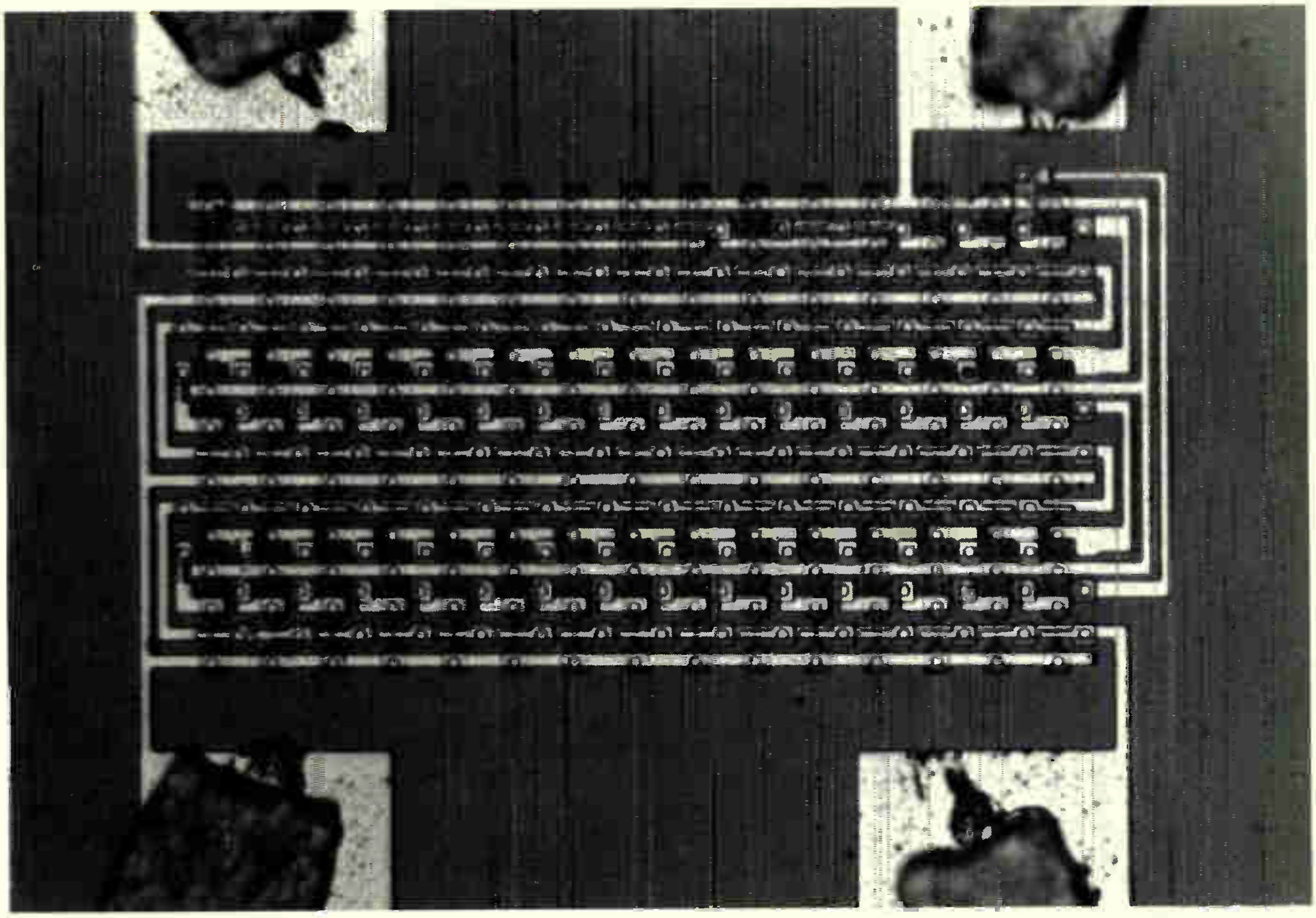


High-performance SOS. C-MOS-on-sapphire circuits built by Rockwell International combine high speed with low power. This experimental 61-stage ring oscillator, fabricated with submicrometer geometries, exhibits gate delays of less than 65 picoseconds.

standard production by 1980. What's more, work is being done in the labs on multilevel-polysilicon interconnections, and the company will soon be using more than one layer of metalization to improve packing density, which at present noticeably lags behind that of MOS processes. Add this to the fact that bipolar makers are less afraid to increase die sizes than MOS manufacturers because of bipolar's higher tolerance of oxide defect densities, and I^2L is well into the running for VLSI.

Year of the Schottky

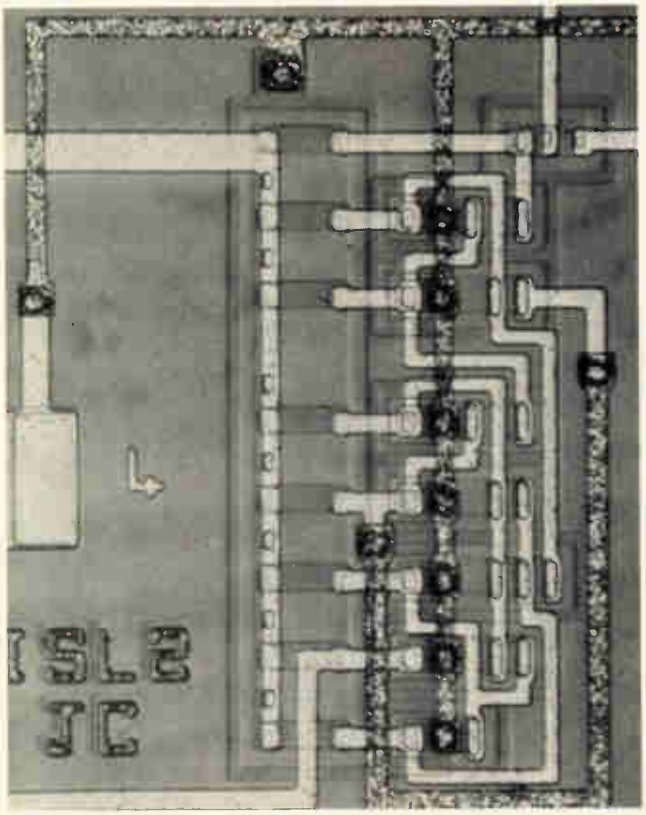
Next year will see the birth of a new family of products that will modify the original I^2L designs and add Schottky barrier diodes in the right places to greatly enhance speed. Although the parts consume slightly more real estate, the reduction in power consumption enhances this technology's attractiveness for VLSI. NV Philips Gloeilampenfabrieken in the Netherlands has demonstrated a significant improvement in the I^2L speed-power product with its integrated Schottky logic, or ISL, and will pass along the benefits to Signetics, its U. S. subsidiary. The first parts out of Sunnyvale—probably gate arrays—will appear early next year.

Two other injection-logic makers, Fairchild and TI, have similar projects under development, and products should make their debut later in 1979. Within a year or so, coupling shrinkages of geometry to 2 or 3 μm with Schottky I^2L should make possible speed-power products as low as 0.05 pJ.

The 7400 family of TTL parts will get a Schottky boost as well. A whole new collection of super-Schottky counterparts, compatible with the existing 7400 family members, will offer the best of two worlds: speed that is equal to or better than standard Schottky TTL, with the power dissipation of the low-power (LS) series. Manufacturers of SSI and MSI devices who will make available such products in the spring of 1979 include Advanced Micro Devices Inc., Sunnyvale, Calif.; Fairchild; Motorola Semiconductor Group, Phoenix; and TI. The parts will go right into 7400 sockets, yet may push TTL to speeds of 100 MHz at milliwatt-per-gate power levels.

C-MOS goes linear, too

Next year will also see more and more linear products built with C-MOS wherever low power has appeal—evidenced by the introduction this year by Intersil Inc., Sunnyvale, Calif., of its C-MOS version of the almost universal 555 timer. With a supply current rating one twentieth of that required by its bipolar counterpart, the device also has a frequency operation and supply-voltage



Schottky I²L. Developed by Philips, integrated Schottky logic, or ISL, improves the speed-power product of I²L 10 times or more. Similar Schottky-transistor-logic projects are under way at Texas Instruments and Fairchild, and parts should appear next year.

range that have been expanded to, respectively, 500 kilohertz and 2 to 18 V. Where C-MOS will not do, I²L will fill the void, for these two technologies will predominate in linear ICs for the coming years: both lend themselves well to putting digital and analog functions on the same piece of silicon.

Don't be surprised, though, if silicon loses its exclusive position as a substrate base for analog circuits. With larger numbers of functions being placed on board linear chips, silicon on sapphire could emerge as an alternative for analog as well as for digital C-MOS. For example, C-MOS is being used for digital-voltmeter chips, even to drive high-voltage vacuum-fluorescent displays; by combining the high-voltage drive with other central functions, designers could then take advantage of the extra real estate SOS provides.

One company that is currently trying its hand at both analog and digital C-MOS circuitry on a common sapphire substrate is Rockwell International. It is developing a regulator-modulator-sequencer control circuit for advanced power conditioning and servicing of pulse-width-modulated switching regulators by incorporating operational-amplifier comparators for level detecting together with master-slave flip-flops for timing, sequence, and mode control.

In operational amplifiers, the big battle is on between two competing mixed processes—bipolar and junction field-effect transistors (bi-FET) versus bipolar and C-MOS circuits (bi-MOS). In the bi-FET corner are to be found such heavies as Fairchild, National Semiconductor, Motorola, Texas Instruments, Analog Devices, and Precision Monolithics. Contenders for a role in that technology are also lining up: Siliconix, Intersil, and Burr-Brown are investigating possible niches not touched upon by other producers.

Then there is the bi-MOS minority. As of late there was RCA Solid State, a loner in the field. Signetics has entered into a second-source agreement with RCA and is expected to start delivering CA3140 op-amp comparators by the end of the year. This should give more credence to a technology that not many linear houses are enthusiastic about. Although these proponents claim fewer discrete parts are needed to bias the bi-MOS transistors, since input current requirements are on the order of 50 picoamperes vs 200 to 400 pA for bi-FET, speed limitations and excessive noise are, so far, inherent disadvantages. Even RCA is looking at future bi-FET products with one eye.

Bi-FET plus

Texas Instruments has opted to pursue both technologies, but with a twist. In addition to bi-FET op amps, the company is investing in a technology it calls Bidfet, which mixes bipolar transistors and JFETs with double-diffused and complementary MOS technologies. This new process allows breakdown voltages of 200 V, with the possibility of achieving 400 V. Plasma-display drivers are among the first product lines Bidfet will address. According to TI's discrete products development manager, Klaus Wiemer, plasma displays will displace cathode-ray tubes when the price of the 32-bit driver ICs drops to 14¢ per bit.

Another company that has invested in a triple process for parts is Harris Semiconductor, Melbourne, Fla. It combines JFETs and bipolar transistors and enhances these devices by means of dielectric isolation to produce a series of op amps.

Meanwhile, Motorola is enhancing its bi-FET products this month. Its family of bi-FET op amps is internally compensated and exhibits well-matched high-voltage JFET inputs by having the resistors laser-trimmed for low offset voltages. Laser trimming provides an input-offset voltage that ranges from 0.5 to 2 millivolts maximum with a typical temperature coefficient of 5 microvolts/°C. Also taking this approach is National Semiconductor, which has a second-generation, bi-FET II series of parts that are laser-trimmed at the JFET input stage down to 2.0 mV or less.

Also, Precision Monolithics Inc., Santa Clara, Calif., is enhancing all its analog multiplexer ICs with bi-FET designs. The units, which are 4-, 8-, or 16-channel devices with either single or differential inputs, have input-protection circuits built on the chip for easier handling. (Siliconix, Harris Semiconductor, National Semiconductor, and Analog Devices produce C-MOS

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versions of these vital interface parts as well, but their units require either dielectric isolation or external compensation to minimize blowouts.)

Linear ICs: expansion continues

Regardless of mixed-process developments, linear ICs built with standard bipolar technology have been a major growth area in the semiconductor world. Now that the microprocessor is being used increasingly in process-control applications, linear houses are thinking up newer and better ways of interfacing with real-world parameters. Display drivers, line receivers and drivers, isolation amplifiers, all are being fine-tuned for tighter specifications in the latest mixed processes.

Voltage references and voltage regulators are also seeing their names in the lights these days. Analog Devices Inc., Norwood, Mass., brought out a bipolar programmable functional seven-voltage output device, and Motorola has introduced a 5-, 6.25-, and 10-V family with long-term stability guaranteed at 25 parts per million per 1,000 hours. For its part, National Semiconductor has a slew of regulator chips, of which the LM117HV is the most interesting—it can regulate 1.2 to 57 V at 1.5 amperes. The company's LM150 also looks impressive: it is an adjustable monolithic regulator providing 3-A output current for a voltage anywhere from 1.2 to 32 V.

Perhaps the most significant development in bipolar linears will be coming from National Semiconductor very shortly: the low-voltage ICs that Robert Widlar, father of the modern op amp, has been working on as a consultant for the past year. Using conventional technology, Widlar has invented a process that will yield parts working from 1 V—the voltage supplied by a single nickel-cadmium cell. No specific devices have been revealed yet, but the first will probably be an operational amplifier, voltage regulator, voltage reference, or comparator. The applications of these parts will be far-reaching in areas like hearing aids, pacemakers, and remote telemetry that must operate from batteries or solar cells.

As for the future, with the continuing transformation of subsystems into components, users will be paying much more attention to cost in the cost-vs-performance tradeoff. The jelly-bean producers, therefore, should certainly flourish in this area as well.

PROFILE

He sees SOS for speed

C-MOS on sapphire may be gaining ground in military and microprocessor designs, but the technology's real strength will be in high-speed applications, says Rockwell International Corp.'s Daryl T. Butcher. "With speeds in the hundreds of megahertz, why confine silicon-on-sapphire to applications limited to bus speed, such as microprocessors and memories?" he asks.

Butcher, who manages systems technology and engineering sciences at the Research and Technology division of Rockwell's Electronics Group in Anaheim, Calif., is almost cocky when he talks about the kind of performance his group has gotten from complementary metal oxide semiconductors on sapphire. "Our 3-micrometer channel-length parts are running at 225 megahertz from an 8-volt supply," he says.

His group has made great strides in speed-oriented experimental designs, disproving the axiom that C-MOS's low power disappears at high speeds. They have managed to dissipate a mere 10 milliwatts or less at speeds of more than 400 MHz with 2-μm channels in parts such as prescalers and counters.

Although the parts will not appear as commercial products until next year, they have proven that speeds even beyond those of n-channel MOS are possible with sapphire-substrate technology. That is why Butcher envisions greater competition between emitter-coupled logic—the fastest logic today—and C-MOS on sapphire, rather than between n-MOS and SOS. "We've shown we can get the speed," he says, "and look at the power dissipation: 2.7 mW for our prescaler is two orders of magnitude less than the 400 mW of its ECL counterpart, the 11C90."

One reason that Butcher's sapphire process does not suffer from high power dissipation at high speed is that the input- and output-voltage levels have been reduced to less than 1 V. "At 5 V, the power used in driving the capacitances would mean the clock would dissipate more power than the entire SOS device," he explains. By lowering the levels and using 300-ohm strip-line techniques, he has cut the power dissipation by more than 96%.

Butcher, 40, earned his BSEE at the University of Illinois in 1959 and has been with Rockwell for 10 years. During that time, he earned a patent for a stabilized comparator design. Combining his work in comparators with the C-MOS-on-sapphire program, he has come up with a complex part: a high-speed, low-power analog-to-digital converter. The 12-bit device performs a full conversion in 2.5 microseconds, yet dissipates an average of only 15 mW. "It's the greatest step forward in SOS technology today," he says. **Robert Brownstein**

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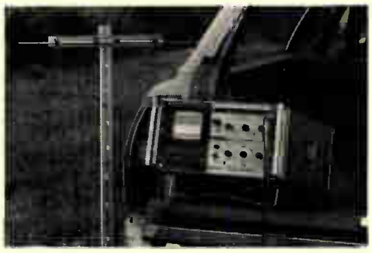

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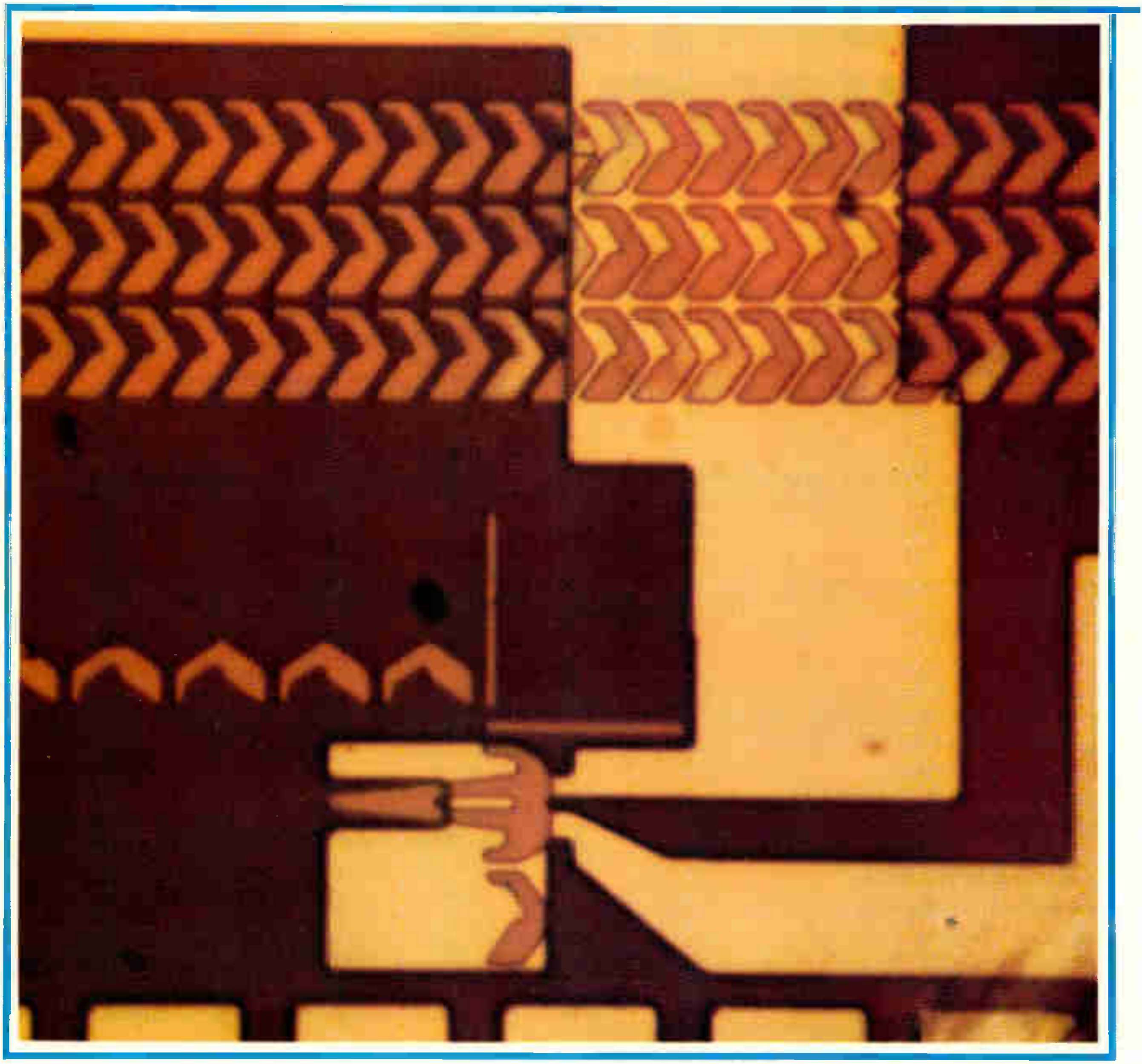


MEMORIES

by Raymond P. Capece, *Solid State Editor*

☐ *Memories are the mainstay of chip makers, and their booming production fuels a rapidly building expertise that is improving the parts in every aspect. This rule will carry through the coming year in all types of solid-state memories: random-access and read-only memories, charge-coupled devices, and magnetic-bubble memories. It is evidenced by storage capacities that grow while all else shrinks: access time, power dissipation, and die size (which means lower cost, to boot).*

Although storage capacities of some of these memory parts will continue to double, 1979 will see an end to the straight-line growth curve of semiconductor memory densities. The quadrupling of capacities every two years will begin stretching out to every three or four years, now that the limits of optical lithography are being pressed. This year's 65,536-bit dynamic RAM will sire a 262,144-bit part no sooner than 1981, for example. While CCDs will hit this 256-K level next year, the gestation of a megabit chip will be at least four more years. The announcement this year of quarter-million-bit bubble memories could be followed by that for a megabit device as early as next year, but the 4-megabit part is a product of the early-to-mid-1980s.

Speedier MOS parts

Faster metal-oxide-semiconductor memories are in order across the boards. Big computer manufacturers will benefit, whether they populate main-memory boards with dynamic RAMs (16,384-bit parts for best cost per bit or the new 64-K chips for packing density) or static RAMS (for quicker access time). Microcomputer manufacturers, too, will need the better speeds to take full advantage of the new breed of high-performance microprocessors that will be designed into the next generation of systems.

The dynamic RAMs that are expected to drop below 100-nanosecond access time next year will indeed give computer manufacturers pause for thought about the static versus dynamic memory choice. New versions of the 16-K dynamics will carry specifications of 80-ns access times, and the 64-K parts will soon follow suit. Redesign of the MOS one-transistor cell is partly responsible for the new low, but clever circuit design that synchronizes all the timing signals on chip is also involved. According to manufacturers, new techniques could drop access times to as low as 50 ns in a year or so, about the level of present static chips.

Nor will the coming improvements in static RAMS make memory-system planning any easier. In laboratories, 1,024-bit statics are running 15-ns access times or better. It will not be long before the industry-standard 4,096-bit 2147, now comfortably achieving 55 ns, follows a similar route. So another decision must be faced: with MOS static RAMs dipping as low as 20 ns, will bipolar memories' ever so slight edge in speed be worth the additional costs?

TI's quarter-million-bit bubble memory (partial view opposite) uses modified chevrons for propagating elements.

Good news is memories' diminishing power dissipation, the product of new bit-cell designs and better materials like low-resistivity polysilicon. In MOS chips, it is also due to one clearly emerging trend: the move toward +5-volt-only operation. The announcement by Texas Instruments Inc., Dallas, of the 4164 64-K dynamic RAM confirms the single-supply trend. Others soon to announce such parts include AMD, AMI, Intel, Mostek, Motorola, and National Semiconductor, and the consensus is for 5-V-only operation.

The 16-K RAM standard, the 2116, uses ±5-V and 12-V supplies, but Intel Corp., Santa Clara, Calif., and Hitachi Ltd. of Tokyo have announced 5-V versions, as will Motorola Inc.'s Semiconductor Products Group, Austin, Texas. However, many memory systems have already been designed for the 2116 and other parts—like 32-K RAMs made by piggy-backing 16-K packages (from Intel and Fairchild) or by packaging two chips side by side (Mostek)—that need three supplies.

Another trend is generalized memory-system design. With memory space easily partitioned into RAM, ROM, or erasable programmable ROM, system designers would no longer have to designate memory sockets for either program storage (ROM) or data storage (RAM)—they could accommodate either at will. Indeed, next year pin-compatible (or nearly so) memory families will ease the job of small- and large-system designers alike.

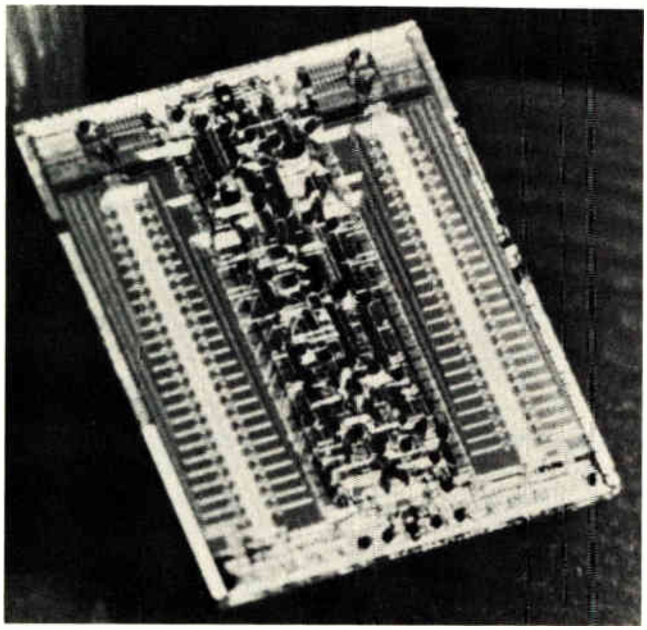
Texas Instruments' 4116 16-K static RAM is the first to unify RAM and ROM callouts. The 2,048-bit-by-8-bit chip, intended for microprocessor-based systems, fits into the same socket as the industry-standard E-PROM, the 2716. In the coming year, electrically erasable 16-K PROMs are expected to take the same route; what's more, the unification will carry on to the 32,768-bit level and eventually to 64-K chips.

Byte-wide access

Meeting the needs of microprocessors and microcomputers, TI's 4116 is also an example of a new breed of RAMs, both static and dynamic, that are organized into byte-wide access. For example, an 8,192-by-8-bit part is a natural to follow the 4164 64-K-by-1 dynamic RAM, to supply a full 8 kilobytes of memory in a single package. Other 64-K organizations, such as half a byte wide, can also be expected as memory makers spin off designs into several market segments.

Byte-wide organization means that an entire microprocessor-system working memory will fit into single chips, so more such parts will join the 4116. Hitachi followed TI with its own version of the part. Both manufacturers' parts have a remarkably small six-element cell—1.6 mil²—as a result of a stacked layout that makes the die size less than 40,000 mil² with fairly conservative channel lengths of 4.5 micrometers.

Geometry shrinkage will further boost speeds and cut costs, and other manufacturers, including American Microsystems Inc., Santa Clara, and Mostek Corp., Carrollton, Texas, will bring out similar yet smaller devices. The California manufacturer will bring out pin-



Not far behind. IBM Corp. unveiled its own 64-K random-access-memory chip, which it will use in a distributed computing system. The device uses n-channel metal-gate technology and multiple supply voltages and is just under 1/4-inch square.

compatible 16-K RAM, ROM, and E-PROM in its three-dimensional V-groove MOS technology, while Mostek is scaling parts with its 2-μm Scaled Poly 5 process.

As if static and dynamics were not enough, the pseudo-static is emerging. These RAMs store data in single-transistor dynamic cells, but have circuitry on chip to do away with most refresh and counter peripheral circuits. To the outside world, they look essentially static.

Mostek's 4816, with a 2,048-by-8-bit organization, is the first such part announced. It refreshes itself in its power-down state. In the active mode, it merely tells the host processor when to refresh. Zilog Inc., Cupertino, Calif., will introduce a similar part next year in a 4-K-by-8-bit version that entirely refreshes itself. Split in two halves, the RAM refreshes one while data in the other is being accessed. If access takes so long that refresh cannot occur, the part will interrupt the host processor.

Good chances

The pseudo-statics stand a good chance of gaining acceptance over static RAMs, especially in the larger capacities. They have the dynamic part's advantage in size, for the six-element flip-flop that is the static cell will never be as small as a dynamic cell. They eliminate the dynamic RAM's drawback of an external refresh requirement, while taking advantage of the process improvements that are bringing the dynamics' speeds close to the statics'. If the on-chip refresh circuitry is small enough to leave most of the real estate for memory storage, then the pseudo-static RAM will have a per-bit storage cost much closer to that of dynamic parts than that of static chips.

New memory chips will not be the only story next year; improvements on existing products will be made. Scaling down of device geometries will make popular memories faster, as well as smaller.

Mostek's first parts to use the Scaled Poly 5 2-μm process will be the 4801 1-K-by-8-bit high-speed static RAM. It evidences both the speed and byte orientation that will be reflected by other chip manufacturers as well. With a worst-case access time of 55 ns in its fastest version, the 4801 will be smaller than 4-K statics. Eventually, its under-20,000-mil^2 size will shrink to 14,000 mil^2. EMM SEMI Inc., Phoenix, which has half of the market for the industry-standard 2147 4-K RAM, will introduce its 8-K version this year as well.

Before long, most manufacturers will be confident of 55-ns static speeds in n-channel MOS memories. The 2147 will be offered by several manufacturers in an even faster version that could dip as low as 25 ns. Among the competing scaled-down n-channel processes, V-MOS from AMI and TI will be a good contender against Intel's high-performance H-MOS, TI's S-MOS, and Scaled Poly 5.

Gaining in popularity are 4-K statics in complementary MOS, mainly because of low power consumption but also because of speed enhancements. The 1-K-by-4-bit HM6514 from Harris Corp., Melbourne, Fla., as well as AMI's S5104 are in the running, and speeds are as low as 200 ns. The power dissipation is still dependent on speed—typically 25–35 mW per megahertz—but stand-by modes are a scant 1 mW. RCA Corp.'s Solid State division, Somerville, N. J., will soon bring out a C-MOS-on-sapphire version that offers enhanced speed and density over bulk-silicon C-MOS chips.

Bipolar gains

While manufacturers of bipolar memories may feel the MOS encroachment, they, too, are advancing speed and power-dissipation specifications. In the last two years, I^2L has seen a tenfold improvement in speed-power product from 5 to 0.5 picojoules, and densities of devices have increased as well, so that now I^2L chips with 30,000 devices or more are practical.

The injection-logic static RAM cell is the smallest of the bipolars, and the speed is getting there: Mitsubishi Electric Corp., Tokyo, has developed a 1-K-by-1-bit I^2L static with an access time of 20 ns. Fairchild Camera & Instrument Corp., Mountain View, Calif., is scaling its Isoplanar injection logic down to 2-μm geometries this year and will soon employ it in a 16-K static RAM.

The best news in bipolars is lower power consumption; it is chasing down n-MOS's high-speed parts. Fairchild's 10470 4-K static, for example, is making its way down to 500 mW, not much more than the 2147.

The fast transistor-transistor-logic RAMs are improving in power dissipation as well, from a milliwatt per bit to several hundred microwatts, while access times dwindle to between 10 and 20 ns. Bipolar memory makers will continue the practice of following TTL designs with even faster emitter-coupled-logic versions, and Signetics, AMD, Motorola, Fujitsu, National, and Fairchild are working on 10-to-15-ns 1-K RAMs and 4-K parts that

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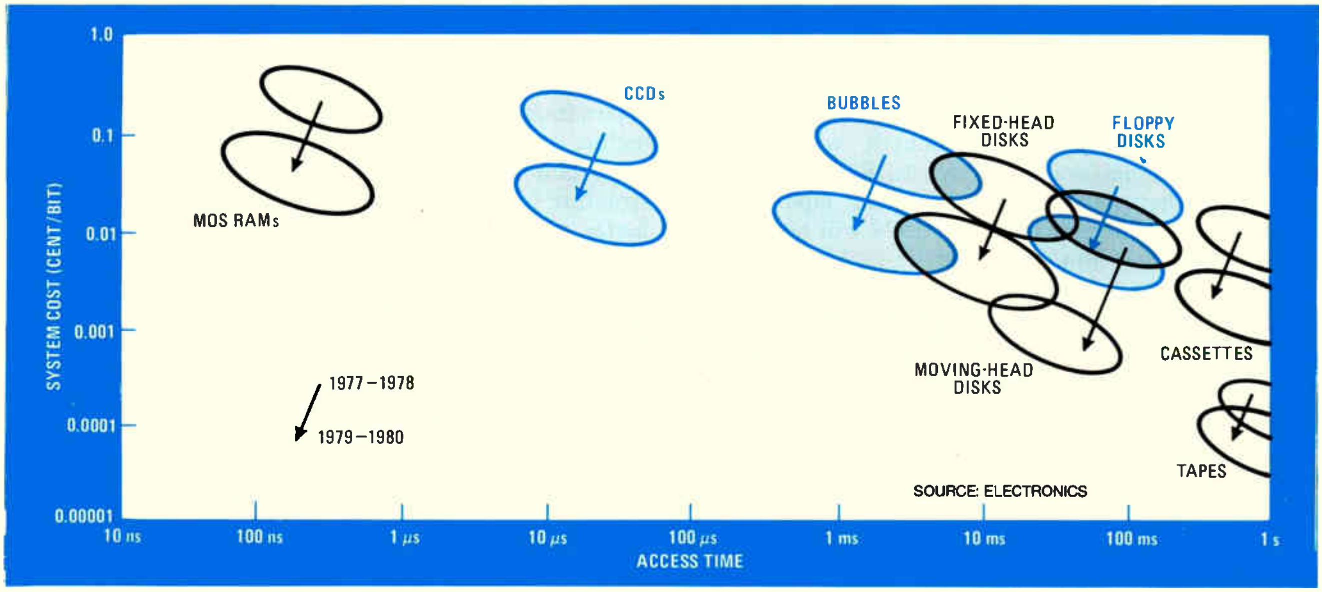


On the descent. Semiconductor random-access memories and serial-access charge-coupled-device memories, bubbles, and floppy disks are rapidly approaching the 10-millicent-per-bit mark. Bubbles could well undergo the most dramatic cost descent of all.

could go as low as 20 ns in the coming year.

Process improvements mean that the ECL chips are no longer the power hogs they once were. Moreover, with 4-K die sizes pared to below 20,000 mil², they now have densities rivaling those of MOS parts of a few years ago.

Read-only memories

The rapid increases in ROM densities reached the 64-K level early this year and will double in the coming year. More important are the gains in speed that will bring n-channel MOS parts into close competition with bipolar chips for mainframe control-store tasks.

Conservative access times of 350 to 450 ns, which have served well in early microprocessor-systems designs, will at first be slashed in half to meet the needs of the new breed of fast microprocessors. As the same refinements of the maturing RAM processes are applied to ROMs, remarkable improvements in speed will result. The sub-100-nanosecond MOS ROM will be greeted warmly by computer makers, working well into microprogrammed architectures that have emerged as a solid trend in computer design.

On the end of the spectrum where large capacity is the main objective, big ROMs reached a milestone this year at the 64-K mark. With 8 kilobytes of storage, a single chip could contain an entire Basic language interpreter. Thus high-level-language programming of microcomputers is not far away.

The erasable ROMs

The 64-K erasable PROM will bow next year, as scaled processes are applied to 32-K chips. Access times of these ultraviolet-erasable devices are improving dramatically, tracking just behind masked ROMs. The 200-ns mark should come with little effort.

The read-only memory to watch is the electrically alterable part, also called the EE-PROM (for electrically erasable). There are two development camps: the Famos technology, which stands for floating-gate avalanche MOS and includes TI, Intel, Intersil, and Motorola, and the metal-nitride-oxide-semiconductor technology, which includes Hitachi and General Instrument Corp. Each is working equally hard on the development of parts that may replace ultraviolet E-PROMs or may even serve as nonvolatile RAMs.

Hitachi has licked many of the problems with its MNOS devices: its 25-V program voltage is compatible with that of E-PROMS; cell size is but 17 μm on a side; standard operation is with +5 V; and access time is reported as low as 100 ns. Hitachi, as well as others, will be directly attacking the E-PROM market with a part that eventually should be cheaper, since the windowed package is a major contributor to high device cost.

CCDs get bigger

Charge-coupled-device memories, with their ill-defined uses and mixed pin assignments, stand to triumph over these hindrances when they hit 256 kilobits next year. The long-loop structures, from Fairchild and TI, should have a major role in computer systems, serving as a fast buffer between slower bulk-storage memories and the main memory. The short-loop devices, promoted by Intel and National Semiconductor have fallen on hard times now that the RAMs they are intended to replace have reached the 64-K level. Both firms are discontinuing their parts but will take a crack at 256-K devices.

Very high-performance CCD memories have been built for military programs for quite some time, going into signal-processing applications that combine high-speed—hundreds of megahertz—with power dissipations dropping as low as a tenth of that of C-MOS memories.

These military products use submicrometer geometries, so it will be easy for their makers to come up with commercial parts that boast 2-μm lines in a year or so.

Finally arriving are the long-awaited magnetic-bubble-memory commercial products, with quarter-million-bit samples available from TI, Rockwell, and in time from others like National, Intel, and Japan's Fujitsu and Nippon Electric Co. Thus 1979 will be the year that bubbles go into system design. Also, the first million-bit bubbles will appear in 1979.

Quicker data access

The architecture of TI's quarter-million-bit chip—224 loops of 1,137 bits each—was changed from that of the earlier 92-K design to a block-replicate structure, which provides much quicker data access, since the minor loops are ported on two sides and data need not be removed from them for reading or writing. TI also included a separate loop for masking out any failed data loops.

The quarter-million-bit bubble chip from Rockwell International Corp., Anaheim, Calif., has similar architecture to TI's, with some subtle differences. Both use 3-μm bubble diameters, but Rockwell's block-replicate structure has 260 loops of 1,025 bits each. It works out better in applications such as fixed-head disk replacement requiring binary blocks: in that case, 1,024 blocks of 256 bits per block can be arranged. Also, the company chose to exclude a masking loop from its chip.

For 1979, Rockwell is promising a million-bit bubble memory chip packaged like the quarter-million-bit device and capable of working in parallel with it. The bubble diameters will shrink to 1.8 μm in 8-μm periods. Texas Instruments will take much the same route in building its million-bit device.

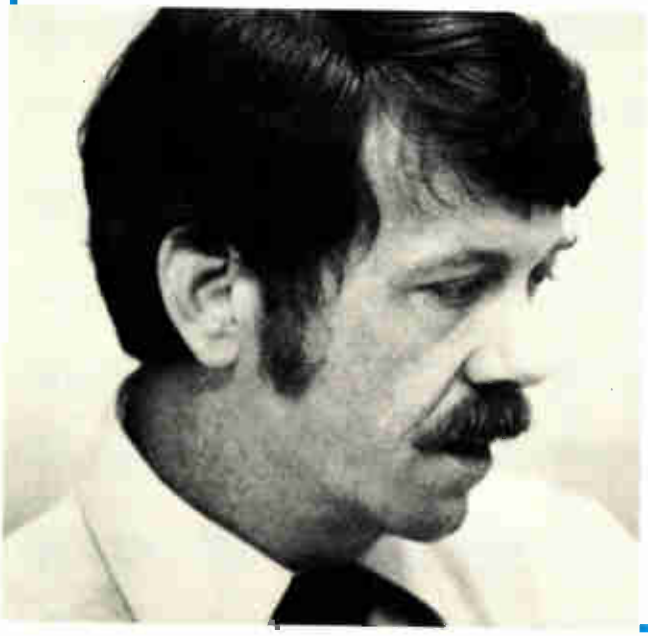
PROFILE

He devised a new E-PROM

As a key designer responsible for the success of Texas Instruments Inc.'s early low-cost calculator program, Dave McElroy was a natural choice in 1976 to spearhead part of a new thrust aimed at developing a leading edge in metal-oxide-semiconductor memory technology.

Named design manager for static random-access and nonvolatile memories in Houston in July of that year, McElroy was charged with getting TI's program in erasable programmable read-only memories off the ground. The assignment was difficult, the 36-year-old Texas native recalls, because the competition already had a big lead. Intel Corp. already had a 8,192-bit E-PROM using three power supplies on the market.

To get into the ball game, "we had to get our hands around a totally alien technology to us, something very new that Intel had developed, and we had to do that very quickly," observes the pipe-puffing McElroy, who has spent all of his nine-year engineering career with TI.



His options for the E-PROM project were two: copy what had already been done or develop a new approach. He chose the latter.

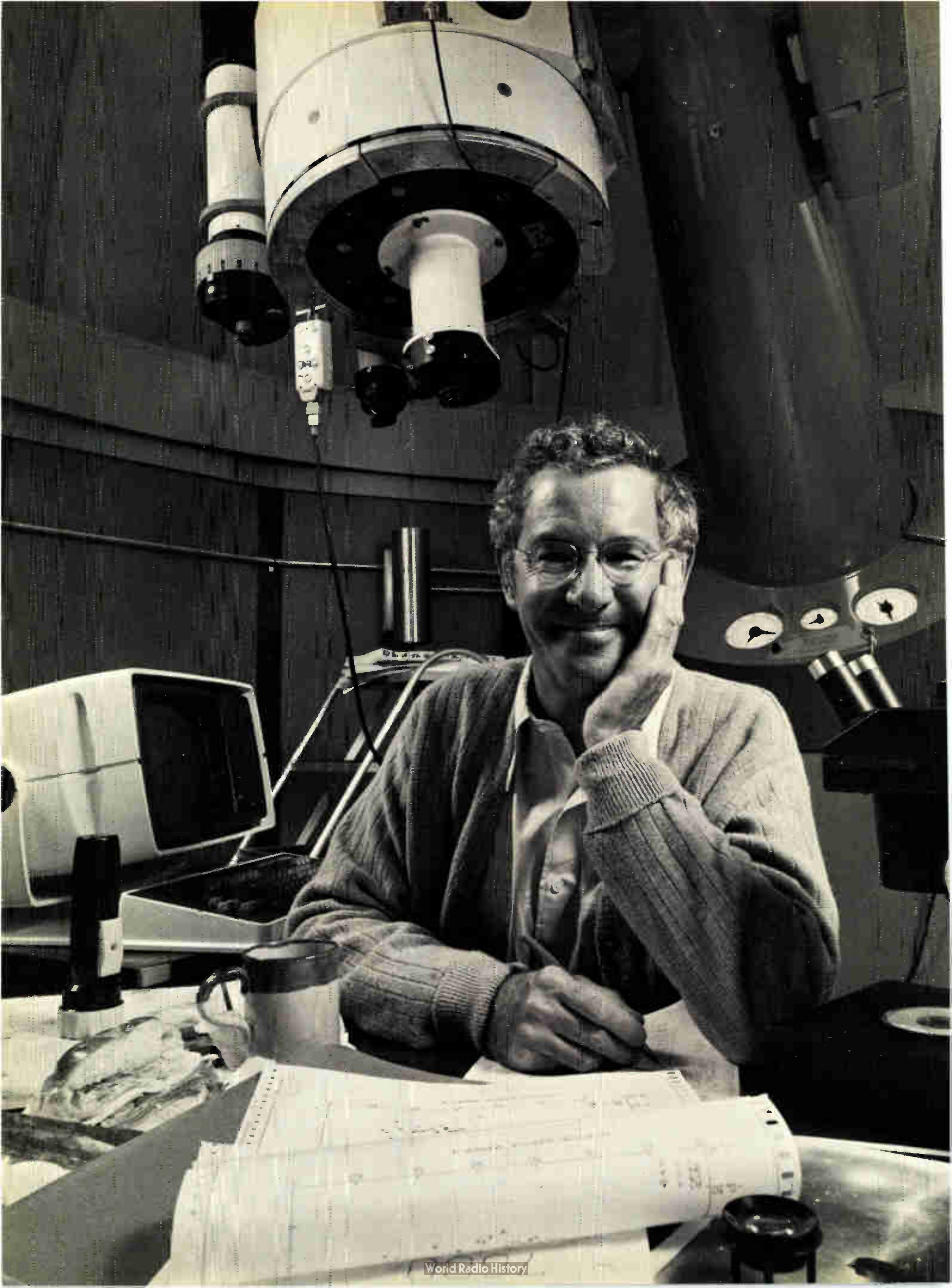
McElroy, a 1969 graduate of Lamar State College of Technology, Beaumont, Texas, combines design expertise with a good bit of process-development experience. So it was natural for him to work closely with process engineers in developing the new process that would be used in the company's E-PROM devices.

As he explains it, the erasable parts already on the market used a technology that required the gate oxide of the peripheral transistors to be the same as that forming the inner level of the memory transistors and determining charge-retention characteristics. The process developed by the TI team isolated the peripheral oxide from the inner memory cell, thus allowing optimization of speed, power, and area characteristics of the peripherals without sacrificing any charge-retention characteristics.

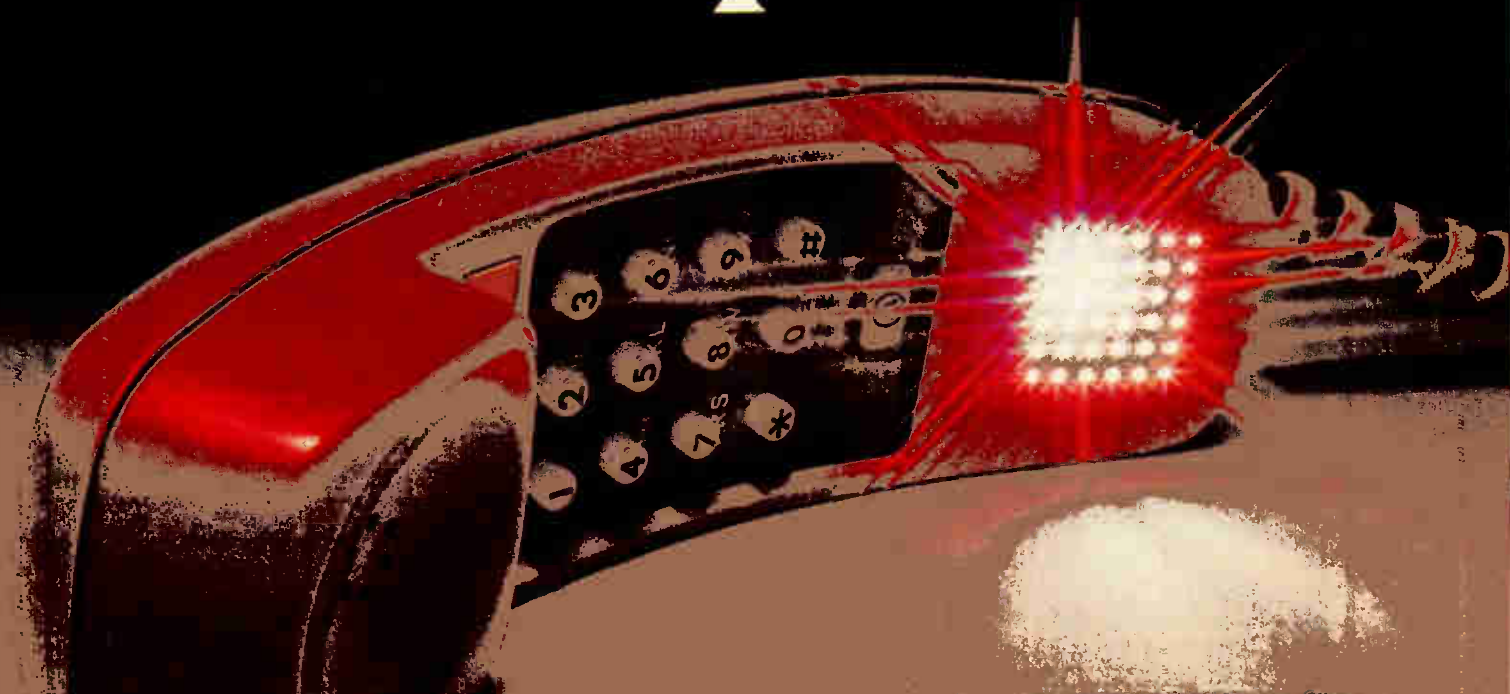
The new process significantly improved E-PROM chip density and was the basis for the series of product announcements that has allowed the Dallas-based company to take a leadership role in this memory type.

The quiet-mannered McElroy was recently recognized for his achievements by election as a TI fellow, an in-house designation reserved for those who have made significant technological contributions on an individual basis or as leader of a small group. Already the holder of three patents, with nine applications pending, he is continuing to lead design efforts aimed at strengthening TI's position in the world MOS memory market.

He will not say specifically what those projects are, but he does promise one thing: even though he is now considered a branch manager, in TI terminology, he plans to stay very close technically to his work. "The more you want to call yourself a manager, the less you can do technically," he observes. "I don't want to get too far away from the technical details, maybe because that's what I feel the most comfortable doing." **Wesley R. Iverson**



How do you see fiber optics?



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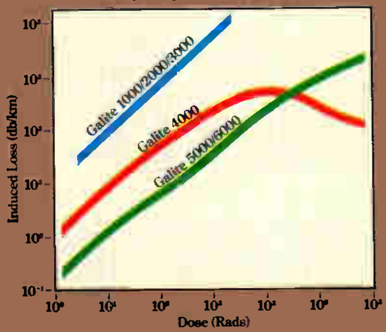

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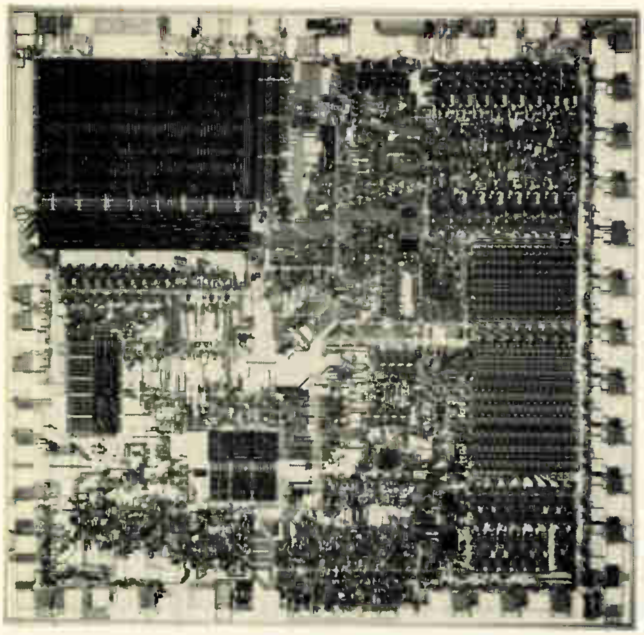

Upgrade. Intel 8086 microprocessor bridges the gap from 8 to 16 bits. The 51,000-mil² chip, built with high-performance 4½-μm n-MOS process contains 29,000 transistors. Next year it will be competing with 16-bit processors from Zilog, Motorola, and others.

emitter-coupled-logic innards into processor elements with transistor-transistor logic on the inputs and outputs. Complementary-metal-oxide-semiconductor technology is also becoming popular for bit-slice applications, since it offers such low power dissipation, and Fairchild and Motorola will offer C-MOS versions of the 2901 family next year. The point here is that bit slices are working hard to keep that step ahead of the fixed-instruction microprocessor chips in performance.

One-chip microcomputers are strong

The stand-alone microcomputers—those 4-, 8-, and 16-bit chips that include random-access and read-only memory, timing, and input/output control in with the central processing unit—have their work cut out for them. They drive high-current loads—tens of milliamperes for direct firing of triacs for ac control or driving alarms and displays—and some take analog signal inputs. And if communication is needed, one-chippers like Mostek's 3873 with a serial I/O port will speak a common protocol like RS-232-C to a host processor or data logger.

In the single-chip microcomputer market, one clear trend is emerging that parallels the way Detroit does business. That is to supply a processing core, and then make everything else an option. The amount of RAM and ROM—like engine size—can be chosen by the customer, as can the I/O structure. Special options, like analog inputs and outputs, serial ports that address several different protocols, and hardware math functions that ease programming of repetitive functions are the tinted glass and air conditioning of the single-chippers. Moreover, the optional functions will expand in variety, enabling mass production to offer semi-custom products just as with automobiles.

Intel has already started such a program around its 8021 8-bit one-chip microcomputer. Besides the CPU, the 8021 contains 1,024 bytes of ROM and 64 bytes of RAM, variable-threshold inputs for touch-panel operation, and zero-crossing detection of ac signals for firing thyristors. The 8022 goes one better with an on-board analog-to-digital converter that allows the chip a pair of analog inputs. Motorola will proceed in the same manner with its 6805 line one-chip version of the 6800 and will even bring out the 6805 C-MOS for low-power applications.

Of course, the makers of 4-bit controller chips have used the big-family ploy for several years now, and the two major suppliers, TI and Rockwell, as well as National and others, have built up a full line of chips—with a variety of RAM, ROM, and I/O options—that dip down as low as 99 cents each in large quantities. And C-MOS versions of the products will take off next year.

Such riotous pricing is the reason that intelligence is being added to so many everyday products—even blenders—to make the devices easier to use, more fail-safe and mistake-proof. The 1979 cars will boast microcomputers for ignition timing and emissions control and also on the dashboard, in trip computers.

Distributed microprocessing

These stand-alone intelligent chips will gain tenfold in automation and computing power once linked to a central controller. Such a trend will begin to emerge only in 1979, when loosely coupled microprocessor networks begin to appear.

Making a great stride towards microcomputer networking is Mostek Corp. The Carrollton, Texas, chip maker's major contribution in the coming year will be the low-cost preprogrammed 3870 microcomputer. The ambitious plan is to preprogram its 2,048-byte ROM with a routine that will make it a communications processor. As a front end, the chip will give any piece of microprocessor-controlled equipment a software identity, enabling a central host computer to interact with it over a twisted-pair line hooking together several pieces of equipment in a star network or daisy-chain fashion. Mostek hopes the chip's serial data-link protocol will become a *de facto* standard, so that it will be able to sell lots of preprogrammed 3870s into simple networks of, say, point-of-sale supermarket cash registers.

The boards

As the power of single-chip processors continues to climb into the 16-bit-word realm and megabyte addressing, board computers follow suit. What's more, intelligent programmable peripheral chips are adding to their flexibility. They allow a large number of interrupts, timing functions, and I/O ports to be customized by the user, all within the board's limited area. Also, since these peripheral chips are growing smarter, they free the CPU for more demanding system responsibilities.

In terms of board evolution, two schools of thought

A 32K byte dual floppy microcomputer system for only $2900* complete.

Standard Features:

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- RS-232 C at 75 to 19,200 baud
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- Four slots used — four slots open for expansion
- Comes complete with disk BASIC
- Includes Interactive Assembler/Editor
- Main processor is an ultra-fast 6502A
- Has auxiliary Z-80 and 6800 micros which allow execution of virtually all 6502, 6800, 8080 and Z-80 code!
- User programmable interrupt vectors on all three micros

The C3-OEM is an ultra-high performance microcomputer system. Its powerful 6502A microprocessor (now triple sourced) outbenchmarks all 6800- and 8080-based computers in BASIC and machine code using the BASIC and assembler provided standard with this system.

In fact, the C3-OEM executes standard BASIC language programs at speed comparable to small 16 bit minicomputers.

Ohio Scientific has a vast library of low cost software for the high performance 6502A including an on-line debugger, a disassembler, several specialized disk operating systems and applications programs such as our word processor package and a data base management system. However, the C3-OEM is not just limited to 6502 based software. This remarkable machine also has a 6800 and a Z-80 microprocessor.

The system includes a software switch so that machine operation can be switched from one processor to another under software control!

So, one can start with existing 6800, 8080 or Z-80 programs while developing new software for the ultra-high performance 6502A.

The C3-OEM isn't cheap. It's a quality product with mechanical features like UL-recognized power supplies, a three-stage baked-on enamel finish and totally modular construction.

It is the product of Ohio Scientific's thousands of microcomputer systems experience. In fact, all the electronics of the C3-OEM have been in production for nearly a year and have field proven reliability. And, best of all, this machine is available now in quantity for immediate delivery!

A full spectrum of add-ons are now available including more memory, up to 16 serial ports, 96 parallel I/O lines, a video display, a parallel line printer interface and a 74 million byte Winchester disk drive.

*25-49 unit price
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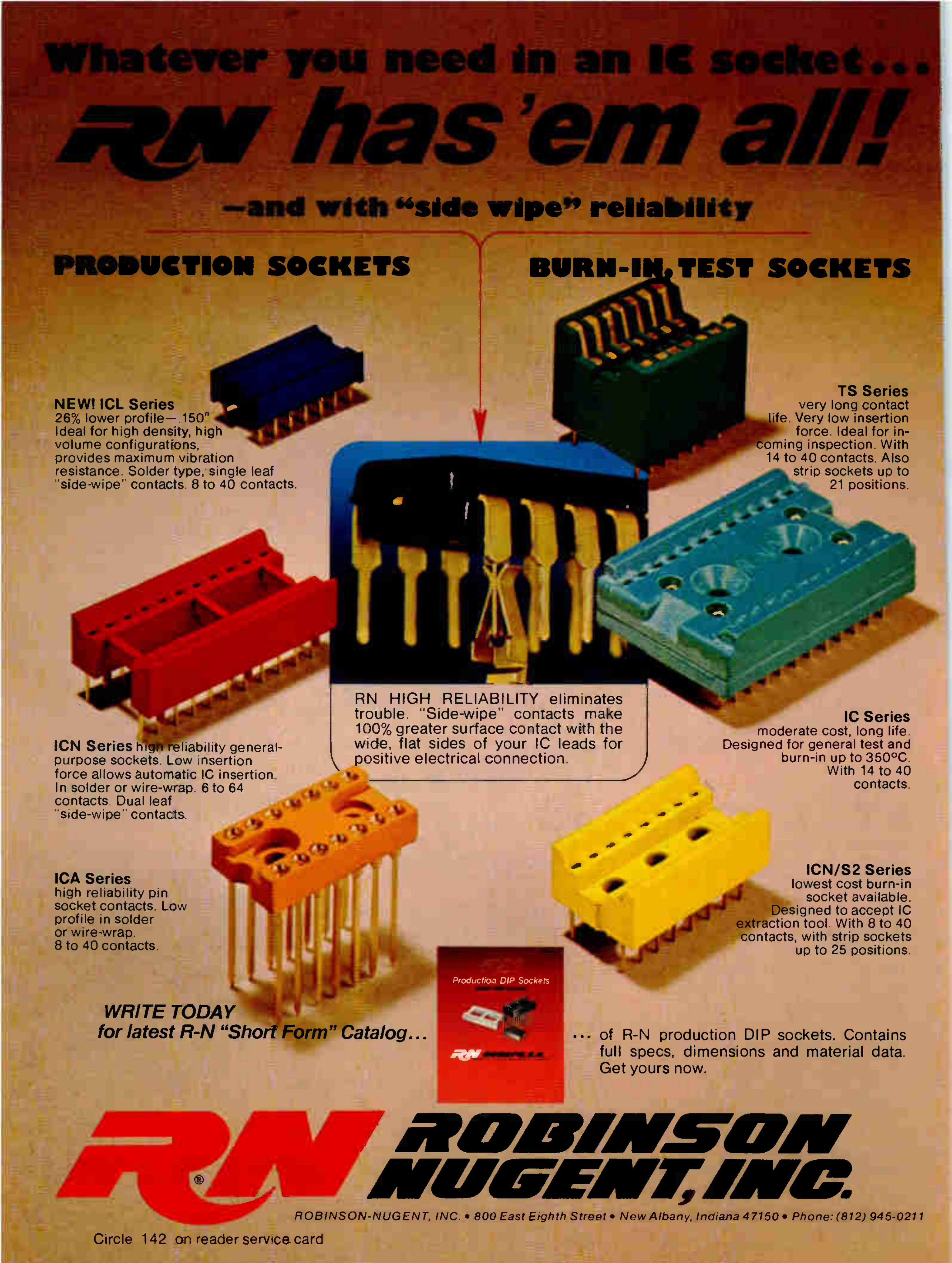
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exist. Some firms think that everything possible should be put on one board, which is of course fine for those users that need all the parts. Others feel justified in splitting up the computing power among a number of smaller boards, to allow a designer to choose only those he needs and not pay for extras.

Mostek, for example, agreed with Pro-Log Corp. of Monterey, Calif., that smaller decentralized boards are the way to go, so they jointly introduced the STD bus and a series of expansion modules to mate with it.

Mostek's modules, called the MD series, center on a Z80-based, 4-megahertz CPU board. Additions will include a triac I/O board, a 16,384-bit static RAM card, a 16-K erasable programmable ROM card, plus three more I/O capabilities than its previous /100 board. TI AG joined to form Advanced Micro Computers Inc.,

Also opting for a decentralized philosophy is Digital Equipment Corp., Maynard, Mass. The firm's Components Group separated its popular LSI-11's CPU and memory and put them on their own, smaller boards exactly half the size of the LSI-11's, thus creating the LSI-11/2. Since its inception, the LSI-11/2 has received much support both from DEC and outside vendors—some 17 companies provide various board products.

But DEC has not neglected the LSI-11. It now lets the user generate his own microcode. An optional board stores the user's microcode, and a 40-wire cable mates the new board to the LSI-11 CPU board for execution.

DEC is not the only board manufacturer enhancing its product line. National Semiconductor has added over 30 different boards to its Series/80 family in the last year. Texas Instruments Inc. of Dallas now has a more powerful CPU board in its 990 series, the TM-990/101M, which doubles the amount of on-board memory and has more I/O capabilities than its previous /100 board. TI also has a new RAM board, one containing RAM and/or erasable programmable ROM, and an I/O board. Motorola is building on its Micromodule series and has added four CPU boards—two based on the 6800 and two based on the 6802, as well as six different analog I/O boards.

Fairchild put the 9440 CPU, which executes Data General's Nova 1200 instruction set, on a single-board computer called the Spark-16. Besides the 9440 CPU, the board has 8,192 bits of RAM and 4,096 bits of PROM that contains an assembler, debugger, and monitor program. Fairchild plans to extend the amount of on-board RAM to 16 kilobytes this year and beyond that to 32 kilobytes or 16 kilowords by the first quarter of next. Next year, in addition, it will market the Blaze-16 two-board set made from the 9400 family of bit-slice components. This will execute the Nova 3 instruction set with up to a 10-MHz clock speed.

Now that board families have matured and their respective bus structures have been firmly defined, it is clear that analog I/O modules, once left to outside suppliers, are being taken over by the CPU and memory board manufacturers themselves. Texas Instruments, for example, has plans for its own analog I/O board to interface with its 990 series, and Data General's microNova now has stand-alone data-acquisition and -control facilities as a result of its new analog cards.

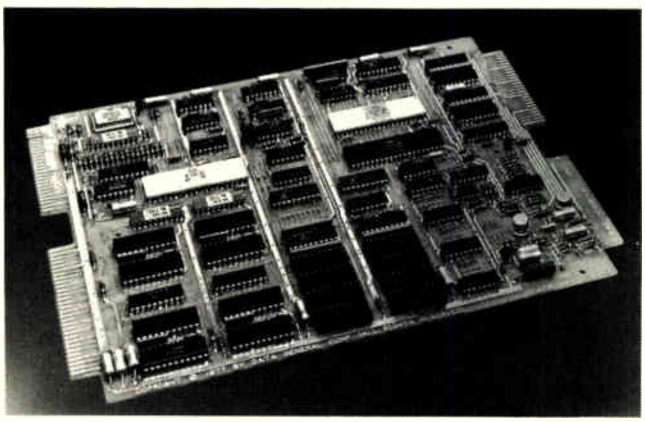
Data General Corp., Westboro, Mass., has also entered the 16-bit single-board computer market. The company's MBC/1 includes the 16-bit microNova CPU, 2 kilobytes of static RAM, up to 4 kilobytes of PROM, an asynchronous communications interface, and a 32-line digital I/O port.

Another recent entry into the one-board world is both a new company and a new board. Advanced Micro Devices Inc., Sunnyvale, Calif., and Germany's Siemens AG joined to form Advanced Micro Computers Inc., Santa Clara, Calif., and its first product is the AMC 95/4000. It features AMD's 9080A CPU (its version of Intel's 8080A), floating-point arithmetic, four direct-memory-access channels, eight programmable interrupt channels, 4 kilobytes of static RAM, up to 12 kilobytes of ROM, and 48 programmable I/O lines. As if this were not enough, the board also contains AMD's own AM 9511 math chip, which can perform 16- and 32-bit 2's complement arithmetic. Boards such as this will definitely take on jobs traditionally given to full-blown minicomputers.

Now, dual-port memory

Many of the recent advances in board computers are straightforward. The latest generation of CPU, memory, and peripheral chips are really the stars of the show. Intel, however, has opted to use an architecture that squeezes more power out of a board. Its dual-port RAM concept is an advance in board architecture, and since the boards employing it, including the new 16-bit 86/12 CPU board, can still use the Multibus, it also represents a smooth transition.

The goal of the dual-port RAM is simple—throughput. Using a three-bus hierarchy, the CPU ties up the system bus only as a last resort. Moreover, the dual-port RAM is a global resource, accessible not only to the board's own CPU, but to other bus-masters as well. A dual-port RAM-controller chip quells any arguments over whose turn it is to get at the data. The dual-port RAM first surfaced on



Micro mini. The MBC/1 microNova from Data General is the first single-board computer to be offered by the minicomputer maker. It features the 16-bit microNova CPU, 2 kilobytes of static RAM, up to 4 kilobytes of PROM, a serial interface, and 32 lines of digital I/O.

MICROCOMPUTER BOARD FAMILIES

	Computer Automation Naked Mini	Data General microNOVA	Digital Equipment Corp. LSI-11	Intel 8-bit iSBC 80 16-bit iSBC 86	Mostek SD	Mostek MD	Motorola MM	National BLC	National IMP	Pro-Log CRS	Pro-Log 7000	Texas Instruments TM990	Zilog MCB
Single-board microcomputer with RAM, ROM, and I/O				2									
Processor board only													
ROM or PROM board													
RAM board													
RAM with battery pickup													
Combined RAM and ROM													
Combined memory and I/O													
General-purpose parallel I/O	1												
Programmable parallel I/O	1												
Optically isolated I/O													
IEEE-488 interface board	1												
Combined serial and parallel I/O													
Serial I/O	1												
Communications controller	1												
Direct-memory-access controller													
Analog-input board													
Analog-output board													
Combined analog input and output													
Triac-output board													
Memory/disk controller													
PROM/E-PROM programmer board													
Video-display controller board													
Interrupt controller board	1												
Programmable clock/timer board													
Fast-math board													
Blank prototyping board													

Gray = 8-bit Color tint = 16-bit

1. Available through intelligent cables
2. iSBC 86 products compatible with 8-bit iSBC 80 family

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the iSBC 80/30 CPU board. It then appeared on the iSBC 544 Intelligent Communications Controller and the iSBC 86/12 16-bit single-board computer. It's a good bet dual-porting will appear on most of Intel's forthcoming boards as the 16-bit family expands to include things like floppy-disk controllers, analog I/O, and so on. It will be interesting to watch other board makers adopt schemes like the dual-port RAM and to see how they move into the 16-bit world.

Unique among expandable memory boards, the Multibus-compatible series of RAM cards from Mupro Inc., Sunnyvale, Calif., uses error detection and correction. The boards will detect and correct any single-bit errors and flag any double-bit failures. Watching Intel's SBC series progress closely, Mupro has already announced a word-oriented family compatible with the recently expanded Multibus.

Board computers have many applications in process control and small systems. And some of the small systems come from the board manufacturers themselves. When a line matures to include a CPU, memory, serial and parallel I/O, and floppy-disk control, the temptation is hard to resist.

National, for example, puts one of three CPU boards in a box with card cage and power supply and calls it the RMC, for rack-mounted computer. Its Starplex takes this idea a step further, combining a BLC 80/20 CPU board, a BLC 8229 CRT controller, and a BLC 8221 floppy-disk controller card in a modular cabinet complete with keyboard, CRT, and dual floppies.

The MCZ-1 is Zilog's answer to the small systems market. The MCZ-1/05, 10, and 90 are its latest additions. All are Z80-based, will operate with 4-MHz clocks, and are supported by Zilog's general-purpose RIO operating system, which locates software modules and manages I/O. Intel, too, integrates its boards into systems. Its latest is the System 80/30, which contains the iSBC 80/30 and room for three more boards. It is now reasonable to predict a System 86/12.

Software design

LSI chips and board computers are making complex digital hardware designs more of a snap, but what of software? To remain competitive, a growing number of engineers are doubling as programmers.

The biggest help here will come in the form of high-level languages adapted for software development. It is doubtful that chip users can be expected to learn any new assembly languages (which is one reason why the 16-bit processors are showing up with instruction sets that are supersets of their 8-bit predecessors). So high-level languages are in fact catching on faster among

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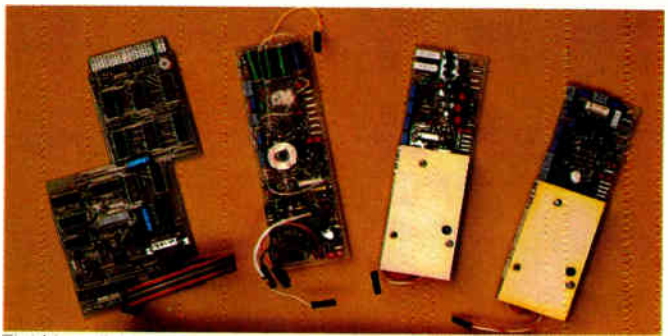

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designers than had been expected. Also they are more legible, portable, and alterable.

Expensive hardware is needed to exploit HLLs, though, and development-system manufacturers like Tektronix Inc., Beaverton, Ore., Millennium Systems Inc., Cupertino, Calif., and Futuredata Computer Corp., Los Angeles, Calif., are getting round this primarily with "universal" systems that can support a variety of processors. Chip maker's units of course support their own chips. Another approach is to keep per-station costs down by allowing multiple users to share expensive peripherals, like disks and printers, through either a dedicated controller or a general-purpose computer.

With Futuredata's latest system, for example, the disk and printer are shared by up to eight users on a high-speed serial link to a network control processor, which makes all the arrangements with the disks and printer. With eight users, per-station costs are below $8,000.

Tektronix admits it has neglected high-level languages to perfect its 8001 and 8002 universal development systems. But the Beaverton, Ore., firm is soon to catch up, primarily through deals with outside software vendors. Both the Boston Systems Office Inc., Waltham, Mass., and National CSS Inc., Norwalk, Conn., have agreed to develop down-loading software for Tektronix systems, and Microsoft, Albuquerque, N. M., markets a version of Fortran to Tektronix users. Also, Tektronix itself is developing a compiled version of Basic, and it is watching Pascal, seemingly ready to make a move.

Among the high-level languages now standard on many systems are Fortran, Basic, Cobol, and Pascal, as well as proprietary languages like Intel's PLM and Zilog's PLZ. Besides compilers (or interpreters) for these languages, more software packages are being added to systems to make programming easier. These include operating systems, editors, file managers, debuggers, and of course, assemblers. As for efficiency in certain applications, assembly language still has to be embedded in the object code generated by HLLs. But with the increasing power of the next-generation CPUs, assembly code will not be employed in any but the most demanding of systems.

Another likelihood is that more sophisticated software will be programmed into ROM. This began with small monitoring routines, but now that 64-K and larger ROMs are in view, high-level languages themselves will be in ROM and put onto boards. National already has three versions of Basic in ROM.

PROFILE

He promotes the C language

Underscoring a growing interest in simpler software solutions are the sales figures of "The C Programming Language" (Prentice-Hall, 1978). It has sold over 10,000 copies in the last six months, or more than four times as many as Brian Kernaghan and coauthor Dennis Richie expected. It is in fact the third popular software text Kernaghan has coauthored since his arrival at Bell Telephone Laboratories over 10 years ago after receiving his doctoral degree from Princeton.

"I write programs for a living," he says. As a member of the Bell technical staff, he has worked on word processing, combinational optimization problems, language design, and software for documentation preparation. Using this experience, he wrote "The Elements of Programming Style" (McGraw-Hill, 1974) and "Software Tools" (Addison-Wesley, 1976) with P. J. Plauger; his newest book derives from the fact that C is now the language of choice at Bell.

Kernaghan believes modern structured languages are the way to go. Unlike Basic and Fortran, which rely heavily on GOTO statements for branching, they more elegantly reflect the underlying algorithm and force the programmer to solve each piece of a problem on the spot.

"I had a tough time producing good code with Fortran," he recalls. "I remember sitting back and saying to myself, 'Hmm, A is less than B . . . I'll go somewhere and figure it out later.' But with languages like Pascal and C, you can change a small portion of your program and not affect the whole world by doing so."

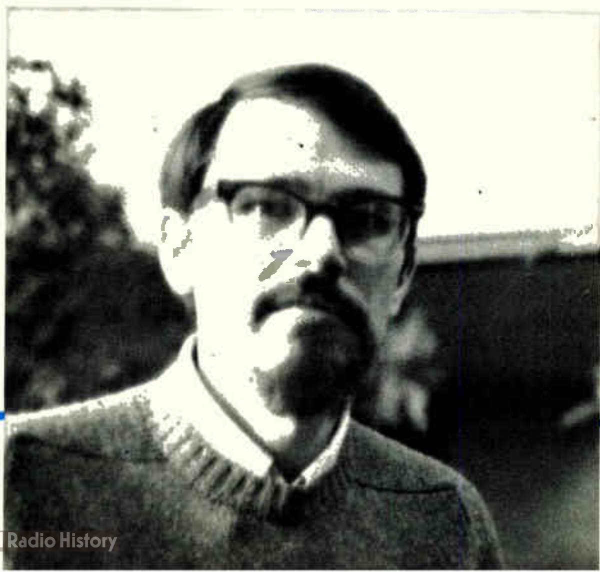
In praise of C, he says, "It can be used on almost every variety of computer, there are few things it can't compile, and it offers something that most languages don't even consider—notational convenience."

In comparison, Pascal "can get verbose and make you think you're walking through glue," he observes. "APL, on the other hand, is cryptic."

Nevertheless, Kernaghan does not entirely discount Pascal. "It's modern, of modest size, and relatively safe. It's especially good for academic work, particularly in view of the alternatives: PL/1 is complicated, Algol got off to a bad start, while Fortran and Basic have no control."

Supposing problems with control flow are now ironed out, what next? "Data handling needs a good hard look," says Kernaghan. Questions like "Is this parameter global?' and 'Where should the data be put so the program will be easy to modify?' still remain largely unanswered."

If his book about the C language looks like being his most successful, what was his most successful program? "One that allows a secretary to typeset mathematical equations," he smiles. **John G. Posa**



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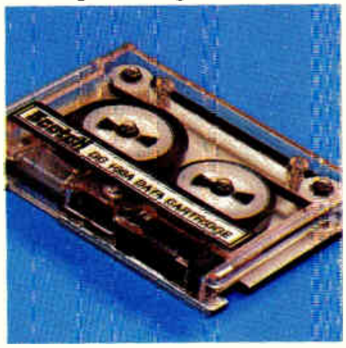

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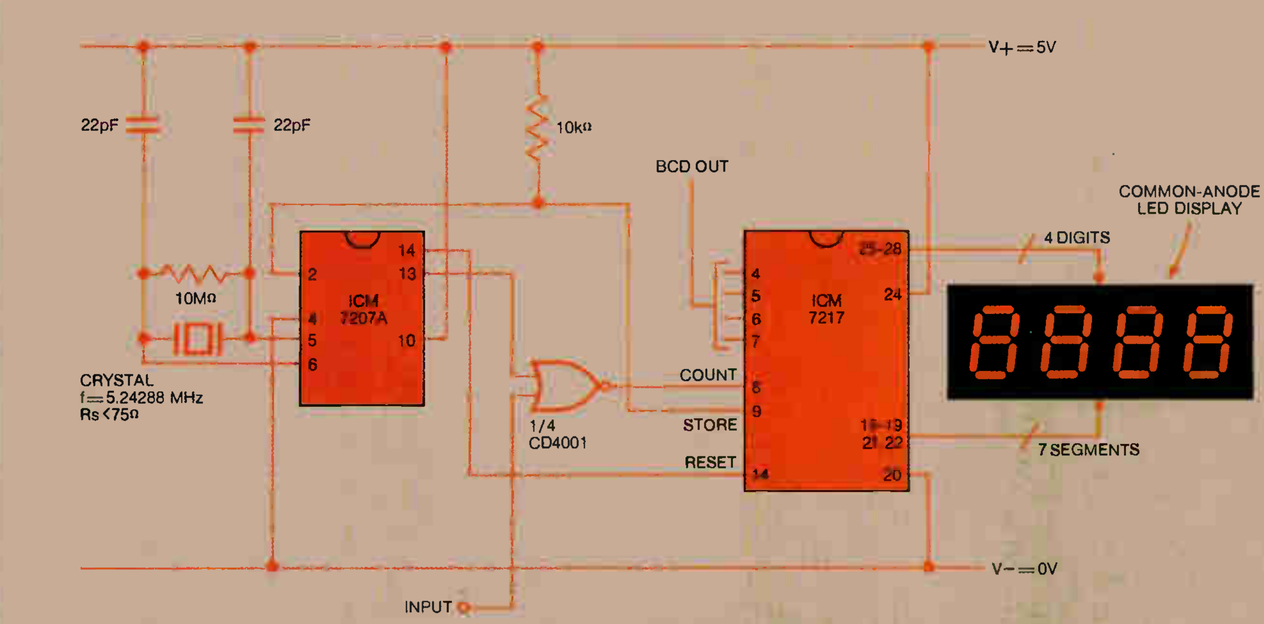

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COMPUTERS

by Anthony Durniak, *Computers Editor*

☐ *The computer industry is preparing to put the next generation of semiconductor technology to work. Both semiconductor and computer houses are working on very large-scale integration for logic and memory chips in both established and emerging technologies such as charge-coupled devices and bubble memories. But it's the computer industry's role to exploit these components' advantages in new architectures—and without outmoding billions of dollars' worth of equipment and software.*

Many mainframe manufacturers spent the past 12 months refining and producing the advanced designs they had announced earlier. So most of the news this year was in the minicomputer sector, which unveiled several new architectures. This advanced hardware is supported by more sophisticated systems software, resulting from stepped-up development programs.

Peripheral makers, too, have been taking advantage of the new solid-state and other technologies to increase densities and enhance performance. CCDs, for example, saw their first use in memory peripherals this year and should be the center of attention during the next. The floppy disk goes on, with manufacturers forecasting higher-than-1-megabyte storage space next year.

As the concept of distributed processing gained in popularity, a number of companies introduced their networking philosophies. Complicating the scene was American Telephone & Telegraph Co.'s announcement of its planned Advanced Communications Service—a switched-digital data communications system that would offer users sophisticated message-switching features.

VAX leads the way

One notable architectural achievement this year was Digital Equipment Corp.'s 32-bit VAX 11/780. The surprising move by the Maynard, Mass., minicomputer-industry leader to a 32-bit structure may have obscured other architectural changes introduced in VAX. Most significant of these is a virtual addressing scheme that can control four billion bytes of memory.

Key to handling this address space efficiently is the use of a 128-entry translation buffer. The buffer stores the most recently used translations between virtual and physical memory in high-speed registers, greatly reducing the memory management overhead. Additional features of the VAX CPU include an 18-kilobyte cache memory and up to 24 kilobytes of random-access memory control storage for diagnostic functions, special instructions, and microcode changes. RAM is also used in the memory busing and I/O subsystem to increase the efficiency of the busing mechanisms.

The industry will continue to see "higher performance at lower cost in a smaller package because of chip technology," says Jim Cockrum, lab manager of the advanced products team at Hewlett-Packard Corp.'s General Systems division, Santa Clara, Calif. That technolgy is also causing designers to rethink architecture, he notes. "It's a question of partitioning the CPU," a problem that may best be answered, he says, by a multiprocessor approach that uses a number of identical elements, each performing a specialized function.

Examples of this rethinking arrived earlier this month, when HP introduced a three-chip central processing unit in its 3000 series 33 minicomputer and in the HP 300, a new general-purpose business computer aimed at dedicated on-line applications. The three-chip CPU, made with complementary-metal-oxide-semiconductor-on-sapphire technology, replaces nine printed-circuit boards that previously comprised the CPU unit of the HP 3000 series II.

Another example of the impact of chip technology is Systems Engineering Laboratories Inc.'s SEL 32/30. By replacing core memory with 16-kilobit RAMs and using multilayered printed-circuit boards instead of wire-wrapped boards, the Fort Lauderdale, Fla., firm packs a 32-bit computer with up to 1 megabyte of main memory into a rack-mountable cabinet 15¾ inches high.

Honeywell Information Systems, too, took advantage of higher-density memory chips to streamline its packaging. The Waltham, Mass., minicomputer maker revamped its entire Level 6 line and now offers common front panels and racks for all models.

Data General Corp.'s vice president for engineering, Carl Carmen, notes that "the cost of RAMs has motivated machine design more in the past five years than anything else." As RAM prices continue to drop, Carmen says, more microcode will be used to create what he calls "soft architecture" in the next generation of hardware.

The Westboro, Mass., firm was not among the manufacturers who introduced new architectures this year, but it did unleash a new top-of-the-line Eclipse M/600 processor that performed some new tricks—and showed that 16 bits still has a lot to offer.

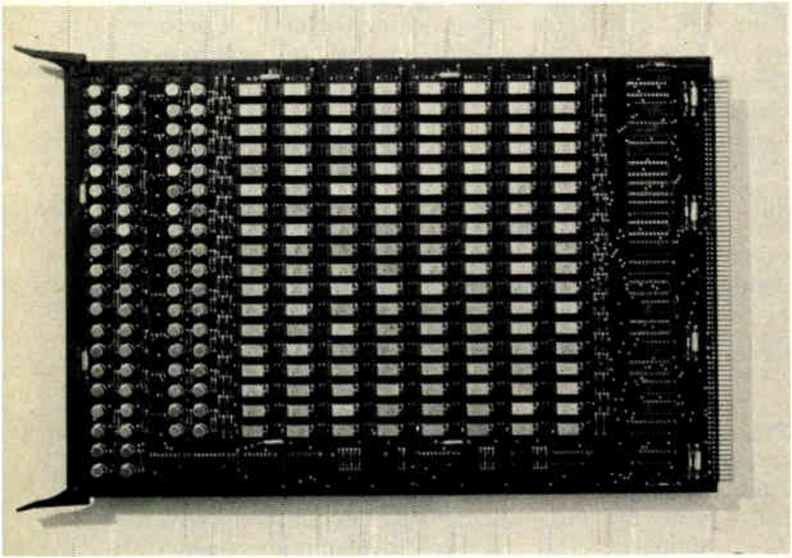
John William Poduska, Prime Computer Inc.'s vice president for research and development, notes that once the computers have all this additional memory there is a question of what to do with it (see "He brought virtual memory to minicomputers"). His answer for the most efficient use of memory is Prime's virtual-memory system, which is based on demand paging of data from disk. The capability was made available to users of mid-range minicomputers with the introduction this year of Prime's 350 system.

Among the other minicomputer vendor announcements this past year, Harris Corp.'s Computer Systems division, Fort Lauderdale, Fla., went to a 48-bit-wide internal bus structure in its new top-of-the-line series 500 minicomputer. Modular Computer Corp., also of Fort Lauderdale, is featuring a pipelined instruction look-ahead in its new Classic computer line.

Bolstering its distributed-processing offerings, IBM Corp. early this month unveiled its 8100 system, a 32-bit minicomputer that makes of a new proprietary 65,536-bit RAM (photo, p. 128). Users will not begin receiving the units until this time next year, however.

In other minicomputers, IBM enhanced its Series I

IBM's experiments with Josephson junctions (left) hold promise of small, fast, nonvolatile RAM.



Disk that isn't. Storage Technology's solid-state disk is one of the first memory peripherals to exploit the speed of charge-coupled devices. Meant to replace the IBM 2305 fixed-head disk, it stores 45 megabytes and has an average access time of 0.7 ms.

processor in model 4955-E by doubling memory capacity to 256 kilobytes and bolstering the real-time operating system to support more memory communications. For 1979, the 4955-E will have Cobol programming language.

Mainframes—more of the same

While minicomputer vendors are introducing new architectures, mainframe makers have been busy filling back orders for processor lines they unveiled during the spring of 1977. Many of these already incorporate advanced architectures.

IBM Corp. delivered the first of its top-of-the-line 3031, 3032, and 3033 processors on schedule in March of 1978 and began digging into a backlog that, says company president John R. Opel, piles up higher than the total computing power IBM has shipped.

With many of its products finding it harder to compete with products from the growing army of plug-compatible marketers, IBM reorganized its System Products division into two parts—the Data Systems and System Products divisions. Analysts see this shuffle as an omen that IBM's next generation of mainframes, often called the E- and H-series, will soon emerge.

Meanwhile, the roll call of plug-compatible challengers is building—in fact, the group's numbers have doubled in recent months. National Semiconductor Corp., Santa Clara, Calif., which in addition to ICs markets add-in memories and central processing units, announced their entrance into the arena as a direct marketer with an IBM-compatible minicomputer that emulates 32-bit operation and uses IBM 370 software.

National's System/400 minicomputer achieves throughput equal to that of an IBM 370/145 by using a bus-central, functionally distributed multiprocessor architecture. Similar to the 400's minicomputer architecture competing in a mainframe world, is Sunnyvale-based Two Pi Co.'s 370-compatible V32 minicomputer.

A number of products that take advantage of technology advances since IBM introduced the 370 series are giving the leader a run for the money. In fact, National's vice president and director of technology development, Pierre Lamond, believes that by 1985 the equivalent of an IBM 370/158 could be made on one chip.

Among the mainframe makers introducing 370-compatible equipment was Magnuson Systems Inc. of Santa Clara, Calif. In the firm's M80, a novel multiprocessor architecture allows redundant computing with up to triplex voting for reliability. Not only do the various M80 models outperform their IBM counterparts, but the modular system is easily upgraded by replacement of function modules so that the series can keep pace with new advances in technology.

Cambridge Memories Inc., the Waltham, Mass., manufacturer of add-on memories, also entered the free-for-all with IBM-compatible computers that they claim will outperform their counterparts by 10% to 15%—and at 80% of IBM's prices. Nor does the list stop here—foreign manufacturers are also arming themselves. Japan's Mitsubishi Electric Corp. has announced that it too will wade into the fray in 1983.

Though it might appear so, not all the action is on the IBM-compatible battlefield. Burroughs Corp., Detroit, Mich., has revamped its line of medium-scale computers with five models that supersede the B 2800, B 3800 and B 4800 families. In the new models, up to four CPUs can be combined in a multiprocessor arrangement; previously, only two CPUs could be coupled in a system. Burroughs is also preparing its sophisticated 7800 processor, introduced over a year ago, for first production shipments this month. Another unit, the Attached Fortran Processor, is being readied for delivery in early 1979. Finally, Burroughs will run benchmarks on its Scientific Processor in the first quarter of 1979. It plans production shipments of the unit, which can perform up to 50 million floating-point operations per second, for the end of next year.

Three other mainframe firms also enhanced existing lines during the year. Control Data Corp., Minneapolis, Minn., upgraded its Cyber 175 line of mainframes, while Sperry Rand's Univac division, Blue Bell, Pa., added to its 1100 line. Sperry also upgraded its 90/80 series of mainframes with three units, including the top-of-the-line 90/80-4, which features buffered memory and up to 8 megabytes of main storage. NCR Corp., Dayton, Ohio, topped out its latest-generation mainframe—the Criterion—with the 8580 and 8590 processors.

The course of computer technology can't always run true, and the year's most notable technology failure was Honeywell Information Systems' high-end Level 66, model 85 processor. Honeywell withdrew it from the market because of packaging and cooling problems with the unit's current-mode-logic circuits, but it hopes to use the technology in the future.

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Functional	0°C to 70°C	0.10	0.10	0.25	0.25	0.10	0.10
DC Parametric	0°C to 70°C			0.65	0.65	0.25 (Note 1)	0.25 (Note 1)
AC Parametric	25°C (Note 2)	0.65	0.65	1.00	1.00	1.00	1.00
Fine Leak	1×10^{-5} Leak Rate	NA	0.65	NA	0.65	NA	0.65
Gross Leak	Step C-1	NA	0.40	NA	0.40	NA	0.40
Mechanical Defects (Note 3)	Critical	0.10	0.10	0.10	0.10	0.10	0.10
	Major	1.00	1.00	1.00	1.00	1.00	1.00

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(1) For linear devices, a 0.25% AQL at 25°C and a 0.65% AQL at 70°C apply.
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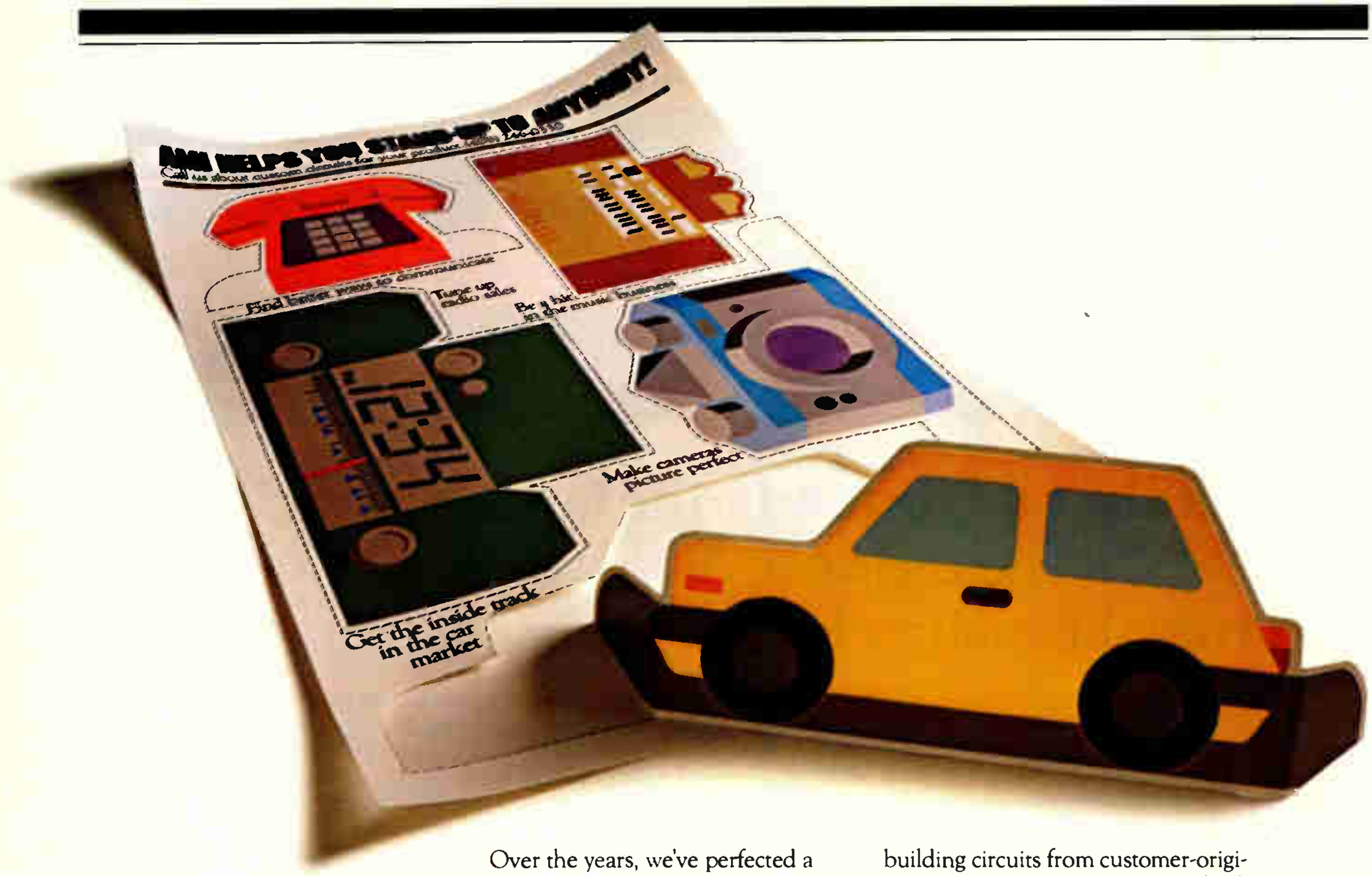

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Though busy with current product lines, mainframers are not ignoring the future. Almost all of them have programs under way to develop very large-scale integrated circuits, higher-density emitter-coupled logic and other current-mode-logic forms, as well as new communications techniques and peripheral devices.

Key to the successful application of VLSI in the computer industry will be test methods, notes Barry Borgeson, Sperry Univac's director of research and technical planning. At Univac "a variety of testing techniques are being researched," he says. "It's not just a matter of partitioning the logic and putting it on a chip." Among the other semiconductor technologies Univac is looking into are complementary metal oxide semiconductor on sapphire, subnanosecond ECL, short-channel n-MOS, and gallium-arsenide materials, he says.

But Borgeson notes that future architectures will be less radical departures from current ones and will deal more with the overall system and less with the individual machine characteristics. "It's hard to add architectural elements without obsoleting past investments in software. In the future we'll deal in systems architectures rather than CPU architectures."

In other experimental developments, IBM dived into cryogenics and found Josephson junctions, with which it prototyped a 15-nanosecond 16,384-bit random-access memory. It also experimented with a tunable-dye laser for data storage.

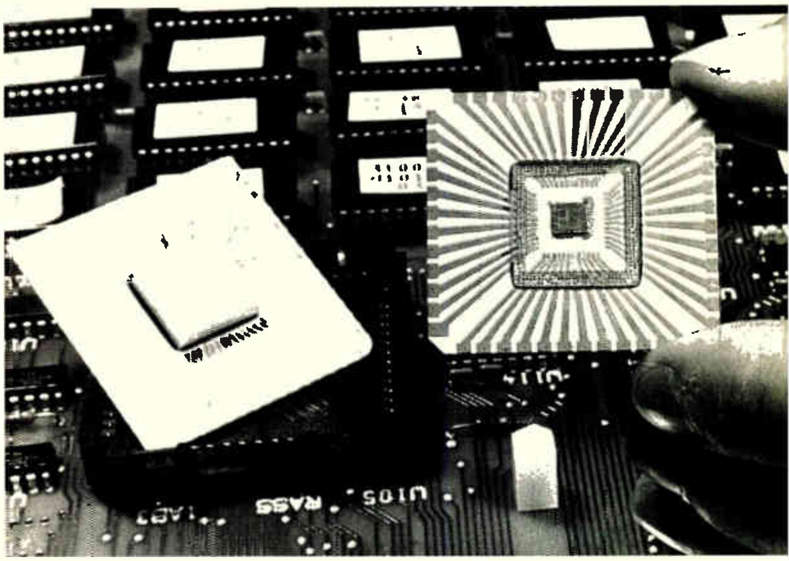
Amorphous semiconductors won a vote of confidence from Burroughs, which worked with Stanford Ovshinsky's company, Energy Conversion Devices, Troy, Mich., to produce 1,024-bit electrically erasable read-only memories. Burroughs' executive vice president for engineering, Lloyd Cali, says the company has no immediate plans for the part.

In general, Cali predicts that the decreasing cost of memory will have a big impact on future mainframe architectures. "In the past, designers optimized the use of working storage through the operating system. Today nobody cares how big the operating system is because [when compared with the system's cost] memory has virtually zero cost." As cheaper and higher-speed memories become available, they can also affect machine design through their use in what Cali calls stored logic—a technique that arranges bits stored in a memory to perform an algorithm. The technique is easier to alter than even a microcoded machine and is easier to design because "it's the closest thing to a hardware representation of pure Boolean logic."

Software development—a burden?

"The next generation of computers will be software-based systems, so the trick is to get the software up to speed," says Michael Resnicow, software product specialist at the Interdata division of Perkin-Elmer's Data Systems group. And quite a trick it will be—with software trailing the present generation of hardware and hardware designers working on the next.

Software development is still a labor-intensive chore,



Shrinking CPU. Using C-MOS-on-sapphire technology, Hewlett-Packard introduced a three-chip central processing unit in its 3000 series 33 and model 300 minicomputers. Two pc boards replace a nine-board CPU that was used in the 3000 series II.

so it's not surprising that computer vendors report more than half of their R&D budgets now go into software. Most are quick to note that this does not include the development of microcode or firmware routines, which is considered part of hardware development expense.

In conjunction with the stepped-up development effort, more and more companies are emphasizing software product announcements. Typical of the new approach was Interdata's introduction of a globally optimizing Fortran compiler for its 8/32 line of minicomputers. Previously the reserve of mainframes, this type of software produces a more efficient machine code by eliminating redundant operations while compiling the program. Such programs run in one half to one third the time they took before optimization, says Resnicow.

Hewlett-Packard's Jim Cockrum estimates that in three to five years software will account for 75% of the computer companies' R&D budgets. "The reason we're in a bind today," says Data General's Carl Carmen, "is that we didn't give software the right emphasis in the past. The best thing for software would be for the hardware guys to go away for four or five years and allow it time to catch up."

In the peripheral products market, the demand for more storage for small computer systems has brought about a new generation of Winchester-type technology fixed-media disk drives in small packages. Using a technology originally developed for mainframes, a number of disk-drive manufacturers have developed units similar both in size and price to traditional cartridge disk drives but offering up to eight times the storage capacity.

Early product announcements came over a year ago from companies such as Control Data Corp., Minneapolis, Memorex Corp. of Santa Clara, Kennedy Co., Altadena, Calif., and Okidata Corp., Mount Laurel, N. J.

Changing display. Cathode-ray-tube-display manufacturers are taking advantage of chip technology to pack more intelligence into less space. Perkin-Elmer's Data Systems group combined a microprocessor and CRT controller on a single chip in its 550 terminal.

The number of offerings doubled recently with the additions of California Computer Products, Anaheim, Calif., Ampex Corp., Redwood City, Calif., and Storage Technology Corp., Louisville, Colo.

Peripheral economy

This year several inexpensive products of this type appeared that should prove popular with original-equipment manufacturers who make low-end minicomputers. The key to cost savings in these units is the blending of features from floppy-disk drive and Winchester-type head technologies. Floppy-disk maker Shugart Associates, Sunnyvale, Calif., joined the fray with one such device. Taking this approach one step further was International Memories Inc., also of Sunnyvale, which scaled down the standard 14-inch disk platter to an 8-inch diameter to produce a Winchester-type disk unit that packs 11 times the storage capacity of a floppy-disk drive into the same space.

As for floppies, after a false start that delayed deliveries six months and more, the first production shipments of double-density, double-sided floppy-disk drives are finally beginning. IBM was first, earlier this year, with production deliveries of its System/34, which contains such a drive. But when other manufacturers began to produce IBM-compatible, 1-megabyte units of their own, they were plagued with technical problems, primarily relating to media wear. These problems appear solved now and, with a number of companies delivering floppy-disk-controller chips, it should get easier for designers to incorporate the higher-density units.

Look for higher-than-IBM densities on plug-compatible mainframe disk-storage units next year. This year, those competing in the IBM-compatible market—including STC, CDC, Memorex, and Sperry Univac's ISS division in Cupertino—began shipping their top-of-the-line IBM 3350-type disk units. But Control Data broke away with the introduction of a unit that offers 625 megabytes of storage per spindle, twice the maximum of IBM's 3350.

Manufacturers of rigid-disk drives are researching a number of techniques that would increase storage. Among these are thin-film head fabrication schemes that would result in a lighter head with a smaller recording gap and hence higher recording densities; new disk coating techniques; and more sensitive feedback control systems that can accurately follow narrower tracks.

Peripheral storage systems are expected to be one of the largest applications of charge-coupled devices. The first such use of CCDs was Memorex' 3770 disk cache unit; Storage Technology Corp. recently followed suit with its disk replacement unit. The Memorex unit operates at the head of a string of disk drives, storing frequently used data in the higher-access-speed CCDs and thereby increasing overall system throughput. STC's 4305 Solid State Disk is designed to replace a fixed-head disk memory in virtual-memory applications and operates some 30% to 50% faster in typical paging applications.

The CCD devices are seen as the harbingers of complex hierarchical memory systems in which CCDs and bubbles would perform a cache or buffer role, disks would provide on-line storage, and an automated tape library would be used for archival storage. Manufacturers are now looking into controls for such systems. These controllers—often called back-end processors—would actually be dedicated computers.

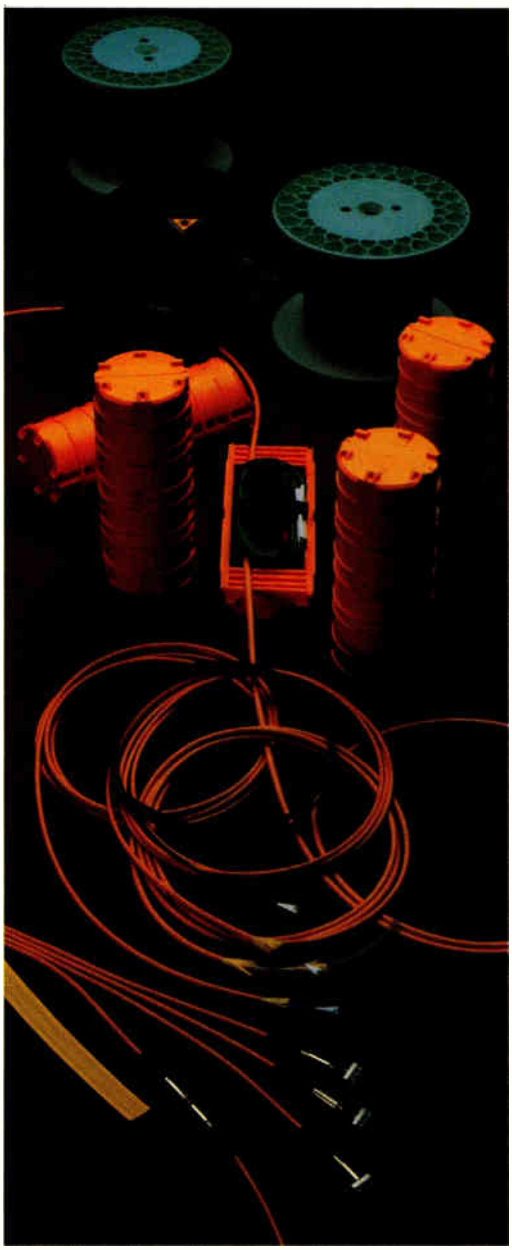
Manufacturers of cathode-ray-tube data terminals are also planning to take advantage of improving chip technology—primarily in the form of single-chip CRT controllers. Hazeltine Corp., Greenlawn, N. Y., uses a National Semiconductor part in its recently introduced 1400. The Terminals division of Perkin-Elmer's Data Systems group, Randolph, N. J., used its in-house LSI design operation to combine a microprocessor and a CRT controller on a single chip in its new 550 terminal.

Distributed processing proceeds

As the market concept of distributed processing catches on, it provides impetus for the various networking, communications, and data-base management technologies needed to implement it. These technologies are incorporated into the growing number of distributed processing "philosophies" introduced by the computer companies—definitions of what networking schemes they will employ and the capabilities they will offer.

IBM led the field with its Systems Network Architec-

The hardware half and the other half.



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ture and the other mainframers soon followed: Sperry Univac with its Distributed Communications Architecture, NCR with its Distributed Networking Architecture, Honeywell with its Distributed Systems Environment, and Control Data with its Distributed Network System and Cyber 170-network products. Burroughs joined the ranks earlier this month with its Burroughs Network Architecture.

Minicomputer and intelligent terminal vendors also unveiled schemes. Digital Equipment Corp. was an early entrant with DECnet and Hewlett-Packard followed with Distributed Systems Networking. Computer Automation Inc., Irvine, Calif., couples its SyFa small business systems with its Virtual Network, built around a centralized network controller and using X.25-type packet-switching communications at speeds up to 56 kilobits/s.

Datapoint Corp., San Antonio, Texas, calls its approach ARC—for Attached Resource Computing. The company's small business computers can be intermixed on a local string of coaxial cable up to 4 miles long and can operate at speeds of up to 2.5 million bits per second. All systems on an ARC network can share data bases and peripherals, and remote systems can have access through traditional telecommunications links. Also based on a coaxial cable interconnection, Ann Arbor, Mich.–based Sycor Inc. ties its intelligent terminals together with Sycorlink, which allows some sharing of data bases.

General Automation Inc., Anaheim, Calif., unveiled Autonet—a modular queue-driven network that can handle up to 255 individual network nodes, each with up to 32 individual communications links. The links use a full-duplex, synchronous-data-link-control protocol at rates up to 2 megabits per second. Besides sharing data bases and peripherals among processors attached to the network, Autonet provides for program-to-program communications.

Looming over the networking efforts of the computer companies is AT&T's plans to introduce a switched data communications service dubbed Advanced Communications Service. The service would provide an interactive call-mode of operation, as well as a message-mode to provide for message storage and forwarding. A key part of the service would be code conversion, protocol translation, and speed-matching capabilities, which together would permit dissimilar units to communicate. ACS could also control message formatting and editing.

PROFILE

He brought virtual memory to the minicomputer

As the cost of semiconductor main memory drops and solid-state technology finds its way into peripheral memory systems, computers at all levels are being packed with more storage capacity. "But how do you use all that memory?" asks John William Poduska, vice president for research and development at Prime Computer Inc., Wellesley Hills, Mass. Without good memory management, higher capacity need not result in improved performance. Poduska's answer is virtual memory—not surprising, since he is the architect of Prime's virtual-memory technology.

In a virtual-memory system, software and hardware techniques, including segmentation and paging, are used so that the user is unaware whether the data he accesses comes from main memory or mass storage, such as disk drive. Thus large programs can be executed without concern for memory management.

Poduska's work with virtual memory is an outgrowth of his experience with the Multics project at the Massachusetts Institute of Technology and later at NASA's Electronics Research Center, Cambridge, Mass., where he was director of the Manned Computer Systems branch.

That's where he was able to apply the Multics virtual-memory approach he learned as a 24-year-old member of the electrical engineering faculty at MIT. "We used the virtual-memory idea at NASA to do research on future manned spaceflights," says Poduska, "including a manned Mars mission, which required very large memories." At NASA, Poduska and his group added a "virtual memory box" to a Honeywell 516 computer and built what he believes was the first multi-user operating system. That operating system was the forerunner of Primos, which Poduska brought to the company in 1972.

By law, NASA had to put the development into the public domain and Poduska tried in vain to get Honeywell interested in a virtual-memory system while he was there. "The idea lay dormant for two years," he says. Then he and six colleagues left Honeywell to form Prime in February 1972. Within nine months, the company designed, manufactured, and shipped its first computer, the Prime 200, after designing the software first. In June of 1973 came the Prime 300, which Poduska believes was the first $100,000-class minicomputer using virtual memory. Until that time, virtual systems were in the IBM 360/67 mainframe class, costing "several millions," Poduska says.

Poduska sees himself as a technology opportunist, taking advantage of component and magnetic technology to bring affordable minicomputers to market. His philosophy seems to work. Prime's sales will zoom by almost an order of magnitude in three years: from $11.3 million in 1975 to near $100 million. **Lawrence Curran**

"Any bunch of hotshots can design a new microcomputer. It takes brains to improve an old one."

John Jones
Product Marketing Manager
Series/80 Microcomputer Systems

2

Series/80 Microcomputer Systems

"We're super aware that forcing a change in system architecture causes customers a lot of pain and agony. It costs a small fortune. And no amount of cross assemblers, translators or mode switches will make things easier.

If you want to hear real horror stories, ask the minicomputer guys. They've seen it.

It just doesn't make sense to me to force customers into a change when there are tons of things you can do to improve any system — especially once it's been in use. And with Series/80 that's exactly what we do.

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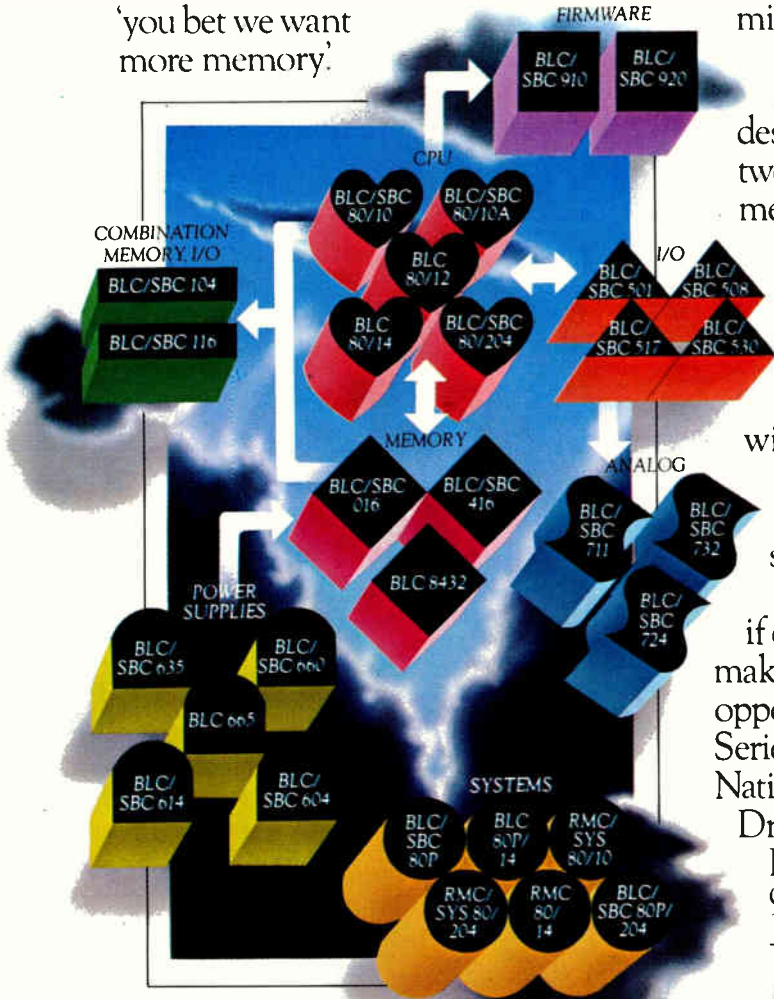
Don't get me wrong. The SBC 80/204 — in fact, all the original SBC products are very good. But coming later lets us take customer reaction into account.

In 80/10 boards, for instance, we felt people might like the on-board memory beefed up. So we got out and talked to customers. They told us, 'you bet we want more memory.'



And that's what we gave them with the BLC 80/11, 80/12 and 80/14.

Customer feedback also led to the development of National's exclusive 32K BLC8432 ROM/PROM memory card, which is twice the capability of everybody else's.

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I feel the best hardware investment is one that protects a software investment. And with Series/80, we're helping create an industry standard microcomputer. So more customers can use an existing software base. And software and hardware designers will be easier to find. Also, two vendors competing for business means freedom of choice. And that's what free enterprise is all about.

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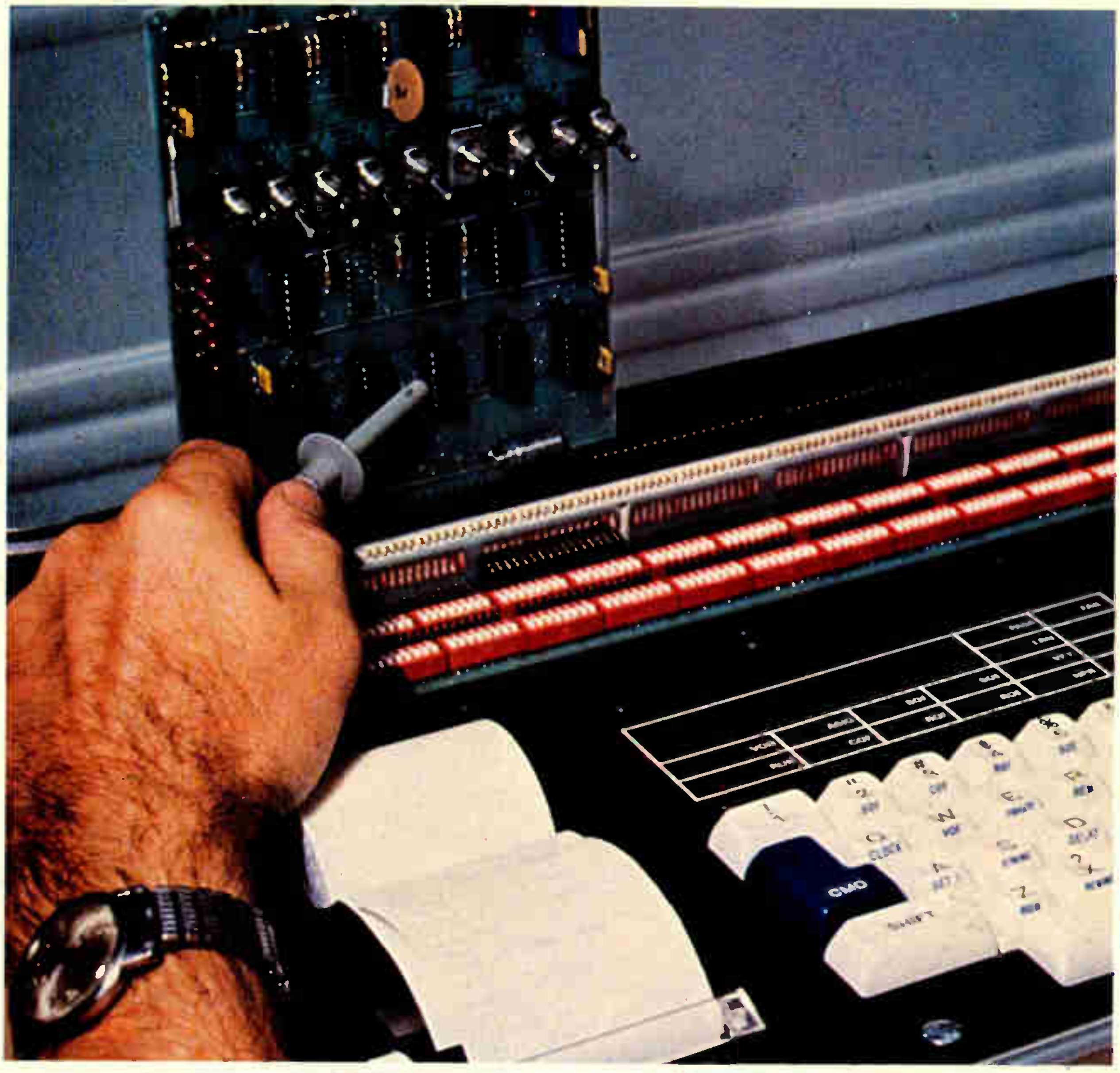


INSTRUMENTS

by Al Shackil, *Instrumentation Editor*

☐ *This year, the microprocessor is having a bigger effect than ever before on test and measurement instrumentation. It is accelerating the transition from traditional analog-to-digital approaches and in addition is giving birth to new test and measurement capabilities. But the limelight does not belong solely to the microprocessor. Other digital circuits are enhancing the resolution of, for example, time and frequency synthesizers. On the analog side, ingenious new cathode-ray-tube designs are boosting the writing speed and screen size of storage oscilloscopes.*

These changes are not refinements for the sake of refinement. With large-scale integration reducing complex systems to chips on boards, traditional testing methods are being taxed to the limits of their capability and economic feasibility. Chip makers run into the problem in attempting to characterize their devices, just as much as chip users do in attempting to verify board performance through all the stages of design, manufacture and servicing.

Moreover, test personnel, already far too few in number, find their skills constantly outmoded by the rapid advance of electronic technology. Thus there is a real need for microprocessor-based equipment that can take over much of the responsibility for evaluating measurements from the operator and may leave him or her with little more than a go or no-go decision to make.

For instance, a recent microprocessor-controlled logic-state analyzer from Paratronics, San Jose, Calif., has a programmable read-only memory that lets it perform up to seven tests, reducing its dependence on the operator's skills.

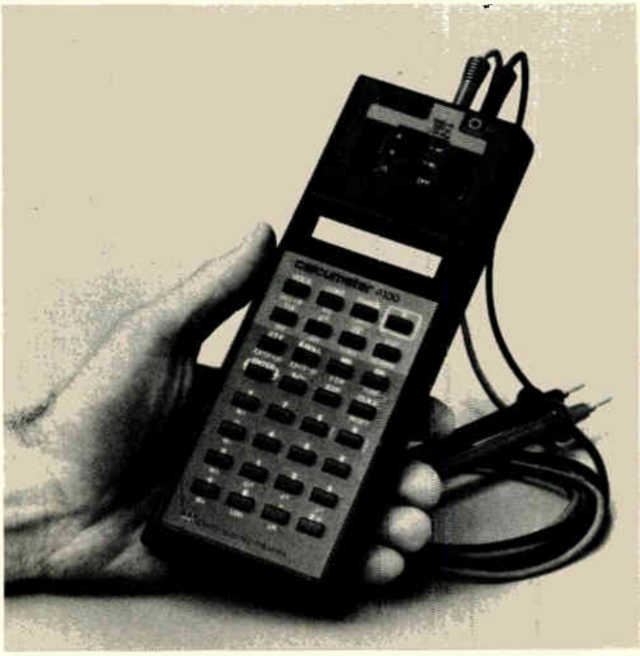
Introduced within the past year, the model 532 is but one of several logic analyzers that continue to emerge as microprocessor-based systems increase in speed and bit size. The number of channels they can monitor has grown from 16 to 24 and even 32 in recent models. The most obvious change in these instruments is the replacement of the front-panel switches and knobs by keyboards indicative of microprocessor control and simpler operator input.

The Paratronics model 532 is a 12-megahertz, 32-channel analyzer for use in the laboratory, on the production line, or in the field. In conjunction with an oscilloscope, it can display up to 256 words in various formats and features 21 triggering modes. It also can do signature analysis, operate remotely by means of an IEEE-488 interface bus, and produce a hard copy of test results through an RS-232 interface.

Some analyzers can capture both logic-state and -timing information simultaneously for production testing or laboratory work. New from Hewlett-Packard Co., Palo Alto, Calif., is the 20-MHz, 24-channel HP 1615A logic analyzer that can display various timing and/or data-domain combinations on its CRT with detection circuitry capable of capturing 5-nanosecond glitches.

Pushing the test parameters to the limit in this type of instrument is the brand-new K100-D logic analyzer from Biomation, a Santa Clara, Calif., division of Gould Inc. The analyzer combines a high-performance timing mode (100 MHz, 16 channels, plus dual 1,024-word memory) with an impressive set of display formatting and decoding capabilities for data-domain analysis. An optional 32-channel input adapter used only for data-domain analysis makes troubleshooting the recent 16-bit microprocessors an easier task. The K100-D features individual high-impedance (1-megohm) active probes consisting of custom hybrid circuits (rather than an active probe pod), which allow signals to be processed very close to the user's circuitry.

Omnicomp's Portable Service Processor (opposite) can guide the operator to component-level faults on LSI boards.

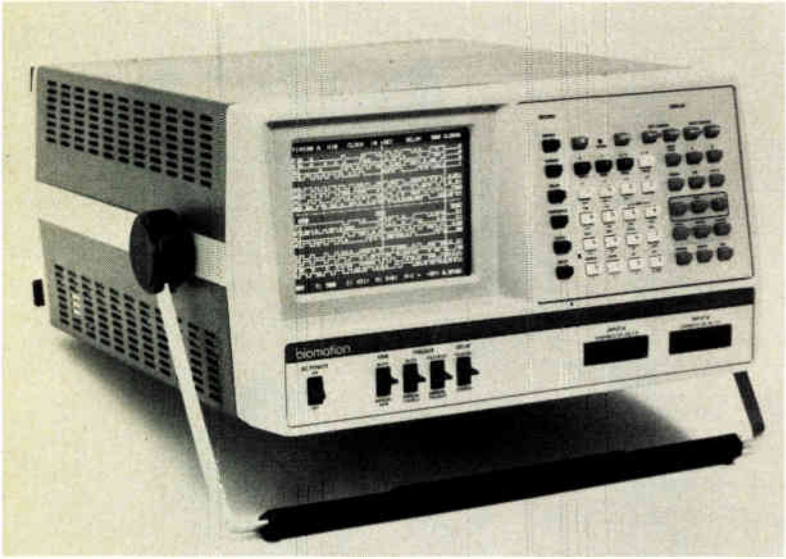


Processing DMM. Besides presenting readings in engineering, scientific, or fixed-decimal notation, the display on ESI's Calcumeter can illustrate sorting ranges in an analog, graphical fashion.

In recent years, the question of the acceptance of the IEEE-488 interface bus has been much debated. Not only has the bus won out, but it is directly responsible for creating new instrumentation in the form of dedicated bus monitors and bus analyzers.

Field assistance

Aimed specifically at helping the shortage of field service personnel of a sophistication to match that of today's LSI is the Portable Service Processor from Omnicomp Inc., Phoenix, Ariz. Surely the forerunner of service instruments of the future, the PSP performs high-speed dynamic testing of circuit boards loaded with transistor-transistor and emitter-coupled logic, as well as metal-oxide-semiconductor devices, including microprocessors and memories. It interfaces with the operator for the most part through its keyboard and light-emitting-diode display and with the boards through an edge connector consisting of 192 fully programmable driver-sensor pins. Thus equipped, it guides the operator in



Keyboard entry. The Biomation K100-D logic-timing and -state analyzer has powerful display formatting and decoding features.

probing for faults by spelling out simple diagnostic instructions in English either on the light-emitting-diode display or on a 20-character-per-line thermal printer built into its case. A digital multimeter also contained within the PSP handles traditional analog measurements.

The unit has up to 96 kilobytes of random-access memory and 6 kilobytes of read-only memory, part of which executes a self test on powering up. An on-board tape cartridge provides 2.5 megabytes of program storage and a fast hardware microprogram interprets the high-level Basic test instructions. A series of translator software packages convert factory test programs and circuit images into the PSP Basic test language. These translation programs offer a major support capability necessary in achieving comprehensive field servicing.

Moreover, the Omnicomp unit provides remote diagnostic capabilities through RS-232 and V-24 interfaces, as well as telephone communications, via an acoustic coupler and modem. It can be operated in either a master or slave configuration with another remote PSP.

Another novel instrument in this class is the Digital Testing Oscilloscope from Biomation. The DTO-1 does automatic testing, as well as manual troubleshooting, on digital and related analog circuitry. Equipped with a single probe and oscilloscope-type controls, it combines the abilities of a go/no-go comparison tester, a time-domain logic analyzer, and a storage oscilloscope.

As a go/no-go tester, the DTO-1 uses its microprocessor to compare the logic waveforms of the system or board under test with those stored on a tape cartridge contained in the unit. As a logic analyzer, it can store and display up to eight traces with various triggering capabilities and 10-ns glitch detection. When operating as a storage scope, it can display digitized analog waveforms and logic traces on the same time base, to aid the troubleshooter in deriving the cause of the fault. Its 100-MHz sampling rate can handle input signals up to 20 MHz, which is even sufficient for even some ECL designs. The unit's microprocessor also executes many self tests within the instrument, including memory diagnostic routines and input calibration tests.

The DTO-1 is virtually self-programming and uses no software language to program tests. Reference logic traces and control settings are acquired from a known-good board and recorded on the unit's tape cartridge for playback in the automatic go/no-go test mode. This feature eliminates considerable programming time and costs while making it easy to add reference material.

Faster storage scopes

Storage oscilloscopes too are making significant advances, particularly in CRT design. Leading the way in the structure and focusing system of electron guns is Tektronix Inc., Beaverton, Ore., with the model 7834 400-MHz storage oscilloscope. The 7834's fast variable-persistence transfer-type CRT has pushed the writing rate up to 2,500 centimeters per microsecond, enabling a single-shot pulse with a 1-nanosecond rise time to be captured clearly on a display area measuring 3.6 by 4.5 centimeters.

Another innovation in storage CRT design is found in the 1744A storage scope from Hewlett-Packard Co. Its storage CRT achieves a writing speed in excess of 1,800 cm/μs and a 100-MHz bandwidth on a 4.32-by-5.7-cm display. The tube does it by incorporating a static field crossover lens to expand the image prior to its display on a conventional phosphor screen.

In general, though, the larger the display area, the harder it is to obtain maximum writing speeds. However, the latest entry into the storage-scope marketplace—the model 3266 from NV Philips Gloeilampenfabrieken of Eindhoven in the Netherlands—features a 900-cm/μs writing speed on a relatively large 7.2-by-9-cm display, plus 100-MHz bandwidths. These specifications are achieved by using an electrostatic lens system as a scan magnifier and placing it in front of the storage mesh in its transfer-type CRT.

Smarter DMMs

Microprocessor control with front-panel keyboard entry also is on the rise in 5½- or 6½-digit digital multimeters. Today these units can handle all kinds of sorting, scaling, linearizing, formatting and automatically controlled interfacing functions.

The 6½-digit model 7065 introduced earlier this year by Solartron Electronic Group Ltd., Farnborough, England, has eight built-in process programs and a ninth program that puts all measurements and processing in charge of an internal real-time clock, so that the unit can function unattended for a span of 96 hours. The 8502A from the John Fluke Manufacturing Co., Mountlake Terrace, Wash., is another microprocessor-based 6½-digit DMM offering an alphanumeric display along with user-selectable digital and analog filtering and accuracy enhancement via the keyboard.

The latest 6½-digit microprocessing digital multi-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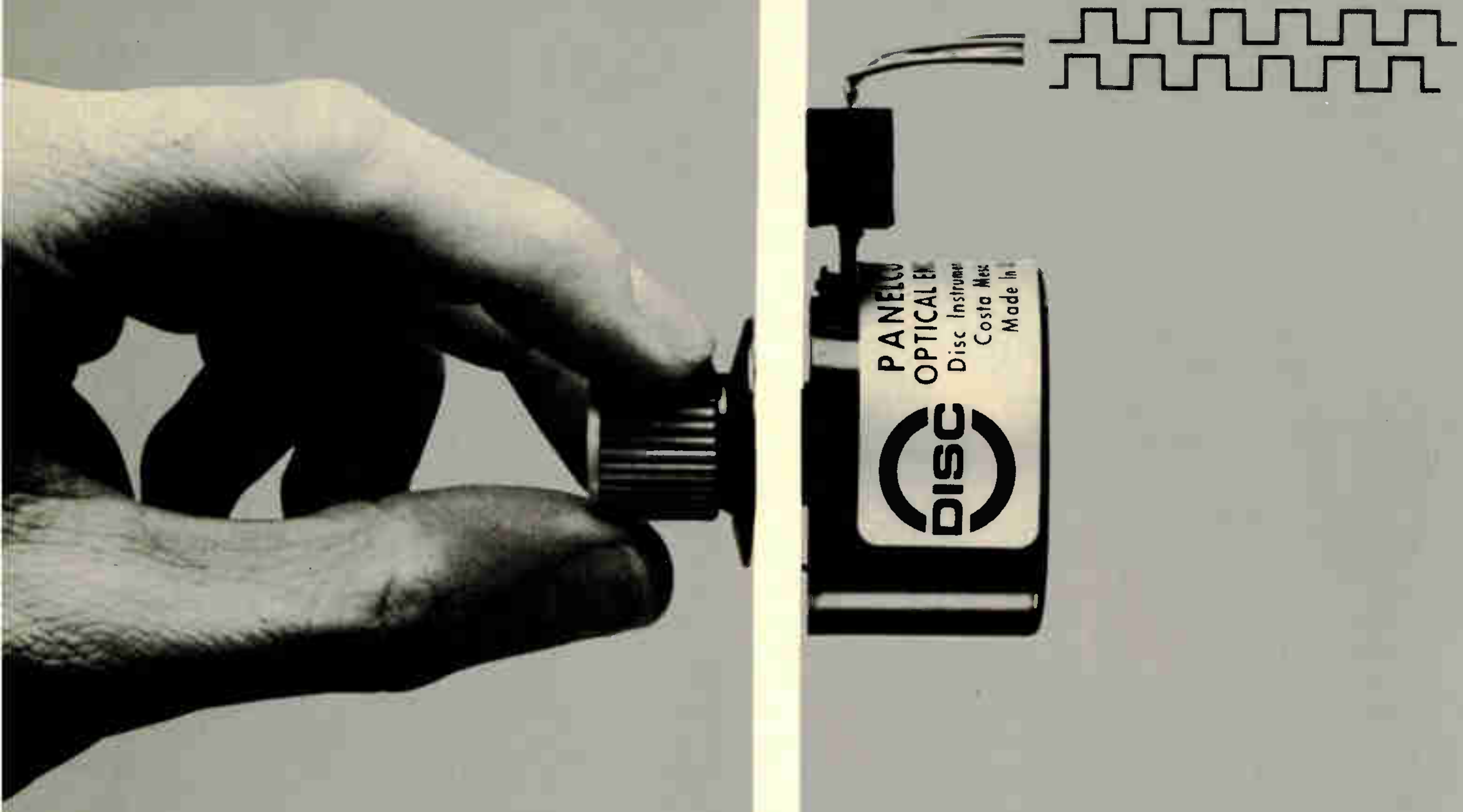

If you're still using potentiometers to help convert mechanical motion into digital signals, there's an easier, less expensive way.

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Circle 170 on reader service card

meter entry is the Series 6000 from Racal Dana Instruments Inc., Irvine, Calif. It was designed for use as a bench-type multimeter, as well as an automatic test system, and features a top reading rate of 34,000 measurements per second. Both the Fluke 8502A (as an option) and the 6000 offer calibration memory modules with which the operator can recalibrate the instrument just by touching a key. The 6000 will automatically test and calibrate itself every four hours and display the relative departure from the limits of calibration, so that the user may set up a maintenance timetable in advance. Such a module cuts calibration costs and downtime since it alone need be sent for annual maintenance and another module borrowed and used in the meantime.

A portable processing digital multimeter, the $389 Calcumeter 4100 from Electro Scientific Industries Inc., Portland, Ore., measures like a 3½-digit DMM and computes like a scientific calculator. The first handheld instrument of this type, it relies on a complementary-MOS microcomputer to automatically condition measurements. Indeed, it uses low-power C-MOS circuitry almost entirely, and its custom microprocessor when not in use even slows down its clock to minimize power drain.

In the lab

Perhaps especially in sophisticated laboratory instruments, the incorporation of the microprocessor and other LSI circuits is improving performance and versatility at price/performance tradeoffs that are sometimes more than acceptable. For instance, the addition of a microprocessor to some designs reduces their price by eliminating redundant circuitry or providing alternative basic design approaches. Among other benefits, instruments are becoming simpler to use, data displays easier to interpret, and confidence levels are rising.

For instance, consider Hewlett-Packard's 3528A dual-channel, low-frequency, fast-Fourier-transform spectrum analyzer. It is about half the price of other dual-channel instruments of its type. In addition, its proprietary 16-bit n-channel MOS processor and FFT make unprecedented use of the cross power spectrum to offer the engineer coherence function analysis, a tool with which he can validate transfer function measurements and trace cause-and-effect relationships between inputs and outputs.

In another example, the HP-5324A microwave counter eliminates two out of the three expensive microwave circuits by using a microprocessor to perform calculations formerly done in an analog fashion. The changeover drops the price to $4,500 from the $6,000 that previous models cost.

Phase-locked developments

Two digital circuit designs have emerged from Hewlett-Packard this year that have broad applications. The first, a patented phase-locked triggered-oscillator circuit, responds to an input trigger not by starting but by suspending operation for a brief known time interval. Upon restarting, it does not allow the phase-locked loop to pull the frequency back into its original phase, as it normally would, but instead locks the new phase to the reference. As a result, it gives the 5359 time synthesizer and 5370A universal time-interval counter respective resolutions of 50 picoseconds in generating time intervals and 20 ps in measuring them.

The second breakthrough is the N-fractional phase-locked loop, in which the voltage-controlled oscillator can operate at not only integral but also fractional multiples of the reference signals, making synthesizers with phase-continuous sweeps possible. Besides offering very good resolution, the circuit lowers costs since there is no need for additional expensive full loops for superior frequency resolution. It is at present incorporated in the 3325A and 3335A frequency synthesizers and the 3585A spectrum analyzer.

Testability

Because the LSI manufacturer produces so many devices, he is forced to run tests that are faster and less complete than users would like. The increased costs of testing, generated by both hardware and software developments, put large test systems like those of Fairchild and Tektronix out of reach for some companies economically. Addressing this market is a new breed of dedicated low-cost (under $40,000) benchtop units like the Q8000 from Megatest Corp., Sunnyvale, Calif., and the MX-17 from Adar Associates Inc., Burlington, Mass.

The cost reduction comes from abandoning stored test stimuli and expected responses (which require huge amounts of memory) in favor of a reference device that duplicates the device under test and generates test patterns. These also lend themselves to high-volume situations in which only a few chip types are being tested, since they rely on a reference module for each device costing from $3,000 to $4,000 each.

However, if testing needs are in the incoming inspection area where lots of different devices are being used and even supposedly identical devices from second sources have different test criteria, a large test system may be the only hope.

The latest introductions by Tektronix, the S-3250 production tester and S-3270 device characterization tester, feature 20-MHz operation, up to 14 clock phases, five driver modes, up to 8 kilobits per pin of local memory, and a testing-oriented software and architecture that provides background data processing while testing occurs in the foreground.

The testing speed race appears to be on again, with memory testers also being forced to keep pace. Macrodata Corp., Woodland Hills, Calif., with its M-1 tester breaks through the 25-MHz barrier (to 12 MHz has been the limit), enabling it to handle the 40-ns cycle time of new 4-K static RAMs as well as 50 ns of the larger 16-K and 64-K static RAMs. Yet with faster (35-ns) memory devices already in sight, the speeds now in effect will be forced to increase.

Certain design characteristics of current LSI devices make them hard to test. Their complexity makes 100%

testing impossible. A lack of test points restricts access to certain chip areas. Their architecture neither is standardized nor lends itself to traditional testing strategies. These problems are compounded when more LSI devices are added to a bus-oriented layout; since many devices share the bus, selective fault isolation becomes hard.

In short, while IC manufacturers have produced chips that made the digital designer's job easier by reducing interfacing problems, they have made the test engineer's job infinitely more difficult. So now, with VLSI approaching rapidly and the use of LSI boards increasing, the emphasis on designed-in testability is growing.

One approach being explored by VLSI manufacturers and users and applicable to both boards and chips involves partitioning the design into functional modules and connecting those modules by buses or pathways in which the routing is programmable. This partitioning can be done by breaking up feedback loops and pathways with latches in a serial fashion so that it becomes possible to access certain areas while isolating others. Moreover, snapshots of compressed test data can be obtained from parallel-in–serial-out shift registers placed at strategic points along the pathways.

Such modifications allow the selective reduction of chip complexity during testing, increased access with a relatively small increase in device pinouts, minimal consumption of substrate area for diagnostics, and increased versatility in overall design application.

PROFILE

They put an LSI board tester in a suitcase

Squeezing most of the capabilities of large $100,000-and up digital production test systems into a suitcase-sized portable tester to sell for $20,000 is no easy task. But Robert G. Fulks, president of Omnicomp Inc. of Phoenix, Ariz., and principal developer of the Portable Service Processor, likes to do what's difficult. "Most people felt a portable circuit-board test system like the PSP couldn't be made," says the former vice president of General Radio Co. (now GenRad Inc.), where he was responsible for engineering, product marketing, and custom products. Rather than wait to be shown, as Missourians have a reputation for doing, the 42-year-old native of Kansas City proudly says, "We showed them it could be done, and we did it."

While earning bachelor's and master's degrees in electrical engineering in 1958 and 1959 from Massachusetts Institute of Technology, Fulks was a co-op student who chose to work at Concord, Mass.-based GenRad because "it was the closest company" in his field. There another MIT co-op student came to work under him—Robert E. Anderson, who received his bachelor's degrees in electrical engineering and industrial management in 1963 and is now Omnicomp's 37-year-old vice president.

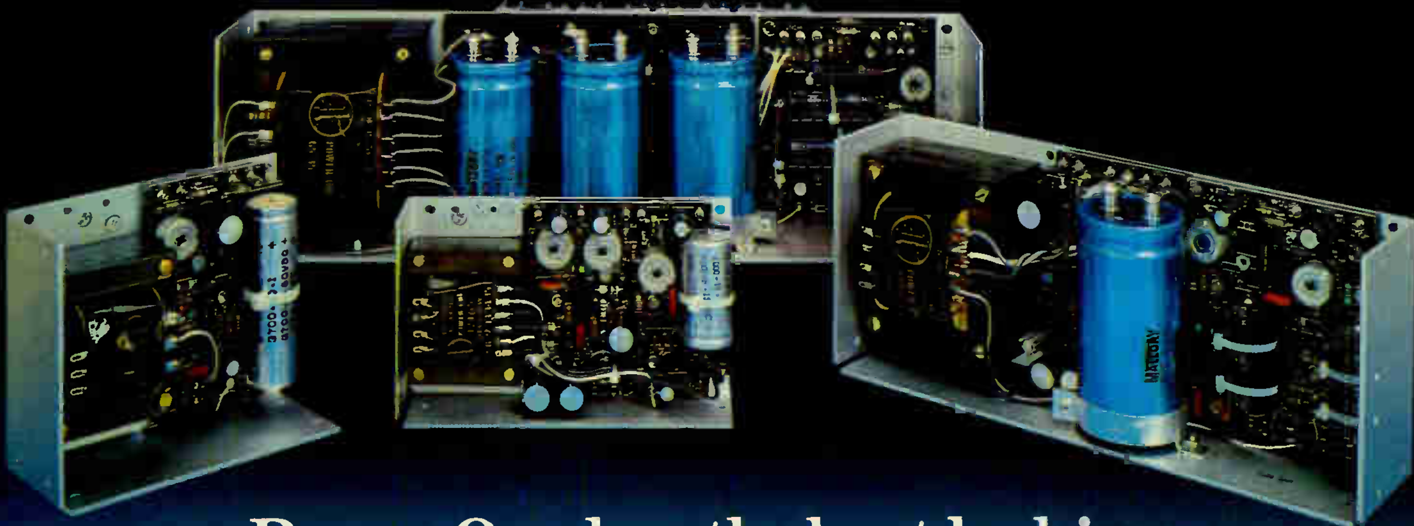
When the New England weather and 15 years at GenRad became too much to endure, Fulks moved to Phoenix, where he founded the Mirco Systems Inc. subsidiary of Mirco Inc. in early 1973. Anderson, then GenRad's European product marketing manager for component and network test systems, joined Fulks in the new venture and the two set out to develop a family of portable, computer-controlled logic-circuit testers. However, when the parent company became more excited about some successful electronic amusement games Fulks also developed, the pair left Mirco to co-found Omnicomp in February 1975.

Perhaps the biggest hurdle in the PSP's development was the need to condense the functional capabilities of production-line board testers into a package no more than a tenth their size. "This forced a different way of looking at the system architecture," says Anderson, a native of Teaneck, N. J., "but we did it with some custom integrated circuits and a lot of shoe-horning." For example, the connection scheme had to be made universal enough so that many board types could be plugged into the PSP without requiring numerous device adapters. Also, he continues, some "seemingly impossible tricks" were employed in layout. One of them was to employ etched circuits instead of cables, so that signals from the 192 input/output pins on three identical driver-sensor boards are in sequence at the top of the tester where the board under test is inserted.

Another area pushed very hard was high-speed processing, Anderson notes. "Traditionally, test system manufacturers put some random-access memory behind each pin. We didn't have the space and money, nor the power, to do that," so they had to come up with another scheme. Fulks (pictured sitting) and Anderson (standing) then developed a Schottky transistor-transistor-logic processor, with a 50-nanosecond cycle time. Its operator can program detailed time slots to make pin changes at specified times for handling the dynamic refresh and clock signals of memories and microprocessors. Equally difficult was the problem of cramming the data base into a reasonable amount of memory. Fortunately for users of the PSP, neither Fulks nor Anderson at first realized how big a problem it would be. Otherwise, says Fulks, "we might not have embarked on the program." **Bruce LeBoss**

"Talk about

OPEN FRAMES



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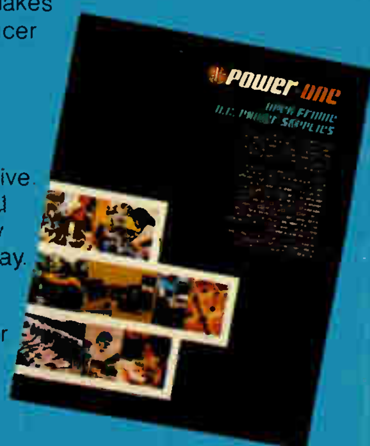

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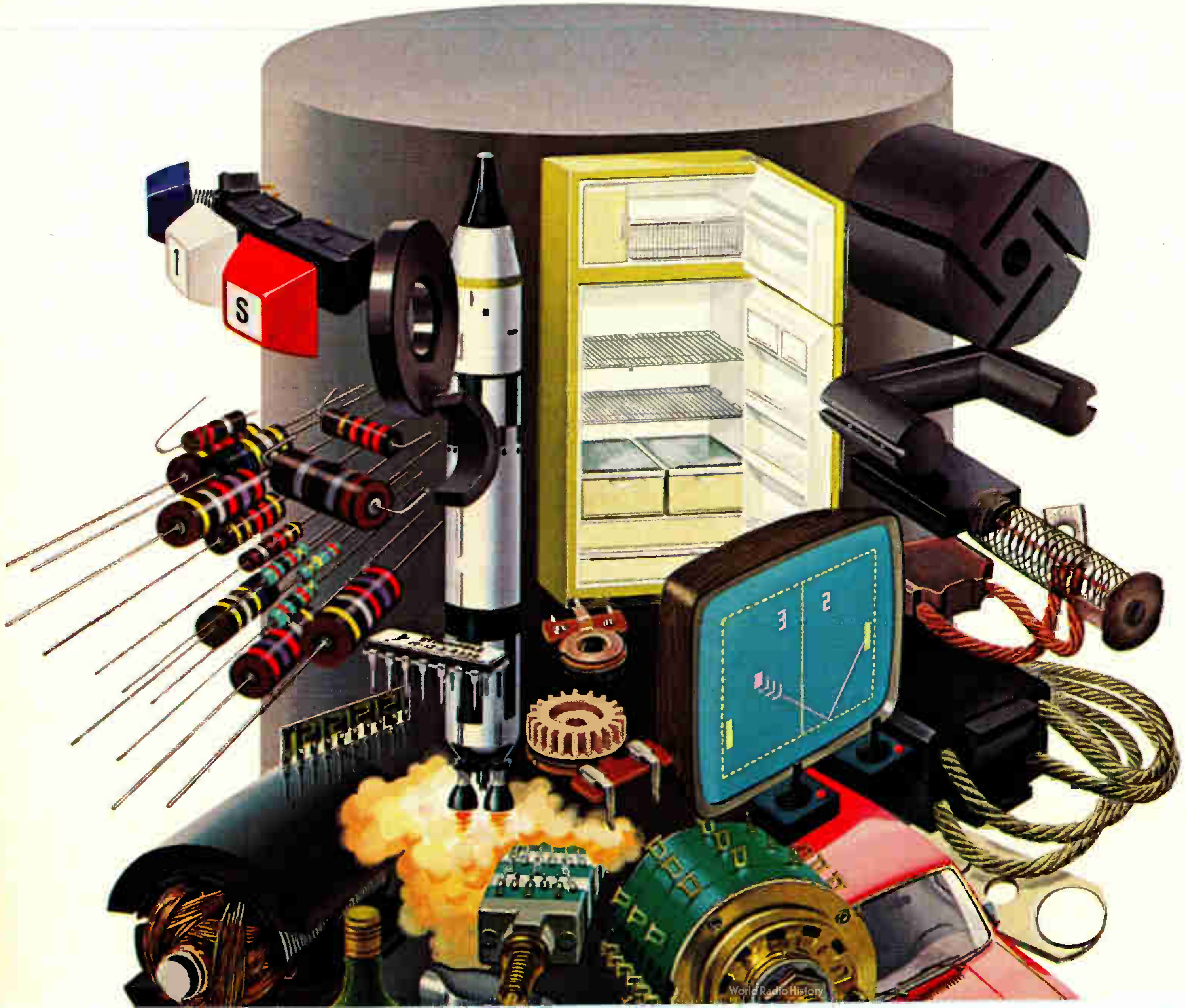
Circle 173 on reader service card

What is a Stackpole?



A Stackpole is a very large corporation, one of the largest privately held manufacturing companies in the United States.

Stackpole is also the name for hundreds of products, made in two million square feet in eighteen plants and sold all over the world.

A Stackpole is an organization of dedicated people with manufacturing, engineering, marketing and management know-how. And a special willingness to help solve your material and component problems.

A Stackpole is a switch.

We're a giant switch-maker. We produce more slide switches than anyone else in the world. All shapes. All sizes. And all kinds of other switches—rotary, rocker and keyswitches. We're a big part of the giant consumer electronics industry.

A Stackpole is a resistor.

We're one of the largest resistor companies, with capacity in the billions. We provide the world with carbon-comp, carbon-film, variable, industrial and special-purpose resistors, as well as resistor networks.

A Stackpole is a ferrite.

Hard and soft. Stackpole is one of the world's largest producers of ceramic magnetizable powders. Our permanent magnet materials are used in a variety of applications. From refrigerator door gaskets to motor segments.

Stackpole is also a major supplier of soft ferrite cores used in the electronics industry. From TV sets to power supplies.

A Stackpole is an automotive brush.

We're the leading supplier of automotive brushes in the U.S. Other brushes, too. And our Carbon Division makes a lot more than brushes. Carbon and graphite anodes. Plates. Rods. Billets. They're all Stackpole.

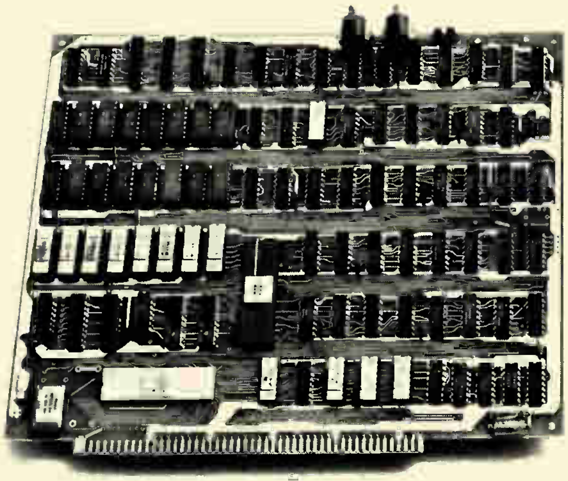

MICRO

Introducing SPARK-16: The MICROFLAME family has given birth to a microcomputer.

Fairchild recently introduced 9440 MICROFLAME™ CPU — the world's first 16-bit bipolar microprocessor that executes an instruction set with minicomputer performance.

Now we're introducing the SPARK-16™ microcomputer designed to demonstrate the capabilities of the 9440 MICROFLAME CPU or to be used as a stand-alone microcomputer for applications requiring 4 K words of RAM (expandable to 8 K words soon, and more later) and 2 K words of ROM.

Major applications for the 9440 MICROFLAME CPU and SPARK-16 board include OEM data processing in a variety of computing control and instrumentation environments; telecommunications PBX switching installations; distributed intelligence, distributed multiprocessing and front-end (terminal) processing.



SPARK-16

FLAME™

MICROPROCESSOR

Where there's flame there's fire.

Fairchild is also introducing its FIRE™ (Fairchild Integrated Realtime Executive) software package. Available now for use with the 9440 MICROFLAME CPU or the SPARK-16 microcomputer are FIRE-LOAD (bootstrap and binary loader), FIREBUG (interactive entry and debugging program), FIRE-EDIT, FIRE-DIAGNOSTICS, FIRE-SYMBUG, BABY BASIC, FIRE-BASIC, FIRE-MACRO (a stand-alone macro-assembler) and FIRE-RLOAD (stand-alone linking loader). These are fully supported and documented.

Execution is on the well-known Data General NOVA™1200 instruction set.

NOVA is a trademark of Data General Corporation.

Hot new technology.

The new microprocessor is based on an advanced form of I^2L technology known as I^3L™ process (Fairchild's Isoplanar Integrated Injection Logic). It provides the combined advantages of bipolar high speed and MOS packing density and power dissipation. In addition to the I^3L circuitry on the 9440 chip, there is conventional TTL circuitry which allows TTL interface with other logic, PROMs and RAMs. We have 8, 10 and 12 MHz parts available in quantity.

The 100-piece price is as low as $100.00 per unit.

A spark of genius.

The SPARK-16 pc board is loaded with features including the 16-bit 9440 MICROFLAME CPU, 4 K words of RAM, (expandable soon), 2 K words of Autoload PROM, memory control with DMA capability, interface logic for a Teletype or RS232C, 100-pin connector with 9440 Bus, connector for TTY/RS232C, control switches (Autoload, Continue, Halt and Reset) and display. BABY BASIC and FIREBUG are available in PROMs. The SPARK-16 board requires only a single 5 V, 4.0A power supply and a TTY or CRT terminal. The single board price is $995.00.

Only the beginning.

More sophisticated FIRE software, board level hardware and LSI support circuits are on the way. Before year-end the software will include an interactive disk operating system (for hard and floppy disks) and shortly thereafter a FORTRAN 77 and PASCAL. New LSI circuits will include a 16K TTL dynamic RAM; a memory control with control, refresh and DMA capabilities; and an I/O bus controller.

For 9440 parts and SPARK-16 boards, contact your Fairchild representative or sales office. For a MICROFLAME brochure and data sheets, call or write Fairchild Camera and Instrument Corporation, MICROFLAME, P.O. Box 880A, Mountain View, California 94042. Tel: (415) 962-4626. TWX: 910-379-6435.

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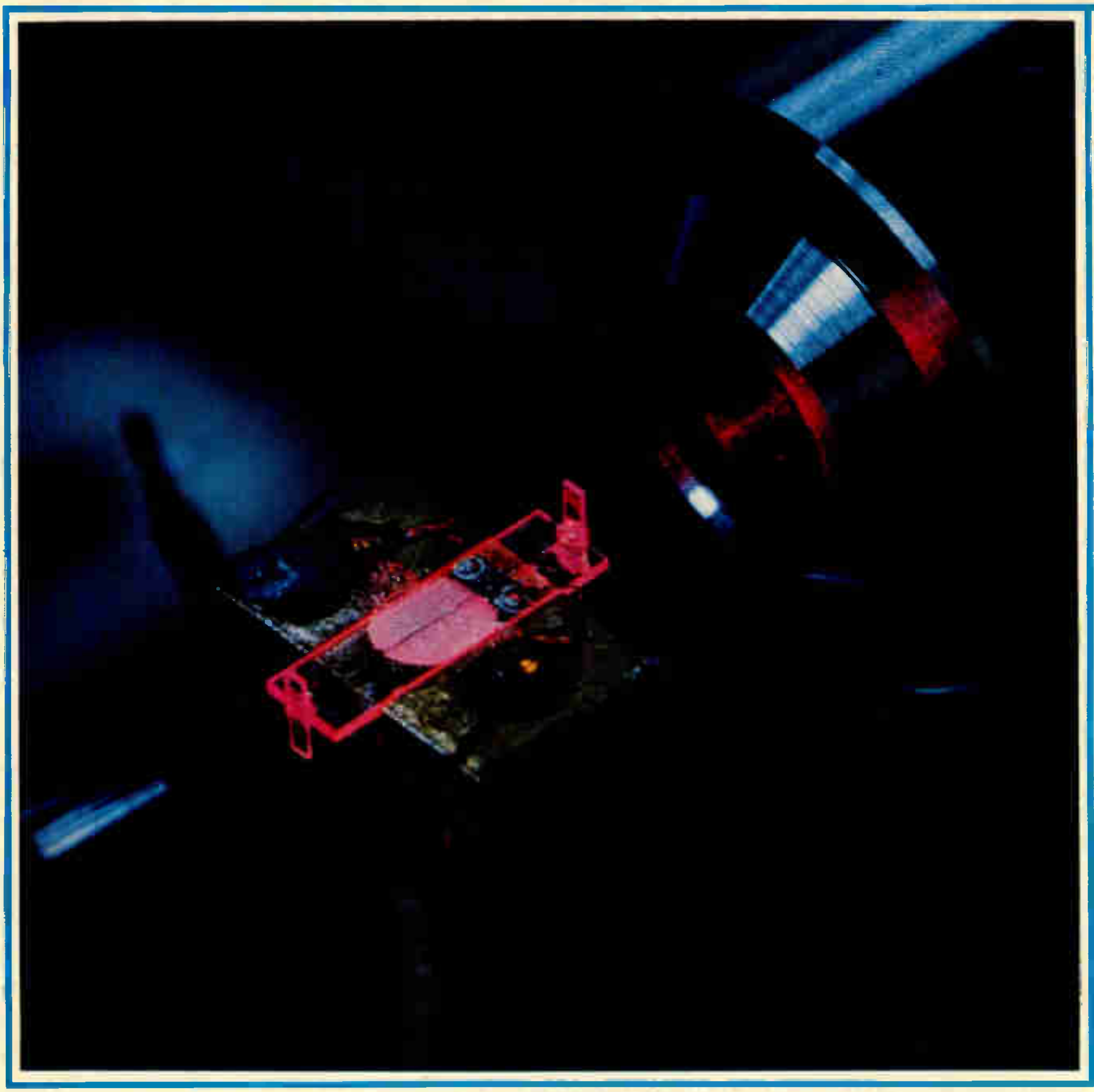


COMMUNICATIONS

by Harvey Hindin, *Communications and Microwave Editor*

☐ *"Give us more," cry the communications users of the world—and more they are getting. More bandwidth from fiber-optic transmission lines, more flexibility from all-digital switching systems, more economy from the application of LSI techniques to the manufacture of codecs, more channels from the implementation of clever modulation schemes, more compression and spectrum-sharing techniques in satellites, and more communications options from the newly proposed telephone-dial-up Advanced Communications System.*

The information revolution in communications, fathered by the ready availability of inexpensive large-scale integrated circuits, has developed new technologies that only a few years ago were gleams in the theoretician's eye:

- The low-loss glass fiber pioneered by Corning in 1970 with a breakthrough specification of 16 decibels per kilometer has been superseded yearly. In 1978, Nippon Telegraph and Telephone Public Corp. achieved 0.66 dB/km in an operating system.
- Codecs—single-chip LSI coder-decoders for converting signals from analog to digital and vice versa for a pulse-code-modulation scheme—did not exist at all in 1975. Today they are being shipped to telephone companies "by the thousands."
- Integrated optics, the analog of semiconductor integrated circuits in the optical frequency range, is promising devices that can perform many of the basic functions of a receiver in one compact, reproducible module.
- New time-domain multiple-access satellite techniques are nearing commercial use: spacecraft-switched TDMA will appear in Advanced Westar, and beam-switched TDMA will be on the next generation of Bell System communication birds. A short while ago these schemes were just design equations.

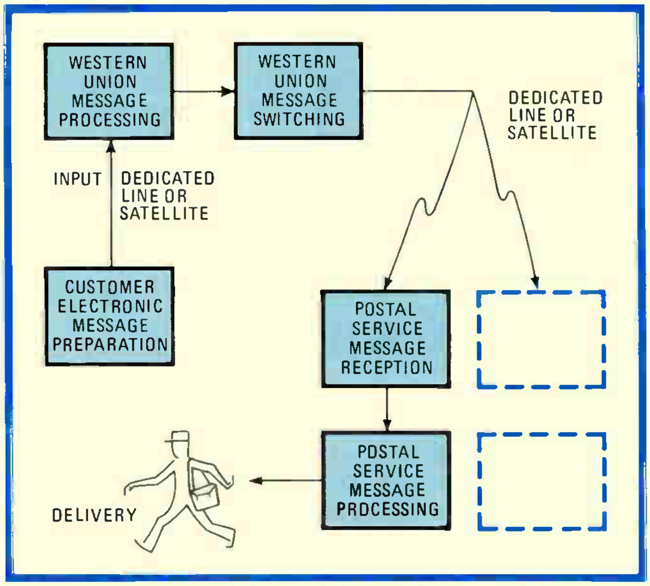
All these developments and more are coming about because of the number of messages people send one another, mainly over the telephone.

Call me some time

With telephone networks going digital, 1978 saw the emergence of another result of LSI techniques—the coder-decoder or codec. Basically an a-d or d-a converter, it is expected to be a multimillion part seller for the semiconductor companies in the 1980s and National claims to have shipped "thousands" already.

The first pieces, complying with either the North American μ law or European A law, have been made or designed by just about every Silicon Valley house and a host of others besides—both domestic and foreign. What the final form of the codec will be is not clear yet, since it will take a couple of years for the expected shakeout to occur. Before this, the preferred chip-process technology for fabrication and system functions must be fully defined. Meanwhile, the competition is fierce with efforts to reduce dissipated power and price and to skip

Multifunction integrated optic device developed by Bell Laboratories (above left) can act as an optical triode.



Electronic bills. Western Union's Electronic Computer Originated Mail, a mailgram-for-industry scheme, will transmit bills and other mass mailings electronically to central post offices where they will be reduced to a letter format and delivered within two days.

evolutionary generations by including either aliasing filters or the necessary duplexing hybrids on a single chip. The ultimate goal—a codec in every phone putting a pulse-code-modulated digital signal right on the line—is some years off; the first codecs are going into switchgear and loops of various kinds.

While the codec has been getting most of the play, the design of the telephone is being upgraded in other ways. Most notably, Bell Canada is testing its electronic E phone in a subscriber environment. Using LSI enables 12 parts to replace the 120 found in Bell Canada's standard push-button phone. Silicon chips allow push-button dialing compatible with any kind of North American switching equipment and enhance the voice quality over conventional phones to boot. Memory chips will allow automatic dialing of pre-stored numbers. Bell Canada claims that it will phase out electromechanical push-button phones if the trial is successful.

Advances are also coming in large digital switches—those clumsy but necessary devices that are the heart of a dial-up system. The cost-effectiveness of an all-digital network is only realized when the whole system is digital and American Telephone & Telegraph Co. is well on its way to realizing this goal. For example, 1978 saw the installation and turn-on of a version of the AT&T Electronic Switching System No. 4 that has standard international signaling capabilities. This digital system links the U. S. through New York with the rest of the world; two more such systems will be in service by 1979. Also that year, the Northern Telecom DMS-300 digital switch will go into operation, linking Canada with the worldwide network.

All this digital technology has affected military communications systems. Mitre Corp. of Boston is currently working on converting the North Atlantic Treaty Organization's communications system in Western Europe into an all-digital system. Security is the watchword here—the brass is more than happy that digital transmissions are readily coded. Mitre is also looking into digital transmissions on fiber-optic cable to replace the 26-pair cable used for military data links. Fiber-optic communication systems are almost impossible to tap—an added advantage for secure transmissions. Interference and crosstalk problems are also nonexistent.

Military communications

Other military efforts include expansion and upgrading of the NATO satellite communications ground stations to provide full digital communications capability with NATO satellites. Ford Aerospace and Communications Corp., Dearborn, Mich., will supervise a four-year, $80 million program for the changeover, with Marconi Space and Defense Systems Ltd. of the UK, Messerschmitt-Boelkow-Blohm GmbH of West Germany, and Page Europa of Italy also involved.

The impact of digital technology will also be felt on the satellite scene as the National Aeronautics and Space Administration pushes to reenter the communications arena. NASA expects the all-digital "smart" satellite—which does on-board switching and processing—to reduce the cost and complexity of ground stations. Up to now, these have been the most expensive element in satellite communication systems. The first study and feasibility contracts have been let already, and more are expected soon.

Application of digital technology is expected to blur the distinction between home, office, and recreation sites when home television sets carry both standard entertainment and special video transmissions. Stock reports, foreign-language lessons and broadcasts, and adult education are some of the potential programs. One such system, wherein the set is coupled to the information source through a phone, will be set up on a trial basis by Bell Canada later this year. Although it denies that a test is forthcoming, persistent reports have it that AT&T is studying a similar system.

How to get it faster

Electronic mail—up to now a much-talk, little-action voice-data-image communications concept—got a couple of boosts in 1978 that will impact the U. S. postal service and other interested parties heavily in the next few years. Chief among these was Western Union's ECOM, for Electronic Computer Originated Mail (see diagram, p. 179). Geared to the originators of high-volume computer-generated mail, the soon-to-start system will use WU facilities to transmit bills and other mass mailings electronically to central post offices for reduction to a letter and delivery within two days.

Further down the line is Rockwell International Corp.'s proposal for an electronic mail system using geosynchronous satellite antennas. Geared to 50-state distribution, the system would consist of 91 30-foot-diameter antennas in a flat array connected by a grid framework. An alternative approach with the same objective is under study by the engineers at the NASA Langley Research Center in Hampton, Va. It uses a 100-to-200-meter-diameter dish with multiple feeds.

In the meantime, some certified common carriers like packet-switching Tymnet Inc. are being used as an electronic mail system by some customers. Packet switching can combine data with electronic mail and reduce the cost of both. In this regard, the major development of 1978 for the data communications industry was Ma Bell's announcement of its Advanced Communications System—a development that puts AT&T squarely in competition with private message networks and with IBM, the major force in Satellite Business Systems Inc.

AT&T's bid for a switched digital service for voice, data, and image communications was long awaited. When it arrived, the industry was jarred by its extensive claims—just about all information-generating equipment in a typical office would be accommodated and the existing telephone network could be used, although the protocols are as yet unclear. This contrasts with the not-yet-built earth stations that would have to be installed on user premises to tie in to the SBS system. The Bell dial-up system will heavily impact both the data communications and computing industry in the next four years, as manufacturers struggle to insure their equipment's compatibility. It has also resurrected the old and probably unsettlable argument over the dividing line between intelligent communications and computing—an issue for the regulatory agencies, the courts, and perhaps even the Congress.

AT&T's proposals are before the Federal Communications Commission and, if that body acts quickly, a fully tariffed service could be available next year. Speedy process could be held up, however, by the proposed revision of the Communications Act of 1934. This almost all-inclusive proposal will undergo heavy negotiation and revision in the next year or two. The bill's particulars will affect the very existence of the FCC in its present form, perhaps change the vertical integration concept of the Bell System in so far as Western Electric is concerned, and may even cut down on the myriad of regulatory matters and lawsuits that constantly engage the energies of the burgeoning communications industry.

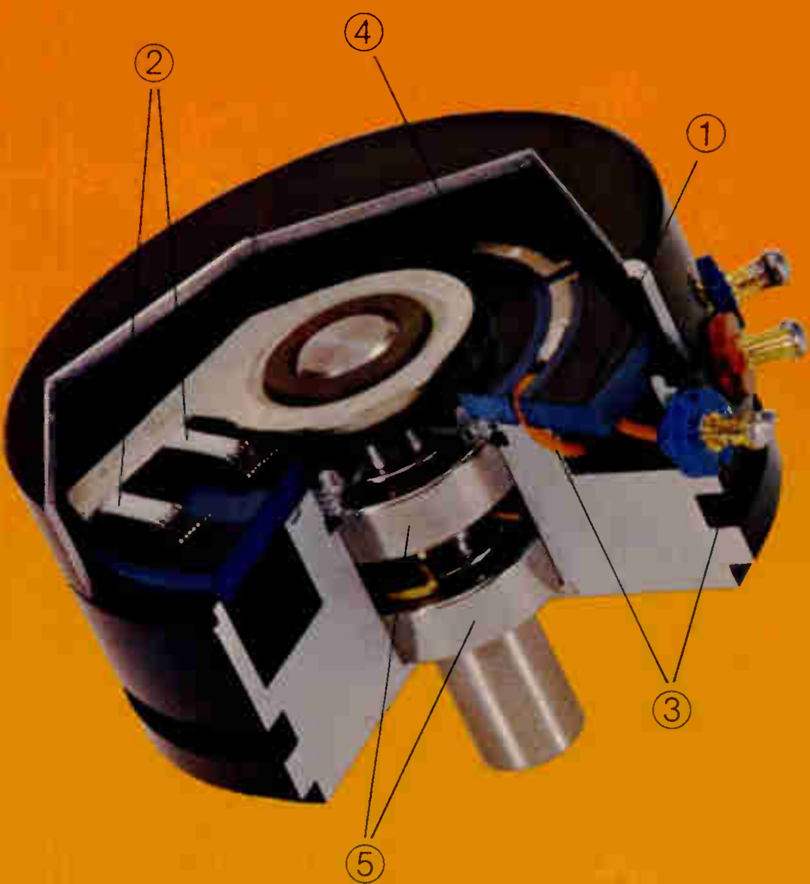
Of course, the most important regulatory action will be the 1978 World Administrative Radio Conference. This once-every-20-years meeting, to convene in Geneva sponsored by the International Telecommunications Union, will answer the basic questions: who gets what portion of the available spectrum and for what purposes for the next 20 years?

A flock of birds

The new satellite systems of the next few years (see table) will start to exploit the space shuttle's heavy-launch capability and will have more telecommunications capacity, higher-speed digital transmission, and longer life than were previously available. Typical of this

The new Quality Standard

With the Dinopot-HQ 5-System Novotechnik sets new standards for precision conductive-plastic potentiometers



5 High-Quality characteristics:

1. Linearization of the assembled unit using its own wiper
2. Elastomer-damped wiper
3. Stress-relieved connections to the resistance track
4. Conductive-plastic collector track
5. Exactly aligned precision bearings

In addition to high reliability this technology offers you some performance data unattained thus far: Operating life of better than 100 x 10^6 revolutions at up to 1500 rpm - Maximum operating speed of 10,000 rpm - Linearities of up to $\pm$ 0.025%. All this at a surprisingly low price.

The conductive-plastic potentiometers Dinopot-HQ5 come in three sizes with resistance ratings of 1 kΩ, 2 kΩ and 5 kΩ.

Servo size 11
1 1/16" (27 mm) dia.
Series P 2500

Servo size 13
1 7/16" (36,5 mm) dia.
Series P 4500

Servo size 20
2" (50,8 mm) dia.
Series P 6500

For more information please contact

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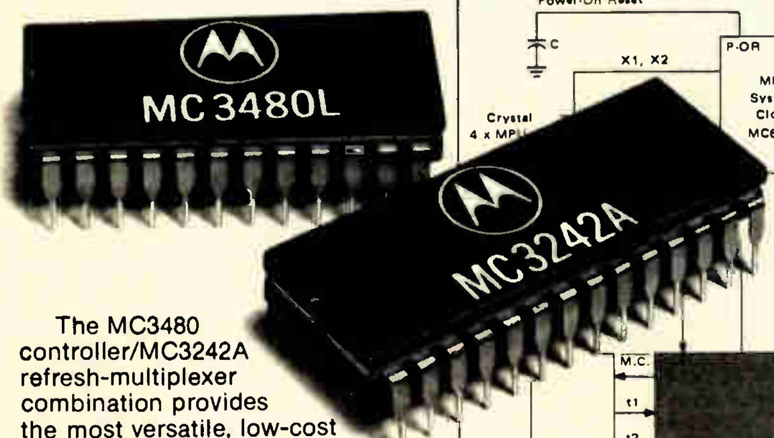
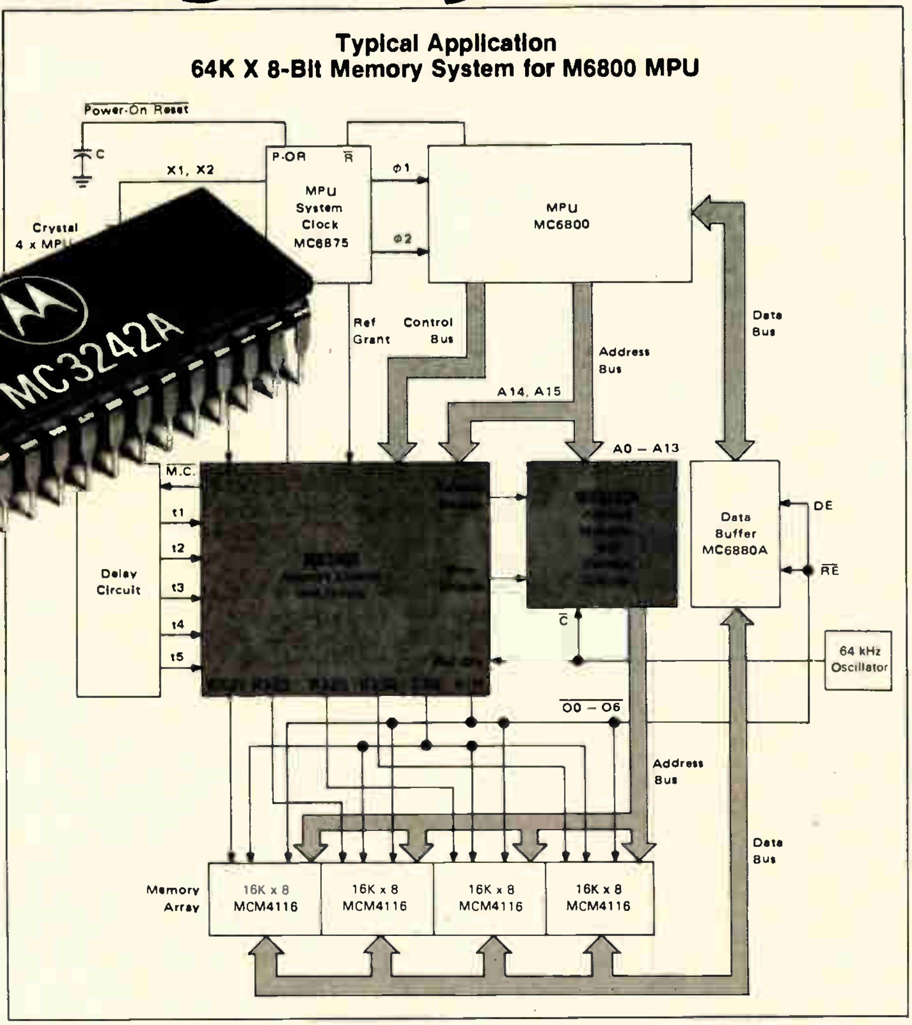
Now you can RAS, CAS, R/W, Mux & Refr all dynamic RAMs with 2 linear chips max, to make a long story short.





The MC3480 controller/MC3242A refresh-multiplexer combination provides the most versatile, low-cost answer to RAM control available.

It does everything scores of TTL parts do*—row-address-select, column-address-select, read/write, multiplex, refresh. You can use it with the M6800 or any MPU. Cut accesss and cycle times. Possibly save as much as 60% in controller system space.

The MC3480 is actually a five-output pulse generator whose edges are controlled by time inputs and whose RAS outputs are steerable by the decoded higher order address bits.

It uses the five general timing inputs in place of a master clock with on-chip timing generation. This gives you optimum flexibility in interfacing with the various MPU families and dynamic memories available. Ours or anybody else's.

In simpler, slow-speed systems, timing signals required can be directly obtained from those available from the MPU system. In systems requiring high-speed memory/MPU cycle times, timing inputs t1-t5 can be obtained using delay lines or a wide range of techniques spelled out on the data sheet.

The MC3242A (3232A) address multiplexer and refresh counter and MC3480 can be used with either cycle steal or transparent refresh methods.

This state-of-the-linear-art, two-part system provides chip enable for expansion to larger word capacity, has high-input impedance for minimum MPU bus loading, employs Schottky TTL technology for high performance and is useful with 4K and 16K and future expanded dynamic RAM systems.

It's the best thing to come along since the 10-second political speech.

100-Up for the MC3480 in ceramic is $6.85; in plastic, $6. The MC3242A is $5.40, ceramic; $4.70, plastic.

For information on these linear interface parts contact Motorola Semiconductor Products Inc., P.O. Box 20912, Phoenix, AZ 85036. Or see your authorized distributor or factory representative.

*The minimum number of digital parts eliminated in all memory systems with the MC3480/MC3242A is: one address decoder, two clock drivers, four D-type latches, three 2-input NANDs and two hex 3-state buffer inverters. Additional parts will be eliminated with an increase in memory system complexity.

MOTOROLA

Semiconductor Group

group, Advanced Westar, scheduled to weigh in at 4,200 pounds, will be shuttle-launched in 1980. The communications payload, powered by a 1,800-watt solar power pack, includes transponders in three frequency bands: 2 gigahertz for up and down link, 4 and 6 GHz for up and down link, and 12 and 14 GHz to provide both NASA and Western Union with service. In one mode, the bird will provide 12 36-megahertz channels at 4 and 6 GHz, and four 250-megabit-per-second time-division multiple-access channels in the 12- and 14-GHz band. Plans call for the deployment of a large number of relatively small earth terminals, so that an individual private-line subscriber can have his own dedicated link for both high-speed voice and data traffic.

Also in 1980, SBS is planning to launch its new series of domestic private-line satellites in the 12- and 14-GHz band. SBS is aiming for the "Fortune 500" U. S. companies and foresees a market equivalent to 200,000 two-way voice circuits by 1985.

Still further away, AT&T Long Lines is planning its 1983 Comstar replacement. Besides the standard 4- and 6-GHz and 12- and 14-GHz capacities, it may opt for 20- and 30-GHz transponders for high-capacity trunks.

All that bandwidth plus . . .

At about a 1-micrometer operating wavelength, integrated optic circuits can be laid down in thin films much as integrated electronic circuits are. Miniature lasers, switches, lenses, prisms, and modulators, and almost complete receivers and transmitters can be formed in this manner. Since the frequency of light is some 10,000 times higher than the highest frequency that can be achieved by an electronic device, the amount of information that can be carried on a light signal is correspondingly greater.

. . . very high speed

Moreover, in principle, optical circuits are considerably faster than electronic circuits. This is especially true when they are combined with the advantages of broadband single-mode fiber-optic transmission lines.

The key question is whether or not it will be possible to design all the necessary elements in the integrated form with adequate performance. Then, too, they must be produced in large quantities at low cost. In 1978, work went on at several labs to show that these things can be done. Japan's Nippon Electric Co., for example, has designed a new generation of optical couplers, filters, and similar devices that use glass rods rather than conventional lenses as the basic component. Incident light is focused and sent in various directions depending on the rod's index of refraction, which varies along its radius.

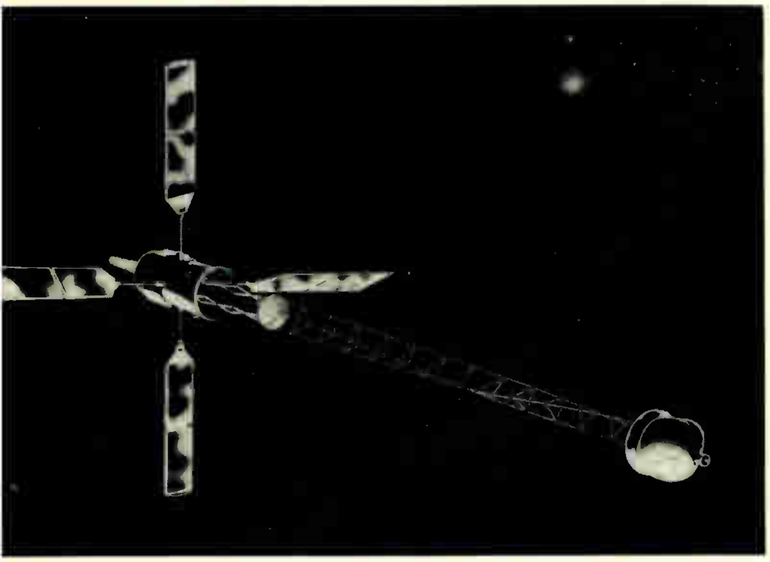
The compact structures Nippon Electric Co. designed are all based on inexpensive 2-to-3-millimeter-diameter rods that are combined with reflection or interference

REPRESENTATIVE FUTURE WORLD COMMUNICATIONS SATELLITES

Satellite system	Type								Status			Start date
	Regional	Domestic	Fixed	Mobile	Broadcast	Experimental	Military	Proposed	Under construction	In planning	R & D underway	
Arab System	●		●								●	1980
Australia		●	●					●			●	1980s
Brazil		●	●		●		●	●		●		1978
ESA/Comsat General (Aerosat)	●			●					●			1979
European Broadcasting Union	●				●						●	1980+
Federal Republic of Germany		●			●						●	1985
IMCO (Inmarsat)	●			●							●	1980+
India		●	●		●						●	1980+
Iran		●	●		●		●	●			●	1983
Satellite Business Systems		●	●							●		1980
United Kingdom	●		●							●		1980s
Andean Nations*	●		●					●			●	1980s
Argentina*		●	●					●			●	1980s
Denmark*		●	●					●			●	1980s

*Proposed regional satellite systems using private transponders

SOURCE: SATELLITE COMMUNICATIONS



The latest Navsat. Successor to the proven Transit communications satellite, Nova will require fewer position-updating transmissions from ground control stations. The plan is for it to orbit the earth's poles in the company of two brother satellites.

layers so as to configure various specific components.

Researchers at Bell Telephone Laboratories have also been busy in 1978, turning out an array of optical receiver components that will be further developed in the next couple of years. A heterojunction electroabsorption modulator suited for neodymium–yttrium-aluminum-garnet–fiber lasers at 1.06 μm is one example. Another is an integrated device that simultaneously filters, couples, and modulates. As a bonus, this last device can also function as a multiplexer and demultiplexer. It is fabricated with coupled titanium-diffused strip waveguides on a lithium-niobate substrate and both the center operating wavelength and the crossover efficiency can be electrically adjusted by dc voltage.

But most exciting is an optical device that performs so many tasks that it is almost a universal optical element. It can be used as a logic element in optical memories, as a pulse shaper or limiter, as an optical switch, a differential amplifier and, perhaps most significant of all, as an "optical triode." What's more, all the switching functions only require about 1 picojoule of light energy.

Bell's new device is designed as an integrated optic version of a bulk-optic nonlinear Fabry-Perot resonator. The nonlinearity is produced by driving an electro-optic element in the resonator with the output of a photodetector that has sampled the transmitted light. As the incoming light is reflected back and forth between the mirrors that form the Fabry-Perot resonator, the beam splitter sends part of the transmitted light back to the detector. The detector output creates an electric field between the electrodes on the electro-optic crystal. This field modulates the crystal refractive index and produces the desired nonlinearity.

The transfer function of the device that determines the operating mode is established by the kind of input signal, shape of the nonlinearity, number of inputs, resonator tuning, amount of feedback and gain. In the optical triode mode, a small additional light signal at the detector produces a large change in transmitted light power. Thus a weak light signal falling on the detector can control the transmission of a powerful light beam incident on the device—triode action. In one experiment, a gain of 7 was measured. Practical application is not around the corner, though, since further experimentation is necessary and other elements necessary for an integrated optic system are not yet fully developed.

Fiber's time has come.

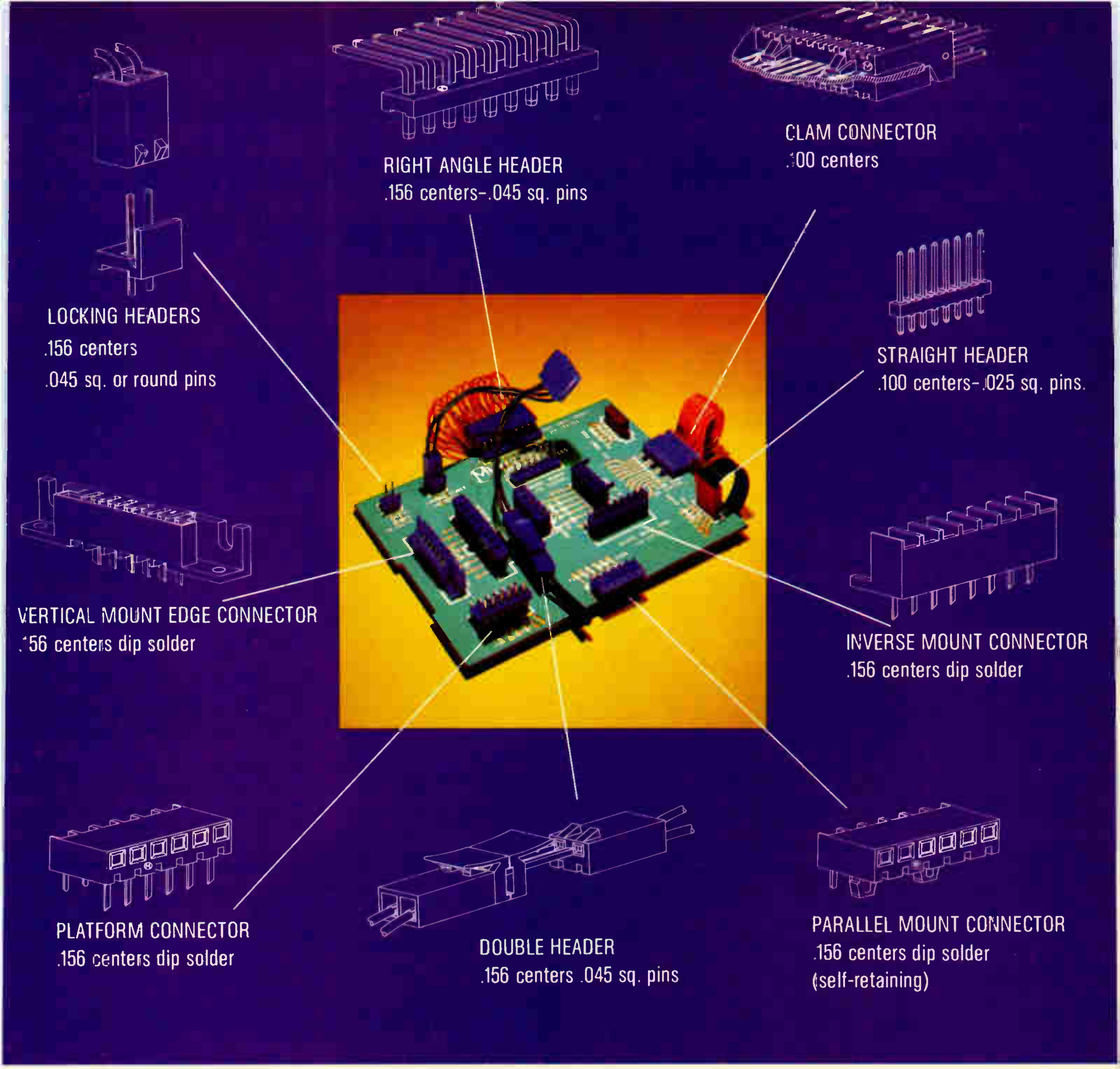
Fiber-optic technology was adapted to many practical applications in 1978 and no area of electronics technology will escape the impact of this data transmission method in the near future. Not since the solid-state revolution has so much technology innovation been applied to communications. Moreover, since the flow of data in today's information-hungry society can be increased without a substantial increase in costs by adapting the new procedures, it appears that those systems that could take advantage of the new technology and fail to do so will become obsolete.

From a production base close to zero in 1970, fiber optics is now seen in or proposed for industrial control devices, avionics, computers, cable television, ships, process control, data transmission, secure communications systems, undersea cables, and telephone conduits in large cities or cable strung out on telephone poles.

In the military realm, a fiber-optic laser gyro is being developed by the Army's Ballistic Missile Defense Advanced Research Center in Huntsville, Ala., for flight control on an advanced interceptor missile. The device will use human-hair-size fiber for data transmission, weigh only ounces, and be the size of a spool of thread. It should replace a softball-size, 15-pound laser gyro. Other military activities include practical system implementation work at the Naval Ocean Systems Center in San Diego, Calif., and the Air Force allocation of funds for a center for aerospace applications at the Wright-Patterson Air Force Base in Dayton, Ohio.

Probably the most extensive use of fiber optics in day-to-day systems has been in data links. More than a dozen companies are in the business in 1978 with more expected to enter it next year. Both digital and analog links for processor-computer interconnections are available in a ready-to-connect format. These units offer the classic advantages of fiber over wire and have met wide acceptance because of their cost-effectiveness.

Work is moving right along also in reducing that most fundamental of fiber-optic cable specifications—the transmission loss. For example, successful transmission of a pulse-code-modulation system signal down an optical fiber for a distance of 53.3 km without repeaters in the line has been announced by the Nippon Telegraph and Telephone Co. It goes so far as to forecast repeater spacings of 70 km at wavelengths between 1.4 to 1.7 micrometers soon. The graded-index optical fiber that



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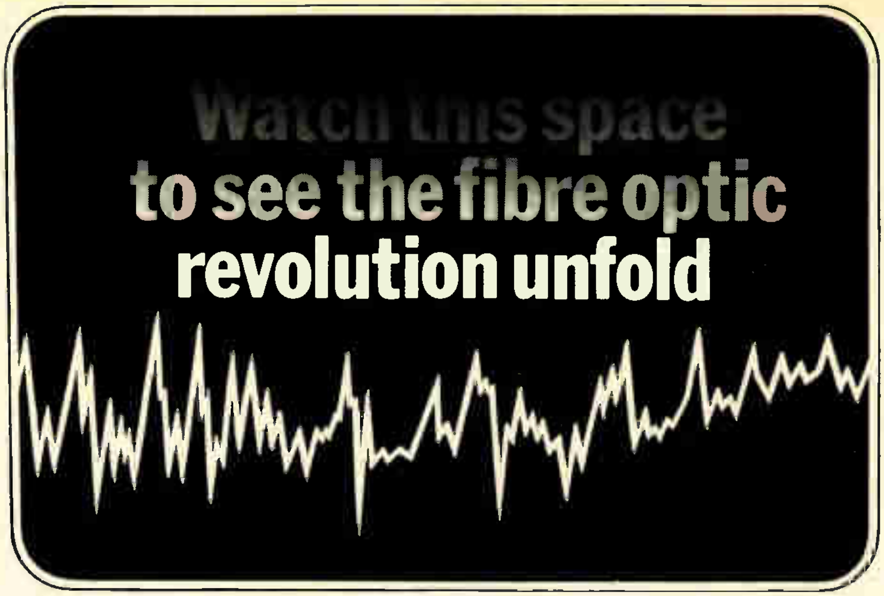

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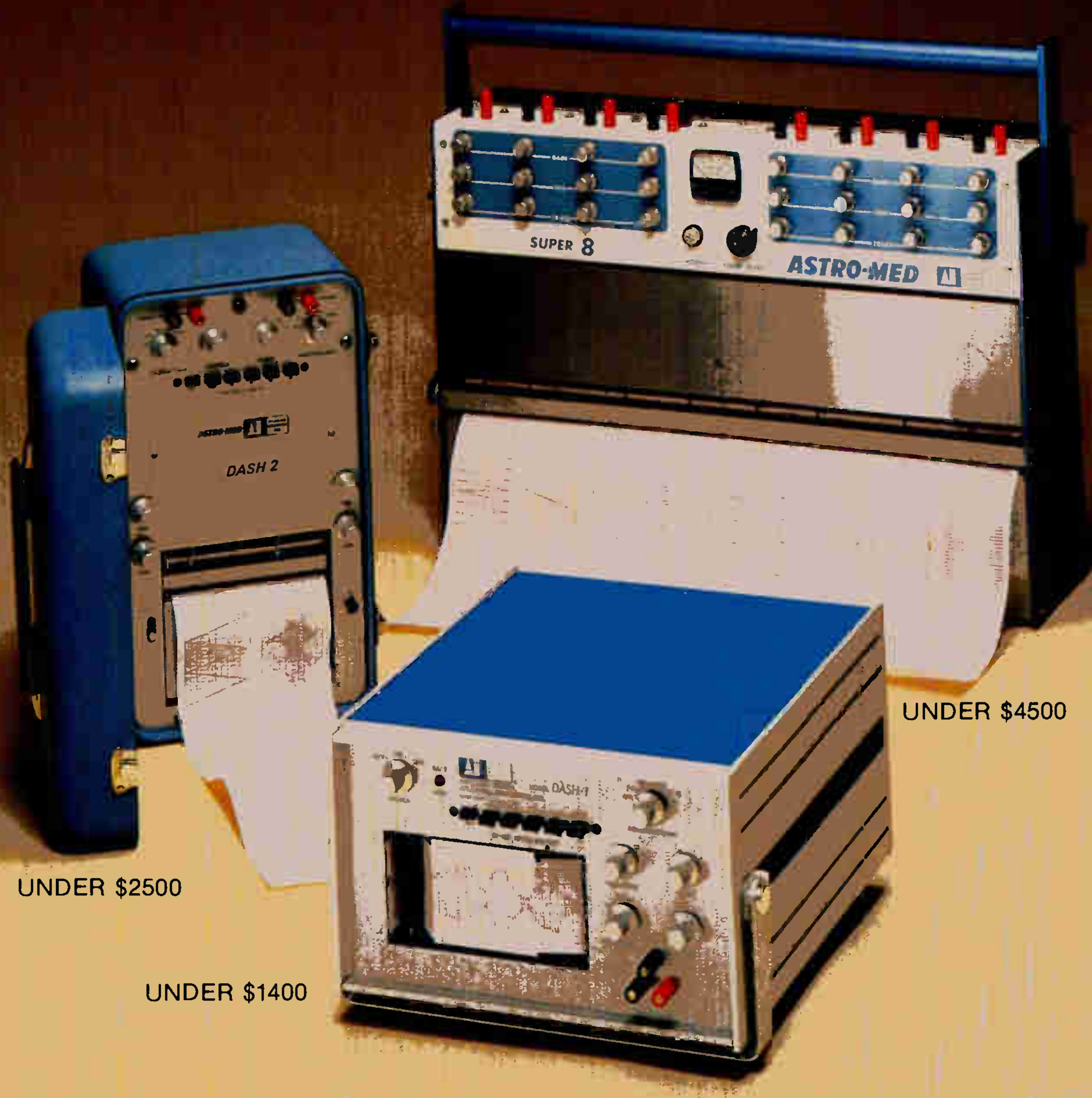

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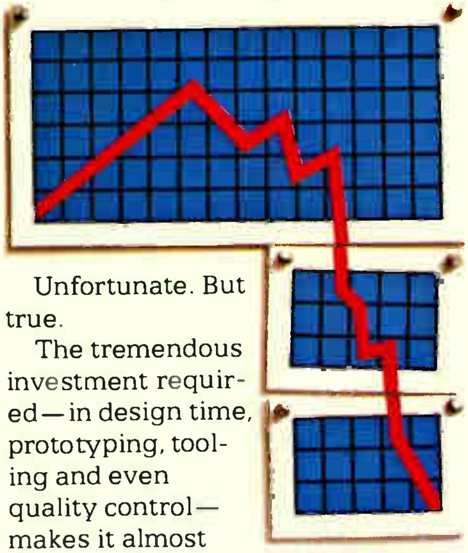
A lot of OEMs who try to make it all themselves don't make it.



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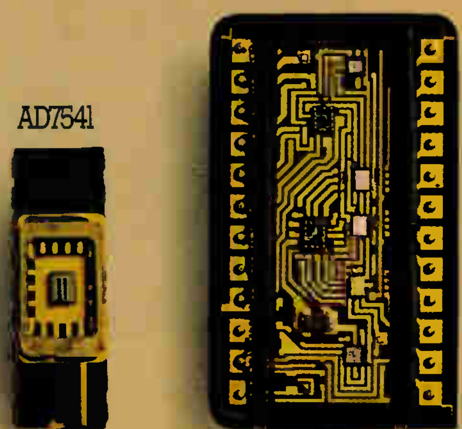
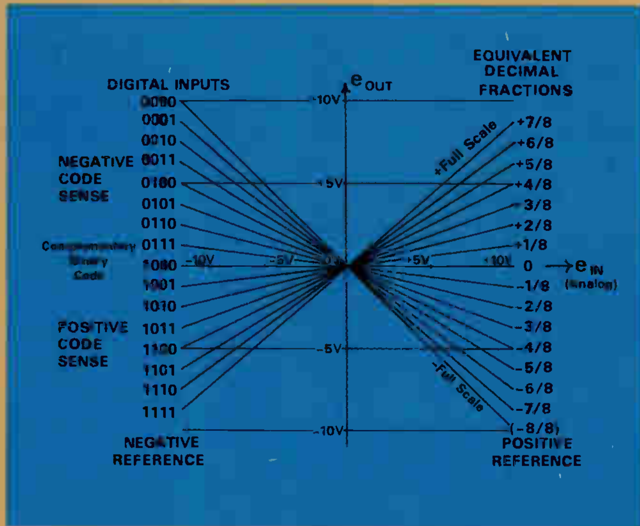
Below: unretouched photo of AD7541 and typical DAC80 with lids removed.

DAC80

AD7541



THIS. NOT THIS.



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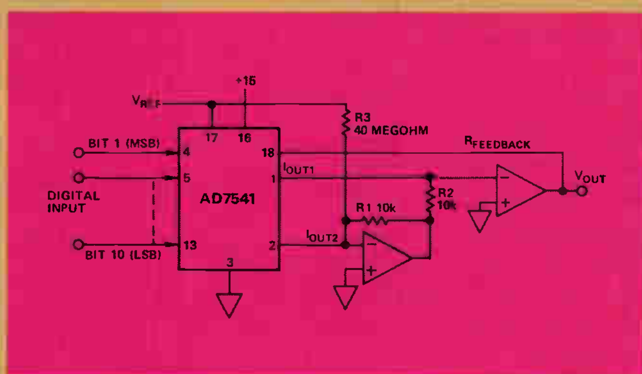
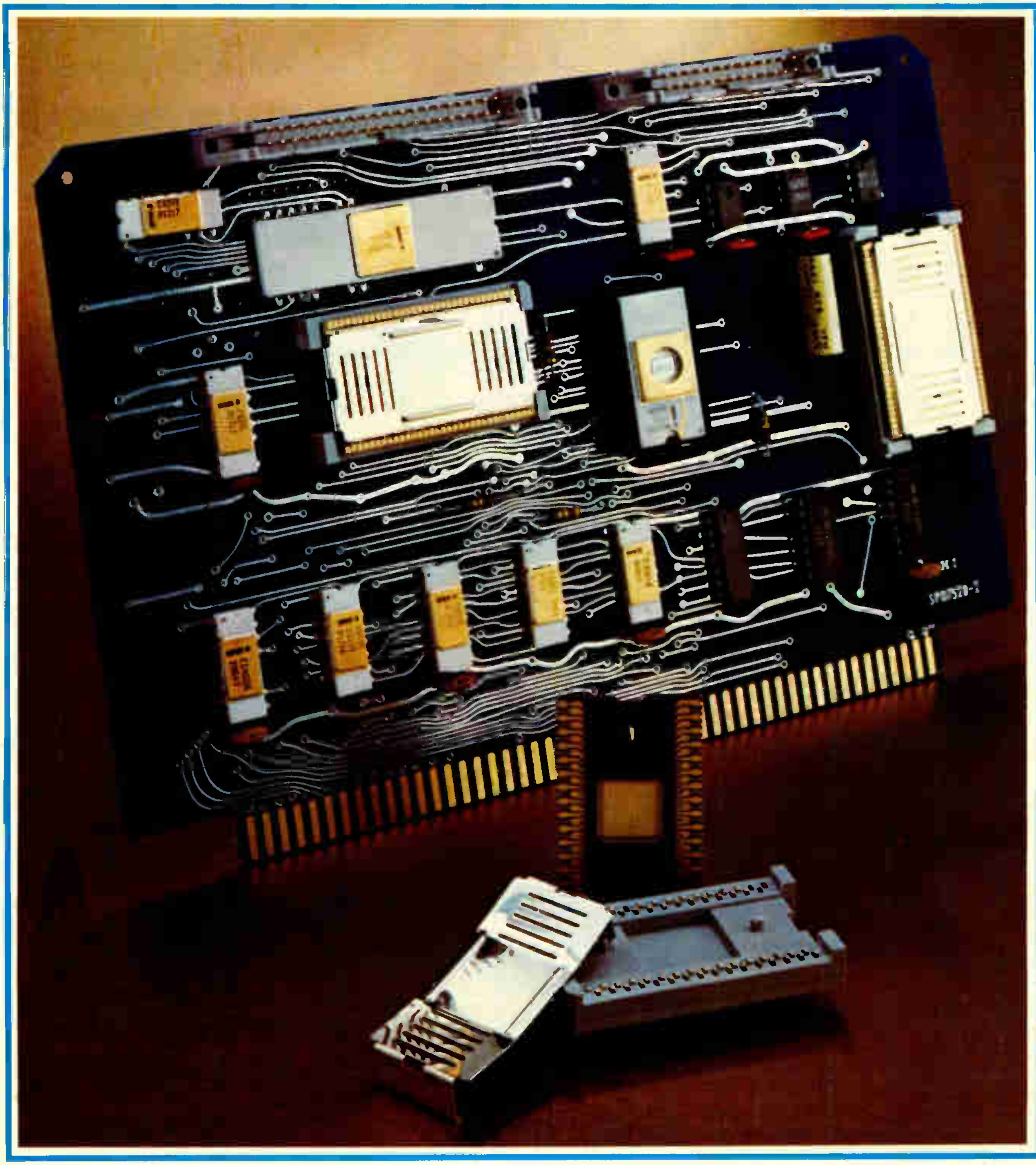


World Radio History



PACKAGING AND PRODUCTION

by Jerry Lyman, *Packaging and Production Editor*

☐ *The many interconnections required by today's large-scale and very large-scale integrated circuits are radically changing the packaging in large and medium-sized digital systems: the cumbersome dual in-line package is gradually being squeezed off new board designs by the square-ceramic or plastic chip-carrier. About a third the area of a DIP, this package also allows LSI chips to attain their rated speed. For mounting this and other devices, a comparatively new substrate material is emerging—porcelainized steel, also known as ceramic on steel—which may be the key to large, low-cost substrates with excellent power-handling capability. Finally, there is the problem of testing the devices on these densely packed boards, and a solution that is beginning to spread is digital in-circuit testing.*

So much happened in chip-carriers in 1978 that it could easily be called the year of the chip-carrier. Control Data Corp. and Intel-3M came out with two new and potentially important ceramic versions. AMP Inc. began delivering plastic sockets for mounting ceramic leadless types, and DuPont's Berg Electronics division started supplying samples of edge clips for the same purpose. Several chip makers are by now packaging standard products in the small carriers, while chip users in the military and in computer firms are becoming increasingly interested in them.

Carriers on the move

The two new ceramic chip-carriers are a 52-pin leadless package from CDC and a 64-pin quad in-line socketed version from Intel-3M. The CDC package, manufactured for the Minneapolis firm by Ceramic Systems Inc. of San Diego, Calif., is intended for high-density, liquid-cooled systems. Its 52 pads include 48 for input/output and 4 for power, and its thermal resistance in a liquid-cooled system is typically 5°C per watt. The 480-by-680-mil package is multilayered with built-in emitter and collector power planes.

The CDC carrier is mounted in a special socket from AMP Inc. of Harrisburg, Pa., which in turn is soldered to a pc board. As the photograph on the right shows, all I/O and power terminals may be probed from the top. This carrier and a scaled-down 24-pin version are slated to be used in an upcoming CDC computer.

The quad in-line package from Intel Corp. of Santa Clara, Calif., and 3M Co. of St. Paul, Minn., is a three-part system (see photo at left) designed specifically for microprocessor devices. The QUIP's parts are a cover or retainer, a 64-pad leadless ceramic carrier, and a plastic socket. The carrier is mounted chip down into the socket, and the retainer holds all parts together. The whole occupies less board area than a comparable DIP but more than a comparable leadless chip-carrier.

The most significant advantages of the QUIP are that it has an integral socket, can be probed even with its cover on, and can easily have the ceramic substrate changed. Most important in microprocessor applications, the substrate may be removed and a special emulator harness plugged into the socket.

Both the new chip-carriers have features likely to be important in VLSI carriers of the future. One is the capacity to be probed, which is vital for expensive and complex chips. Another is the ability to change chip-bearing substrates. A third is power dissipation of at least 2 watts.

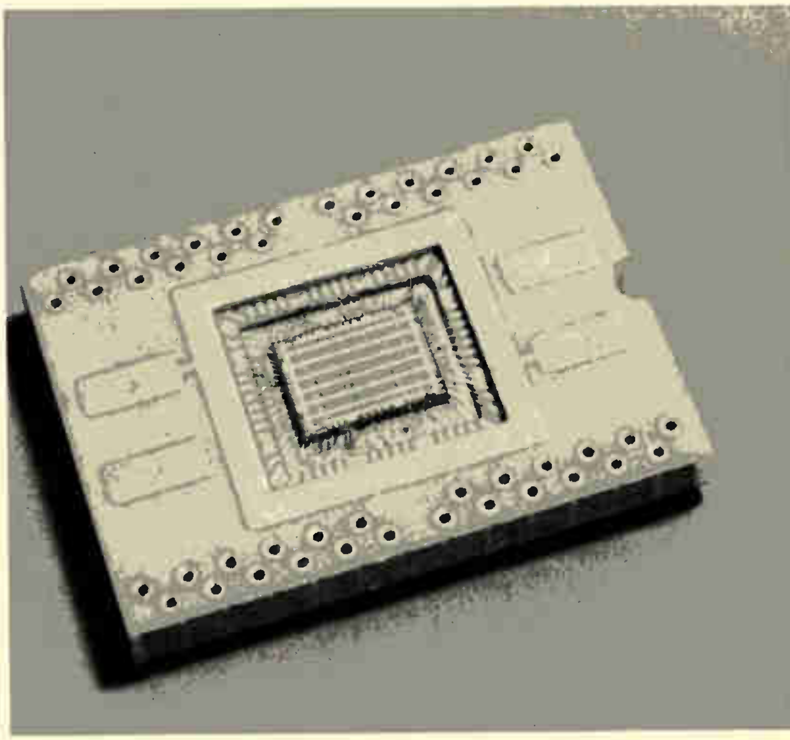
A standard

Perhaps even more significant for the acceptance of the new packages is the fact that a standard for them will be ready by late this year. The Joint Electron Device Engineering Council's JC-11.3.1 task group on LSI packaging has written a specification for a family of five ceramic and plastic chip-carriers, four of which are already starting to become available. The fifth, General Instrument Corp.'s Minipak, is not being marketed.

Jedec's leadless type A and B ceramic carriers require a socket for mounting on pc boards. AMP Inc. has already designed and is now supplying a plastic one that can be probed and has an integral heat sink; it mates by either pressure-point contacts or reflow soldering to the standard Jedec pattern of interconnections on 50-mil centers. Other companies are at present working on their versions of a socket for the leadless carrier, and these units should be ready in 1979.

The Jedec leaded type B is specified as a ceramic substrate with edge clips on 50-mil centers on all four

Intel-3M's 64-pin quad in-line package (left) consists of a leadless substrate, socket, and heat-dissipating cover.



Liquid-cooled. Control Data Corp.'s engineers have designed this custom ceramic chip-carrier for large ECL arrays. The carrier has 48 I/O and 4 power pads and is multilayered with built-in emitter and collector planes. Liquid cooling holds thermal resistance to 5°C/W.

IN-CIRCUIT CARD TESTING COMPARED TO FUNCTIONAL TESTING		
	In-circuit	Functional
Initial cost	moderate	high
Programming effort	low to moderate	moderate to high
Fixturing	mechanically complex, electrically simple	mechanically simple, electrically moderate
Fault isolation	inherent	optional at extra cost
Effectiveness per program dollar:		
for analog discrete devices	excellent	very poor
for hybrid devices	poor to fair	fair
for digital devices	fair	excellent
Applicability	planar boards only	cards and modules

SOURCE: COLLINS AVIONICS DIVISION, ROCKWELL INTERNATIONAL CORP.

sides. These clips, which are forced onto the sides of the substrate and then soldered in place, should be available in early 1979 from Berg. This Cumberland, Pa., division of DuPont has been producing similar edge clips with 100-mil centers since 1970.

Lastly, the premolded plastic leaded type A, made only by AMP, has been out in sample quantities for some time. During the first half of 1979, AMP and Jade Corp. of Huntingdon Valley, Pa., should demonstrate a completely automated equipment line for bonding chips on film carriers to premolded packages attached to reels of lead frames.

One of the objections to chip-carriers has been that a user had to wire-bond his chips to the cavities on these units, rather than buying them already packaged thus from the IC manufacturer. This is now changing, and Mostek, Fairchild, Texas Instruments, and Motorola will supply ICs housed in leadless ceramic carriers. For instance, Mostek Corp. of Carrollton, Texas, now offers three of its metal-oxide-semiconductor random-access memories (4116, 4027, 4104) in leadless ceramic chip-carriers of its own design. In fact, it combines two MK 4116 16-K RAMs packaged in chip-carriers on an 18-pin ceramic motherboard. This fits a 32-K RAM into the same board space as a standard 4116 in a DIP.

The military services and computer mainframe manufacturers are already using chip-carriers. Military use is mainly of ceramic chip-carriers reflow-soldered to larger ceramic substrates or motherboards. In addition, the Air Force has given TI a contract to develop a low-cost chip carrier. Meanwhile, the Dallas firm, RCA Corp.'s Government and Commercial Systems unit of Moorestown, N. J., General Electric Co. of Utica, N. Y., and Martin Marietta of Orlando, Fla., as well as many independent hybrid firms, are among those currently using this technique.

If chip-carriers prove solderable directly to printed-circuit boards, that could well turn out to be their largest potential use. At present, Sperry Univac, Western Electric, and other large commercial electronic firms are evaluating this possibility. In fact, should the AMP leaded carrier prove out environmentally, despite not being sealed, it could snare the commercial market. For the present, the use of leadless carriers either in sockets or with edge clips looks the most promising for pc-board work. Eventually, it appears that there could be room for all four types plus newer variations, depending on the specific application and environment.

Porcelainized steel

No matter what packages are used, a substrate or board is necessary for mounting them. But neither the alumina substrates of thick-film hybrids nor the epoxy glass (G-10 or FR-4) of pc boards is totally satisfactory. The first are expensive, brittle, and limited to sizes no more than about 2 inches square, while the second, though low-cost, has poor thermal properties and is not easy to multilayer and plate.

The relatively new material of ceramic-coated steel combines many of the advantages of pc-board and thick-film circuitry and throws in a couple more of its own—excellent power handling and a built-in power plane. Like pc technology, it offers large areas, plated-through holes, and wave-soldering of larger components. Yet the same techniques used to multilayer a thick-film hybrid can be applied to a ceramic-on-steel board on both sides. Moreover, thick-film conductor, resistor, and insulating materials can be screened and fired onto substrates as

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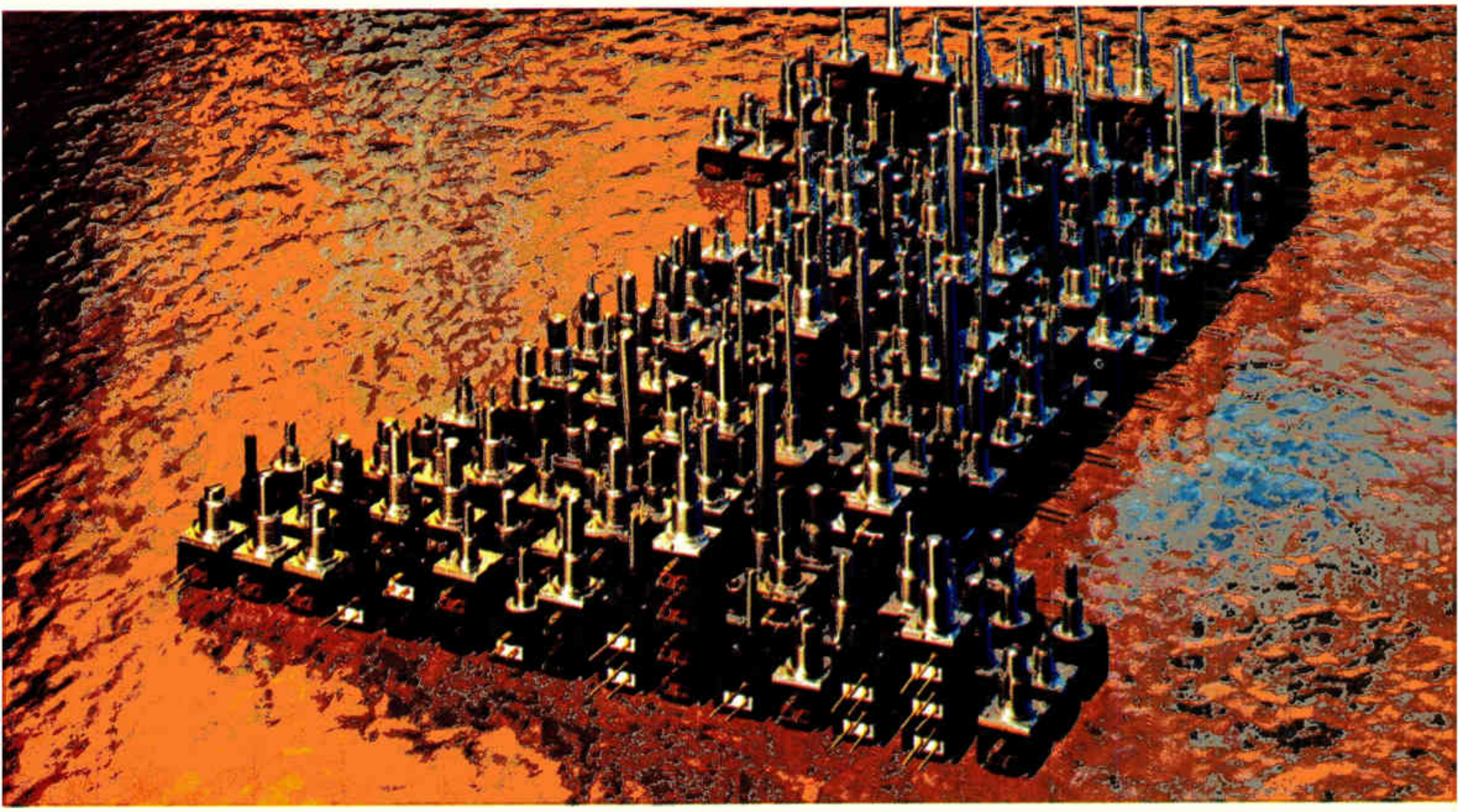
	250 ohms to 10 megs		Modified Log CW (A) or CCW (B)			
Cermet	100 ohms to 5 megs	±10%	Linear (U)	2.0 Watts at 70°C	1.0 Watt at 70°C	2.0 Watts at 70°C
	250 ohms to 1 meg		Modified Log CW (A) or CCW (B)			
Conductive Plastic	100 ohms to 1 meg	±10% or ±20%	Linear (U)	0.5 Watt at 70°C	0.25 Watt at 70°C	0.5 Watt at 70°C
	500 ohms to 1 meg		Modified Log CW (A) or CCW (B)			



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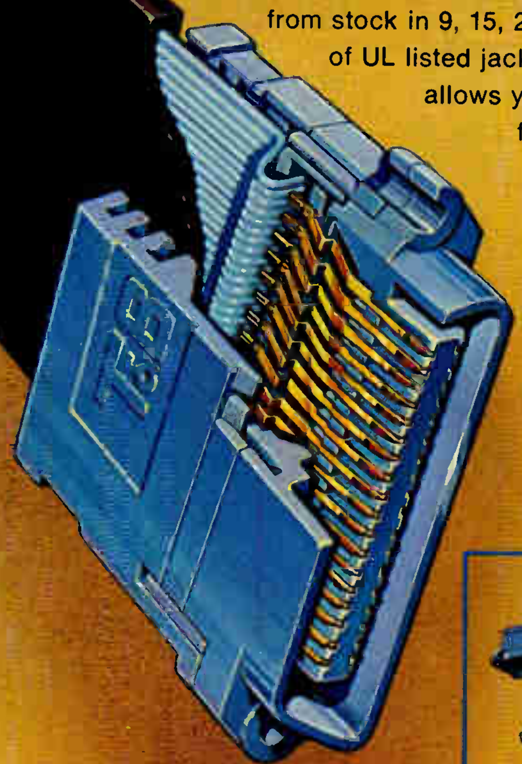

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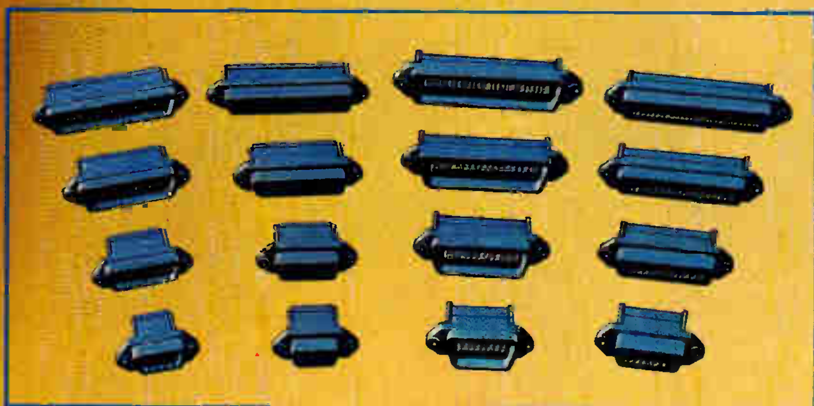

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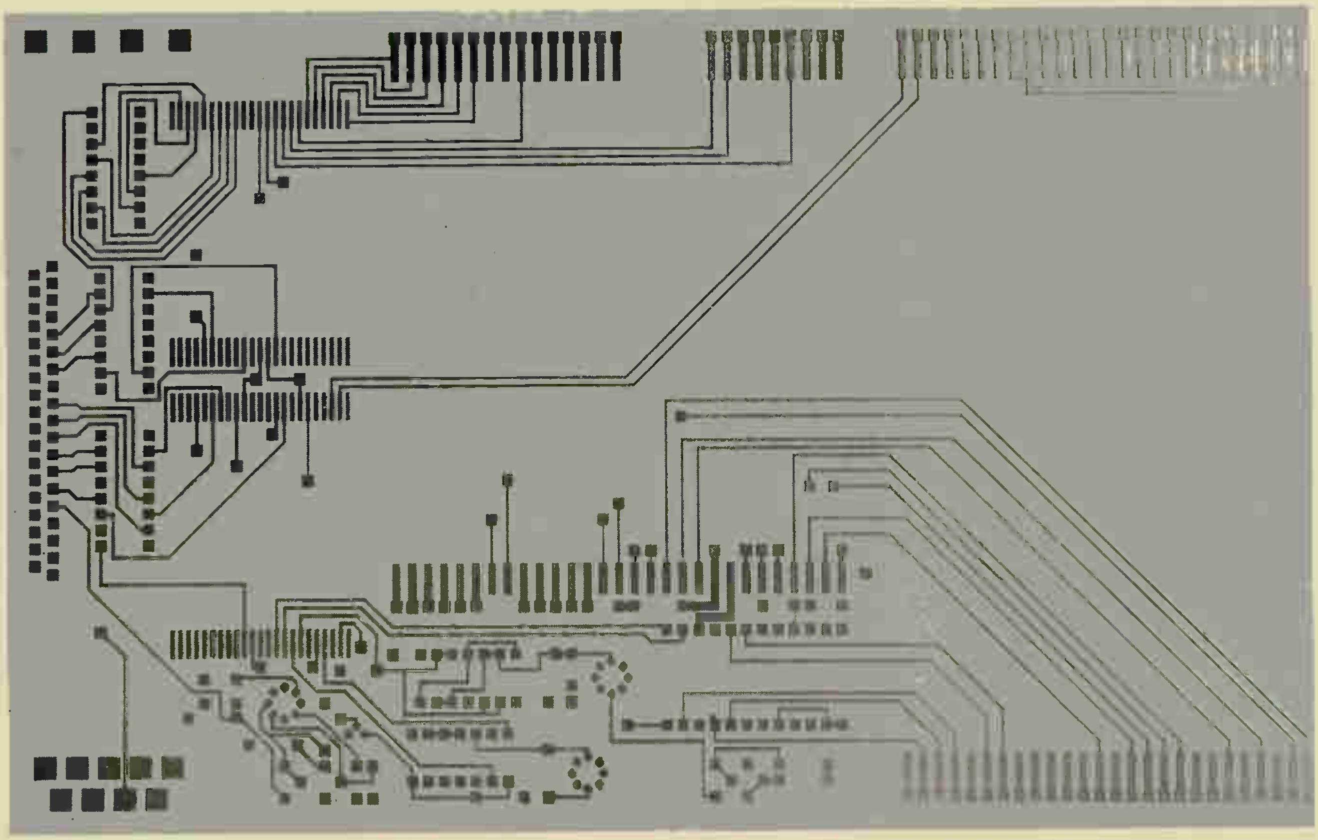


Ceramic on steel. Porcelainized steel substrates may allow low-cost pc boards with both screened-on conductors and passive components plus a built-in ground plane. The copper conductors on this military pc board have been screened onto such a substrate.

large as 12 by 18 inches, and bare chips can be wire-bonded to the conductor material. Thus the new technology could be used to produce not just a standard two-sided wave-soldered board with discrete leaded components or a large multilayer thick-film hybrid but actually a mix of both.

Over the last two years, the effort to provide a ceramic-on-steel substrate with compatible thick-film inks has accelerated. There are now two suppliers of these metal substrates, Erie Ceramic Arts Co. of Erie, Pa., and Alpha Advanced Technology of Newark, N. J. In the thick-film-material field, Cermalloy, Cermet Division of Bala Electronics, West Conshohocken, Pa., Electro-Science Laboratories Inc., Pennsauken, N. J., and Thick Film Systems of Santa Barbara, Calif., have joined Electro Materials Corp., Mamaroneck, N. Y., and DuPont as suppliers of inorganic thick films for resistors, conductors, and dielectrics on ceramic-coated steel.

The materials, which resemble standard thick-film inks, fire at 600°C, or lower than for standard thick film. Conductors available include silver, palladium silver, gold, and nitrogen-fired copper. The resistive paste is ruthenium oxide, which has a resistive temperature coefficient of about 250 ppm/°C.

Because of its low cost, high density, and ease of assembly, this new substrate is a likely replacement for pc poards in all sorts of consumer applications. Already the technique is being evaluated by manufacturers in the television, automotive, toy, and white-goods industries. (Just imagine a dish washer or refrigerator with its controlling electronics screened and fired onto its porcelainized steel housing.)

Even military suppliers like RCA Government and Commercial Systems are interested. A military pc board's copper conductors screened onto a ceramic-on-steel substrate is shown above. The RCA unit has also duplicated large multilayer hybrids by reflow-soldering leadless ceramic chip-carriers to a ceramic-on-steel motherboard. All of these approaches are being checked against long-term environmental factors, since little is yet known about their effect on the material.

Possibly the technique can also be applied as a large high-density hybrid for more sophisticated industrial or computer applications. But this is not likely to happen in the immediate future.

Enter digital in-circuit testing

As the combination of LSI and advanced packaging techniques boosts circuit density and complexity to still higher levels, it is also aggravating the test engineer's main problem: how to get an acceptable board yield at a minimum cost. So in-circuit testing is spreading as a means of isolating and prescreening the passive and active components and connections on a board before going to the more expensive functional test (see the table on p. 196 for a comparison of in-circuit and functional testing). The growing importance of in-circuit testing is showing up in two ways—entry of more firms into the field, and development of digital testing for on-board LSI devices. Originally only FaultFinders Inc. of Latham, N. Y. (recently acquired by Fairchild), and Zehntel Inc. of Concord, Calif., designed and produced machines for in-circuit inspection of analog components and circuitry. These testers use a special bed-of-nails fixture for accessing circuit nodes with spring probes on pogo pins.

Within the last two years, four more large companies have entered this market—Computer Automation Inc., Irvine, Calif., Teradyne Inc., Boston, Mass., GenRad Inc., Concord, Mass., and Hewlett-Packard Co., Palo Alto, Calif. Most of their machines supplement full analog in-circuit capability with a limited digital in-circuit capability that allows a user to isolate a small- or medium-scale IC and statically test its truth table. But with a complex LSI device like a microprocessor, this method is no longer adequate and breaks down.

The new in-circuit testers, the Zehntel TS-800 and the Hewlett-Packard 3060A, can test boards with complex digital LSI. Both use a technique called signature analysis, in which a low-impedance drive isolates a device from its neighbors and time-dependent frequency stimuli create a comprehensive input test pattern. The resultant bit stream at the device output is analyzed for a consistant signature; a faulty device yields a different signature than expected.

Both the new machines can also do straight functional analog or digital testing. More machines with this dual capability are bound to appear soon.

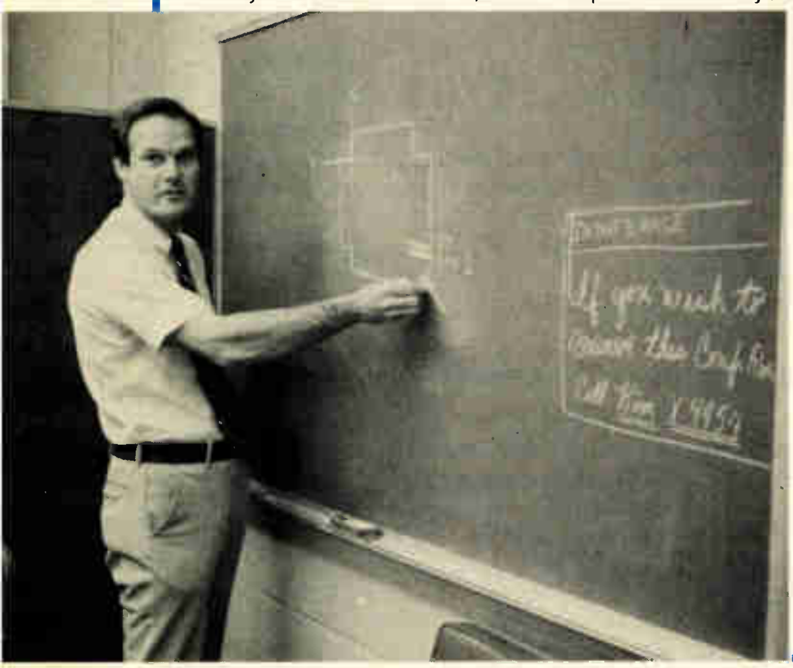
It is interesting to note that the HP machine functionally tests through its bed of nails, which can access many more points than the normal edge connector input. This approach, too, could become more prevalent in future test systems.

PROFILE

He pushed chip-carriers

If chip-carriers now seem assured of being the package on the circuit boards of the next generation of sophisticated computers, credit for their acceptance must go in part to Dan Amey. As chairman of the Joint Electron Device Engineering Council's JC-11.3.1 task group on packaging for large-scale integrated circuits, he has spread the chip-carrier gospel in papers and talks at technical conferences. And as engineering manager of packaging techniques at Sperry Univac's facility in Bluebell, Pa., he and his group are evaluating three chip-carrier types.

Amey has been at Sperry Univac for 11 years. For the last six, he has been responsible for packaging in small and medium-sized computer systems. In these years, he has seen his company move from wire-wrapped double-sided pc boards crammed with dual in-line packages, to multilayer boards with DIPs, to developmental multilayer boards bearing ceramic carriers and thick-film hybrids.



He took his first serious look at the chip-carrier only in January 1976, in the course of a major study by Sperry Univac to establish what hardware made the most economic sense for LSI packaging. The presentation of its ideas plus a recommended design to the Computer Packaging Society of the Institute of Electrical and Electronic Engineers led to an *ad hoc* committee of users and manufacturers of LSI circuitry and packages. This group, of which he was a member, asked Jedec to bring a standardization proposal to the attention of industry.

Jedec accepted the idea, and in August 1976 a task group on LSI packaging began work under Amey's chairmanship. The result is the well-known standard proposing: a five-member family of 50-mil-center chip-carriers that all fit on a standard pc pattern; a family of 40-mil-center devices for ceramic substrates; and a standard for dual and quad in-line packages. Amey points out that one of the results of the Jedec spec has been to publicize chip-carriers and to stimulate new developments in this field.

He has presented more than eight technical papers on all aspects of LSI package standardization. At Sperry Univac, his group is at present studying AMP's leaded plastic carrier, ceramic leadless carriers in sockets, and ceramic leadless carriers with edge clips. In addition, it has developed a line of thick-film digital hybrids that are compatible in size and mounting with the Jedec LSI standard. This effort has by now influenced both new applications for chip carriers and the substrate orientation and input/output conventions of the Jedec spec.

Although Amey himself has had success with leaded carriers, he has this to say about the field in general: "No one package or packaging technique will satisfy all LSI applications. In general, users are better off if they can choose from a variety of packages and freely change from one to the other without system redesigns."

He notes, too, that the success of the Jedec chip-carrier activity has been due to a rare group effort by semiconductor manufacturers, package suppliers, and users of LSI circuits.

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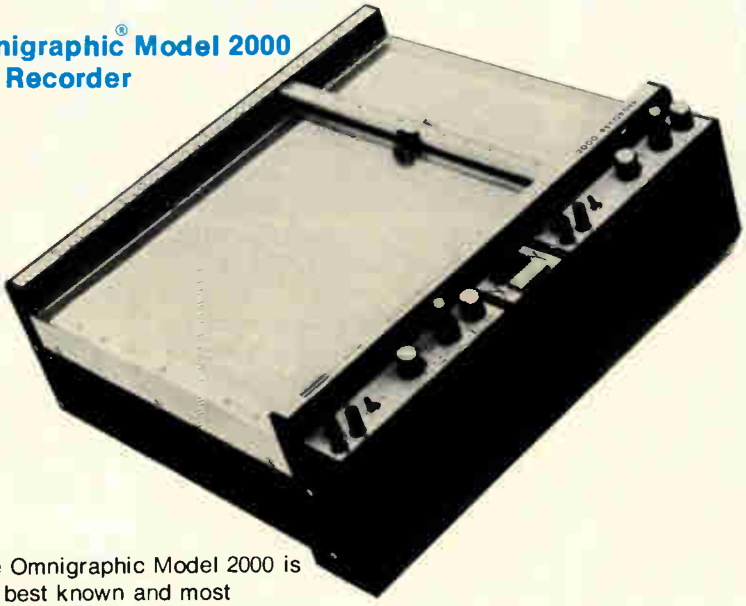

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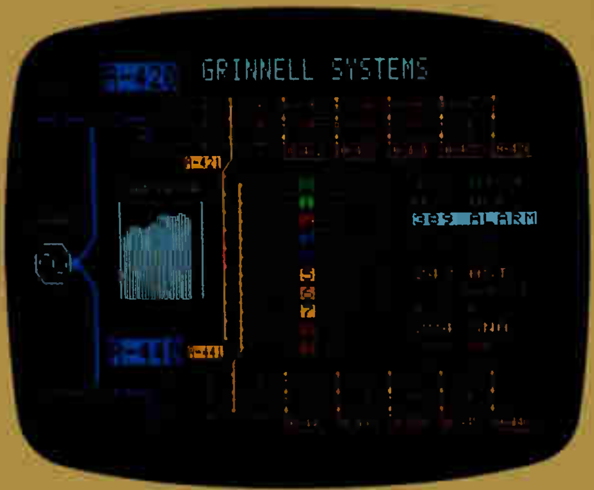

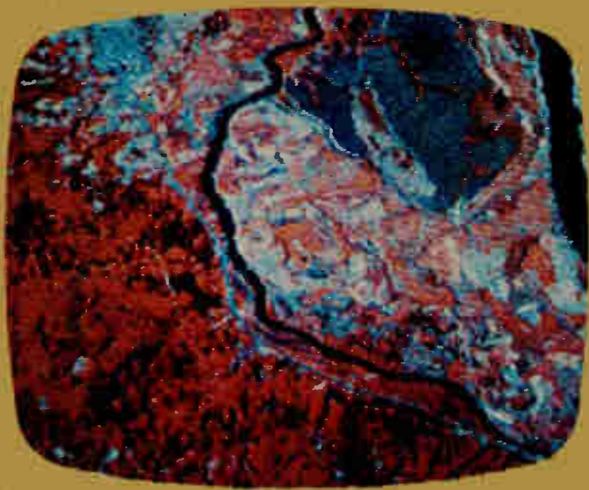

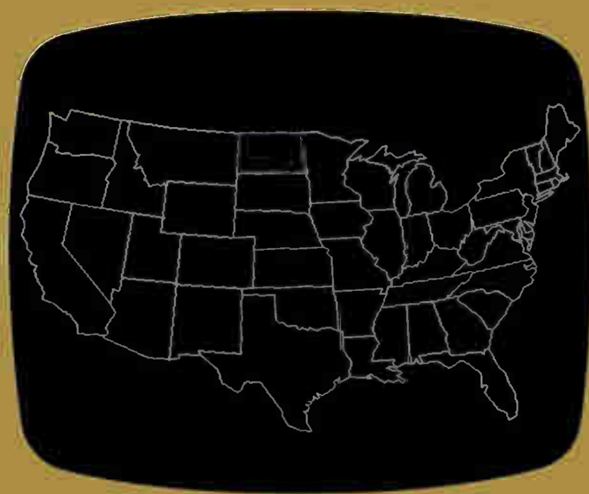

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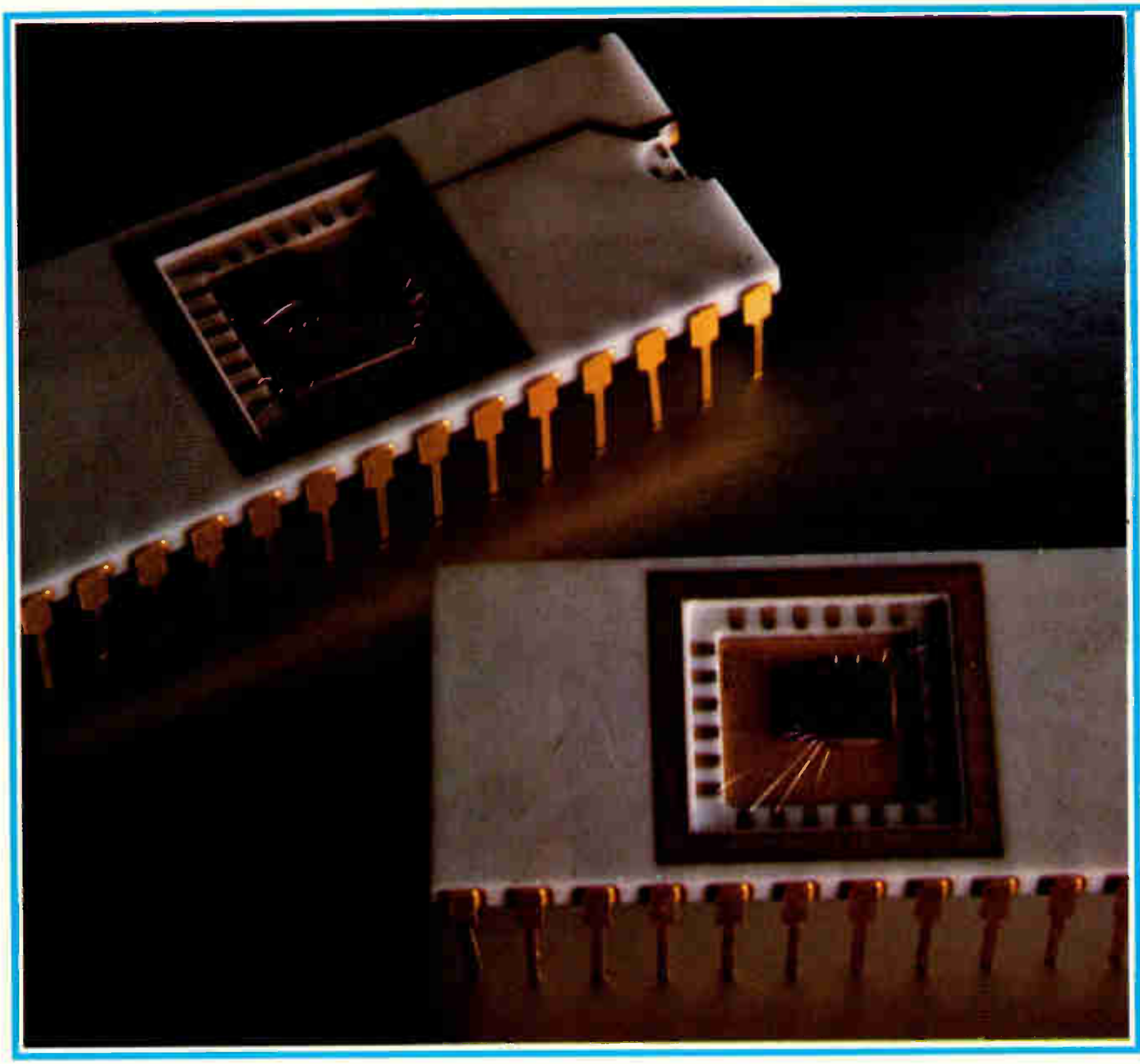


COMPONENTS

by Nicolas Mokhoff, *Components Editor*

☐ *The same creative use of solid-state processes and techniques that keeps logic and memory devices on the move is showing up in other components. Complementary-metal-oxide-semiconductor, emitter-coupled, and integrated injection logic are enhancing converter speed and resolution to the point where last year's 8-bit analog-to-digital and digital-to-analog models are giving way to 10-, 12-, and 16-bit parts. Work on gallium compounds and other materials is making solid-state optical displays brighter, more colorful, and longer-lived. Thin-film resistor networks are experimenting with silicon chrome and rivaling discrete devices for precision; V-groove MOS and novel packaging are boosting the ratings of power semiconductors; and sensors are becoming both smaller and more sensitive.*

In short, size and price keep going down, while reliability goes up.

A highlight in the converter market has been the frantic grab for the sockets housing the industry standard hybrid d-a converter, the DAC-80. Having dominated the market since the first DAC-80 was introduced in 1975, Burr-Brown Research Corp. of Tucson, Ariz., is now being challenged by two technologically innovative alternatives from Analog Devices Corp., Norwood, Mass., and Beckman Instruments Inc., Fullerton, Calif., not to mention both companies' second sources. The former used its ingenuity and monolithic capability to bring out a three-chip version of Burr-Brown's 11-chip hybrid, claiming improved reliability over the DAC-80's impressive track record—fewer than 0.5% of them were returned in the past two years, according to Burr-Brown, and most were faultless.

Beckman chose to give the user a low-power C-MOS alternative: a 150-milliwatt part versus Burr-Brown's 800-mw model. This is a direct descendant of the company's successful microprocessor-compatible, 12-bit C-MOS 7545 and 7546 four-quadrant multiplying d-a parts for use with an external ac reference. Beckman is committed to C-MOS and is also looking into the possibility of using sapphire substrates for higher performance as prices for silicon-on-sapphire processes go down. The a-d counterparts of the 7545 and 7546 can be expected shortly for some 20% less in price; they will be fully microprocessor-compatible converters, using chip and ladder switches, successive-approximation registers, and peripheral control logic.

The Analog Devices AD 574 (opposite) is a two-chip, microprocessor-compatible analog-to-digital converter.

Also from Analog Devices is the AD574, a complete two-chip 12-bit a-d converter that has output circuitry for direct coupling to 8-, 12-, or 16-bit microprocessor buses. One chip is the AD565 12-bit d-a converter with a voltage reference on it, and the other is an I²L device with a successive-approximation register and controls.

More data converters

Another company introducing a 12-bit d-a converter is Motorola Inc.'s Semiconductor Group, which thus far admittedly is doing a catch-up act. In its 8-bit d-a converter, however, one skill that gives the Phoenix firm an edge is MECL, its version of high-speed emitter-coupled logic. Capable of converting data at rates above 25 megahertz, this monolithic IC exhibits a settling time of 10 nanoseconds, fast enough for display processing and video broadcast systems. Hooked up as a successive-approximation a-d converter, it achieves a full-scale output voltage of 10.2 volts, though limited by a 51-milliampere drive capability. The chip uses thin-film processing throughout and will cost a moderate $26.

In this ultrafast conversion-speed category, a couple of other companies have impressive products. TRW LSI Products of Redondo Beach, Calif., shines with its 8-bit a-d converter in a 64-pin dual in-line package. Manufactured with the triple-diffusion process unique to the company's LSI devices, the converter digitizes data at from dc to 30 MHz. It consists of 255 strobed compara-

TABLE 1: PERFORMANCE PARAMETERS OF DISPLAYS

Display type	Power requirements (nominal) (mW)	Drive requirements	Speed	Temperature range (°C)	Color	Digit height (in.)	Operating life (hr)
Liquid-crystal	0.045	10 V pk-pk, 1 μA ac	medium	0° to + 55°	limited	2.0	10,000 – 50,000
Light-emitting-diode	15	5 V, 10 mA, dc	fast	– 55° to + 85°	yes	0.6	100,000 – ∞
Incandescent	250	4.5 V, 24 mA ac per segment	slow	– 50° to + 70°	limited	1.0	50,000 – 200,000
Gas-discharge	275	180 V, 2 mA ac per segment	fast	0° to + 65°	limited	0.8	100,000 – 200,000
Planar-gas-discharge	750	200 V, 2 mA dc per segment	fast	0° to + 70°	limited	0.5	25,000 – 100,000
Vacuum-fluorescent	90	18 V, 1.3 mA ac plus filament and grid supplies	fast	0° to + 70°	yes	1.0	10,000 – 150,000

SOURCE: CREATIVE STRATEGIES INTERNATIONAL

TABLE 2: PRECISION RESISTORS COMPARED

Characteristics	Wire-wound	Metal-film	Bulk-metal
Resistance tolerance	1%, 0.1%, 0.01% (0.005% at extra cost)	1%, 0.1% (0.05% at extra cost)	1%, 0.1%, 0.01%, 0.005% (0.001% hermetically sealed)
Temperature coefficient of resistance (TCR)	standard: ± 25 typical: ± 10 special: ± 5	standard: ± 50 typical: ± 25 special: ± 10	standard: 5 instrument: 5 range: 1
Differential TCR (tracking)	standard: up to 50 typical: 20 good: 10 (5 by selection)	standard: 100 typical: 50 good: 20 (5 by selection)	standard: 5 typical: 3 good: 1 (0.5 by selection)
Rise time (ns)	200 (50 by processing)	10 (typical)	2 max. (1 typical)
Voltage coefficient	good	good except high values	good
Noise	good	good except high values	good
Stability (MIL SPEC) moisture high-temperature exposure load life	MIL-R-39005 0.1% 0.1% 0.1%	MIL-R-55182-J 0.4% 0.5% 0.5%	MIL-R-55182/9 0.05% 0.05% 0.05%

SOURCE: VISHAY RESISTIVE SYSTEMS CORP.

tors and exhibits a recovery time of 20 ns from a full-scale step input.

To come up with a 10-ns part, Advanced Micro Devices Inc., Sunnyvale, Calif., uses 15 ECL comparators in a 4-bit configuration. The disadvantage here is that, for an 8-bit converter, five parts have to be put together in a series-parallel arrangement. In Worcester, Mass., Micro Networks Corp. is trying its hand at 3- and 4-bit converters with 30- to 50-nanosecond conversion speeds, while in Canton, Mass., Datel Systems Inc. has 3-bit a-d slices, working in the 20-MHz region, that should find use in high-speed check-reading machines.

Speed is being enhanced in multiplying d-a converters as well. Hybrid Systems Corp., Bedford, Mass., has introduced the DAC 391, a 12-bit two-quadrant multiplication hybrid converter that settles in 750 ns to a step change of ±½ least significant bit in the full-scale range. For a $125 starting price, that family offers both voltage and current outputs in 24-pin DIPs.

Meanwhile Burr-Brown is also covering the high-performance end of the spectrum. It will introduce 16-bit hybrid d-a and a-d converters of the DAC-80 type at the end of the fourth quarter of 1979. The a-d model will have all the thin-film resistors mounted on one chip and laser-trimmed to guarantee 14-bit accuracy to ±0.003% for a price of $175.

Other companies that have introduced and are about to bring out 10- to 16-bit converters with all sorts of functions on board are: Datel, Fairchild Camera & Instrument, Harris Semiconductor, Hybrid Systems, Intersil, Micro Power Systems, Raytheon Semiconductor, Signetics, Siliconix, and Teledyne-Philbrick.

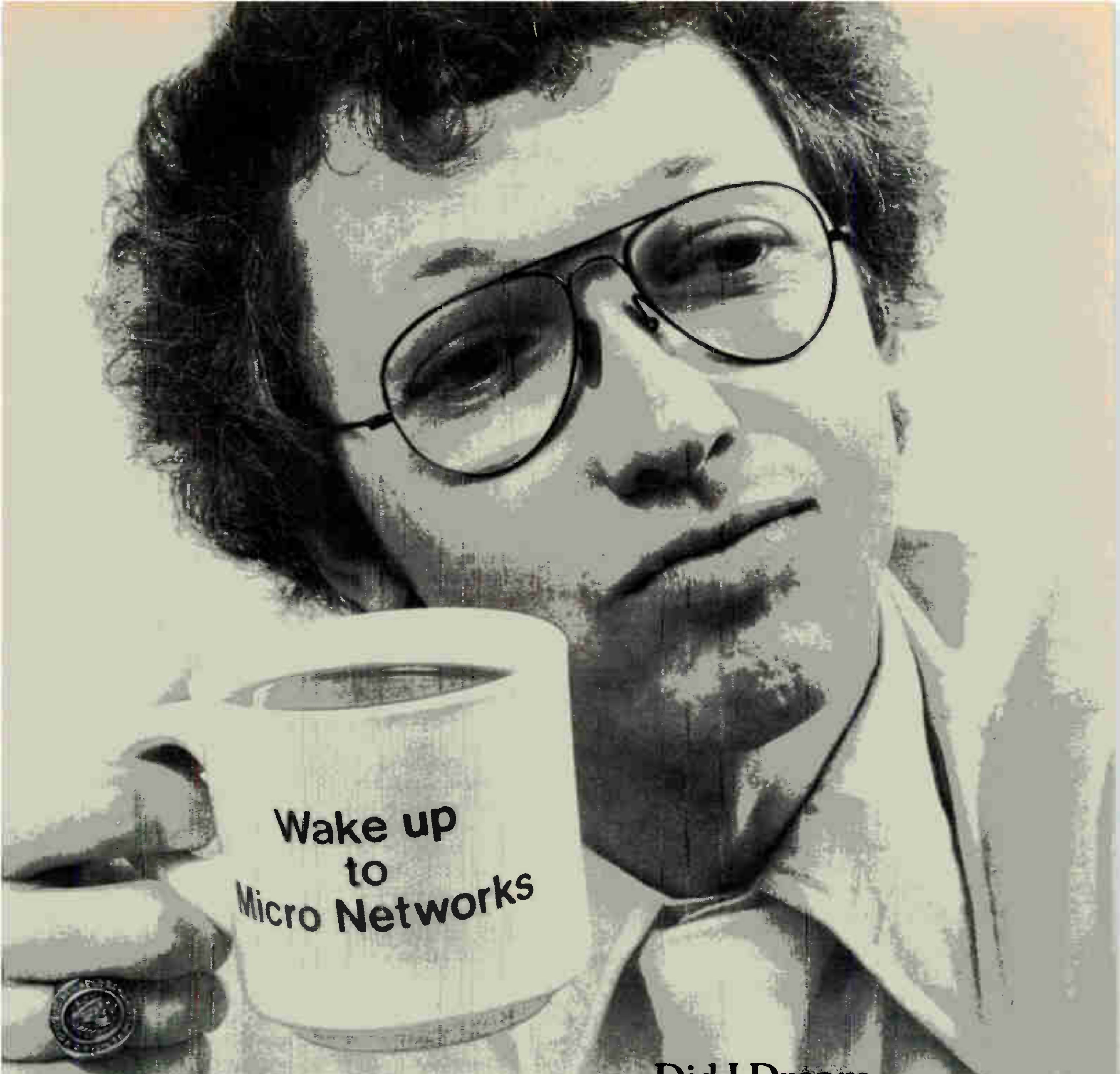
This past year has witnessed a rash of new analog input/output boards. It seemed that whoever is in the data-converter business was bound to expand vertically by putting these converters on boards and surrounding them with peripheral circuitry that would interface the real world to any of a dozen of the most popular 8- and 16-bit microcomputers. By far the most often tapped microcomputers are the iSBC 80 series from Intel Corp. and the LSI-11 series from Digital Equipment Corp.

Analog I/O

Other systems with which the boards are interfacing are Texas Instruments' 9900 series, Motorola's Micromodule and Exorciser series, Pro-Log and Mostek's 4- and 8-bit boards, as well as Zilog's Z80-MCB. Datel Systems Inc., Canton, Mass., has even produced an I/O board for Digital's PDP-11 minicomputer line.

The analog-based companies that designed their boards around the iSBC 80 and/or the LSI-11 series are: Analog Devices, Datel, Data Translation, ADAC, Burr-Brown, and Analogic. Even Micro Networks decided to plunge in with a first-generation version for the iSBC 80, and a board for TI's 9900 system is soon to come. Meanwhile, old timers in this business like Analog Devices and Burr-Brown came out with second-generation boards that eliminated many of the extra "bells and whistles" that the basic user does not really need but ends up paying for. And pay he does, with prices for the boards ranging anywhere from $250 to $750.

As for the coming year, those companies who have initially invested vertically can be expected to expand horizontally, catering for more and more microcomputers. They find that dealing with the large microcomputer houses for whose products they have designed the boards initially is much more lucrative if done in volume much like original-equipment manufacture. The OEM decision



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is forced upon the I/O analog board producers by the age-old business decision of building versus buying that every engineer faces. With the option of building the interface for his own specifications turning out to be less expensive, the OEM business end of the boards is cementing a gold-lined avenue between Electronics Row in the East and Silicon Valley in the West.

Refinement in displays

Not content with existing display technologies, manufacturers are experimenting with electrochromic, fluorescent-activated, the PLZT chemical compound, and electrophoretic approaches all of which resemble the liquid-crystal display. But they are also busy improving LCDs, light-emitting diodes, and other optical readouts, with a view especially to lowering costs. Table 1 lists the performance parameters of today's display types.

In LEDs, gallium compounds are receiving special attention. For greater brightness, gallium arsenide phosphide is being processed on gallium phosphide and vice versa. For a blue LED, gallium nitride is being tried as the emitter of a display segment.

Development programs in LCDs range widely. The aims are to lengthen their operating life, make them easier to multiplex, address, and install, as well as more rugged and easier to view—but perhaps above all, to increase their operating temperature range and switching speed.

For instance, heaters are now being developed that would maintain the liquid crystal at higher temperatures so that it may switch faster. A new material, phenylcyclohexane (PCH), is being tried that supposedly operates at least twice as fast as that presently used, over a wider temperature range. Texas Instruments Inc. of Dallas circumvented the whole temperature problem neatly in a digital I^2L watch that it introduced recently with LCD analog display hands: an on-chip voltage regulator compensates for the negative temperature coefficient of the LCD ester mixture used.

As for ease of viewing, pleochroic dyes are being tested in the liquid-crystal background for a better contrast ratio. Nor is the polarizer material being neglected. Polaroid Corp. of Cambridge, Mass., has developed one that does not degrade as rapidly in high humidity; however, it yields a narrower field of view, which must be corrected by using a thinner and more expensive back glass.

Passive precision

In passive components, the push is toward greater precision. Beckman Instruments has built thin-film resistor networks with a precision equivalent to that of individual precision metal-film discretes but for 30% less cost. Packaged in 16- and 14-pin DIPs, they track 5 ppm/°C while offering 1% to 0.1% resistance tolerance, 50-ppm/°C temperature coefficients, and 0.5% to 0.1% resistor ratio tolerances.

Meanwhile Vishay Resistive Systems Group, Malverne, Pa., is improving precision parts manufactured with the company's unique bulk-metal design. It has introduced bulk-metal precision resistors with a novel paddle kind of lead that requires only two weld points instead of four. This carries heat away from the resistor for a better load-life stability than other precision resistors (see Table 2). Moisture and high temperature exposure stabilities also compare favorably with those of wire-wound and metal-film precision parts.

A significant breakthrough in discrete resistors with 10% to 20% tolerances was achieved by Allen-Bradley Co., Milwaukee, Wis. A combination of new resistive materials and manufacturing techniques for the cermet trimmer line yielded parts exhibiting a typical temperature coefficient of ±35 ppm/°C. compared to the usual 120 to 200 ppm/°C of others. Also, Thinco of Hatboro, Pa., has found a way of vacuum-depositing microminiature coils on different material substrates, ideal for high-density packages.

Power technology

In power semiconductors, many V-MOS field-effect transistors are by now being installed in products. Indeed, TO-202 and TO-220 packages are rapidly becoming the industry standards for power applications in small enclosed environments.

Siliconix Inc. gave birth to the V-groove devices in Santa Clara, Calif., two years ago and in June introduced an improved version—the VN84BA, a 12-A device rated at 80 V with 3-ohm on-resistance. Among other companies that are bringing out or will be announcing V-MOS power parts are Fairchild, Semtech, Intersil, TI, ITT Semiconductor, and Motorola. They are after key markets for the parts: switching power supplies, audio equipment, and electronic ignition and distributor systems in automobiles.

Meantime, new packaging techniques are being explored and extensive thrusts into higher sustaining voltage ranges are being made. Siliconix is applying the V-groove construction to junction FETs capable of switching kilowatts in nanoseconds. Another possibility it is examining is a complementary design to the original V-MOS—p-channel V-MOS, in which the driving transistors would run just below the supply voltage. The resulting devices would be simpler to design, have fewer internal parts, and be easier to use.

In the world of Darlington transistors, General Electric Co. has produced a latching transistor that combines the advantages of the asymmetric thyristor with those of the power Darlington. The 800-V transistor in a TO-3 housing latches on at 1 A, after which this base drive may be removed. It can then turn off collector currents up to 25 A with a negative base pulse. The device, however, can also be turned off by a diode in much the same way as a gate-assisted thyristor. These features make the device an economical replacement for expensive power Darlingtons.

Darlingtons are what Fairchild Camera & Instrument Corp.'s discrete product group in Mountain View, Calif., is shipping to General Motors each month for automobile electronic ignition systems. Moreover, a big effort is on to develop 500-ns transistors for switching power supplies. This would be in addition to the already established lines of products used in switchers that Fairchild now possesses—diodes, transistors, linear ICs, and small-signal transistors.

Examples of high-power technology shrinking into a semiconductor package are the devices RCA Corp.'s Solid State division, Somerville, N. J., calls transcalent, because they are permeable to heat. Its three families of 250-A rectifiers with blocking voltages of 1,200 V, 100-A transistors at voltages of 800 V, and 400-A thyristors are quarter the size and 15% the weight of equivalently rated devices because they are packaged in a unique way. Instead of adding bulky heat sinks and heat-dissipating fins externally, RCA bonds one end of a heat pipe directly to the wafer surface and attaches fins to its other end. Water passes through the pipe, absorbing the heat and giving it up to the fins. Initially priced at $1,125, the parts came down to $400 when second-generation devices were recently introduced with even higher ratings.

Sensors, meanwhile, are responding to the pressures for miniaturization and high performance. National Semiconductor Corp. of Santa Clara, Calif., is now making commercially available the one and only monolithic pressure transducer—the LX0603—which was the mainstay of its hybrid transducer for some time. Texas Instruments is also working on a whole line of silicon sensors for registering key automobile engine readings; slated for 1979 introduction, these semiconductor parts will exhibit response times of 5 seconds to the competition's 30 s. In another area of sensor technology, Analog Devices announced the AD590J temperature-to-current transducer in a package small enough to fit inside a thermocouple's ⅛-inch weld fitting. Operating over a −55°C to +150°C range, the device produces a current output that changes 1 microampere per °C from a value of 298.2 μA at room temperature. The package and specifications combination make the part economically attractive wherever temperature fluctuations are critical to the performance of these devices. And that covers almost the breadth of electronic systems, subsystems, and components.

PROFILE

He put Darlingtons into cars

To many people automotive electronics means microprocessors and memories, but to Fairchild product development manager Vikram M. Patel at Fairchild Camera & Instrument Corp., Mountain View, Calif., it means Darlingtons. Five years ago, Delco wanted an ignition system that had low enough current to reduce wear and tear on the points, yet a high enough voltage at the secondary coil to fire the spark plugs. So he designed the first Darlington to go into cars.

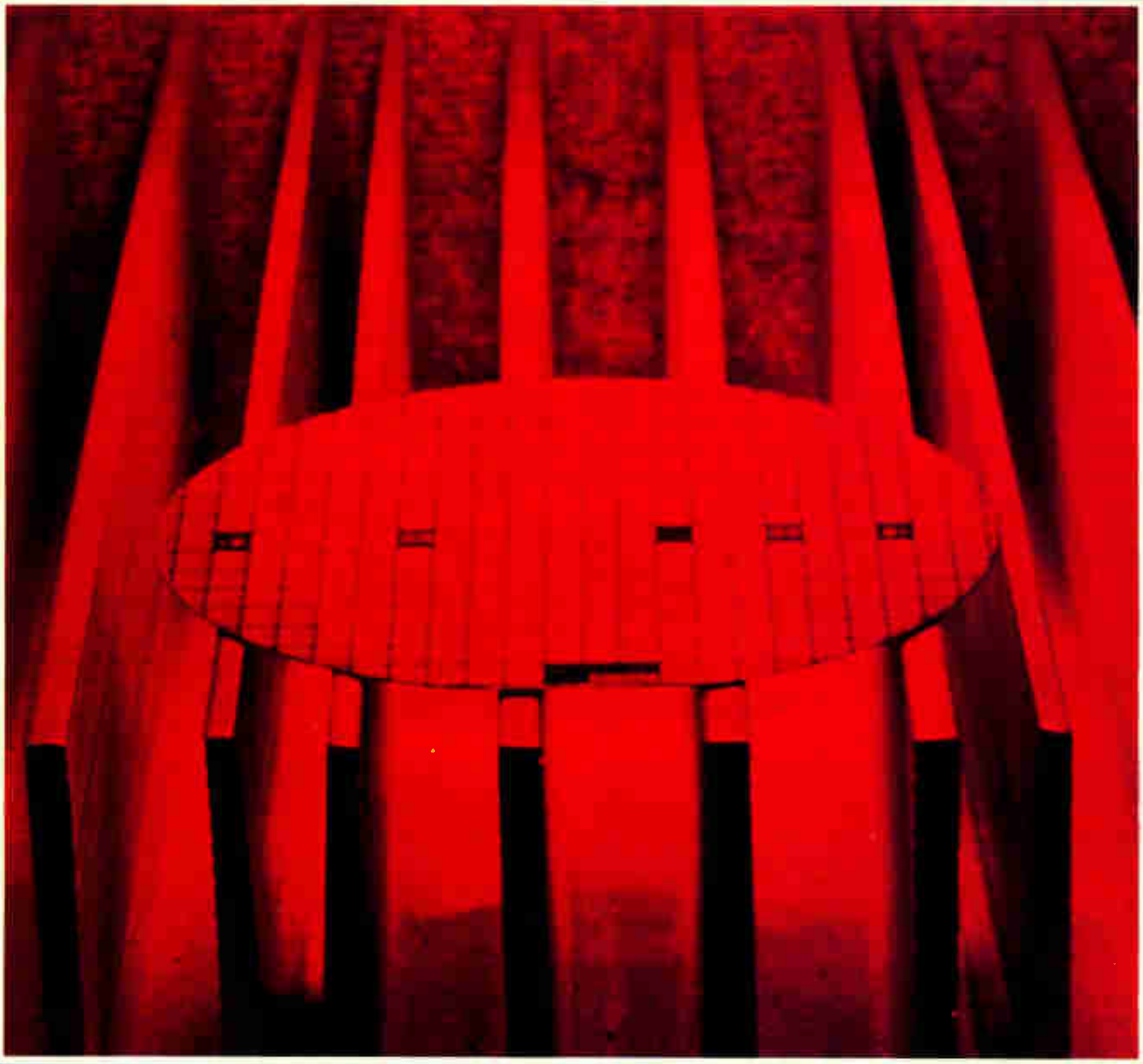
Since then, Patel has remained instrumental in expanding the often neglected frontiers of discrete component technology. For the U. S. Air Force, for example, he designed an 800-volt complementary npn-pnp bipolar planar transistor. He is also credited with the fastest switching transistor in the world, a device with three epitaxial layers that switches in 500 nanoseconds. He was also working on a Darlington design for Wankel ignition systems until GM killed the rotary engine project.

To get the 500-ns transistors, he came up with a discrete emitter design to "ensure that the emitter-periphery-to-emitter-area ratio is as high as possible." In power transistors it is typically 0.25 but in Patel's it is 0.75.

In an industry enchanted with microprocessors and chip memories, he prefers the discrete world. "In discrete technology you can look at the broader picture in the sense that you can design and know the process, whereas in IC manufacturing things are too compartmentalized. There are more parameters to play with in discrete processing than in, say, transistor-transistor logic, where the process stays the same and only geometries change."

Moreover, he believes that changing requirements will fuel discrete development for years to come. For example, applications for power transistors and power rectifiers will grow because the market is not yet mature, he says. Also, work has to be done on improving the secondary breakdown of switching transistors, increasing their switching speeds and getting 1,000-V devices into mass production.

Born in India, Patel earned a BSEE and a BSME in 1966 from Gujarat University. After receiving an MSEE from Stevens Institute of Technology, Hoboken, N. J., in 1969, he worked for Transitron Electronics Corp., Wakefield, Mass., and RCA Corp., Somerville, N. J., before joining Fairchild in 1973. He left for Unitrode Corp., Watertown, Mass., for 10 months before rejoining Fairchild's transistor division in August. **William F. Arnold**



CONSUMER

by Howard Wolff, *Associate Editor*

☐ *For the companies that entertain, educate, or just generally bemuse the consumer with their electronics-loaded equipment, the year has been one of improvement and refinement rather than dramatic technological breakthrough—and 1979 at this point promises more of the same. While such developments as the use of microprocessors and one-chip electronic tuning for television sets or the expansion of video cassette capacity for home recorders are exciting to the people who design and sell them, the impression such advances make on the customer is minimal. There has been nothing to compare with some of the developments that spurred radical changes of the past—the Trinitron tube, the $99 calculator, the first video games.*

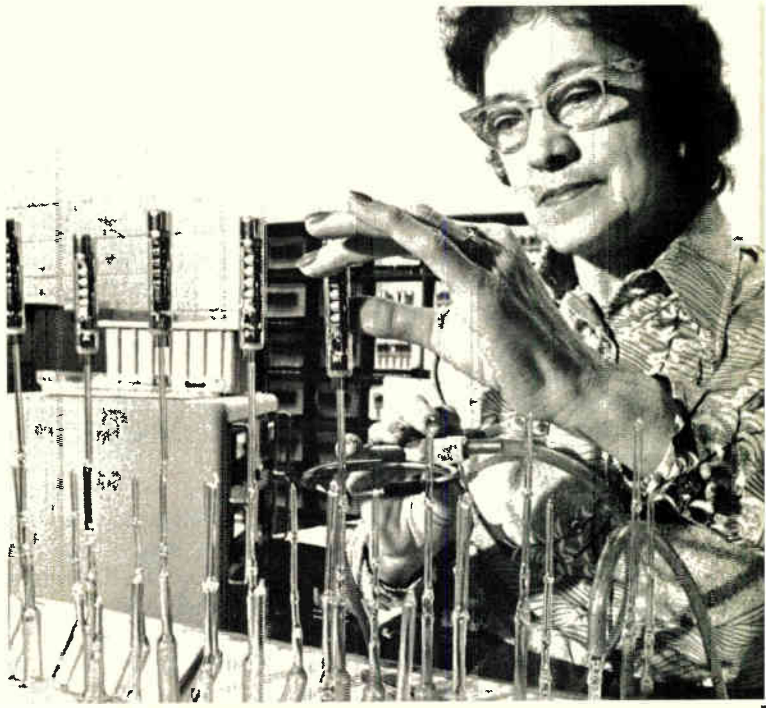
But that is not to say that the designers have nothing to show for their year's labors. In television, black-and-white receivers are now commodity items, but a developing trend is to add on a-m/fm radio and tape recorders. In color TV, most of the evolution is taking place in the larger (19-to-25-inch-screen) models. There, the trend is to pack more electronics into less real estate, with more movement toward completely automatic adjustment of brightness, color, and contrast.

It is in construction that today's television sets—and other consumer electronic items for that matter—most reflect the international flavor of the business. The industry's technology base has broadened to include most of the world: designs aimed at reducing circuits and parts, lowering energy consumption, and using more and larger integrated circuits now come from Europe as well as Japan and the U. S.

In the arena of TV games, on the other hand, the technological innovation is strictly from America. There, the movement is away from custom chips and add-ons. Instead, the video playthings that are hitting the market for the big Christmas push will be gussied up with programmable microprocessors, add-on memory, tape inputs, and additional programs.

But due to come on strongest in the games field is a class of products that are more than games—the educational nonvideo sets. These microprocessor-centered devices feature word and number games. Texas Instruments Inc. of Dallas probably has the most advanced in its Speak & Spell, which itself breaks new technological ground with a voice-synthesizer chip that takes children through spelling and pronunciation drills disguised as games. As for the larger and more expensive video playthings—video cassette recorders—outside of increased tape capacity, the only development of note is the domination of the Video Home System format over its rival Beta because it performs better for a comparable cost and can handle four-hour tape cassettes. And home computers still are a solution seeking a problem: manufacturers are scratching for applications while trying to convince consumers it is worth their time and effort to learn to use the machines. Meanwhile, small businesses are the best customers for the smaller systems that were originally thought of as the perfect domestic slave.

Opposite is a C-MOS wafer intended for digital watch circuits, undergoing processing at RCA Solid State.



Tube cut. Glass stems remain on exhaust machine after RCA worker cuts them from top sections of photomultiplier tubes.

But it is perhaps in the area of projection television that a true innovation is still to take place and where much of the early excitement that seems to surround the next big-ticket item is currently centered.

Projection TV waits in the wings

Projection, or large-screen, television has reached the point where its market is now divided into parts—over and under $2,000 retail. Getting the price of the more expensive sets down to a level that is more palatable to the public is one problem; the other, and perhaps more difficult one, is to exterminate the performance bugs. These, too, come in two classes, with even the more expensive sets afflicted by them. The first involve brightness, contrast, and resolution; the second, limited viewing angle. Ironically, systems that have overcome one class of affliction seem to suffer from the other.

At the moment, the only big U. S. electronics manufacturer involved in projection TV is General Electric Co., Fairfield, Conn. Its rear-projection Widescreen 1000 is about to receive a big push in advertising for the holiday season and should also benefit from the problems of the dollar against the yen, since competitive sets from Panasonic and Quasar will be hard put to stay below $4,000.

Meanwhile, the question is when the other big American TV names—RCA Corp. and Zenith Radio Corp.—will decide that technology has overtaken the bugs and jump into the market. The answer apparently is that they are both watching and waiting; when projection television is able to deliver a bright enough picture for

$2,000, they probably will be there.

Looking ahead, some steps toward those goals are about to be taken. Kloss Video Corp., Cambridge, Mass., says that American and Japanese manufacturers are showing interest in producing under license its bright three-tube Schmidt system. Meanwhile, Kloss itself says it is ready to turn out 30,000 sets of tubes annually. Another three-tube system, with an f1 lens from U. S. Precision Lens Co., Cincinnati, and monochrome tubes from Clinton Electronics Corp., Rockford, Ill., could come in at a reasonable price and offer brightness of 60 to 80 foot-lamberts.

Advent Corp. of Cambridge, Mass., one of the early manufacturers of projection systems, is replacing its model 750 with the 760, a two-piece, three-lens affair designed to sell for $3,300.

Finally, the newest system of them all to attract attention is the Aqua Beam system developed by Arthur Tucker, president of both Electronic Systems Products Inc. and Big Picture Inc. in Titusville, Fla. It uses a single projection lens and three 9-inch monochrome tubes that feed into dichroic mirrors with a fluid optical system. A high-resolution unit designed to be used with video cassette recorders by discotheques will sell for about $5,600; first consumer units will cost $2,800.

Shrinking the prices of VCRs

Aside from such developments, and predictions about whether the consumer will part with thousands of dollars to see larger athletes, Love Boats, and Charlie's Angels, engineers at consumer electronics companies have been concentrating on getting prices down. The need to do so is particularly urgent in Japan, where the climbing value of the yen vis à vis the dollar has seen American prices of products made in Japan soar comparably. Since it takes years to build a plant in the U. S., such developments as the Victor Co. of Japan's low-cost Vidstar color camera to use with home VCRs present bright hope for the future. Designed to retail in the $700 range, the camera compares with Toshiba's $1,000 model and even more expensive ones from Hitachi and Victor itself.

Sony Corp. is taking a different route for its latest home camera—charge-coupled devices. Tentatively due to hit the market next fall, the camera uses three CCD sensors for the primary colors and has a total of 111,192 picture elements—226 horizontal and 492 vertical. What's more, Sony claims to double horizontal resolution through use of a spatial offset technique. What remains now is to get the camera's sensitivity to match that of vidicon versions and to bring its price down to the $1,000 mark. Toshiba Corp., too, is working on a CCD camera—but its model uses just one array. Its CCDs will have 512 vertical and 340 horizontal elements. The firm plans to introduce a broadcast version of the camera early in 1980, but work still must be done to get the price down to the home VCR level.

Japanese technology also is reducing the number of ICs in big-ticket items, such as VCRs. Hitachi researchers have developed an advanced and simplified signal system for the VHS-format VCR aimed at reducing the number of parts to 450 from 1,400. They use seven large-scale ICs: three for luminance, three for chrominance, and the seventh to deal with the precision servo system.

The Japanese are even working on video disk systems—remember them? Sony Corp. researchers have developed an optical system in which the disk rotates at 900 revolutions per minute instead of the standard 1,800 rpm, thus breaking through the half-hour barrier with a disk that can play an hour on each side. Such developments keep video disk recording alive, but don't look for such systems to make a big splash commercially in the next few years.

Television is still king

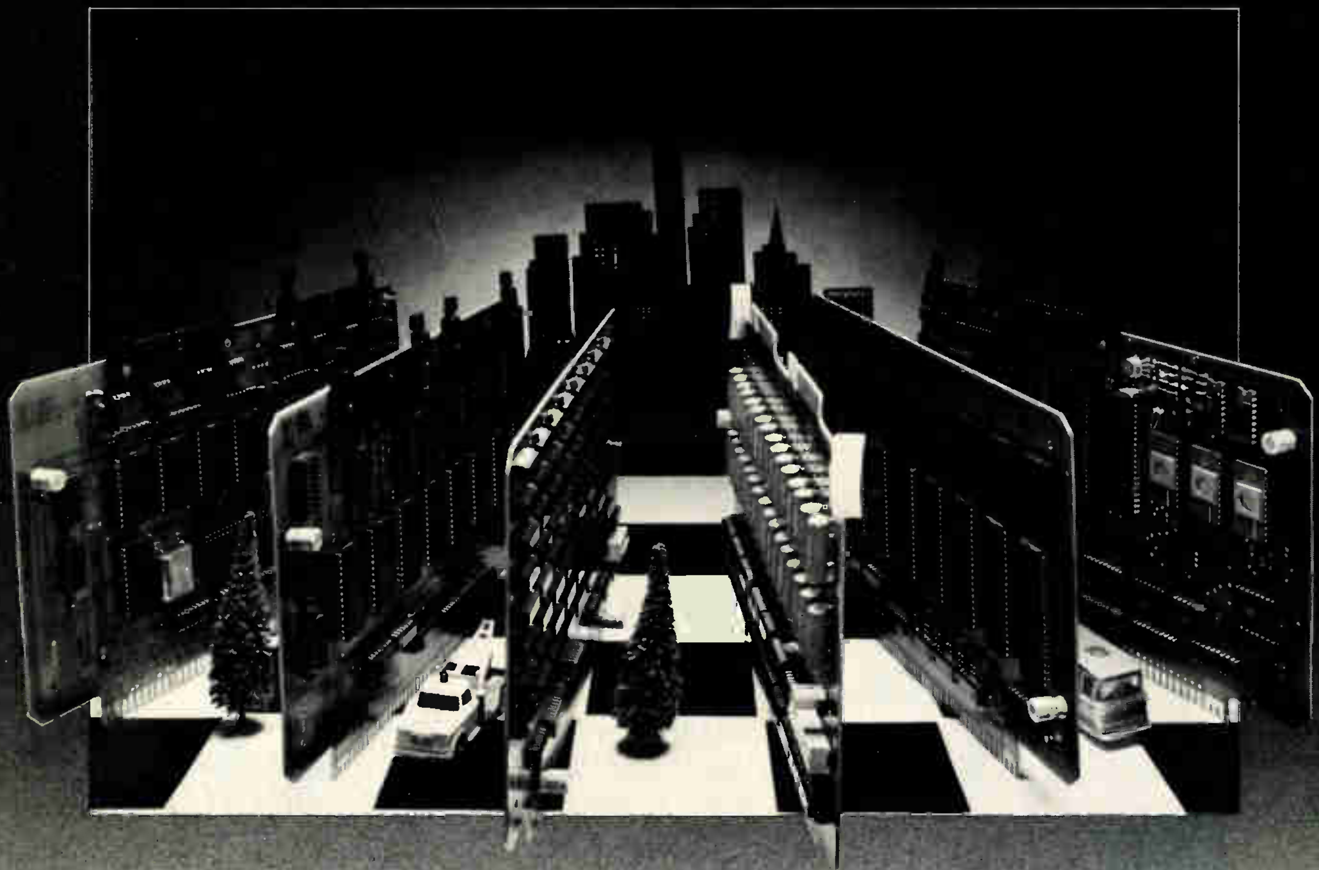
Until the prices of such relatively exotic playthings as VCR and projection TV come down, the anchor of the consumer electronics industry is still television. And microprocessors will be making their way into the set more often in the next few years. Typical is National Semiconductor Corp.'s MTC—for microprocessor-based, software-defined television controller—developed at the Santa Clara, Calif., company's labs in West Germany. It controls channel selection and search tuning and offers display of channel, date, and time through a digital-to-analog converter and 256 bytes of complementary-metal-oxide-semiconductor random-access memory. The system permits the viewer to get the various information-display options available in Europe—Videotest, Antiope, Viewdata, and the like—and thereby serve in effect, with a second microprocessor, as a home computer.

Also in Western Europe, where digital tuning and infrared remote control have been standard on receivers for some years, designers are looking to new technologies to enable them to push more features into the sets. Now they have seen the future and it looks like digital tuning based on frequency synthesizers. Companies with chips to do the job on the market or close to it are the Netherlands' Philips, West Germany's Siemens and Intermetall, and Motorola Semiconductor in Geneva.

In the U. S., the most recent innovation in television receivers was last year's development by General Electric of automatic color control based on the external, vertical-interval-reference signal. Now comes the refinement of VIR circuitry, beginning with a large-scale IC for line recognition and signal processing from Fairchild Camera and Instrument Corp., Mountain View, Calif. And Japan's Matsushita Electric Industrial Co. will have in its new sets an IC that uses VIR to control color saturation. The chip will go into Panasonic sets from parent Matsushita and Quasar receivers from its U. S. subsidiary; it also will be sold to other manufacturers. The circuit needs only about 60 peripheral parts and requires no assembly-line adjustments.

For wristwatches, something big may have been started this year when Texas Instruments introduced its electronic timepiece with a display of liquid-crystal hands. The watch face contains 120 elements connected using a multiplexing technique that employs just 26

CREATIVE ARCHITECTURE



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contacts. The device also has a programmable logic array built with integrated injection logic, allowing the 154-by-268-mil chip to sport a built-in voltage regulator. The watch will compete with both conventional- and digital-face watches, even though its initial price is $275 to $325. But TI is confident that it will have models in stainless-steel cases selling for less than $50 next year.

Auto makers continue to look to electronics

Pushed by tough Federal legislation requiring better fuel economy and cleaner exhaust emissions, the automotive industry continues to seek the help of electronics. On-board microprocessors are the only available technology able to control an engine precisely enough to make it both cleaner and more efficient. Here is what Detroit plans for its 1979 products.

Ford Motor Co.'s LTD and Mercury Marquis will introduce the EEC-II system, which controls spark timing, exhaust-gas recirculation rate, and air/fuel ratio, based on inputs from seven sensors (crankshaft position, throttle position, barometric pressure, manifold absolute pressure, exhaust-gas oxygen, exhaust-gas-recirculation valve position, and engine coolant temperature). At its heart is a 12-bit Toshiba custom microprocessor.

General Motors Corp.'s C-4 (computer-controlled catalytic converter) engine control system, which made its debut last year in some California models, will continue to appear on more models in California until 1981, when it will go nationwide. The C-4 system basically keeps the air/fuel ratio extremely close to stoichiometric conditions, thus maximizing the efficiency of the three-way catalytic converter. System components include an electronic control module containing a Motorola 6800 microprocessor (GM's Misar spark-timing control module uses a Rockwell chip), an electromechanical carburetor, coolant-temperature and oxygen sensors, and the catalytic converter. But engine control is only one application of electronics on wheels. Hard on the heels of GM's success with its Cadillac Seville trip computer, Chrysler Corp. will introduce a similar unit, using a Mostek 3870 microprocessor, in 1979 trucks.

Beyond 1979, the Big Three are looking for improved reliability, inexpensive transducers, "fail-soft" capability, and feasible on-board diagnostic circuitry. And although research and development continues, radar-based control and safety systems are way down the pike.

PROFILE

He helped viewers tune in

Advances in television receiver design generally stem from the engineering talents of two teams, not one person, and generally it's the group at the components producer that develops the basic concepts for the set maker's engineers to apply.

An exception to both rules is Hans Mangold, head of TV Development at West Germany's Grundig AG. By recognizing the potential of certain techniques long before others, Mangold has helped his Nuremberg-based company become Europe's technological front runner in TV design and West Germany's undisputed leader in color TV sales, with an estimated market share of 25%.

Mangold, 55, joined Grundig straight out of Munich Technical University in 1950. After a stint designing radios, his first major accomplishment in TV engineering was to develop transistorized tuners. His second notable achievement in the 1960s, was to help pioneer variable-capacitance diode tuning.

Diode tuning, Mangold notes, not only simplified receiver design but also "provided the platform for the further advance of electronic control techniques"—notably digital techniques and the replacement of analog with digital memories in 1972. That was the year when Texas Instruments Inc. began supplying integrated circuits to Grundig. "Working with that company was quite an experience," Mangold says. To get TI engineers, accustomed as they were to industrial and military component specs, to "think consumer" was not always easy, he notes. But he is quick to add that working with TI was, and still is, "highly beneficial to us."

TI also made the devices needed to implement Mangold's and his fellow designers' idea for a voltage synthesis method for station searching and selection. That came in 1975, a year that also saw Grundig introduce the infrared remote control method later adopted by most other West German set makers.

Besides pushing new tuning and control concepts, Mangold has helped streamline receiver production. He came up with the printed coils that Grundig made in house and began using in volume in 1964. Later he helped his firm become the first in Europe to use an IC incorporating the complete video intermediate-frequency stage, and in 1972 he introduced modular design on a large scale. Last year he persuaded Siemens AG to come out with surface-wave filters at reasonable cost.

To Mangold, a soft-spoken and amiable man, electronics is both work and hobby. "It's on my mind day and night," he says. Until this year, he oversaw both TV and video cassette recorder development at Grundig. But now that TV design has reached a certain plateau, he is devoting all his time to VCR activities. **John Gosch**

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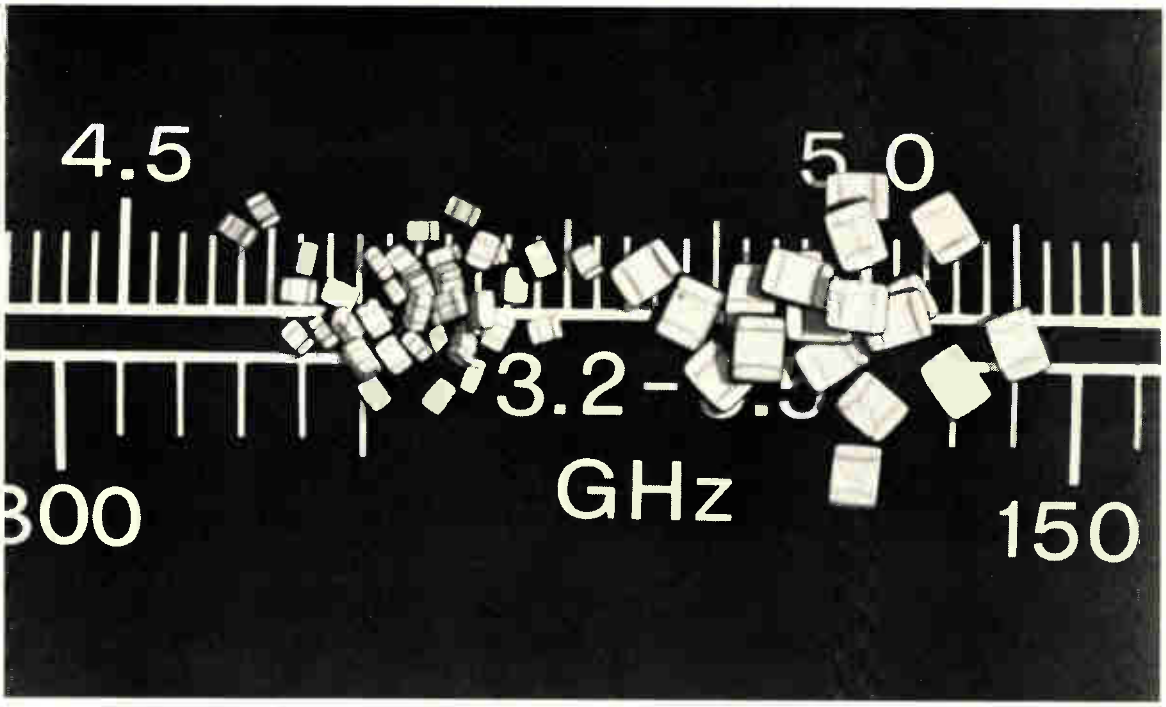

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CHRONOLOGY

October 1977	● National Semiconductor introduces its 2900 4-bit-slice processor. Device, built with emitter-coupled logic, is 20% faster than Advanced Micro Devices' original part. *Oct. 13, p. 34* ● Mobil Tyco Solar Energy Corp. develops a process for growing 3-in.-wide continuous ribbons of silicon from a melt. The process is aimed at solar cell production. *Oct. 27, p. 41*
November 1977	● Beckman Instruments announces the first d-a converters to combine microprocessor compatibility and low power dissipation: the 12-bit C-MOS 7545/7546. *Nov 10, p. 26* ● Digital Equipment Corp. announces its first 32-bit minicomputer, the VAX-11/780. *Nov. 10, p. 36* ● Rockwell International's Collins Group is first to qualify data-encryption chip that meets the U. S. National Bureau of Standards' Federal data-encryption specifications. *Nov. 10, p. 42* ● Honeywell develops automatic-focusing module with analog IC as its core; incorporated into the Konica C35AF, it contributes to a completely automatic camera. *Nov. 10, p. 40* ● Signetics introduces the 5030 and 5031, two a-d converters using a new triple-slope conversion technique. They are the first monolithic converters to be built using a low-power Schottky process. *Nov. 24, p. 44*
December 1977	● Sandia Laboratories produces thick-film hybrid circuits that survive 300°C. *Dec. 8, p. 36* ● IBM builds 1,024-bit yttrium-iron-garnet bubble lattice memory. *Dec. 8, p. 40* ● Bell Laboratories reports excellent results of eight-month field trial of fiber-optic telecommunications system in Chicago. *Dec. 22, p. 43* ● French Laboratoire d'Electronique et de Technologie de l'Informatique builds 128-by-128-element LCD on a 6.4-mm^2 matrix for videophone use. *Dec. 22, p. 55 or 3E*
January 1978	● Fairchild ships 9440 16-bit I^2L microprocessors that execute instruction set of Data General's Nova minicomputers. *Jan. 5, p. 56* ● RCA shows first high-quality video camera to use CCDs. *Jan. 19, p. 33*
February 1978	● Data General unveils its Eclipse M/600 minicomputer, which utilizes a mainframe-style I/O scheme, enabling throughput of 16-bit minis to rival that of some 32-bit machines. *Feb. 2, p. 40* ● Communications Transistor Corp. announces first V-MOS field-effect transistors, which enable 100-W operation in the vhf portion of the rf spectrum. *Feb. 2, p. 131* ● IBM builds 2-kilobit RAM with Josephson-junction memory cells. *Feb. 16, p. 43* ● Hitachi uses polyimide resin for insulating layers in linear ICs, enabling fabrication of denser chips. *Feb. 16, p. 48* ● Intel announces the 8086 16-bit microprocessor. *Feb. 16, p. 99*
March 1978	● Fujitsu offers first 64-K dynamic RAM. Unit, which uses +7- and −2-V supplies, is built with 2-μm polysilicon gates. *March 2, p. 33* ● Robert Widlar, father of 741 op amp, designs linear bipolar circuits for National Semiconductor that operate from 1-V supply. *March 2, p. 39* ● Stanford University combines an insulated-gate triac with MOS components on the same piece of silicon, creating Trimos devices—fast, high-current solid-state switches. *March 2, p. 42* ● General Electric produces a nickel-cadmium cell in a dual in-line package. *March 16, p. 41* ● Texas Instruments develops scanning laser to sense wafer defects. *March 16, p. 48* ● Fairchild and Motorola bring out standardized ECL gate arrays. *March 30, p. 39* ● Honeywell Information Systems scraps its 66/85 large-scale computer after finding problems with its current-mode logic. *March 30, p. 46* ● ILC Data Device Corp. makes the first hybrid a-d converter to break the 2-μs time barrier for conversion. *March 30, p. 115*

Significant advances in electronics technology reported over the past year in *Electronics*

April 1978

- Shugart Associates utilizes Winchester technology to make a 14.5-megabyte hard-disk drive priced under $1,500. *April 13, p. 43*
- Hewlett-Packard combines microprocessor technology and fractional-N synthesis to increase spectrum analyzer's accuracy. *April 27, p. 107*

May 1978

- Rockwell International announces the 6500/1, a one-chip version of its 8-bit 6500 microprocessor family. Chip is its first successful n-channel device. *May 11, p. 40*
- National Semiconductor introduces its IBM-compatible System/400 and is joined by Two Pi Co. with its V32. *May 11, pp. 81, 228*
- Intel 8022 is first 8-bit microcomputer with on-board a-d converter. *May 11, p. 183*
- Philips readies 11-cm-diameter, one-hour stereo disk that is played back by optical means using a laser diode in the pickup arm. *May 25, p. 33*
- Standard Microsystems Corp. develops Clasp (Coplamos large-stage programmable) process, which greatly speeds turnaround time of ROMs compared with standard metal-mask process. *May 25, p. 39*
- Nippon Telegraph and Telephone develops a single-fiber connector for optical fibers. *May 25, p. 40*
- Magnuson Systems Inc. joins the competition in the IBM-compatible mainframe arena with the introduction of its M80 computer. *May 25, p. 93*

June 1978

- Philips develops Schottky-clamped I^2L device with 3.5-ns gate delay and 400-μA gate current. *June 8, p. 41*
- Alpha-particle radiation is shown as a source of soft errors in CCD memories and dynamic RAMs; causes snag in development of dense memories. *June 8, p. 42*
- Zehntel Inc. produces in-circuit tester using signature analysis that tests digital LSI and MSI parts on pc boards. *June 8, p. 240*
- P-MOS chip from Texas Instruments, used in low-cost children's spelling aid, is first to synthesize speech from contents of a ROM. *June 22, p. 39*

July 1978

- Hewlett-Packard bolsters top of its computer line with the 3000 series III and unveils its first business computer, the HP-250. *July 6, p. 33*
- IBM generates 1-μm light bubbles, analogous to magnetic bubbles, in magnesium-doped zinc-sulphide thin film. *July 6, p. 33*
- Texas Instruments announces first 16-K static RAM. *July 20, p. 39*
- AT&T reveals its plans for a switched data-communications service. *July 20, p. 41*

August 1978

- Nippon Telegraph and Telephone's lab develops X-ray lithography system with alignment accuracy of ± 0.1 μm. *Aug. 3, p. 69*
- Europe conducts its first trial transmissions of digital TV signals via satellite. *Aug. 3, p. 70*
- First 16-K pseudo-static RAM (dynamic cells with on-chip refresh counter circuits) is readied by Mostek. *Aug. 17, p. 33*
- Texas Instruments announces first commercial quarter-million-bit bubble memory chips. *Aug. 17, p. 39*
- Intel introduces its iSBC 80/30 single-board computer with dual-port RAM. *Aug. 17, p. 109*

September 1978

- Single 5-V 64-K dynamic RAM is unveiled by Texas Instruments. *Sept. 14, p. 39*
- Sperry Univac develops first commercially licensed C-band system for satellite data communications to use 5-m-diameter antennas. *Sept. 14, p. 46*
- Rockwell International announces quarter-million-bit bubble memory with driver, support, and peripheral products. *Sept. 14, p. 161*

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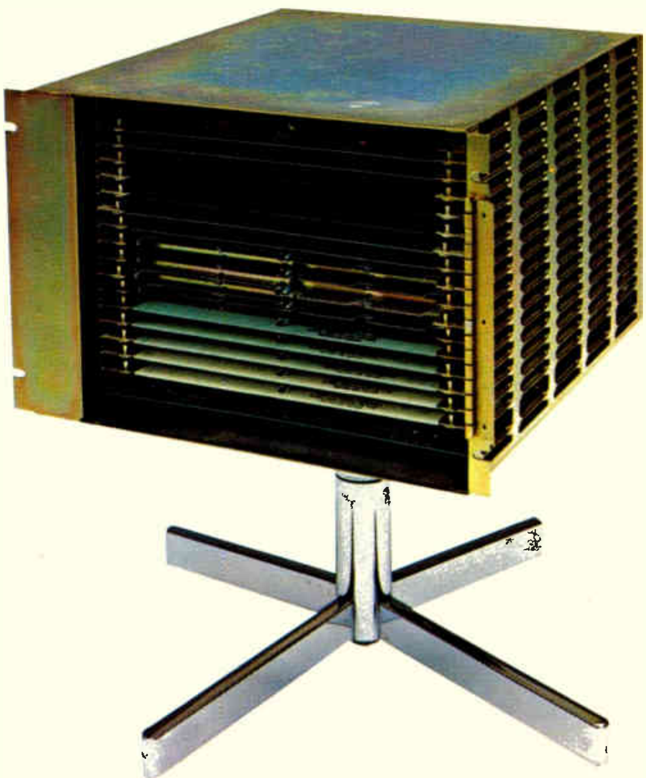

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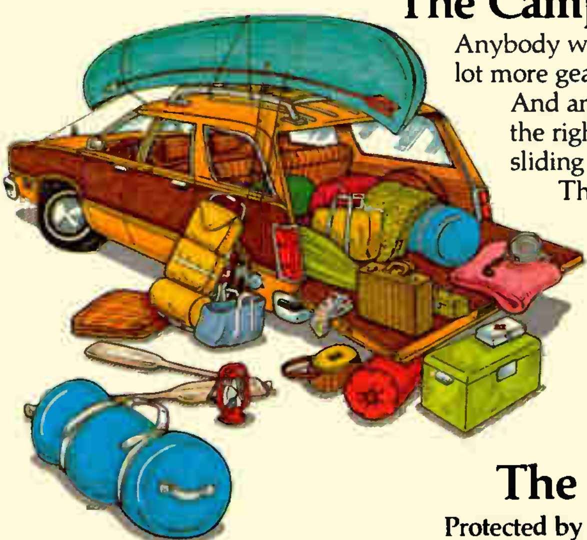

Anybody who goes camping knows that your station wagon can fill up with a lot more gear than you thought you'd ever need to rough it.

And anybody who knows station wagons realizes that, unless you have the right protection, an uncarpeted deck can get pretty roughed up from sliding gear across it.

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For more information on how M&T can help you protect the institutions that are nearest and dearest to you, write to our Director of Corporate Communications, M&T Chemicals Inc., Rahway, N.J. 07065, or call (201) 499-0200. And use our great competitive edge to your profit.

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Circle 228 on reader service card

Memory tester runs at 25 MHz

Automatic unit can check out 4-K static RAMs with 40-ns cycle times; maximum skew error is 1.5 ns

by Larry Waller, Los Angeles bureau manager

With present automatic test equipment unable to keep pace with ever-faster random-access memories, the stage is set for another generation of testers in this competitive business. Apparently beating the ATE pack is Macrodata Corp.'s true 25-MHz machine—meaning it can fully exercise such devices as a 40-ns-cycle-time 4,096-bit static RAM. The firm shipped its first M-1 memory tester late last month to a customer it would not identify, but which industry sources say is volume memory-maker Intel Corp.

"The issue is sheer 25-MHz speed and nanosecond timing accuracies," says Jack G. Salvador, executive vice president and general manager. "Our M-1 tester can make accurate measurements of 40 ns on the 4-K metal-oxide-semiconductor RAMS without guessing. The 10–12-MHz testers that are state-of-the-art today can't do it."

Making do. What Salvador refers to is a make-do situation in which memory manufacturers and users find themselves. Many new devices are faster than their test equipment, which mostly dates back four to five years. To get around this, they make a time measurement at less than the all-out cycle time, then mathematically extrapolate to an implied clock rate.

Besides the 40-ns 4-K RAM, the Macrodata tester can handle larger static RAMS (16,384 and 65,536 bits) at 20-MHz clock rates and 50-ns cycle times. At 25 MHz, its capability also can accommodate transistor-transistor-logic and emitter-coupled-logic RAM testing, along with dynamic RAMS that have cycle times somewhat slower than static devices.

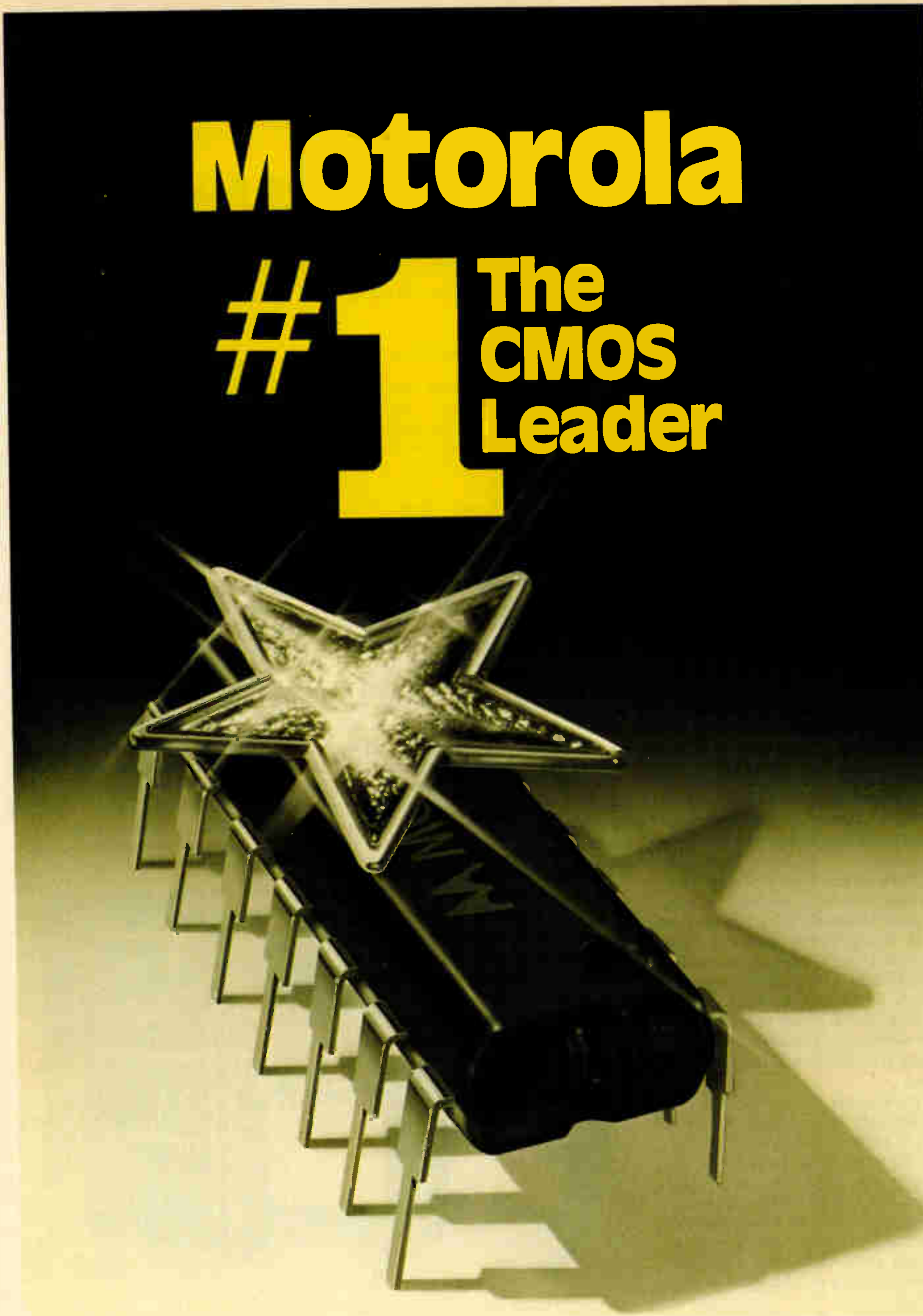
In all-important timing characteristics, the machine has 1.5-ns maximum skew error and edge-placement error of less than 1 ns, Macrodata claims. In calibrating the unit, a critical point with the ATE gear, a self-calibration in software allows "it to be done by a technician, rather than an engineer, by typing in a keyboard instruction," Salvador says. It stays in calibration for days, he claims.

Inside drivers. Salvador says the M-1 breaks new ground with its method for interfacing with the memory device under test. Present testers, for the most part, have to place driver electronics outside the console, next to the device itself, to get accurate test signals. To get around this cumbersome arrangement, Macrodata has designed a hybrid comparator package that allows measurement and error processing at the end of a cable connected to internal drivers.

The M-1 tester kicks off an entire second-generation family, says Salvador, with new machines for other large-scale-integrated devices planned during the next year or so. While he will not be pinned down to giving schedules for microprocessor testers, he observes that "major portions of the M-1, such as the 64-channel test head, timing base and computer supervision, obviously are compatible" with microprocessor testing.

Macrodata's price is $110,000. So far, only four prospective buyers have been permitted to see the M-1, but there already is a backlog and 120-day delivery. It will be shown at the Institute of Electronic and Electrical Engineers' 1978 test conference, from Oct. 31 to Nov. 2, at Cherry Hill, N. J.

Macrodata Corp., 21135 Erwin St., P. O. Box 1900, Woodland Hills, Calif. 91365. Phone (213) 887-5500 [338]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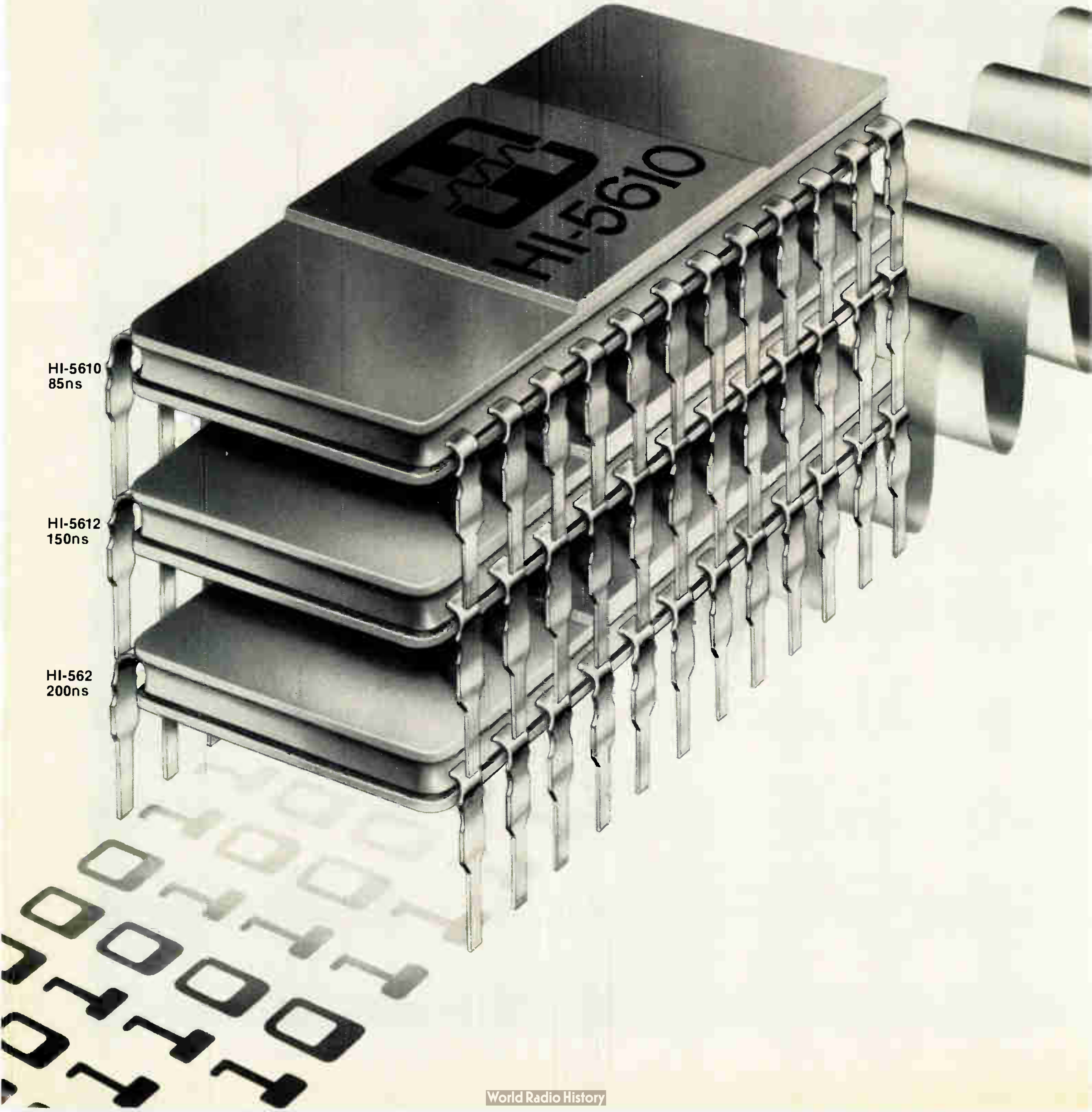

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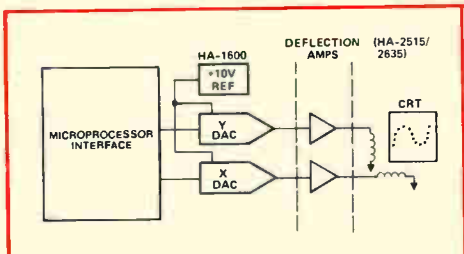
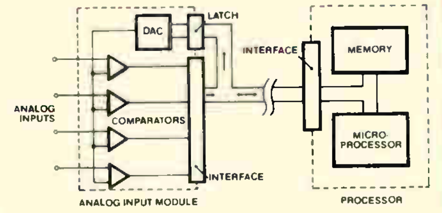
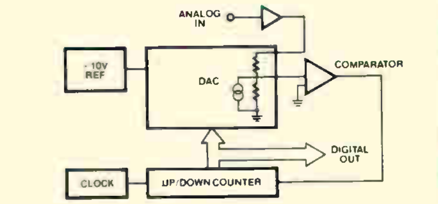


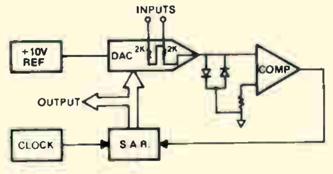
CRT GRAPHIC DISPLAY



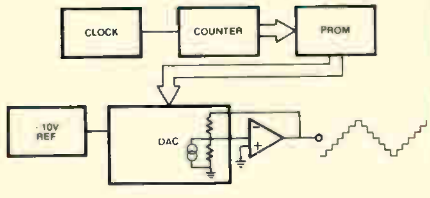
DATA ACQUISITION SYSTEM



TRACKING A/D



HIGH SPEED 12-BIT ADC



WAVEFORM GENERATOR

	HI-562	HI-5612	HI-5610
Bits	12	12	10
Settling Time to ±½ LSB	200 ns typ	150 ns typ	85 ns typ
Differential Linearity (0-75°C)	±½ LSB max	±½ LSB max	±½ LSB max
Low Gain Drift (0-75°C)	±5 ppm/°C	±5 ppm/°C	±5 ppm/°C
Output Current	5 mA	5 mA	5 mA

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Circle 235 on reader service card

Instruments

Reference stable to 2 ppm/year

Solid-state unit is less temperature-sensitive than saturated cells

Voltage references of the conventional saturated-cell variety are still the most stable units available, provided they are maintained under the tight environmental control of a standards laboratory. In the everyday world, however, solid-state devices offer many advantages.

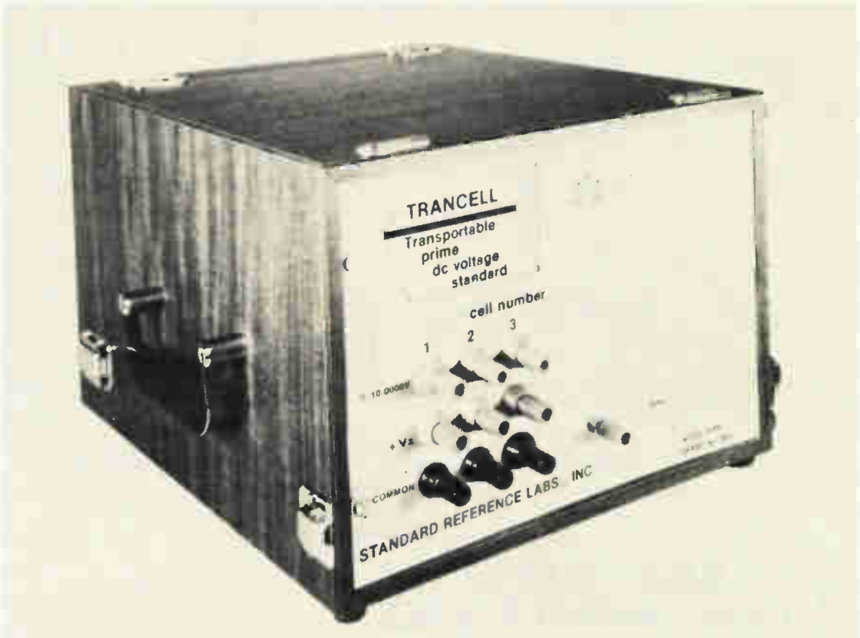
The latest zener-diode voltage reference from Standard Reference Labs, for example, boasts a long-term drift of no more than 2 parts per million per year and a typical short-term drift of 0.2 ppm/hour. This compares to 1 ppm/year for a saturated chemical cell under ideal conditions; under average indoor conditions, the chemical cell's drift is more like 3 ppm/year.

Each cell in the Trancell 100-SC family has two outputs: a zener voltage of about 6.3 v with the stability specified above, and a 10.0-v output derived from the diode voltage by means of an op amp and a resistive feedback network. The 10-v output is stable to within 10 ppm/year and 0.5 ppm/hour. Three versions of the 100-SC are offered: the two-cell Trancell 102-SC, the three-cell 103-SC, and the four-cell 104-SC.

Because they provide a precise +10-v level, units in the 100-SC series are easily combined with precision voltage dividers to develop accurate, continuously variable voltage levels suitable for calibrating such instruments as high-accuracy digital voltmeters and analog-to-digital and d-a converters.

Unlike chemical cells, the Trancell 100-SC units are essentially immune to long-term temperature-history effects, which may disable saturated cells for weeks or months. The response times to charging and discharging currents are much shorter as well, thereby minimizing their cumulative effects. Further, the solid-state construction means that the Trancells are hardly affected by reasonable amounts of shock and vibration.

A particularly useful feature of the 100-SC models is their self-calibration capability, made possible by the zener-voltage output. When calibrating the 10-v output against the zener voltage, the user connects



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And, with nearly 40 ready-to-go TM 500 plug-in instruments to choose from, you can handle just about any test or measurement application anywhere, on a moment's notice. The TM 500 family includes DMMs, Counters, Generators, Amplifiers, Power Supplies, Oscilloscopes, Logic Analyzers and Word Recognizers designed to meet a variety of performance capabilities.

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the 10-V output to the input of a precision Kelvin-Varley resistive divider. The divider is then set to the zener voltage, and a high-sensitivity null detector is connected between the divider output and the zener output of the Trancell. Any error will show up on the null detector and may be eliminated by an adjustment potentiometer built into the 100-SC voltage-reference units.

The three-cell Trancell 103-SC, which fulfills the common requirement for three independent standards, sells for $4,300 and has a delivery time of 16 weeks.

Standard Reference Laboratories Inc., Pollitt Drive South, Fair Lawn, N. J. 07410. Phone John Halgren at (201) 797-3907 [351]

Synthesized generator has low single-sideband noise

For adjacent-channel interference and spurious-response testing of receivers, cavity-tuned oscillators are usually used because they produce less single-sideband noise than do synthesized-signal generators and they do not generate nonharmonic spurious signals. But synthesized-signal generators offer programmability, a distinct advantage in automatic test applications.

Aiming to end this dichotomy, designers of the model 8662A synthesized-signal generator paid particular attention to maintaining signal purity. In the frequency-reference section, the output of a low-noise 10-MHz reference oscillator is further cleaned by two crystal filters. The synthesizing oscillator, on the other hand, uses a technique in which inductance-reactance elements are switched in and out of the circuit using p-i-n diodes. Combining these switched values with narrow-tuning varactors produces a very high Q, spectrally pure oscillator with a 2-to-1 tuning range.

The results of this worksmanship are reflected in the 8662's specifications. The 10-kHz-to-1,280-MHz generator resolves 0.1 Hz below 640 MHz and 0.2 Hz above. Between 320 and 640 MHz, SSB noise is −132 dBc/Hz at 10 kHz offset (dBc is a measurement of noise signal power with respect to the carrier level).

Below 320 MHz, noise is even less; above 640 MHz, SSB noise increases to only −126 dBc/Hz for the same offset. While spurious signals have not completely disappeared, they are at least −90 dBc up to 640 MHz and −84 dBc above it.

Output attenuation for the 8662 ranges from +13 dBm to −140 dBm with 0.1 dB resolution. The attenuator is inherently accurate to within ±3.75 dB at −140 dBm and at 1,280 MHz. Between +13 dBm and −120 dBm, absolute accuracy is within 1 dB, achieved using microprocessor applied corrections.

In addition to improving the

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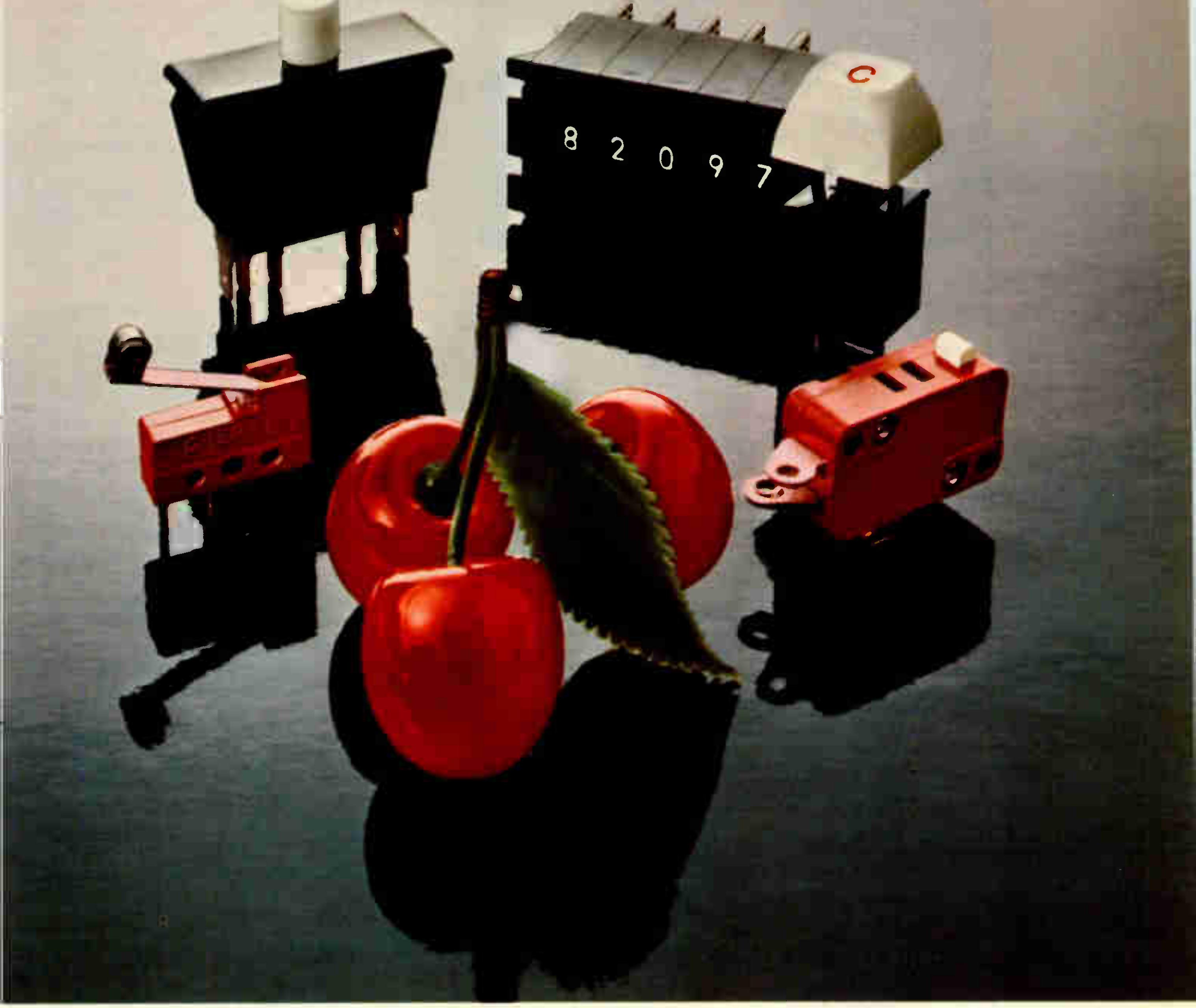

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Circle 239 on reader service card

instrument's accuracy, the microprocessor also improves switching speed, simplifies front-panel test control, and allows storage and control of up to nine complete sets of front-panel settings. Ultimately, this latter feature permits operators to build test sequences that can be performed automatically.

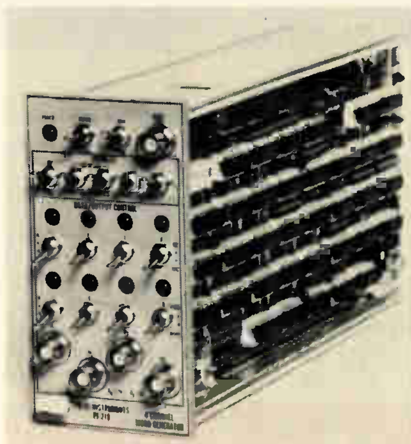
Inquiries Manager, Hewlett-Packard Co., 1507 Page Mill Rd., Palo Alto, Calif. 94304 [353]

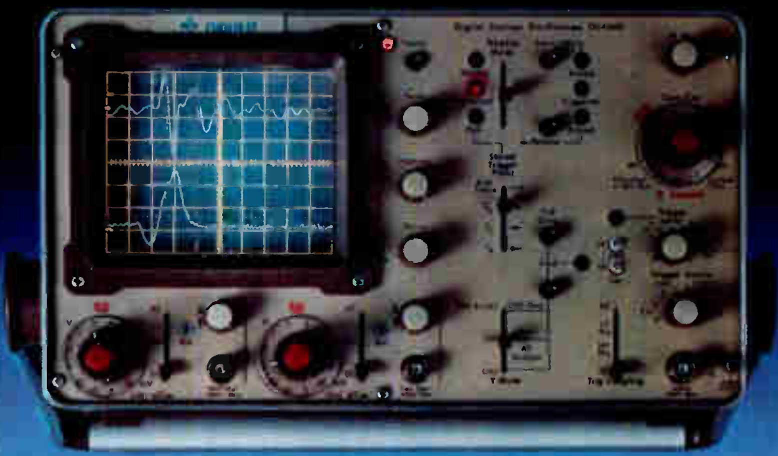
Four-channel unit generates 32-bit words at 30 MHz rate

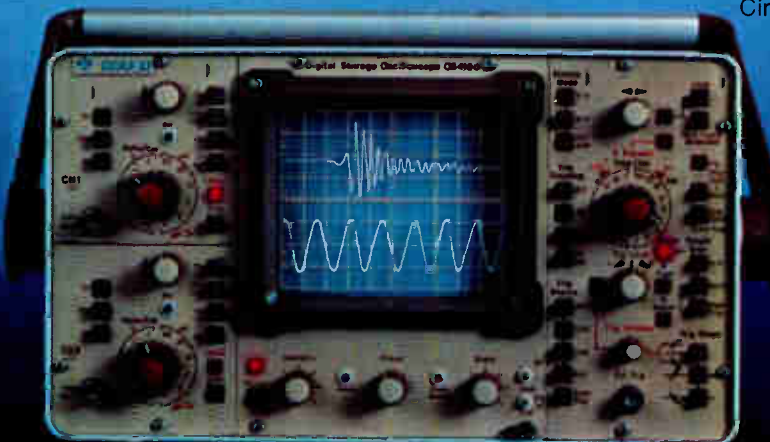
Plug-compatible with Tektronix's TM-500 power modules, the PI-210 is a four-channel, 32-bit-word generator that works at bit rates up to 30 MHz when used with the PI-100A clock generator.

The PI-210 was designed specifically for testing high-speed digital circuits and systems requiring a combination of digital word patterns and continuously adjustable pulse delays and widths; three independently adjustable controls for pulse delay and return-to-zero width are provided.

Word length is variable between 2 and 32 bits, and a maximum word length of 128 bits may be achieved by cascading channels. Data may be generated in serial or parallel format and independent RZ/NRZ and WORD/$\overline{\text{WORD}}$ controls are provided for each channel. For a given power module, the number of channels is expandable to a maximum of 16 in







four-channel increments. The outputs are capable of driving a minimum of 2 V across 50Ω.

Transistor-transistor-logic compatible, the PI-210 is priced at $850 in single quantities.

Pulse Instruments Co., 1536 W. 25th St., San Pedro, Calif. 90732. Phone Dave Kan at (213) 541-3204 [354]

Logic analyzer sells for under $1,300

The 2710-D is a data logic analyzer designed for compatibility with 8-bit microprocessors. Using the clock of the system under test, the unit can store data, address, and three microprocessor control-line bits in its 27-by-64-bit random-access memory. Recorded information is displayed on the analyzer's 16-digit light-emitting-diode display. The instrument, which is small and light enough to be carried in an ordinary briefcase, is priced at $1,295.

The analyzer works at speeds up to 10 MHz and has two clock qualifiers. Triggers A and B, which are each 27 bits wide and user-definable, allow nested triggering to isolate faults within various program loops. When combinational triggering is used in conjunction with the clock qualifiers, as well as with the 0-to-9,999 clock delay feature, virtually any program event can be stored in memory for analysis by the user at his leisure.

The 2710-D is controlled from its 24-button keyboard, accepting inputs in hexadecimal, octal, or decimal notation. Base conversions can be made by entering data in one form and displaying it in another.

The 16-digit LED display shows the memory location of a recorded word, the 16-bit address word, the 8-bit data byte, and the three qualifiers. Users can scroll through data, viewing one word at a time, or address a specific recorded word.

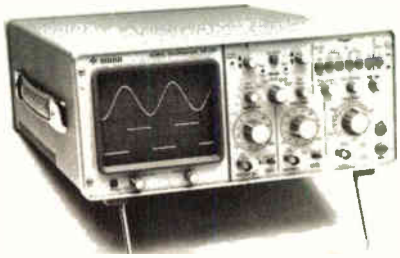
The unit measures 2.75 by 9.5 by 13 in. and weighs about 7 lb.

Gould Inc., Biomation Division, 4600 Old Ironsides Dr., Santa Clara, Calif. 95050. Phone (408) 988-6800 [355]

15-MHz portable oscilloscope has full-size display

To get a portable oscilloscope, purchasers have to give up some of the capabilities found only in larger, laboratory units. But designers of the OS255 have decided that would-be portable-instrument buyers will not have to surrender their eyesight, too—they have provided their instrument with a full-sized, 8-by-10-cm cathode-ray tube to present clear, single-trace, dual-trace, or X-Y displays. So as not to deplete their patrons' pocketbooks, they have priced the unit at a low $795.

For that money, users get a dc-to-15-MHz instrument with a 2-mV/cm vertical sensitivity over the entire bandwidth. In addition to ac- and dc-coupled triggering modes, a television mode is provided in which an active sync separator automatically selects line or frame triggering according to the selected sweep speed. A selectable time base with sweep speeds up to 500 ns/cm can be expanded by a factor of five by means of a pushbutton, thus providing a maximum speed of 100 ns.



Although relatively inexpensive, the unit has features that are usually found only on more expensive models, such as invert and add controls, a switched X-Y display mode, 1-V, 1-kHz square-wave calibration and 4-V positive-ramp outputs, and a 1-V intensity-modulation input for handling logic-analyzer outputs.

Delivery of the 15-lb unit is within 30 days; it can be seen in Europe at next month's Electronica.

Gould Inc., Instruments Division, Marketing Services, 3631 Perkins Ave., Cleveland, Ohio 44114. Phone (216) 361-3315 [357]

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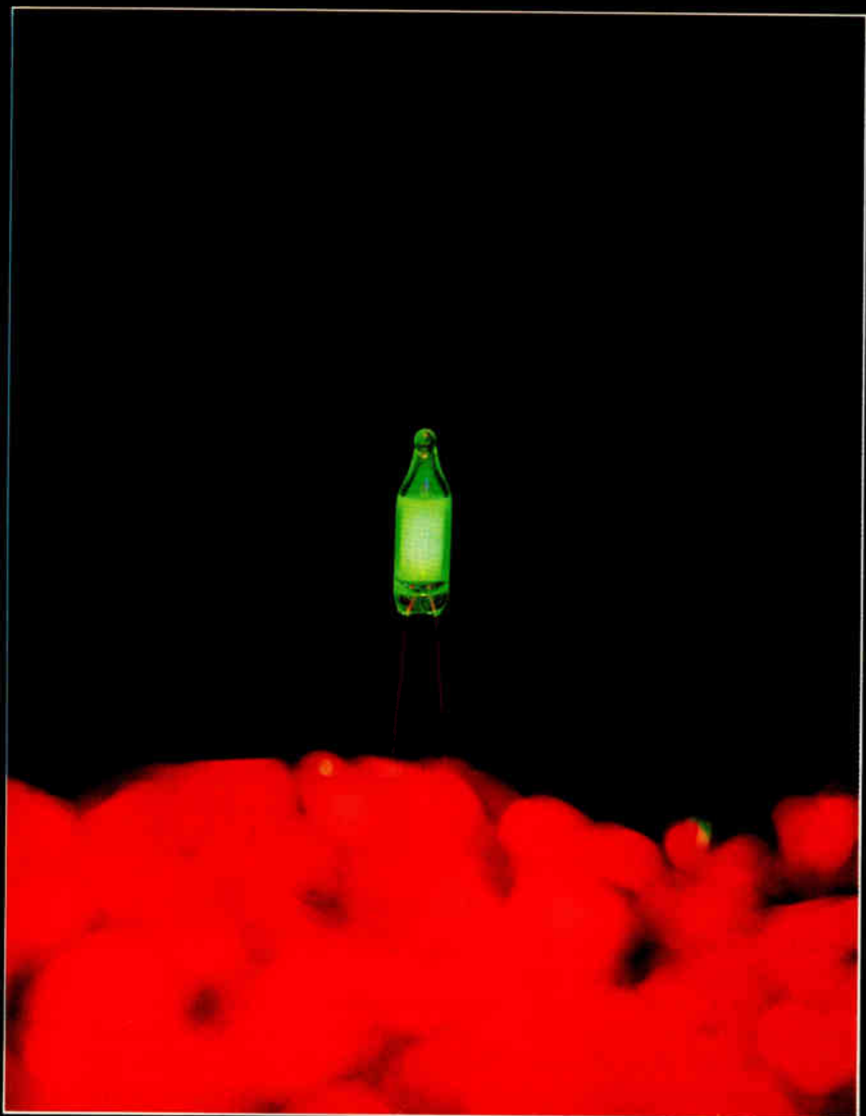
electronic tube manufacturer

Long-life Fluorescent Glow Lamp



Fluorescent glow lamps have been considered superior to the conventional red and orange neon lamps as they Provide a psychologically soothing effect with stable coloring. There has been, however, some doubt as to the stability of their properties, and they had been thought inapplicable for circuits.

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	(Beam brightness is lowered to 50%)	

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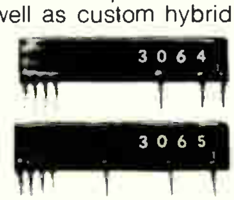

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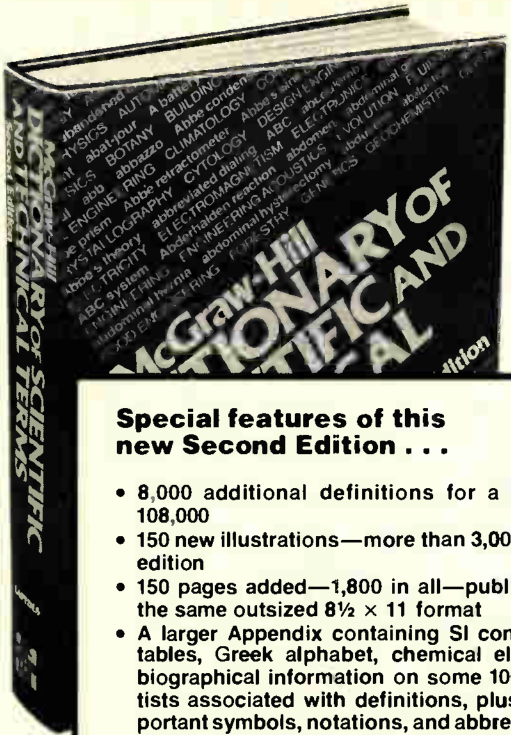

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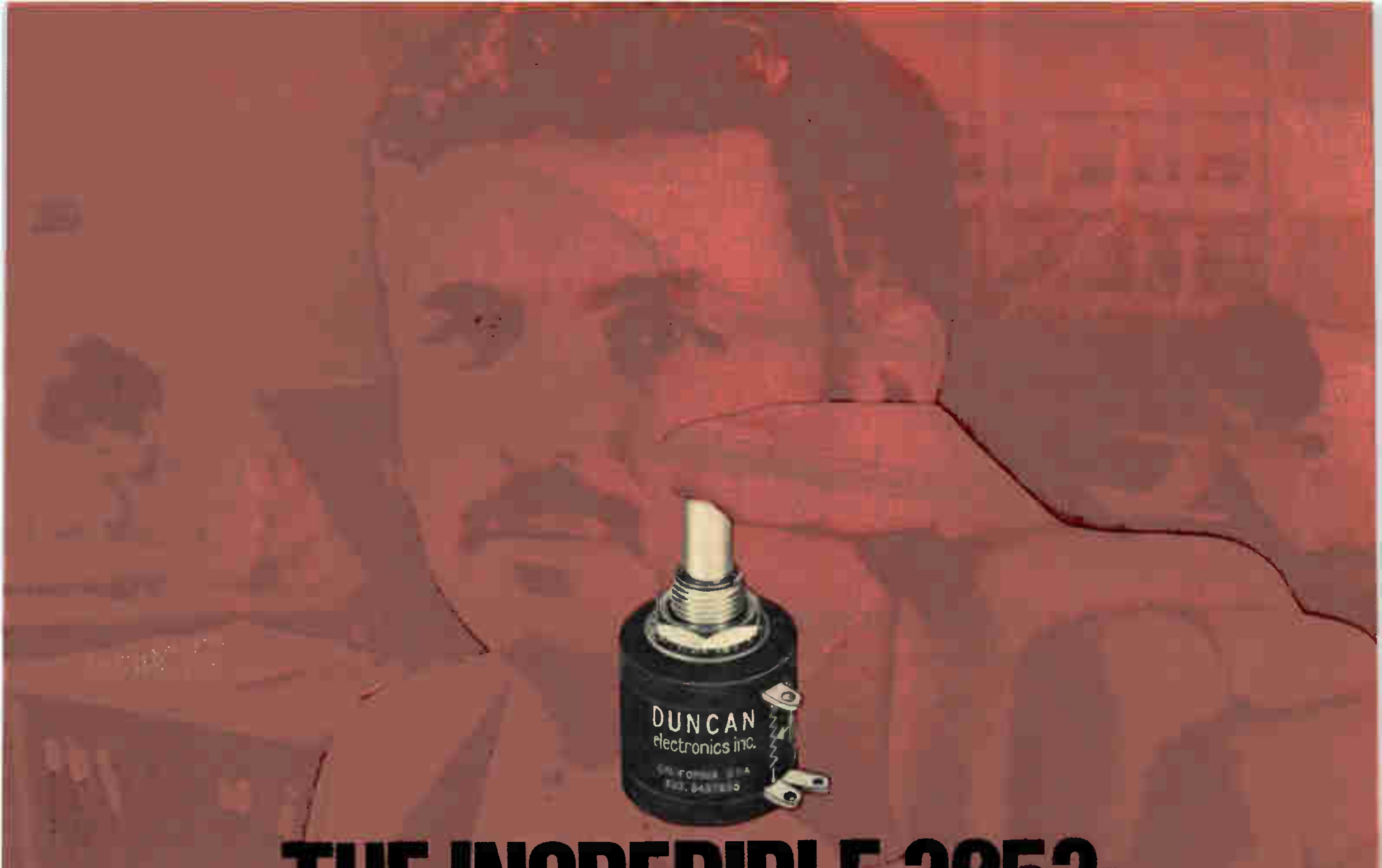

THE INCREDIBLE 3253:
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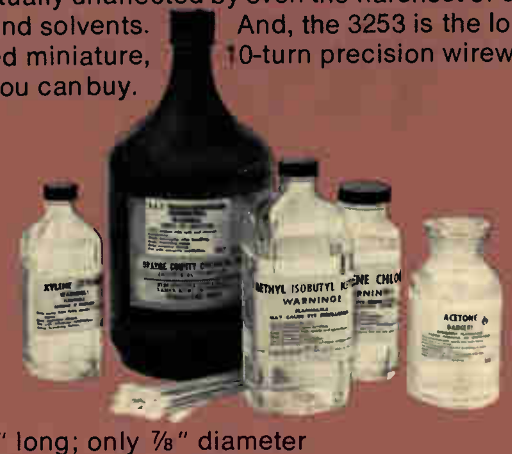
When it comes to performance, Duncan delivers. The versatile 3253 is precise enough for the most exacting applications. The tough, durable housing is virtually unaffected by even the harshest of cleaners and solvents. And, the 3253 is the lowest-priced miniature, 10-turn precision wirewound pot you can buy.



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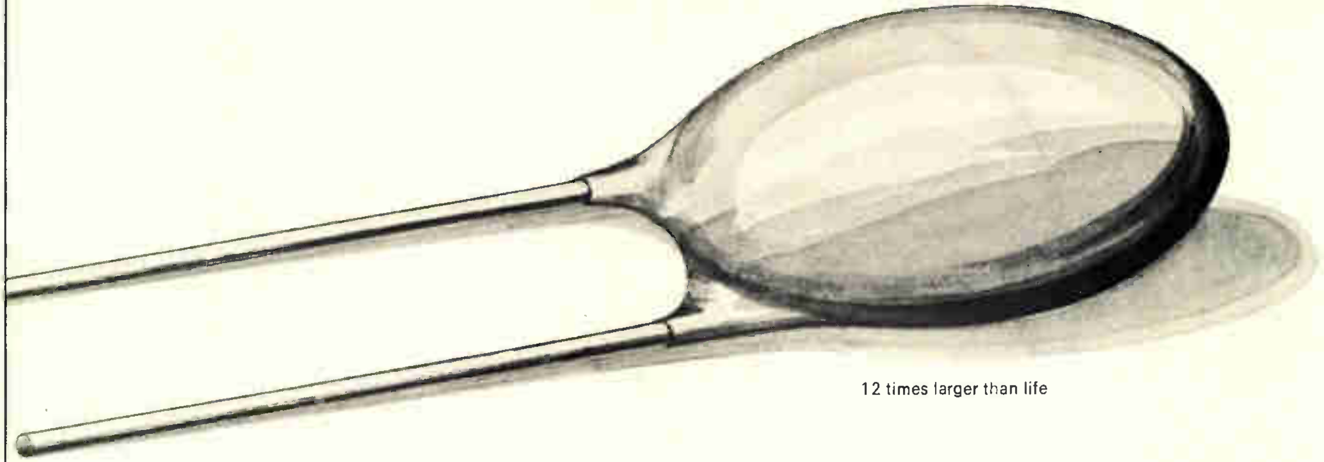

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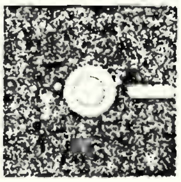
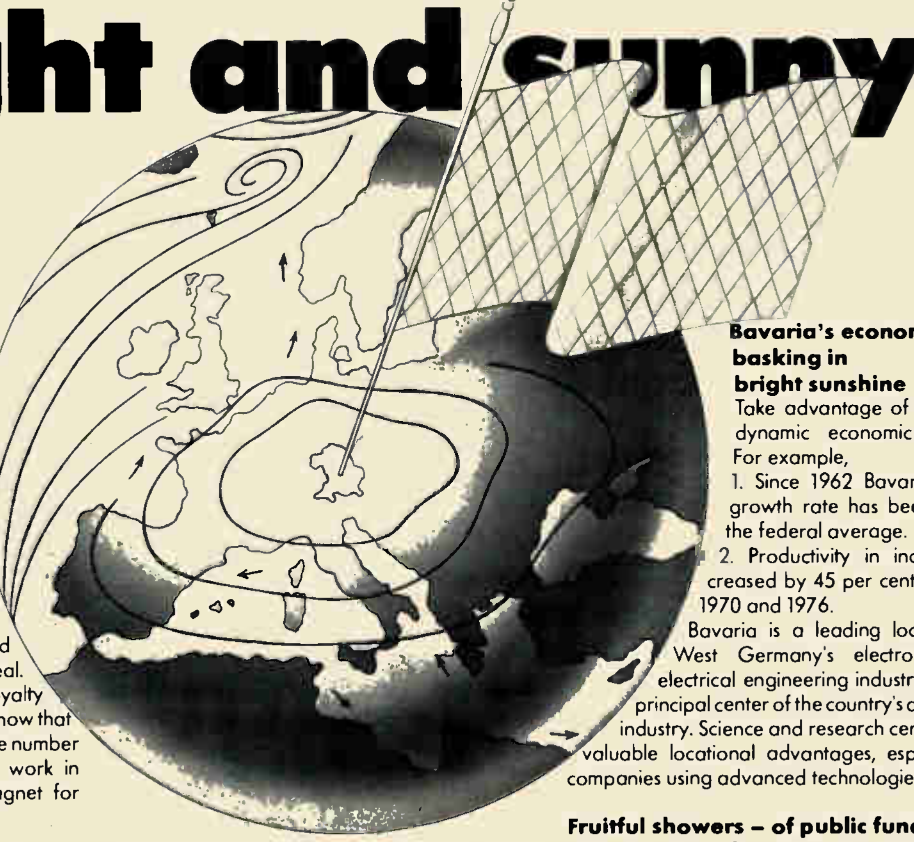


Weather forecast outlook for your investments in Bavaria:

bright and sunny



General climatic conditions
In every respect Bavaria offers an ideal climate for business initiatives. The political and economic stability which this West German state has enjoyed for many decades helps to safeguard your capital investments. The profound confidence placed in Bavaria's economic and political development is reflected in the high level of foreign investments: DM 3.2 billion since 1962.

No dark clouds over the labor market
Bavaria's well-trained workers are good partners who will give you a square deal. They are known for their reliability and loyalty to the firms in which they work. Statistics show that strikes are few and far between. The large number of qualified young people coming to work in Bavaria shows that the state is a magnet for highly skilled personnel.

Infrastructure helps to generate a favorable investment climate
Bavaria's infrastructure meets the exacting requirements of a modern industrial state. (Note that the Federal Republic of Germany has the most extensive network of autobahns or superhighways in Europe.) The international airports in Munich and Nuremberg and many strategically located airfields throughout the state link Bavaria to Europe and the world. The sources of available energy range from natural gas to nuclear power. Industrial sites with utility connections are laid out in all parts of the state.

Bavaria's economy basking in bright sunshine
Take advantage of Bavaria's dynamic economic growth. For example,
1. Since 1962 Bavaria's GNP growth rate has been above the federal average.
2. Productivity in industry increased by 45 per cent between 1970 and 1976.

Bavaria is a leading location for West Germany's electronics and electrical engineering industry and the principal center of the country's aerospace industry. Science and research centers offer valuable locational advantages, especially to companies using advanced technologies.

Fruitful showers – of public funds to promote sound investment projects
The Bavarian government encourages the establishment of production facilities in Bavaria's assistance areas by granting generous tailor-made financial aid (for example, subsidies of up to 25 per cent of the cost of an investment or low-interest long-term loans).

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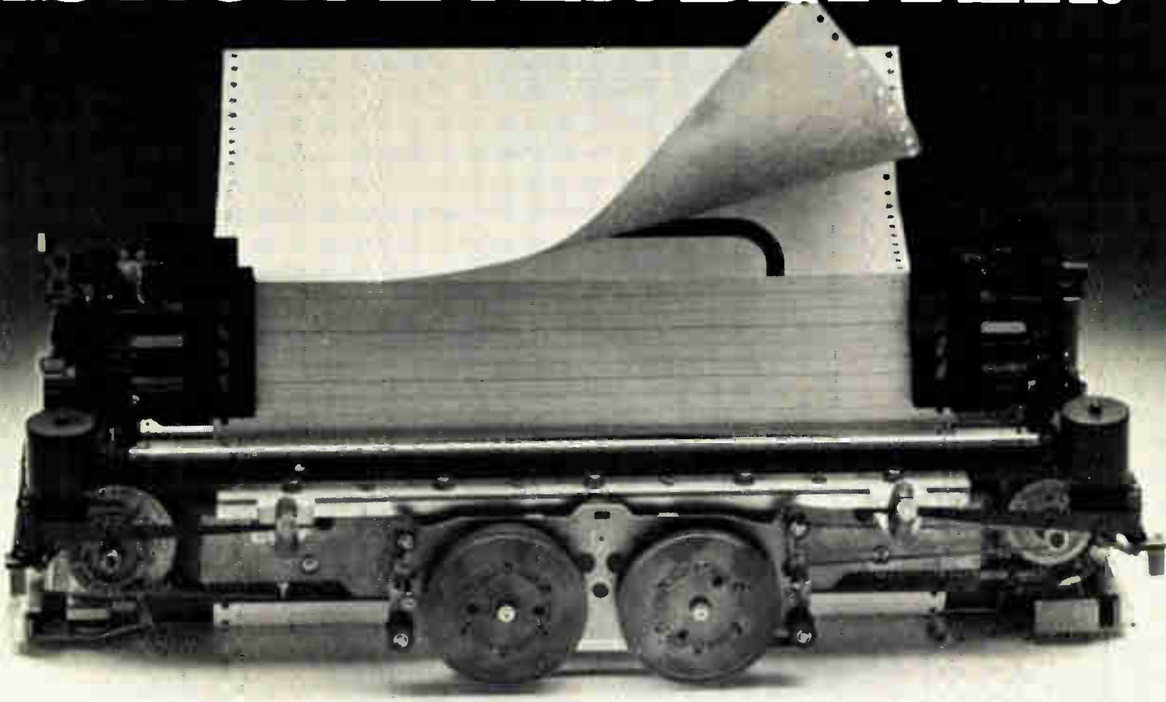
Circle 249 on reader service card

THE BEST 300 LPM PRINTER ON THE MARKET IS NOW EVEN BETTER.



In order to build up a customer base of more than 40,000 units in three years, you have to have a superior printer. And no matter how you look at it, the Teletype* model 40 printer has a lot going for it.

Look at cost. Nowhere does anyone offer as much in a 300 LPM printer for as little as the model 40 costs. At the OEM price of under $2000, it even compares favorably against low-speed printer costs.

Look at reliability. The model 40's unique design utilizes a minimum of moving parts for a maximum of on-line time. Plus proven LSI (Large Scale Integration) circuitry handles many functions formerly performed mechanically. This reduces hardware requirements and increases printer life.

Look at features. The unit is completely operational to give you everything necessary to go on-line. You also get 32 switch-selectable no-cost options to choose from, easily changeable character sets, and self-diagnostics.

Finally, look at product support. Not only do we offer nation-wide service, we'll maintain your printer for as little as $23 per month—and that includes labor and material.

With all that going for the model 40, how could we make it even better? Two ways.

First, we gave it a new, simplified OEM interface. Simply command the motor on, watch for the next character command, and send data.

Next, ribbon life has been significantly extended with our new re-inker mechanism that's available as a low-cost option.

No wonder we're getting a reputation as the OEM printer people.

THE OEM PRINTER PEOPLE

*Teletype is a trademark and service mark of the Teletype Corporation.

Circle 250 on reader service card

10-W amplifier covers wideband

Class A unit works from 1 to 1,000 MHz using hybrid coupling

The fourth and most powerful of Amplifier Research's W series of ultra-wideband Class A amplifiers, the model 10W1000 is the only unit of its kind on the market that can put out a linear 10 W in the frequency range from 1 to 1,000 MHz.

In that range, the unit provides a power gain of at least 40 dB that is guaranteed flat to within ±1.5 dB, although typical flatness is on the order of only ±1 dB. Up to 10 W, gain compression is less than 1 dB, but the unit can be pushed to produce 14 W. In the linear mode, harmonics in the output are at least 20 dB below the fundamental frequency, and the third-order intercept point is typically 50 dBm.

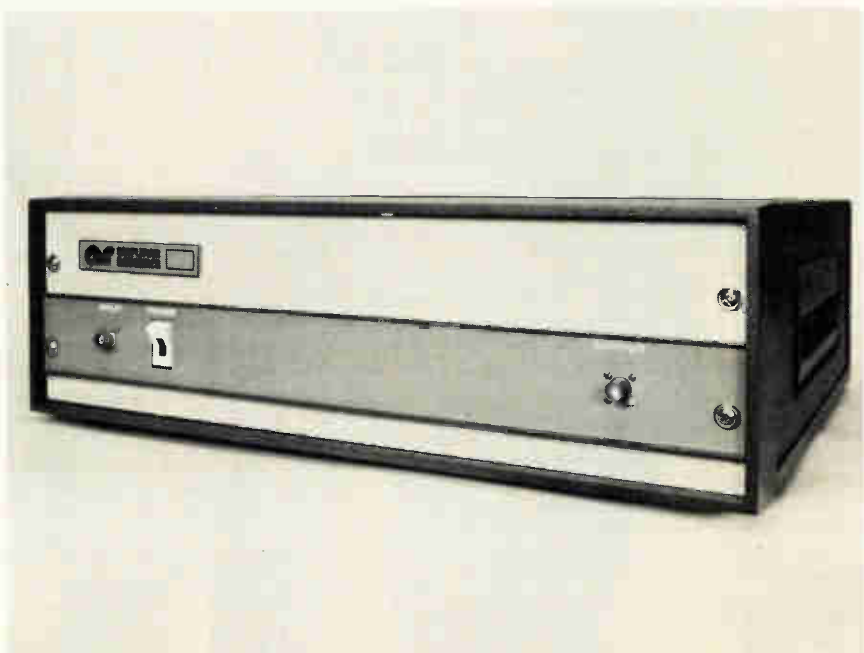
To obtain these power/bandwidth characteristics, Don Shepard, company president and the man largely responsible for the 10W1000's design, departed from the single power transistor techniques used for other models of the series and made use of hybrid coupling—combining the outputs of several amplifiers using ferrite isolators.

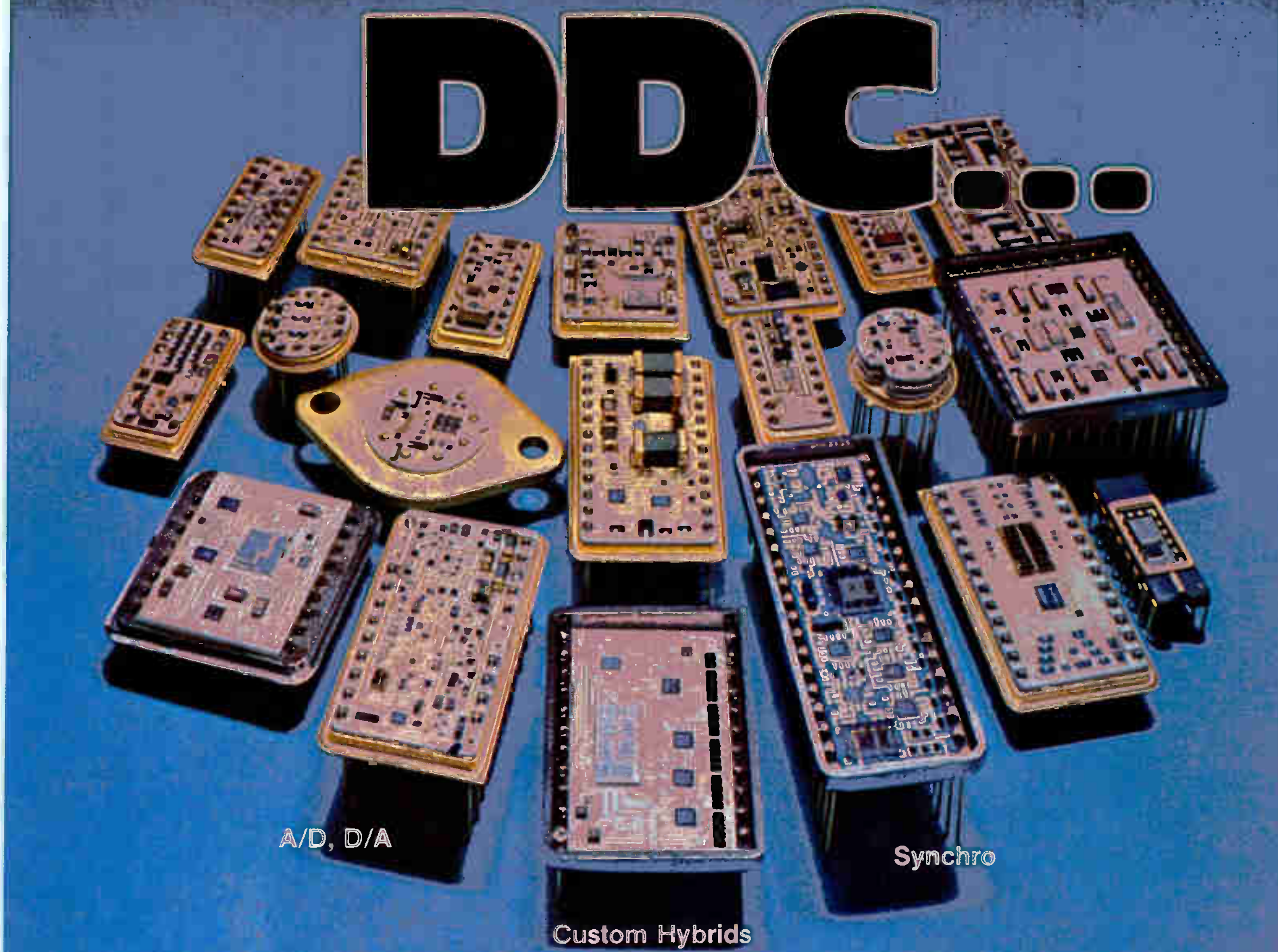
"We tried to find an individual transistor that could provide the linearity we needed at the right rating, but it doesn't seem to have been made yet," he explained. But by going to hybrid coupling, the company was able to retain most of the proven design of its earlier models.

The Class A device's specifications make it ideal for use as a single power amplifier for checking receivers of varying power and frequency characteristics and for radio-frequency interference testing. But Shepard notes that the unit was designed with the philosophy that "you can't control a customer's situation."

A knowledge of how people wanted to use the unit dictated its protection-circuitry design. When overdriven by 3 dB into an open load, the amplifier will automatically shut itself down after about 50 μs.

In many applications, the 10W1000 will be driven by a sweep generator, most of which have automatic gain controls. Since it takes the agc time to start having an effect





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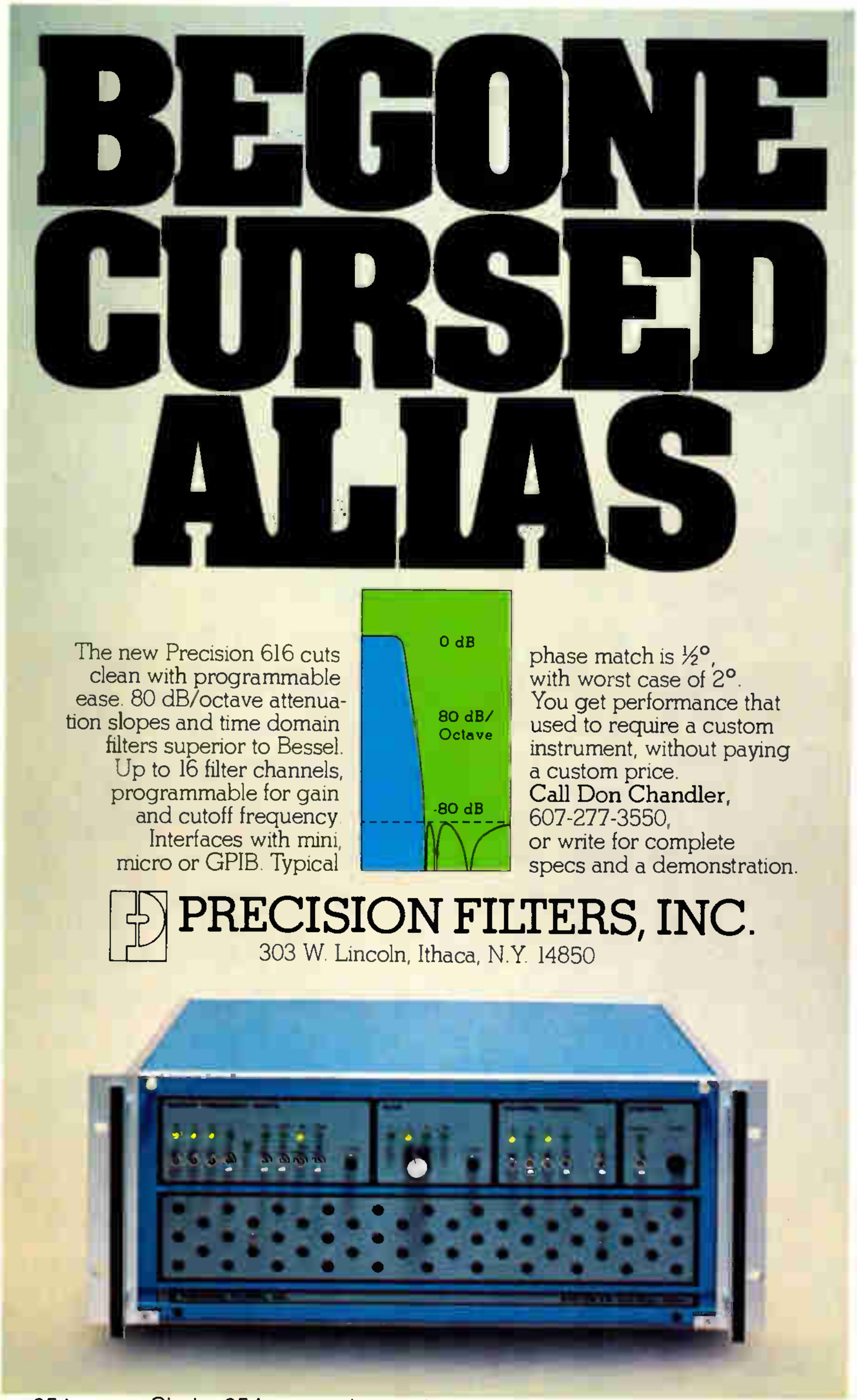
Circle 253 on reader service card

on the generator's output, the initial part of the sweep can overdrive the amplifier, but for such a brief period as not to be harmful; hence, the built-in delay.

The impedance of the input, as well as the output, is matched for 50 Ω. The unit exhibits a maximum input voltage-standing-wave ratio of 2:1; that for the output is at least 2.5:1; Further production line data should reduce that figure, according to Shepard.

The unit, complete with power supply, measures 19.8 by 8 by 18 in. and weighs 40 lb. It is priced at $4,900. Delivery is within 60 days.

Amplifier Research, 160 School House Rd., Souderton, Pa. 18964. Phone (215) 723-8181 [401]



Circle 254 on reader service card

30-MHz transistor boasts 200-W minimum power

Designed for use in military, commercial, and marine communications systems, the LØT-1000 is a 200-w transistor that is linear in the range from 2 to 30 MHz. The device's advanced packaging design keeps its thermal impedance at a low 0.42°C/w, assuring reliable operation at 100°C and at its minimum peak envelope power of 200w.

The semiconductor tolerates a voltage-standing-wave ratio of 3:1 at minimum, typically withstanding a 10:1 ratio in a collector-load configuration. Third-order intermodulation distortion is guaranteed to be less than −34 dB and is typically −36 dB. It is rated for a minimum

breakdown voltage of 110 v.

The LØT-1000 is priced at $51.50 in quantities of 100 to 499 and is available in sample quantities now. Production quantities will be available later in this quarter.

TRW Inc., RF Semiconductor Division, 14520 Aviation Blvd., Lawndale, Calif. 90260. Phone Dave Hoffmaster at (213) 679-4561 [409]

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Frequency synthesizer. The easy-to-use front panel lets you select sinewave, frequency (11-digit resolution) and up to 10V peak-to-peak amplitude into 50Ω. Direct readout of units on the 3325A is given in peak-to-peak, rms or dBm. And for low-distortion audio and VLF/ULF testing, the 3325A can be used as a low-cost frequency standard as well.

Function generator. Squarewaves to 11 MHz with 20 nsec rise time let you evaluate timing and gating circuits with precision. Or, use the triangle and ramp waveforms to 11 kHz with 0.05% linearity for accurate VCO testing and amplifier performance analysis.

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And there's more. Ten storage registers for quick recall, external amplitude and phase modulation, ±719.9° phase offset, auxiliary 21 to 61 MHz output, self test, and synchronization capability with other instruments. Plus two field installable options: An oven-controlled 10 MHz oscillator for stability of 0.05ppm/week ($550**) and a 40V peak-to-peak output to 1 MHz ($200**).

Get all the details on this new wideband frequency synthesizer, programmable function generator or phase-continuous frequency sweeper from your local HP field engineer.

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** Domestic U.S.A. price only.
*** HP's Implementation of IEEE Standard 488-1975

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098/44

Circle 255 on reader service card

oscillator, a crystal oscillator–buffer section, and the necessary mixers and logic circuitry. The device replaces about 8 to 10 transistors, a varactor, and two to three coils.

To provide linear voltage-to-frequency transfer characteristics, the device employs an external tuned tank circuit in conjunction with a lead-lag phase-shift network. The tank circuit sets the center frequency of the VCO, and the output signal is phase-shifted by the lead-lag network. Both the original output signal and the phase-shifted signal are then amplified and the two are summed. The amount of phase variation is determined by the control voltage that sets the ratio of the lead and lag signals. The resulting phase shift and the Q of the tank circuit determine the total range of the voltage-controlled oscillator.

The chip meets or exceeds the spectral purity requirements of the Federal Communications Commission for frequency synthesizer systems. When it is used in a 40-channel system, its spurious outputs are 70 dB below the carrier in band and 80 dB below the carrier out of band. Receiving-to-transmiting transfer time is about 10 ms, and transfer time from channel 1 to 40 is about 50 ms. The LM1862 requires a 7.5-V supply and dissipates 200 mW. It is priced at $2.50 in original-equipment quantities and is delivered 12 to 16 weeks after receipt of order.

National Semiconductor, 2900 Semiconductor Dr., Santa Clara, Calif. 95051. Phone (408) 737-5000 [404]

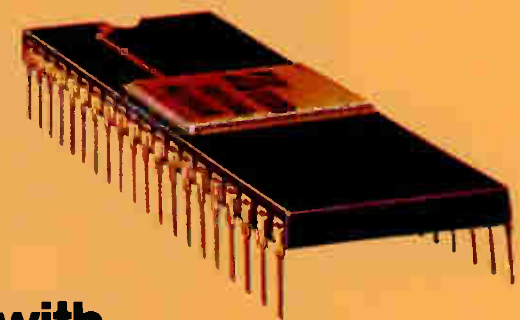
Duplex fiber-optic link uses simple mechanical hookup

Terminating fiber-optic communications lines can be such a difficult task that many designers are reluctant to avail themselves of the technology's potential benefits. Noting this aversion, Radiation Devices has so designed the Fibercom duplex data link that making fiber-optic connections is a simple mechanical process—one that can be performed by field technicians after only an hour's training.

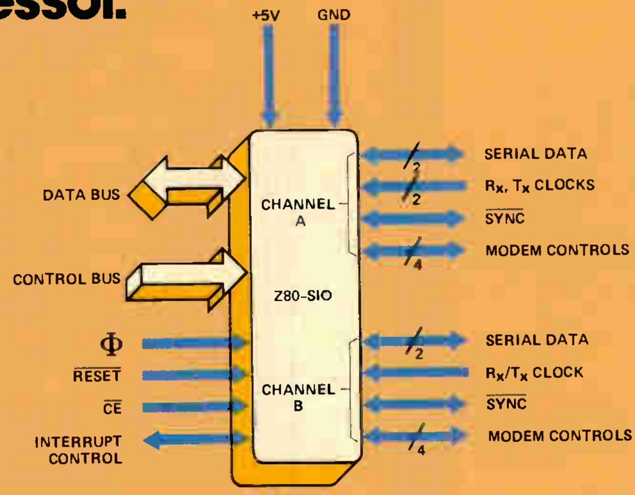
The system is designed to work with single-fiber cables consisting of a fused-silica optical fiber, typically surrounded first by cladding, then by a buffering layer and a strengthening member, and finally by an outer jacket. The basic components of the duplex link are an optical source, a detector, and two sets of connectors.

Connecting a cable to the source or detector is a simple two-part process. First, about 30 cm of the cable's outer jacket and strengthening member are stripped away, and the cable is passed through a compression fitting until the leading edge of the remaining jacket and member just pass through the

Now Zilog does double-duty.



Introducing the world's first dual-channel data communications device. It works with (almost) anyone's microprocessor.



The Z80 Serial Input/Output: Here at last is a general-purpose device that can efficiently solve data communications problems for just about any microprocessor on the market.

The Z80-SIO is the world's first dual-channel, multi-protocol, serial communications interface circuit. It supports all serial data communications techniques with a single, N-channel (+5V) 40-pin device.

What else would you expect from the company that's pledged to stay a generation ahead in microcomputers?

Check out the Z80-SIO today. It's on your Zilog distributor's shelves right now in prototype or production quantities. Make double sure your next design delivers all the performance you're looking for.

CHANNELS:	Two independent, full-duplex with modem controls.					
DATA RATES:	0-550k bits/second (Z80-SIO); 0-880k bits/second (Z80A-SIO).					
OPERATING MODES:	Asynchronous; bisynchronous (with CRC generation and checking); SDLC/HDLC (with CRC generation and checking).					
COMPATIBLE WITH:	Z80/Z80A	8080A	8085A	6800	6500	9900

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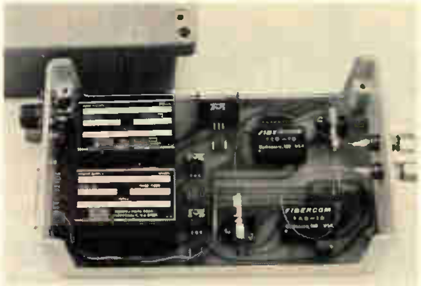

fitting. Hand-tightening this fitting fastens the cable securely to the link.

Once the cable is secured, 3 cm of buffer and cladding is stripped away, and the optical fiber thus exposed is sheared off with a low-cost cleaving tool. Thus prepared, the end of the cable is pushed into the source or detector assembly until it "bottoms out" onto the actual source or detector element. The element is protected by a tough, yet resiliant, conformal coating so that neither the element nor the cable can be scratched; mating is simplified by the fact that the diameters of the source and the detector are much greater than that of the optical fiber. Connection is completed by tightening a nut on the assembly, locking the optical fiber in place.

Depending upon the model chosen, data rates of up to 500 kilobits/second or 5 megabits/second are attainable. Choosing a 400-μw or 40-μw source provides transmission distances of 2,000 or 200, respectively. The units can be configured for use with 115-v ac or 15-to-24-v dc supplies and transistor-transistor-logic or RS-232 inputs and outputs. Individual units are priced from $425 to $875 depending on options, and delivery is four to six weeks.

Radiation Devices Inc., P. O. Box 8450, Baltimore, Md. 21234. Phone Patricia Rybak at (301) 628-2240 [403]

Solid-state replacement for TWT amplifier is long-lived

Offering an extremely long life cycle—approximately 50,000 hours—the AD 181003 is a solid-state replacement for traveling-

Our family gives you a flat answer.

Our new flat cable connector family has both standard and stackable sockets, PCB connectors and headers, all designed for lowest total applied cost.

In socket connectors our BA Series gives you a low profile package with the option of either open or closed cover design for both end-cable and through-cable applications.

Our BD Series stackable socket line concept permits stacking two connectors on a wire-wrappable post.

For direct solder applications our BC Series handles PCB connector needs.

Featured with the product family is a simple universal termination system designed for minimum tooling cost.

For your header applications our low profile BB Series line is available for both vertical and right-angle mounting in solder or wire-wrappable designs.

Contact GTE Sylvania, Connector Products Operation, Box 29, Titusville, PA 16354. Phone: 814-589-7071.

Remember, good connections run in our family.

SYLVANIA GTE

Circle 259 on reader service card

wave-tube amplifiers that operate in the 18-to-26-GHz frequency range.

The unit has a minimum gain of 38 dB and a maximum noise figure of 10 dB. It employs standard rf connectors and a WR42 waveguide; it can operate from power supplies that provide either 115 v ac or −15 v dc. It will also operate in military environments.

Units are priced at approximately $8,000 and are available in 60 to 90 days.

Aercom Industries Inc., 405 Tasman Dr., Sunnyvale, Calif. 94086. Phone (408) 744-1320 [407]

Band-splitting filter keeps Touch-Tones 40 dB apart

Designed for use as the front end of a dual-tone multifrequency, or Touch-Tone, receiver, the TTF-1 is a band-splitting filter that works directly with such decoders as Mostek's MK-5102 and Collins/Rockwell's CRC 8030 without any additional parts.

The passband gain of the device can be set by the user with a single resistor and is variable from a minimum of −10 dB to a maximum of +40 dB. Attenuation for 941-Hz and 1,209-Hz signals is typically 45 dB, whereas for 60-Hz/697-Hz signals it is 17 dB. Input impedance is 50 kΩ minimum, and power consumption is typically 25 mw. The TTF-1 operates from a nominal 5-v supply that can vary up to 18 v.

In single quantities, the device is priced at $48 and is available from stock to six weeks.

Konix International Corp., P. O. Box 4929, Margate, Fla. 33063. Phone George Tunny at (305) 753-0474 [408]


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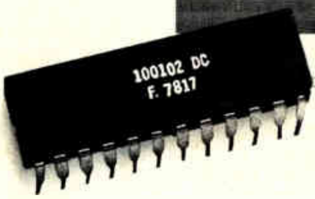
And, it's a big family: 33 logic circuits, seven compatible memory products, and an LSI gate array. Plus an 8-bit slice with parity on the way.

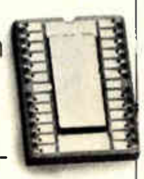


What it all means is this: You can now build a faster system with fewer parts without adding power or new logic.

Lightning-fast logic.

Our new ECL family incorporates the fastest standard family of integrated circuits on the market today. The F100K family. Produced with Fairchild's advanced Isoplanar II process. Featuring gate delays of 750 ps. And four-to-five-level-deep MSI circuits with delays of 2.5 to 3 ns.

F100K is fully voltage and temperature compensated. It offers you high speed at reduced power. A high level of on-chip integration. The most flexible logic functions available. And optimum I/O pin assignments to minimize crosstalk, noise coupling and feed-through; and facilitate OR-ties and power-bus routing.



F100K circuits come in both a 24-pin flatpak and ceramic DIP.

F100K SUB-NANOSECOND ECL LOGIC PRODUCTS

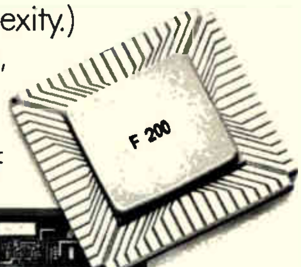
Device	Function	Available
100101	Triple 5-input gate	now
100102	Quint 2-input gate	now
100107	Quint ex-or/nor	now
100112	Quad driver	now
100114	Quint line receiver	now
100117	Triple AOI	now
100118	5-wide AOI	now
100122	9-bit buffer	now
100123	Hex bus driver	now
100130	Triple D latch	now
100131	Triple D flip-flop	now
100136	Multipurpose counting register	now
100141	8-bit universal shift register	now
100142	4 X 4 content addressable memory	now
100145	16 X 4 register file	now
100150	Hex D latch	now
100151	Hex D flip-flop	now
100155	Quad multiplexer/latch	now
100156	Mask-merge	now
100158	8-bit shift matrix	now
100160	Dual 9-bit parity checker/generator	now
100163	Dual 8-input multiplexer	now
100164	16-input multiplexer	now
100165	Universal priority encoder	now
100166	9-bit comparator	now
100170	Universal demux/decoder	now
100171	Triple 4-input multiplexer	now
100179	8-bit carry lookahead	now
100180	Fast 6-bit adder	4Q '78
100181	4-bit ALU (binary/decimal)	now
100182	Wallace tree adder	4Q '78
100183	2 X 8-bit recode multiplier	4Q '78
100194	Quint transceiver	now

The short-delay array.

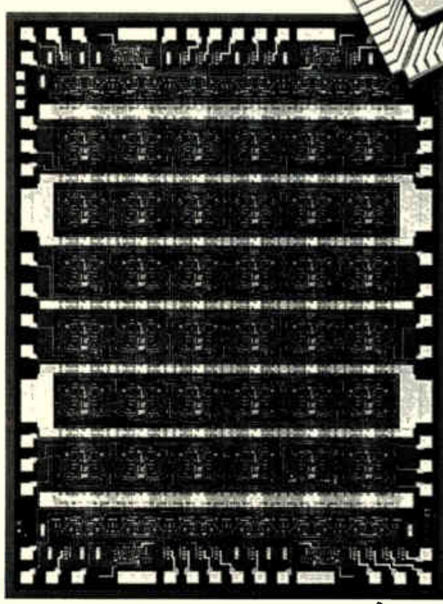
F100K COMPATIBLE MEMORY PRODUCTS			
Type	Organization	Speed (MAX)	Status
100145A	16 X 4 RAM	10 ns	production
100414	256 X 1 RAM	10 ns	production
100415	1024 X 1 RAM	20 ns	production
100416	256 X 4 PROM	20 ns	production
100422	256 X 4 RAM	10 ns	4th Qtr. '78
100470	4096 X 1 RAM	35 ns	sompling
100475	1024 X 4 RAM	25 ns	2nd Qtr. '79

To make a fast system faster, you have to reduce interconnection delays. And that means LSI. Which means choosing between standard bipolar slices, dedicated custom design and uncommitted arrays.

Our new F200 ECL gate array family makes your decision easy. It's considerably faster than bipolar bit slice approaches. It's less costly and less time-consuming than dedicated custom design. (The design cycle is about five months, as opposed to 18 months for a dedicated LSI design of equivalent complexity.) And it gives you the advantages of uncommitted LSI arrays, without any of the disadvantages.

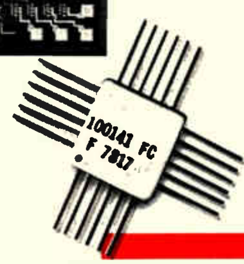


The F200 gate array offers typical gate propagation delays of 750 ps. It is totally F100K compatible. It consists of a master diffusion set of 168 discrete ECL gates (switches), designed for complete hook-up flexibility. Functions for up to 250-300 equivalent gates may be designed by customizing both layers of metallization. Ease of layout is facilitated by a comprehensive macrocell library.



The array contains 144 2-input internal low-level gates, arranged in a 6 X 6 matrix of cells. Each cell consists of four gates. There are also 24 output high-level gates, each having 50Ω line-drive capability.

The F200 array comes in both a 52-pin leadless package for liquid cooling and a 68-pin JEDEC LSI package for air-cooled systems.



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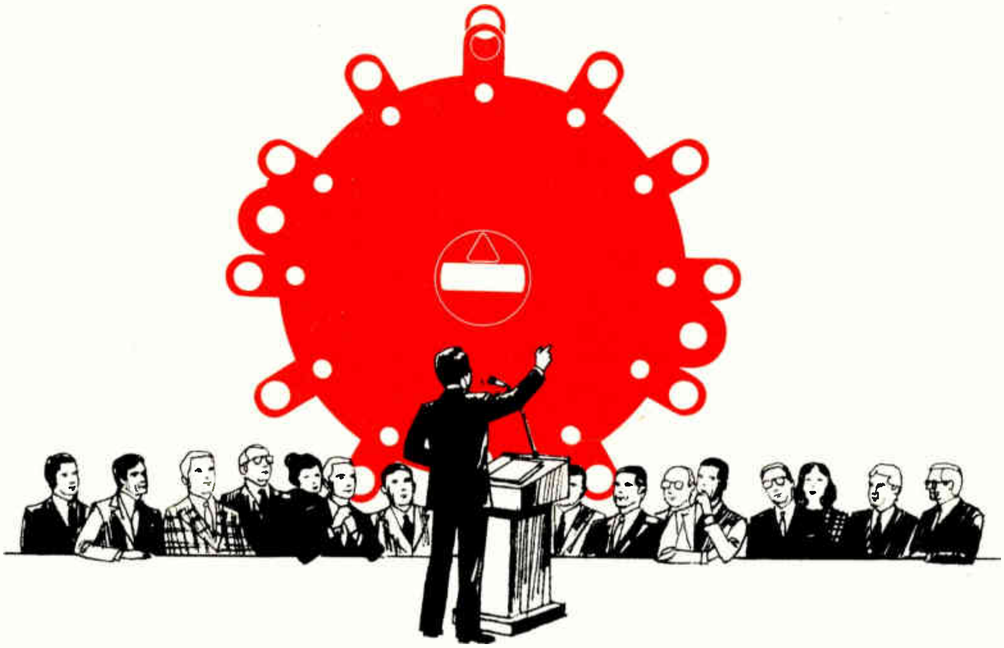

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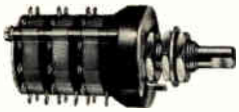

SERIES 42-44

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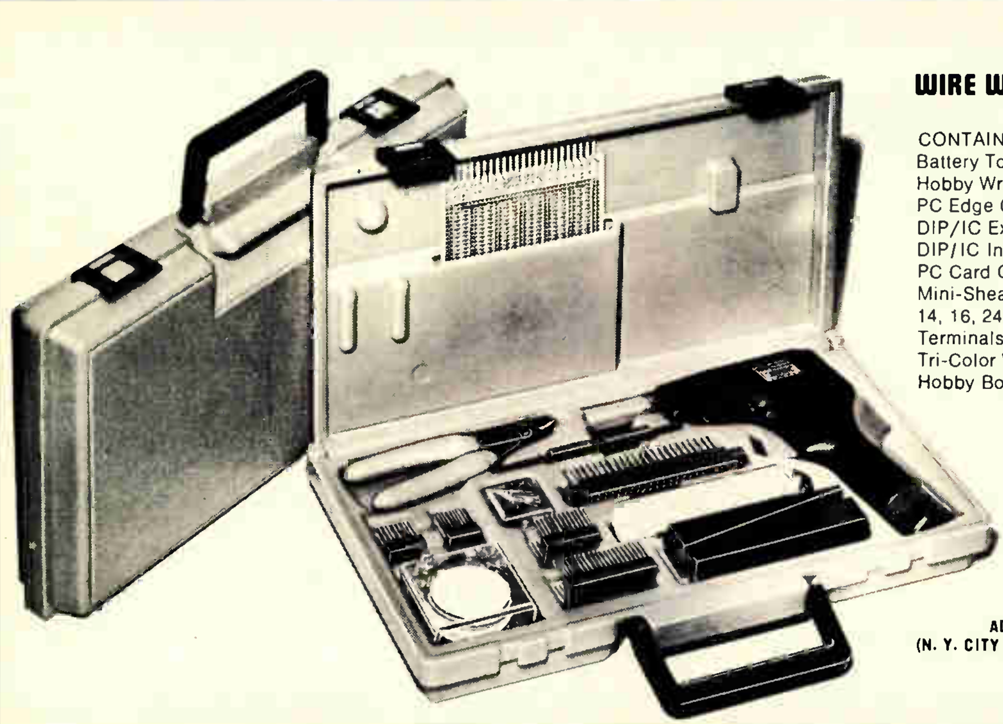

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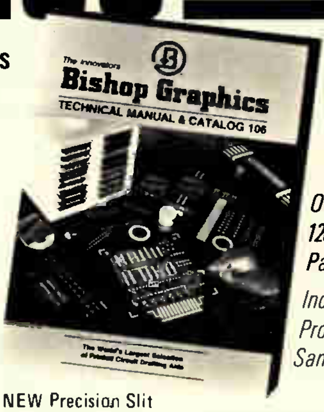

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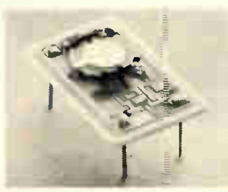

Pinched for space? These 4-pin ceramic DIP crystal oscillators are only .200" high, .820" long, .520" wide. Frequency ranges: TTL, 31.5 KHz—60 MHz; CMOS, 250 Hz—10 MHz. Stability: ± .01% and ± .1% standard. As low as ± .0025% available. Temperature range: 0° to 70° C. Typical price (100 pieces, 10 MHz): $7.50 each.

For complete specs circle Reader Service Number or write: CTS Knights, Inc., 400 Reimann Ave., Sandwich, IL 60548. Phone: (815) 786-8411.

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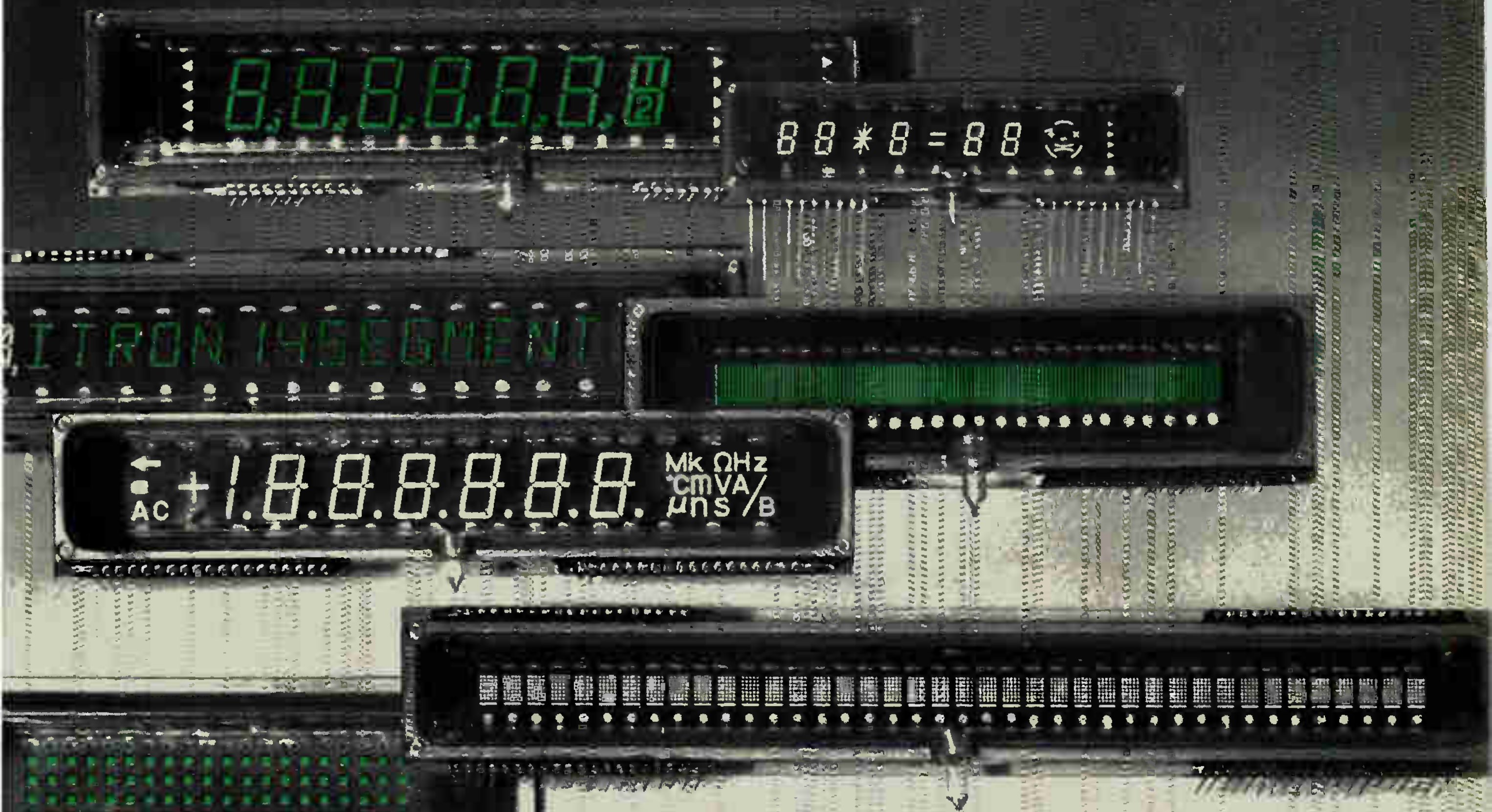
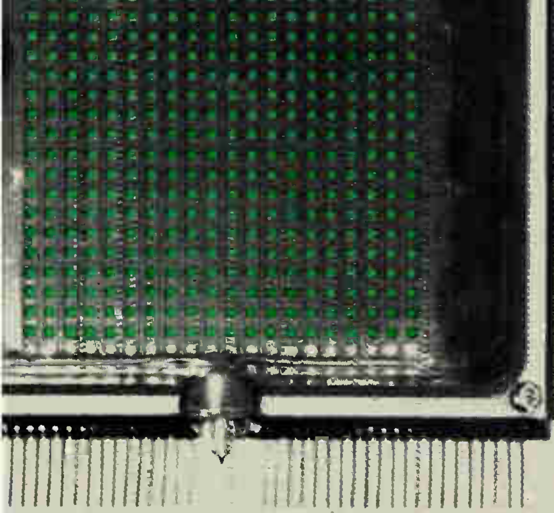
Circle 111 on reader service card

Why limit your application opportunities? Go with Noritake's optimized Itron displays!





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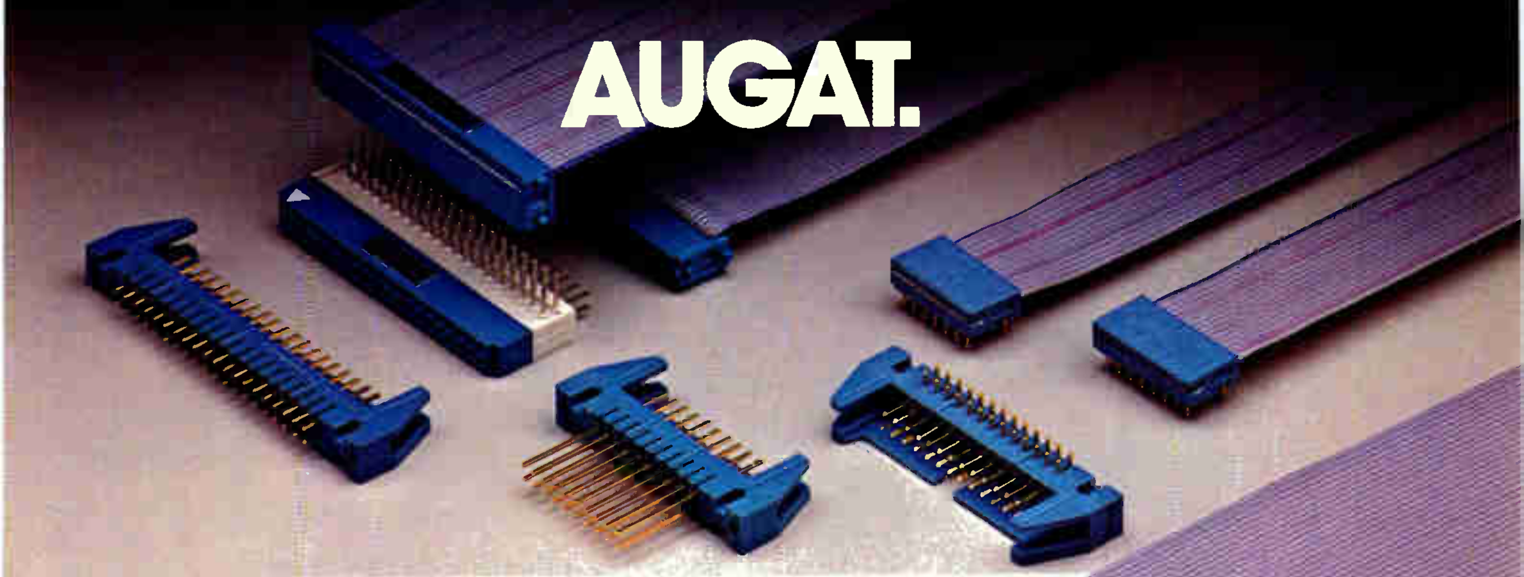

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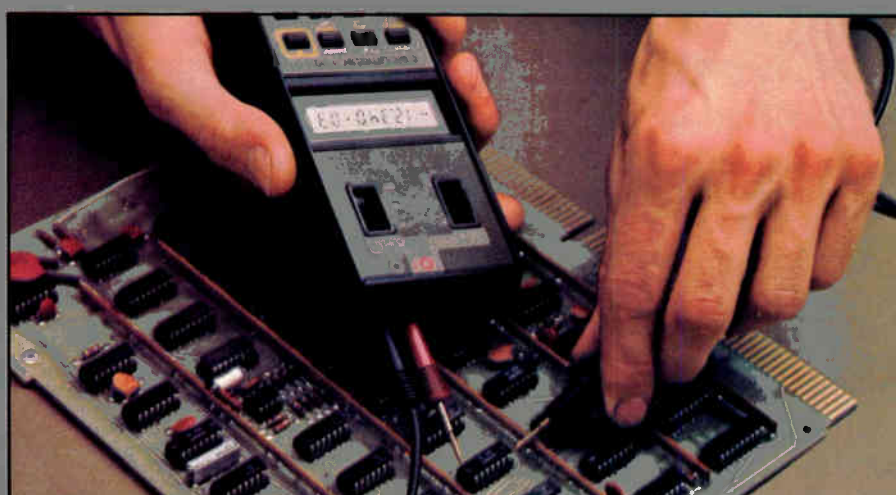

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V					SCIENTIFIC NOTATION
Ω	⎓ dc	FIXED RANGES	CONTINUOUS MEASUREMENTS	SPECIAL MEASUREMENT MODES	FIXED DECIMAL

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*Exclusive sales agent for all Calcumeter products designed and manufactured by Electro Scientific Industries.

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A must for anyone desiring automatic data printout, this low cost printer plugs into the Calcumeter's bidirectional data port next to the output jacks. Internal clock permits interval sampling ranging from 3 seconds to three hours. Five button control. AC powered.

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	Temperature Probe #4120	69.00	
	Battery Eliminator #4110	12.50	
	RF Probe #4122	69.00	
	Banana Plug Adaptor #4115	6.00	
	Foot Switch #4116	18.00	
	Soft Case—Calcumeter #4118	9.50	
	Soft Case—Printer #4119	9.50	
	Current Probe #4132	89.00	
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25 years

Designed and produced by
ELECTRO SCIENTIFIC INDUSTRIES, INC.
Portland, OR.

Industrial

Control unit has programmer

Nine setpoint-versus-time programs reside in unit with three-mode controller

Continuing its evolutionary campaign to apply the benefits of microcomputer technology to the industrial-control area, Honeywell's Process Control division has developed what it believes is the first microprocessor-based digital control programmer that combines, in a single box, a setpoint-versus-time programmer and a three-mode controller. Unlike the earlier TDC 2000, which applied the microprocessor to large, interactive systems, the new DCP 7700 is a dedicated controller for unit processes. Typically, it will be used to control the temperatures of furnaces, environmental chambers, ovens, kilns, and the like.

Built around an Intel 8080, the DCP 7700 is capable of storing up to nine separate programs consisting of a total of 200 functions. Each function can be a ramp, a soak, or a switch actuation. Among the key features of the new programmer-controller are a nonvolatile memory that needs no battery backup to retain stored programs during a power failure, key-lock security to prevent unauthorized changing of programs, and an extensive self-diagnostic program that exercises all of the unit's electronics, displays, and push buttons.

All functions, including the writing, verifying, and editing of programs, are controlled by front-panel push buttons. One time- and memory-saving feature is an automatic cycle command, which causes a program to repeat itself a preset number of times.

Another important feature, which can be implemented or disabled in the field, is guaranteed soak; this allows a soak to proceed only when the process variable gets within an adjustable error band around the set point. The soak period starts at that time.

The controller portion of the instrument can be provided either with a standard 4-to-20-mA current output or with a time-proportional output implemented by a set of relay contacts. The current can work into resistances from 0 to 1,000 Ω. The relay, whose contacts are rated at 120 V and 3 A, has an adjustable cycle time of 2 to 120 seconds.

A three-mode unit, the controller provides proportional, derivative, and integral action. Its output can be controlled automatically or manually, and it can perform bumpless

transfers from one mode to the other. Its temperature range can be field-selected for Fahrenheit or Celsius by an internal slide switch. Any standard thermocouple can be accommodated, as can a 100-Ω platinum resistance temperature detector. The unit can also accept 4-to-20-mA, 0-to-1,000-mV, and 1-to-5-V linear inputs.

The 7700 communicates in engineering units. Temperatures are set in degrees, not in percentages.

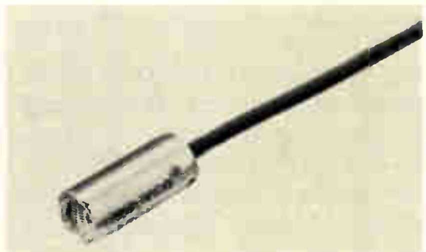
In small quantities, the model 770011 programmer-controller sells for $2,990. Three programmer-only models are also available: the single-programmer model 770010 at $2,400, the dual 770020 at $2,500, and the triple 770030 at $2,600. Quantity discounts are available on all four units. Delivery times are 10 to 12 weeks after receipt of order.

Honeywell Process Control Division, 1100 Virginia Dr., Fort Washington, Pa. 19034 [371]

Small microphone hears big noises

Designed to measure high-intensity sound during flight testing of jet aircraft, the model 8550M1 piezoresistive microphone responds to audible sounds from 100 to 190 dB SPL with a high-level output. The tiny transducer measures just 0.17 in. in diameter and 0.37 in. in length and weighs 10 g, including cable.

A sculptured-silicon diaphragm



that has a Wheatstone bridge with four active arms diffused into its surface is responsible for the unit's performance and ruggedness. Operation is in the gage mode, with the back of the diaphragm referred to atmospheric pressure through the cable. Hybrid circuitry within the case provides temperature compensation up to 200°F.

Endevco Dynamic Instrument Division, Rancho Viejo Road, San Juan Capistrano, Calif. 92675. Phone Jon Wilson at (714) 493-8181 [374]

Relative humidity transducer features fast response speed

Changes in relative humidity are sensed by the electrically conductive surface layer of the PCRC-11 transducer. Although the surface layer is integral with a nonconductive dielectric substrate, it is uncoated; therefore, the 7/8-by-1 5/8-by-1/16-in. unit adsorbs, rather than absorbs, water. This lowers the unit's response time, hysteresis, and temperature coefficient.

The sensor monitors relative humidity from 0% to 100% over a

Smart performance on a dumb budget.

For the cost of a dumb instrument, you can now have a very sophisticated microprocessor controlled universal timer/counter. The new Racal-Dana Series 9500.

The Series 9500 gives you our patented Auto Trigger function that automatically sets trigger levels to the ideal trigger point of each incoming waveform at the touch of a button. No more hunting, no more guessing.

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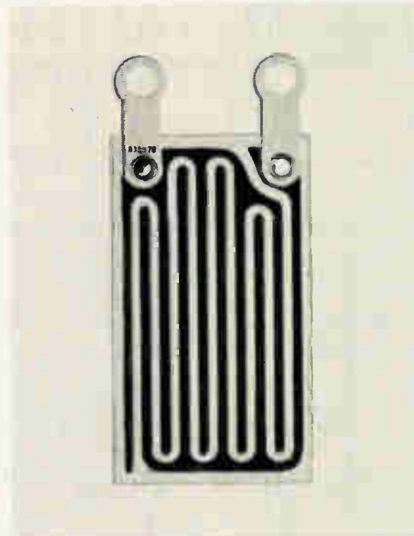
Racal-Dana Instruments, Inc., 18912 Von Karman Ave., Irvine, CA 92715. Phone: 714/833-1234.

RACAL-DANA

RACAL

Circle 4 for Product Demonstration
Circle 275 for Literature Only



temperature range of −60°F to +200°F. Response time is largely a function of ventilation. At zero ventilation, the transducer takes at least 30 seconds to register a 63% change in relative humidity; this drops to milliseconds with moderate air ventilation.

Phys-Chemical Research Corp., 36 West 20 St., New York, N.Y. 10011. Phone (212) 924-2070 [375]

Bidirectional controller stores 50 preset numbers

The Series 7920 Multicontroller automatically controls multistep machining and processing operations with the help of a microprocessor-based predetermining counter.

Preset numbers are entered into the counter on a front-panel keyboard. Count and preset information appears on a six-decade light-emitting diode display, while the preset row number shows up on a second display. Input circuitry accepts pulses up to 10 kHz in unidirectional operation and quadrature, add/subtract, and count-direction inputs in the bidirectional mode. Common or individual prewarn/slowdown outputs operate while counting up as well as counting down.

A nonvolatile memory permanently retains all count, preset, and programming data. Open-collector

output sequencing and hold time, as well as other operating modes, are also entered through the front-panel keyboard. The Model 7920 also includes a separate six-decade predetermining batch counter.
Veeder-Root, 70 Sargeant St., Hartford, Conn. 06102. Phone A. Patricelli at (203) 527-7201, Ext. 422 [376]

6- or 8-digit counter-timer has built-in battery

Depending on which plug-in function card is inserted into the 8000 Series counter-timer, it can operate as a direct counter of switch closures or ac or dc pulses, a programmable timer, a rate meter, or a digital tachometer. All function cards are field-programmable for high-speed counting and use in electrically noisy environments.

The unit itself is available in six- and eight-digit versions, using orange light-emitting diodes. The 8000 Series contains a built-in 110/220-V, 50/60-Hz power supply, from which 110 mA at 5 V is available to drive photoelectric and proximity devices and shaft encoders. Also included is a rechargeable nickel-cadmium battery capable of supporting the count for six months

New products

during power outages.

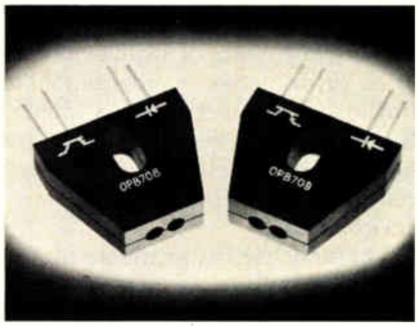
The 8000 Series is available in panel-mounted, wall-mounted and base-mounted versions. Delivery is from stock; prices start at $130.

Kessler-Ellis Products Co., Atlantic Highlands, N. J. 07716 [377]

Reflective object sensors are low-cost, reliable

For noncontact sensing applications such as paper-edge detection, motor-speed control, and proximity detection, the OPB 708 and 709 reflective object sensors combine high efficiency with solid-state reliability.

Each mates a solution-grown light-emitting diode with a photosensor—a silicon npn phototransistor in the OPB 708, a photo-Darlington in the OPB 709—in a molded plastic package. The photosensor receives radiation from the LED only when a reflective object is in its field of view, so it could be used in, say, an automated container-filling operation to



initiate the flow of the liquid or powder to be packaged.

With the unit positioned 0.150 in. from a reflective surface and a LED current of 40 mA, typical output current for the 708 is 50 μA for a 90% diffuse surface, 1 mA for a specular surface like aluminum foil. Under the same conditions, the OPB 709's output current would be 7.5 mA and 100 mA, respectively.

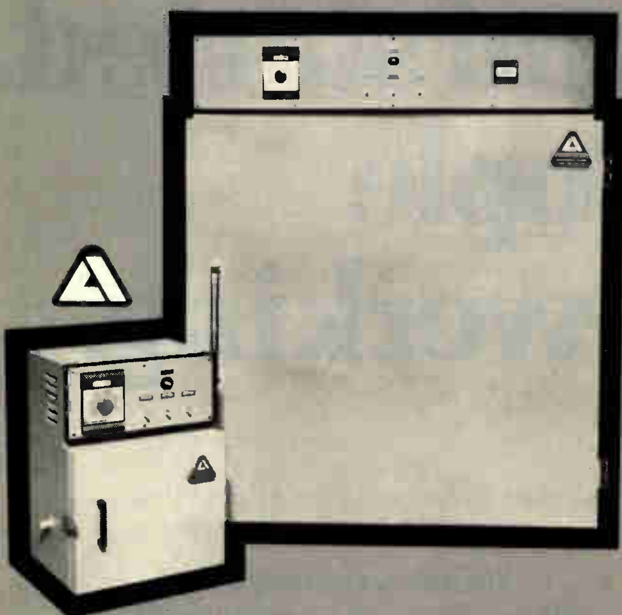
Both models are available from stock. In quantities of 1000, the OPB 708 is priced at $1.75, while the OPB 709 costs $2.75.

Optron Inc., 1201 Tappan Circle, Carrollton, Texas 75006. Phone (214) 242-6571 [378]

Circle 28 on reader service card

ASSOCIATED ENVIRONMENTAL SYSTEMS

Reliable Low Priced Chambers



Low cost liquid CO_2 cooled BK series chambers from ½ ft.³ to 27 ft.³ working volume. Temperature ranges from −100°F to +425°F with control stability ± ½°F. All with RFI free, solid-state controls, forced air circulation, adjustable high temp failsafe, stainless steel interiors, all as standard items. Automatic programmers, various size viewing windows, access ports, liquid Nitrogen (LN_2) cooling, and ambient air cooling are optional.

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For those customers with longer test requirements, Associated offers the most complete line of self contained mechanical, cascade refrigeration chambers — the SK and FK Series. Ranges from −120°F to +350°F with control stability ± ½°F. Bench top units in 1, 2, 5, 8 ft.³ and floor models in 14, 33, and 64 ft.³. Associated also offers a complete line of temperature-humidity, salt spray test component chambers and walk-in rooms.

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Subsidiary of Walter Kidde & Company, Inc.
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 Circle 30 on reader service card

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For specifications on 5 to 250 pound capacity Minibeams that operate in tension or compression—for details on load cells with capacities to 100 tons, contact Interface, Inc., 7401 E. Butherus Dr., Scottsdale, AZ 85260 USA. (602) 948-5555. Telex 668-394.

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interface
ADVANCED FORCE MEASUREMENT

Circle 31 on reader service card

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4 thru 50 Bellowform Contacts

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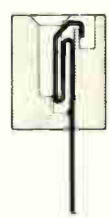
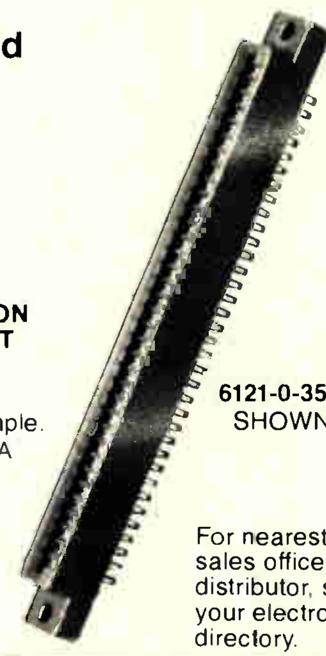


TYPICAL SECTION THRU CONTACT



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Continental Connector Corporation
34-63 56th Street, Woodside, N.Y. 11377
PHONE: (212) 899-4422

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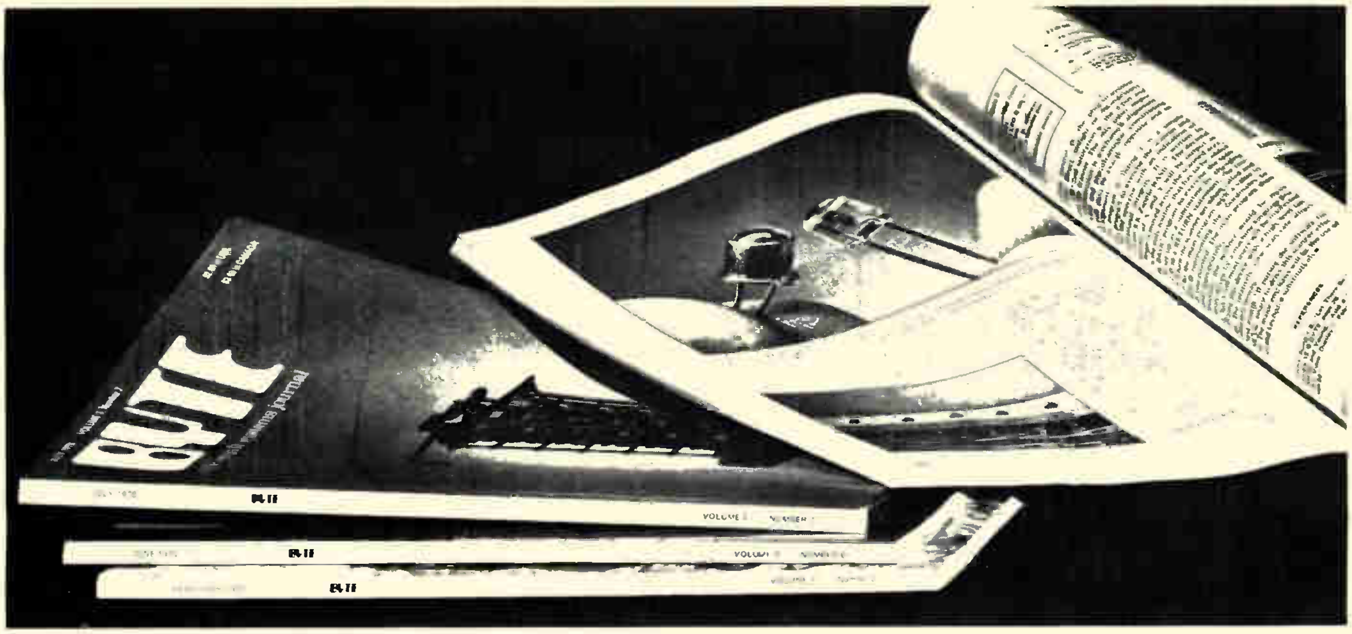

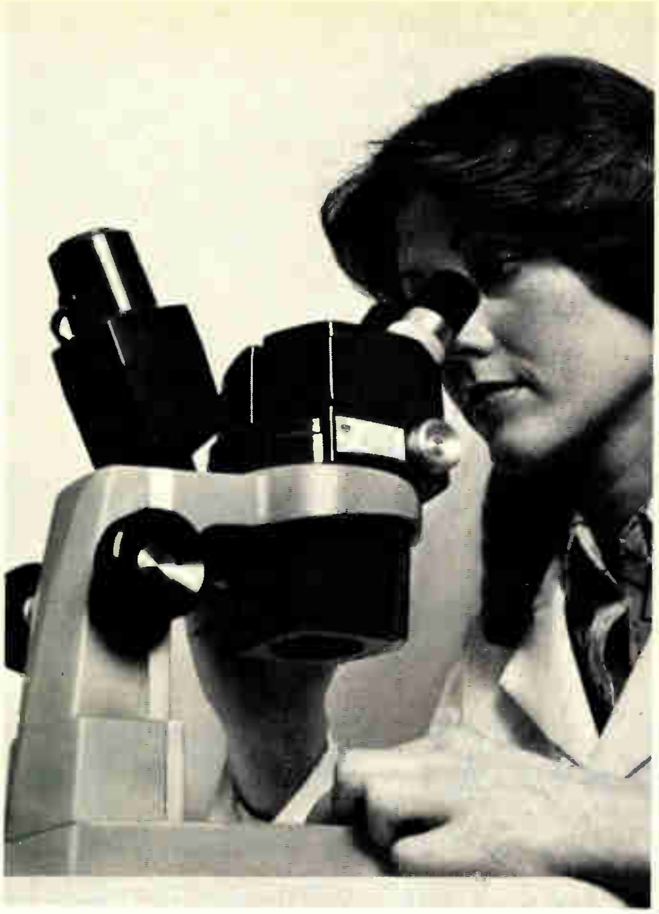

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New products

Data acquisition

Analog boards mate to Multibus

ADAC 710 series interfaces with Intel, National single-board computers

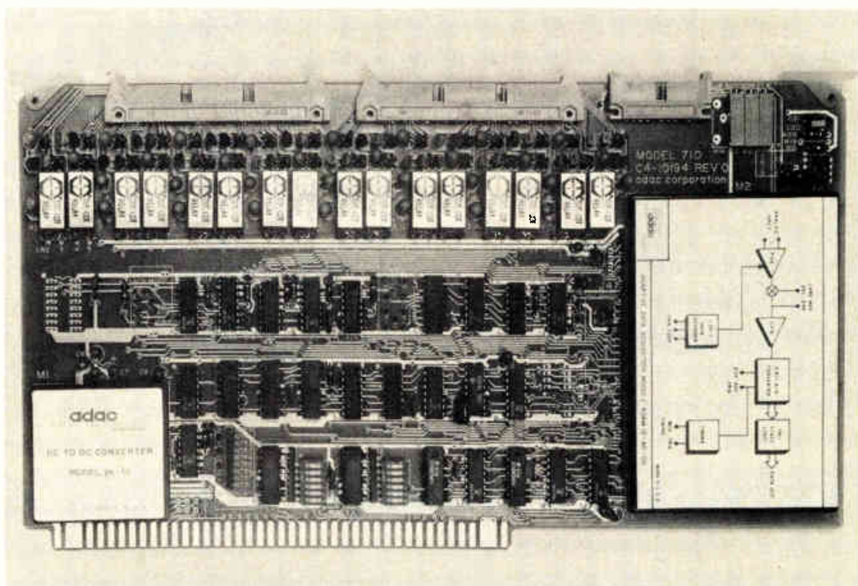
Microcomputers are increasingly finding their way into industrial and process-control applications. That means they often have to acquire low-level dc signals from strain gauges, thermocouples and other transducers in noisy, high-voltage environments. To simplify that task, engineers at ADAC Corp. have come up with a series of analog-input boards that interface directly with the single-board computer bus used by Intel Corp.'s iSBC and National Semiconductor Corp.'s BLC series.

The ADAC 710 series will acquire signals from 10 mv to 500 mv full scale, with a resolution of 2 μv, for processing in the Intel SBC-80/10, SBC-80/20 and MDS-800 systems, and the National BLC-80/10. A. L. Grant, ADAC's vice president for marketing, is not claiming a first with the low-level capability for those systems, but says he knows of no similar input boards that offer the useful combination of features embodied in the series.

Those features include the ability to withstand common-mode voltages up to 250 v and still pick up the low-level imputs; a 12-bit successive-approximation analog-to-digital converter combined with a software-programmable-gain amplifier; and an optional cold-junction-compensation circuit that can be software-programmed on a channel-to-channel basis to allow direct operation with all standard thermocouples. "Combined with the fast sampling rate of 200 samples per second, we think these features make these boards unique," Grant maintains.

The model 710-8 is the version of the board offering eight differential input channels; it sells for $895 in quantities of one to four. The 710-16 will accommodate 16 channels of low-level inputs and is priced at $1,195. Either of the boards can provide the cold-junction-compensation circuit for thermocouples for an additional $75.

In addition, expander boards are available that increase the number of input channels by 8 and 16, respectively. They are the models 710-RX-8 and 710-RX-16, which are priced at $695 and $995, respectively. They, too, can accommodate the cold-junction-compensation circuit. With the appropriate connector, up to seven of the 710-RX 16-



channel expansion boards can be arranged in a daisy chain.

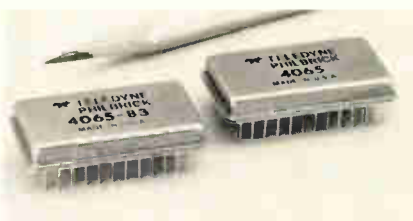
The basic data-acquisition system on all the boards contains ADAC's multi-reed-relay flying-capacitor low-level multiplexer. The 710 series can operate with a software choice of program control or program interrupt and a jumper choice of memory-mapped I/O or isolated I/O. The software-programmable-gain amplifier includes automatic zeroing and six gain settings: 10, 20, 50, 100, 200, and 500 mv full scale. Delivery of any model is 30 days after receipt of order.

ADAC Corp., 15 Cummings Park, Woburn, Mass. 01801. Phone A. L. Grant at (617) 935-6668 [381]

12-bit d-a converter settles accurately in 100 ns

With high-speed microprocessors muscling into the industrial market, critical control applications will require digital-to-analog converters that are not only reliable and accurate but fast as well. Two 12-bit d-a converters, models 4065 and 4065-83, are ready to meet that demand; they settle to within 0.01% for a full-scale step in a blinding 100 ns maximum, 60 ns typical.

Laser-trimmed thin-film networks and proprietary quad current switches translate the converters' transistor-transistor-logic-level inputs into current outputs. Output ranges of 0 to 4 mA or −2 to +2 mA are pin-selectable. The monotonicity range for both units is from −36°C to +125°C; within that range, nonlinearity is typically within ±½ least significant bit and differential nonlinearity is guaranteed not to exceed 1 LSB. At 25°C, both those specifications are within ±½ LSB



You may not know how expensive a pushbutton really is until months after it's paid for.

The true measure of a pushbutton's cost isn't so much what you pay. It's how many times you pay it.

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If you spend less in the first place, you could end up with a higher price tag from what you spend over and over in repair costs and downtime.

That's why it's worth it to specify the MICRO SWITCH Advanced Manual Line (AML) of pushbuttons, rockers, paddles and indicators. It's the most complete line of manual controls ever offered, designed to save you money from start to finish.

AML is easy to wire, thanks to single-level termination, simple snap-in PC board mounting and sub-panel mounting that uses individual, strip or matrix hardware (see inset). The result is low installed cost.

And of course, you get traditional MICRO SWITCH reliability and long life. Which means money savings over the long haul.

No matter how many words you use to describe the broad AML lineup, it all comes down to just two: cost effectiveness. For a panel that's pleasing to the eye as well as the budget.

If you'd like a personal demonstration just call 815/235-6600.

MICRO SWITCH is also ready to provide you with field engineers for application assistance and a network of authorized distributors for local availability.

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MICRO SWITCH

FREEPORT, ILLINOIS 61032

A DIVISION OF HONEYWELL

Circle 113 for Data

maximum. Zero offset and gain errors, both adjustable to zero, are a maximum of ±½ LSB and ±1%, respectively.

For reliability, both converters are subjected to internal and external visual inspection, stabilization bake, and fine and gross seal testing of their hermetic packages. The 4065-83 earns its suffix by also passing burn-in and temperature cycling tests. All screening is performed along the lines of MIL-STD-883, method 5008.

Both converters exhibit high temperature stability and, to ensure that this characteristic is used optimally, they contain highly stable internal voltage references and internal thin-film resistors for use with external operational amplifiers. In single quantities, the 4065 is priced at $160, the 4065-83 at $220. Both are available from stock.

Teledyne Philbrick, Allied Drive at Rte. 128, Dedham, Mass. 02026. Phone Robert Jacobs at (617) 329-1600 [383]

Analog I/O board fits DEC computers

With the ST-LSI input/output board, users can slip 32 single-ended analog-to-digital and 2 digital-to-analog channels directly into a single slot in their LSI-11 or PDP-11/03 computers. The I/O board has a resolution of 12 bits as well as a throughput rate of 25,000 samples per second.

The unit comes with an on-board clock that has 16 programmable time bases for sample sequencing. Starting with a board containing 16 a-d channels priced at $625, purchasers are able to add another 16 channels for $40, 2 d-a channels for $180, and either a programmable-gain amplifier for $195 or a differential instrumentation amplifier for $90. All configurations come with a diagnostic program and instruction manual. Delivery is from four to six weeks.

Datel Systems Inc., 1020 Turnpike St., Canton, Mass. 02021. Phone (617) 828-8000 [385]

Let's talk control.

Whether you're monitoring a complex automated line or depending on the operation of a single closed loop system, control is vital to efficient, effective performance. Hi-G time delay relays and solid state controls give you flexible, reliable control.

Our SC series 10 amp AC solid state controls (above) give you all the solid state advantages, optional field programming, and attractive pricing.

Hi-G field programmable TDP series time delay relays have an easy access window. To change wiring terminals in seconds. Change timing parameters with almost no downtime. Plus accommodating a much larger range of input operating voltages. Our six types can be programmed for ninety-eight operating modes. Our TDP-1 can replace eighteen adjustable models.

The TL series time delay relays feature hybrid thick film technology. For extremely stable, highly reliable control. In smaller, more convenient packages. With spade lug for quick connections, sockets, or permanent solder connections.

For increased operating efficiency, we have all the control you need. So let's talk. (203) 623-2481.

Electronics Division
Hi-G Co., Inc.
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Let's talk controls.

Circle 131 on reader service card

tions of note are its common-mode-rejection ratio of 80 dB minimum, its open loop gain of 110 dB minimum, a slew rate of 3 V/μs, and a bandwidth of 1 MHz.

The AD542 is available in both commercial and military temperature versions. Prices for the device begin at $2.50 in quantities of 100. It is available from stock.

Analog Devices Inc., Semiconductor Division, 829 Woburn St., Wilmington, Mass. 01887. Phone (617) 935-5565 [343]

Two-lead LED lamp turns from red to green

The CSL-310L lamp is a clever configuration of two light-emitting diodes in a single T-1¾, two-lead package. Biasing the lamp in one direction causes it to emit red light; biasing it in the opposite direction produces a green light.

This "traffic-light" capability suggests that the lamp be used in critical go/no-go applications. The device's three-state aspect makes it useful for power-off/standby/ready status displays, too.

Optimized for visibility in ambient light, the red and green light intensities are 2 and 4 millicandelas, respectively, with a 25-mA current. With this current, the voltage drop across the lamp is 2.4 V, and both diodes are protected against reverse voltage.

In hundreds, the lamps are priced at 95¢ each and are available from stock.

OPCOA Division, IDS Inc., 330 Talmage Rd., Edison, N. J. 08817. Phone Robert Kokesh at (201) 287-0355 [344]

Short capacitor shrinks power supply size

In power-supply applications, ordinary capacitors often rise above the module board like grain elevators above a Kansas wheat field. Such capacitors can be a design nuisance that dictates the final package size. The ML and TL series of aluminum

electrolytic capacitors, on the other hand, do not impose such design constraints: their body height is less than or equal to their body diameter.

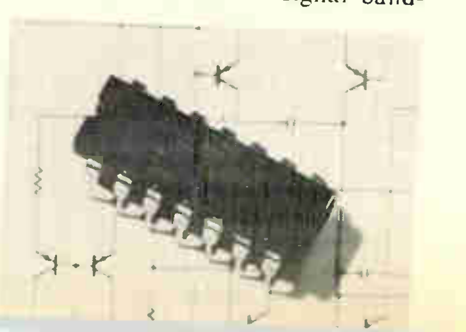
The capacitors have values between 2,200 and 22,000 µF, with a tolerance of −10% to +30% and rated voltages of 16 to 100 V dc. Leakage currents are 5 mA or less and the units can withstand ripple currents as high as 4.5 A. At 85°C and rated voltage, they have a 1,000-hour life.

The TL capacitors come with terminals for mounting on printed-circuit boards, while the ML units have standard solder-lug terminals. Deliveries are from stock to eight weeks.

Panasonic, One Panasonic Way, Secaucus, N. J. 07094. Phone Steve Belcak at (201) 348-7270 [348]

Operational amplifier powers large load over wide band

Suitable for application in high-quality audio equipment, instrumentation and control circuits, and telephone channel amplifiers, the NE5533 is a dual operational amplifier that has a narrow signal band-



Let's talk good connections.

Cambridge fastfit™ co-axial connectors are the easiest way to make all the good connections you need. On the production line, just crimp the braid. In the field, simply trim it with a knife. You get a high integrity termination every time.

Fast and fool-proof. That's the fastfit approach. Because fastfit connectors have the same electrical and mechanical characteristics as Q.P.L. 39012 military types. They have fewer parts, for easier installation. And are competitively priced.

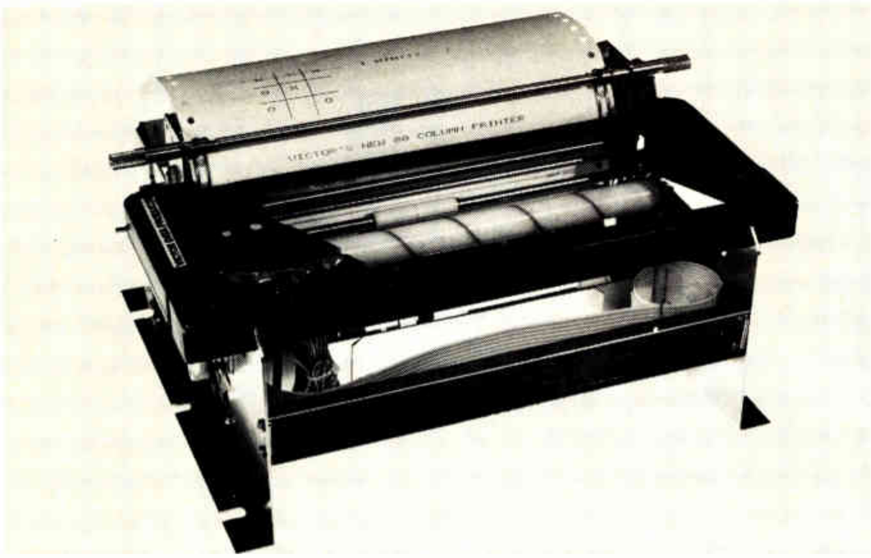
Let us know what you need. The Cambridge line of fastfit connectors includes more than fifty sizes and types. If you need custom designed connectors to fit your special application, we have the design expertise and the production capability to give you the benefits of the fastfit approach. Fast. Reliable. Cost-effective.

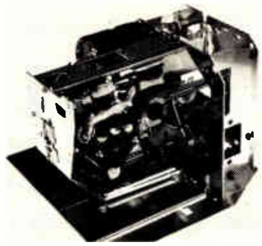
Whatever your communications application, Cambridge has all the good connections you need. So let's talk. (203) 243-1761.

Cambridge Products Corp.
Division of Hi-G, Inc.
244 Woodland Avenue
Bloomfield, CT 06002.

Let's talk connectors.

Circle 148 on reader service card





width of 10 MHz, a power bandwidth of 200 kHz, and a slew rate of 13 v/μs. It is capable of driving 10 v rms into a 600-Ω load.

The unit is internally compensated for gains equal to or greater than +3 and its frequency response can be optimized using an external capacitor. Voltage gains of 100,000 for dc signals or 6,000 at 10 kHz are attainable; supply voltages can be anywhere in the range from ± 3 v to ± 20 v.

An A version of the device with tighter specifications than the standard unit is also offered. Both versions come in 14-pin dual in-line packages and are available from stock. The standard version is priced at $2.15 in quantities of 100 or more, the A version at $2.80 in similar quantities.

Signetics, P. O. Box 9052, 811 E. Arques Ave., Sunnyvale, Calif. 94086. Phone Guy Caputo at (408) 739-7700 [346]

Code switch speaks binary-coded hexadecimal

The model SMC-301-AK panel-mounting bidirectional code switch has 16 positions, which are set by pushing the up- or down-counting buttons, as needed. Each position is marked with a hexadecimal designation, 0 through 9 and A through F. Advancing the switch to any one of these positions opens or closes a contact on each of the unit's four lines, thus producing a binary-coded hexadecimal switch path.

Individual units occupy less than 0.3 in.^{2} of panel space and can be snapped together with other units (as shown) without additional hardware. Nor is additional hardware required for panel mounting: end plates on the switches or gangs of switches provide snap-in mounting.

Individual switches are priced at $5.28 in quantities from 50 to 99; delivery is two to three weeks. Other position markings are available on special order.

ALCO Electronic Products Inc., 1551 Osgood St., North Andover, Mass. 01845. Phone Tom Clark at (617) 685-4371 [350]

Let's talk business.

Good business. Profitable business. Your business. We can help. With decades of research and development behind us, Hi-G remains dedicated to providing premium quality electrical and electromechanical products at affordable prices. Combining advanced design with highly automated production gives you more for your business dollar. All the way down the Hi-G product line.

With fastfit™ RF connectors from the Cambridge Products Division. Solenoids from the Magnetec Division. Flagship™ and Q.P.L. relays from the Relay Division. Time delay relays and LIQUA-SENSE™ liquid level sensors from the Electronics Division. Multi-layer PC boards from the Defiance Division. And professional-grade transformers from the Merrimack Division. If it's made by a division of Hi-G, it's made right. And that makes good business sense. For us. For you.

Let's talk about your special requirements. How we can meet them with economical, highly reliable Hi-G products. If you mean business, let's talk. Call Alvin Lukash, President. (203) 623-2481.

Hi-G Incorporated
580 Spring Street,
Windsor Locks, CT 06096.

Let's talk business.

Circle 152 on reader service card

Boschert low-power switchers win OEMs' stamp of approval. Here's why.

Low cost. Only Boschert is delivering switching power supplies that are cost-competitive with linears in the 25 to 400 watt range. That's because Boschert is focusing exclusively on the design and production of low-power switchers. Our modular design techniques are lowering prices while maintaining quality and reliability.

Small, light and efficient. Boschert power supplies are perfect for microprocessor-based systems and other digital equipment because they're five times smaller than comparable linear supplies, and nine times lighter. Because little power is wasted as heat, they require no fans — only convection cooling. And Boschert switchers are well-suited for high pulse-load environments such as printers: when additional power is required, it is available instantaneously — at any output.

Multiple outputs. Boschert power supplies are convenient for system designers because they offer as many as six outputs in flexible voltage configurations. Our computer-evaluated modular design approach with 90 percent common components allows us to meet your unique technical requirements at low cost, with a minimum of design time.

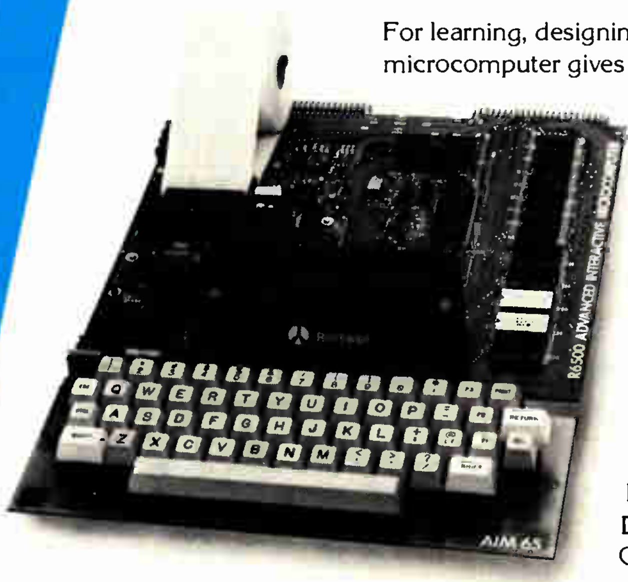
Boschert experience and reliability. Boschert has assembled the finest switching power supply design and production team anywhere. Our facilities are prepared to meet expanded production schedules rapidly and reliably — with rigorous automatic burn-in, wave soldering and testing techniques. With over 50,000 of our power systems in operation today, we're the leading company for low-power low-cost OEM switchers.

For information, contact a Boschert representative. Or write Boschert Incorporated, 384 Santa Trinita Ave., Sunnyvale, CA 94086. Phone (408) 732-2440. TWX 910-339-9241. The finest microprocessor-based systems are powered by Boschert. What about yours?

Circle No. 154 for more information

Micro power

Microcomputer with printer–$375. That's Rockwell Micropower.



For learning, designing, work or just fun, Rockwell's AIM 65 microcomputer gives you an easy, inexpensive head start.

- 20-Column Printer and Display
- Dual Cassette, TTY and General-Purpose I/Os
- R6502 NMOS Microprocessor
- System Expansion Bus
- Read/Write RAM Memory
- PROM/ROM Expansion Sockets
- Advanced Interactive Monitor Firmware
- Big Terminal-Style Keyboard

For more on AIM 65 and how you can develop programs in assembly language or BASIC, write Microelectronic Devices, Rockwell International, D-727-F 4, P.O. Box 3669, Anaheim, CA 92803 or phone (714) 632-3729, or contact your local Hamilton-Avnet office.

Rockwell International

...where science gets down to business

Now you can get your favorite programs in color.

Heeeeeeeerrrresssss Xerox!

With the new 6500 Color Graphics Printer. The first printer that can put full-color reproductions of computer generated graphics in your hands in seconds.

So now, for the first time, you can quickly get a permanent record in full color.

A permanent record to hand out after presentations, or as part of a report on an ongoing project.

Process industries, for example, can use the 6500 CGP for prints of process variables such as temperature, pressure, flow, valve settings and to record alarm conditions for analysis. It can help railroads keep track of their train routes. Graphics data processing centers can now print graphic data in color.

And when the 6500 CGP isn't working off a computer, it becomes a great way to make full-color copies from regular hard-copy originals. Or even 35mm slides.

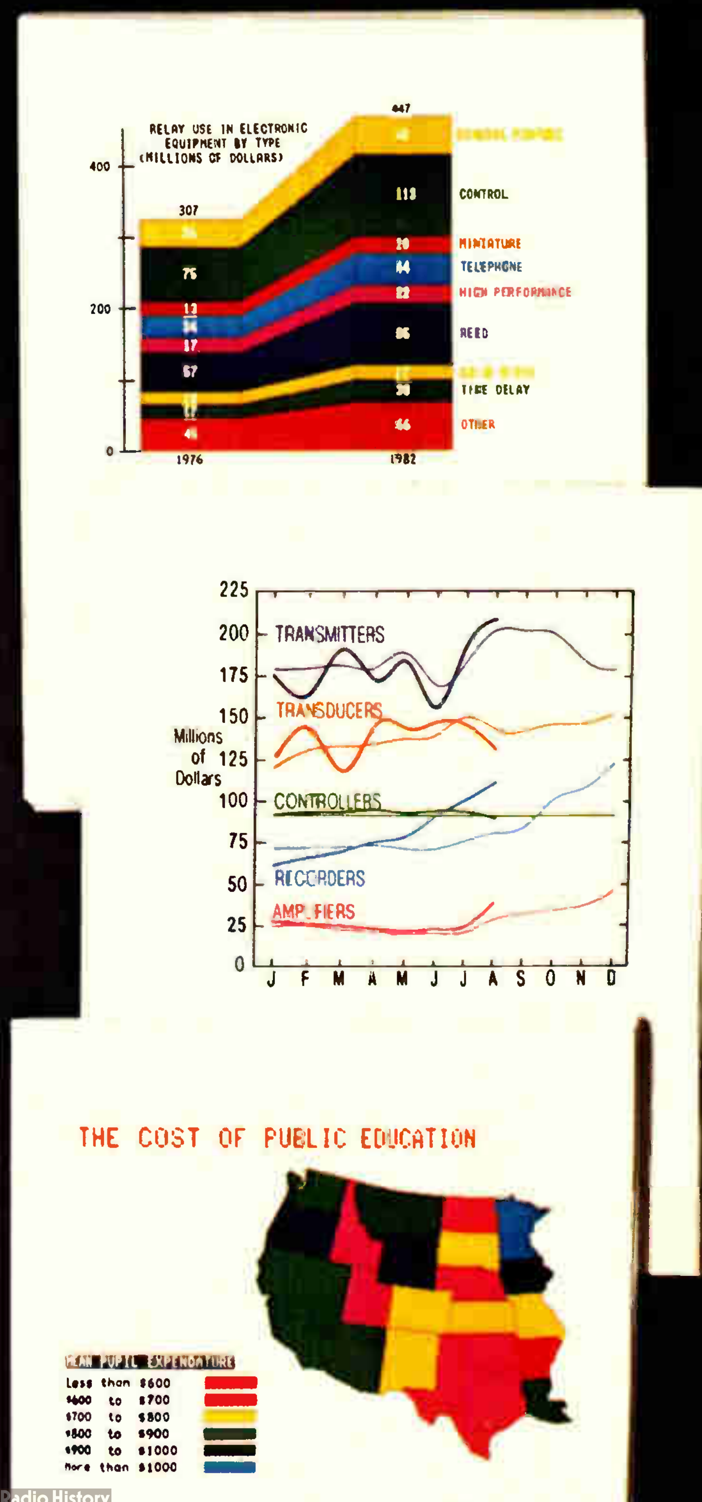
So ask about the 6500 Color Graphics Printer.

It'll not only make your programs look better.

It'll do wonders for your ratings.

XEROX

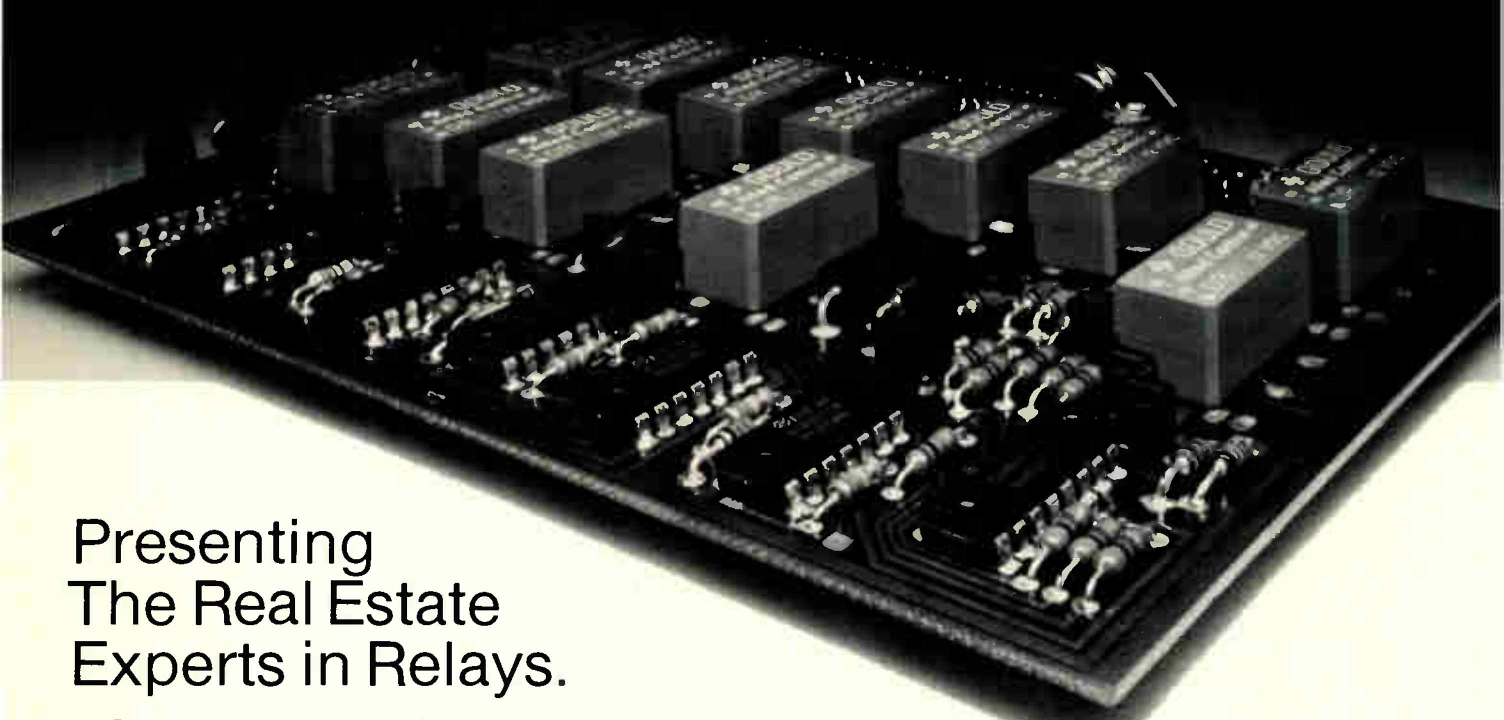
Circle 162 on reader service card



These prints were made on a 6500 CGP.

XEROX® and 6500 CGP are trademarks of XEROX CORPORATION.

Allied Control Relays:
When real estate is at a premium!



Presenting The Real Estate Experts in Relays.

Challenge: squeeze maximum relay performance into premium PCB real estate. Continued sophistication demands greater relay miniaturization, plus consistent high quality and reliability. Teltone board shown squeezes in 1 MPC and 11 DR (DIP) units.

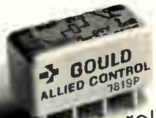
Our Allied Control Relays have led the way in meeting the challenge.* We offer a broad line of new and proven relays in five families:

Cradle Relays
The pioneer in relay down-sizing. Wide variety in sensitivity, mounting and contact configurations. DC, AC, multipole and latching.

Low Profile Relays
MPC, MPCS, MPCL (1, 2 or 4 poles). New DIP and SIP series. Pacesetting high density packaging. Sealed versions withstand fluxing, wave soldering, in-line cleaning.

Midget Industrial Relays
New Midget power relay series GH and GY (1, 2, 3 or 4 poles). Open frame BOT/BOY, PO Series. Hermetically sealed BOHR, POHR Series. Heavy duty, AC, DC, up to 15 amp contact rating.

Solid State Relays
E22, E-3, *new* E-6 series relays. Extremely low electrical noise, long life characteristics. Zero axis voltage switching. Good for hostile atmospheres and otherwise severe applications. (4 through 40 amps)



Military Relays
QPL, ½ size high performance crystal can relays to MIL-R-39016/6-109 L or M. Full size crystal can relays to MIL-R-5757/13 and round can multipole relays to MIL-R-5757, 5 and 10 amp as applicable.

Specify Allied Control Relays for your premium real estate.
See catalog data in EEM or call your Gould/Allied Control Relay representative or distributor.
Gould Inc., Electrical Products Group, 100 Relay Road, Plantsville, CT 06479, 203-621-6771.

Key System Intercom board compliments of TELTONE

*Write for test data: Low Profile TR 202 Cradle TR 104

GOULD

Circle 163 on reader service card

Packaging & production

Conductive coat cuts emi

Sprayed copper liquid lowers the cost of shielding plastic cases

Injection-molded plastics have become extremely popular as both instrument and computer enclosures because of their low cost and high resistance to shock. However, the plastic cases provide no shielding against electromagnetic interference. Conductive gasketing and coating for the plastic enclosures have been devised to cut emi, but these have turned out to be fairly expensive. Now Acheson Colloids has developed a new copper coating with an acrylic binder that can be sprayed and air-dryed onto plastic surfaces at an approximate cost of 0.22 cent per square foot. The new one-coat system needs no protective overcoat.

The new material, Electrodag 436, is a liquid with a density of 15.1 lb/gal. When dry, the conductive coating has a sheet resistance of 0.5 Ω/square at a thickness of 1 mil. The attenuation of a 2-mil coat is 60 to 70 dB from 0.1 MHz to 10 GHz. Maximum service temperature is 177°C and the shelf life of the new material is a minimum of six months. Theoretically, 1 gallon will cover 620 ft² with a 1-mil coating.

Acheson has extensively tested samples of the new material against exposure to heat, humidity, and salt spray. For instance in heat-stability tests (140°F for 72 hours), the resistance of a sample changed from 0.16 to 0.46 Ω. Other samples tested for humidity stability (120°F in 100% humidity for 168 hours) went from 0.19 to 0.50 Ω. In salt-spray testing (5% salt solution at 95°F for 48 hours), resistance went from 0.18 to 0.13 Ω. Conventional copper coatings showed much greater resistance changes after this kind of exposure.

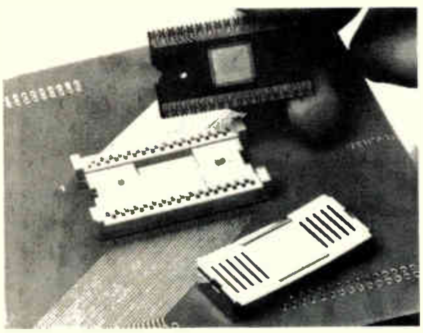
The new coating can be spray applied with conventional jet spray systems. A 1.5-to-2-mil coat is recommended for good shielding performance. This product dries to the touch in about 1 minute and can be handled in about 30 minutes. The conductive material is currently being evaluated by several large electronics firms. Supplied in concentrated form, it can be diluted with either MIBK or with a blend of isopropanol and toluol.

Acheson Colloids Co., a division of Acheson Industries, Port Huron, Mich. 48060. Phone (313) 984-5581 [391]

64-pin package minimizes pc-board real-estate needs

The 64-pin quad in-line package developed jointly by Intel and 3M [*Electronics*, Aug. 31, p. 42] is now being offered to other integrated-circuit manufacturers. The package, which consists of a leadless chip-carrier, a socket, and a heat-dissipating cover, takes up about 40% less space on printed-circuit boards than conventional dual in-line packages.

The chip carrier is mechanically keyed so that it can be oriented properly in the socket. The carrier is



inserted without force or special tools and is pressed in place over spring-wipe contacts by the heat-dissipating cover. The pin configuration of the socket dictates the manner in which it must be inserted on the pc board.

The QUIP measures 1.1 by 1.89 by 0.35 in. and the carrier's square chip cavity has 0.4-in. sides. Thermal resistivity of the assembly is 35° C/W in still air; maximum lead impedances are 500 mΩ and 5 pF for the longest lead. In quantities of about 50,000, the 64-pin packages are initially priced at $6 each, or about 9.4¢ per lead.

3M Co., Dept. EP8-8, P. O. Box 33600, St. Paul, Minn. 55133 [396]

Snap-on insulator protects repair and service people

An insulating cover that fits over TO-3 devices, the model 8909NB is designed to prevent service and repair personnel from receiving electrical shocks by accidentally coming into contact with a live case. A small hole on the case's top will admit a needle probe so that electrical measurements can be taken without removing the cover.

Molded from Zytel 101L nylon, the snap-on case meets flammability standard UL 94V-2 and can be used in low-vibration applications. In quantities of 1,000 or more, the insulators are priced at 4.5¢ each. They are available from stock.

Thermalloy Inc., 2021 W. Valley View Lane, Dallas, Texas 75234. Phone Jim Pritchett at (214) 243-4321 [399]

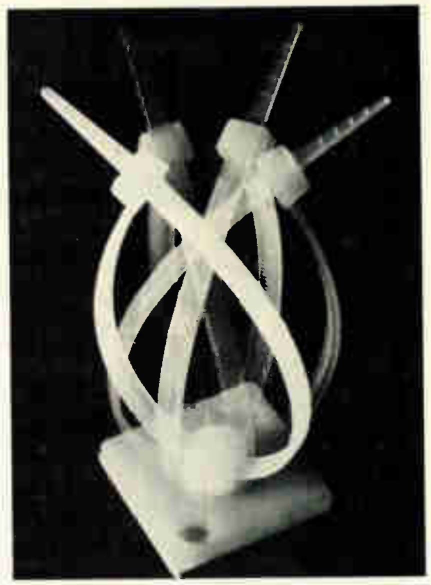
Adhesive tie holder swivels to accommodate new routings

The model FTH-4A is a device with a swivel head that holds tied wires or cables in place. Adhesive-backed, the nylon holder can be mounted on any flat surface without drilling holes.

To use the FTH-4A, one end of a

Circle 178 on reader service card

New products



plastic tie is passed around the cable or wire to be secured and passed through a slot in the unit's swivel head. Should cable rerouting be required, the head can be rotated to accommodate the new routing.

Units without the adhesive backing are also offered. Both types are available from stock. Free samples are available on request.

Richco Plastic Co., 5825 N. Tripp Ave., Chicago, Ill. 60646. Phone Linda Rooney at (312) 539-4060 [400]

System tests zener diodes to accuracies within 0.1%

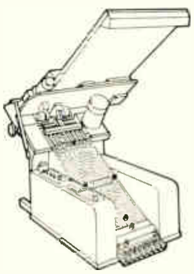
A zener-diode tester based on the Series Five test system meets the demand for units which can evaluate today's improved devices. Suitable for testing essentially all zener types, including parts with zero temperature coefficients, the system can make measurements which are accurate to within 0.1%.

Based on a PDP-11/34 with dual floppy disks, the tester can, with an optional supply, generate forcing functions as high as 250 V and 250 mA. Tests in the 60-to-1,000-Hz range can also be performed.

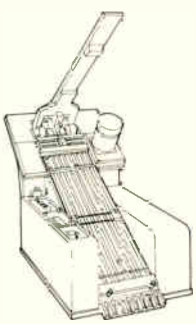
Preprogrammed tests included with the systems software need only operator-entered forcing functions and limits. New tests and functions

"At MCT, We Take The Sweat Out of Buying a Hot Handler...

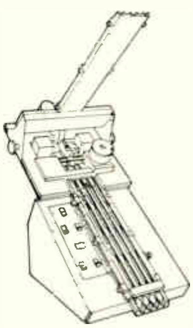
...With Our Series 2608E"



Series 2608M
8,500 DPH
Expanded Input
Ambient Handler



Series 2608
10,000 DPH
Ambient Temperature
Handler



Series 2604
5000 DPH
Ambient Temperature
Handler

Considering elevated temperature DIP testing? Our Series 2608E Elevated Temperature Handler provides accurate (± 1° C) hot handling at temperatures up to 125°C and eliminates the installation, performance and maintenance worries of other handlers, no sweat.

We install every Series 2608E, and we train your operators and service personnel at the time of installation. Our selection of universal logic interfaces and our comprehensive library of tester interfaces assure you that the Series 2608E will be easily integrated into your testing operation.

Key performance features like 7000 DPH speed . . . 13-track input and 8 programmable output categories . . . the ability to handle .3, .4, and .6-inch wide devices and devices with 8 to 40 leads . . . all combine to make the Series 2608E the ideal handler for incoming inspection.

Durable mechanical assemblies; five-million cycle contact life, and 'leads up' cycling of devices assure that the Series 2608E will be up and running so you won't be running to call your serviceman.

When you purchase an MCT Series 2608E from us, you benefit from our expertise as the major supplier of elevated temperature handlers to the semiconductor industry worldwide. With our strong support programs in the areas of installation, service and operator training, we can give you top-notch hot handling . . . no sweat.

For more information on the Series 2608E and our other handlers, contact, MCT, Inc. P.O. Box 43013, St. Paul, MN 55164 or call (612) 482-5170.

micro component technology incorporated

can be created using Basic language with specialized verbs. The system supports four test stations, and special input/output cards allow communication to and from external test instruments or special systems.

Depending on the options chosen, the unit is priced from $75,000 to $100,000. Delivery is within 90 days.

Lorlin Industries Inc., Precision Road, Danbury, Conn. 06810. Phone (203) 744-0096 [413]

Heat sink balances two transistors thermally

The PSE1 series of heat dissipators can thermally balance two power transistors using a design that minimizes loss of board space. Models in the series accommodate transistors in 152, TO-220, TO-126, TO-202, and TO-127 cases.

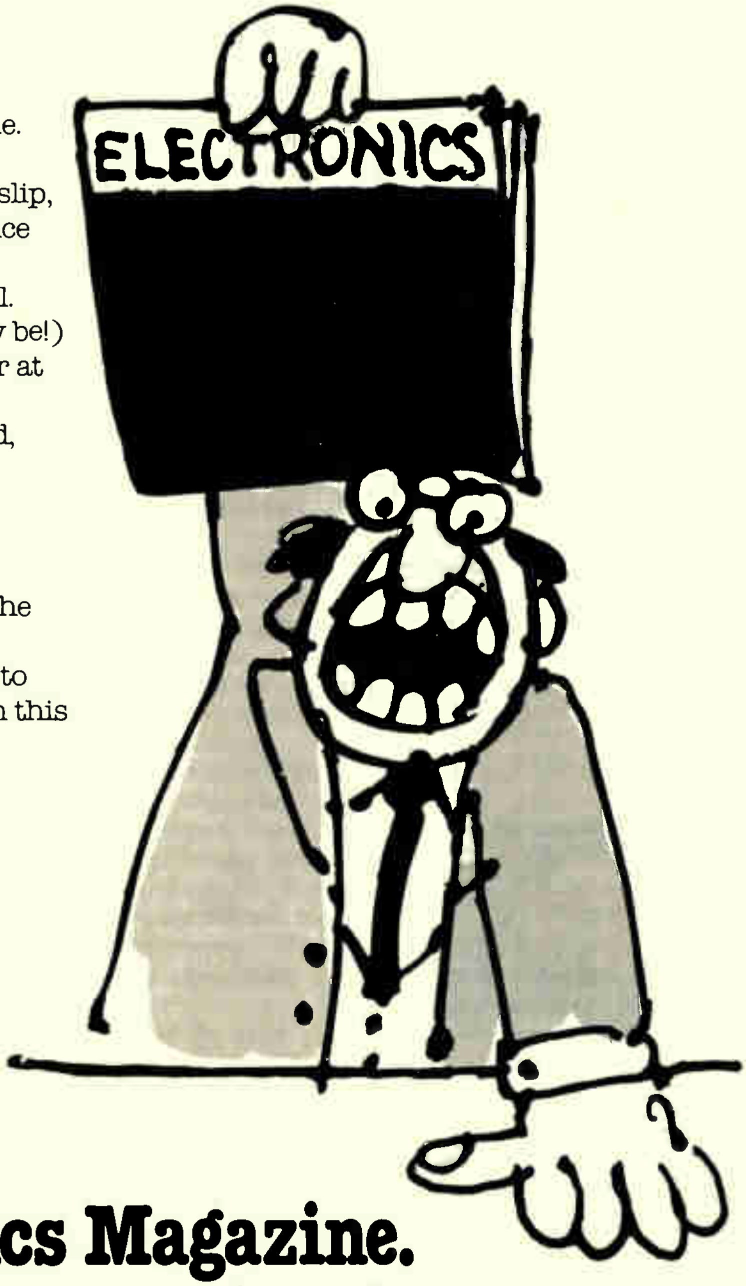
The units can dissipate up to 3 w per transistor with a case temperature rise of 100°C in natural convection and up to 9 w per device with a case temperature rise of 75°C in a 1,000-feet-per-minute forced air environment. In 1,000-and-up quantities, sinks with black anodized finish are priced at $.244 each while those without finish cost $.131 each. Delivery is from stock.

International Electronics Research Corp., 135 W. Magnolia Blvd., Burbank, Calif. 91502 [414]

Connector handles mix of electrical and optical wires

Now it is possible to assemble in a single standard connector housing a mix of power, signal, coaxial, and fiber-optic cables. AMP Inc. has added to its Multimate line fiber-optic ferrules for single optical fibers, allowing for the first time intermixing of various cable types. To optimize control of optical core alignment, the ferrules are designed to fit 16-gage connector cavities. The ferrules can accommodate 400-to-600-μm diameter single optical fibers with jackets up to a maximum

Who stole page 39?



This whodunit happens all the time. By the time the office copy of Electronics Magazine gets to your name on the routing slip, a page is missing. Or maybe the reader service cards. Or an entire article has been clipped. Sometimes you never get the magazine at all.

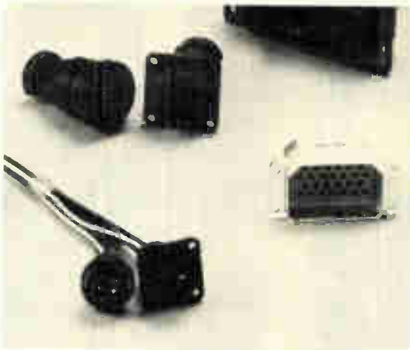
Other times the magazine is (glory be!) intact. But dogeared. Or otherwise abused. Or at the very least, you get it late.

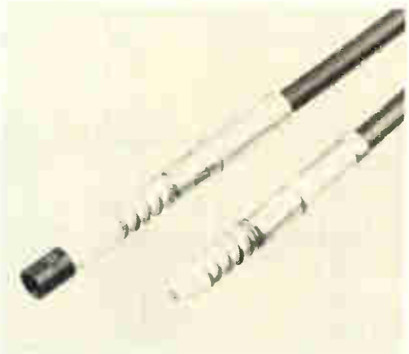
O.K., we'll grant that a second-hand, third-hand, or maybe seventh-hand copy of Electronics is better than none. But it's no substitute for the copy that comes directly to you—to your home if you wish—with up-to-the-minute news and information of the technology in this fast-moving field.

To get your very own subscription to Electronics send in a subscription card from this magazine. And if they are missing, write to subscription department, Electronics, McGraw-Hill, 1221 Avenue of the Americas, New York, N.Y. 10020.

Electronics Magazine. The one worth paying for.

New products





of 90 mils in diameter—large enough for many applications.

The stranded wire size is restricted to 16 gage as well, making the connectors ideal in applications such as machine and process control, remote monitoring, utility distribution systems, and automobiles. The fiber-optic ferrules exhibit losses of 2 dB when 0.002-in. spacing is maintained between the two facing fiber surfaces. The bodies of both the male and female ferrules are molded of resilient thermoplastic, then fitted into brass retention sleeves. The retention springs are stainless steel, and the compression springs, needed to ensure the 0.002-in. spacing, are fabricated from cadmium-plated music wire.

The cost per fiber-optic line is $6 to $7, which is approximately ⅓ the cost of previously available optical links. A typical 12-to-24-pin connector costs 15 to 20¢ per standard mated wire pair. The standard Multimate housings, besides accepting the fiberoptic ferrule, accommodate the following: screw machine solid contacts, precision formed contacts and coaxial contacts.

AMP Inc., Harrisburg, Pa. 17105. Phone (717) 546-0100 [415]

Rugged enough to ride the rails in all weather — a MAP criss-crossed the country on a railroad flatcar helping a major automobile manufacturer acquire and process shock and vibration data in real time. Back in the lab, MAP controlled a hydraulic shaker system for modeling and simulation of the actual roadbed conditions.

More than 200 MAPs are installed worldwide. Many are operating in diverse rugged environments. Aboard geophysical exploration vessels, in trucks, and in aircraft, MAP's reliability under stress is being proved again and again.

MAP is more than an ordinary array processor. It's a fully software-supported intelligent co-processor with fast FORTRAN controlled I/O Scrolls for real-time data acquisition. MAP's unique architecture minimizes host overhead and produces either real-time or continuous multi-user processing with up to 40-megabyte transfer rates. MAP is cost effective too — typical systems start under $30,000.

MAPs are being used in image processing, medical research, scientific computation, seismic exploration . . . sonar, radar, speech, acoustics, communications, simulation . . . and much more. Get the facts on MAP — call or write for specifications, pricing, references or a demonstration.

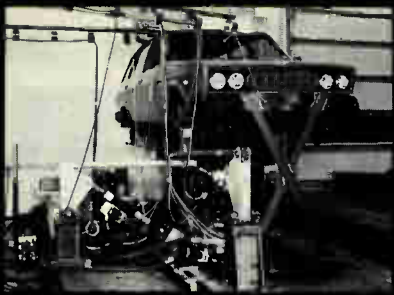


Photo courtesy of MTS Systems Corporation

cspi CSP Inc.
209 Middlesex Turnpike
Burlington, MA 01803
(617) 272-6020

What can a railroad ride tell you about Array Processing?

MAP™ is the only Array Processor that functions in real time...all the time.

See the MAP-300 demonstrated at the Canadian Computer Show, Toronto, Nov. 28-30 at Booth #1103.

Circle 194 on reader service card

The function of this function generator is to make your job easier.

B&K-PRECISION
Model 3010 $175

If you stop and think about it, the function of any generator *should be* to make your job easier. When we at Dynascan designed our new Model 3010 function generator, that's exactly what we had in mind.

How did we achieve this? The 3010 was designed inside and out to be convenient and fast to use, and to provide years of trouble-free operation.

The 3010 generates all of the popular waveforms you're most likely to need, at only $175. In addition to generating square, sine and triangle wave outputs, the unit offers a fixed TTL square-wave output. Sine-wave distortion is less than 1% and triangle-wave linearity and square-wave symmetry are a near perfect 99%. A convenient row of reliable pushbuttons provides fast, error-free selection of the appropriate range and output waveform.

The stable voltage-controlled oscillator (VCO) of the 3010 is varied on each range by the front-panel frequency control, or the VCO external input. A 0 to 5.5 volt ramp applied to the VCO external input will provide a 100:1 output frequency change. In this way, the 3010 can be used as a sweep generator for response tests. Other features that will help your job run smoothly include: .05% stability, a variable DC offset control for engineering and quality control applications, a convenient tilt-stand handle, and a detailed 38-page operations manual.

Because the B&K-PRECISION Model 3010 covers from 0.1Hz to 1MHz in six ranges, you'll probably be able to use it in more applications than you first guessed. These include IF response tests, test-instrument linearity measurements, transducer tests and digital clock-pulse substitution.

For a chance to have your day run a little smoother, contact your local B&K-PRECISION distributor for immediate delivery or a demonstration.

B&K PRECISION DYNASCAN CORPORATION

6460 West Cortland Street, Chicago, Illinois 60635 • 312/889-9087
In Canada: Atlas Electronics, Ontario • Intl. Sls: Empire Exporters, Inc., 270 Newtown Road, Plainview, L.I., NY 11803

Circle 196 on reader service card

PLUG ALL YOUR MEASUREMENT NEEDS INTO ONE RECORDER.

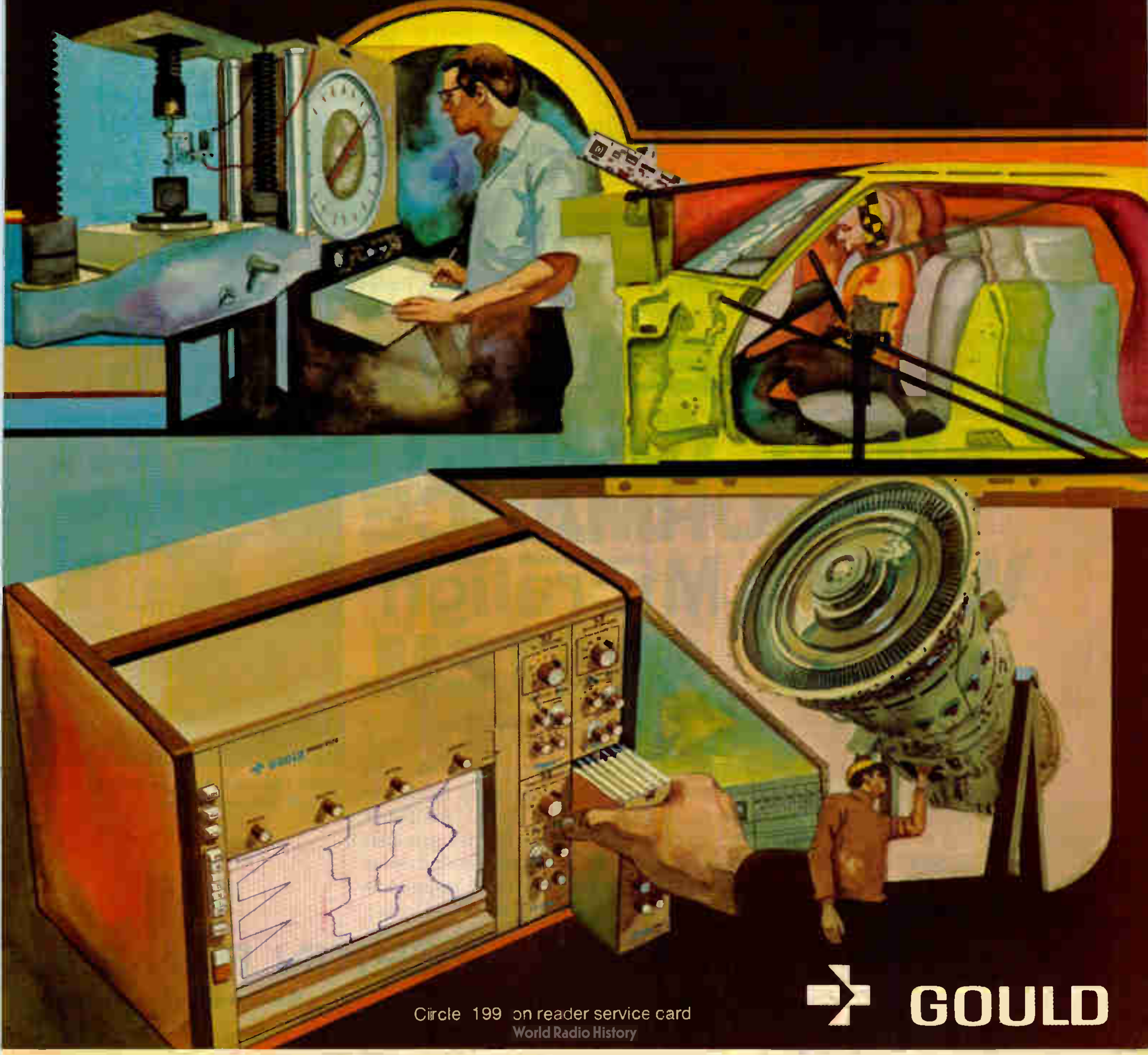
Gould plug-in signal conditioners give you all the versatility you need so you don't have to buy new recorders as your measurement needs change.

This modular approach allows you complete latitude of measurement capabilities. Measure microvolts to kilovolts; microstrain to 10,000 microstrains; temperature from −250° to 2500°C; frequencies from 10 Hz to 50KHz. Simply plug in the appropriate signal conditioner.

And you get all this versatility without sacrificing any of the features you expect from your Gould instrument — calibrated zero suppression, low pass filtering to eliminate high frequency interference, full floating inputs for operation up to 500 volts off ground at any sensitivity setting.

Find out how one recorder can satisfy all your measurement needs. Contact Gould Inc., Instruments Division, 3631 Perkins Ave., Cleveland, OH 44114. Or Gould Alco S.A., 57 rue St. Sauveur, 91160 Ballainvilliers, France.

For brochure call toll-free: 800-325-6400, ext 77. In Missouri: 800-342-6600.



Circle 199 on reader service card

GOULD

Introducing act 1

(avionic computer terminal)

Conic puts a dramatic advance in avionic computer testing on the line with you.

Now for the first time you can quickly test computers "on-line" with Conic's portable Avionics Computer Terminal. (We call it act 1).

It can inspect, modify and correlate computer and computer controlled systems operation *in real time* by combining the capabilities of hardware and software development systems, a production tester, and system support equipment in one single instrument. Use it for unattended automatic testing.

act 1 gives you:

- Three hardware breakpoints which may be logically linked or used independently
- Up to 65K of external memory which can substitute for and/or extend the Target Computer (TC) memory
- Independent mapping of four TC memory zones
- Two 1K, 16 bit stacks for the memory address bus and the memory data bus. A 1K, 8 bit stack is available to monitor external signals
- The ability to disassemble any section of the TC memory. Program execution may be monitored and displayed on the CRT or the optional line printer
- Simplified commands which may be entered via the internal keyboard, keypad or cassette tape recorder or the external paper tape punch

To get the whole story of act 1, call or write Bill Strauser at Conic Data Systems, 9020 Balboa Avenue, San Diego, CA 92123. Phone (714) 279-0411.

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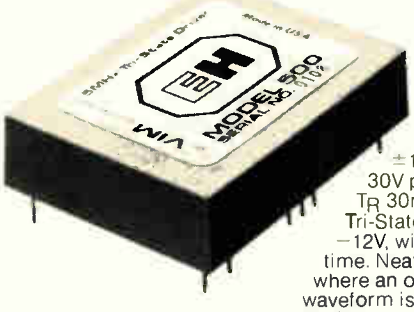

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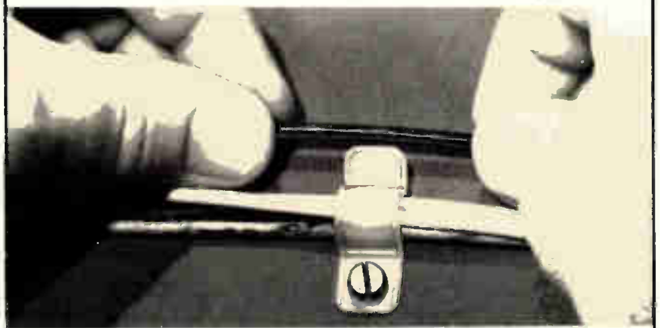

Just slip wires in or out for changes or removal.

Now, new convenience in initial assembly plus versatility for easy inspection, removal or changing of wires. Wires are easily slipped in and out of specially designed lip. Contour of clip plus spring-back flexibility of nylon, provides easy assembly yet holds bundles securely. Clip is screw mounted.

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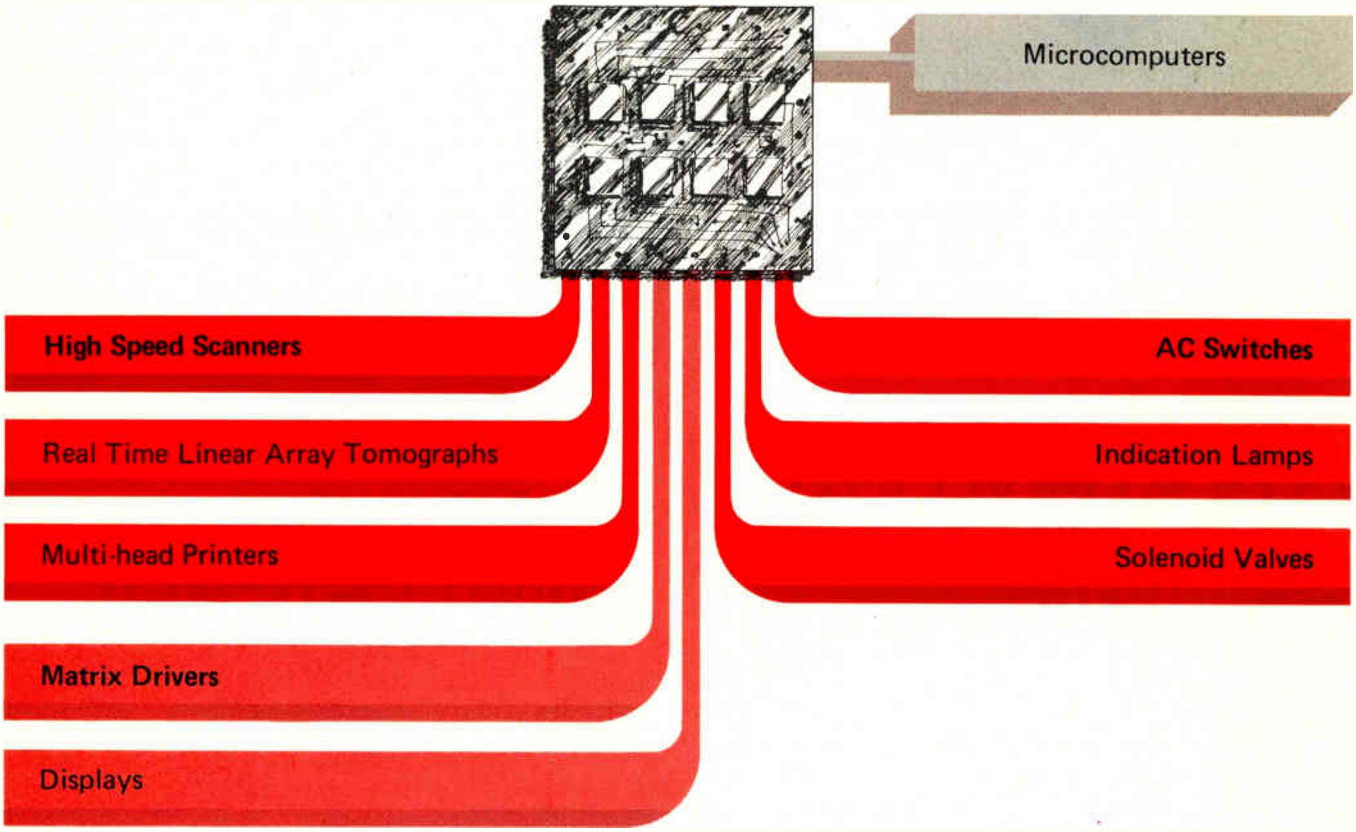
Circle 208 on reader service card

High Voltage IC Switch —the new look in interface

The interface between microcomputers and controlled devices used to be an engineer's nightmare, requiring relays, transistors, thyristors and a lot of complicated circuitry. Now Hitachi has changed all that.

Our new High Voltage IC Switch not only eliminates all the complex gadgetry and achieves a substantial reduction in size, but also increases reliability and boosts power capacity (220V, 200mA), thereby permitting direct drive and the handling of several functions through one IC.

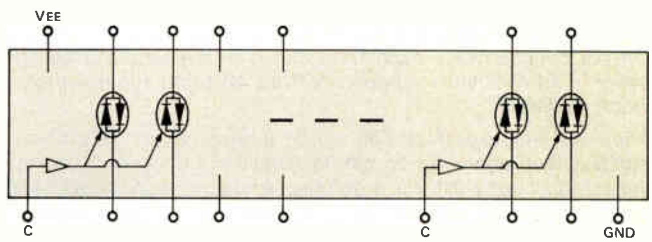
As high speed scanners for piezo devices, AC switches driven directly by microcomputers and matrix drivers for various displays, High Voltage IC Switches are giving interface the clean, functional look of the future.



Main specifications:

Items	Max.	Unit	Measuring conditions
Voltage	220	V	Ir = 10μA
Average current	200	mA	per switch
dv/dt	500	V/μs	0 — 200V
Voltage drop	1.5	V	Tj = 25°C, 200 mA
Junction temperature	−10~+80	°C	—

Circuit configuration:



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L19

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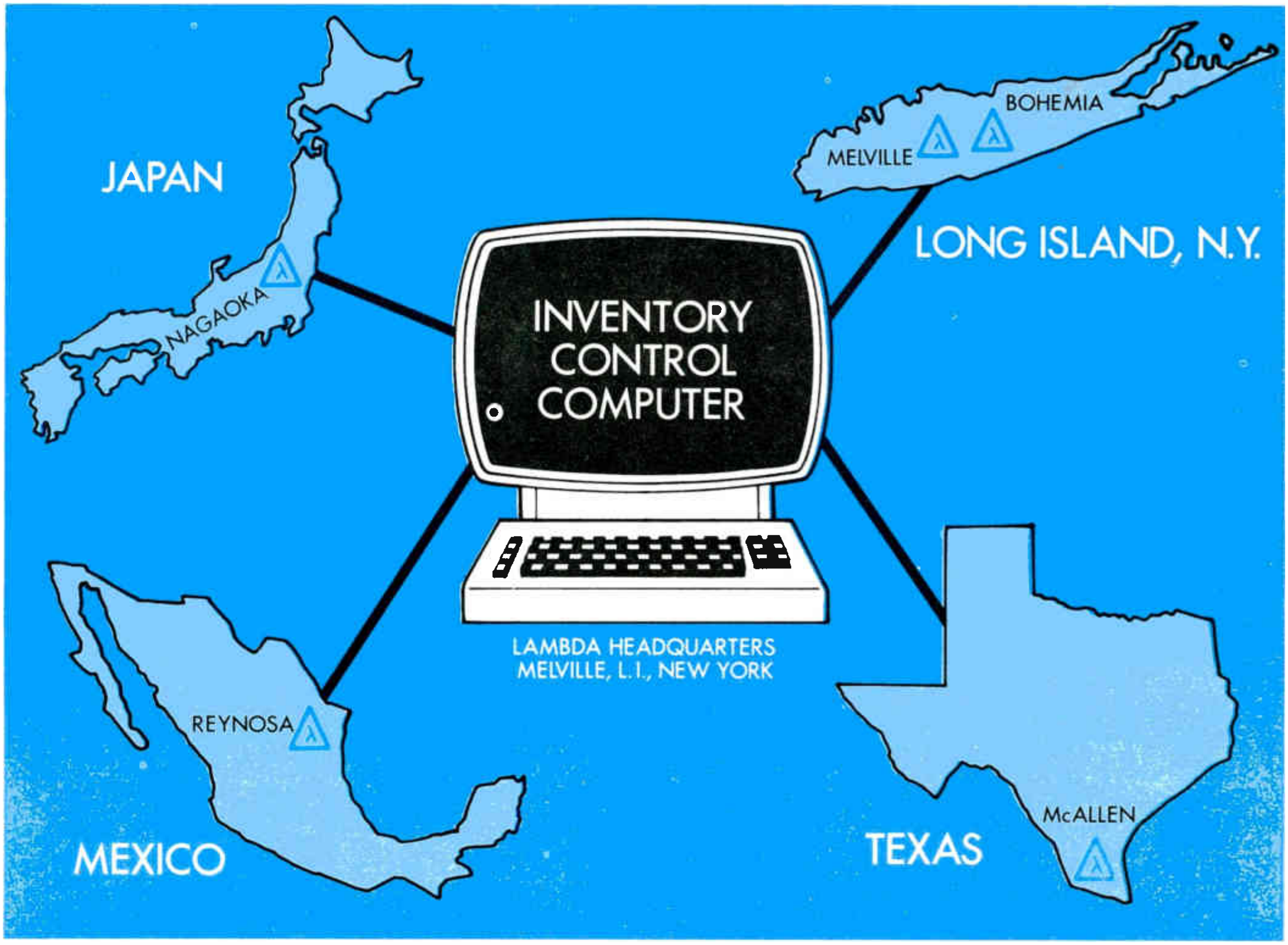

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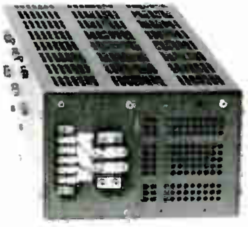
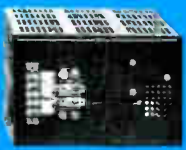


38%
Efficiency
$599

LXS-EE 110/220 VAC INPUT



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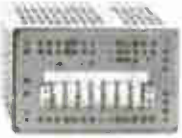

38%
Efficiency
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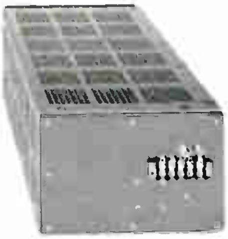
LXS-B 110/220 VAC INPUT

1976-

Switching power supplies

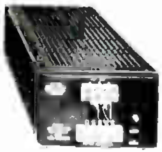


70%
Efficiency
$773

LGS-EE 110/220 VAC INPUT OR 44-58 VDC INPUT

70%
Efficiency
$642

LGS-6 110/220 VAC INPUT OR 44-58 VDC INPUT



70%
Efficiency
$476

LGS-5 110/220 VAC OR 20.5-32 VDC OR 44-58 VDC INPUT

70%
Efficiency
$345

LJS-12 110/220 VAC 130-160 VDC INPUT

70%
Efficiency
$285

LJS-11 110/220 VAC 130-160 VDC INPUT

70%
Efficiency
$230

LJS-10 110/220 VAC 130-160 VDC INPUT

60%
Efficiency
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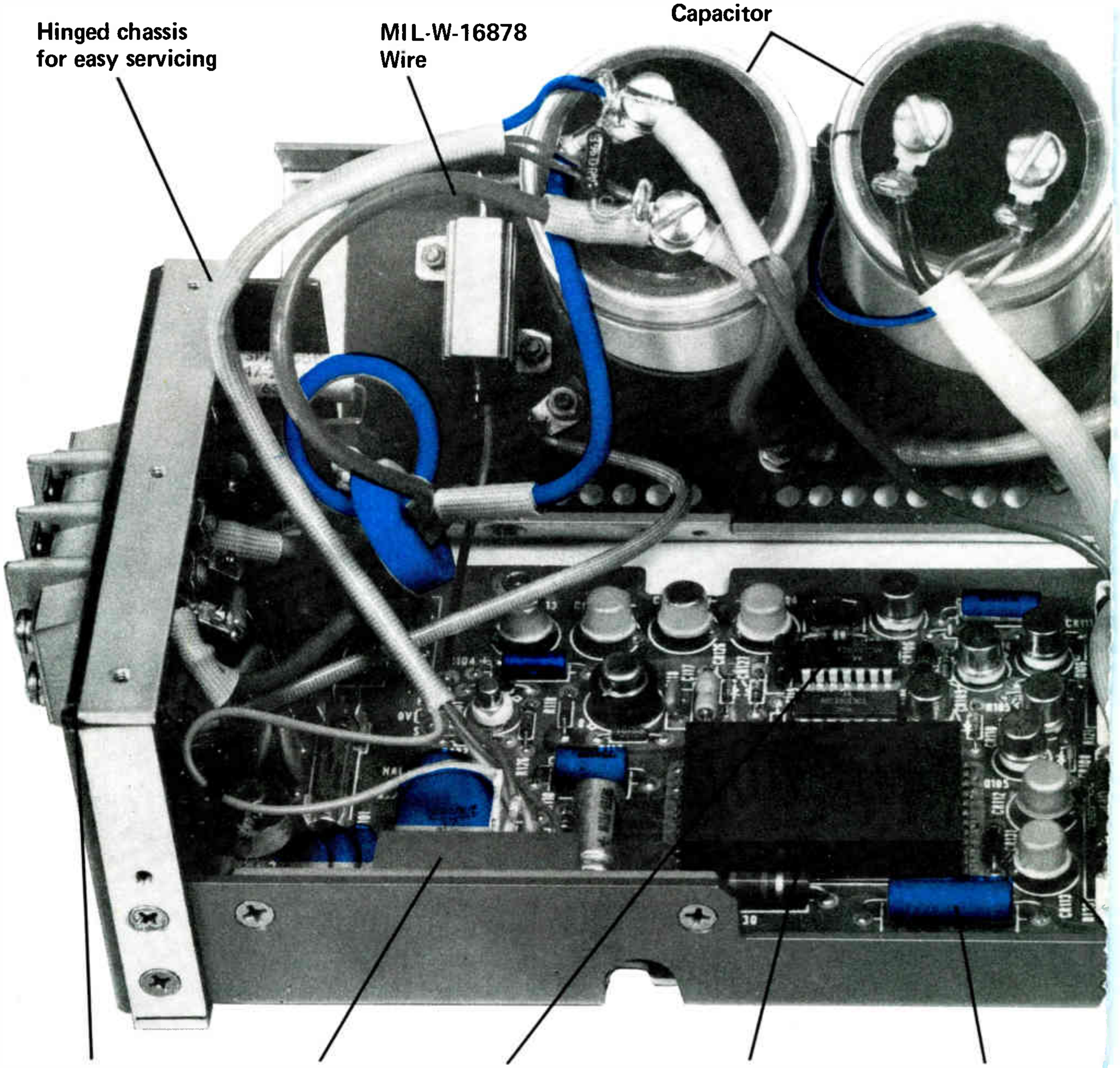
LJS-13 110/220 VAC 130-160 VDC INPUT

Here's why Lambda LG series the most advanced switching



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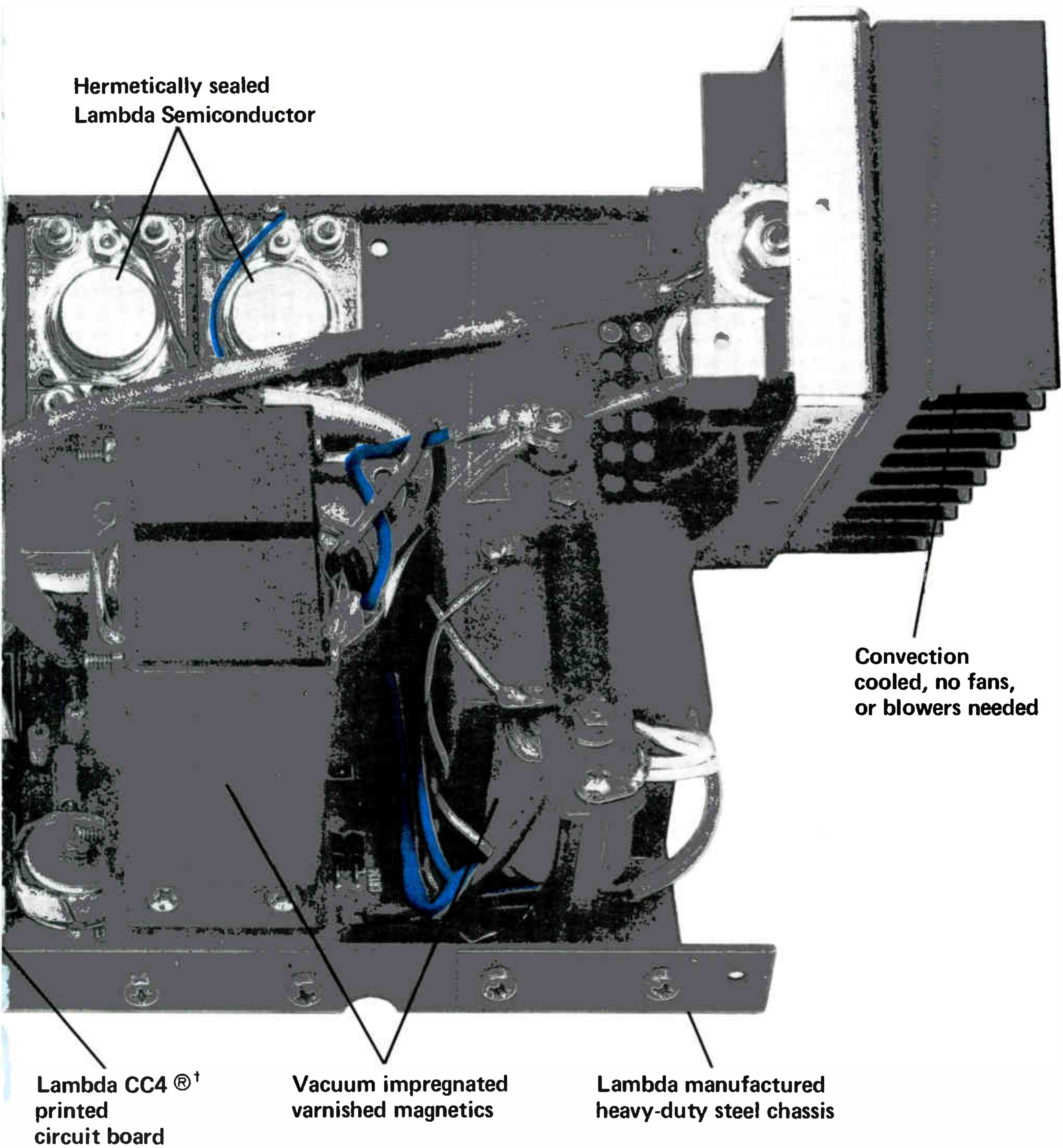
switching power supplies are power supplies in the world.



Features of LG Series

- 84 models, 4 package sizes
- up to 200 Amps, up to 28 volts
- input 20.5-32, 44-58 VDC as well as 105-132 VAC/187-242 VAC/ 205-265 VAC
- hi-reliability obtained thru new advanced circuitry
- less than 120 components for LGS-5
  less than 140 components for LGS-6
  less than 160 components for LGS-EE
  less than 200 components for LGS-G
- convection-cooled, no fans or blowers needed
- meets mil spec MIL-I-6181D EMI conducted
- meets MIL-STD-810C
- efficiency up to 75%
- density up to 1.2 watts/cu in
- 5 year guarantee
- serviceability—designed for ease of field repair
- built-in OV shuts down inverter and crowbars output voltage
- power failure hold-up time (see curve)
- fungus proofing standard
- 20 KHz switching
- vacuum varnished impregnated transformer
- hermetically sealed Lambda semiconductors
- listed in UL recognized component index
- CSA certified

Features of LJ Series

- 56 models, 4 package sizes
- up to 30 amps, up to 28 volts
- 20 KHz switching
- built-in OV shuts down inverter and crowbars output voltage
- efficiency—greater than 70%
- convection-cooled, no fans or blower necessary
- serviceability—designed for ease of field repair
- power failure hold-up time: 16 msec
- AC input 105-132/187-265 VAC
- reg-0.4%
- ripple—10 mV rms
- listed in UL recognized component index
- guaranteed for 5 years

Voltage and Current Ratings

AC INPUT 105-132 VAC STANDARD

5 VOLTS ± 5% ADJ

MODEL	REGULATION (line load)	RIPPLE mV (RMS)	MAX AMPS AT AMBIENT OF 40 C	50 C	60 C	71 C	PKG SIZE	DIMENSIONS (inches)	PRICE
LJS-13-5-0V	0.4%, 0.4%	10	5.0	5.0	4.0	2.8	13	4 3/4 X 1 25/32 X 6 5/16	$160
LJS-10-5-0V	0.4%, 0.4%	10	10.0	10.0	8.0	5.5	10	4 3/4 X 1 25/32 X 7 15/16	230
LJS-11-5-0V	0.4%, 0.4%	10	20.0	20.0	16.0	11.0	11	4 3/4 X 4 5/16 X 7 15/16	285
LJS-12-5-0V	0.4%, 0.4%	10	30.0	30.0	24.0	16.5	12	4 3/4 X 6 1/4 X 7 15/16	345
LGS-5-5-0V-R	0.1%, 0.1%	10	45.0	38.0	31.0	21.0	5	3 3/16 X 4 15/16 X 14 5/8	476
LGS-6-5-0V-R	0.1%, 0.1%	10	70.0	61.0	51.0	38.0	6	3 3/16 X 7 1/2 X 15 1/8	642
LGS-EE-5-0V-R	0.1%, 0.1%	10	110.0	100.0	86.0	72.0	EE	4 15/16 X 7 1/2 X 16 1/2	773
LGS-G-5-0V-R	0.1%, 0.1%	10	200.0	180.0	155.0	130.0	G	5 3/16 X 19 X 14	1404

6 VOLTS ± 5% ADJ

MODEL	REGULATION (line load)	RIPPLE mV (RMS)	MAX AMPS AT AMBIENT OF 40 C	50 C	60 C	71 C	PKG SIZE	DIMENSIONS (inches)	PRICE
LJS-13-6-0V	0.4%, 0.4%	10	4.1	4.1	3.3	2.3	13	4 3/4 X 1 25/32 X 6 5/16	$160
LJS-10-6-0V	0.4%, 0.4%	10	8.3	8.3	6.6	4.5	10	4 3/4 X 1 25/32 X 7 15/16	230
LJS-11-6-0V	0.4%, 0.4%	10	16.7	16.7	13.3	9.2	11	4 3/4 X 4 5/16 X 7 15/16	285
LJS-12-6-0V	0.4%, 0.4%	10	25.0	25.0	20.0	13.7	12	4 3/4 X 6 1/4 X 7 15/16	345
LGS-5-6-0V-R	0.1%, 0.1%	10	38.0	33.0	26.0	18.0	5	3 3/16 X 4 15/16 X 14 5/8	476
LGS-6-6-0V-R	0.1%, 0.1%	10	60.0	56.0	49.0	36.0	6	3 3/16 X 7 1/2 X 15 1/8	642
LGS-EE-6-0V-R	0.1%, 0.1%	10	100.0	90.0	80.0	65.0	EE	4 15/16 X 7 1/2 X 16 1/2	773
LGS-G-6-0V-R	0.1%, 0.1%	10	170.0	151.0	132.0	109.0	G	5 3/16 X 19 X 14	1404

12 VOLTS ± 5% ADJ

MODEL	REGULATION (line load)	RIPPLE mV (RMS)	MAX AMPS AT AMBIENT OF 40 C	50 C	60 C	71 C	PKG SIZE	DIMENSIONS (inches)	PRICE
LJS-13-12-0V	0.4%, 0.4%	15	2.0	2.0	1.7	1.1	13	4 3/4 X 1 25/32 X 6 5/16	$160
LJS-10-12-0V	0.4%, 0.4%	15	4.2	4.2	3.4	2.3	10	4 3/4 X 1 25/32 X 7 15/16	230
LJS-11-12-0V	0.4%, 0.4%	15	8.3	8.3	6.6	4.5	11	4 3/4 X 4 5/16 X 7 15/16	285
LJS-12-12-0V	0.4%, 0.4%	15	12.5	12.5	10.0	6.8	12	4 3/4 X 6 1/4 X 7 15/16	345
LGS-5-12-0V-R	0.1%, 0.1%	15	24.0	20.0	16.0	11.0	5	3 3/16 X 4 15/16 X 14 5/8	476
LGS-6-12-0V-R	0.1%, 0.1%	15	37.5	35.0	30.5	23.0	6	3 3/16 X 7 1/2 X 15 1/8	642
LGS-EE-12-0V-R	0.1%, 0.1%	15	60.0	53.0	46.0	38.0	EE	4 15/16 X 7 1/2 X 16 1/2	773
LGS-G-12-0V-R	0.1%, 0.1%	15	105.0	95.0	85.0	70.0	G	5 3/16 X 19 X 14	1404

15 VOLTS ± 5% ADJ

MODEL	REGULATION (line load)	RIPPLE mV (RMS)	MAX AMPS AT AMBIENT OF 40 C	50 C	60 C	71 C	PKG SIZE	DIMENSIONS (inches)	PRICE
LJS-13-15-0V	0.4%, 0.4%	15	1.6	1.6	1.3	0.9	13	4 3/4 X 1 25/32 X 6 5/16	$160
LJS-10-15-0V	0.4%, 0.4%	15	3.3	3.3	2.6	1.8	10	4 3/4 X 1 25/32 X 7 15/16	230
LJS-11-15-0V	0.4%, 0.4%	15	6.7	6.7	5.3	3.7	11	4 3/4 X 4 5/16 X 7 15/16	285
LJS-12-15-0V	0.4%, 0.4%	15	10.0	10.0	8.0	5.5	12	4 3/4 X 6 1/4 X 7 15/16	345
LGS-5-15-0V-R	0.1%, 0.1%	15	18.7	16.5	13.2	9.0	5	3 3/16 X 4 15/16 X 14 5/8	476
LGS-6-15-0V-R	0.1%, 0.1%	15	30.0	28.0	24.5	20.5	6	3 3/16 X 7 1/2 X 15 1/8	642
LGS-EE-15-0V-R	0.1%, 0.1%	15	47.0	42.0	36.0	30.0	EE	4 15/16 X 7 1/2 X 16 1/2	773
LGS-G-15-0V-R	0.1%, 0.1%	15	85.0	75.0	65.0	55.0	G	5 3/16 X 19 X 14	1404

20 VOLTS ± 5% ADJ

MODEL	REGULATION (line load)	RIPPLE mV (RMS)	MAX AMPS AT AMBIENT OF 40 C	50 C	60 C	71 C	PKG SIZE	DIMENSIONS (inches)	PRICE
LJS-13-20-0V	0.4%, 0.4%	15	1.2	1.2	1.0	0.7	13	4 3/4 X 1 25/32 X 6 5/16	$160
LJS-10-20-0V	0.4%, 0.4%	15	2.5	2.5	2.0	1.4	10	4 3/4 X 1 25/32 X 7 15/16	230
LJS-11-20-0V	0.4%, 0.4%	15	5.0	5.0	4.0	2.7	11	4 3/4 X 4 5/16 X 7 15/16	285
LJS-12-20-0V	0.4%, 0.4%	15	7.5	7.5	6.0	4.1	12	4 3/4 X 6 1/4 X 7 15/16	345
LGS-5-20-0V-R	0.1%, 0.1%	15	13.5	11.5	9.3	6.3	5	3 3/16 X 4 15/16 X 14 5/8	476
LGS-6-20-0V-R	0.1%, 0.1%	15	23.0	21.5	18.5	15.5	6	3 3/16 X 7 1/2 X 15 1/8	642
LGS-EE-20-0V-R	0.1%, 0.1%	15	34.0	30.0	26.0	22.0	EE	4 15/16 X 7 1/2 X 16 1/2	773
LGS-G-20-0V-R	0.1%, 0.1%	15	62.0	55.0	48.0	40.0	G	5 3/16 X 19 X 14	1404

24 VOLTS ± 5% ADJ

MODEL	REGULATION (line load)	RIPPLE mV (RMS)	MAX AMPS AT AMBIENT OF 40 C	50 C	60 C	71 C	PKG SIZE	DIMENSIONS (inches)	PRICE
LJS-13-24-0V	0.4%, 0.4%	15	1.0	1.0	0.8	0.6	13	4 3/4 X 1 25/32 X 6 5/16	$160
LJS-10-24-0V	0.4%, 0.4%	15	2.1	2.1	1.7	1.2	10	4 3/4 X 1 25/32 X 7 15/16	230
LJS-11-24-0V	0.4%, 0.4%	15	4.2	4.2	3.3	2.3	11	4 3/4 X 4 5/16 X 7 15/16	285
LJS-12-24-0V	0.4%, 0.4%	15	6.3	6.3	5.0	3.4	12	4 3/4 X 6 1/4 X 7 15/16	345
LGS-5-24-0V-R	0.1%, 0.1%	15	11.5	9.9	7.9	5.4	5	3 3/16 X 4 15/16 X 14 5/8	476
LGS-6-24-0V-R	0.1%, 0.1%	15	20.0	19.0	16.0	13.0	6	3 3/16 X 7 1/2 X 15 1/8	642
LGS-EE-24-0V-R	0.1%, 0.1%	15	30.0	27.0	23.0	19.0	EE	4 15/16 X 7 1/2 X 16 1/2	773
LGS-G-24-0V-R	0.1%, 0.1%	15	54.0	48.0	42.0	35.0	G	5 3/16 X 19 X 14	1404

28 VOLTS ± 5% ADJ

MODEL	REGULATION (line load)	RIPPLE mV (RMS)	MAX AMPS AT AMBIENT OF 40 C	50 C	60 C	71 C	PKG SIZE	DIMENSIONS (inches)	PRICE
LJS-13-28-0V	0.4%, 0.4%	15	0.9	0.9	0.7	0.5	13	4 3/4 X 1 25/32 X 6 5/16	$160
LJS-10-28-0V	0.4%, 0.4%	15	1.8	1.8	1.4	1.0	10	4 3/4 X 1 25/32 X 7 15/16	230
LJS-11-28-0V	0.4%, 0.4%	15	3.6	3.6	2.9	2.0	11	4 3/4 X 4 5/16 X 7 15/16	285
LJS-12-28-0V	0.4%, 0.4%	15	5.4	5.4	4.3	3.0	12	4 3/4 X 6 1/4 X 7 15/16	345
LGS-5-28-0V-R	0.1%, 0.1%	15	9.6	8.2	6.6	4.5	5	3 3/16 X 4 15/16 X 14 5/8	476
LGS-6-28-0V-R	0.1%, 0.1%	15	17.5	16.5	14.5	12.0	6	3 3/16 X 7 1/2 X 15 1/8	642
LGS-EE-28-0V-R	0.1%, 0.1%	15	25.0	23.0	20.0	16.0	EE	4 15/16 X 7 1/2 X 16 1/2	773
LGS-G-28-0V-R	0.1%, 0.1%	15	46.0	42.0	36.0	30.0	G	5 3/16 X 19 X 14	1404

Voltage and Current Ratings

DC INPUT 20.5-32 VDC STANDARD

5 VOLTS ± 5% ADJ

MODEL	REGULATION (line load)	RIPPLE (mV RMS)	MAX AMPS AT AMBIENT OF 40°C	50°C	60°C	71°C	PKG. SIZE	DIMENSIONS (Inches)	PRICE
LGS-5-5-C-OV-R	0.1%, 0.1%	10	35.0	31.0	25.0	16.5	5	3 3/16 x 4 15/16 x 15	$535

6 VOLTS ± 5% ADJ

LGS-5-6-C-OV-R	0.1%, 0.1%	10	29.0	26.0	21.0	14.0	5	3 3/16 x 4 15/16 x 15	$535

12 VOLTS ± 5% ADJ

LGS-5-12-C-OV-R	0.1%, 0.1%	15	15.0	13.5	10.0	7.0	5	3 3/16 x 4 15/16 x 15	$535

15 VOLTS ± 5% ADJ

LGS-5-15-C-OV-R	0.1%, 0.1%	15	13.0	11.0	8.0	5.6	5	3 3/16 x 4 15/16 x 15	$535

20 VOLTS ± 5% ADJ

LGS-5-20-C-OV-R	0.1%, 0.1%	15	10.5	9.0	7.0	4.5	5	3 3/16 x 4 15/16 x 15	$535

24 VOLTS ± 5% ADJ

LGS-5-24-C-OV-R	0.1%, 0.1%	15	8.5	7.5	6.0	3.9	5	3 3/16 x 4 15/16 x 15	$535

28 VOLTS ± 5% ADJ

LGS-5-28-C-OV-R	0.1%, 0.1%	15	7.5	6.8	5.4	3.5	5	3 3/16 x 4 15/16 x 15	$535

DC INPUT 44-58 VDC STANDARD

5 VOLTS ± 5% ADJ

LGS-5-5-D-OV-R	0.1%, 0.1%	10	40.0	32.0	25.0	16.5	5	3 3/16 x 4 15/16 x 15	$476
LGS-6-5-D-OV-R	0.1%, 0.1%	10	60.0	53.0	45.0	36.0	6	3 3/16 x 7 1/2 x 15 1/8	655
LGS-EE-5-D-OV-R	0.1%, 0.1%	10	90.0	85.0	73.0	54.0	EE	4 15/16 x 7 1/2 x 16 1/2	832

6 VOLTS ± 5% ADJ

LGS-5-6-D-OV-R	0.1%, 0.1%	10	35.0	28.0	21.5	14.0	5	3 3/16 x 4 15/16 x 15	$476
LGS-6-6-D-OV-R	0.1%, 0.1%	10	50.0	46.0	41.0	35.0	6	3 3/16 x 7 1/2 x 15 1/8	655
LGS-EE-6-D-OV-R	0.1%, 0.1%	10	78.0	67.0	56.0	42.5	EE	4 15/16 x 7 1/2 x 16 1/2	832

12 VOLTS ± 5% ADJ

LGS-5-12-D-OV-R	0.1%, 0.1%	15	17.5	14.0	10.8	7.0	5	3 3/16 x 4 15/16 x 15	$476
LGS-6-12-D-OV-R	0.1%, 0.1%	15	31.0	28.0	24.0	18.0	6	3 3/16 x 7 1/2 x 15 1/8	655
LGS-EE-12-D-OV-R	0.1%, 0.1%	15	39.0	33.5	28.0	21.0	EE	4 15/16 x 7 1/2 x 16 1/2	832

15 VOLTS ± 5% ADJ

LGS-5-15-D-OV-R	0.1%, 0.1%	15	14.0	11.0	8.6	5.6	5	3 3/16 x 4 15/16 x 15	$476
LGS-6-15-D-OV-R	0.1%, 0.1%	15	25.0	23.0	20.0	15.0	6	3 3/16 x 7 1/2 x 15 1/8	655
LGS-EE-15-D-OV-R	0.1%, 0.1%	15	32.0	28.0	23.5	17.5	EE	4 15/16 x 7 1/2 x 16 1/2	832

20 VOLTS ± 5% ADJ

LGS-5-20-D-OV-R	0.1%, 0.1%	15	11.5	9.3	7.1	4.6	5	3 3/16 x 4 15/16 x 15	$476
LGS-6-20-D-OV-R	0.1%, 0.1%	15	19.0	18.0	16.0	12.0	6	3 3/16 x 7 1/2 x 15 1/8	655
LGS-EE-20-D-OV-R	0.1%, 0.1%	15	26.0	22.5	18.5	14.0	EE	4 15/16 x 7 1/2 x 16 1/2	832

24 VOLTS ± 5% ADJ

LGS-5-24-D-OV-R	0.1%, 0.1%	15	9.8	7.8	6.1	3.9	5	3 3/16 x 4 15/16 x 15	$476
LGS-6-24-D-OV-R	0.1%, 0.1%	15	16.0	15.0	13.0	10.0	6	3 3/16 x 7 1/2 x 15 1/8	655
LGS-EE-24-D-OV-R	0.1%, 0.1%	15	21.5	18.5	15.5	11.5	EE	4 15/16 x 7 1/2 x 16 1/2	832

28 VOLTS ± 5% ADJ

LGS-5-28-D-OV-R	0.1%, 0.1%	15	8.7	7.0	5.4	3.5	5	3 3/16 x 4 15/16 x 15	$476
LGS-6-28-D-OV-R	0.1%, 0.1%	15	14.0	13.0	11.0	9.0	6	3 3/16 x 7 1/2 x 15 1/8	655
LGS-EE-28-D-OV-R	0.1%, 0.1%	15	19.5	17.0	14.0	10.5	EE	4 15/16 x 7 1/2 x 16 1/2	832

Voltage and Current Ratings

AC INPUT 187-242 VAC STANDARD

5 VOLTS ± 5% ADJ

MODEL	REGULATION (line load)	RIPPLE mV (RMS)	40°C	MAX AMPS AT AMBIENT OF 50°C	60°C	71°C	PKG. SIZE	DIMENSIONS (Inches)	PRICE
LGS-5V-5-OV-R	0.1%, 0.1%	10	43.0	36.5	28.0	15.0	5	3 3/16 x 4 15/16 x 14 5/8	$533
LGS-6V-5-OV-R	0.1%, 0.1%	10	63.0	55.0	46.0	34.2	6	3 3/16 x 7 1/2 x 15 1/8	719

6 VOLTS ± 5% ADJ

MODEL	REGULATION (line load)	RIPPLE mV (RMS)	40°C	50°C	60°C	71°C	PKG. SIZE	DIMENSIONS (Inches)	PRICE
LGS-5V-6-OV-R	0.1%, 0.1%	10	37.0	32.0	23.0	13.0	5	3 3/16 x 4 15/16 x 14 5/8	$533
LGS-6V-6-OV-R	0.1%, 0.1%	10	54.0	50.4	44.1	32.4	6	3 3/16 x 7 1/2 x 15 1/8	719

12 VOLTS ± 5% ADJ

MODEL	REGULATION (line load)	RIPPLE mV (RMS)	40°C	50°C	60°C	71°C	PKG. SIZE	DIMENSIONS (Inches)	PRICE
LGS-5V-12-OV-R	0.1%, 0.1%	15	23.0	19.0	15.0	7.0	5	3 3/16 x 4 15/16 x 14 5/8	$533
LGS-6V-12-OV-R	0.1%, 0.1%	15	34.0	31.5	27.4	20.7	6	3 3/16 x 7 1/2 x 15 1/8	719

15 VOLTS ± 5% ADJ

MODEL	REGULATION (line load)	RIPPLE mV (RMS)	40°C	50°C	60°C	71°C	PKG. SIZE	DIMENSIONS (Inches)	PRICE
LGS-5V-15-OV-R	0.1%, 0.1%	15	18.5	16.0	12.0	6.0	5	3 3/16 x 4 15/16 x 14 5/8	$533
LGS-6V-15-OV-R	0.1%, 0.1%	15	27.0	25.2	22.0	18.4	6	3 3/16 x 7 1/2 x 15 1/8	719

20 VOLTS ± 5% ADJ

MODEL	REGULATION (line load)	RIPPLE mV (RMS)	40°C	50°C	60°C	71°C	PKG. SIZE	DIMENSIONS (Inches)	PRICE
LGS-5V-20-OV-R	0.1%, 0.1%	15	12.6	10.8	8.7	4.6	5	3 3/16 x 4 15/16 x 14 5/8	$533
LGS-6V-20-OV-R	0.1%, 0.1%	15	20.7	19.3	16.6	13.9	6	3 3/16 x 7 1/2 x 15 1/8	719

24 VOLTS ± 5% ADJ

MODEL	REGULATION (line load)	RIPPLE mV (RMS)	40°C	50°C	60°C	71°C	PKG. SIZE	DIMENSIONS (Inches)	PRICE
LGS-5V-24-OV-R	0.1%, 0.1%	15	11.5	9.9	7.9	3.9	5	3 3/16 x 4 15/16 x 14 5/8	$533
LGS-6V-24-OV-R	0.1%, 0.1%	15	18.0	17.1	14.4	11.7	6	3 3/16 x 7 1/2 x 15 1/8	719

28 VOLTS ± 5% ADJ

MODEL	REGULATION (line load)	RIPPLE mV (RMS)	40°C	50°C	60°C	71°C	PKG. SIZE	DIMENSIONS (Inches)	PRICE
LGS-5V-28-OV-R	0.1%, 0.1%	15	9.6	8.0	6.0	3.3	5	3 3/16 x 4 15/16 x 14 5/8	$533
LGS-6V-28-OV-R	0.1%, 0.1%	15	15.7	14.8	13.0	10.8	6	3 3/16 x 7 1/2 x 15 1/8	719

AC INPUT 205-265 VAC STANDARD

5 VOLTS ± 5% ADJ

MODEL	REGULATION (line load)	RIPPLE mV (RMS)	40°C	50°C	60°C	71°C	PKG. SIZE	DIMENSIONS (Inches)	PRICE
LGS-5V1-5-OV-R	0.1%, 0.1%	10	43.0	36.5	28.0	15.0	5	3 3/16 x 4 15/16 x 14 5/8	$533
LGS-6V1-5-OV-R	0.1%, 0.1%	10	63.0	55.0	46.0	34.2	6	3 3/16 x 7 1/2 x 15 1/8	719

6 VOLTS ± 5% ADJ

MODEL	REGULATION (line load)	RIPPLE mV (RMS)	40°C	50°C	60°C	71°C	PKG. SIZE	DIMENSIONS (Inches)	PRICE
LGS-5V1-6-OV-R	0.1%, 0.1%	10	37.0	32.0	23.0	13.0	5	3 3/16 x 4 15/16 x 14 5/8	$533
LGS-6V1-6-OV-R	0.1%, 0.1%	10	54.0	50.4	44.1	32.4	6	3 3/16 x 7 1/2 x 15 1/8	719

12 VOLTS ± 5% ADJ

MODEL	REGULATION (line load)	RIPPLE mV (RMS)	40°C	50°C	60°C	71°C	PKG. SIZE	DIMENSIONS (Inches)	PRICE
LGS-5V1-12-OV-R	0.1%, 0.1%	15	23.0	19.0	15.0	7.0	5	3 3/16 x 4 15/16 x 14 5/8	$533
LGS-6V1-12-OV-R	0.1%, 0.1%	15	34.0	31.5	27.4	20.7	6	3 3/16 x 7 1/2 x 15 1/8	719

15 VOLTS ± 5% ADJ

MODEL	REGULATION (line load)	RIPPLE mV (RMS)	40°C	50°C	60°C	71°C	PKG. SIZE	DIMENSIONS (Inches)	PRICE
LGS-5V1-15-OV-R	0.1%, 0.1%	15	18.5	16.0	12.0	6.0	5	3 3/16 x 4 15/16 x 14 5/8	$533
LGS-6V1-15-OV-R	0.1%, 0.1%	15	27.0	25.2	22.0	18.4	6	3 3/16 x 7 1/2 x 15 1/8	719

20 VOLTS ± 5% ADJ

MODEL	REGULATION (line load)	RIPPLE mV (RMS)	40°C	50°C	60°C	71°C	PKG. SIZE	DIMENSIONS (Inches)	PRICE
LGS-5V1-20-OV-R	0.1%, 0.1%	15	12.6	10.8	8.7	4.6	5	3 3/16 x 4 15/16 x 14 5/8	$533
LGS-6V1-20-OV-R	0.1%, 0.1%	15	20.7	19.3	16.6	13.9	6	3 3/16 x 7 1/2 x 15 1/8	719

24 VOLTS ± 5% ADJ

MODEL	REGULATION (line load)	RIPPLE mV (RMS)	40°C	50°C	60°C	71°C	PKG. SIZE	DIMENSIONS (Inches)	PRICE
LGS-5V1-24-OV-R	0.1%, 0.1%	15	11.5	9.9	7.9	3.9	5	3 3/16 x 4 15/16 x 14 5/8	$533
LGS-6V1-24-OV-R	0.1%, 0.1%	15	18.0	17.1	14.4	11.7	6	3 3/16 x 7 1/2 x 15 1/8	719

28 VOLTS ± 5% ADJ

MODEL	REGULATION (line load)	RIPPLE mV (RMS)	40°C	50°C	60°C	71°C	PKG. SIZE	DIMENSIONS (Inches)	PRICE
LGS-5V1-28-OV-R	0.1%, 0.1%	15	9.6	8.0	6.0	3.3	5	3 3/16 x 4 15/16 x 14 5/8	$533
LGS-6V1-28-OV-R	0.1%, 0.1%	15	15.7	14.8	13.0	10.8	6	3 3/16 x 7 1/2 x 15 1/8	719

SPECIFICATIONS OF LG SERIES

DC output

voltage range shown in tables

Regulated voltage

regulation line	0.1% for 105 to 132 VAC, 187-242 VAC, 205-265 VAC
regulation load.	0.1% for 0 to full load
ripple and noise	10mV RMS, 35 mV p-p for 5 and 6V units 15mV RMS, 100mV p-p for 12 thru 28V units
remote programming resistance .	1000 ohms/volt
remote programming voltage . .	volt per volt

Temperature coefficient . . . . 0.03% per°C

AC input

line. . . . . 105-132 VAC, 47-440 Hz

power . . . . 360 watts max. at 0.6 P.F. for LGS-5
750 watts max. at 0.7 P.F. for LGS-6
1100 watts max. at 0.6 P.F. for LGS-EE
1800 watts max. at 0.7 P.F. for LGS-G

DC input . . . .

20.5-32 VDC, LGS-5-C packages only. Input voltage specs. comply with minimum usable voltage for lead acid batteries.
44-58 VDC. "D" models only.
145 VDC ± 10%, LGS-5, LGS-6 packages only.

Efficiency . . .

64% minimum except LGS-EE-D and LGS-6-D which are 60% minimum and LGS-5-C which is 55% minimum.

Soft-start circuit: (LGS-6,LGS-6V,LGS-EE,LGS-G only)

limits in-rush current at turn-on.

Overshoot

no overshoot at turn-on, turn-off or power failure.

Ambient operating temperature

continuous duty 0° to 71°C.

Storage temperature range

−55°C to +85°C

Overload protection

Electrical

pre-set electronic current limiting at factory. Internal failure protection by means of line fuse.

Thermal

by self-resetting thermostat on heat sink.

Overvoltage protection

built-in fixed overvoltage protection standard on all units. When a pre-set voltage is exceeded, the overvoltage protector crowbars the output and removes the inverter drive.

EMI

Conducted – conforms to MIL-I-6181D.

Radiated – see graphs for performance.

Cooling – convection cooled.

DC output controls

simple screwdriver voltage adjustment over the voltage range.

Metering (LGS-G only)

digital panel meter monitors output voltage/current by means of a Volt/Amp selector switch

Input and output connections

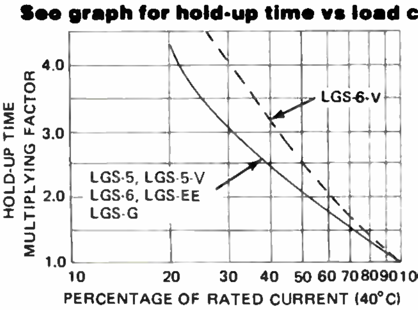
by heavy duty barrier strip; heavy duty studs on all LGS-6, EE and G.

Mounting

two mounting surfaces, three mounting positions for LGS-5
one mounting position for LGS-5V, 6, 6V, 6D, EE, EED and G.
For LGS-5-C and 5D models derate current 10% for mounting positions in which the radiator fins are not vertical.

Power failure

See graph for hold-up time vs load current on all units. (Except LGS-C and LGS-D models).



HOLD-UP TIME AT 100% RATED 40°C CURRENT (IN MILLISECONDS)

MODEL \ SERIES	LGS-5 LGS-5-V	LGS-6	LGS-EE	LGS-6-V	LGS-G
– 5–OV–R	16.5	18.0	16.5	24.0	16.5
– 6–OV–R	16.5	17.5	9.4	23.0	16.5
–12–OV–R	5.0	3.0	9.3	7.0	1.0
–15–OV–R	5.0	4.5	8.3	8.0	2.0
–20–OV–R	5.0	6.0	5.0	10.0	6.0
–24–OV–R	5.0	2.0	2.5	8.0	5.0
–28–OV–R	5.0	1.0	7.0	8.0	5.0

Hold-up times as a function of load current.

Remote sensing

provision is made for remote sensing to eliminate effects of power output lead resistance on DC regulation.

Fungus proofing

all units are rendered fungi inert.

Military Specifications

The LGS series has passed the following tests in accordance with MIL-STD-810C.

1) Low Pressure – Method 500.1, Procedure I.
2) High Temperature – Method 501.1, Procedure I & II.
3) Low Temperature – Method 502.1, Procedure I.
4) Temperature Shock - Method 503.0, Procedure I.
5) Temperature – Altitude – Method 504.1, Procedure I. Class 2 (0°C operating)
6) Humidity – Method 507.1, Procedure I.
7) Fungus – Method 508.1, Procedure I.
8) Vibration – Method 514.2, Procedures X & XI.
9) Shock - Method 516.2, Procedures I & III.

MIL-1-6181D – Conducted and radiated EMI with one output terminal grounded.

Physical Data

Package Model	Size (inches)	Weight Net (lbs)	Weight Ship (lbs)
LGS-5	3 3/16 x 4 15/16 x 15	13 1/2	15
LGS-6	3 3/16 x 7 1/2 x 15 1/8	20	23
LGS-EE	4 15/16 x 7 1/2 x 16 1/2	26	31
LGS-G	5 3/16 X 19 X 14	42	45

Options

AC input

For LGS-EE and LGS-G models only
For LGS-5, LGS-6 see preceding page

Add Suffix	For Operation at:	Price Qty 1-14	Price Mixed Models Qty 15 & up	Price Single Model Qty 15 & up
–V	187-242VAC * 47-440Hz	12% or $30†	12% or $30†	10% or $30†
–V1	205-265 VAC 47-440Hz	12% or $30†	12% or $30†	10% or $30†

*derate 10% for V option only † whichever is greater

Accessories

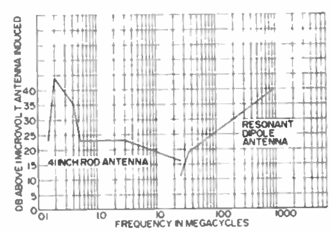
Rack adapters available.

Guaranteed for 5 years

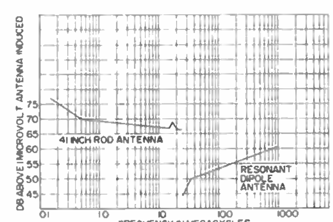
5 year guarantee includes labor as well as parts. Guarantee applies to operation at full published specifications at end of 5 years.

UL/CSA

Listed in UL recognized components index; CSA certified.



Narrow band (cw) radiated interference limits



Broadband and pulsed cw radiated interference limits

SPECIFICATIONS OF LJ SERIES

DC output

voltage range: refer to tables

regulation, line	0.4% for line variations from 105-132VAC.
regulation, load	0.4% for load variations from 0 to full load
remote programming resistance	1000 ohms/volt
remote programming voltage	volt/volt
ripple and noise	10mV rms, 50 mV p-p for 5V and 6V models; 15 mV rms, 100 mV p-p for 12V to 28V models.
temperature coefficient	0.03%/°C.
power failure	output will remain within regulation for 16 msec after power failure.

AC input

line	105-132 VAC 47-440 Hz
hold up time	16 msec min at low line and full load, and V_O max.

DC input

145 VDC ± 10%

Overshoot

no overshoot on turn-on, turn-off, or power failure

Efficiency

greater than70% (60% FOR LJS-13) with advanced 20 KHz switching circuitry

Ambient operating temperature range

continuous duty from 0°C to 71°C with load current ratings as shown in tables

Storage temperature range

-55°C to 85°C

Overload protection

Electrical

external overload protection: automatic factory preset electronic current limiting circuit limits the output current thereby providing protection for the load as well as the power supply.

internal failure protection: provided by fuse.

Input and output connections

heavy duty terminal block on front of chassis.

Controls

DC output controls

simple screwdriver voltage adjustment over the voltage range

Remote sensing

provision is made for remote sensing to eliminate effect of power output lead resistance on DC regulation.

Remote shutdown

capability of remote on-off control for either positive ground or negative ground output.

Overvoltage protection

built in fixed overvoltage protection on all model outputs.

Mounting

One mounting surface.

Options

AC input

Add Suffix	For Operation at:	Price Qty. 1-14	Price Mixed Models Qty. 15 and up	Price Single Model Qty. 15 and up
–V	187-265 VAC 47-440 Hz	12% or $30*	12% or $30*	10% or $30*

*whichever is greater

See Physical Data below for sizes of "V" option power supplies — The "V" option supplies sizes are larger than equivalent standard power supplies.

Physical Data

Package Model	Weight (lbs.) net	Size (inches)
LJ-13	1.6	4 3/4 X 1 25/32 X 6 5/16
LJ-13-V	2.0	4 3/4 X 1 25/32 X 7 15/16
LJ-10	2.0	4 3/4 X 1 25/32 X 7 15/16
LJ-10-V	3.0	4 3/4 X 1 25/32 X 9 1/16
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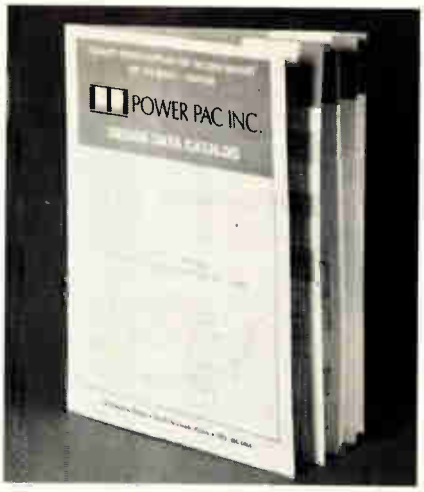
New literature

C-MOS microprocessor family. A 36-page guide describes the HM-6100 family of 12-bit microprocessor products. It covers the architecture, instruction set, and specifications of the CPU and highlights support circuits, such as C-MOS memories, bus drivers, communication circuits, and I/O controllers. Specifications and pin-out diagrams for all system elements are provided. The guide also describes support systems and software and introduces a 12-bit single-board computer, the Micro-12, which can be used to evaluate the HM-6100 family. Send request on letterhead to Harris Semiconductor Group, Dept. 53-035, P. O. Box 883, Melbourne, Fla. 32901.

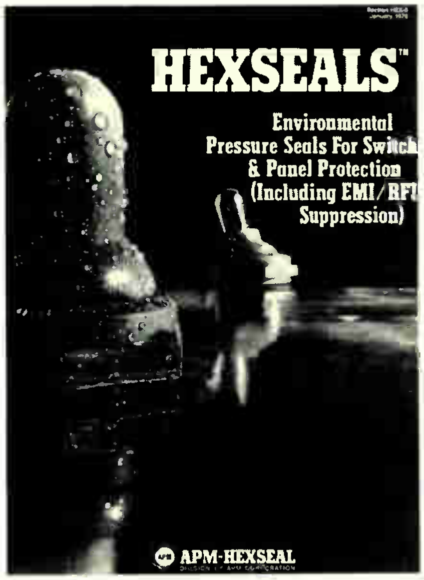
Power supplies. Features and options of a line of off-the-shelf and custom-made power supplies are described in a 12-page design data catalog. Illustrations and dimen-



sional drawings accompany specifications of open-frame types with single, double, and triple outputs and modular and pc-board–mountable units with single and double outputs. An outline of the company's facilities will interest potential users. Power Pac Inc., 32 Meadow St., South Norwalk, Conn. 06854. Circle reader service number 421.

Antenna systems. Technical data and applications information for antenna and transmission-line systems are presented in a 160-page catalog. Photographs and supporting charts illustrate the line, which includes satellite earth-station antennas, terrestrial point-to-point microwave antennas, microwave waveguides, air- and foam-dielectric coaxial cables, rigid lines, pressurization equipment, and specialized and custom-designed antennas. Field services, including system planning, delivery, assembly, installation, and testing are described. Ask for Catalog 30. Andrew Corp., 10500 West 153rd St., Orland Park, Ill. 60462 [422]

Switch seals. An updated catalog details a series of environmental-pressure sealing boots designed for push-button, rotary, and toggle switches, as well as indicators and circuit breakers. The boots, which

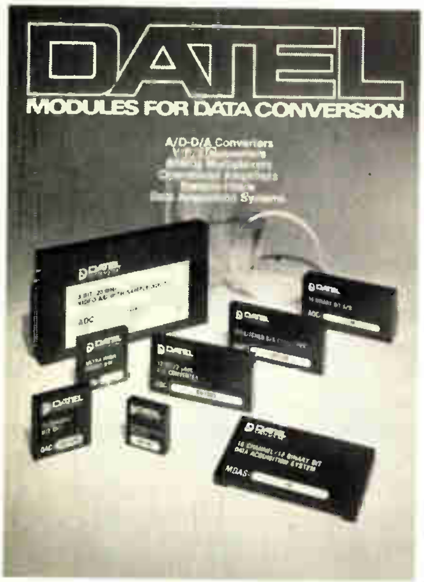


protect their contents against contaminants under internal and external pressures of up to 15 lb/in.^{2}, are made of silicone rubber. They have a molded-in hex-nut that replaces the protected device's original mounting nut. Selection is made by matching the switch's thread size and actuator's height to the dimensions listed for each boot. Illustrations and dimensional drawings are included in the 8-page catalog. APM-Hexseal Corp., 44 Honeck St., Englewood, N. J. 07631 [423]

Bonding wire. Anyone involved in the packaging and production of semiconductors will be interested in this technical review of the structure and properties of aluminum-1% silicon bonding wire. Entitled "Metallurgy, Fabrication and Use of Aluminum-1% Bonding Wire," the 15-page brochure discusses how the material's parameters are influenced by and controlled during processing and ultrasonic wire-bonding. Photomicrographs and charts accompany the text, which also outlines continuing R&D. Plessey Materials Corp., 3333 Bowers Ave., Suite 250, Santa Clara, Calif. 95051 [424]

Flat cable. Two different types of flat cable are described in a 28-page brochure. Tape Cable, a trade name for flat flexible cable, and ribbon cable, with cemented or woven-together individually insulated conductors, are both available from stock or custom made by the manufacturer. Technical data, charts, and illustrations detail the construction and specifications of each type. The brochure also includes a useful glossary and military specification information. For a copy of "Flat Cable, EC3-78," write to Brand-Rex Co., P. O. Box 498, Willimantic, Conn. 06226 or circle [425]

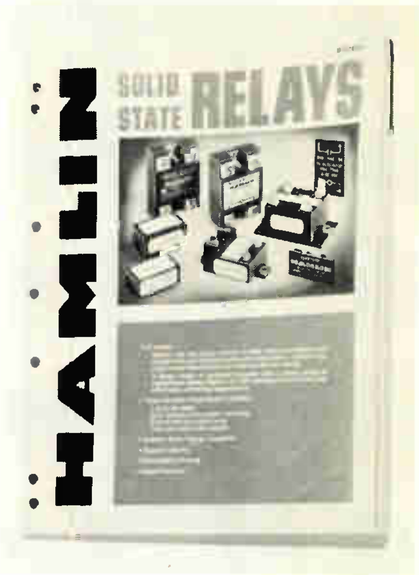
Data-conversion modules. A 144-page catalog and reference guide gives descriptions and complete specifications for a line of analog-to-digital and digital-to-analog converters, data-acquisition system mod-



ules, and data-conversion accessory circuits, including analog multiplexers; sample-and-hold amplifiers; operational amplifiers, both modular and monolithic; instrumentation amplifiers, and voltage-to-frequency converters. In addition to the details of each product, there is a section on the principles of data acquisition and conversion. Datel Systems Inc., 1020 Turnpike St., Canton, Mass. 02021 [426]

Word processing. Users rate more than 80 models in this survey of word-processing systems. Ratings are based on ease of operation, functions/features, applications, service and support and overall satisfaction. Detailed results of this survey are available for $12 from Datapro Research Corp., 1805 Underwood Blvd., Delran, N. J. 08075.

Solid-state relays. This 12-page catalog covers a line of solid-state relays with each series pictured and mechanically diagrammed. The new 7580 optically isolated ac solid-state thyristor driver and the 7800 series hybrid solid-state relays are described here, as are complete performance curves and ratings for all series. Write for bulletin B-07600, Hamlin Inc., Lake & Grove Streets, Lake Mills, Wis. 53551 [427]



Optoelectronics. Included in this color catalog are complete specifications for reflective switches, optical switches, optically coupled isolators, infrared light-emitting diodes, photodiodes, phototransistors, and photodarlingtons. Fiber-optic components and data systems, displays, and detectors are also mentioned, and tabular data are coded for easy reference to accompanying outline dimension drawings and product photographs. Copies are available from Spectronics, Product Marketing Dept., 830 E. Arapaho Rd., Richardson, Texas 75081 [428]

Microwave devices. Product description and specifications for microwave devices are presented in this 120-page catalog, which has been expanded to include the new "supercomponents" and recent developments in a line of comb generators. Standard lines of crystal-controlled oscillators, power and intermediate-frequency amplifiers. ferrite devices, multipliers, and microwave subsystems are also described in detail. TRAK Microwave Corp., 4726 Eisenhower Blvd., Tampa, Fla. 33614 [429]

Microcomputer support. Meeting the specific needs of the Texas Instruments minicomputer user is the aim of this new 48-page catalog. It features such items as TI Silent Writer paper, flexible disks, ¼-in. data cartridges, and other media, plus accessories, supplies, storage, connectors, computer-room furniture, and such hard-to-find items as

cables custom designed to assure compatibility with TI equipment. Also available is the new 64-page fall 1978 edition of the Minicomputer Accessories Catalog that can serve as a source for all minicomputer users. Minicomputer Accessories Corp., Dept. P-7, Box 9004, Sunnyvale, Calif. 94086 [430]

New books

NCR Data Communications Concepts, E&L Instruments Inc., Derby, Conn., 1978, $6.95.

For anyone with a need to know about data communications, this is an important minitext. One of a group put out by E&L Instruments in its Bugbook series, it was originally prepared by the Technical Education Department of the National Cash Register Co. It explores the various concepts, techniques, and limitations of data communications in an elementary but satisfying way and is also a good introduction to further work and readings.

Thirteen well-illustrated chapters cover verbal and visual communications, computers and communications, telephone systems, circuit terminations and modes of operation, conventional intelligence signals, modulation methods and techniques, basic carrier systems, wire transmission lines, transmission problems, telephone-circuit corrective elements, interpretation of circuit specifications, and modems. Moreover, detailed appendixes cover communications terminology, code charts, wire gauges, interface standards, teletypewriter alphabets, and other handy information. Tests with answers are given so that the serious reader can check his progress.

As the editors point out, the book is geared to telephone applications. However, the material is so fundamental it may be used as a basis for the study of computer networking, data transmission in a process control system, data transmission in microcomputers, and so on.

There is little or no mathematics. Anyone with the appropriate engineering background can go through the material almost as fast as he (or she) can read, and while he will not be a designer or decision maker in data communications at the end, the necessary groundwork will have been laid for the further studies needed to make this happen.

Completion of the material should also enable the reader to cope better with the so-called information explosion the electronics industry is undergoing. Even someone who wants nothing more than to understand the data communications impact of AT&T's proposed Advanced Communications System on intercompany data communications or of IBM's SBS system in terms of the key words and concepts will find this a good place to start.

However, the editors have perhaps oversimplified matters just a little by including such elements as how to determine the logarithm of a number, a table of common logs and the formulas for Ohm's law, etc. But this is a minor complaint. Anyone who does need such material for a full understanding of what is going on should probably start with the NCR Basic Electronics Course With Experiments—another Bugbook in the series. **Harvey J. Hindin**

How to Become a Professional Engineer, 3rd ed., John D. Constance, McGraw-Hill, 325 pp., $17.50.

IEEE Standard Techniques for High-Voltage Testing, 6th ed., Power System Instrumentation and Measurements Committee of the IEEE Power Engineering Society (sponsor), IEEE Press (distributed by John Wiley & Sons), 125 pp., $13.00.

Physics and Technology of Low-Temperature Plasmas, S. V. Dresvin, ed., The Iowa State University Press, 471 pp., $25.00.

The Waves of Change—A Techno-Economic Analysis of the Data Processing Industry, 1st ed., Charles P. Lecht, Advanced Computer Techniques Corp., N. Y., 186 pp.

McGraw-Hill Dictionary of Physics and Mathematics, Daniel N. Lapedes, ed., New York, 1,024 pp., $22.50.

An Introduction to Decision Logic Tables, revised ed., Herman McDaniel, PBI-Petrocelli Books (distributed by McGraw-Hill), 160 pp., $12.00.

Laser Beam Information Systems, William C. House, ed., PBI-Petrocelli Books (distributed by McGraw-Hill), 192 pp., $15.00.

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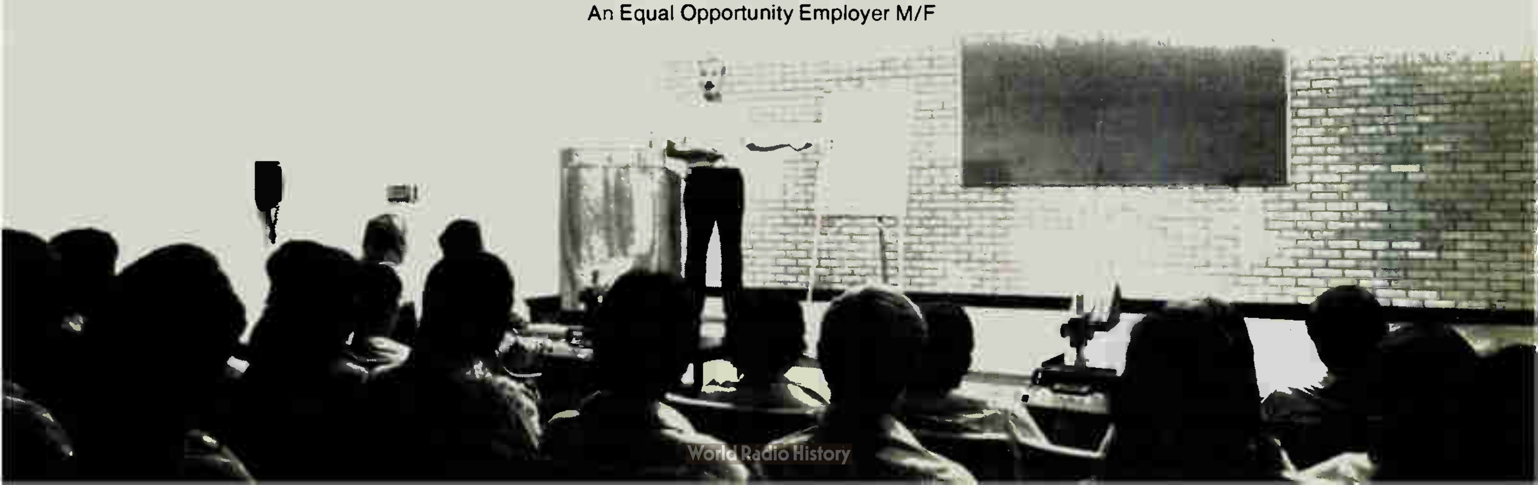

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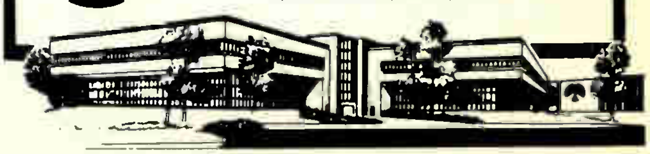

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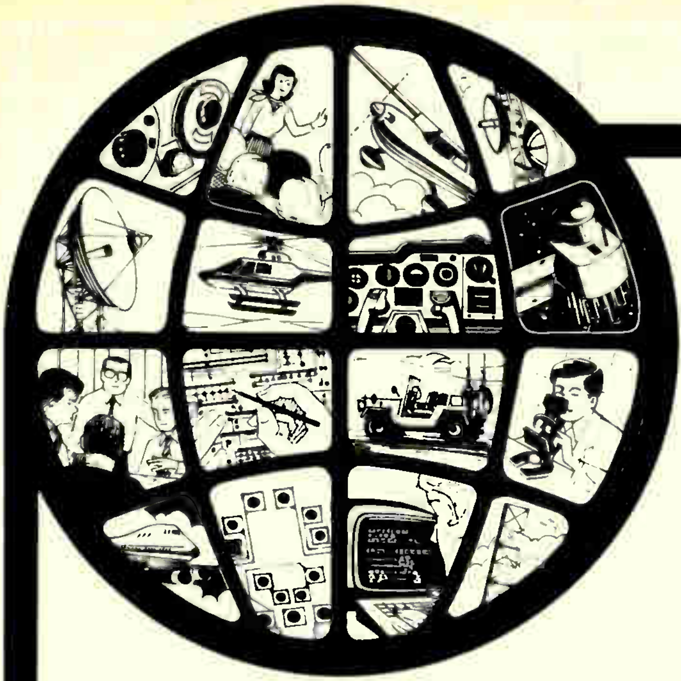

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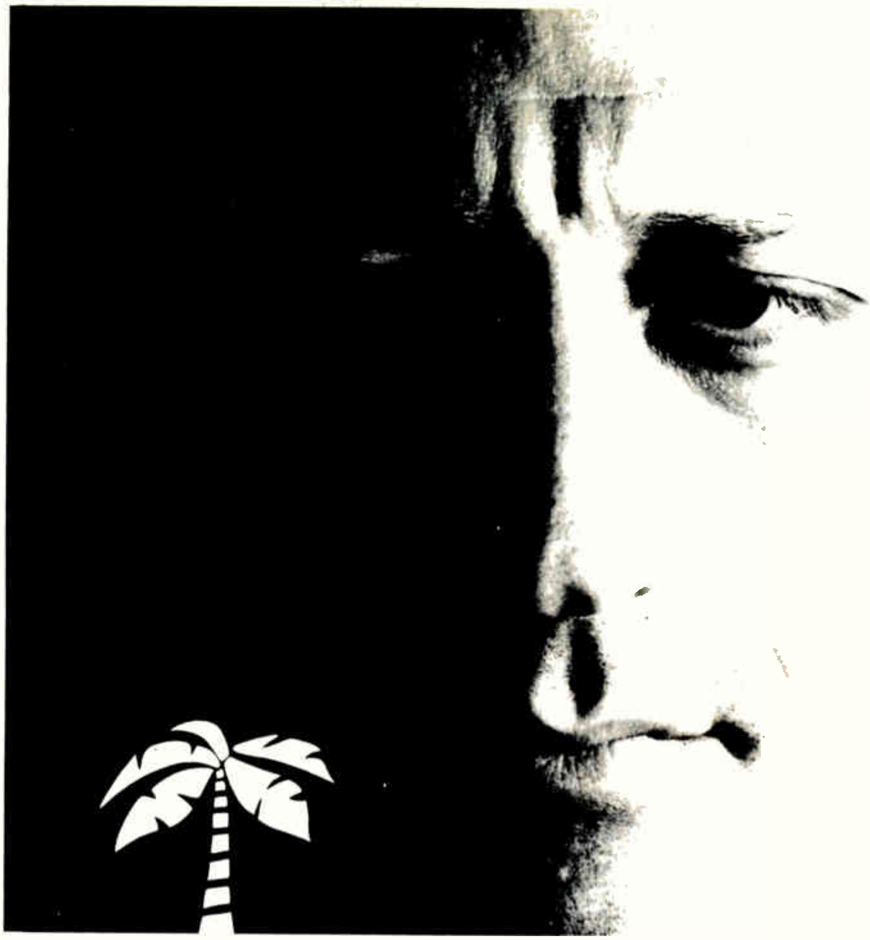

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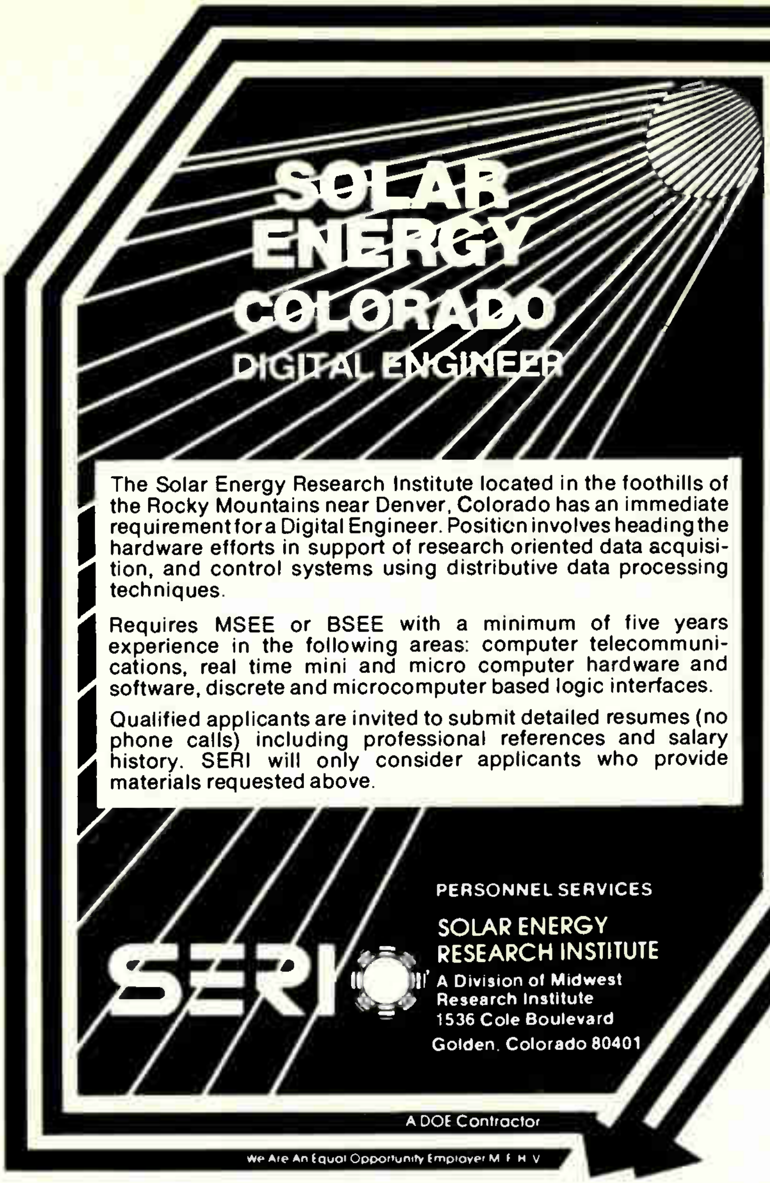

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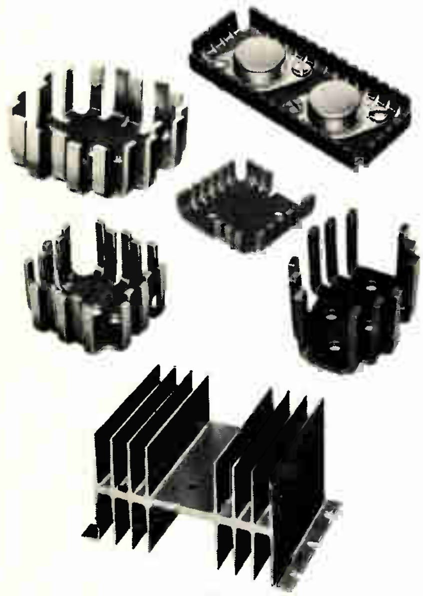

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