JANUARY 13, 1981

DIGITAL AUDIO DISK PLAYERS PUSH TOWARD MARKET/102

Uncommitted logic arrays boast analog sectors/164

Minimizing man-made noise in optical data links/146

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1981 WORLD MARKETS

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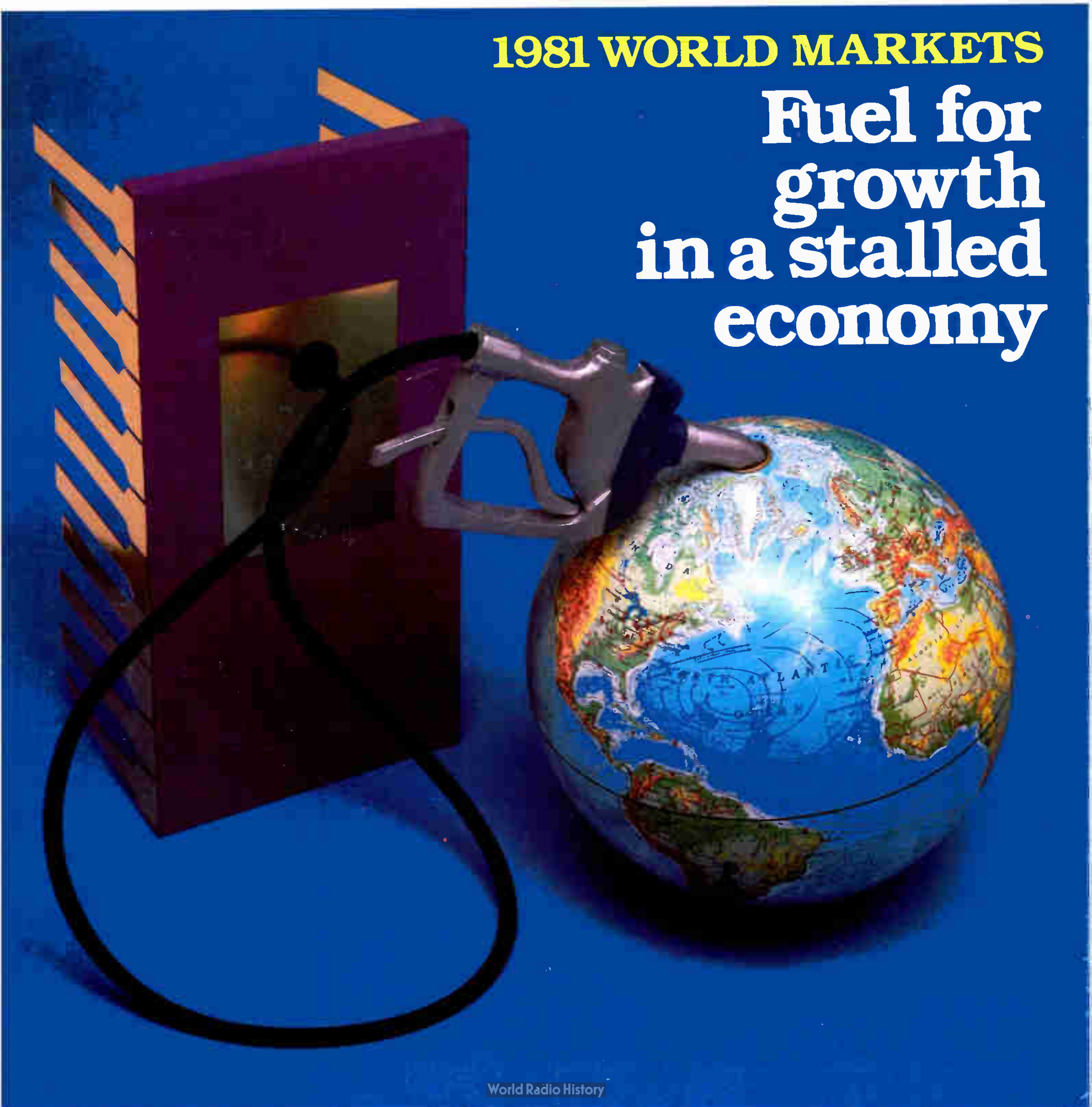


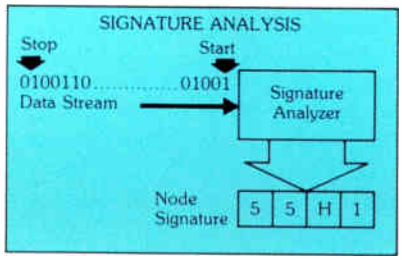
7. Circuit Board Testing Update/No. 7 in a series from Hewlett-Packard.

SIGNATURE ANALYSIS: A NEW AND EFFECTIVE METHOD OF TESTING MICROPROCESSOR-BASED BOARDS AT SPEED

If you're producing microprocessor-based products, you've probably found that board level testing is no trivial problem. That's because the complexity of the microprocessor (MPU) has introduced a number of new testing problems, especially when the boards must be tested at operating speeds.

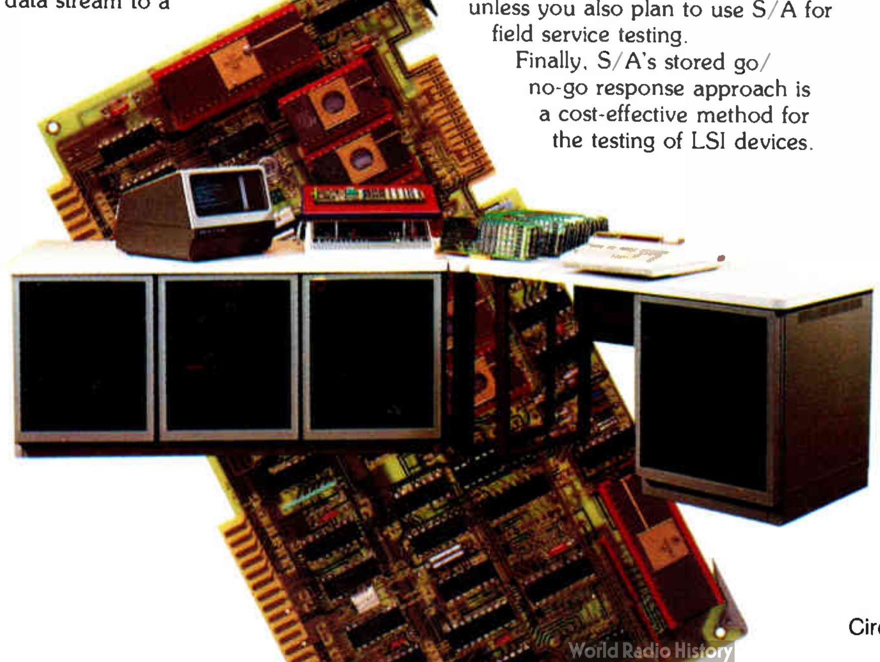
What are the new testing problems?
At-speed testing of dynamic devices creates five major problems: 1) Synchronizing most test systems with the MPU's fast on-board clock isn't possible; 2) The MPU's bi-directional bus makes fault isolation difficult; 3) Existing test systems often aren't fast enough to test today's dynamic memory devices thoroughly; 4) Most test systems cannot exercise the MPU's software — a must, and 5) Functional test development costs are increasing with device complexity. To solve these problems, Hewlett-Packard created new testing techniques.

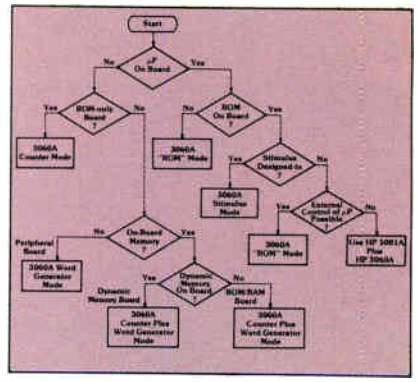
How HP developed Signature Analysis.
In 1977, as a means of reducing field service costs, HP developed a new method of testing dynamic devices. Called Signature Analysis (S/A) it is a data compression technique that reduces a complex data stream to a series of unique four-digit hexadecimal signatures. Under test, the signature of each circuit node is compared to a stored value, making it easy to locate faulty nodes.



Solving the five major problems.
Signature Analysis has made MPU board testing manageable by solving the testing problems outlined above. First, S/A can be synchronized with the MPU's on-board clock at rates up to 10 MHz. Second, interacting with the board under test, S/A can verify the data stream from a specific device on bi-directional buses. Third, the S/A technique is fast. It can locate speed-related faults in dynamic devices. Fourth, with S/A, the board under test is stimulated with a software test routine executed by the on-board MPU. With HP's 3060A, the test system can now supply this test routine to the MPU. No longer must S/A be designed into the board — unless you also plan to use S/A for field service testing.

Finally, S/A's stored go/no-go response approach is a cost-effective method for the testing of LSI devices.





You can put this new tool to work for you now.
Signature Analysis is part of the High Speed Digital Functional Test option to the proven HP 3060A Board Test System. This option is priced at $12,000* and can be added to 3060A's currently in service. The technique is complemented by the 3060A's programmable drivers, in-circuit program generator, and bed-of-nails visibility for automatic backtracing. Note, in the flow chart above, how the 3060A with this option provides flexibility in the selection of dynamic stimulus for board test applications.

For additional information.
To receive complete details on the HP 3060A Board Test System and the High Speed Digital Functional Test option, write: Hewlett-Packard, 1507 Page Mill Road, Palo Alto, CA 94304. Or call the HP regional office nearest you: East (201) 264-5000, West (213) 970-7500, Midwest (312) 255-9800, South (404) 955-1500, Canada (416) 678-9430.

*Domestic U.S.A. price only.

091/2

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02003A

HEWLETT PACKARD

Electronics
The International Magazine of Electronic Technology
Vol. 54, No. 1 • January 13, 1981

Highlights

Cover: World markets persist in growing despite fears, 121

Whatever their country of origin, the electronics markets continue to expand faster than the general economy. However, doubts about how long the industries can resist the mounting recession loomed large as 1980 ended. For the U. S. in particular, confusion about the New Year reigns, though the overall outlook is positive (p. 122). An adequate but not thrilling gain is expected for Japan (p. 139). For Europe, the predictions are even less promising (p. 134).

The cover was designed by Art Director Fred Sklenar, constructed by Ann Dalton, and photographed by Joe Ruskin.

Japanese and Europeans nearing consensus on digital audio, 102

American stereo makers seem uninterested, but the Europeans and Japanese are preparing for a meeting on digital audio disk systems that is likely to recommend adoption of the Philips-Sony approach. To be held in Tokyo next month, the meeting has no formal power, but most companies are expected to go along with its recommendation in order to avoid the marketing burden of incompatible systems.

How to minimize emi in an optical data link, 146

Despite the immunity of optical fiber to electromagnetic interference, an optical data link may still be susceptible to man-made noise. The cure is at hand in careful receiver design, based on both classic radio concepts and techniques unique to fiber optics.

Conductive polymer creates unique current protector, 159

The best features of thermistors, slow-blow fuses, and circuit breakers are united in conductive polymer switches. The devices work on the thermistor principle but can handle much higher currents and, like circuit breakers, can be reset.

Uncommitted logic arrays embrace analog elements, 163

Automated interconnection is a prime attraction of a new series of bipolar and complementary-MOS ULAs that aims at expanding the range of applications of these devices. Two C-MOS versions, in fact, contain areas dedicated solely to the needs of analog circuitry.

And in the next issue . . .

Restructuring a microprocessor from the substrate up . . . automating a wafer-production line . . . how sign-magnitude encoding simplifies multichannel data conversion . . . a low-power n-channel MOS static random-access memory . . . an automated test network that can keep up with a changing test floor technology.

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Circle 5 on reader service card

Publisher's letter

The annual effort of forecasting the electronics markets for the United States, Western Europe, and Japan requires several months of preparation culminating in the exacting work of crunching all the numbers into final form.

It starts with the preparation of the forms to be mailed to manufacturers. For the U. S. survey, questionnaires covering some 475 separate product categories go out to over 1,500 firms representing the various market sectors. Similar but shorter questionnaires are sent to companies in 11 European countries and to firms in Japan.

When the returns are in, the McGraw-Hill Publications Co.'s Economics department prepares sheets breaking down responses for each category and then reviews the estimates with our department editors. The editors also call upon outside market analysts and company researchers for additional expert opinion. This year, as an added measure, the news bureaus around the country contacted a score of industry observers to get a final fix on the rapidly changing U. S. market. The result of all this effort is in the forecast starting on page 121.

This year we had an additional assist in the form of an Apple II computer. Set up and run by technical managing editor Ray Capece, the machine proved invaluable in handling the complex tables required for the three markets.

"We used canned software," Ray reports. "Apple Post took care of the mailing list, and VisiCalc, a balance sheet program, was perfect for the tables. The computer allowed us to run totals quickly and to make changes without having to recalculate rows and rows of figures. We also got annual percentage changes."

But Ray learned in a small way the lessons that many computer users experience. "We pushed the software to its limits and soon felt the need for more horsepower," Ray explains. "Once the entries get into the thousands, the central processing unit begins to show signs of strain—as does the operator."

Despite the headaches, the computer was a great help and has now become a necessary part of the market forecast. Our machines, which include the Apple with 48-K bytes of random-access memory, a cathode-ray-tube display, dual minifloppy-disk store, and a Centronics 779 printer, have already been put to work on other office chores. Now we are wondering how we ever got along without them.

As part of the survey that appears in this issue, we are also putting together the Electronics 1981 World Markets Forecast Data Book. Available March 2, this book will contain far more detail than could be included in the published report.

Besides a reprint of the 24-page forecast, it will describe the forecasting methodology and how the figures were collected. It will also include a range of estimates for each product item in the U. S. report, plus compound annual growth rates covering the six years from 1979 to 1984. In addition, the book will have an analysis of the 1981 U. S. forecast, coupled with an economic outlook prepared by the McGraw-Hill Economics department.

Finally, the figures will be completely broken down for each of the 11 European countries surveyed, covering consumption of equipment and components for the three years 1979–81. These tables, which were used to prepare the summary contained in the published report, will have greater resolution of the numbers in many of the product categories. The 11 countries are Belgium, Denmark, France, Italy, the Netherlands, Norway, Spain, Sweden, Switzerland, the United Kingdom, and West Germany.

The 1981 forecast data book costs $125 and may be obtained from Electronics Magazine Books, 1221 Avenue of the Americas, New York, N. Y. 10020. Payment must accompany the order.

Catch the Bus for Completely Automatic Distortion Measurement

Designers and ATE people requested it — a NEW distortion analyzer with IEEE-488 bus compatibility. Now Krohn-Hite responds with the first *totally* automatic instrument for measuring low distortion, voltage, and frequency.

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Circle 162 on reader service card

More gate array activity

To the Editor: Some misconceptions may have been created in "Gate Arrays—A Special Report" [Sept. 25, p. 145] with respect to Signetics' semicustom logic programs. These efforts include gate arrays and composite cell logic.

Our customers have been using CCL since 1975 to fabricate circuits with TTL performance levels up to 800 gates. Our first gate array, the 2,000-gate I²L (integrated-injection-logic) 8A2000, was introduced in 1977. It is still in production and we are supplying custom gate arrays as well as codes to major customers.

Also, the chart comparing gate speed and array complexity [p. 146], though informative, employs a worst-case delay of 6 nanoseconds for the Signetics 1,200-gate 8A1200 while using typical or even best-case values for the other arrays. In fact, the present typical delay for the 8A1200 is 3.5 ns, and we have demonstrated typical delays of 2 ns and worst-case delays of 4 ns, which will be specified on 1981 products.

The author's description of ISL (integrated Schottky logic) implies that we simply add Schottky-barrier diodes to the outputs of I²L gates. But ISL is dramatically different from I²L, since it involves a right-side-up vertical npn and two pnp transistors—one vertical and one lateral—merged so that the pnp devices clamp the npn out of saturation. This gives the 3.5-ns performance, with standard Schottky processing and power levels one tenth those of 74LS (low-power Schottky).

Also, the emphasis on oxide-isolated complementary-MOS may be misplaced. All indications are that many major semiconductor manufacturers are pursuing bipolar technology for their primary gate array activities.

Regarding computer-aided design, we offer a simulation program called Sigsim that customers can access via telephone in their own plants. Sigsim checks for testability and performs fault grading. Another simulator can analyze an entire system.

Our CAD library also includes the following programs:

- Gaspar (gate-array symbolic placement and routing) allows symbolic digitizing of a hand-generated Mylar representation of an application. It also performs a design rule check to identify layout errors unique to semicustom approaches.
- Latch (layout and topology check) ensures that the Calma mask-data base created using Gaspar is identical to the logic diagram used for simulation.
- Sengen (Sentry generation) creates a Sentry test program using the simulation exercise results.

This software is in use now, and our automatic place-and-route program will be available by mid-1981.

Signetics' data base allows the customer with an interactive graphics capability to generate and submit a data base compatible with the Calma system, as an alternative to laying out the design option manually on a Mylar coding sheet.

Further, though the performance of C-MOS is progressing, arrays built with this technology still cannot compete in applications requiring TTL speed. So I suggest that the task of replacing TTL is best shouldered by bipolar semicustom products.

Jim Fahey
Signetics Bipolar LSI Division
Sunnyvale, Calif.

Official approval

To the Editor: The Technology Update on memories [Oct. 25, p. 124] seemed to indicate that Intel's 28-pin family of ultraviolet-light–erasable programmable read-only memories was the only one officially approved by the Joint Electron Device Engineering Council. The 24-pin family made by Motorola, Texas Instruments, and others, however, is also officially Jedec-approved. Specifically, Motorola's 64-K E-PROM in a 24-pin package and Intel's 28-pin family were officially approved at the same meeting, on Oct. 7, 1980. This was to give users the choice of a 24-pin part compatible with today's industry-standard ROMs or a 28-pin device for future expansion designs.

Also, Motorola has been testing the MCM2801 E-PROM since early summer. This device, though low in density, was the first announced n-channel floating-silicon-gate EE-PROM with a thin (tunnel) oxide. The new series of EE-PROMs planned by Motorola that was mentioned in the story will begin with a 2-K-by-8-bit part similar to Intel's 2816.

David C. Ford
Motorola Inc.
Austin, Texas

Real rewards for innovation

To the Editor: I couldn't agree more with your editorial comment on U. S. annual technology prizes [Nov. 20, p. 24]. If a significant cash prize were included with the honor—10 prizes, for instance, in differing areas, of $25,000 each—it would be the most visible, most highly "leveraged" quarter million dollars the Government could spend in this century! Look at the amazing accomplishments prompted by the Kremmer prize for man-powered flight.

If only 10% (I'll guess 50,000 people) of our technical work force—inspired by these prizes and the chance of achieving something beyond the traditional $100 reward for an issued patent—put in as little as 1 hour a week extra, that would add up to an incredible 2.5 million man-hours of effort. Individual engineers or inventors would win and industry would win, with a revitalizing effect on the country.

How about naming the prizes after William P. Lear, who made exactly the kind of practical contributions the awards are intended to stimulate. Not only did Bill Lear make advances in the electronics, aircraft, and automotive fields, but also he is the only major corporate officer I ever knew to personally answer letters about ideas from little-known individuals or companies.

Peter Lefferts
Santa Clara, Calif.

Corrections

In the Designer's Casebook, "Low-cost timers govern switched-mode regulator" (Dec. 18, p. 97), D_1 should be a high-current diode, such as the MR830, and not the 1N914 shown.

Interested in higher performance software?

The Mark Williams Company announces **COHERENT**,™ a state of the art, third generation operating system. **COHERENT** is a totally independent development of The Mark Williams Company. **COHERENT** contains a number of software innovations not available elsewhere, while maintaining compatibility with UNIX*. The primary goal of **COHERENT** is to provide a friendly environment for program development. The intent is to provide the user with a wide range of software building blocks from which he can select programs and utilities to solve his problems in the most straightforward manner.

COHERENT and all of its associated software are written totally in the high-level programming language **C**. Using **C** as the primary implementation language yields a high degree of reliability, portability, and ease of modification with no noticeable performance penalty.

Features

COHERENT provides **C** language source compatibility with programs written to run under Seventh Edition UNIX, enabling the large base of software written to run under UNIX (from numerous sources) to be available to the **COHERENT** user. The system design is based on a number of fundamental concepts. Central to this design is the unified structure of i/o with respect to ordinary files, external devices, and interprocess communication (pipes). At the same time, a great deal of attention has been paid to system performance so that the machine's resources are used in the most efficient way. The major features of **COHERENT** include:

- multiuser and multi-tasking facilities,
- running processes in foreground and background,
- compatible mechanisms for file, device, and interprocess i/o facilities,
- the shell command interpreter—modifiable for particular applications,
- distributed file system with tree-structured, hierarchical design,
- pipes and multiplexed channels for interprocess communication,
- asynchronous software interrupts,
- generalized segmentation (shared data, writeable instruction spaces),
- ability to lock processes in memory for real-time applications,
- fast swapping with swap storage cache,
- minimal interrupt lockout time for real-time applications,
- reliable power failure recovery facilities,
- fast disc accesses through disc buffer cache,
- loadable device drivers,
- process timing, profiling and debugging trace features.

*UNIX is a trademark of Bell Labs

Software Tools

In addition to the standard commands for manipulating processes, files, and the like, in its initial release **COHERENT** will include the following major software components: **SHELL**, the command interpreter; **STDIO**, a portable, standard i/o library plus run-time support routines; **AS**, an assembler for the host machine; **CROSS**, a number of cross-assemblers for other machines with compatible object format with **'AS'** above; **DB**, a symbolic debugger for **C**, Pascal, Fortran, and assembler; **ED**, a context-oriented text editor with regular expression patterns; **SED**, a stream editor (used in filters) fashioned after **'ED'**; **GREP**, a pattern matching filter; **AWK**, a pattern scanning and processing language; **LEX**, a lexical analyzer generator; **YACC**, an advanced parser generator language; **NROFF**, an Nroff-compatible text formatter; **LEARN**, computer-aided instruction about computers; **DC**, a desk calculator; **QUOTA**, a package of accounting programs to control filespace and processor use; and **MAIL**, an electronic personal message system.

Of course, **COHERENT** will have an ever-expanding number of programming and language tools and basic commands in future releases.

Language Support

The realm of language support is one of the major strengths of **COHERENT**. The following language processors will be supported initially:

- **C** — a portable compiler for the language **C**, including stricter type enforcement in the manner of **LINT**.
- **FORTRAN** — portable compiler supporting the full ANS Fortran 77 standard.
- **PASCAL** — portable implementation of the complete ISO standard Pascal.
- **XYBASIC**™ — a state of the art Basic compiler with the interactive features of an interpreter.

The unified design philosophy underlying the implementation of these languages has contributed significantly to the ease of their portability. In particular, the existence of a generalized code generator is such that with a minimal effort (about one man-month) all of the above language processors can be made to run on a new machine. The net result is that the compilers running under **COHERENT** produce extremely tight code very closely rivaling that produced by an *experienced* assembler programmer. Finally, the unified coder and conformable calling sequences permit the intermixture of these languages in a single program.

Operating System

In part because of the language portability discussed above, and in part because of a substantial effort in achieving a greater degree of machine-independence in the design and implementation of the **COHERENT** operating system, only a small effort need be invested to port the whole system to a new machine. Because of this, an investment in **COHERENT** software is not tied to a single processor. Applications can move with the entire system to a new processor with about two man months of effort.

The initial version of **COHERENT** is available for the Digital Equipment Corporation PDP-11 computers with memory-mapping, such as the PDP 11/34. Machines which will be supported in the coming months are the Intel 8086, Zilog Z8000, and Motorola 68000. Machines for which ports are being considered are the DEC VAX 11/780 and the IBM 370, among others.

Because **COHERENT** has been developed independently, the pricing is exceptionally attractive. Of course **COHERENT** is completely supported by its developer. To get more information about **COHERENT** contact us today.

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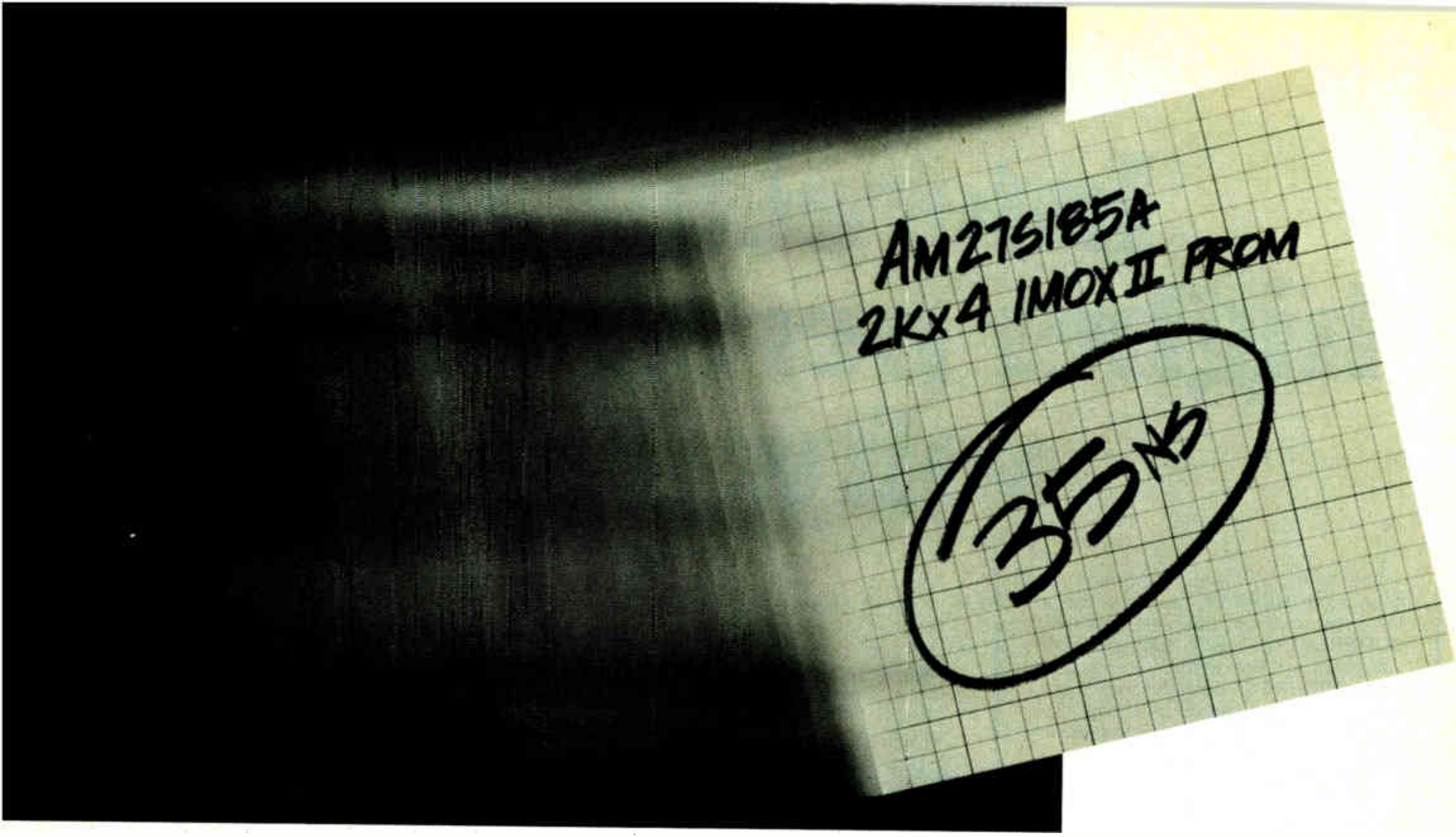

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News update

■ An X-ray scanning system that produces three-dimensional, moving pictures of bodily organs will get its first tryout on humans this year. Encouraged by the system's resolution and performance in tests on animals, researchers at the Mayo Clinic Biodynamics Research unit in Rochester, Minn., are under way on a test that would scan approximately 50 persons during 1981, according to a Mayo source.

The scanning system, called a dynamic spatial reconstructor [*Electronics*, Oct. 12, 1978, p. 40], operates somewhat like computerized axial tomography but produces 3-d pictures rather than CAT scanners' two-dimensional images. Using multiple X-ray tubes, the DSR performs up to 60 scan sequences per second and generates images of as many as 240 1-millimeter-thick slices of a cylindrical volume 30 centimeters in diameter and 30 cm long.

Many views. The machine costs $3 million and weighs 17 tons. It produces 75,000 cross-sectional views of a body in the same time a CAT scanner needs to produce one.

The systems's two computers (a Modcomp Classic and a Control Data Corp. Cyber 170) digitize this mass of data, assigning it coordinates within the volume of tissue being scanned. They then can manipulate the information to reconstruct images with 3-d perspective on a television screen.

The images may show internal organs from any desired angle, in part or in whole, in motion or in stop-action format. They can be rolled, rotated, tipped, or enlarged on screen.

Mayo researchers are working on a display system that will use a variable-focus membrane mirror to produce true 3-d images, says Earl H. Wood, Mayo project director. Still at least a year away, the system would let researchers walk around the images and examine and even "dissect" them electronically, he adds. "We should be able to do everything a surgeon does in an autopsy, only do it noninvasively, repeatedly, and on living bodies," Wood predicts. **-Linda Lowe**

People

McAdams must ride herd on world electronics standards

As the new president of the International Electrotechnical Commission, William A. McAdams must direct the thrust of international standardization for the production, transmission, and utilization of electrical energy. And in the 1980s that will increasingly include the standardization of parts, interfaces, and networks on a worldwide basis—not an easy task, as he readily agrees.

McAdams comes to the presidency of Geneva-based IEC with sound credentials. He served as vice president of the commission's U. S. National Committee from 1960 through 1968 and then became its president through 1974. In industry, he has been responsible for the external standardization efforts of General Electric Co., most recently as manager for industry standards on the executive staff at corporate headquarters in Fairfield, Conn. McAdams, 62, retired last March and has continued as a consultant to GE since then.


IEC head. William McAdams, now a consultant to GE, wants faster action on standards.

Holding a bachelor of science in physics and mathematics from Washington College, Chestertown, Md., McAdams has worked as a ballistics engineer for Du Pont, as a research physicist on the Manhattan District nuclear project in World War II, and as a research and engineering specialist in the field of radiation protection.

Two areas McAdams intends to examine during his three-year tenure are those of telematics—two-way communication via television—and plug and socket standards. He notes that the first area will present some difficulties in that the International Standards Organization has been responsible for all computer and telecommunications work, but that all semiconductor companies are firmly attached to the IEC. "IBM has been satisfied with the ISO's work, and the computer and data-processing industries in the U. S. also have a voice on the ISO through CBEMA [the Computer and Business Equipment Manufacturers Association]," he points out. "It will be a difficult move to get them interested in the work the IEC is doing."

The discussion on plug and socket standards has been going on for the past 10 years, McAdams notes, adding that "there are several different designs in place. A new standard might create more of a hazard than using the older ones."

Farber attacks problem of computer availability

"How would you like it if you were locked out of your office for a random two hours each day?" asks David J. Farber, a professor of electrical engineering and computer science at the University of Delaware. One of the three principals in the software consulting firm of Caine, Farber & Gordon Inc. in Pasadena, Calif., and codesigner of the Snobal programming language, Farber finds that question relevant to the problem computer systems face in the office-of-the-future market.

"Computer systems must be available and robust to an extent well beyond that considered adequate in today's computer marketplace," he says. "Though there are a few exceptions," Farber told the recent International Conference on Computer Communications in Atlanta, "the

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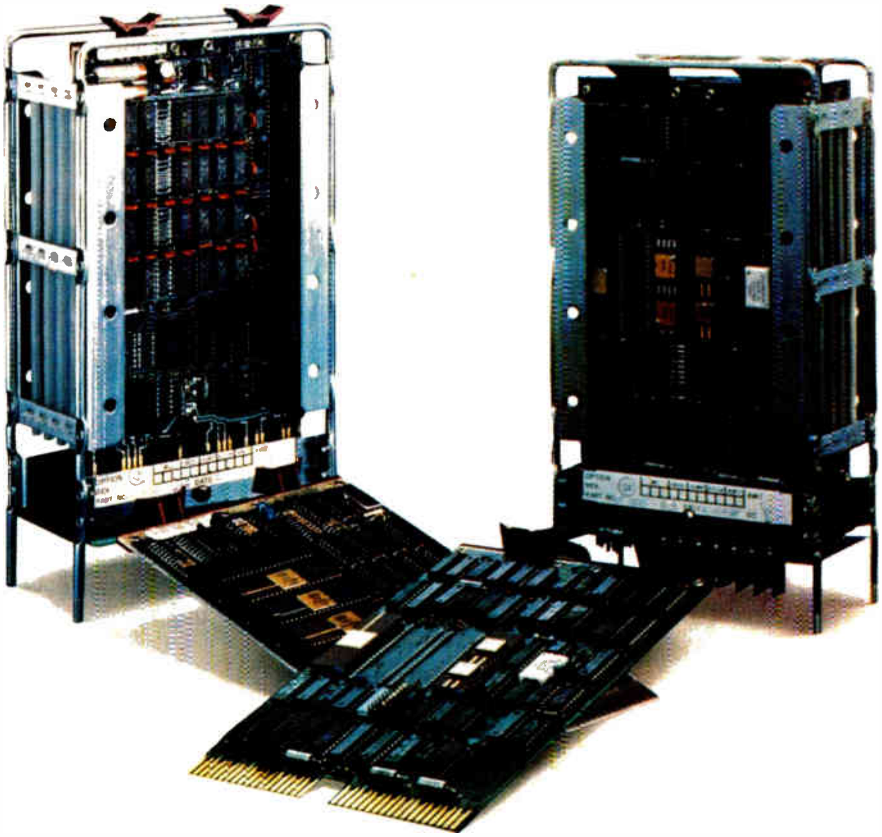

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Keep 'em up. Software expert David Farber says availability has to be built in.

commercial computer companies don't have the attitude that the communications vendors have toward higher accessibility."

This availability has to be engineered into the hardware and software. Says Farber: "Very large-scale integration offers a solution to the problem. In hardware, it offers a path to such self-checking processors as Intel Corp.'s iAPX432, as well as multiprocessor architecture with built-in fail-soft capabilities that let the user buy into an appropriate level of software reliability."

Farber sees the office-of-the-future concept as a natural blending of computer and communications technology, and he is no stranger to either. His consulting firm has developed software for some of Intel's communications chips and he had a hand in designing the Distributed Computer System. This was a pioneering local ring network oriented to distributed processing.

"In the office-of-the-future industry, software speed is not as important as robustness and ease and safety of change." But, "most important," Farber concludes, "is a fundamental change in the attitude of vendors toward realizing that where computers are involved in assisting human-to-human communications, they must adopt the attitude of the communications companies toward the availability of the product." □

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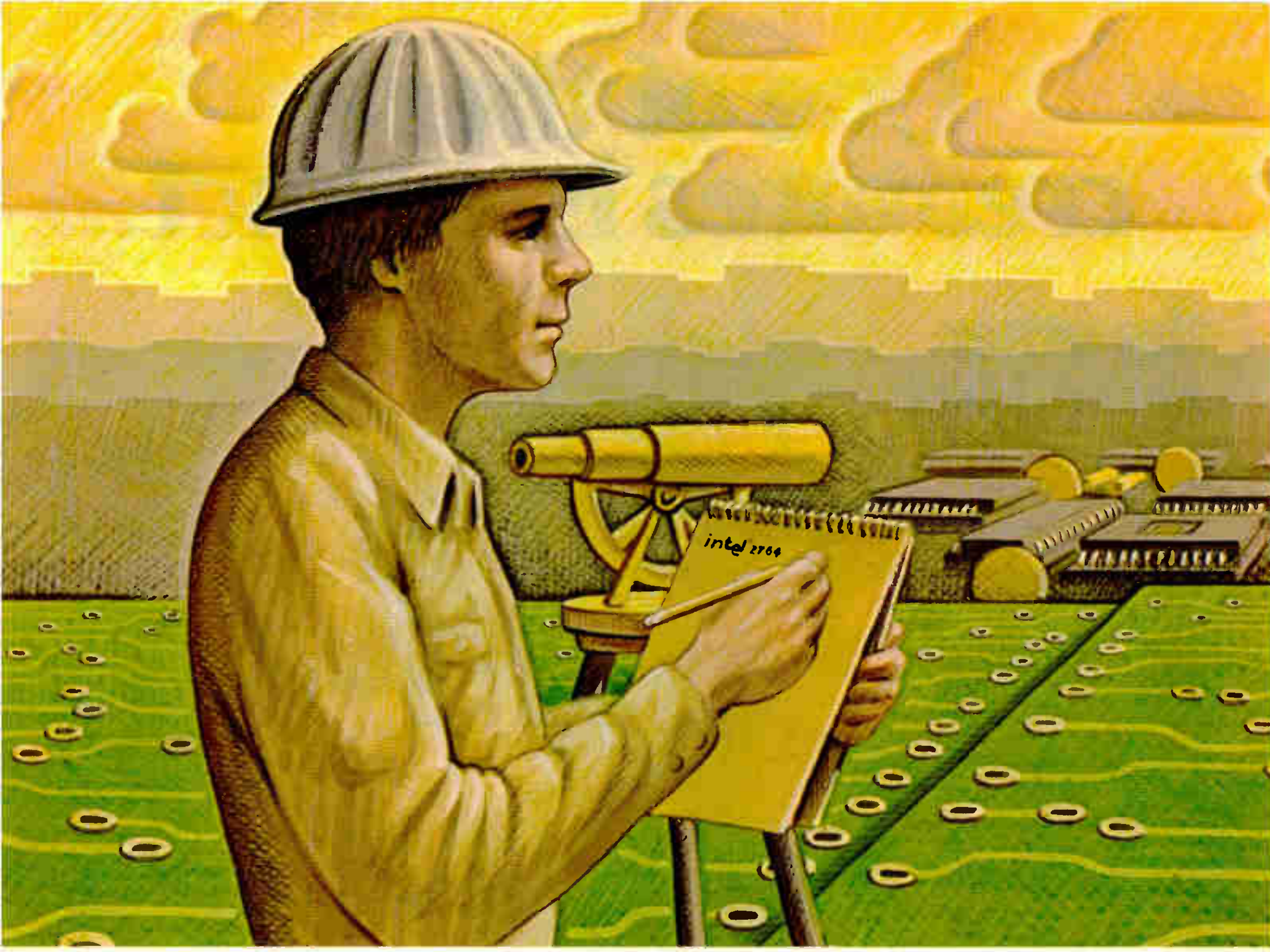

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Like its predecessor, the 2732A, our new 2764 is fabricated by Intel's proven fourth-generation EPROM technology, HMOS*-E. This technology allows us to shrink 2764 die sizes down dramatically, making this the smallest 64K EPROM chip in production. And HMOS-E makes possible the 2764's standard access time of 250ns. Which means you now have an alternative when you need high speeds and high densities—in applications such as controller systems for automated milling machines, vector color graphics displays, and over-the-horizon terrain radar.

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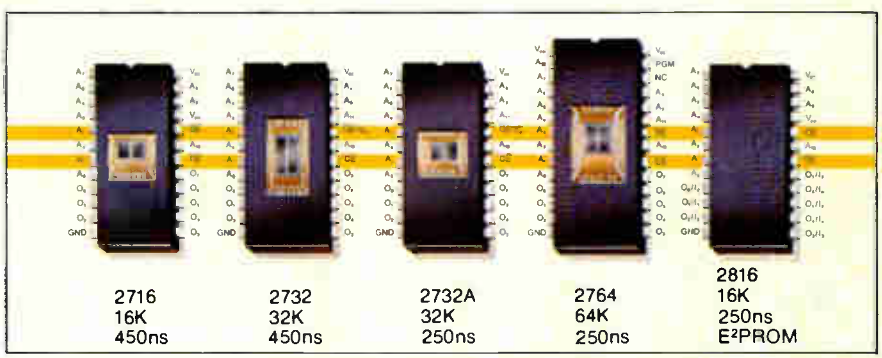

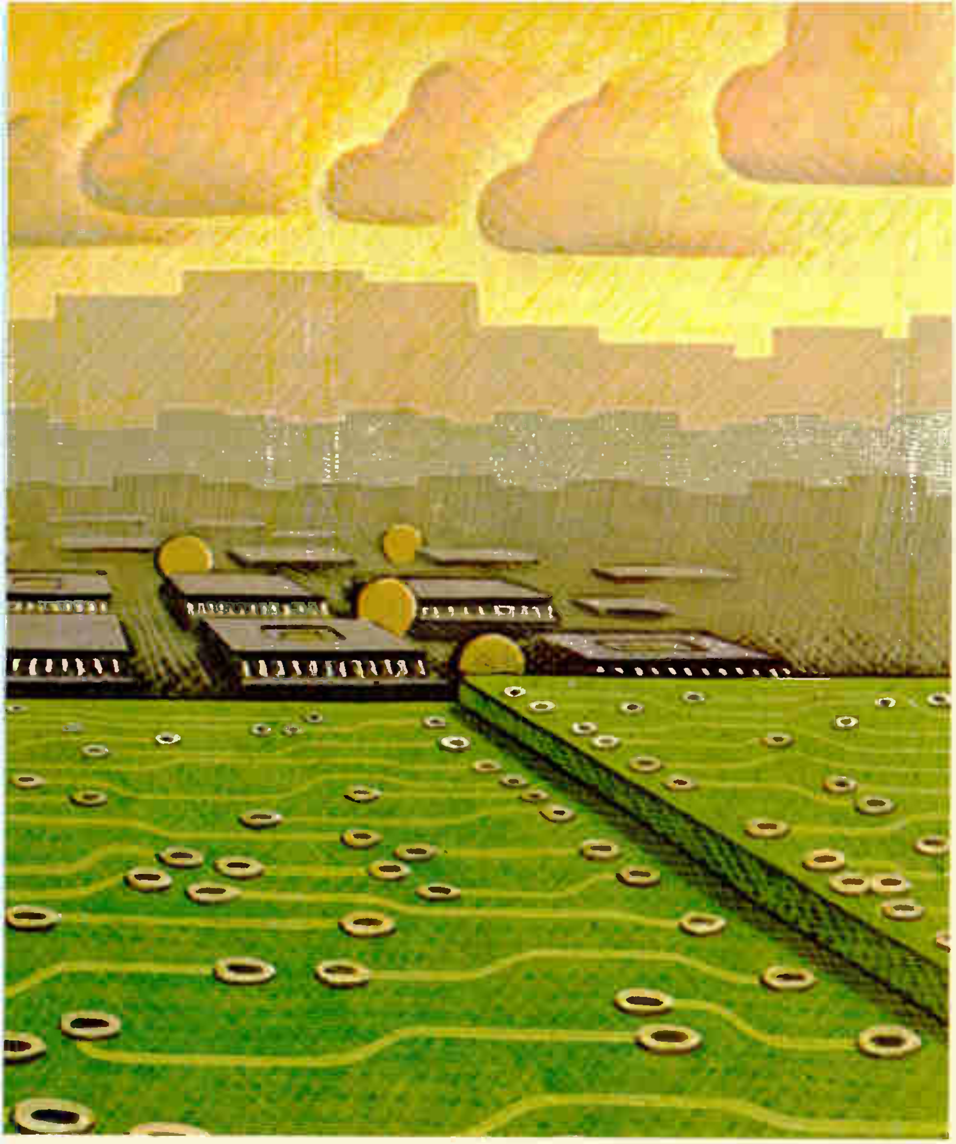

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2764's pinout conforms to the 28-pin JEDEC standard for Byte-Wide memories from 16K to 256K bytes. So when you design with 28-pin sites now, you can choose the EPROM that meets your needs today. Then upgrade your memory performance or density later — without any jumpers or expensive engineering changes.

Intel's universal EPROM solution

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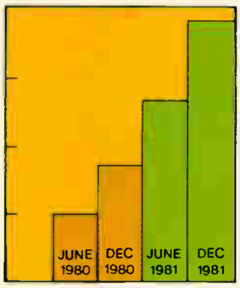

Intel's EPROM Production Ramp-up

Getting all of the EPROMs you need will be easier, too. We'll more than triple our production capability by the end of 1981. Plus, more than ten ROM and EPROM manufacturers have already committed to the JEDEC Byte-Wide memory pinout standard, further increasing your design choices.

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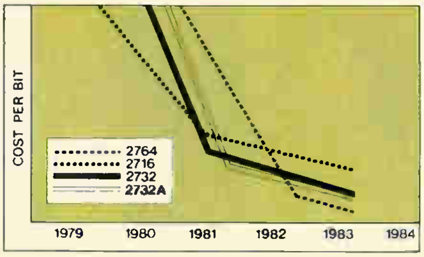

Cost-Per-Bit Decline for Intel EPROMs

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*HMOS is a patented Intel process.

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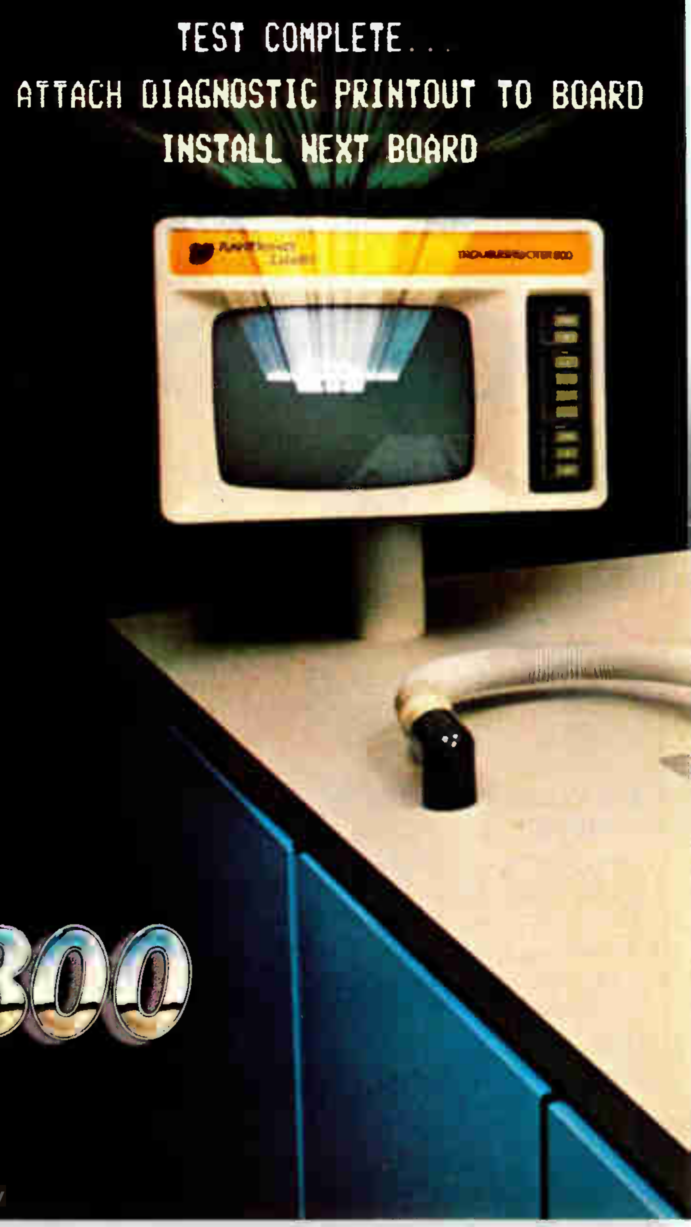

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Keeping an eye on the watchers

The controversy roiling the waters over at the Institute of Electrical and Electronics Engineers goes much deeper than who should decide the outcome of a referendum on an amendment to the IEEE's constitution (p. 332). That dispute involves the election tellers' committee, the board of directors, outside legal counsel, and the general staff.

All the fuss, however, is likely to obscure an even more important point. The amendment was proposed by the same group of people—the board of directors—that has now declared it passed. Moreover, the measure not only establishes the office of president-elect but also greatly enhances the directors' power over election timing and procedures [*Electronics*, Aug. 28, 1980, p. 24]. So now we have the spectacle of a body appointing itself the ultimate judge of whether its own proposals have or have not been accepted.

In its haste to ratify the amendment, the board has managed merely to enlarge the group of skeptics and potential antiestablishmentarians among the institute's members. Surely a little more time spent deliberating the matter would have gone a long way to shore up the faith of the rest of the IEEE in its leadership.

A third, and perhaps as important, issue concerns the recent confusion over how votes should be counted. Until now, there apparently was no hard and fast rule as to whether all votes—yes, no, and blank—count or whether only the yeses and noes should be tallied. There have been some close referendums the past few years, and it is interesting to contemplate how they may have been affected by the manner in which ballots were tabulated.

It is unlikely that the IEEE board deliberately tried to slip its amendment past the membership by counting the votes in a particular way. It is more plausible to suppose we have witnessed yet another case of bad planning coupled with a lack of legal sophistication. But in any event, it might be time for the IEEE's members to ask *quis custodiet ipsos custodes*—who will guard the guards?

1981: more good than bad

As the New Year started, the electronics industries were smitten with an attack of uncertainty. After gliding smoothly through the 1980 recession, the market was said to be showing signs of decline. The temptation is to think that a downturn like the one in 1975 is here. But that should be resisted. Remember that times have changed since then.

Producers of electronic equipment are now in better shape to weather a dip than they were five years ago. With inventories low and backlogs built up, there is no reason to believe that they will not be able to absorb declining bookings.

Also, all the portents are that any decline will be relatively short-lived, perhaps lasting only through the first half of 1981. In any event, even the most pessimistic prognosticators say that the worst will be over by April. And with venture capital plentiful once again after a long drought, the prospects for the long term are still better for electronics than for many other industries. Also, with companies less inclined to lay off personnel, they will be able to catch the uptrend.

So the year ahead, while not all good, certainly does not shape up as one to be feared. In fact, with the pervasiveness of electronic technology spreading so rapidly, years to be feared might just be bad memories.

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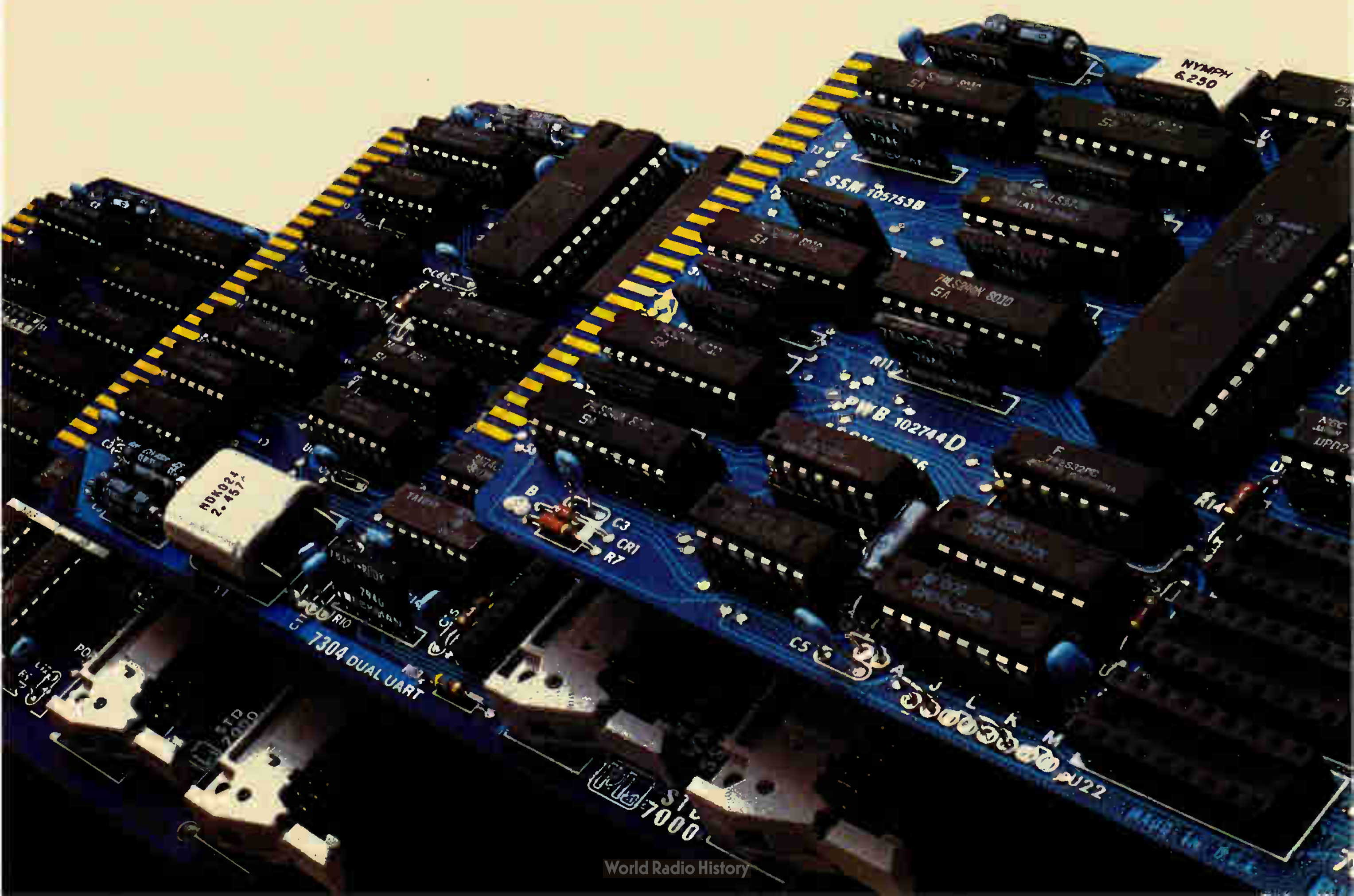

Meetings

15th Annual Television Conference, Society of Motion Picture and Television Engineers (862 Scarsdale Ave., Scarsdale, N. Y. 10583), St. Francis Hotel, San Francisco, Feb. 6–7.

Los Angeles Technical Symposium, Society of Photo-Optical Instrumentation Engineers (P. O. Box 10, Bellingham, Wash. 98225), Sheraton-Universal Hotel, North Hollywood, Calif., Feb. 9–13.

28th Industrial Relations Conference, EIA, Canyon Hotel, Palm Springs, Calif., Feb. 17-19.

ISSCC—1981 IEEE International Solid-State Circuits Conference, IEEE, Grand Hyatt Hotel, New York, Feb. 18–20.

Spring Compcon 81, IEEE Computer Society, Jack Tar Hotel, San Francisco, Feb. 23–26.

Nepcon West '81, Industrial & Scientific Conference Management, Inc. (222 W. Adams St., Chicago, Ill. 60606), Anaheim Convention Center, Anaheim, Calif., Feb. 24–26.

1981 ACM Computer Science Conference and Technical Symposium on Computer Science Education, Association for Computing Machinery (John W. Hamblen, Conference Chairman, University of Missouri–Rolla, Rolla, Mo., 65401) Stouffer's Riverfront Towers, St. Louis, Feb. 24–26 (conference) and 26–27 (symposium).

Information Utilities '81, Online Inc. (11 Tannery Lane, Weston, Conn. 06883), New York Hilton, New York, March 2–4.

Fifth International Conference on Software Engineering, IEEE *et al.*, Town and Country Hotel, San Diego, Calif., March 9–12.

Micro-Delcon '81—Fourth Annual Conference on Computer Technology, IEEE Computer Society, Delaware Bay Section, (H. P. Morneau, E. I. du Pont de Nemours & Co., Engineering Department, Louviers 3113, Wilmington, Del. 19898), John M. Clayton Hall, University of Delaware, Wilmington, March 10.

Fourth Electromagnetic Compatibility Symposium and Technical Exhibition, Institute for Communications Technology (T. Dvorak, The Federal Institute of Technology, Zurich, Switzerland), Federal Institute of Technology, March 10–12.

Semicon/Europa '81 and Second SEMI European Symposium on Materials and Processing, Semiconductor Equipment and Materials Institute Inc. (625 Ellis St., Suite 212, Mountain View, Calif. 94043), Züspa Convention Center, Zurich, Switzerland, March 10–12.

Spring Conference, Sperry Univac Series 1100 Users, USE Inc. (Box 461, Bladensburg, Md. 20710), Grand Hyatt Hotel, New York, March 16–20.

14th Annual Simulation Symposium, IEEE *et al.*, Holiday Inn Resort, Tampa, Fla., March 16–20.

Third Annual Microelectronics Measurement Technology Seminar, Benwill Publishing Corp. (1050 Commonwealth Ave., Boston, Mass. 02215), San Jose Hyatt, San Jose, Calif., March 17–18.

1981 Office Automation Conference, American Federation of Information Processing Societies (P. O. Box 9659, 1815 N. Lynn St., Arlington, Va. 22209), Albert Thomas Convention Center, Houston, Texas, March 23–25.

Fifth International Conference on Digital Satellite Communications, IEEE *et al.*, Congress Building, International Fair of Genoa, Genoa, Italy, March 23–26.

Digital Communications Techniques Seminar, IEEE and Princeton University Department of Electrical Engineering, Princeton University, Princeton, N. J., March 24.

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Electronics newsletter

Analysts expect smaller IBM systems

Look for International Business Machines Corp. to join the personal computer competition with much smaller systems than it now has, aimed at a relatively unsophisticated customer. That was the consensus last week at a seminar, "Mass Marketing of the Small Computer," conducted by the New York Society of Security Analysts. The feeling there was that, although the small-computer market is dominated now by Apple and Radio Shack, Armonk, N. Y.–based IBM's **recent efforts to market directly to the end user at its own retail stores like the one in Philadelphia foreshadow such a product thrust.**

The analysts also expect Japanese companies to become a big factor by the end of the year, competing heavily for an as yet untapped pool of consumer dollars. Many of those present agreed that independent service organizations and modular portable software will go a long way toward fueling the growth of Japanese companies' market share in the U. S.

MIT researchers devise 3-d LED display system

The Massachusetts Institute of Technology has unveiled a true three-dimensional display using a plate of light-emitting diodes mounted on a turntable and spinning around its vertical axis. David G. Jansson, a member of the staff of MIT's Cambridge, Mass., Innovation Center, says that **the display could be used in medical, computer-aided design, radar, sonar, and other applications and that the institute is looking for licensees.** The 2-by-2-in. prototype plate holds an array of 4,096 LEDs and spins 15 to 20 times per second (900 to 1,200 rpm), with 256 images displayed during each revolution. Persistence of vision, plus close LED spacing—32 to the inch—make for a fairly high-resolution display viewable in three dimensions from all angles except those perpendicular to its axis of rotation—that is, immediately above or below. The display is computer-driven via a capacitatively coupled data link having a bandwidth of nearly 63 Mb/s.

Sevin resigns as head of Mostek

L. J. Sevin has resigned as chairman and chief executive officer of Mostek Corp., the company he founded in 1969. His announcement surprised a meeting of the directors of United Technologies Corp., which acquired Mostek a year ago. The 50-year-old Sevin was unavailable for comment, but his company said that **he is "examining personal opportunities, including some which would involve UTC."** Meanwhile, Mostek president Charles V. Prothro, 38, assumes Sevin's duties at the Carrollton, Texas, semiconductor memory maker.

VLSI Technology Inc., led by Synertek trio, ready to enter market

Backed by $10 million in equity financing, VLSI Technology Inc. is moving from concept to reality. **The investment makes it the largest semiconductor startup since Zilog Inc. in 1974.** The firm, formed in 1979 in Los Gatos, Calif., plans to provide original-equipment manufacturers with tools and training to design their own systems on a chip, to design circuits for customers with no or overloaded in-house capabilities, and to produce products that can be customized, such as mask-programmable read-only memories and gate arrays in high-density MOS and complementary-MOS technologies. The management includes three cofounders of Synertek Inc.—president Jack Balletto and vice presidents Dan Floyd and Gunnar

Wetlesen—and chairman Q. T. Wiles, former group vice president and general manager of TRW Inc.'s Electronic Components divisions and currently chairman of Granger Associates.

Selsyn indicator aimed at steel

To help computerize the aging U. S. steel industry, ILC Data Device Corp., Bohemia, N. Y., is offering an indicator linked to a selsyn that will provide a digital readout of positional information on steel rollers. It also has a direct digital computer interface. Replacing some analog meters in steel-monitoring systems, the SI-500 unit accepts inputs from a five-wire selsyn, converting this positional information **into a digital signal using a 10-bit synchro-to-digital converter and an 8-bit microprocessor.**

Signetics to turn out two-chip CPU for Philips' minicomputer

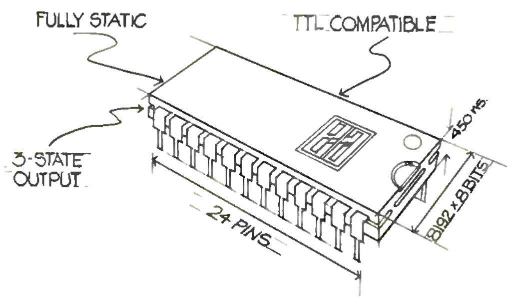
Working closely with its Signetics Corp. affiliate in Sunnyvale, Calif., NV Philips Gloeilampenfabrieken's Data Systems division expects to see first silicon next quarter on a proprietary 16-bit central processing unit that represents a large-scale integrated implementation of its popular P800 minicomputer series. Comprising two chips—an instruction execution unit and a memory management unit—fabricated in a dense n-MOS process with 3.5-μm minimum features, the CPU **will support virtual memory management, dynamic code changes, and multiprocessor structures, as well as coprocessors for decimal and floating-point operations.** Meanwhile, Signetics, which is making the chips for the Philips division in Apeldoorn, the Netherlands, is considering whether to offer the set commercially or to become an alternative source for certain members of Motorola's 68000 16-bit microprocessor family.

Network Systems to broaden line

Flush with an influx of funding from its initial public stock offering at the end of 1980, Network Systems Corp., Brooklyn Park, Minn., will be pushing to broaden its base in the burgeoning market for digital networking systems. **Several pilot installations are planned during 1981 for Hyperbus**, a local network system designed specifically with an eye toward linking fast display terminals, instrumentation equipment, and distributed minicomputers having speeds of up to 5 Mb/s and built by a variety of manufacturers. Also in the works is a satellite line adapter for the company's existing Hyperchannel network line, which currently employs coaxial cable using fixed burst rates of 50 Mb/s. Other products in development include a maintenance adapter for monitoring information flow within local networks and a shared bulk memory product, known as Hypercache, for use in Hyperchannel networks.

Addenda

The first incarnation of BBN Information Management Corp.'s InfoMail, the hardware-independent applications software package for electronic mail [*Electronics*, Nov. 6, 1980, p. 48] **will run on Digital Equipment Corp.'s VAX operating system and sell for $30,000.** The Cambridge, Mass., firm plans at least three more versions—two of them adapted to IBM systems—later this year. . . . Britain's BICC Ltd., a $3 billion maker of electrical equipment, **is buying Boschert Inc. of Sunnyvale, Calif.,** a leading producer of switching power supplies, for $29 million.



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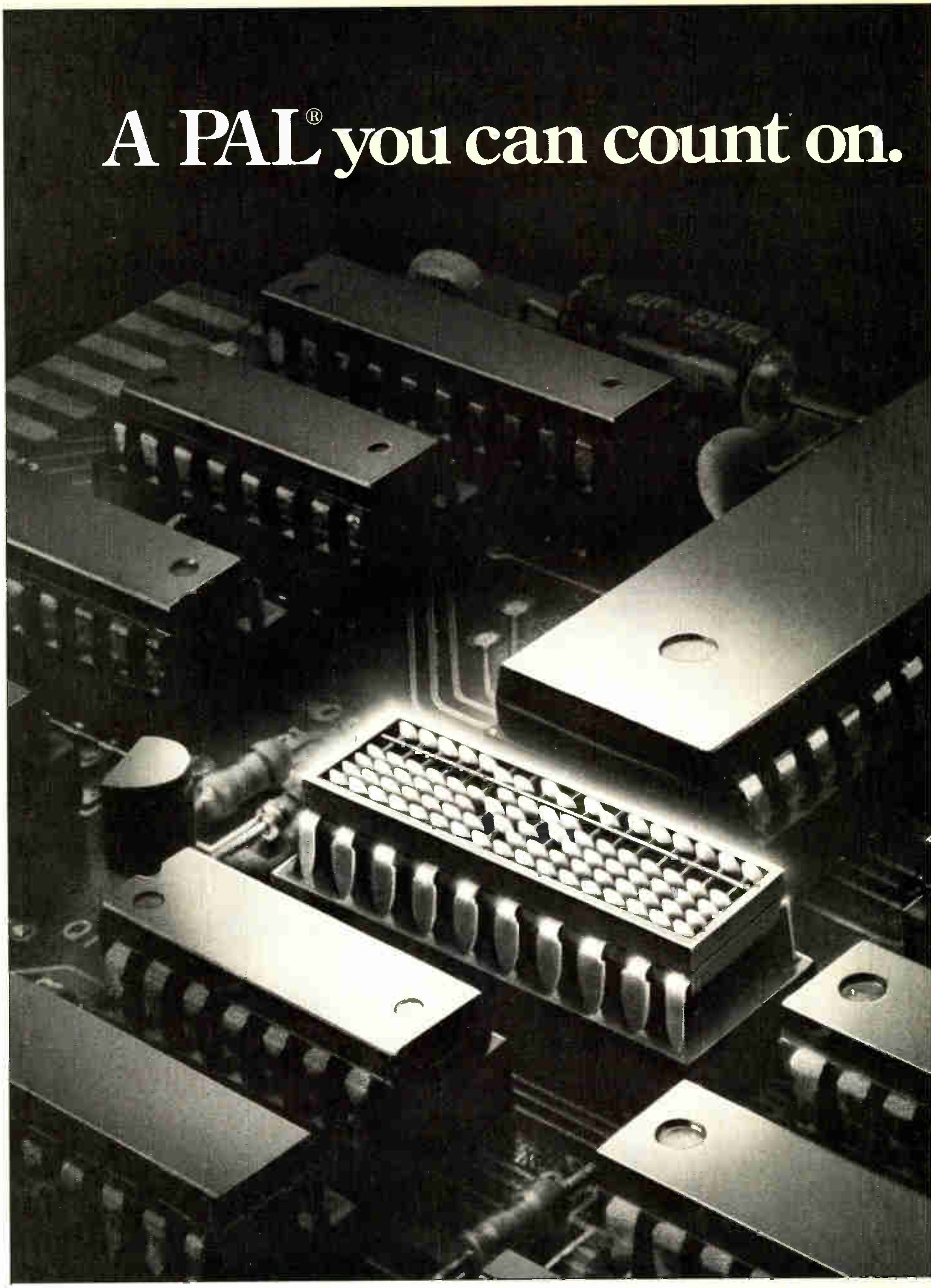
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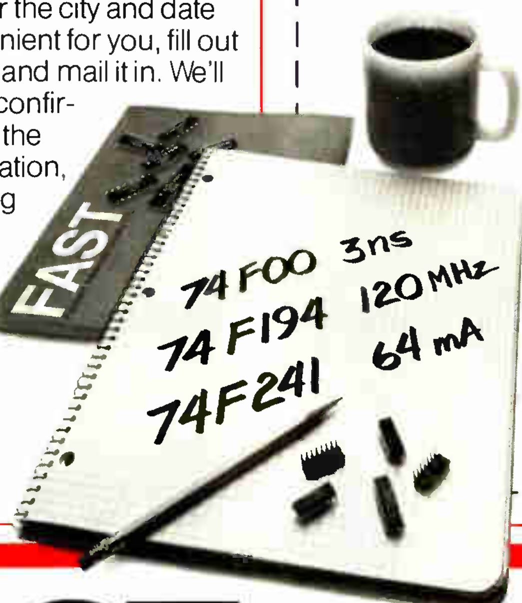

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FAST made easy.

Ada computer on five boards set to bow

by Ana Bishop, Assistant New Products Editor, and R. Colin Johnson, Microsystems & Software Editor

Western Digital modifies its Pascal Microengine to run programs in new high-level language

First off the starting block with a computer that runs the high-level language Ada is Western Digital Corp., which has adapted its five-chip Pascal Microengine for the purpose. In addition, it will offer the Ada machine as a multiboard system, rather than on the single board of the Pascal implementation.

The Newport Beach, Calif., company owes much of its jump on the competition to its interest in TeleSoftware Inc., which wrote the first commercial Ada compiler. However, other microprocessor and systems makers are certain to be in the running. Intel Corp. has already said its forthcoming 32-bit microprocessor will be designed to execute Ada.

The highly modular language, developed for the Department of Defense, is sparking interest among makers of all types of computing machinery, and a number of companies are reporting work that should result in systems applications [*Electronics*, Dec. 18, 1980, p. 39]. For Western Digital, producing the microcode for the instruction set proved relatively easy because Ada is a superset of Pascal.

The two Microengine chip sets have the same 16-bit arithmetic and logic unit and associated registers. Only the three control read-only memories are different. At a system level, however, the new offering looks much different.

The Pascal Microengine was packaged as a single-board computer with a floppy-disk controller, and expanding its capabilities proved extremely difficult. The Ada Microengine will come in a system that is spread over five boards (see figure).

Expandable. Moreover, its box and modular bus will accommodate five more boards, such as more input/output cards or some of the boards that are yet to come. Among those planned are a hard-disk controller, a real-time clock, and data-encryption and bus-error-detection cards.

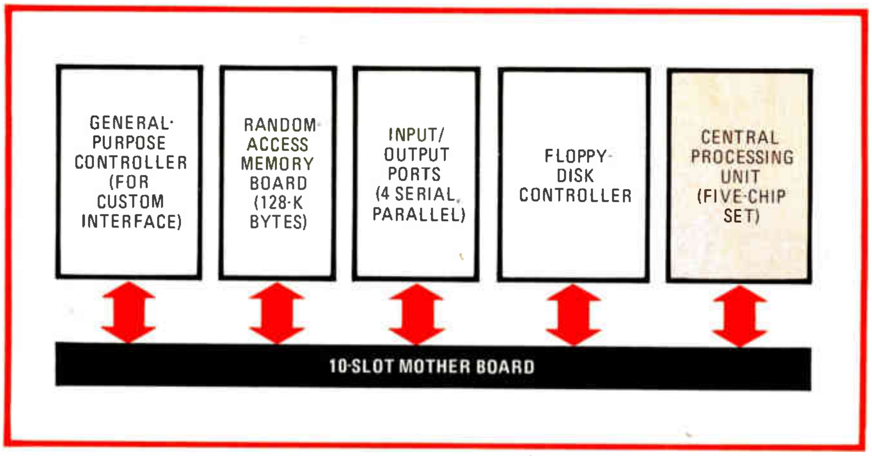
The company will be selling its five-board ME1660 for $6,210 in original-equipment-manufacturer quantities, with full production scheduled for April. A $12,750 system configuration, the ME1675, will include a cathode-ray-tube terminal, a line printer, and two 8-inch floppy-disk drives.

Since the Ada Microengine is tailored to the new language, it should offer one of the fastest execution speeds available. But, it can expect considerable competition from Intel's iAPX-432, because this powerful 32-bit machine also is being designed specifically for Ada.

However, the Santa Clara, Calif., company has said it is aiming the 432 at multiprocessing applications and possibly mainframe replacement [*Electronics*, Nov. 6, p. 42]. The chip set may sell for around $3,000 when it becomes available in the second half of this year.

Also later this year, Digicomp Research expects to introduce a dual-processor board-level computer that will run on the Ada compiler from TeleSoftware with the Microengine chip set on one board and a Z80 8-bit processor on the other. Thus, users will be able to run the many high-level languages compiled for the Z80, as well as Ada. The system will plug into the popular S-100 bus, as does the Ithaca, N. Y., company's just-introduced Z80–Pascal Microengine duo (see p. 290).

An Ada compiler is an eagerly



Ada on the boards. In adapting its Microengine chip set to the high-level language Ada, Western Digital has developed a multiboard, expandable 16-bit computing system.

awaited item, and TeleSoftware has already shown its preliminary version at the recent Association for Computing Machinery conference in Boston. The San Diego, Calif., company, underwritten by Western Digital and General Electric, is headed by Pascal popularizer Kenneth L. Bowles. The software actually will compile an Ada subset, but it will lack only some little used features of the full language. Such important features as its multitasking facilities will remain.

Peripheral equipment

Redesign drops cost of minifloppy to $85

An $85 tag on a minifloppy-disk drive suggests consumer applications, and that's what Micro Peripheral Inc. intends for its new model 61. The Chatsworth, Calif., company has knocked $170 to $200 off the quantity price of its standard 5.25-inch unit by paring down its design.

"The personal computer manufacturers tell us the minifloppy is the logical choice for mass memory storage if price and performance are right," says Robert E. Didion, executive vice president and chief operating officer. As in small-business computer applications, the devices offer a better price per bit than hard-disk drives and are more adaptable than semiconductor memories. Compared with the tape cassettes that many personal computers now use, they can be randomly accessed and store more data.

Such inexpensive key peripherals are increasingly seen as a necessity if personal computers are to realize their market potential. In fact, it is likely that other manufacturers will follow in Micro Peripheral's tracks.

Retention. The model 61 retains most of the performance of the model 51, which is part of Micro Peripherals' principal product line aimed at business applications. For example, it can handle a 250-K-byte single-sided disk, and a double-sided version in the works will give it the same capacity as the model 52.

What the company did was to make over a broad-based design that can work with most minicomputers into one that will serve just a few types of machines. Its engineers stripped down the standard unit to its essential functions, replaced its expensive industrial-grade components with cheaper ones, and thus redesigned its support electronics.

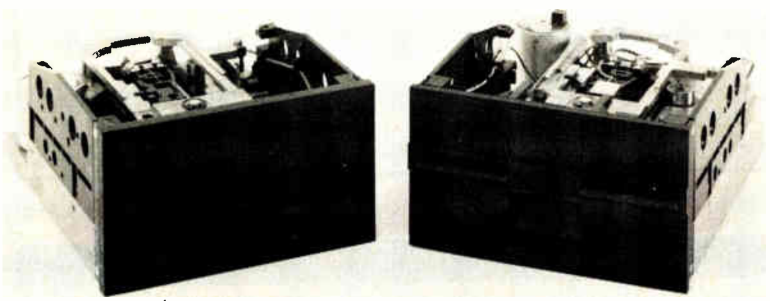
First they did away with the interface electronics that allows the business line to plug into most small computers without changes. Then they removed the sensing functions that monitor read/write activity for error recovery. However, the sensing circuitry will be an option.

The engineers also took a hard look at the components list and took such tacks as replacing the servo-controlled motors with units positioned mechanically. Thus the stepper motor cost drops from $20 in the model 51 to less than $5 in the model 61, and the drive motor drops from $10 to $3.50, the company says.

The net result is to simplify the drive electronics. Micro Peripherals cut the component count some 30% from the 148 parts in the model 51. Also helping keep costs low is the use of existing tooling, die castings, and other production equipment.

As for the model 61's performance specifications, "they are very close to the model 51," Didion claims. Average access time is between 5 and 8 milliseconds against a guaranteed 5 ms, and the data-transfer rate similarly drops somewhat from the 51's 125-kilobit-per-second rate. The seek-error rate should be about the same as the 1 in 10^6 guaranteed for the business drive.

In fact, the only performance concession should be reliability. For its business computers, Micro Peripherals guarantees 9,200 hours as the mean time between failures—and if the model 61 turns out to have a 2,500-hour MTBF, that would be nearly three years of 15-to-20-hour-a-week operation. -Larry Waller



Stripped down. Micro Peripheral's new minifloppy-disk drive for personal computers (left) is a simpler version of its small-business product line (right) that performs nearly as well.

Communications

Lightwave radios are getting closer

With communication via fiber-optic cables well established, the next frontier for light-transmissive systems looks to be radio signals. Optical radio systems, with their high data capacities, could usurp microwave territory in military, commercial, and satellite applications, says Vincent W. S. Chan, staff member at the Massachusetts Institute of Technology's Lincoln Laboratory in Lexington, Mass.

Optical radio has long been an enticing possibility, but atmospheric attenuation and scattering have been formidable obstacles. Now powerful laser sources and sensitive receivers make such systems possible.

But they are not just around the corner. "Systems analysis at the optical frequencies often differs significantly from that at lower frequencies due to the vastly different

Talking with a submarine

A major worry for the military is maintaining contact with a deeply submerged submarine. Radio waves do not propagate very far under water, so the submarine must often surface or trail an antenna, measures welcomed by the prying eyes of enemy satellites. Optical communications links from satellites may be the answer, since some light frequencies propagate through water with much less attenuation than radio waves.

The U. S. Department of Defense has sponsored many studies of such systems—a blue green laser beam penetrates water reasonably well—and the first experiments are getting under way. Of major concern—even more so than the attenuation and scattering characteristics of the water—are the effects of clouds on light propagation, as is true with any optical radio communications system.

Thus the Defense Advanced Research Projects Agency is sponsoring experiments with an airborne laser transmitter that will send a pulse-position-modulated signal through a dense cloud cover to a ship on the surface. The experiment will use a neodymium-yttrium-aluminum-garnet laser with a frequency doubler giving a blue green color. It is scheduled for the middle of the year near California's San Clemente Island. **-H. J. H.**

technologies of sources, modulators, and detectors," Chan says. Even optical noise is different from microwave noise—quantum effects are important because of the discrete photon nature of the light signals.

Chan's overview of the system architectures and technology issues is a high point of the session on optical radio communications at this week's National Radio Science Meeting in Boulder, Colo. Sponsored by the U. S. National Committee of URSI, the International Union of Radio Science, it covers a broad spectrum of radio communications issues, from radio astronomy to electromagnetic noise to signal and system technologies.

With satellites. In Chan's view, optical radio channels will be particularly important in satellite communications, including satellite-to-underwater-receiver applications (see "Talking with a submarine"). Depending on the application, designers of the forthcoming systems will be wrestling with such problems as atmospheric turbulence, aircraft boundary-layer effects, and weather and ocean distortions—all phenomena that interfere but little with electrical radio systems.

A key question is the type of receiver and appropriate modulation scheme. "There are two architectures to consider," Chan says. "Either coherent (homodyne or heterodyne) or incoherent (direct-detection) systems may be suitable, depending on which has the better specifications for the applications at hand." Unlike the situation in microwave systems, direct-detection schemes are not always simpler and less expensive than coherent systems, which excel in pulling signals out of background noise.

Comparison. One scheme for comparing the different kinds of receivers is being covered at the meeting by Paul J. Curlander of International Business Machines Corp.'s Information Systems division in Boulder. After comparing idealized perfect systems, he reports that "for most practical data rates, the [theoretical] optimum receiver is at most 3 decibels better than coherent homodyning and 6 dB better than coherent heterodyning." Since receivers of either type are so close to the idealized optimum, given bandwidth and power constraints, any needed system improvement must be sought elsewhere.

However, there is a place for incoherent, or photon-counting, optical radio systems, says Edward C. Posner of the Jet Propulsion Laboratory in Pasadena, Calif. In an admittedly futuristic scenario, he argues that for communication with satellites at the edge of the solar system, such an optical setup "could maintain an adequate imaging data rate on the order of 100 kilobits per second."

That data rate would return more than enough video information to an earth station. However, acquiring the data for tracking a satellite could be a problem, he says, because the incoherent optical link lacks directivity and phase information. A microwave link would be needed for this purpose. **-Harvey J. Hindin**

Solid state

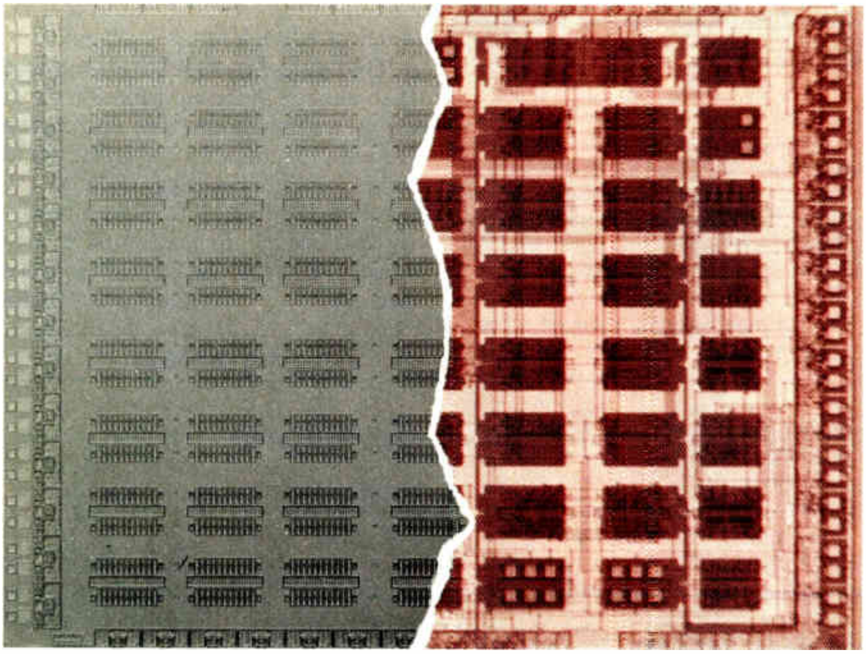
Gate array tribe gets another family

Semiconductor manufacturers are pushing the development of gate arrays because their uncommitted logic looks like a perfect avenue for exploiting the density advantages of large-scale and very large-scale integration. The newest family out the door is coming from Texas Instruments Inc., which is introducing 540- and 1,008-gate arrays and an accompanying arsenal of customization software.

Like many chip makers, TI believes that VLSI technology calls for specialized parts, because the vast number of logic elements on one integrated circuit means a system on a chip. Since systems ordinarily need to be customized for unique environments, the number of customers served by standard parts will drop sharply, the Dallas company figures.

Logic arrays offer the same attraction as do microprocessors: customization through programming. With fully automated gate-positioning and wiring algorithms, the task of tailoring the array to an application becomes one of program writing.

Evidence of the interest in gate arrays [*Electronics*, Sept. 25, p. 145] is found in the growing number of major semiconductor firms who are joining what has been a cottage industry. Ferranti, Motorola, and Signetics, among others (see pp. 163 and 240) are major suppliers already; IBM and other mainframe companies make arrays for their own products; and American Microsys-



Geometric patterns. TI's Schottky-transistor-logic 1,008-gate array has 56 cells of 18 gates each in a pattern (left) that eases interconnection of points for customization (right).

tems, Mostek, and more are planning to enter the field.

The growing number of array manufacturers are opting for emitter-coupled-logic technology for the highest speed, or complementary-MOS processes for low power. TI has taken a different approach by settling on Schottky transistor logic, or STL, an advanced form of diode-transistor logic.

Drawbacks. "You can't use ECL in the office environment because the cost penalties for cooling are hard to justify," says L. R. "Gib" Gibson, manager of TI's gate-array design program in Houston. As for C-MOS, he says, it is unable to drive high load capacitances, so that interconnecting critical paths without adding extra gates is difficult.

Neither of these drawbacks is present in STL technology, which has a density advantage over TTL. Nonetheless, TI says it will produce future arrays in additional technologies—and since it has all but dropped out of the ECL race, C-MOS is a good bet.

Another advantage of STL arrays is the easy adaptability to automated wiring because the points to be interconnected can be laid out in a straightforward geometric pattern. In the 1,008-gate array in the photograph, the basic cell is a rectangle that contains 18 five-output gates and accompanying load resistors. Like IBM, TI uses a triple-level metal system with logic signals on the first two and power and ground signals on the third.

Design rules. The new chips are built with 3.8-micrometer design rules, but TI has already figured out what will happen when its STL is scaled down to 1.4-μm rules. The typical gate propagation delay of 2.5 nanoseconds will plummet to half a nanosecond, where the fastest ECL arrays are right now. The propagation delay for C-MOS gates ranges from 3 ns for recent chips to 25 ns for older designs.

The company is shooting for availability of its two parts in the second half of this year. The 540-gate array, in a 40-pin plastic package, will cost somewhere between $20 and $25 in quantities of 10,000, a price tag that matches competitive chips. However, the charge for developmental work on the customizing could go up to $40,000, somewhat higher than the competition's.

Since gate arrays are input/output-intensive and demand pin-laden packages, TI will be offering leadless chip carriers. -**John G. Posa**

Consumer

Computers, chips bow in Las Vegas

Showgoers are trekking their way home from the annual Consumer Electronics Show that ended Sunday in Las Vegas, having seen examples of steady technological development. Among the introductions on hand were a speech-synthesis board with a fixed vocabulary of numbers and words intended for clocks and desktop calculators, new personal computers, and chips designed for television and television-related applications. There were even some new electronic games.

General Instrument Corp. used the show to unveil its VSM-0232 speech module, a board-level version of its forthcoming SP-0256 speech processor on a chip [*Electronics*, Nov. 6, p. 41]. The 3¼-by-5-inch board can work as almost a plug-in module for applications that can use its fixed vocabulary, which is oriented to time and mathematics.

It will cost $49 each in quantities of 100 or more, and users who need a custom vocabulary for small-volume applications will be accommodated at a higher price. GI's Microelectronics division, Hicksville, N. Y., expects that large-volume users will order the SP-0256 integrated circuit with a custom built-in read-only memory and will use the board as a development tool.

Personal computers. Continued vitality in the personal computer field is evidenced by the number of product introductions at the show. Hewlett-Packard Co. is expanding its personal computer line designed for businessmen and technical users with the $2,250 HP-83, which eliminates the tape cartridge drive and thermal printer of the HP-85 and leaves the choice of peripherals to the user.

Both computers may be hooked up to disk drives and line printers, but HP expects that potential HP-83 users will jump at the $1,000 savings

Circle 43 on reader service card

Phone directory takes typed inputs

Automating a common office chore with microprocessor control, a personal telephone directory and dialer will recall a phone number as the user types in the name. The Zelex 910 uses a Zilog Z80 and in its basic configuration can store up to 70 names and numbers in random-access memory.

The desktop unit's Mylar keyboard may be used to alter the directory and includes a key to activate the automatic dialer. To call up a number, the user simply types in the name or part of the name; as soon as enough letters appear for the Z80 to pick out the right entry, the name and number appear on the vacuum fluorescent display.

Most automatic dialers work by associating a designated key with each entry or with punch cards for each entry, but the first type's directory is limited by the number of its keys and the second type requires individual insertion of each card. The $695 Zelex 910 is limited only by the number of 2-K-by-8-bit Mostek 4816 RAMs it can hold; it is expandable to about 340 entries in 90-name increments at about $1 per name.

Pilot production of the new machine is under way at Zelex Corp., a fledgling Santa Ana, Calif., firm. President Richard D. Alexander says that a major design goal was to hold down component costs by such tactics as a time shared driver chip for both keyboard and display and software implementation of functions. **-Larry Waller**

over the HP-85. The Palo Alto, Calif., company also introduced new business software that will run on both the 83 and 85.

Powerful hand-held calculators, long an HP speciality, were another area of innovation, with a new HP-41CV that holds 2,000 lines of program data, five times the memory of the previous top-of-the-line model. It will cost $295, and the HP-41C's price tag will drop $45 to $250.

Bridging the gap between hobbyist and small-business personal computers is the aim of introductions made by two other manufacturers. APF Electronics Inc. of New York presented its Imagination Machine II as a complete small-business computer system. The $1,100 basic unit uses a cassette memory and has interfaces for floppy-disk drives and for a random-access memory module.

The Imagination II can display color alphanumerics and graphics using a standard color TV receiver, as can the new $300 VIC 20 [*Electronics*, Dec. 18, p. 35] from Commodore Business Machines Inc., Norristown, Pa. Both machines generate small displays: 16 lines of 32 characters each for the Imagination II and 23 lines of 22 characters each for the VIC 20.

TV chips. With the home TV set doubling as a display for videotex systems, video disk players, and the like, integrated circuits that enhance this role are becoming available. At its hospitality suite, GI, for one, showed a three-chip set that will let personal computer makers include a videotex decoder.

The company has drawn on its experience in making chip sets for England's Prestel viewdata system, which sends information over telephone lines, and for electronic games that use the TV set as a display. In quantities of 10,000, the decoder chip set will sell for about $25.

With video cassette recorders offering high-speed playback and fast forwarding, the Variable Speech Control Corp. of San Francisco has decided it is time for an IC that incorporates its pitch-correction technique [*Electronics*, Aug. 22, 1974, p. 87]. The linear bipolar custom IC will be coupled with a Matsushita bucket-brigade-device chip to eliminate the distortion that accompanies speeded-up sound. It can also be used with the video disk players that are beginning to appear.

Games, too. No Consumer Electronics Show would be complete without new electronic games, and Gabriel Industries is one company that obliged this year. The New York division of CBS Inc. introduced a hand-held electronic version of its popular board game, Othello.

An 8-bit Rockwell International microprocessor provides eight levels of difficulty in the game, mulling over 10,000 possible moves at the highest level. Othello will go on sale in the first quarter, but it will not come cheap: list price is set for around $120. **-Gil Bassak**

Peripheral equipment

3.5-in. floppy disk raises density levels

Sony Corp. is diving into office automation with a splash, introducing a desktop word processor that has an innovative smaller floppy-disk drive, as well as what amounts to an electronic typewriter fitting handily into a briefcase. Indeed, packing performance into small spaces seems to be a Sony goal, for its 3.5-inch Micro Floppy disk drive features

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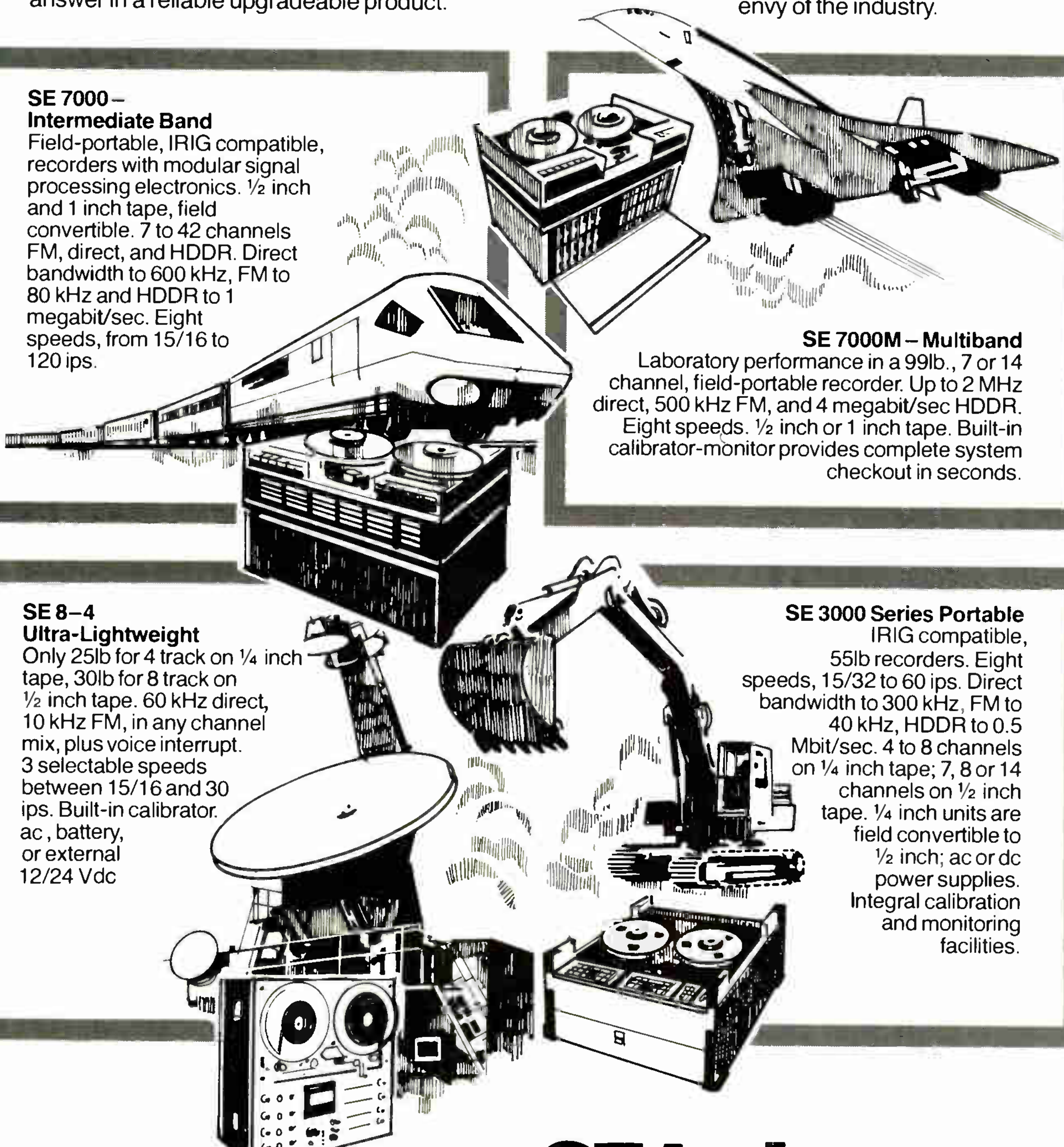

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design advances that give an unformatted capacity of 437.5-K bytes, close to the middle of the wide range of capacities in competitive 5.25- and 8-in. floppy-disk drives.

The Japanese company has drawn on its expertise in consumer electronics design to boost the drive's storage capacity. Two of the small drives can be mounted right in the word processor's keyboard, contributing significantly to the system's compactness (see "Sony heads for the office").

Density up. The disk drive's capacity stems from both greater track density and a higher bit density on the tracks. The inspiration for these improvements was the approach used in Sony's video recorder line.

The engineers redesigned the head assembly to allow a much narrower recording track. The typical floppy disk has a block-shaped read/write head flanked by two erasing heads that pare away the irregular edges of the recorded track. Though this erasing scheme trims track width in order to increase the number of tracks, density hikes are limited to the degree that the width of the three-head assembly can be shrunk.

Rather than being block-shaped, the Micro Floppy's read/write head has sides that narrow to the width of the data track in the region of the gap that performs the read/write operations. Rather than mounting erasing heads on either side, the engineers designed a single head that trails the read/write head.

The result is equivalent to 135 tracks per inch, compared with the 48 or 96 tracks/in. of 5.25-in. minifloppies. These narrower tracks do require improved positioning accuracy for accurate reading and writing—but Sony takes a new tack by working on positioning of the disk rather than of the head assembly.

Positioning. To reduce wear on the hub in the conventional soft plastic medium as it is repeatedly impaled on the drive's tapered spindle, the engineers designed a new disk-mounting and -centering system by adding an off-center rectangular slot to the hub. The drive has a center spindle and an off-center pin, so that the disk can be lined up in only one easily repeatable position.

Another adaptation of video recorder technology is the 500-oersted magnetic coating. This high-coercivity coating on the plastic of the floppy disk makes possible a recording density of 7,610 bits in each inch of track, versus the 5,000 to 6,000 bits/in. of the larger floppies.

The disk's packaging is also innovative. A plastic case replaces a cardboard one, and a protective metal guard slides over the read/write opening when the disk is removed from the drive. The guard reduces the chance of dust contamination.

The Micro Floppy's signal requirements are compatible with the larger floppies, so the current crop of controller chips can be used with it. Sony's newly created Data Products division expects to be selling its first offering at a price comparable to that of the typical 5.25-in. disk drive—around $400. **-Tom Manuel**

Sony heads for the office

In introducing its desktop word processor and its electronic typewriter that fits into a briefcase with plenty of room to spare, Sony Corp. is serving notice that it takes office automation seriously. The series 35 stand-alone processor should prove strong competition for units like the Wangwriter and the IBM Displaywriter, and the Typecorder typewriter already is proving to be an attention grabber.

The series 35 has a base price of about $9,900 and includes a 55-character-per-second, letter-quality daisy-wheel printer and two of the new 3.5-inch Micro Floppy disk drives. The basic Wangwriter [*Electronics*, Dec. 18, p. 36] from Wang Laboratories costs $7,500 with a 20-character/s daisy-wheel printer and a single 8-in. floppy-disk drive. IBM's Displaywriter [*Electronics*, July 3, p. 95] starts at $7,896 with a 40- or 60-character/s daisy-wheel printer and a single 8-in. floppy-disk drive.

These prices include full-page displays and detached keyboards, and though it might appear that Sony has a price disadvantage, adding second drives to the competitive units boosts their cost above that of the series 35. Into a 17-by-13-by-5-in. package Sony fits the keyboard, the two drives, and a microcassette tape unit that can take inputs from the Typecorder.

Weighing only 3 pounds, this silent typewriter uses a microcassette tape recorder rather than paper. Its output can be transferred to a printer, computer, or word processor. It has a built-in microphone for dictation—and the series 35 can be used as a playback unit for transcription.

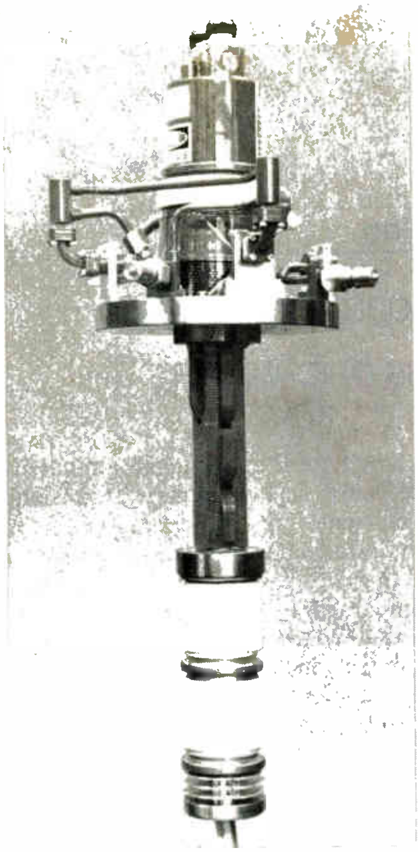
The Typecorder has a standard typewriter keyboard and a single-line liquid-crystal display. Though it is unlikely to replace conventional typewriters, as the company claims it will, it could prove useful for executives who need to capture both voice and text information outside the office and who can justify the $1,400 cost. **-T. M.**

Microwaves

TWT design attains 10 times more power

With an eye to the military theater, Varian Associates is raising the curtain on a traveling-wave tube that could give millimeter-wave technology a major role in high-frequency radar systems. Engineers at the Microwave Tube division say the VTA-5700 has 10 times the power output of prior microwave sources, yet was achieved cost-effectively with what amounts to a gang-machining production technique and a coupled-cavity architecture.

"The new TWT now gives designers the high-power source needed to develop higher-resolution millimeter-wave radar systems," says Arnold E. Acker, research and development sales manager at the Palo Alto, Calif., division. The wavelengths of experimental radars in the 30-to-300-gigahertz range are so short that they can pinpoint hard-to-detect targets, but their signal sources provide too low a power output to give good resolution of the reflected beam.



Powerful TWT. Varian Associate's new VTA-5700 TWT for millimeter-wave applications generates an average power 10 times that of previous microwave sources.

The 35-GHz VTA-5700 provides more than 30 kilowatts of peak power with an average output of 9 kW at a 300-microsecond pulse length. Varian's best previous millimeter-wave offering is a 12-year-old klystron amplifier, a 35-GHz continuous-wave tube that provides a 1-kW average output.

Problem. The stumbling block with high-frequency tubes operating at millimeter-wave frequencies has been realization of a stable output in a design that requires a minimum of production-line tuning. "We were reluctant to enter the military arena with conventional TWTs, doubting that they could be practically produced at a reasonable cost, without first achieving significant advancements in electron-gun and millimeter-wave–circuit design," says George Caryotakis, executive vice president of the Electron Device Group at Varian.

Thus the designers gave careful attention to avoiding unwanted reflections of rf waves, which can destabilize the output. They developed a new method of attaining precise rf matching between cavities and between circuit sections to provide the needed power stability, along with minimum phase and gain variations "so important to high-resolution radar techniques," Acker says.

The rf matching depends on a Varian version of gang machining, a well-known technique in which a multiheaded tool reduces the differences in tolerances among like parts by machining them simultaneously and reduces the number of parts by machining complex shapes in one pass. The coupled-cavity design permits it to operate at higher powers more efficiently because it eliminates the obstruction of helix delay lines other TWT architectures use.

In the electron gun, the Varian-designed modulating anode can control the beam without the usual control grids. Thus high-power performance improves, because the grids can intercept a portion of the beam.

In operation, the TWT in the photograph on page 47 would have a beam-focusing electromagnet surrounding the extension below the polished disk. "The VTA-5700 has the highest-density electron beam employed in a TWT," Acker claims. Current density is 1,000 amperes per square centimeter and power density approaches 50 megawatts/cm^2.

Use. The U.S. Army Ballistic Missile Defense Advanced Technology Center at Huntsville, Ala., sponsored development of the VTA-5700. The initial application should be in a radar to be installed at the Kwajalein National Missile Range in the Pacific. The radar is in design at the Lincoln Laboratory at MIT.

The Army is also funding development of a next-generation TWT, which Varian expects will operate at frequencies approaching 60 GHz. "Such tubes," Caryotakis notes, "are certain to influence new millimeter-wave system development in radar, communications, and electronic warfare equipment."

Solid-state parts are not an alternative to microwave tubes in high-frequency, high-power applications, he adds. Though that technology has reached frequencies approaching 20 GHz and peak output powers of about 5 kW, it cannot reach them in the same part. **-Bruce LeBoss**

Packaging

Sandwich design of pc board promotes direct soldering of leadless chip-carriers

Separating the support and circuit functions of the printed-circuit board has led to a design that promises to realize an important goal: reliable direct soldering of leadless chip-carriers onto the board. The design—a thin double-sided pc board sandwiched to a dielectrically coated metal support plane—has a thermal coefficient of expansion close to that of the ceramic of the chip-carrier.

The typical epoxy-glass laminated pc board has a higher expansion coefficient than the ceramic, which frustrates reliable solder connections of the two, particularly over a wide temperature range. Yet the improved board densities the leadless chip-carriers offer have encouraged their use with very large-scale integrated circuits [*Electronics*, July 3, 1980, p. 40], usually with the help of an intermediary package like a sock-

POS terminal features bubble memory

The first fruit of the joint venture of TRW Inc. and Fujitsu Ltd. is on display at this week's National Retail Merchants Association Show in New York, and as befits the venue, the introduction is a point-of-sale terminal. The TRW-Fujitsu Co. 7880 offers a bubble memory and plasma display—both as options—and a built-in magnetic-strip credit card reader.

Moreover, the $3,785 POS terminal comes with a reliability figure of one breakdown per year as against four for the $4,475 terminal TRW has offered. The bubble memory and plasma display options, priced at $875 and $775, respectively, are geared toward specialty stores with one or two terminals per site and no on-line computer control.

The Fujitsu bubble memory, which comes in 32- to 256-K-byte increments, can store operating programs, as well as transactional data like sales reports used on site and forwarded at predetermined intervals to a central computer. Other POS terminals have used disk or tape storage.

The 320-character plasma display offers prompting for the operator and interactive display of the data being entered. Highlighting of information is possible because the display has two character sizes that may be intermixed. The earlier TRW terminal uses a cathode-ray-tube display.

Both TRW and Fujitsu have been major factors in the POS markets in their home countries, and the 7880 will be made by Fujitsu and marketed by TRW, with initial deliveries in the third quarter. The joint venture [*Electronics*, Sept. 25, p. 102] also plans to introduce small-business systems. **-Terry Costlow**

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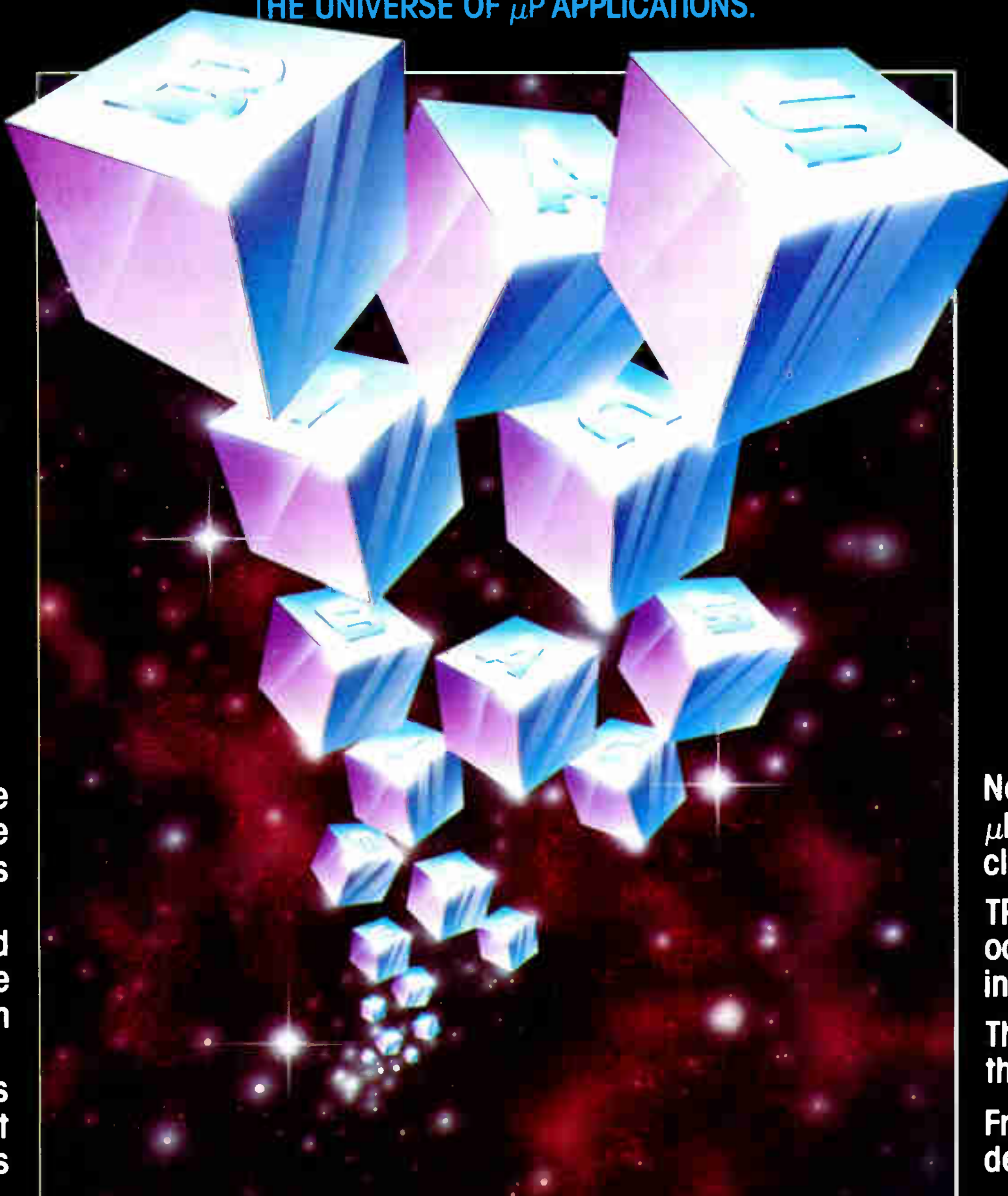

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Phase-Locked Loops ease AM/FM design

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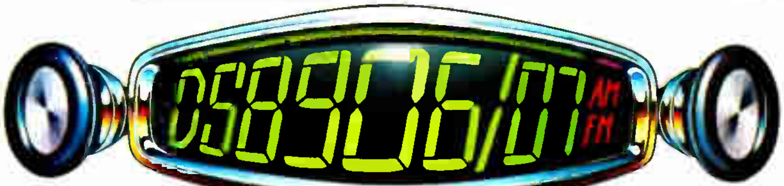

Universal PLLs simplify AM/FM design.

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In addition to their AM and FM frequency references (500Hz and 12.5kHz, respectively for the DS8906; 10kHz and 25kHz, respectively for the DS8907), both PLLs feature a 50Hz "time of day" reference for digital clock radio designs. All generated from an on-board 4MHz crystal controlled oscillator.

High volume production. National Semiconductor, a long-time leader in bipolar ECL/I²L technology, has their distributors well-stocked with both the DS8906 and DS8907 Phase-Locked Loops. And due to their current high volume production, these versatile PLLs are very competitively priced.

For complete information on National's low-noise Phase-Locked Loops, check box number 047 on this issue's National Archives coupon.

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Now microcomputers know when they're making a mistake.

Parity and Error Checking and Correction make National's BLC-8064 Family many times more reliable than conventional microcomputer memories.

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The first μP that directly executes Tiny BASIC.

National's new INS8073 microinterpreter significantly reduces software development time and costs.

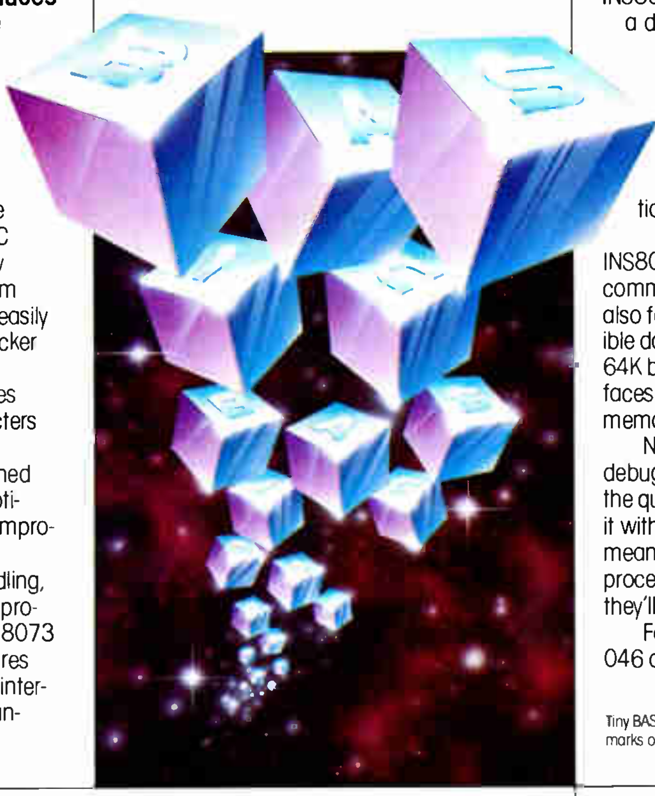
The INS8073 is the newest member of National's growing family of microprocessors.

The Tiny BASIC Microinterpreter™ speeds the development cycle because it allows users to program in Tiny BASIC instead of assembly language. So now source code manipulation and program revision can be done faster and more easily than ever before. It also pays off in quicker hardware check out.

The new INS8073 directly executes high-level programs from ASCII characters stored in external ROM or RAM.

National's Tiny BASIC is a streamlined high-level language that powerfully optimizes application software without compromising capabilities.

The INS8073 features string handling, logical operators, DO loops and allows program access to the status register. An 8073 based system includes powerful features that are expected of μPs such as full interrupt, multiprocessing and assembly language capabilities.



Requires no development system. The INS8073 completely eliminates the need for a dedicated, full-blown software development system. Rather, it's programmed directly through any RS232C compatible terminal. STARPLEX,™ National's complete development system, can also be used to develop Tiny BASIC applications, but is not a requirement.

A new universe of applications. The INS8073 incorporates 2.5K of internal ROM committed to the Tiny BASIC interpreter. It also features an 8-bit MICROBUS™ compatible data bus and a 16-bit address bus with 64K bytes of addressing capability. So it interfaces easily with National's broad range of memories and μP peripherals.

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Two new low-power real-time clocks keep track of everything from tenths of seconds to leap years.

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They also feature a power-down mode for extremely efficient operation. The MM58167 takes voltages as low as 2.0V and the MM58174 as little as 2.2V.

Their mask-programmable interrupt timers can be set to provide a variety of interrupt signals ranging from 0.1 sec to 1 month. The MM58167 also includes alarm-type latches and a standby interrupt for μP wake-up during power-down mode.

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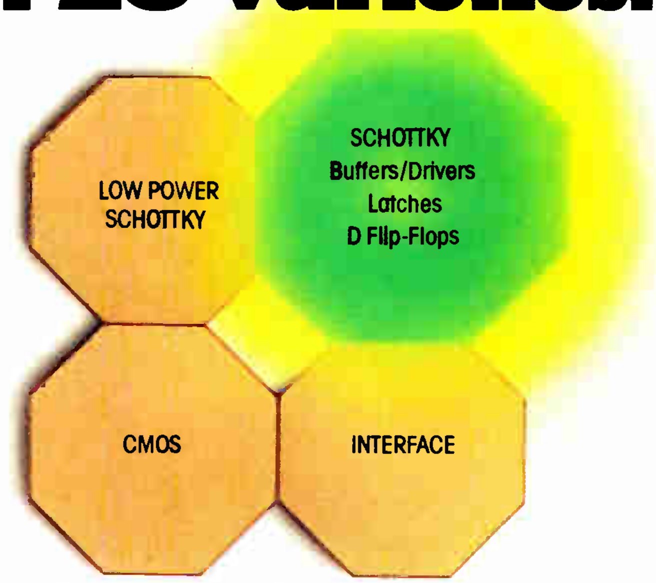

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	DM74S941	DM54S941
LATCHES	DM74S373	DM54S373
D Flip-Flops	DM74S374	DM54S374

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News briefs

Comsat eyes subscription TV field
U. S. consumers would be able to receive three channels of television programming directly from 12-gigahertz satellites under a proposal filed recently with the Federal Communications Commission by Communications Satellite Corp., the U. S. arm of the international satellite communications network, Intelsat. The subscription service would put a 2½-foot antenna on the roof of each subscriber—and to get quality reception with this small a fixture, the satellite would have to radiate more power than the usual birds. The service faces a number of likely regulatory hurdles. For one, the allocations of the frequencies in the 12-GHz band will not be decided for North America until 1983. Also, TV broadcast suppliers are likely to object to the competition. Finally, government and private bodies are likely to object to Comsat's entry into a business not called out in its original charter.

IBM narrows broad optical pulses
The different frequencies making up a digital pulse travel at different speeds in an optical fiber, and the pulses are broadened, or smeared, so that they are not received with the same waveform as they had when transmitted. This often results in unacceptable error rates. In an experimental solution to the problem, investigators Hiroki Nakatsuka and Daniel Grischkowsky of International Business Machines Corp.'s Thomas J. Watson Research Center in Yorktown Heights, N. Y., capitalize on the pulse-narrowing characteristics of certain alkali metal vapors that are opposite to the broadening effects of the glass used in optical fibers.

As with the predistortion technique developed by Bell Laboratories [*Electronics*, May 24, 1979, p. 42], success depends on knowing in advance what the broadening will be. In the IBM experiments, 50 centimeters of metal vapor in a container was carefully designed to compensate (by cancellation) for the broadening due to travel through 30 meters of fiber. With multiple passes through the container, the effects of travel through kilometers of fiber could be corrected, Nakatsuka and Grishkowsky say.

Acquisitions rate continues at year-end
The holiday season saw a number of companies buying themselves Christmas presents, as the pace of acquisitions in the electronics industries continued unabated. Four-Phase Systems, the Cupertino, Calif., maker of multifunction computer systems, agreed in principal to acquire Two Pi Corp., a Sunnyvale, Calif., subsidiary of U. S. Philips Corp. that makes IBM-compatible superminicomputers. Britain's BICC Ltd., a $3 billion manufacturer of electrical equipment, is buying Boschert Inc., also of Sunnyvale, a leading producer of switching power suppliers.

In Beaverton, Ore., Tektronix Inc. has concluded an agreement to sell its medical instruments unit to Squibb Corp. for about $10 million. With sales of about $12 million in portable patient monitors in its last fiscal year, the unit will join three other 1980 Squibb medical instrument acquisitions: Advanced Technology Laboratories Inc., Spacelabs Inc., and Vita-Stat Medical Services Inc. It will operate in new facilities in the Beaverton area.

et or a small leaded motherboard.

In chip-carrier applications, the new design offers a packaging capability equivalent to that of an eight-layer board, as well as better heat transfer and lower noise than an epoxy-glass board, says its developer, Vernon L. Brown, a technical supervisor at Bell Laboratories, Denver. He devised Lampac (for laminated printed-circuit board) several years ago to improve interconnection density with dual in-line packages, but from the start he saw its promise for mounting leadless chip-carriers.

Separation. "Unlike a conventional pc board, Lampac separates circuit interconnection from the physical support, ground plane, and heat sink functions," he says. In the resulting sandwich, the board is still epoxy-glass, but it is only 5 mils thick versus 62 miles for the standard board.

"With a thick, self-supporting board, you are stuck with material in which it is difficult to create small plated through-holes," he says. "What we have done is to make the interconnection material thin, so that our ability to make small plated through-holes is improved. This in turn has increased interconnection density significantly.

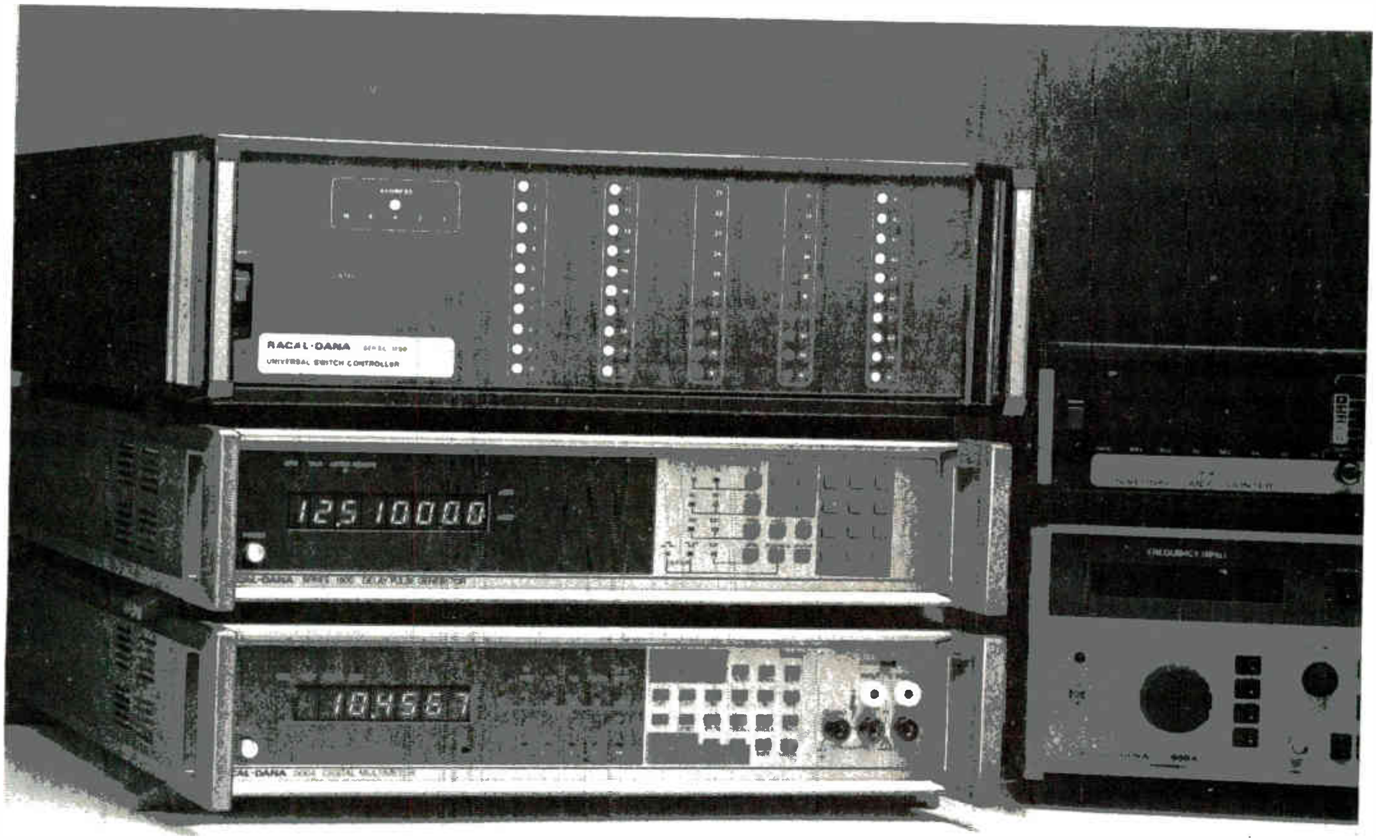
"The metal core we have chosen for a support improves the electrical and thermal performance of our board," he adds. "In addition, we are now able to choose the coefficient of thermal expansion of the composite."

With chip-carriers, the Lampac interconnections are vias only 11 mils in diameter rather than plated through-holes, saving even more board surface. Thus Lampac's two-sided interconnection is the equivalent of eight layers of interconnections on a multilayer board.

Cooler. Heat dissipation improves because it is possible to make a direct thermal connection from the IC to the metal support plane. The chip body may be thermally connected to a metal platform in the chip-carrier, and an extension brought out as a thermal lead may be connected to the support plane; the result is a low thermal impedence for the heat. What's more, the metal support may be connected to an even larger heat sink.

Brown says Bell Labs has soldered leadless chip-carriers with as many as 68 solder pads to Lampac boards and is evaluating even larger carriers. The usual support plane is steel, which offers low cost, high strength, and easy fabrication, but another promising material is copper-clad nickel-iron alloy because its metallurgical composition can be tailored to give a thermal expansion exactly matching that of the ceramic body of the leadless chip-carrier.

Materials research is not the only avenue Brown is pursuing. "We have not yet approached maximum density," he says. Smaller vias and smaller pads are possible with the use of advanced techniques for drilling holes. **-Jerry Lyman**



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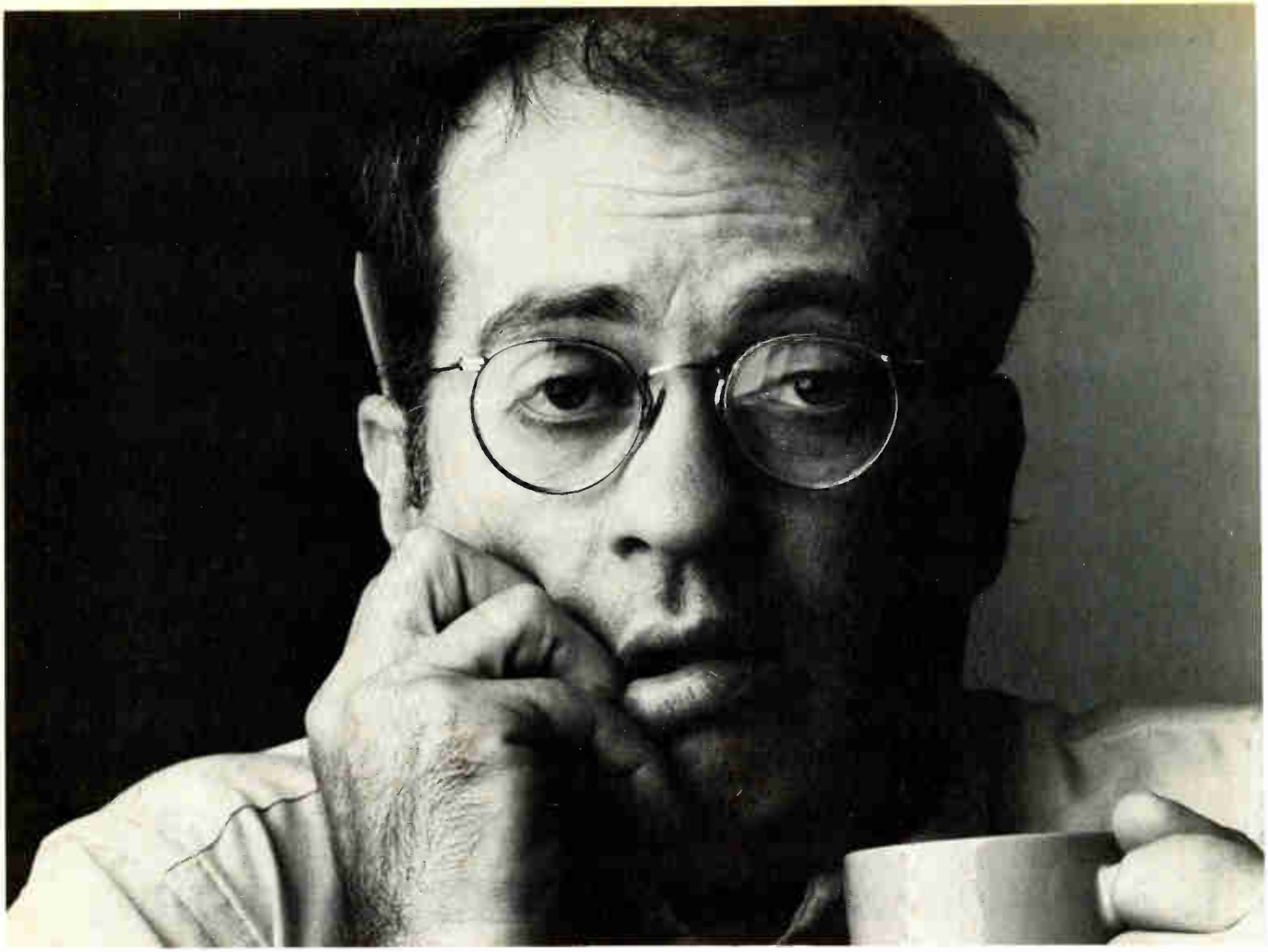

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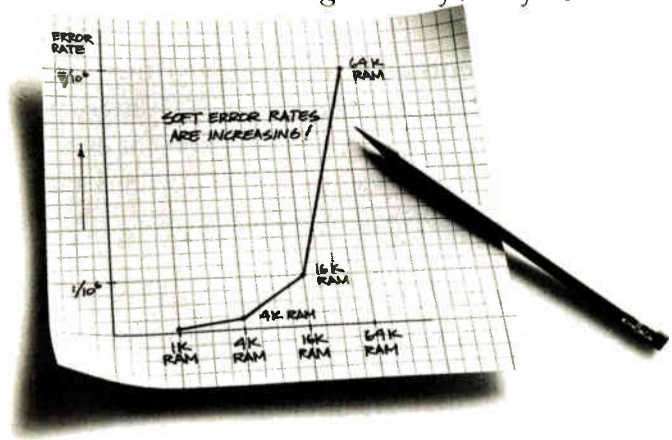

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Washington newsletter

Defense budget of $196 billion set by Carter . . .

A record military spending request of more than $196 billion for the fiscal 1982 year that begins next Oct. 1 will be the parting gift package for Ronald Reagan in President Carter's final budget that goes to Congress on Jan. 15. **The 14.6% increase over the current year's $171.4 billion program represents a gain of just 4.6% after discounting inflation,** say defense budget officials, and more than half of the new total will go for personnel costs, including military salary increases. Nevertheless, the Carter proposal represents a new stumbling block for the incoming President, who has committed himself to increasing the military budget to cover the purchase of a new manned bomber, the MX strategic intercontinental missile, and the eventual doubling of the Navy's fleet to 600 ships. "Reagan may be able to juggle the distribution of some of the money," observes one budget source, "but it is doubtful whether he can increase it in view of his commitment to a 10% cut in individual taxes." No Reagan revisions are expected to go to Congress before mid-February.

. . . as Reagan changes may be delayed by Carlucci dispute

Disagreement between the Pentagon transition team headed by William Van Cleave and Reagan's designated Secretary of Defense, Caspar Weinberger, over the latter's choice of Frank Carlucci as deputy secretary may delay Reagan changes in the fiscal 1982 military budget until mid-February. **"They just may not have the [technologically qualified] people in place to make the choices,"** says one outgoing Carter appointee, since the dispute compounds the usual problem of recruiting industry experts to fill the estimated 1,000 middle-management appointive civilian jobs in the Defense Department and the military services.

Associates of Van Cleave are circulating an undated "background" document on Carlucci, now deputy director of the Central Intelligence Agency, who earlier served Weinberger when he was Secretary of Health, Education and Welfare in the Nixon-Ford years. Printed on plain white paper, it says in part that the "personal comraderie" (*sic*) between Weinberger and Carlucci "cannot compensate for the deficiencies and difficulties Carlucci would bring to this highly significant office."

AT&T ordered to trial despite negotiations on antitrust suit

The Federal antitrust trial of American Telephone & Telegraph Co. will begin Jan. 15, as scheduled, despite a request by the Justice Department and AT&T attorneys for a 60- to 90-day delay to complete negotiations of a pretrial settlement. Federal judge Harold Greene ordered the trial to proceed, noting that the requested delay was too long and that settlement negotiations could continue during the litigation. Nevertheless, telecommunications industry and Government sources still **expect that a settlement will be reached before a trial can be concluded.**

One report is that AT&T would put all unregulated competitive products made by Western Electric and their associated research and development performed by Bell Laboratories into a fully separated subsidiary. Such a reorganization plan—already in progress—was first disclosed by AT&T president William M. Ellinghaus last fall [*Electronics*, Oct. 23, p. 58]. At the same time, AT&T would agree to open its 23 regional operating companies to competitive industry procurement. In return, the Justice Department would drop its six-year-old suit and permit modification of the 1956 consent decree under which AT&T agrees not to compete in telecommunications equipment and services markets that are not regulated, according to the report.

Washington commentary

Reagan's plans for Japanese relations

Japan's trade and defense policies will probably come in for early criticism under the new U. S. Administration as Ronald Reagan talks tough to America's allies about opening their home markets to U. S. products and increasing their share of the West's military spending burden. That, at least, is what members of the Reagan transition team assert.

The job of pushing Japan to open its home markets faster and more fully will fall to William Brock, who is being named Special Trade Representative following his success as Republican national chairman in the 1980 campaign. Casper W. Weinberger, Reagan's choice for Secretary of Defense, will have the task of getting Japan to raise its defense spending in its fiscal year 1981 beyond the 7.6% increase to $11.5 billion proposed by Prime Minister Zenko Suzuki last month. But getting defense budget increases past Japan's Diet has always been difficult because of the antimilitary feelings that have become part of the country's politics since World War II.

Neither job will be easy, say officials in both the Commerce and the Defense Department, who note that outgoing Defense Secretary Harold Brown has pushed hard for at least a 10% Japanese defense budget increase to offset the growing Soviet threat in Asia. But Brown, even with the support of the Japanese Defense Agency, failed. In trade, as in defense spending, Acting Special Trade Representative Robert Hormats summarizes the position of the Japanese as "figuring out just how little they can do and then doing only that."

Giving more than a little

But Reagan advisers are convinced that the incoming Administration must get Japan to give more than a little in trade. Beyond the ongoing U. S. problems with steadily rising imports of Japanese cars, consumer electronics, and steel, American electronics manufacturers are warning Reaganites about the increasingly real threat of rapidly rising imports of telecommunications equipment and semiconductors, as well as computers and word processors.

New figures from the Commerce Department support this concern. They show that 1980 imports of basic telephone and telegraph hardware from Japan alone rose 42% from the 1979 level of $105 million. This gain was a major factor in the 66% jump in all telephone imports of $454 million. And although the U. S. maintained a positive trade balance of $95 million for the year, that surplus was cut 45% from the 1979 level. "If the present trend continues," warns the Commerce Department, "trade could fall into a deficit by 1985."

Japan and departing Carter Administration officials are nevertheless hailing the bilateral agreement with the U.S. in December that finally opens some of Nippon Telegraph & Telephone Public Corp.'s $3 billion in annual purchases to U. S. producers. But the Electronic Industries Association's John Sodolski and others are skeptical. "The agreement is very complex," says the EIA Communications division vice president, "and relies heavily on the good faith of the Japanese" for its fulfillment. "Many are skeptical about the implementation of the agreement," Sodolski cautions, noting that EIA members "would have preferred an even stronger instrument."

Off to a slow start

Though U. S. electronics industries executives are generally pleased with statements of Reagan transition team leaders about taking a harder line with Japan on trade as well as about talking tough with defense partners concerning military expenditures, some industry leaders are troubled by the signs that have emanated from the transition office itself.

"Brock and Weinberger are both strong appointments, but they can't do the job all by themselves," says one industry executive, who wishes to remain anonymous. "There are more than 5,000 appointive jobs throughout Government that need to be filled, yet the transition team seems to be going nowhere on these."

Other industry officials also find Reagan's withdrawn posture during the pre-inaugural period troubling. One industry source who has worked with it on a voluntary basis notes that "the transition office is pretty well screwed up; it is overstaffed and way over budget. It's mass confusion." Observations like these are widespread throughout Washington.

Those reports are not encouraging to Reagan advocates in the electronics industries who see a need for a coordinated policy and relatively fast action by the new President and the 97th Congress on trade and defense issues vital to the U. S. and all of its partners. There is little consolation for them in the comment of one transition worker that "at least we are doing a better job than the Carter team did four years ago." Even if true, the comparison is better left unspoken.

-Ray Connolly

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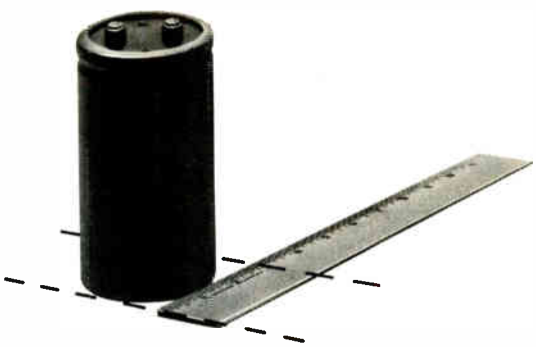

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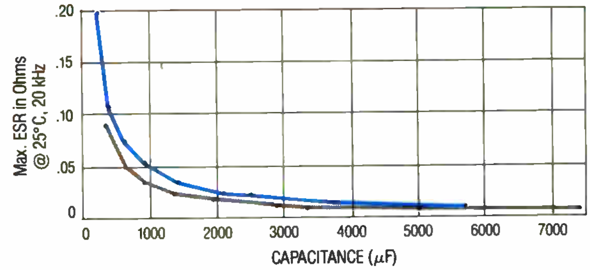
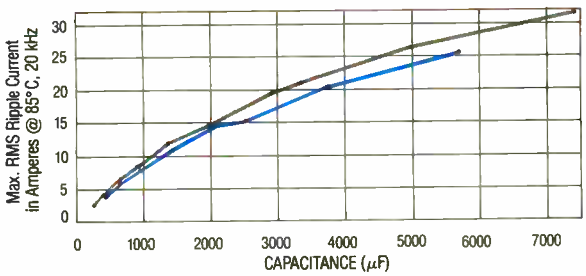


Curve plotted in gray represents capacitors rated at 200 VDC. Curve plotted in blue represents capacitors rated at 250 VDC.

HIGH RIPPLE CURRENT CAPABILITY



Curve plotted in gray shows ripple current capability for capacitors rated at 200 VDC while curve plotted in blue shows ripple current limits for capacitors rated at 250 VDC.

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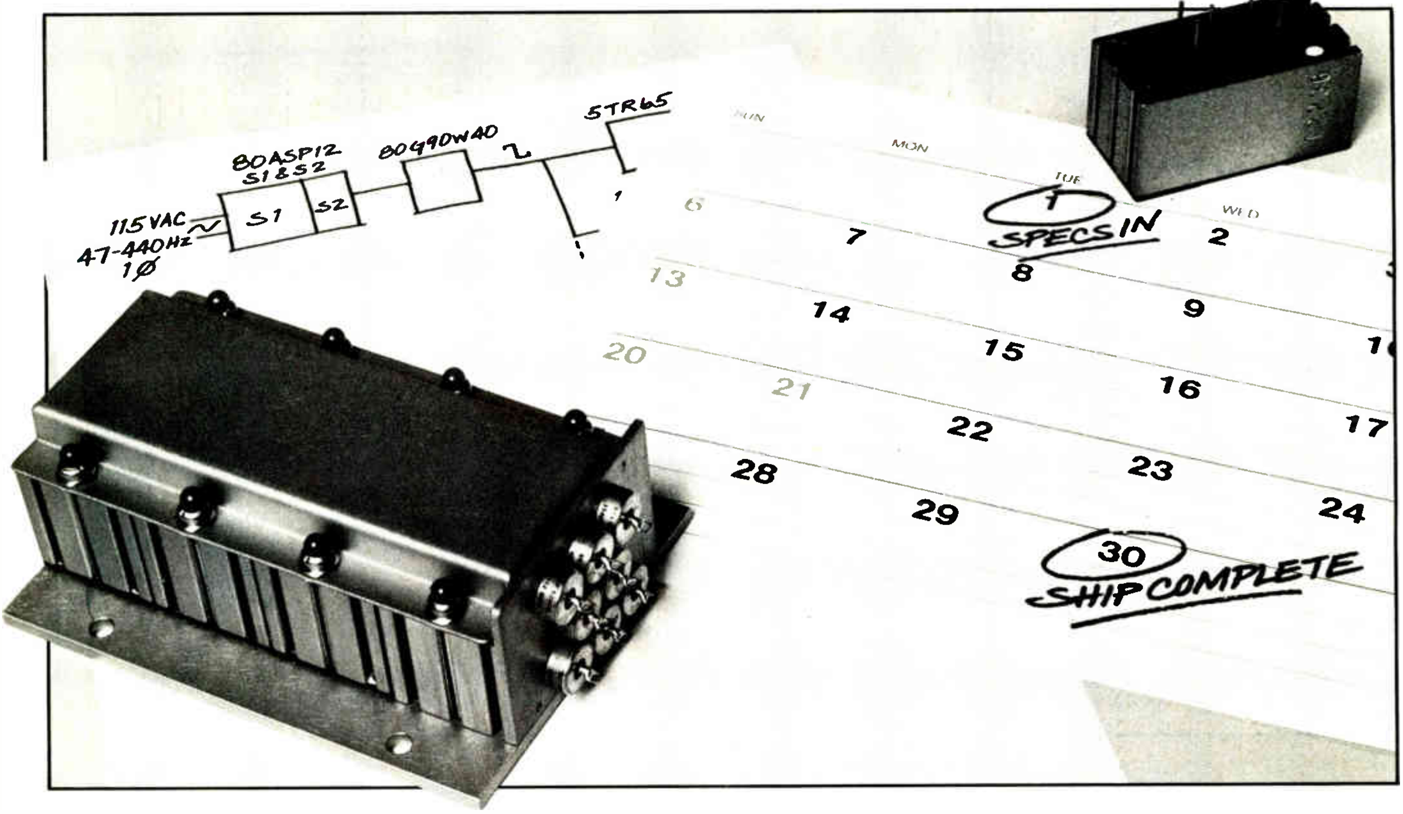

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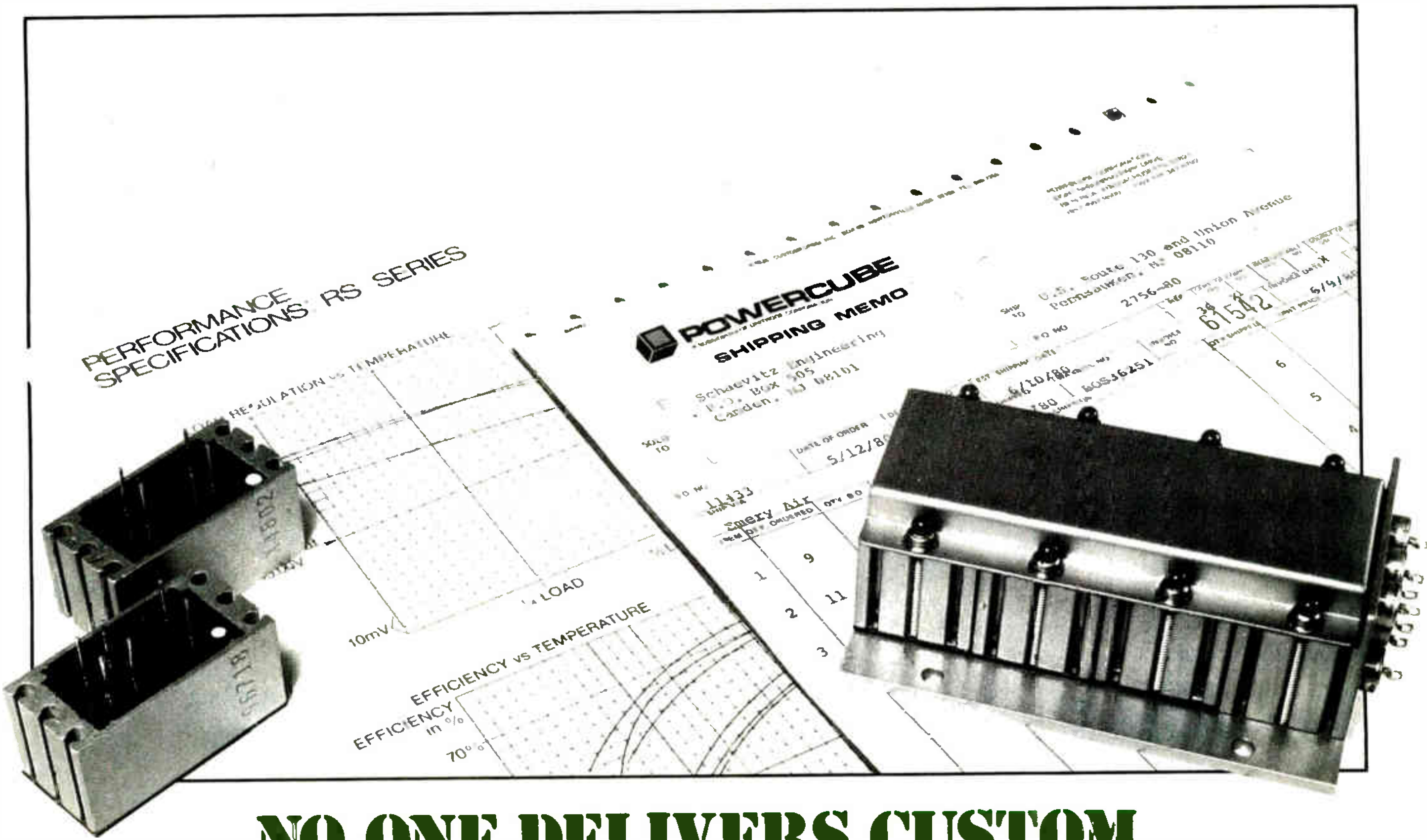

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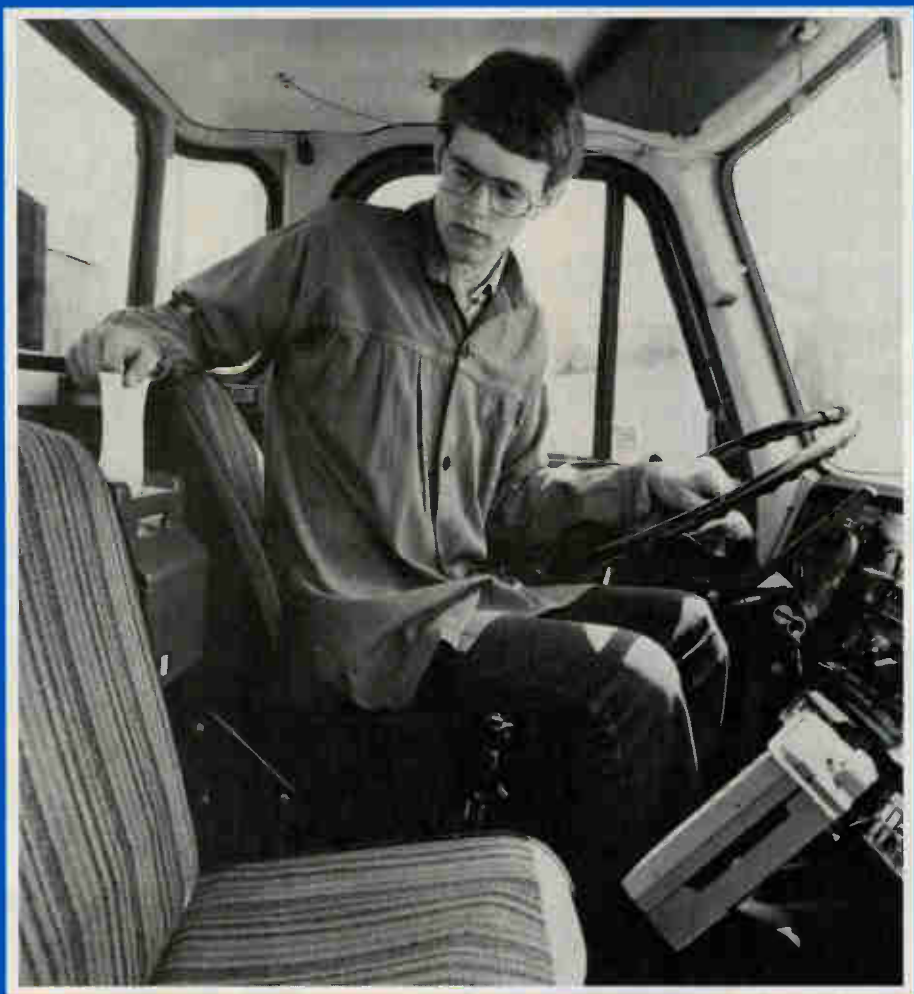

International newsletter

Europe plans its own Ada software . . .

Western Europe's Common Market Commission has awarded $8.3 million in contracts for developing software, including a compiler and program support environments, in the U. S. Department of Defense's high-level language, Ada. About $4.8 million goes to a French-German consortium consisting of Siemens, CII–Honeywell Bull, and ALSYS, a company owned partly by CII-HB and partly by Ada language developer Jean Ichbiah [*Electronics*, Dec. 18, p. 39]. The rest went jointly to Italy's Olivetti, Danish electronics firm Christian Rovsing AS, and the Danish Datamatics Center, an industry-owned study organization. A British software house, Systems Designers Ltd., is a subcontractor in the Italo-Danish project.

Financed under the European Commission's 1979–83 computer industry support scheme, the project is **one of several efforts intended to keep Europe competitive with the DOD's development of Ada** in the U. S.

. . . as well as its own satellite business service

Emulating IBM and other U. S. corporations, European post and telecommunications authorities plan to launch their own satellite business service by 1983. It will enable large organizations to transmit and receive high-speed data, video conferencing, high-resolution facsimile, and other services over 2-Mb/s channels using 4-meter (13-ft) 12- or 14-GHz antennas located on their premises. As members of the Eutelsat Council, established in 1978 to manage the European communications satellite project, the 17 authorities had agreed in December that **all but the first of five communications satellites planned for the 1980s should be able to operate directly from private 4-meter dishes,** as well as from large ground station antennas for international traffic. In addition, Eutelsat will lease capacity on Telecom I, to be launched by the French to provide their own national satellite business service, also by 1983. Further out, the European PTTs have agreed to harmonize their telephone network standards to create an integrated digital network throughout Europe that will complement the satellite service.

Amorphous silicon creates solar cells for consumer uses

Sanyo Electric Co. of Japan has earmarked $50 million for a plant to build amorphous-silicon solar cells for consumer products. By the end of this year, production should have started of enough cells to build power panels for 1 million calculators per month. In other products, including radios and tape recorders, Sanyo plans to use the cells to charge nickel-cadmium batteries. Consisting of a thin film of amorphous silicon on an inexpensive substrate, such as glass, the cells **use at most 1% of the silicon needed by a single-crystal cell.** Yet they produce a similar output under fluorescent light, thanks to a response curve that offsets their low 3% to 5% efficiency. Sharp Corp. is also showing interest in amorphous-silicon solar cells.

CII-Honeywell Bull to drop CML

CII–Honeywell Bull is abandoning current-mode logic for its future generations of mainframes. The Franco-American computer maker uses CML for its top-of-the-line DPS 7 machines and an even larger mainframe it is to announce soon [*Electronics*, Oct. 11, 1979, p. 78]. CII-HB officials insist they are satisfied with the technology, but decided to drop it as part of "a general technological reorientation." Honeywell Information Systems Inc., which coordinates research with CII-HB and owns 47% of the Paris-based company, ran into serious problems with CML and turned to Schottky TTL circuits for its own top-of-the-line DPS 8 series [*Electronics*, Oct. 25,

p. 44]. Notes an official at RTC–La Radiotechnique Compélec, which supplies CII-HB with CML, "The company finds itself in a very uncomfortable position as the only [non-Japanese] mainframe maker using CML."

Siemens builds GaAs broadband amplifiers

Following in the footsteps of several U. S. companies, West Germany's Siemens AG is about to start delivering samples of gallium arsenide amplifiers for broadband applications. With a noise figure of around 4.5 dB over most of its 40-MHz-to-1-GHz range and an output of either 320 mV into 50 Ω or 400 mV into 75 Ω, the monolithic device is **superior to any bipolar-transistor–based hybrid amplifier now on the market,** according to the Munich-based company. At 1 GHz, the noise figure checks in at 6 dB. The gain flatness is 20 ± 0.5 dB. Another version, to follow shortly, will have a frequency range extending to 2 GHz. Using GaAs of its own manufacture, Siemens produces **a highly uniform active layer by direct ion implantation, which also reduces costs and fabrication time.** Gold contacts enhance device reliability. Applications for the CGY 21 include satellite signal receiving systems and measuring equipment.

France starts installing electronic mail system

In its first foray into electronic mail, CII-Honeywell Bull is installing a Mini 6 model 6/43 minicomputer as a switch linking 120 word processors. It is also the first electronic mail center for CII-HB's customer, the Direction Générale des Télécommunications, the French telecommunications authority. To go on line in May, the system links Adrex Plus word processors capable of storing 138-K characters and made by SMH-Adrex Alcatel of Paris. It will be somewhat primitive, being based on message-switching software previously developed by CII-HB and unable to provide automatic call-up. But given the French government's thrust into office automation and CII-HB's plans to expand into that field, **the DGT electronic mail system is likely to trigger a series of government contracts** for the Franco-American mainframe maker.

Addenda

In Spain's **first overseas sale of data-processing technology,** the country's telephone company, CTNE, has been awarded a $22 million contract by Argentina's Sintel to supply a Tesis-5 data-transmission network and have it installed and operating by 1982. . . . Sweden's two TV receiver manufacturers, Luxor and Svenska Philips, are planning **to manufacture 90-cm and 1.5-meter antennas** to enable Swedish homes, apartment houses, and cooperatives to pick up West German TV satellite broadcasts in 1984 . . . The Norwegian post office has given NV Philips Gloeilampenfabrieken of the Netherlands **a $28 million–plus order to install 1,800 banking data terminals at 450 major post offices,** starting in late 1982 and finishing by the end of 1984. . . . Now that its first 12-GHz satellite is up and running, Satellite Business Systems of McLean, Va., has applied to the Federal Communications Commission for permission to hook up five of its U. S. customers to their Canadian operations. **That hookup would create the world's first private international digital communications service.** . . . Early in March, Austria's postal authorities will start teletext trials **involving 300 television and telephone subscribers throughout the country.**

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  - Events A during B Average
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  - Totalize
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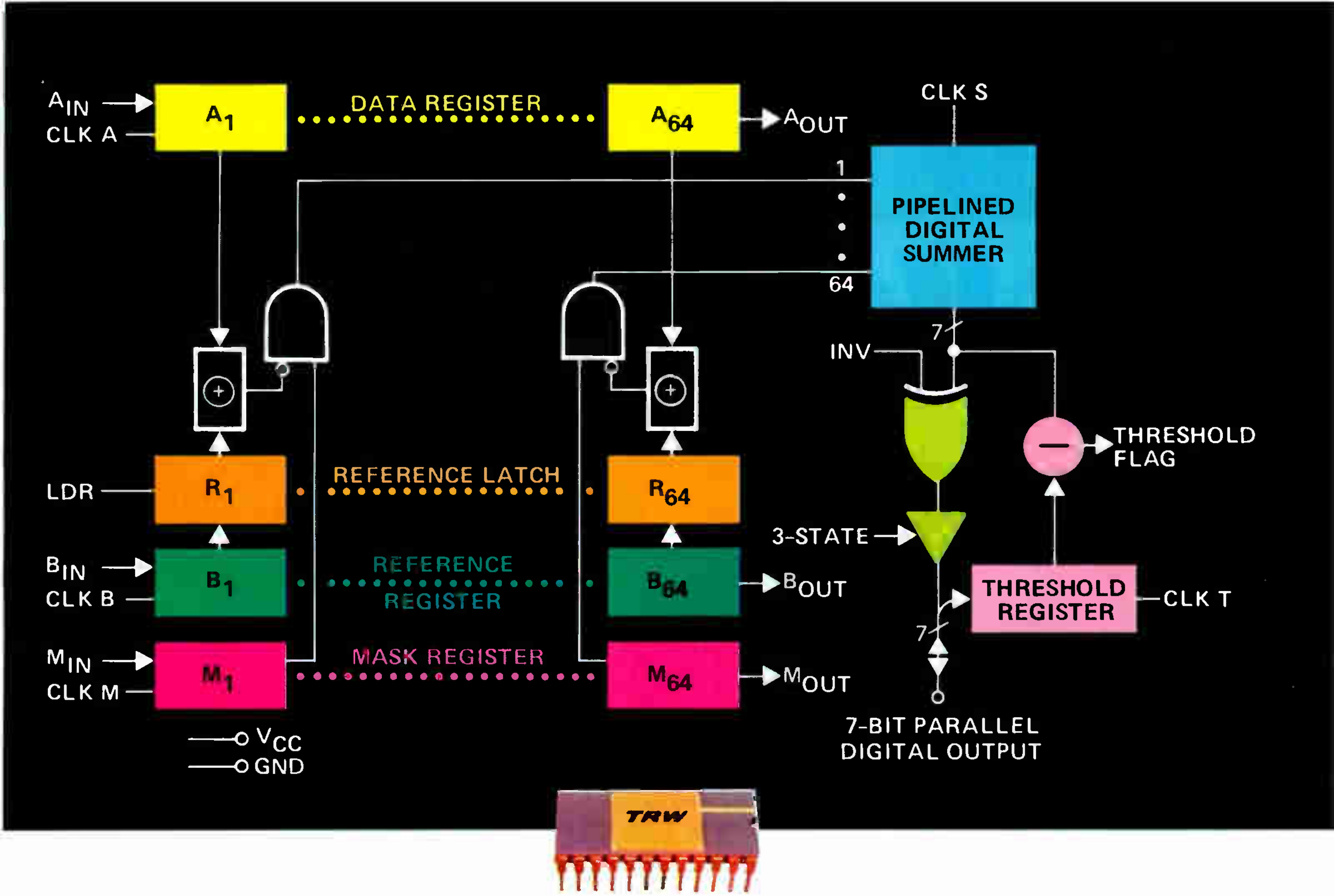

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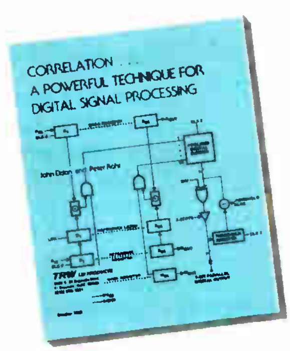

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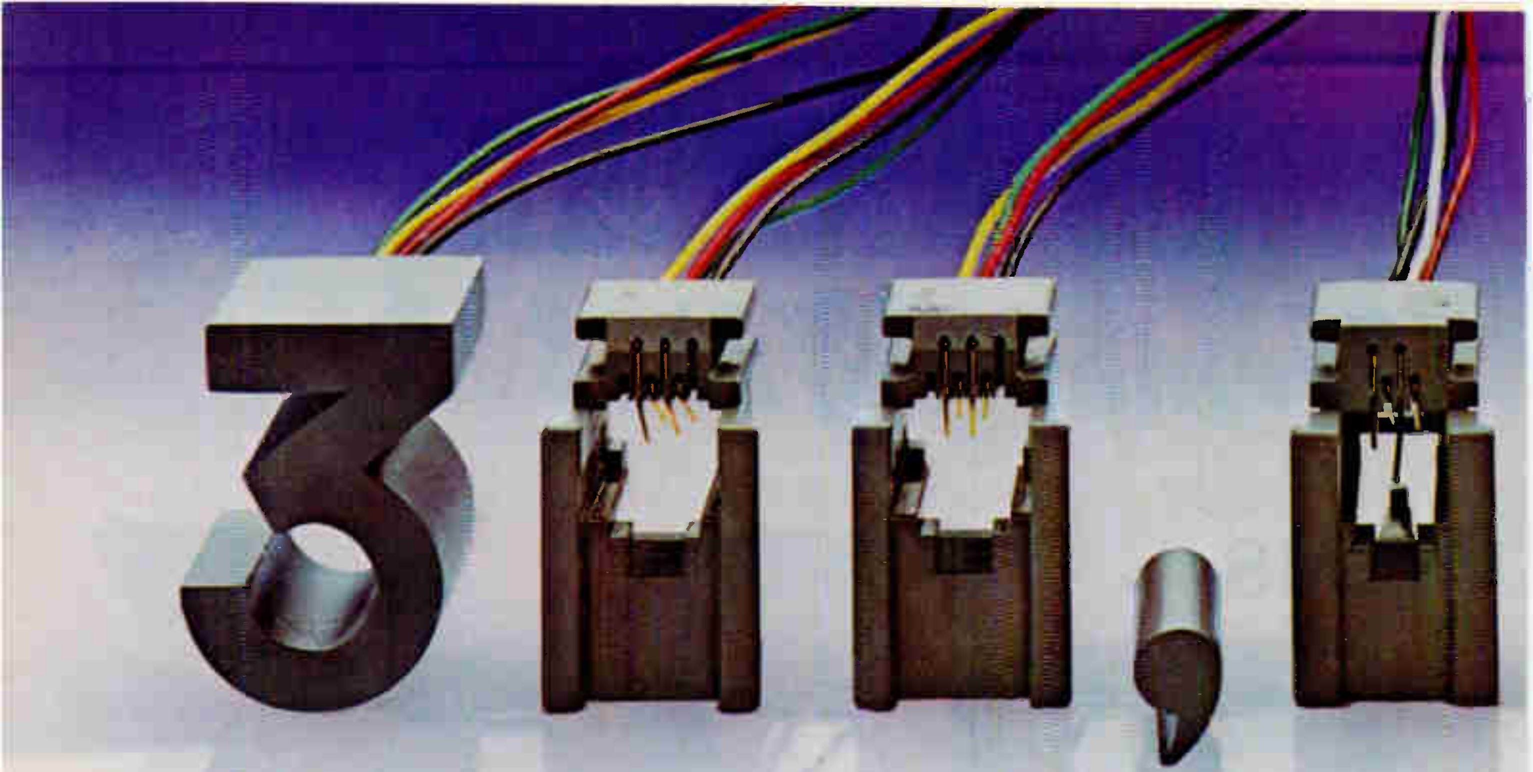

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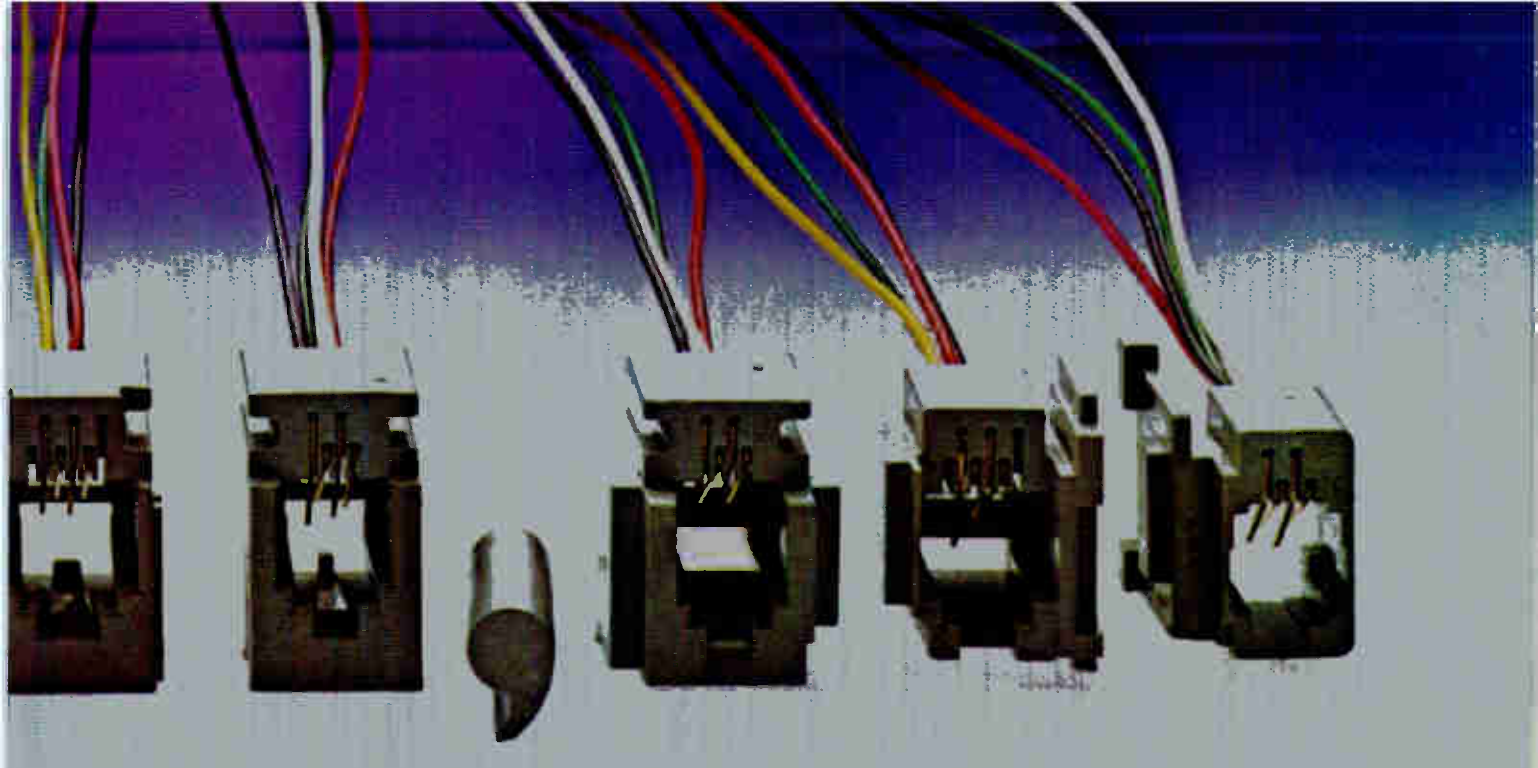

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Analog signals pass TV programs over optical net

by John Gosch, Frankfurt bureau manager

A nondigital approach lends an unusual simplicity to a broadband fiber system linking 25 West Berlin homes

Twenty-five households in West Berlin have just been hooked up to one of the first broadband optical communications system to go into operation in Europe. A single fiber delivers any 2 of 7 5-megahertz TV channels plus any 2 of 14 frequency-modulated stereo channels to each subscriber, who can receive all 4 simultaneously.

What distinguishes the network from others in, for example, the U. S. and Japan is its simplicity, which is due to the fact that it transmits only analog signals, says AEG-Telefunken. The Frankfurt-based company built the $3 million experimental system for the West German post office, which is now testing it. As a consequence, observes Erich Rauth, head of development at the company's communications cable systems group in Backnang, "there is no need for any kind of analog-to-digital or digital-to-analog conversion," so that TV and radio sets can be used without modification, just as they exist today.

Being a broadband system, the net could of course be used for telephone and even color videophone communications, as well as for viewdata and video text services. But "right now, we are primarily interested in evaluating moving-picture transmissions as provided by everyday TV programs," says Hermann Wissmann, who is in charge of West Berlin's regional post office administration.

Resembling a telephone communications system in its starlike architecture, the network extends for about 2.5 kilometers (roughly 1½ miles) and does without repeaters. The longest stretch of uninterrupted cable is approximately 800 meters (around half a mile), Rauth says.

Paired. The system links a communications distribution center, a cable-TV and fm radio head station, and a subscriber unit at each of the 25 households. These units are connected to the distribution center by two fibers, one each for incoming and outgoing transmissions.

The subscriber selects a TV program with an infrared keyboard-type remote-control unit. The IR signals are picked up by the set's external channel selector, which sends corresponding electrical pulses over a coaxial cable to the subscriber unit. From there, optical information goes via one fiber to the distribution center, where a small computer manipulates a switching network so that the subscriber receives the selected program over the other fiber. Together with the program, the center transmits pulses to the TV set that identify the channel and display its number on the channel selector.

Japan

Smaller, simpler GaAs logic could serve computers as well as communications

A Japanese laboratory has developed the same high-speed, high-density, low-power gallium arsenide logic as British Telecom [*Electronics*, Dec. 18, p. 66]. Both require just two transistors and one diode per stage and therefore can occupy much less than half the real estate of the more complex types of normally-on GaAs logic previously announced by Rockwell International and Hewlett-Packard [*Electronics*, Nov. 20, p. 39].

Being capacitively coupled, the new logic cannot handle direct current and the British were contemplating its application in communications only. But the Japanese believe that, suitably initialized and maybe also refreshed, it might be a candidate for the supercomputer for which the country's Ministry of International Trade and Industry is trying to obtain funds [*Electronics*, Aug. 12, p. 65]. Nobuo Hashizume, who heads the team working on the new logic, calls it Schottky-barrier-coupled Schottky-barrier-gate GaAs field-effect-transistor logic, or SSFL for short.

Ring oscillator. For ease in fabrication, the prototype devices in an 11-stage ring oscillator have gates 3 micrometers long and 50 μm wide (the state of the art in gate length is on the order of 0.5 μm). Yet each stage in the ring oscillator has a propagation delay of only 120 picoseconds. Power consumption per stage is 12 milliwatts for a supply voltage of 4.6 volts. Fabrication of the device on an epitaxial layer with a doping density of 9.2×10^{16} atoms

Automatic billing. Hand-held computer in holder in truck cab enables printer (not shown) to produce on-the-spot invoices from delivery data entered by driver.

the truck cab that produces an invoice from data entered by the driver on a hand-held computer.

Sam-Projekt A/S of Them, Denmark, a manufacturer of microprocessor-based systems, developed the terminal equipment. It centers on the battery-operated computer.

Simple to use. Built around an 8-bit Intel 8085 microprocessor, the device stores all the pertinent data—customer's identity, type of goods, size of delivery, discounts, and so on—in semiconductor random-access memory. When inserted in a holder mounted in the truck cab, it conveys this information, at the push of a button, to the printer. The holder is linked to the printer by cable, and the computer transfers its data to the holder by infrared light. The truck's battery is connected to both the printer and the holder, which therefore can recharge the computer's batteries. Finally, at night, the terminal also passes on its stored delivery data to a central computer, again via its holder's cable.

In addition, before each round of deliveries, the Sam-Link computer is loaded with all pertinent information, such as customers' orders and addresses, prices, and taxes, which the printer reproduces for use by the truck driver. This data serves both to produce the invoices and to update the computer's record of the truck's changing contents.

Being programmable, the Sam-Link computer can provide statements not only for oil deliveries but also for delivering beer, collecting milk, and making supermarket deliveries. The billing program is written in assembly language or PL/M and stored either in programmable read-only memory or in a combination of RAM and ROM.

Plusses. The advantages of on-the-spot billing are considerable, notes Sam-Projekt. The seller can count on quicker payment and thus reduced interest costs, as well as no mailing costs; the customer has an opportunity to check the bill for errors before the driver has left; and the driver has no reports to write when he gets home. Besides Dansk Esso, a Danish brewery and other customers are also using the terminals on their regular rounds.

The computer terminal weighs about 1 kilogram, so that it can be held in one hand. A liquid-crystal display shows each entry as it is made. Additional equipment includes a truck controller, which automatically shuts off a tank truck pump when a preset volume has been reached, and a liter counter that registers the volume of liquids delivered by the truck. **-Alfred Pedersen, McGraw-Hill World News**

France

Three firms dedicate chip sets to Antiope

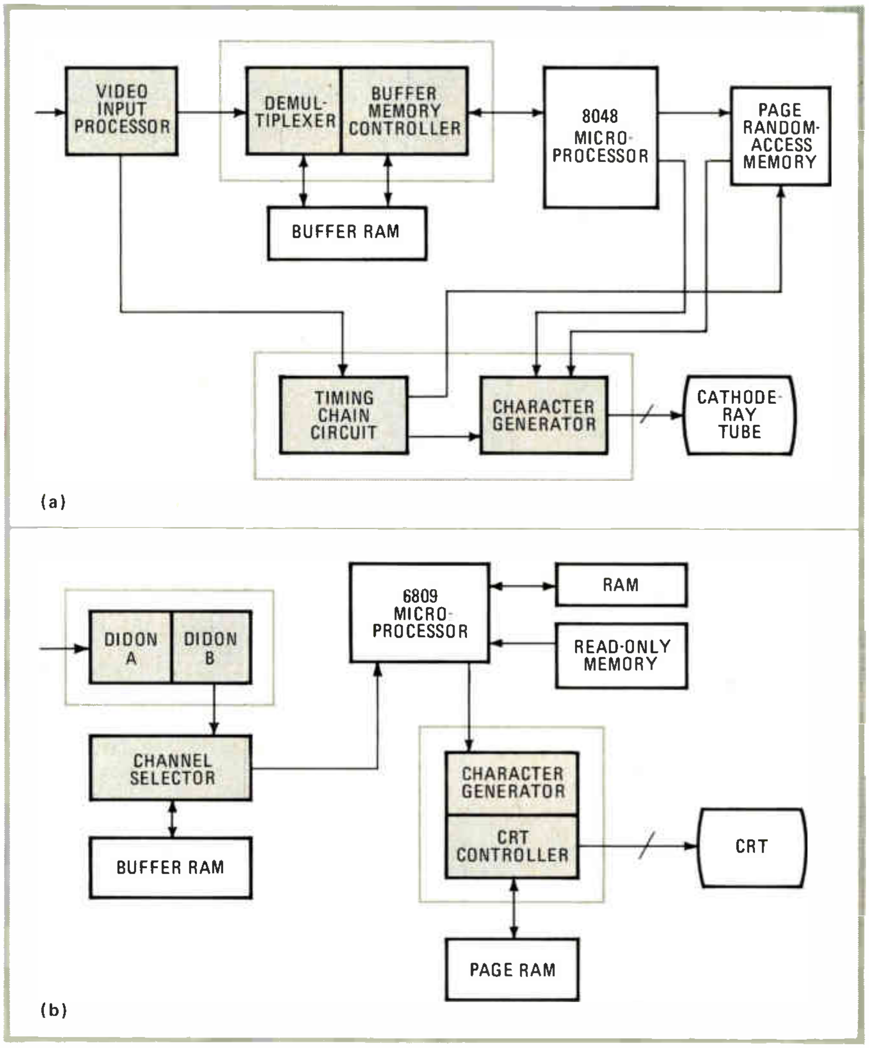
What is the best way of taking a digital teletext signal out of an analog TV signal and displaying it on a color TV screen? Each of France's three largest semiconductor makers has come up with its own answer for Antiope, the French teletext system.

Their chip sets do have similarities, of course. All basically divide the job up into three functions—data acquisition, processing, and display. And each decoder will in fact ultimately consist of three dedicated chips, plus a microprocessor and memory chips. But the details vary, as do the companies' strategies for reaching that goal.

Two of the contenders—RTC-La Radiotechnique Compélec, the components subsidiary of NV Philips Gloeilampenfabrieken of the Netherlands, and EFCIS (Société pour l'Etude et la Fabrication de Circuits Intégrés Spéciaux), the Thomson-CSF subsidiary—plan to have complete, albeit provisional, Antiope decoders ready in time for the on-air Antiope test scheduled to begin in April at Columbia Broadcasting System's Los Angeles station, KNXT. But the third contender, Texas Instruments France, scorning an intermediate stage, is working on its definitive chip set, which by now lacks only a video display processor.

Linear ICs. All three companies use linear bipolar circuits to separate the digital Antiope signal from the composite analog video signal [*Electronics*, June 19, 1980, p. 79]. Since both TI and Philips previously encountered the same problem in developing decoders for the British Ceefax teletext system, they were able to bring out their single-chip data-slicing (video-processing) circuits first. The semiconductor division of Thomson-CSF expects to have its so-called Didon (a French acronym for TV-broadcast digital data) data-acquisition circuits ready within a month or so, but proposes to use two bipolar chips, not one, for its provisional design.

In the remainder of the RTC decoder's data-acquisition section, the bit clock extracted from the Antiope data is fed not only into the integrated-injection-logic circuit that handles demultiplexing, but also into an n-channel MOS timing-chain circuit that synchronizes the entire decoder. Because Antiope can transmit at up to 6 megahertz, a buffer memory is needed to store demulti-



Interim. The five dedicated chips (tinted) designed by RTC (a) and EFCIS (b) to translate French teletext signals onto the TV screen will ultimately become three (gray outlines).

plexed data waiting to be processed. For the time being, RTC proposes a pair of I^2L gate arrays to handle, respectively, demultiplexing and the control of the 2-K-byte buffer memory (see diagram).

"Gate arrays are rather expensive when large quantities are involved," concedes Claude de Féligonde, commercial director for RTC's Antiope circuits. He adds that the company plans to replace the pair with a single n-MOS integrated circuit before the end of 1982.

Family supplies. As for its microprocessor, RTC plans eventually to use a member of Philips' own 8400 series of 8-bit n-MOS chips, together with the group's high-speed data bus. But the provisional design, says Antiope project engineer Claude Iroulart, will employ an Intel 8048 8-bit device, which Philips second-sources but which requires about 10 TTL circuits to interface it with the rest of the decoder.

In the display portion of RTC's definitive chip set, the character generator circuit will be integrated with the timing chain circuit on a single n-MOS chip. But in the meantime, the company is using the two circuits it developed for the electronic directory project being run by the Direction Générale des Télécommunications, part of the French post and telecommunications authority [*Electronics*, July 5, 1979, p. 86].

The EFCIS approach also groups demultiplexing and buffer memory

SCIENCE/SCOPE

Pictures from space are helping mariners in the eastern Gulf of Mexico conserve fuel and travel faster in colder months by showing them where major currents are flowing. Data on the Gulf Loop Current, a circulation of water that moves roughly clockwise through the eastern portion of the Gulf, comes from a GOES (Geostationary Operational Environmental Satellite) spacecraft. An infrared sensor aboard the satellite senses the warmer waters of the current. This information is then converted into pictures and a map showing the Loop Current's coastal edge by latitude and longitude. Ships then can sail with or avoid the current, which flows up to three and one-half knots. The Hughes-built GOES satellites are operated by the National Oceanic and Atmospheric Administration.

Computerized machines have improved the manufacture of radar systems by ensuring quality and reliability. Hughes has developed special equipment to assemble about 80 percent of the components in the AN/APG-65 radar for the F/A-18 strike fighter. One piece of equipment automatically selects proper components from a bank of up to 50 parts, tests them, positions them, and solders them into place. An operator monitors the work on a television screen to check alignment and make manual adjustments if necessary. The machines, by assembling every component in exactly the same way, help keep costs low. Hughes builds the APG-65 radar under contract to McDonnell Douglas Corporation for the U.S. Navy and Marine Corps.

Though placed in an extremely hostile environment just below and on the center line of a 20-mm cannon, the AN/APG-65 radar on the F/A-18 Hornet strike fighter is designed to meet high standards of accuracy and reliability. A special isolation system and structural honeycomb material isolate the radar from gun vibration and acoustical noise to prevent interruptions in operation when the gun is fired. A fluorosilicone material also seals the radar from gun gas that could contaminate electronic components. Hughes builds the APG-65 radar under contract to McDonnell Douglas Corporation for the U.S. Navy and Marine Corps.

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control. In cooperation with Thomson-CSF's semiconductor division, the company has put both functions on a single n-MOS circuit and is already supplying samples of the device.

To be replaced. Also like Philips, EFCIS plans to use one microprocessor for its provisional design and another in its final chip set. A Motorola 6809 8-bit microprocessor, which the company produces as a second source, will process the data in its first decoders. But marketing vice president Yves Thorn says that the company plans to develop an optimized version of the cheaper 6805 in definitive versions. By adding 2- or 3-K bytes of on-chip read-only memory to the 6805, he explains, EFCIS can do away with the additional random-access memory and ultraviolet-light–erasable programmable ROM (E-PROM) chips necessary with the 6809.

Since Thomson-CSF is also participating in the electronic directory project, and since both the directory and Antiope operate on the same videotext standard, it comes as no surprise that EFCIS, like RTC, is proposing a pair of display circuits developed for the directory project. And although EFCIS' president, Paul Mirat, does not want to commit himself to a specific date for a single n-MOS chip to handle both cathode-ray-tube control and character generation, he is confident that, like RTC, EFCIS will have three dedicated chips by the end of 1982.

Thus all three competitors should have definitive versions of their decoder chip sets ready for production by the end of next year. EFCIS and RTC now plan to keep the RAM needed to store Antiope pages waiting to be displayed separate from the buffer memory for incoming data. Therefore, in addition to their three dedicated circuits, each will require two RAMs, plus, of course, the microprocessor. TI is combining both memory functions into a single RAM, so its decoder will consist of one RAM, a microprocessor, and three dedicated circuits—a data slicer, a prefix processor, and a video display processor. **-Kenneth Dreyfack**

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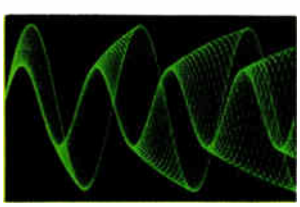

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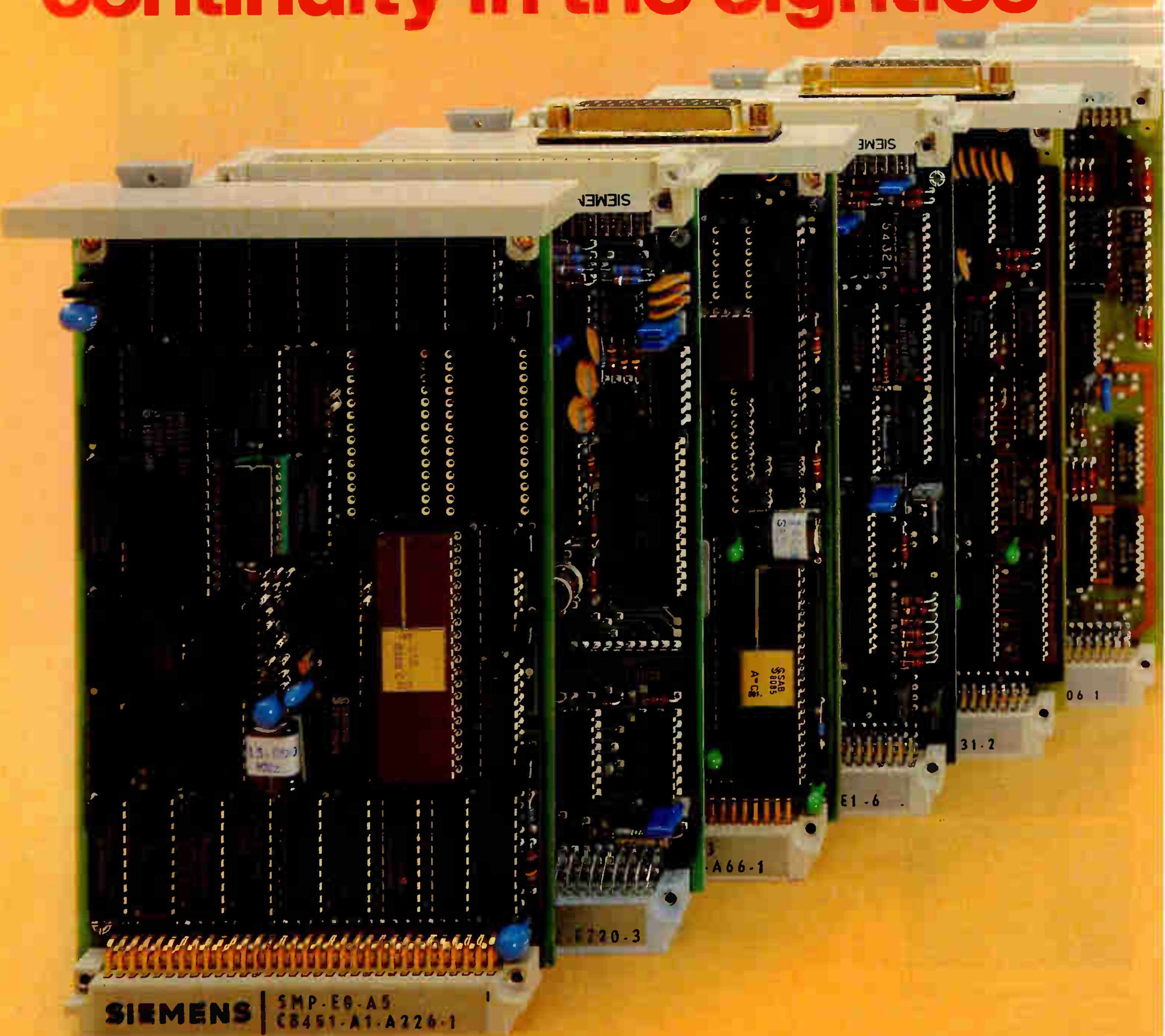

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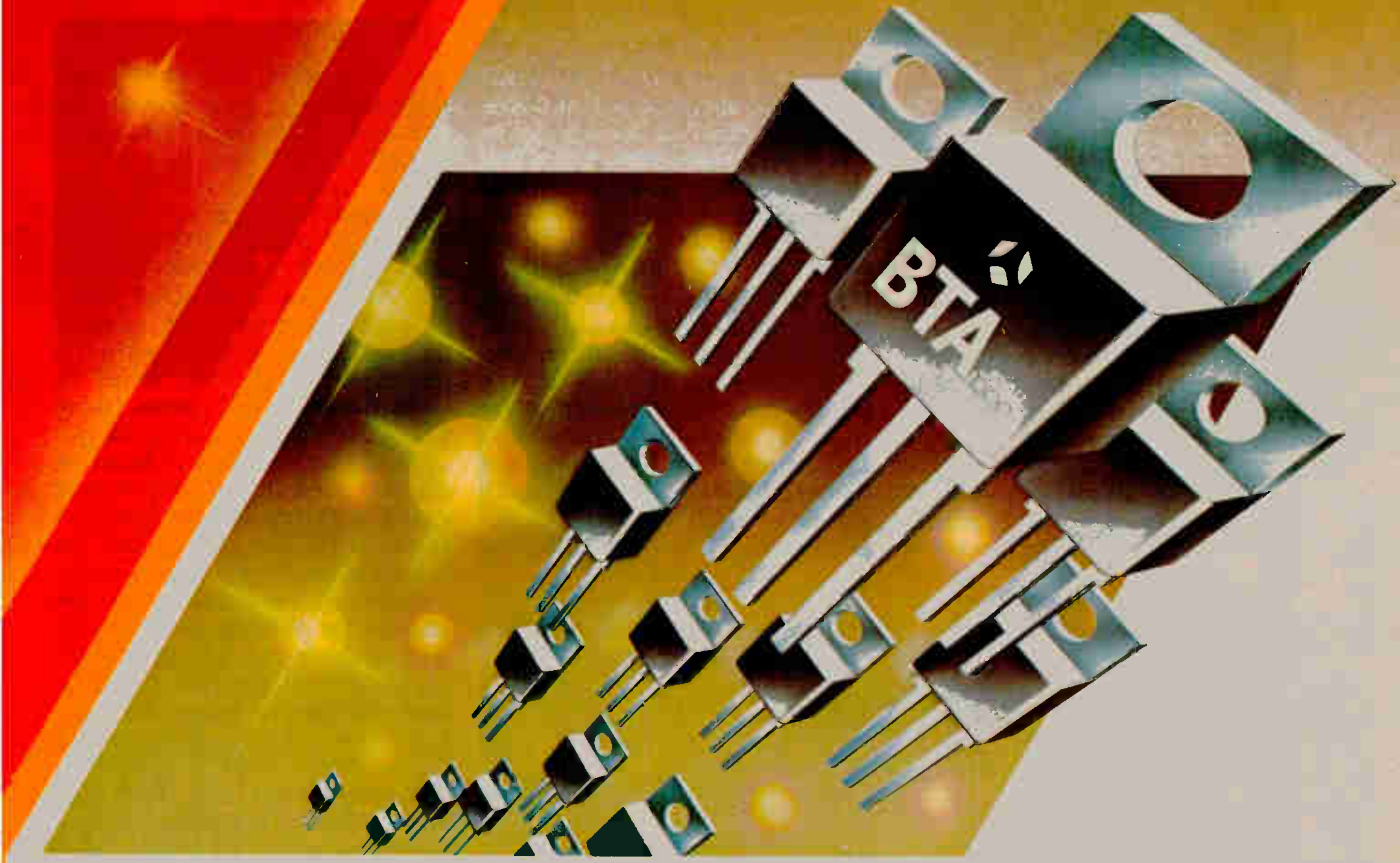

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degrees or days of the week.

The ease with which custom designs can be accommodated arises from advances in display manufacture. As a late entrant into the market, Lucid Displays has been able to invest in the latest production equipment, manufacturing displays in batches at a time from glass sandwiches that are presently 6 in. square but will eventually be up to 16 in. square. Both custom and standard products can be run down the same production line with no extra tooling.

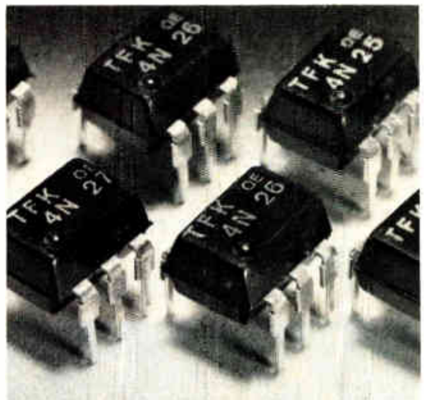
The company was formed by Saunders-Roe Developments Ltd., which backed a group of engineers with long-standing experience in the technology with $1 million. It plans to provide a high-volume capability for both standard and custom LCDs, building on the pioneering research work of Britain's Royal Signals and Radar Research Establishment. The latter, together with the University of Hull and BDH Chemicals Ltd., Pool, Dorset, developed a range of liquid-crystal materials that now accounts for over 60% of world consumption—cyano-biphenyls and terphenyls, which are stable in sunlight and have a wide temperature range.

In the batch production technique developed by Lucid, both the front and rear electrodes and the spacer-sealant are deposited on the glass in a single operation. Individual displays are separated only after injection of the twisted-nematic biphenyl material. The sealant-spacer used to separate glass faces by 8 μm is a heat-cured plastic developed for the purpose. The group aims to provide displays of increasing complexity with plans for dot-matrix displays and displays of up to 30 characters.

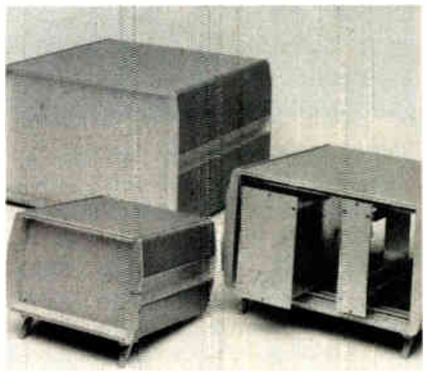
Lucid Displays, Swallowfield Way, Dawley Road, Hayes, Middlesex, UB3 1D1 England [441]

Correction

Microampere and microsecond were wrongly abbreviated in the story on the e3100 microcomputer from Eurosil GmbH appearing in the Dec. 4 issue, p. 6E. The e3100 uses 30 μA (not 30 mA) at 1.5 V; the machine cycle time should have been given as 30 μs. Electronics *regrets these errors.*



Members of the 4N series of optoelectronic couplers incorporate a gallium arsenide luminescent diode as a transmitter and a silicon npn planar phototransistor as a receiver. Each coupler comes in a six-pin dual in-line package. AEG-Telefunken, 7100 Heilbronn 2, West Germany [442]



Type 16 universal enclosures have grooves in the sides, enabling them to do without separate handles. They are built for 100-by-160-mm and 100-by-200-mm Eurocards, as well as for double-sized Eurocards. AKA Mayr AG, CH-8635 Dürnten, Switzerland [443]

The model 7851 digital temperature measuring set can deal with temperatures from −100.0° to +199.9°C. Featuring an accuracy of within 0.1°C, it has a serial binary-coded decimal output and a power consumption of about 4 VA. Burster, 7562 Gernsbach, West Germany [444]

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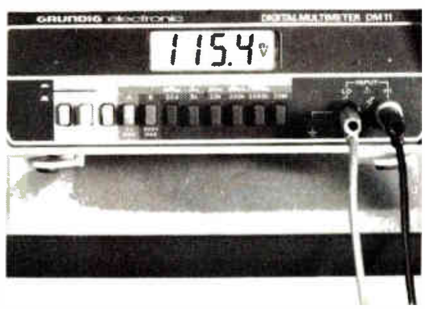
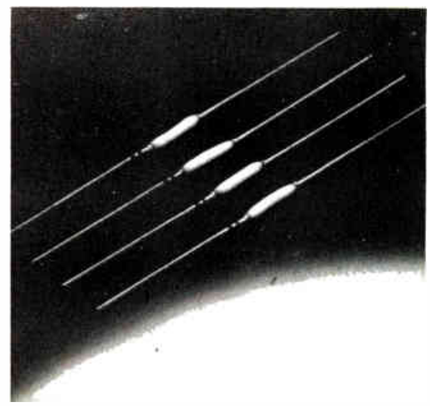
New products international

The H-A series of connectors, available with 3, 6, 16, or 32 pins, have a contact resistance of less than 2 mΩ for screw-type connections and less than 5 mΩ for crimp connections. They are rated at up to 380 V ac. Contact GmbH, 7000 Stuttgart 80, Schulze-Delitzsch Str. 29, West Germany [445]

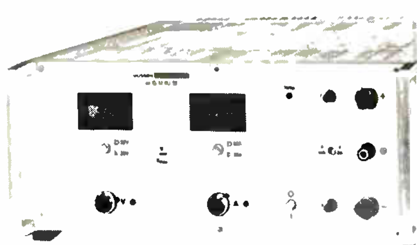
The S60 solderer heats up in 6 seconds and cools down within 10 to 15 seconds. Housed in a break-resistant plastic case, it weighs about 700 g and can be used either with a tip for 2.5-mm² work or with one for finer work. Engel GmbH, 6200 Wiesbaden, P. O. Box 2340, West Germany [448]



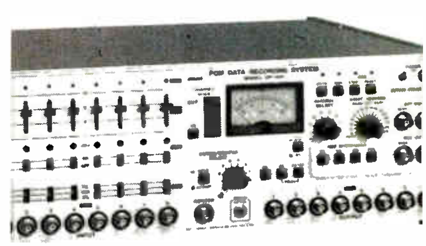
Portable digital multimeter DM11, with 26 measuring ranges for ac and dc voltages, currents, and resistances, has batteries set for 2,000 hours of operation and a 15-mm-high liquid-crystal display to indicate magnitude, polarity, and range. Grundig AG, 8510 Fürth, Kurgartenstr. 37, West Germany [446]



For use in line transformers and cascades, a series of rectifiers has been designed to handle up to 24 kV at 2 mA. The rectifiers, which have a moisture-resistant sintered glass package, come belted for automatic mounting. Dithraterm, 8300 Landshut, Ludmillastr. 23/25, West Germany [449]



Power supply model 64G 32 RU 50, a 19-in. unit with a digital indicator, supplies up to 1,600 W—a 50-A output at 32 V. Voltage stability is specified as within 0.001% despite 0-to-100% load variations. Gossen GmbH, 8520 Erlangen, P. O. Box 1780, West Germany [447]



Model RP-881 is a digital recorder of analog data using pulse-code modulation on video cassettes. It has a range of dc to 20 kHz, a dynamic range of more than 70 dB, and no wow, flutter, or drift. NF Circuit Design Block Co., 6-3-20 Tsunashima Higashi, Kohoku-ku, Yokohama 223, Japan [450]

New products international

The Percept series of solid-state electronic pressure indicators, designed for gases and liquids, indicates both direct and differential pressures from full vacuum to 100 lb/in.^{2}, and static pressures up to 150 lb/in.^{2}. Perflow Instruments Ltd., 83 Denzil Rd., London NW10 2UY, England [451]

Model TR 7200 universal scanner, for use in data-acquisition and test systems, has built-in switch cards for multiplexer, relay actuator, and matrix functions and provision for control by an IEEE-488 bus. Takeda Riken Industry Co., 1-32-1, Asahi-cho, Nerima-ku, Tokyo 176, Japan [452]

The 2123 multipurpose waveform generator produces sine, square, and triangular waves between 0.003 Hz and 200 kHz. All functions have a source impedance of 60 Ω with a variable output of 10 V p-p maximum. Marconi Instruments Ltd., Longacres, St. Albans, Herts. AL4 0JN, England [454]

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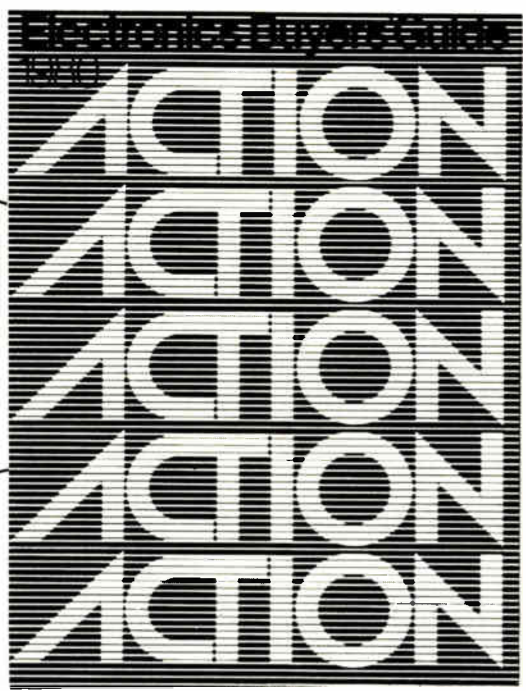

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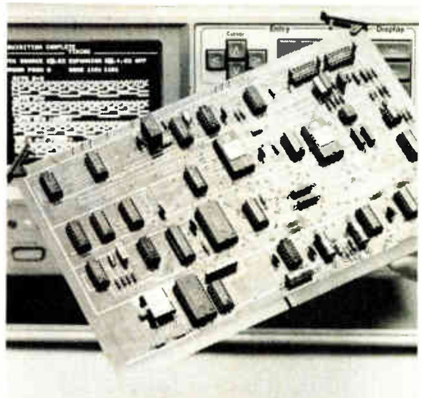
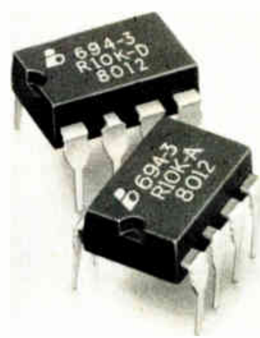


The 5001 is a serial input/output interface that enables Gould's LA5000 logic analyzer to be linked directly with line printers, paper-tape punch/readers, teleprinters, and cassette-tape units. Gould Instruments Division, Roebuck Road, Hainault, Essex 1G6 3UE, England [455]

A telegraph and data test set includes the 8620 microprocessor-based generator, the 8630 telegraph and data analyzer, and the 8660 telegraph and data test center. GPW Electronics Ltd., 55 Cobham Rd., Ferndown Industrial Estate, Wimborne, Dorset BH21 7RA, England [456]



Model 694's eight-pin dual in-line package contains four isolated precision thin-film resistors for parallel and serial connection. It comes in four accuracies of absolute and ratio tolerances from 1.0% to 0.05%. Beckman Instruments Ltd., Queensway, Glenrothes, Fife KY7 5PU, Scotland [457]

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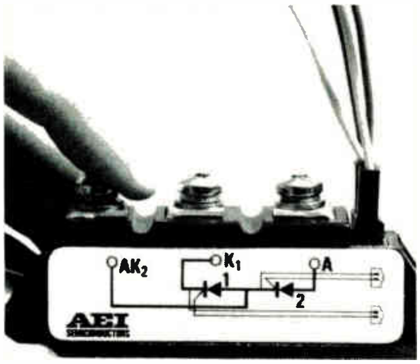
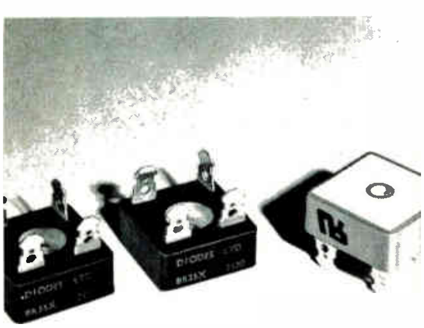


The PBT 45 and 55 series of dual-thyristor power modules are designed for dc motor controllers, lamp dimmers, battery chargers, and welding controllers; they have voltage ratings of 400 to 1,200 V. Marconi Electronic Devices Ltd., Carholme Road, Lincoln LN1 1SG, England [458]

The PM 4201 digital cassette recorder serves as a memory extension unit for equipment unable to provide complete controller functions. It reproduces cassettes at high speed. NV Philips Gloeilampenfabrieken, Science and Industry Division, P. O. Box 523, 5600 AM Eindhoven, The Netherlands [459]



The components of the BR series of bridge rectifiers, mounted in chip form on a thin alumina substrate, have a typical junction-to-heat-sink thermal resistance of 0.57°C/W and a typical junction temperature of 96°C at full rated output. Diodes Ltd., 16 The Broadway, Newbury, Berks., England [461]

Circle 465 on reader service card

The SEM 505 also features a unique data link system that synchronises the operation of transmitters and receivers, and relays all operational data to a series of function modules that monitor each other's parameters and acts upon the acquired data accordingly. Furthermore, these function modules can be configured, re-configured, extended or upgraded to suit the specific needs of the user.

The advanced state-of-the-art of this new scanning electron microscope (the MFD, for example, is considered to be one of the most important achievements in detector technology since the introduction of the Thornley-Everhard secondary-electron detector) is indicative of the level at which Philips is contributing to the fields of microelectronics and micro-sciences.

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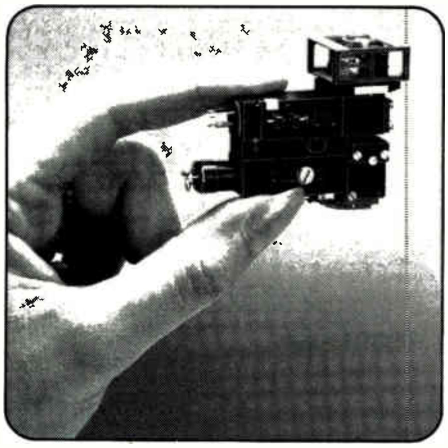

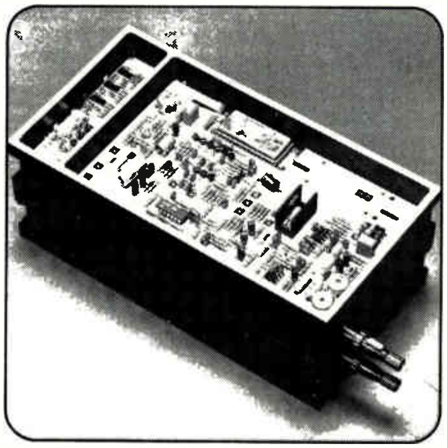

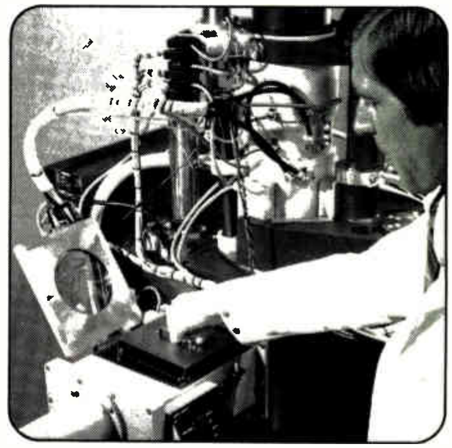

Optical data storage. Philips' diode laser optical data storage system – the world's first – employs a micro-miniature read/write head, along with extremely high precision radial tracking and error-detection/correction systems, to record and/or retrieve 10^{10} data bits on a double-sided, 12-inch tellurium coated disk. An AlGaAs diode laser, contained in the head, produces sufficient pulsed light output to write, or burn, 1-μm data pits in the tellurium film, while an electro-optical system, also in the head, maintains an objective focusing accuracy of 1-μm with a radial tracking accuracy of 0.1-μm.

Circle 467 on reader service card

Optical transmission repeater. Eleven one-way repeaters, spaced at 8km intervals along a total line section length of 96km, are being used in laboratory trials of a longhaul 140Mbit/s optical line transmission system. Each repeater is equipped with a Running Digital Sum (RDS) counter which, together with the code rules of the 5B-6B line code, permit direct error code monitoring per repeater section. A transmitter and a receiver are also contained in the extremely compact repeater housing.

Circle 475 on reader service card

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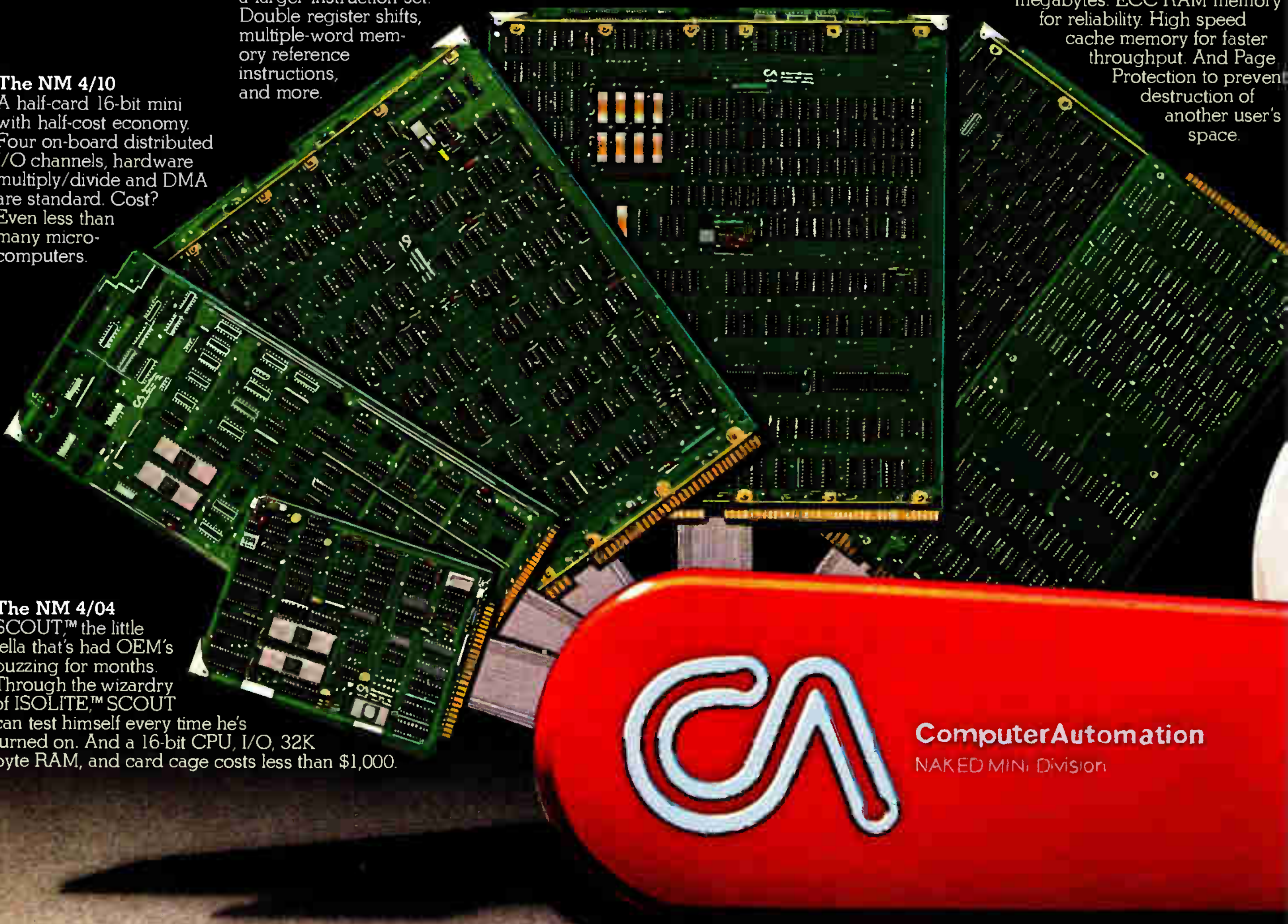

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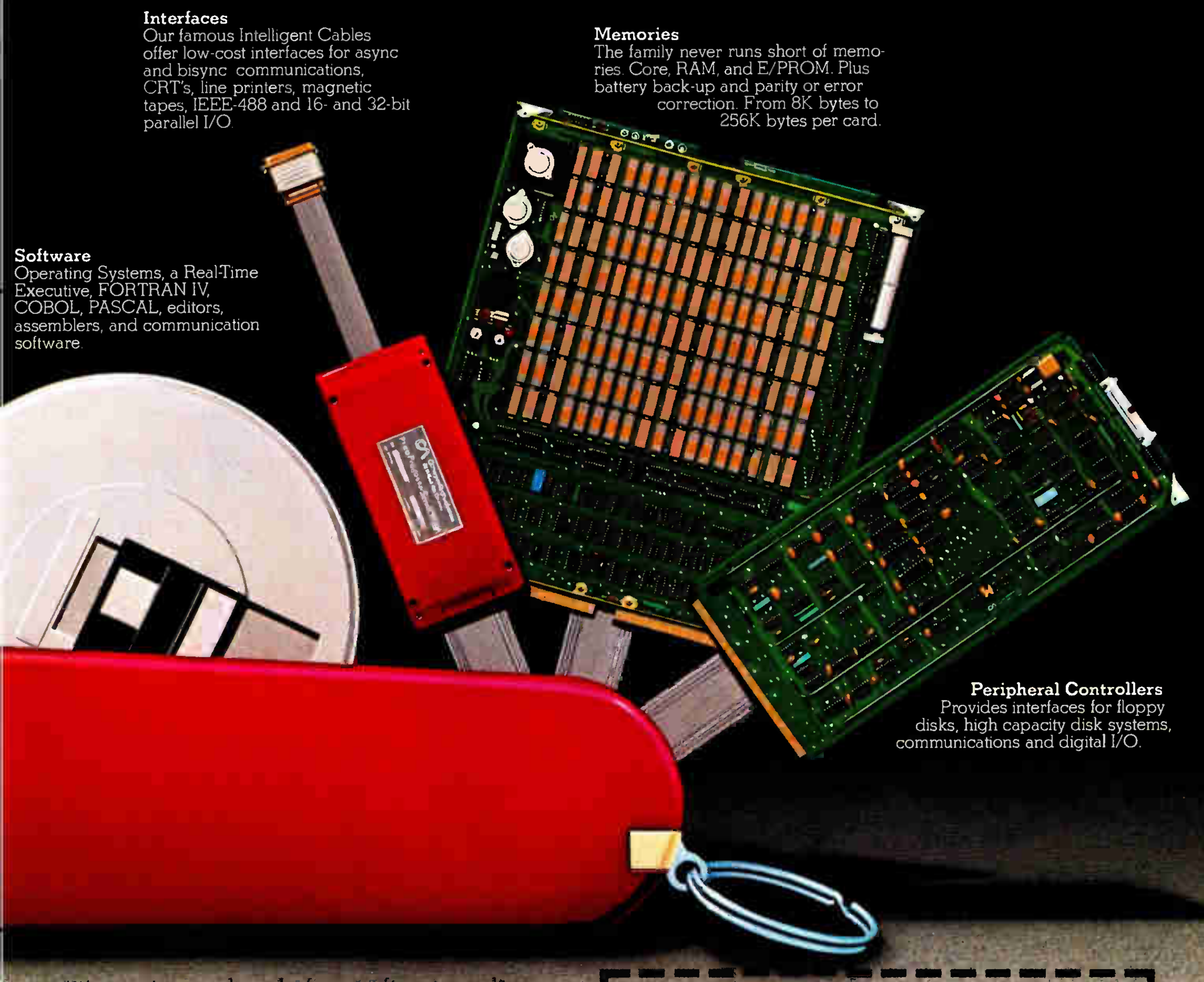

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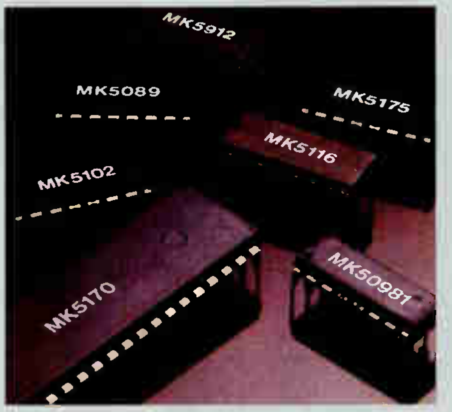

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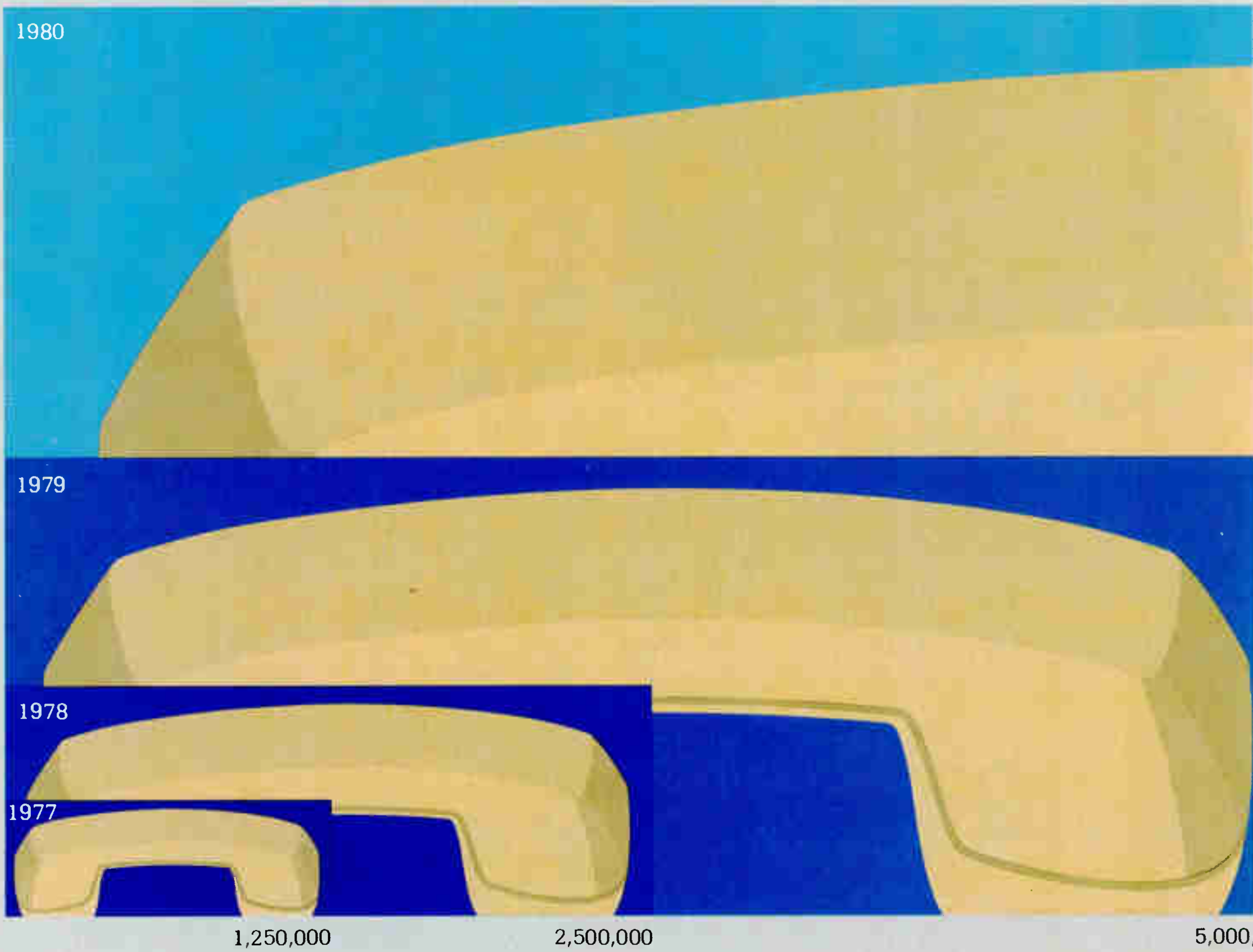

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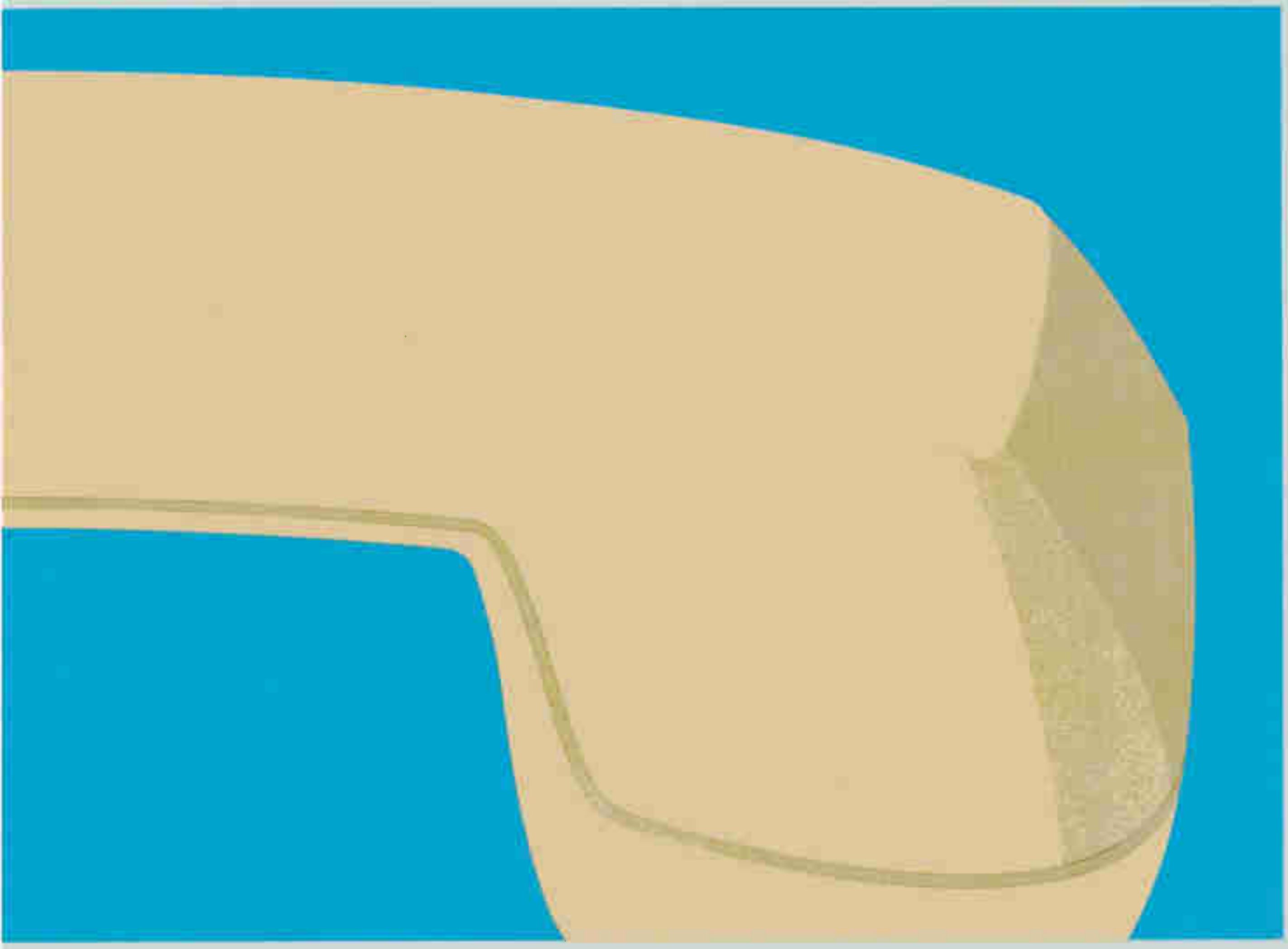

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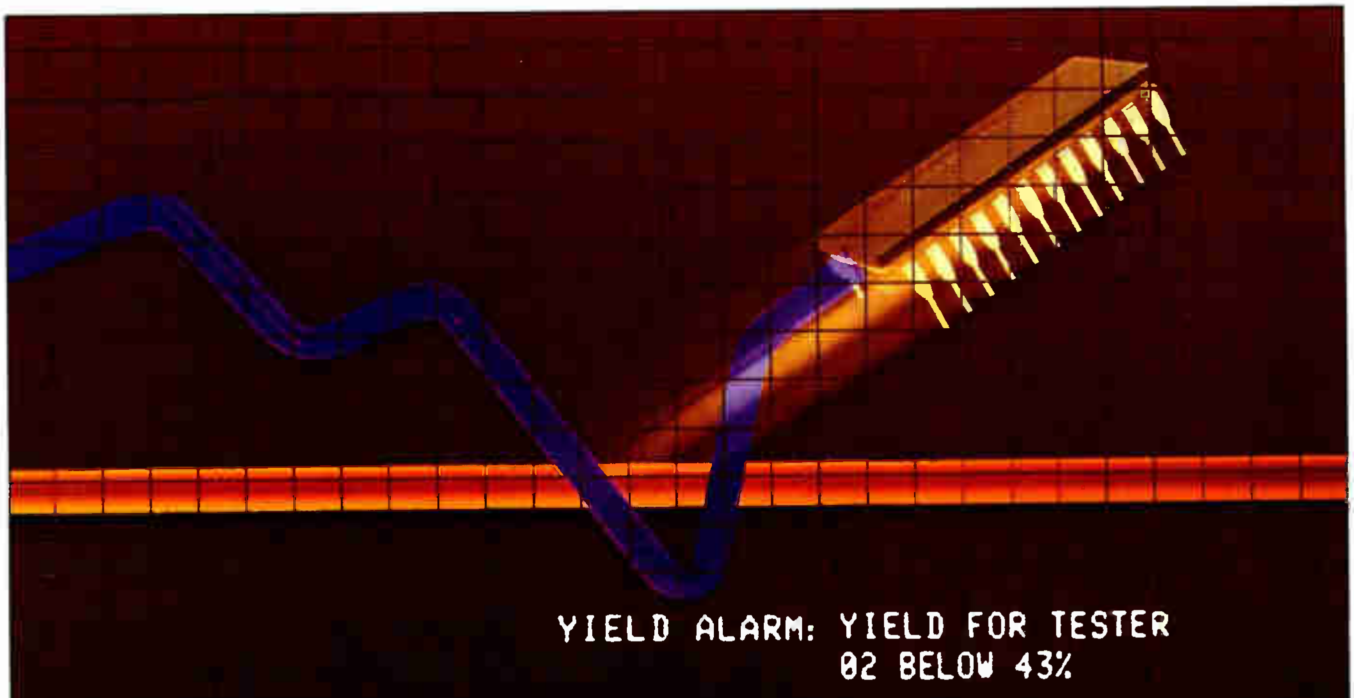

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TERADYNE

Zilog, at six, hews to master plan

Microcomputer maker keeps a complete system picture, from the chip to the integrated product, in its view

by Bruce LeBoss and Martin Marshall, San Francisco regional bureau

A change in leadership for a six-year-old high-technology company could be expected to force changes in operating philosophy. But in the case of Zilog Inc., the only thing that changed was the name on the door of the president's office: the Cupertino, Calif.–based company is still traveling the road its founders laid out for it in 1974.

That road leads upward, from chip to integrated system. For Zilog sees itself as involved in the complete system picture, from microprocessor to microcomputer, with plans for future products that include development systems, 32-bit computer systems, and all the peripherals a user could ask for.

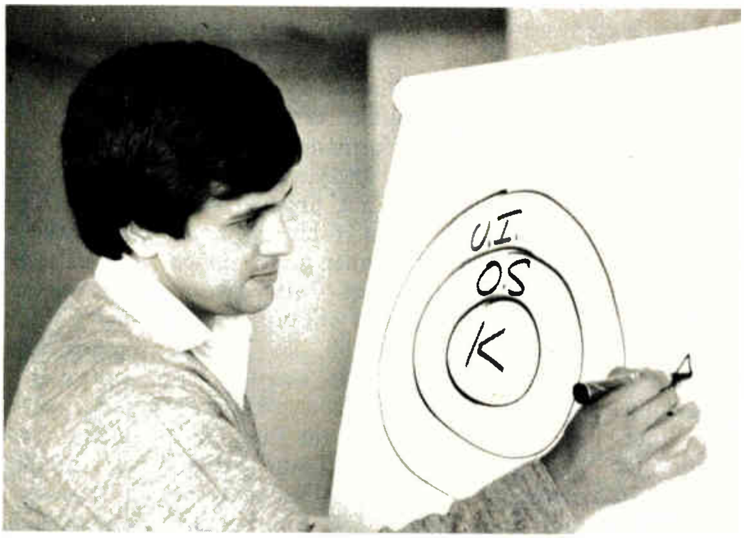
The approach, in the words of cofounder and former president Federico Faggin, "will prove its worth in time." It was Faggin who recently moved up to a job as vice president of Exxon Enterprises Inc.'s Computer Systems Group, to be succeeded at Zilog by Manny Fernandez. Exxon is the parent of Zilog; the Zilog approach makes it fit neatly into Exxon's high-technology family and also distinguishes it from other chip makers such as Intel Corp. In short, Zilog is a total microcomputer company.

The firm has yet to turn in a profitable year, but in 1981 it should be very close to breaking even. "From then on, we expect profitability," says Faggin, who sees sales of several hundred million dollars in 1985. By then, he says, the company will be "even more dominant in the 8-bit marketplace," with the Z80 and its extensions, and the Z8 will be "the premier microcomputer in the high-performance segment" of that market. As for the Z8000, Faggin notes, "I expect it to have achieved the No. 1 position in the 16-bit arena" in terms of design-ins and implementations.

According to a major industry analyst, about $10 million of Zilog's $20 million in MOS sales in calendar 1979 was in microprocessors and peripherals; that gave it about 4% of an estimated $250 million market. In calendar 1980, the company's market share increased to 5.8%, says the analyst, or about $22 million out of $375 million. Most of its microprocessor and peripherals sales are still in the 8-bit market, with only about $2.5 million to $4 million from sales of the Z8000 family.

Looking ahead to 1985, an industry observer says, "Personally, I believe that Exxon is backing Zilog for the long haul. I don't think Zilog's present negative profitability will be a hindrance. In 1985, I expect to see the company in the market, and I expect it to be a major force in the 16-bit marketplace." The observer, however, does not share the rosy view that it will dominate the 16-bit market in five years. He says, "My gut feeling is that the ranking of 16-bit suppliers in 1985 will be Intel, Texas Instruments, Motorola and its second source, and Zilog and its second sources." He adds that there may be some variation, with TI and Motorola fighting for the No. 2 spot, and, he says, "I wouldn't be surprised to see Zilog possibly ending up in third place."

Obviously, without the support of Exxon or a comparable backer, it would be difficult, if not impossible, for Zilog to finance a development effort of the magnitude it envisions. But Faggin expects the investment to pay big dividends. Although the company did not close 1980 in the black, several months of the year were profitable. Final 1980 sales, when tallied, are expected to approach $50 million, more than a 40% in-



New boss. Manny Fernandez, president of Zilog, says, "In future systems we see an interplay between the CPU instruction set, drivers, UNIX kernel, operating system, languages, and applications software."

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memory management unit, since "that would be a third-generation peripheral." According to Fernandez, the instruction set of the Z8000 series will be a subset of the instruction set for Zilog's 32-bit processors.

The first solution to the compatibility problems that may be caused by the expansion to 32-bit microcomputers is that structured software must be able to migrate. Hierarchical levels of each of the fundamental system elements must be established so that all of them match as the user moves up the complexity scale. As Fernandez puts it, "Our customers must be able to trust that we will protect their software investment, which we recognize is much larger on 16-bit systems than on 8-bit systems."

Multiprocessing will be another important piece of the Zilog game plan. There will be multiprocessing configurations that will allow as many as five 8-bit CPU chips to work together with up to three 16-bit CPUs and one 32-bit processor. These multiple CPU chips will then be able to partition the tasks in such a way that different software is run simultaneously on each microprocessor. The microprocessors can then pass messages through first-in, first-out buffers to inform a main CPU when individual tasks are completed.

MCZ computers. Clearly, among the first multiprocessor configurations to appear will be computer systems in Zilog's own MCZ series. To accommodate the 32-bit processor, the firm will expand its current Z-net protocols to the 32-bit Z-net II protocols. Communication between the original Z-net and a Z-net II will be achieved through a gateway device. The offering of board-level products will continue to be part of the overall scheme as Zilog enters the 32-bit world, but the company has yet to determine which of its options to pursue in this area.

Inevitably, the driving force behind all these hardware expansions must be the software. For Zilog, this means a strong commitment to the UNIX operating system developed by Bell Laboratories, as well as a long march toward the placing in silicon of such items as languages, utilities, and popular applications programs.

The UNIX operating system was chosen after Bell Labs announced that licenses would be available at a very reasonable price. The operating system also has the advantage of being a proven one. It will soon be enhanced to support segmented virtual memory, which also falls in line with Zilog's plans. "The UNIX operating system is already running on Z8000s in the laboratories at Zilog," Fernandez notes.

The implanting of high-level languages in silicon will add a nonclassic curve to the graph of software development costs. The user will be able to buy just the CPU and build the other elements around it or to mix and match precut drivers, languages, interfaces, applications, or kernels with its own custom software modules to speed the task. Zilog currently looks ahead to two or three generations of such chips, promising full migration paths.

The company cannot commit all major applications programs to silicon, but according to Fernandez, "certain applications software will be selected for silicon from a wide base of applications programs. The user will be able to add value from the CPU up to the applications level or go from the applications back to the CPU." To aid in the design process, Zilog now gives the user information on the software-instruction calling conventions of the Z8000.

Expanding this philosophy into the area of interconnections, Zilog has begun to license its Z-bus architecture to users for a nominal fee. In spelling out the company's strategy for future interconnection systems, Fernandez lists priorities as:

- Symmetry, to give simplicity to the system.
- Hierarchy, to accommodate 8-, 16-, and 32-bit CPUs.
- Flexibility, to handle single or multiple tasks, users, and stations.
- Performance, independent of the number of nodes.
- Reliability, including the ability to create redundant systems, and independence from node to node.

Bug killers. Finally, Zilog will have to provide the tools necessary for the user to debug these more complex systems. Upcoming development systems will be host-independent, to accommodate the increased processing power that will be needed. The first of these will be a 16-bit Z8000-based development station. Such systems will have separate and inexpensive in-circuit emulation modules that also plug into the recently introduced Z-scan system. The buyer will have the full use of local networking connections for his development system, so that high-speed printers, large disks, and mainframe processors can be shared among development stations. Migration of software from the MCZ-1 system through future Zilog systems up to large ones such as a Digital Equipment Corp. PDP-11 can be achieved through the PL/Z language, through Cobol, and later through C.

Needless to say, implementing such an agressive development effort as Zilog's undertaking will not come cheaply. Zilog plans to increase research and development spending in 1981 by at least 60%. The percentage of sales that R&D expenditures represent is believed by the company to be at least twice that of any other microcomputer supplier. □

From the Z80

Its founders formed Zilog Inc. in November 1974 with the intent of integrating the design and manufacturing technologies of both semiconductor devices and computer systems to achieve a broad-based product line. Aided by investment capital from Exxon Enterprises Inc., Zilog made the transition from concept to reality in mid-1975. A year later, it took the wrappings off its initial offering, the Z80 central processing unit, which is recognized by many as the industry's most powerful 8-bit general-purpose microprocessor. It had the software advantage of an Intel 8080 instruction superset combined with the architectural regularity features of the Motorola 6800. Subsequent introductions of the Z8 single-chip 8-bit microcomputer and Z8000 16-bit CPU are helping Zilog gain recognition as a technology leader in microcomputer systems. **B. LeB. and M. M.**

Consumer electronics

Digital audio players push to market

Philips-Sony approach probably will be selected as the standard, with Christmas 1982 the target for marketing drive

by Robert Neff, McGraw-Hill World News

With the world's leading stereo makers rapidly nearing consensus on a standard format, digital audio disk (DAD) players could be less than two years away from the consumer market. And judging from their relative lack of interest, it seems that U. S. manufacturers are for the most part leaving the innovation and development to their Japanese and European rivals.

Compared with currently available disks that are digitally recorded but must be played back with conventional, analog stereo equipment, the DAD players and their disks offer sound reproduction that is characterized by one expert as an order of magnitude better.

In the optical recording approach most favored, a master recording is made by a pulse-code-modulated laser beam. To play back, the modulations are detected and converted into an analog signal.

Even as the Japanese and Europeans prepare for next month's meeting of their informal industry group in Tokyo, a meeting that will probably recommend adoption of the technique devised independently by the Netherlands' NV Philips Gloeilampenfabrieken and Japan's Sony Corp. as a worldwide standard, activity in the U. S. is limited to three manufacturers of professional studio equipment, none a household word in entertainment electronics. The three are Soundstream Inc. of Salt Lake City, Utah; MCI Inc. of Fort Lauderdale, Fla.; and the Mincom division of 3M in Minneapolis.

The group holding the upcoming meeting is known as the Digital Audio Disc Conference and is made up of 47 manufacturers, most of them Japanese. Though it has no formal power, most companies will abide by its decision in hopes of avoiding the incompatibility obstacles that have been created by makers of video cassette recorders and video disk systems.

This impending commercialization of digital audio disk systems is coming sooner than many observers had predicted since it was first demonstrated publicly four years ago [*Electronics*, Nov. 24, 1977, p. 78]. Some still argue that the technology will not gain widespread use until the late 1980s. But Japan's powerhouse stereo industry is already planning a mass marketing assault in time for Christmas 1982 that many think will develop into a deep penetration by 1985.

The most enthusiastic executives even foresee digital technology completely replacing conventional analog records and players by the early 1990s. "It took 17 years to switch from 78 rpm to 33," says Itaru Watanabe, deputy general manager of Hitachi Ltd.'s television audio and video products division and secretary of the digital conference's executive committee. "But this time it should take 7 to 10 years, depending on the price of players."

LSI gives impetus. Underlying the technology's accelerating momentum is the fact that major manufacturers have come up with large-scale integrated circuits to replace the hundreds of conventional ICs heretofore needed, along with the 16-bit digital-to-analog converters that convert pulse-code-modulated signals into analog equivalents. When mass-produced, these chips will dramatically reduce both the cost and size of the converters. Also, movement toward standardization has been smoother than many had believed possible, although three completely different formats remain in contention.

Watanabe explains that the DAD conference is looking for an audio-

Future player. This prototype digital audio disk player was shown by Sony at the Tokyo audio show last October. Compatible with the Philips system, it is not a product yet.

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TIP 120/1/2	NPN	60-100V	8A	65W
TIP 127/8/9	PNP	60-100V	8A	65W
TIP 130/1/2	NPN	60-100V	12A	70W
TIP 135/6/7	PNP	60-100V	12A	70W
2N 6034/5/6	PNP	40-80V	8A	40W
2N 6037/8/9	NPN	40-80V	8A	40W
2N 6386/7/8	NPN	40-80V	15A	65W
2N 6666/7/8	PNP	40-80V	15A	65W

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only system with a low bit rate and a compact size. "That looks very much like the Philips proposal," he says. (Sony's main contribution has been improvement of the error correction and modulation.)

The two companies each showed a different but compatible prototype of their Optical Digital Compact Disc system at the All-Japan Audio Fair in October. Both were about the same size, with Sony's weighing about 9 pounds and measuring about 7 by 10 by 3½ inches. The system's 12-centimeter disk fits easily into a jacket pocket yet boasts a playing time of 60 minutes per side, or twice that of both sides of a conventional 30-cm long-playing record. Its solid-state laser pickup does not damage the disk.

Keep trying. Nevertheless, Victor Co. of Japan and West Germany's AEG-Telefunken also have digital audio disk systems that they are pushing for worldwide adoption and that the conference is still officially considering. Japanese firms show little interest in Telefunken's proposal, largely because its groove-and-stylus format presumably would cause eventual disk wear, but JVC's Audio High Density (AHD) system [*Electronics*, Oct. 23, 1980, p. 80] is a stronger contender. Both JVC and Matsushita Electric Industrial Co., of which it is an affiliate, say they will market it no matter what, but Matsushita plans to sell a Philips-Sony–compatible system as well.

Among U. S. manufacturers, only one is currently willing to commit itself to the consumer market. That is Soundstream, which uses a unique recording technique involving an optical pickup that moves over a fixed record shaped like a 3-by-5-inch index card. Company president Thomas Stockham says, "We will have a consumer playback unit in 18 to 24 months. We may market it ourselves; it is possible that we will license it."

At 3M's Mincom, the feeling is that if the division gets into the consumer market, it will sell components used in its magnetic-tape systems or licenses, not finished disk players. The division buys custom components for its systems and builds its own digital-to-analog and analog-to-digital converters. Marketing development manager Clark

Different route. Pioneer's proposed compact optical disk and player is not compatible with the Philips-Sony version, which will probably become the standard in the field.

Probing the news

Duffy says that more than 40 of its multichannel systems have been installed in recording studios.

Some stereo makers see a potential bonanza in digital audio disk technology far beyond the promise of new player sales. Though the best amplifiers and speakers are now up to digital requirements, most purchased several years ago are not. Some consumers wishing to fully enjoy digital sound may wind up buying entire new systems.

Sounds good. It does not take a good ear to appreciate digital's superiority to high-quality analog systems. The improvement is not just marginal: the system is noiseless and almost distortion-free; eliminates wow, flutter, and crosstalk between channels; and boasts a dynamic range of about 96 decibels, 50% wider than that of analog records, with a ruler-flat frequency response from dc to 20,000 hertz. And some makers are claiming a notable signal-to-noise ratio of at least 90 dB.

The sampling rate of the Philips-Sony system is 44.1 kilohertz; for JVC's format it is 47.25 kHz. In contast, Mincom's professional equipment has a rate of 50 kHz.

As for the d-a converters, both the Philips-Sony and the JVC version use units with 16-bit resolution. According to Matsushita's Masahiro Kosaka, a chief engineer in its Wireless Research Laboratory, each bit is good for 6 dB worth of dynamic range.

He adds that the converters cost in the $230-to-$240 range when bought from outside vendors, but that many companies are developing a hybrid technology using several ICs and a thin-film resistor network with laser trimming that will be cheaper in large quatities. Moreover, Kosaka says that two-chip converters now in development will be in use in the digital players that hit the market in 1982 and will cost less that $50 apiece, with the price soon dropping to about $10.

Most Japanese makers are talking of an introductory price for a player of $475 to $700, about the same as a top-end analog player and cartridge. But several claim that a $100 price

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Circle 107 on reader service card

See EEM pp 1071-1073

tag by 1985 is not unthinkable as LSI, semiconductor laser, and lens costs plunge with mass production. Expensive tone arms, cartridges, and cases will be unnecessary. "The arms can be made of chopsticks and the boxes from the shell of an *ekibento* [train station box lunch]," Watanabe says only half-facetiously. Software and hardware makers alike estimate that disks will retail for about the same as conventional LPs on a playing-time basis.

But there is one major factor that could delay introduction. Disk makers readily admit that it will not be easy to offer a wide selection of digital recordings within two years. The DAD conference has a software committee composed of record company representatives working on disk standards, but they have not reached agreement yet, according to Yoshiro Furusawa, manager of the engineering department of Toshiba-EMI Ltd.

Some cold water. And digital audio is not without its skeptics among hardware makers, especially smaller firms that lack the financial resources or semiconductor manufacturing ability of the majors. At Sansui Electric Co., for example, Central Research Laboratory general manager Susumu Takahashi says, "The big question is when DAD will reach an acceptable price. I hope it doesn't become another chicken-or-egg race where if the price doesn't come down, no one will buy, and if no one buys, companies won't spend on cost-cutting techniques."

Practically all of Japan's major consumer electronics firms have demonstrated their ability to make at least a prototype optical digital player. For most, converting to the Philips-Sony approach would be relatively easy. The race will be about which can build the most and cheapest LSI parts and laser diodes the soonest. Marketing prowess will also be crucial. Some big integrated firms like Mitsubishi and Toshiba that are not now leading stereo makers see digital audio as an opportunity to muscle their way to the top on sheer financial and technological strength, notwithstanding their current marketing deficiencies. □

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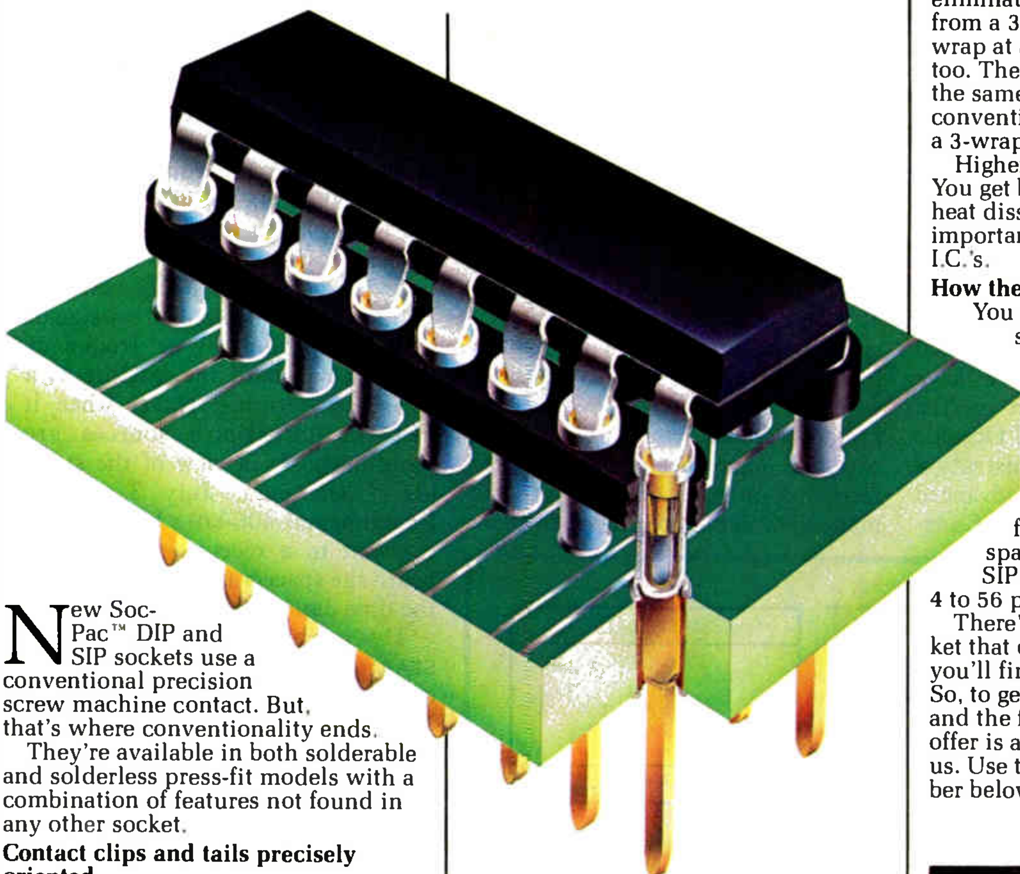

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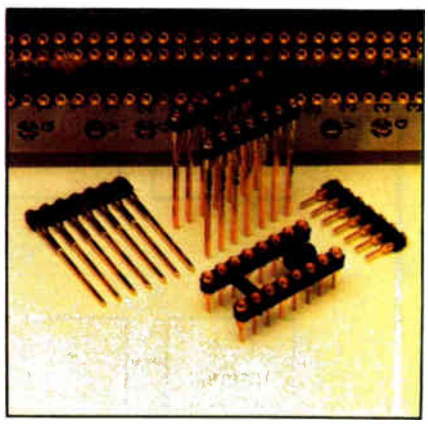

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Communications

Sarsat to speed sea, land rescues

International program involving U. S., France, and Canada will use NOAA-E satellites to eliminate search and rescue flaws

by Pamela Hamilton, New York bureau manager

Search and rescue operations for downed aircraft and disabled vessels are hard in the best of circumstances, and if an effective monitoring system is unavailable, they verge on the impossible. Those operations should prove easier, however, once a search and rescue satellite-aided tracking system called Sarsat goes into operation in the spring of 1982.

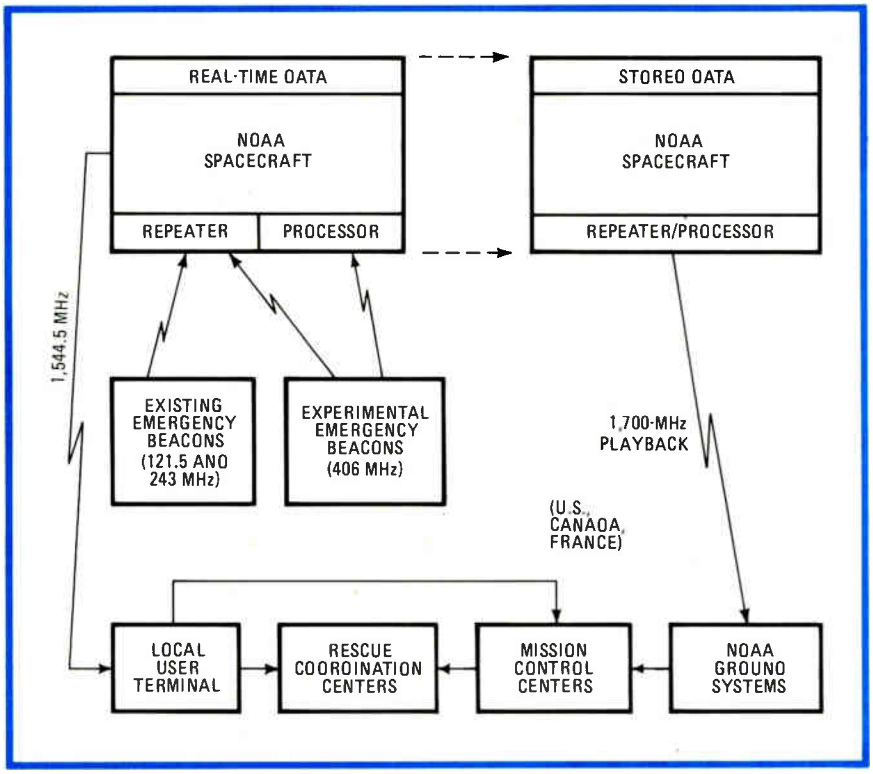
Working together, the United States, Canada, and France have based the Sarsat program on the next generation of National Oceanic and Atmospheric Administration satellites—the NOAA-E, an advanced Tiros-N satellite. France and Canada will supply the on-board equipment that will ride on the American spacecraft. The Soviet Union will also cooperate in the venture, but employing its own satellites.

Currently, search and rescue operations in the U. S., Canada, and France rely on distress signals from low-power radio beacons operating at 121.5 and 243 megahertz. Aircraft are equipped with emergency locator transmitters (ELTs) and ships with emergency position-indicating radio beacons (Epirbs). The signals of both have been designed for reception on receivers that must be manually monitored. However, there is no system as such for continually monitoring these beacons, and even if their signals are received, direction-finding equipment is often not available. Also, determining the validity of the data is difficult because the transmission contains no identifying or positional data.

Added beacon. With Sarsat, the 121.5- and 243-MHz distress signals will be relayed by a frequency repeater on board the satellite to a local user terminal (LUT) when it and the ELT/Epirb sources are simultaneously in view of the satellite [*Electronics*, July 3, p. 84]. Experimental 406-MHz beacons will transmit to a receiver-processor on board the spacecraft that will sift out the time data in the distress signal.

The repeater will be supplied by SPAR Aerospace Ltd. of Montreal and will accept all three signals—121.5, 243, and 406 MHz—relaying them to ground stations by a 1.544-gigahertz downlink, according to Bernard J. Trudell, search and rescue mission manager for the Sarsat project at the Goddard Space Flight Center in Greenbelt, Md.

The analog repeater takes the 100-milliwatt signals at these three different frequencies, multiplexes them with the 2.4-kilobit digital signal from the on-board processor, and phase-modulates this multiplexed signal onto the 1.544-GHz downlink. The bandwidths at 121.5, 243, and 406 MHz are 25, 46, and 80 kilohertz, respectively. Thus, the amplification factor of the signals varies according to the amount of power needed to sustain the 8-watt downlink signal. The noise figure for the 121.5-MHz signal is 5 decibels and for the 243- and 406-MHz signals,



Listener. Sarsat provides for frequency repeater on National Oceanographic and Atmospheric Administration satellite to transmit distress signals to a local user terminal.

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3.5 dB. "These noise figures allow signals to be detected down to about −170 dBW, depending on how good the original signal is," notes Harvey L. Werstiuk, Sarsat technical manager for the Canadian Communications Research Center in Ottawa.

Franco-Canadian handoff. The receiver-processor is to be built in France by Electronique Marcel Dassault and will accept the 406-MHz signals. It will then feed these signals in parallel to the Canadian repeater. The processor will also store the signals until one of the two existing NOAA ground stations at Fairbanks, Alaska, or Wallops Island, Va., comes into view. It is designed to handle distress messages from up to 90 ELTs simultaneously.

Crucial to this on-board processing system are two identical processors. Each of these uses a phase-locked servo loop to lock rapidly onto the 160-millisecond unmodulated burst that signals the start of a message from a distress beacon. In addition, the processors contain a doppler counter that determines the received frequency of the signal at better than 0.035 hertz. The information extracted from the bit stream, as well as a time tag and the received frequency, are formatted by the processor's encoder and then passed through a buffer to the satellite's information-rate processor.

This processor modulates the data onto the satellite's downlink transmitter in the Canadian repeater for real-time transmission to in-sight LUTs. It also stores the data on tape until it can be dumped in a NOAA main ground station. From the frequency and time data, the ground stations can locate the beacon.

RCA bird. The NOAA-E is being built by RCA Corp.'s Astro Electronics facility in Princeton, N. J., and will be the fifth in a series of NOAA polar-orbiting environmental satellite systems. However, it will be the first one that will carry a search and rescue payload.

The cooperative venture with Russia, called Cospas-Sarsat, is scheduled to begin shortly after the launch of NOAA-E. Russia will supply two of its own satellites. □

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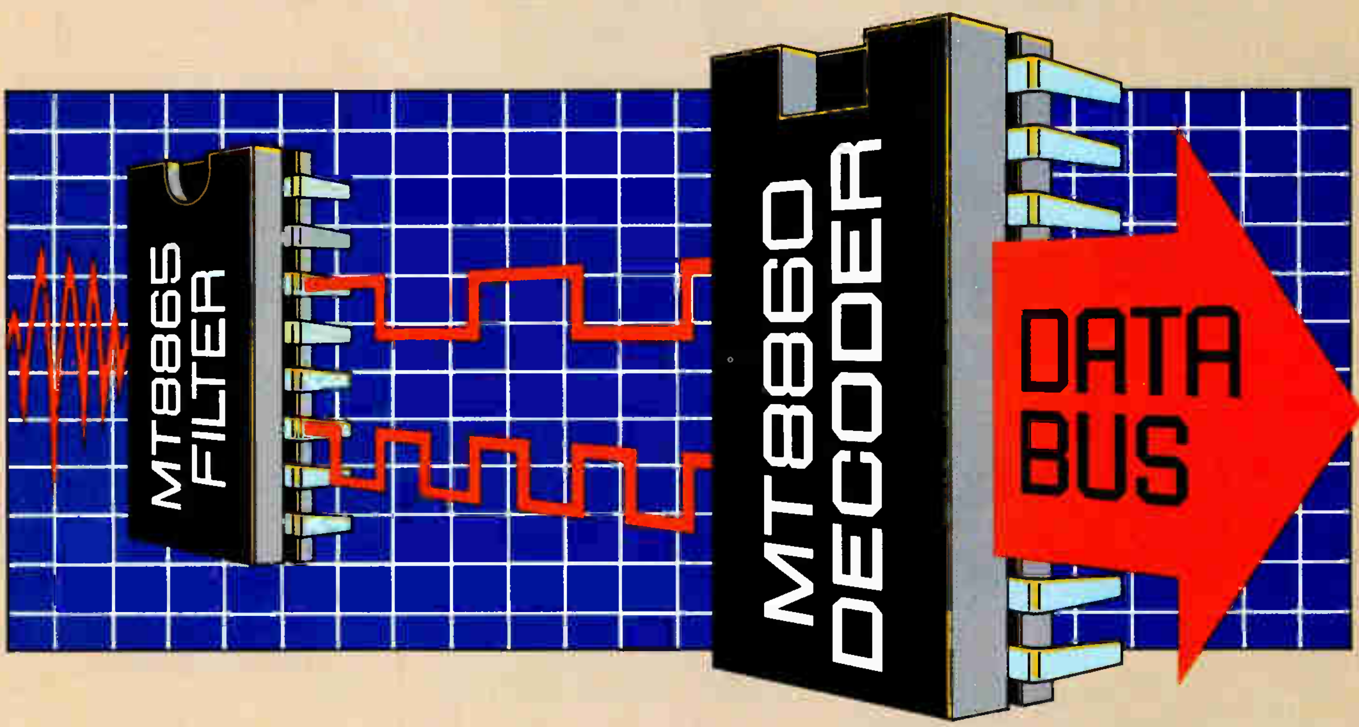

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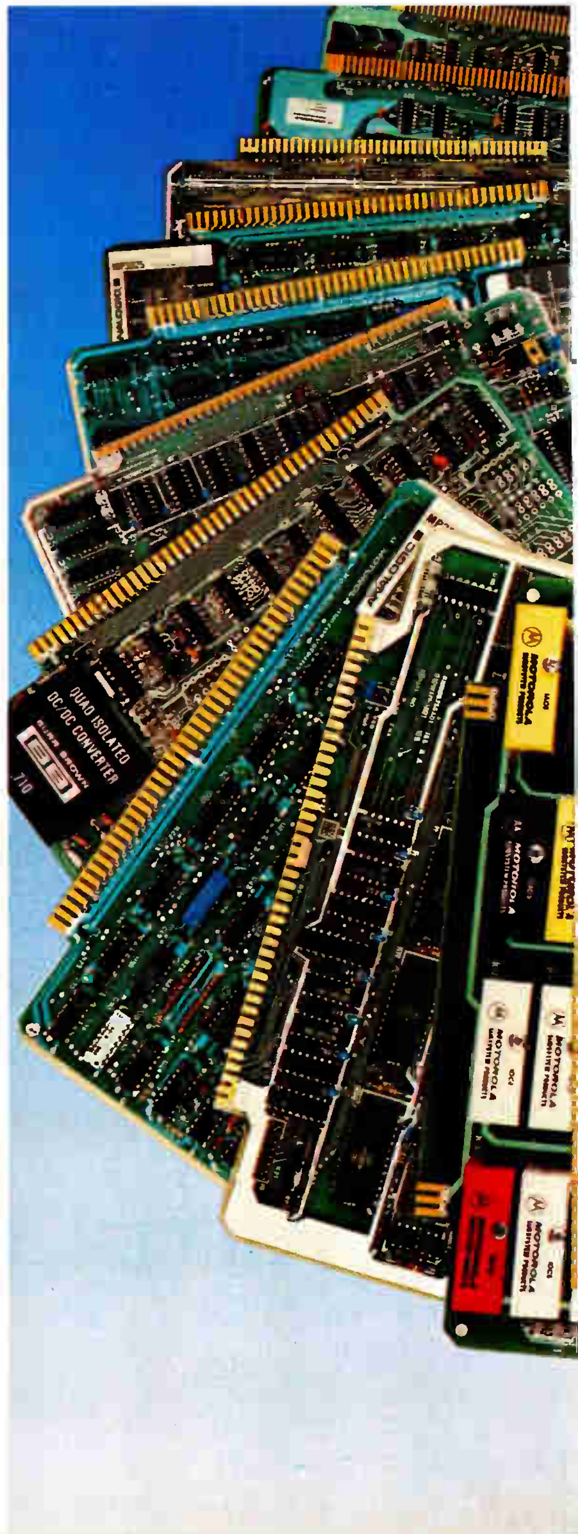

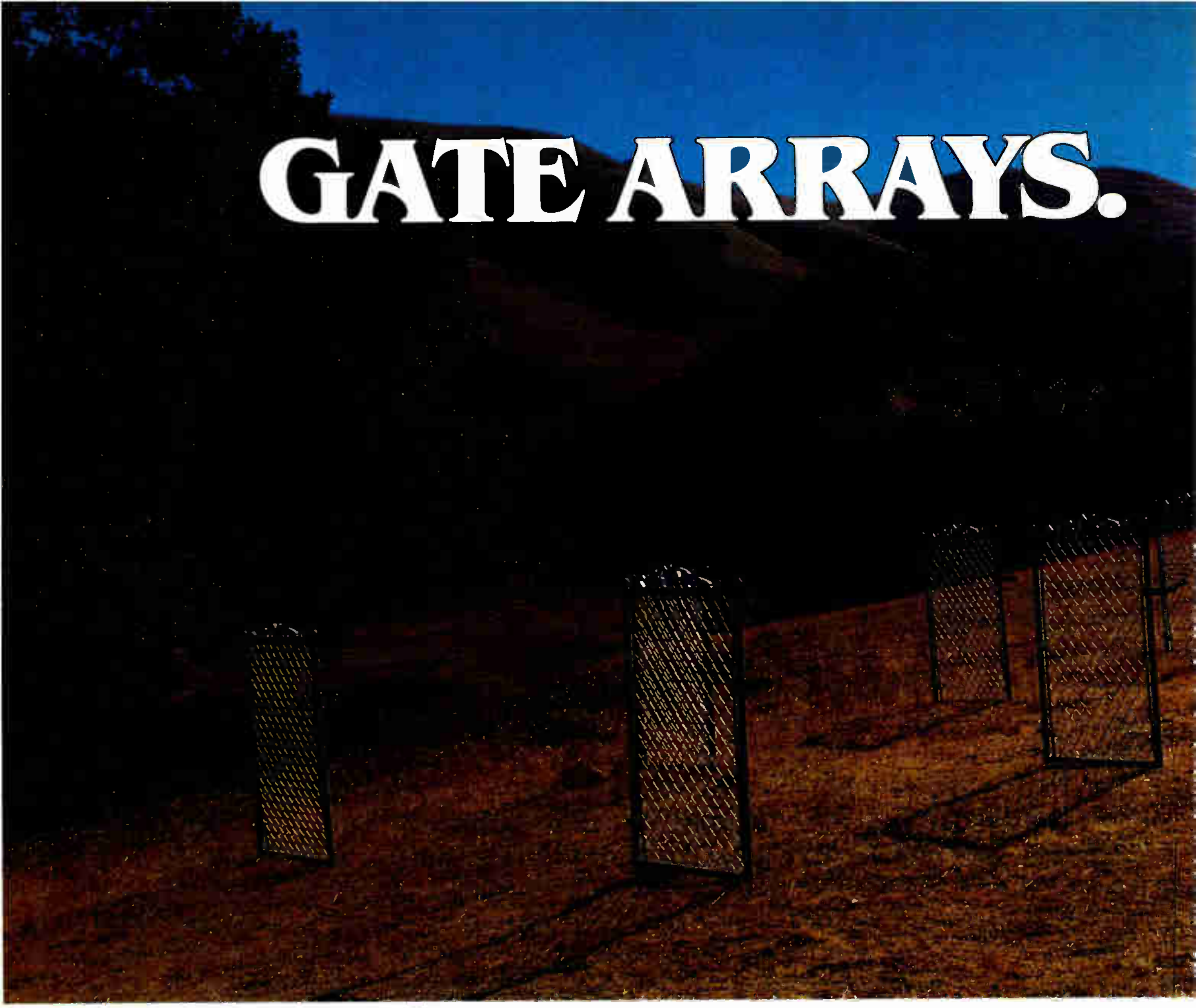

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C-1275	1275	7 nS per gate	12-14 weeks	28 to 42 pin DIP or 64 pin square pack
C-2000	2000	7 nS per gate	13-16 weeks	40 pin DIP or 64 pin square pack
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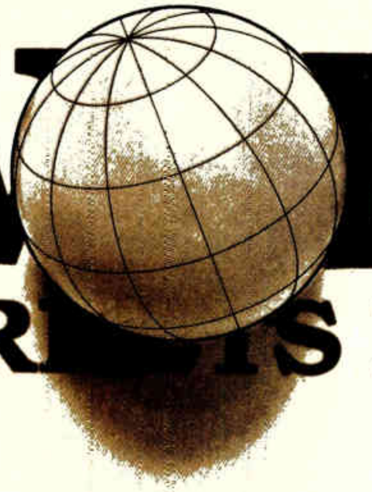
WORLD MARKETS FORECAST



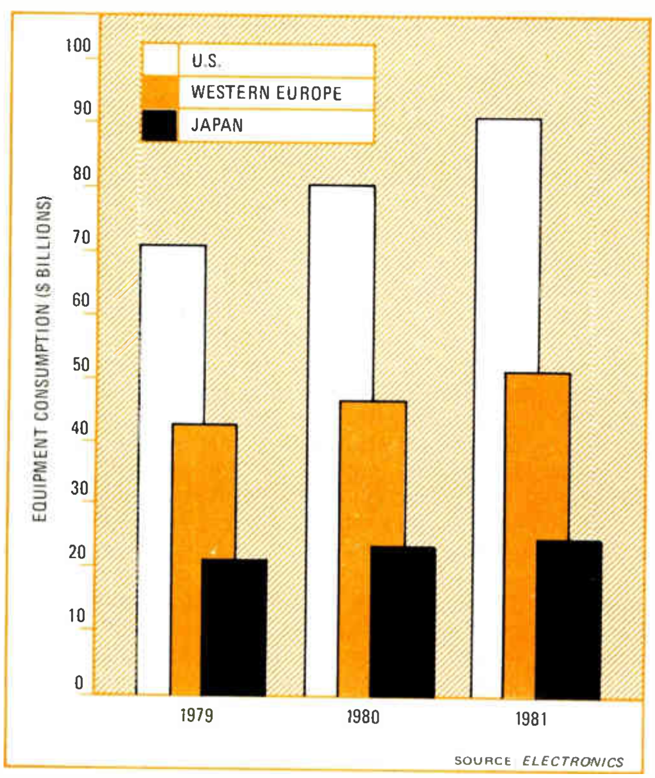
With total equipment consumption of $168 billion forecast, electronics markets will fuel continued growth in 1981, despite a sagging worldwide economy

These are not the best of times, but neither are they the worst. The electronics manufacturers of the three principal industrial regions—the United States, Western Europe, and Japan—once again rang up a better-than-expected year in 1980 despite the economic woes besetting the world.

The coming year, however, will severely test the electronics industries' resistance to recession. The economic outlook ranges from poor (in Europe), to confused (in the U. S.), to so-so (in Japan). Electronics growth rates are generally expected to be flat or to slow, but as usual, there are silver linings. Computers and peripheral equipment, for example, will chalk up substantial gains in all three major markets.

Based on surveys conducted from September through early November, *Electronics*' 1980 estimate for total equipment sales in these three markets is $150 billion, figured in current dollars. That represents a 12% increase from 1979 to 1980, both of which are considered recessionary years.

The picture is much the same for 1981: a grand total of $168 billion for a 12% increase. As for components, including all semiconductors, the combined total in current dollars for 1980 was $38.5 billion, and the forecast for 1981 is a modest 10% to $42.5 billion.



The electronics industries in the United States for the most part sailed through 1980 without a hitch until markets began faltering in the last couple of months. Total equipment consumption, according to the *Electronics* survey, was $80.4 billion, a 12% increase over 1979. Components consumption also gained, reaching $76.4 billion.

But the times, they are a-changing. Entering the new year amid portents of decline, the industry can expect at least half a year of struggle. Nevertheless, the *Electronics* forecast calls for a 13% increase in 1981 in equipment sales to $91 billion. Sensitive to the trends in equipment consumption, components, too, should show gains reaching $18.4 billion. That means good growth for equipment and level growth for components.

On the plus side, inventories are low, thanks to the dampening effect of inflation and the prudence of management. In addition, fairly solid backlogs should cushion the shock of declining orders in the first quarter. Most industry observers agree that the first half will be slow. But when the recovery will arrive is less clear. Some predict that bearishness will peak in April, but true recovery will not be felt until the end of the year. Others prefer to stick to their earlier view that the second half will see the recovery, setting the stage for expansion in 1982.

Generally lagging behind the U. S. economy, Western European countries began the New Year faced with the recession that North America was feeling in the second quarter of 1980. All of the usual economic ills are there—high cost of energy, uncontrolled inflation, high unemployment levels in some countries, and governments strapped for money. The gross national product for the dozen main countries in the region will grow only 1% this year compared with 1.5% in 1980.

As in the U. S., the slumping economies will have an impact on electronics consumption, but in Western Europe, too, growth will be positive. *Electronics'* survey of 11 countries shows a total equipment market of $51.28 billion in 1981. Components will hit $12.28 billion, according to the forecast.

That 9.7% rise for equipment, however, is less than the 10.5% gain registered in 1980. Growth rates are also declining for components. Last year this sector moved up 8.6%, but this year the figure will be a modest 5.8%. Indeed, the decline in European components consumption is contributing to the problems of U. S. companies, which often count on this market to bolster domestic sales.

As it was last year, much of the slower growth is due to the nearly flat markets for consumer electronics, particularly color television sets and radios. The computer and to a lesser extent the communications sectors pulled up the equipment totals.

Although the computer companies are feeling the effects of the slow economy, solid growth, as in the U. S., will still be possible. The reason is that data-processing systems have attained the status of necessities in Europe, thanks to vastly improved price-performance ratios. Thus sales of computers and peripherals should rise 12.4% during 1981.

Counterbalancing that picture, consumer electronics will only keep pace with the general economies. The *Electronics* survey indicates a $14.8 billion total in 1981, which is a mere 6% improvement over 1980, also a slow year.

The situation in Japan is much the same—computers and peripherals, up; consumer, flat. Most nations would like to suffer the 4% gain in GNP that Japan is expecting. But the island nation has problems in pushing up its GNP, being totally dependent on imported oil and also fearful that trade protectionism around the world will stifle its vital exports.

Still, Japan's electronics markets have fared well. In 1980 total domestic equipment consumption increased by almost 13% to $23 billion. This year the gain will be 10%, to $25 billion. Leading the parade will be data-processing equipment. More confident than ever that they can compete on the world market, the Japanese computer firms rolled out a steady line of machines during 1980. This year data-processing and office equipment consumption should surge by nearly 13% to $9.41 billion domestically, providing a springboard for the export markets.

The Japanese communications market, paced by the move to digital exchanges and the usual good growth of facsimile equipment, should again move upward. A gain of 11% to $3.6 billion is projected.

As for the once high-flying consumer sector, hopes for pulling up a better-than-flat year in that area depend on video cassette recorders and video cameras. Of course, the consumer companies rely on exports for their continued growth, and if consumer spending falls off in the U. S. and Europe, the Japanese could be in for hard times.

U.S. MARKETS

Amid economic doubt the industries expect a slow start, but 1981 looks tolerable; prosperity is further off

The United States economy skidded into 1981 with the brakes on. The tenuous recovery that began in the second half of 1980 fizzled out, and the double dip that many economists fear appears to be in the making.

As the year ended, a double-barreled shot—sharply rising interest rates and more oil price increases—hit the economy. Consequently, the predictions made earlier for this year have to be tempered. The original scenario called for a slow first half followed by a recovery in the second half and a full-fledged expansion at the beginning of next year. The real gross national product, according to McGraw-Hill Inc.'s Economics department, was pegged at a very modest 0.9% gain.

Now, however, it looks as though the second half will also be slow and the recovery-to-expansion two-step will not begin until 1982. Compounding the uncertainty is the inauguration of a new Republican Administration headed by Ronald Reagan and a relatively inexperienced White House supporting cast.

Although it appears that most segments of the U. S. industrial complex have been able to adjust to rising energy costs, the 21% prime rate that was announced in mid-December was a backbreaker. Small businesses will be particularly hard hit. But even large manufacturers, if they have not committed funds previously, will hesitate to spend for new plant and equipment.

This cautious pause will have a downward ripple effect on consumer spending as well. Housing starts, which were beginning to look healthy again, will also slow until the prime rate once more begins to drop.

The electronics industries are starting to feel the pain, too. Based on the annual survey conducted by *Electronics*, virtually every product sector simply skipped the 1980 recession, but they may not escape this year's.

Because of the pervasiveness of electronics, it has become fashionable to view the industry as recession-resistant. But the signs of a downturn are flashing red for semiconductors and components and for some computer and consumer equipment. Some industry analysts believe that the bottom will not be reached until April, although there will always be pockets of prosperity for certain high-technology products. Adding to the confusion is the fact that there is considerable venture capital money available.

Thus uncertainty, leaning toward gloom, fills the air. As a result, the numbers forecast for this year should be read with caution. These figures were taken in a wideranging industry poll during September and October, when business conditions were looking up. Few could have anticipated the rapid deterioration starting in November. Nevertheless, the outlook for the long term is positive. For 1981, it is up, but less up. It is going to be another of those years that, though bearable, most companies will be glad to see past.

COMPUTERS

Market's quick march ignores slow economic tune

Where was the 1980 recession? That's what the computer and peripherals sector of the U. S. markets is asking as it springs off a solid growth year. The total U. S. market for data processing and office equipment in 1980 was $30.7 billion, a gain of 16% over 1979.

The 1981 market is expected to increase in dollar terms by 17%. By 1984, it will shape up to be $61 billion, according to the annual *Electronics* survey. In short, the computer industry, with few exceptions, is outperforming the general economy in this time of recession. This relative strength may be explained by the integral and pervasive role computers now play in business. Computing resources are now considered indispensable to increase efficiency and productivity. To this indispensability add rapidly declining systems costs and the result is that computer systems are still acquired or upgraded with cost savings in mind and may be one of the last areas of expense to be cut. Even so, the market for large-ticket items like big mainframe systems and large distributed-processing systems and networks may flatten during the first half of the year.

However, some segments of the market are still expanding at rates that are significantly greater than the growth of the total market. All small computer systems costing less than $100,000, including minicomputers and superminis, as well as word-processing systems, desktop computers, and personal computers, form a segment that enjoyed a growth rate of 27% last year. This group, which should log a 24% gain in 1981, is expected to become the source of half the dollar volume of the computer industry by mid-decade. Small-business computers, ranging from the Apple II to the low end of the IBM and Hewlett-Packard lines, are not just for small businesses; individuals and departments of large and medium-sized companies are also using them.

Minicomputers, once the superstars in the computer market, with growth rates of 35% or higher for a number of years, have slowed a little to a compound growth of 23%. A compound growth rate of 25% per year is expected over the next four years.

Another segment of the computer market that looks like a good business to be in is building computer systems that are compatible with IBM software and peripherals. This market, pioneered by Amdahl Corp. and including companies like Magnusson Computer Systems, IPL Inc., National Advanced Systems, and Two Pi Corp., is not shown as a separate breakdown in the *Electronics* survey, but recent financial statements report good sales and earnings growth for these firms.

Display market looks good

Display terminals, both intelligent and dumb, are booming. According to Datapro Research Corp., Delran, N. J., "the marketplace has barely been penetrated, the demand is insatiable, and the potential is seemingly endless. Predictions that display terminals will soon become as familiar as telephones or typewriters do not seem unreasonable."

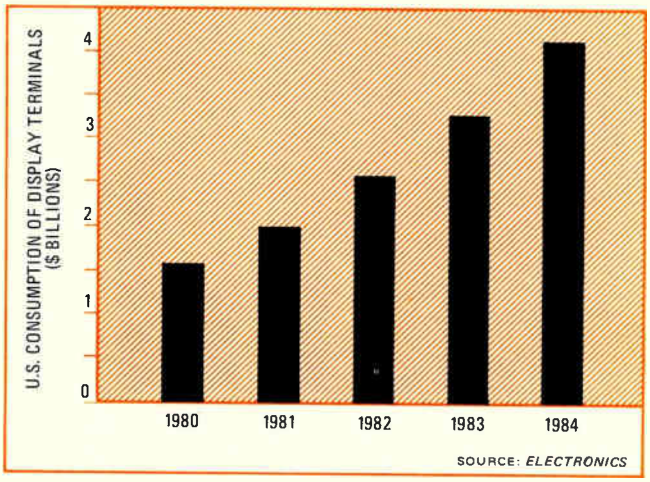
That market in fact expanded about 23% in 1980, should increase 27% in 1981, and then should average 28% from 1982 through 1984 (see chart). As for the entire intelligent segment of the computer terminal market, Creative Strategies International, San Jose, Calif., pegs it at about 32% a year for the early 1980s. And graphics terminals should do even better, increasing at a 35% annual rate, International Data Corp. predicts. The new field of business graphics terminals should hit 65% growth, according to the Waltham, Mass., firm.

Storage peripherals is another area of seemingly unending growth potential. Disk drives of all types and in sizes ranging from 2.52 billion bytes per unit to minifloppy drives are becoming a necessary part of nearly every computer system. As the cost of storing a byte of data on a disk drops ever lower, the price elasticity of the demand shows up and ever greater amounts of disk storage get bought for computer systems. The overall market for rigid-disk drives grew to $2.01 billion in 1980 and will grow by 19% in 1981. It should reach a total of $3.76 billion in 1984.

As expected, the fastest-growing part of the whole disk drive market is the products aimed at small-business computer systems such as the 8- and 5¼-inch Winchester disks and 5¼-in. minifloppy disks. Both these categories of small-disk drives will be growing at a rate of 40% or better during the first part of the 1980s.

One notable exception to the rosy picture was the large system costing more than $1 million. Perhaps the category most likely to feel the recession, this group registered a comparatively small gain of 7% in 1980 but is expected to bounce back with a 12% increase in 1981.

Everywhere. Display terminals, standing alone or in clusters, are showing up in most computer applications, providing a solid growth market for the next five years. The emergence of the integrated electronic office will trigger much of the demand.



CONSUMER

Entertainment and other sectors hold up despite economic pinch

Generally the most sensitive to recessions, the consumer electronics market has held up relatively well. *Electronics*' survey indicates that the total consumer sector, including automotive electronics, grew by 6% last year.

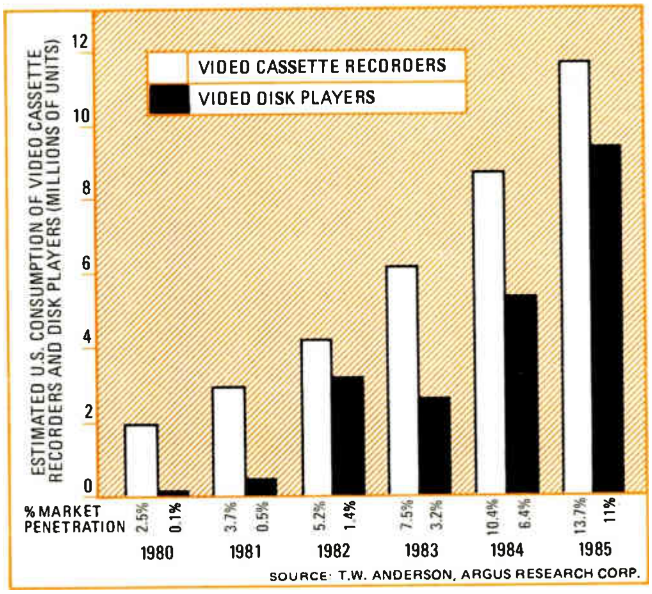
That's not bad for a year marked by so much economic uncertainty. But the sharp increase in interest rates, along with certain rises in oil prices, will dampen consumer spending. Nevertheless, video cassette recorders continue to move, with more than 1 million units expected to be shipped to dealers in 1981. In addition, this year will mark the all-out battle for the video disk player market, with the various manufacturers lining up behind the two capacitive or the one optical system. Furthermore, projection TV finally looks like a serious contender this year as well.

The nonpareil of high-fidelity audio equipment, digital gear, is still off on the horizon. But in the meantime, hi-fi sales look to be healthier than in previous recessions. According to *Electronics*' survey, hi-fi equipment should grow by 4% this year.

Outside the entertainment categories, microwave ranges, calculators, and watches are all slated for a fairly good year. Even within the troubled U. S. automobile industry, electronics is cruising, with $517 million in sales expected for 1981.

Recession-wary television set makers shipped an estimated 9.85 million color units to dealers last year—the second-best performance ever. The main reason for the upsurge is the replacement market—consumers are retiring sets purchased during the big sales years of the late 1960s. In addition, new ways to use color sets, cable TV, and VCRs have made it more desirable to own a unit.

Up and coming. Video disk players are due to enter the marketplace seriously this year and gain rapidly in share of market compared with video cassette recorders. However, it appears that the industry expects tape and disk units to exist side by side.



Video cassette recorders, too, rang up solid gains last year. This year, the total number of installed units will be about 2.89 million, for a market saturation of only a little under 3.9%.

With sales of 75,000 units expected this year, projection TV sets may finally break out of neighborhood bars and restaurants and into consumers' homes. New models will be introduced this year by RCA, Magnavox, Zenith, and Pioneer, to name a few. They will join projection sets already on the market from major firms such as GE, Sony, Panasonic, Advent, and Quasar.

But the most-talked-about video item for 1981 is undoubtedly the video disk player. In March, RCA Corp.'s Consumer Entertainment division will begin sales of its grooved Capacitance Electronic Disk (CED). This first year, RCA expects to sell some 200,000 of the highly touted CED players in competition with Magnavox Consumer Electronics Corp., which previously introduced an optically scanned system.

As in the early days of VCRs, when there were incompatible systems vying, set manufacturers are lining up behind one or the other types. If their 57% share in the color TV market is anything to go by, RCA and its supporters could be the driving force in disk players. The market is still too new to predict at all precisely; however, somewhere between a pessimistic 200,000 and an optimistic 600,000 units are expected to find their way into homes this year.

On wheels

Electronics consumption by the U.S. automobile industry is holding the road. For 1980, the value of nonentertainment electronic systems has been placed at an average of almost $55 for all U.S. cars and light trucks, putting last year's market for electronic systems at about $409 million.

By 1985, when the last of the mandated emission and economy regulations is imposed and more safety and convenience features are in place, the value of the electronic systems should average $308 for an estimated 10 million U.S. vehicles. That means that a total of about $3 billion will be spent by the auto makers on electronic subsystems, according to the forecast of one automotive electronics executive.

The outlook for electronic games is less rosy. Following their introduction in 1977, electronic hand-held and other nonvideo games experienced expansions of 433% to $112 million in 1978 and 289% to $436 million in 1979. Figures for 1980 are portraying a $550 million market for manufacturers and a jump to $666 million in 1981.

As for computers, the home market has been slow to develop. But analysts predict that by 1985 it, too, will open up, partly as an educational aid for children and partly as a source of games.

COMMUNICATIONS

Cost-effectiveness of semiconductors and deregulation feed steady growth

As if to spite those who have been preaching recession for two years now, the communications sector of the electronics industries continues to roll along. At the end of 1980, still-higher interest rates promised anew to put a damper on activity. However, *Electronics*' survey predicts that 1981 will be another growth year for communications equipment, with sales totaling $5.3 billion, 13% above 1980.

What drives the communications industry these days is cheap chips and cheap bits—in other words, the cost-effectiveness of semiconductor device technology. Microprocessors, memory, communications chips, and a myriad of special-purpose devices make possible a range of communications services to the home, office, and factory that were not even imagined only 10 years ago.

Competition grows

In addition, both the original-equipment manufacturer and the communications service user felt the benefits of ferocious competition in 1980. That fire was stoked by the Government's clear desire to reduce regulation to a minimum. Even though there was still no action on the rewrite of the Communications Act of 1934—this landmark legislation must await the incoming Reagan regime and the 97th Congress—the Justice Department and the Federal Communications Commission made lots of moves.

They encouraged giant AT&T to start setting up its unregulated business subsidiary and prodded Xerox, IBM, Satellite Business Systems, and other hopeful purveyors of communications services to look to the 1980s with more optimism. Xerox introduced its much-heralded Ethernet system for interoffice communications, and SBS launched its first satellite after five years of effort and $375 million. AT&T's Advanced Communication Service, however, was still hidden in that company's extensive woodwork, and Xerox's Xten was likewise maintaining a low profile.

Lots of fiber

The three major markets for fiber optics in decreasing order of importance are optical waveguide and cable telephony, computer-to-terminal data communications, and video transmission (see graph). Automobile illumination and signal systems will also be a strong market by the mid-1980s, but they are not so concerned with high-technology, low-loss fibers and sensitive receivers.

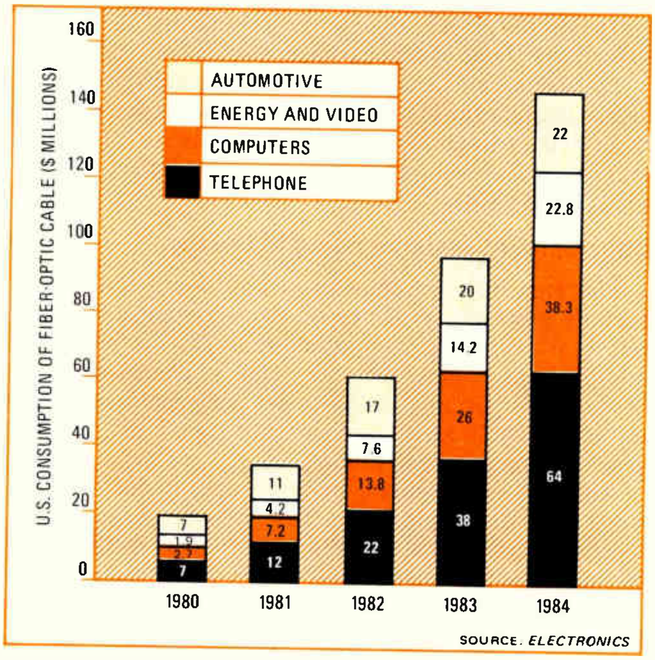
The fiber optics industry continues to grow, since fiber-optic systems have both environmental and bandwidth advantages that copper systems find hard to match. Moreover, as connectors are standardized, and manufacturers slide down their learning curves, their cost continues to decline, and some optical systems are even becoming competitive with copper systems for certain applications. For 1981, the *Electronics* survey predicts that sales of fiber-optic communications systems will be $153 million, a rise of 72% over the $89 million estimated for the year that just ended.

Just starting to develop is a market for universal or almost-universal local networks, so that data for 1980 is not available. Although estimates of the future vary widely depending on the definition of local network, it is clear that such systems, from Ungermann & Bass, Xerox (Ethernet), Zilog, and a swarm of other manufacturers, will stimulate the data-communications business in the years ahead.

Cheap chips and cheap bits help the manufacturers of digital communications equipment to fight off recession, and they are doing a good job of it. For example, satellite earth stations and associated equipment manufacturers will reach a total sales of $189 million in 1981. A particularly bright picture is expected for the makers of private automatic branch exchanges for data switching, who can expect a rise of 36% to total sales of $30 million.

The communications industry, dominated as it is by multimillion dollar satellites; large switching equipment; complicated signal-processing devices; hard-to-install local, national, and international networks; and other capital-intensive equipment, does not react to economic change quickly. Rather, it is extremely concerned with depreciation economics. This concern tends to lessen the impact of new developments like digital technology and fiber optics on rapid industry growth. So, although there is no question that these categories will advance in the 1980s, the process will be slow.

Four users. The fiber-optic waveguide and cable industry supplies the communications community with a diversity of cable types both for high-technology applications in telephony and computers and for light pipe applications, where fiber attenuation is of little concern.



TEST & MEASUREMENT

ATE, development systems, logic analyzers heat up sales

This year's pattern will reverse last year's for makers of test and measurement equipment. The downturn that ended the final half of 1980 will continue into the first half of 1981, but some growth should follow, just as it marked the initial half of 1980, says *Electronics'* survey.

Overall last year, the growth rate was 12%, as instrument makers experienced a rise in U. S. sales of general test equipment to $2.2 billion and of overall equipment to $3.6 billion. This year they expect totals of $2.5 billion and $4.1 billion, respectively, once again an overall 13% increase. Although such growth may seem lackluster compared with what the industry has come to expect, it will easily outperform the economy in general thanks to two factors—the spread of digital electronics and the continuing reliance on increased productivity for increased profitability.

As a result, automated test systems, microprocessor development systems, and logic analyzers will continue to be the hot products. They will account for roughly a third of all general-purpose instrumentation sales and will grow as a group by roughly 24%.

Of the three, automated test systems will grab the largest market share. Production of very large-scale integrated circuits and their consumption by original-equipment manufacturers will add most to sales of automated component test systems this year. Market size should grow by a healthy 19% to $288 million.

However, getting a larger share of the pie will not be easy. While purchasers will be attracted by such features as networking to help them exercise better control on the production floor, they will also be looking for lower-cost systems with better price-performance ratios. Then, too, they will want highly modular systems that can be expanded to keep up with new devices. Add to that the entry into the market of new participants and the scenario for 1981 is one of fierce competition.

The same holds true in the board, or subsystem, test arena. Users want more for less, and though there will be more dollars to go around—$300 million, or 21% more than last year—competition for those dollars will be tougher than ever.

Development systems rising to the top

The area between component and board testing will become more the province of the development system this year. Like the component that gave it birth, the microprocessor development system's phenomenal increase in importance to designers will continue, undeterred by the recession. Sales this year will top last year's, ringing up $218 million.

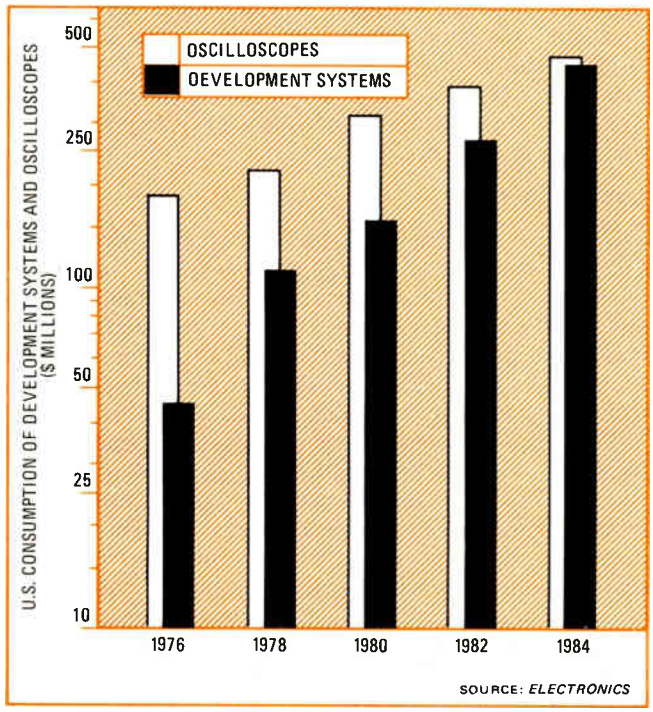
Although that figure is a hefty one, it does not yet wrest the leadership from oscilloscopes. Sales of all scopes will rise some 13% this year to $347 million. But by mid-decade, the crown will change hands.

Actually, the oscilloscope's functions will migrate to both the development system and the logic analyzer, muddying the distinction between the traditional instrument and its newer rivals. This year, new introductions by manufacturers of logic analyzers will spur the sale of those instruments as computer manufacturers and others spend approximately $65.5 million, up 23% from 1980, to stock factory and field depots with these digital tools.

Research facilities will spend 12% more this year—$744 million—for the purchase of analytical instruments. The best performers in this area, in terms of overall volume and percentage increase, should be gas chromatographs and atomic absorption spectrophotometers. This year, sales of gas chromatographs are expected to surpass those of liquid units for the first time, racking up $91 million, or 15% more than in 1980. Sales of atomic absorption spectrographs should rise by 21%, a $9 million increase over last year.

The medical electronics market in general seems headed for a dip in 1981, with a total of $2.45 billion barely keeping up with inflation. Two areas seem extremely robust, however. Sales of ultrasonic diagnostic equipment, increasing faster than those of X-ray equipment, including computerized tomographic scanners, should rise 27% to $272 million. In addition, the growing use of pain-suppression and biofeedback equipment in physical therapy should boost the market for those devices by a hefty 47%, to $157 million this year.

Future developments. The rapidly expanding market for microprocessor development systems, up 24% last year, will rival that for the largest selling instrument, the oscilloscope, by 1984, and surpass it in total sales by the mid-1980s as digital applications expand.



SEMICONDUCTOR

Growth rate slows as economy falters, but computer demands remain firm

Remember late 1979, when, at the last minute, semiconductor industry analysts got cold feet and painted a gloomy picture for 1980? A year later—almost to the day—a sense of *déjà vu* prevails, caused by such concerns as a prime rate that borders on usury, soft pricing of commodity components like memories, and looming overcapacity.

Of course, 1980 was not so bad after all. But the general economy has become so depressed that the resiliency of the semiconductor industry is being tried. *Electronics'* prognosis for 1981 is not as glum as some, but it estimates that the U. S. market in 1981 will grow less than 18%, as opposed to last year's 26%.

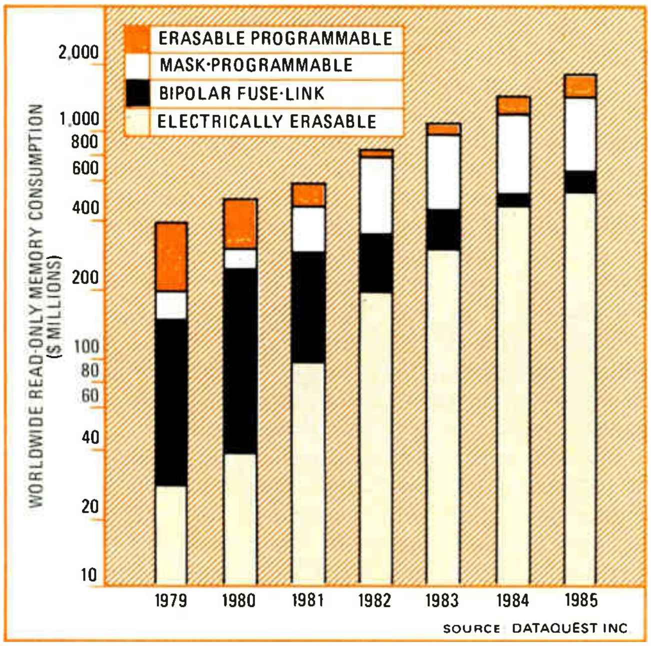
This view resembles that of Merrill Lynch, Pierce, Fenner & Smith Inc., New York, which now predicts a worldwide 1981 growth of 16.5% for semiconductors. Merrill Lynch vice president Michael Krasko notes that computer sales remain strong and that semiconductors follow the demand for end equipment.

Integrated-circuit consumption—up 20% to $5.8 billion in 1981—will, as usual, represent the fastest-growing segment of the U. S. solid-state market. Domestic consumption of optoelectronic components, too, will experience a sharp 15% increase to $330 million this year as emerging markets like telecommunications and office data processing increase their IC usage.

The discouraging news about dynamic random-access memories is a very soft market. The 64-K RAM is still expected to be, by 1984, the world's first billion-dollar component, but it will take a lot of unit sales to get there. The reason: in mid-1980, the general prediction was that the average selling price of a 64-K RAM would be $40 in 1981 and $25 in 1982, but those numbers are on their way to becoming half of what was expected, says Rosen Research Inc. of New York. Now it is all but certain that the average selling price for a 64-K RAM will wind up in the teens before 1982. As for the 16-K RAM, it currently sells for less than $2.50 in the U. S. and less than $2 in Japan.

Pricing of erasable programmable read-only memories has been equally disappointing for chip makers. A recent research brief from Goldman, Sachs & Co., New York, noted that the price of a 16-K E-PROM fell 75% in 1980, from about $19 to about $4.75. The new 32-K E-PROM, which began last year with an average selling price of over $100, crashed even harder to its current quotation of only $12—a 90% decline.

Converging. The worldwide markets for erasable- and mask-programmable read-only memories will brush each other in about 1982. Similarly, consumption of electrically erasable memories will ramp up to meet bipolar fuse-link ROM usage in 1984.



Slower expansion

As for bubble memories, development of the market will not be as swift as once anticipated, says Venture Development Corp. of Wellesley, Mass., in a recently revised report. It now predicts that worldwide bubble memory shipments will rise from $18.4 million in 1980 to $226 million in 1985—an average annual increase of 65%. It adds that fixed-head disk drives may be displaced by bubble memories in 1984 if the latter's price drops down to the range of 15 millicents per bit.

Microprocessors and microcomputers, for their part, will fare well the coming year, especially the high-performance units. Sales of 16-bit microprocessors, which now stand at $37.5 million, will increase to $75 million by the end of 1981. Single-chip microcomputers are expected to outpace multichip systems as large-scale integration puts more useful functions on each die.

Growing as fast or faster than the sales of the processors themselves are those for the peripheral and support chips that mate with them. International Resource Development Inc. of Norwalk, Conn., figures that while MOS microprocessors will enjoy a compound annual growth rate of 35% from 1979 to 1989, LSI support circuits will average a 37% rise.

In some areas, market figures for TTL circuits show signs of the competition from high-speed MOS ICs. For example, in static RAMs the increase for MOS units is an anticipated 24%, whereas bipolar counterparts will lag with an 18% gain. Likewise, standard TTL, Schottky, and low-power Schottky small- and medium-scale integrated logic families are feeling the crunch from fast new complementary-MOS parts.

Certain bipolar devices, such as those based on emitter-coupled logic, continue to be sought after for the most demanding applications. Besides memories and logic circuits, the market for ECL gate arrays will also broaden, along with the gate-array market in general.

COMPONENTS

Hybrid and modular components lead several sectors to high ground

For component makers as a whole, modesty—in terms of sales growth—is indeed a virtue, given the lackluster general economy. So last year's dollar gain of nearly 8% can be seen as cause for satisfaction, if not joy.

Within this market, the performance of such basic components as resistors and capacitors varied significantly, with increases of almost 4% and 7%, respectively. Some resistor segments, like carbon-film types, even experienced declines. But sales of thick- and thin-film resistor networks and of chip resistors and capacitors were more healthy, a reflection of the increasing importance of hybrid integrated circuits.

In fact, despite the overall modesty, hybrid and modular component sales for 1980 were up some 24% over 1979, going from $182 million to $226 million; *Electronics* projects a further 23% increase this year and then nearly 79% through 1984. Even more notably, data-conversion products should grow in sales over 100% between 1981 and 1984, paced by hybrid and modular digital-to-analog and analog-to-digital converters.

Sales of high-frequency microwave components remained strong, supported by an expansion of communications applications into yet-higher-frequency bands. This can be seen from the roughly 13% sales increase for microwave hardware from 1979 to 1980 and the whopping gain of 62% for high-frequency power and special-purpose tubes. In contrast, electron tube sales for 1980 grew by a meager 4% and 1980 sales for traditional receiving tubes were down from the previous year by more than 9%.

Displays also rode out the recession last year. The $246 million 1980 market for readout devices grew a respectable 16% over 1979's sales of $212 million, with multiple-character liquid-crystal and dot-matrix gas-discharge displays leading the way. *Electronics*' survey estimates that both types of display will increase in sales by more than 50% from 1981 to 1984, going from $54.5 million to $87 million and $47.4 million to $72 million, respectively. Single-character light-emitting-diode displays should garner larger market shares of incandescent and fluorescent displays.

The market for switches of all types remained relatively solid, increasing some 10% last year, up from 1979's sales of $644 million to last year's $710 million. Total switch sales should grow more than 35% between 1981 and 1984.

PACKAGING & PRODUCTION

IC-processing gear grows with VLSI; pc board sales to double by 1984

Yet another sector of the U. S. electronics industries whose market has defied recession—so far—is packaging and production. Among the brightest growth prospects in this area belong to integrated-circuit processing equipment like sophisticated electron-beam and optical projection aligners, plasma etchers, ion implanters, and automatic wire bonders. This entire industry is in a state of expansion.

Electronics' survey estimates that the U. S. market for semiconductor production and test equipment in 1980 was $917 million and forecasts an annual growth rate of 17% for 1979–84. That would lead to about $2.25 billion in sales for IC-processing equipment by 1984.

Equipment for lithography—wafer steppers, 1:1 projection systems, electron-beam systems—dominates the capital investment list, often representing more than 50% of a company's expenditures on wafer fabrication equipment. Machines of this type, whose prices range from $500,000 to $1.5 million, are a key element in making large-scale and very large-scale integrated circuits. They, too, should see about a 17% growth rate per year, lasting into the late 1980s.

There is one important snag, however. If interest rates remain high, as predicted, financing these lithography systems—or any other expensive IC equipment, for that matter—will become extremely difficult. Sky-high interest rates could slow or even reverse the growth potential of the manufacturers of such gear.

On the interconnection front, the important printed-circuit market continues to expand at about a 20% to 25% rate. Last year's total pc board sales of $1.4 billion should almost double by 1984. Single-sided pc boards, a relatively small market, will grow only at about a 4% rate, whereas two-sided board sales will increase more than two thirds by 1984. In the vital multilayer area, 1980's sales of $375 million should rise to $650 million by 1984. According to Gnostic Concepts Inc. of Menlo Park, Calif., the multilayer board's share of the pc market should rise from 24% in 1979 to 30% in 1984.

Tied in with the pc board is the dual in-line socket, which represents a $150 million market, with about a 22% growth per year projected to 1984. The IC socket panel should experience a similar growth.

For connectors in general, sales were up only slightly in 1980 from 1979, with the exception of the flat-cable connector market, where a growth of 11% occurred. Long range, the connector industry, according to market analyst Merrill Lynch, Pierce, Fenner & Smith Inc., New York, should grow at an average annual rate of 13.5% during 1979–84.

INDUSTRIAL

Ill winds blow some good to makers of energy management, industrial control systems

Cautious is the word for the outlook for electronics in industrial process and machine tool controls, as well as building management systems, in the face of the uncertainties about the business climate. Budgeted plans, particularly those committed when interest rates were lower, will go ahead. However, new equipment purchases being considered will most likely be postponed until interest rates come down. Overall, *Electronics*' survey pegs the industrial sector at $3.26 billion this year, a 15% gain over 1980.

The effects of the continuing energy crisis have their brighter side. For example, the market for process control equipment, about $702 million in the U. S. in 1980, is enjoying a flurry of activity as petrochemical and utility companies convert and refurbish existing facilities to accommodate a changing mix of fuels. According to the U. S. Department of Commerce, the process control industry will experience a real compound annual growth of 10% through 1985, making it the fourth-fastest-growing industry—behind aircraft, machine tools, and industrial heating. Fueling this expansion is the fact that process control gear often pays for itself within a year.

Within this category is the programmable sequence controller, sales of which grew by about one third in 1980 over 1979—to about $202 million—and should increase about another 28% this year. Depending on the complexity of the task to be performed, some are microprocessor- or even minicomputer-based and others use discrete solid-state logic requiring no computer programming knowledge on the part of a technician. For sequence controllers as a group, programmable and hardwired, total sales were $216 million for 1980, could climb to $272 million this year, and should continue to grow at a compound annual rate of 11% through 1985.

Numerically controlled machinery is another area where manufacturers can expect a quick return on investment. About 32% of the dollars spent for metal-cutting machinery, or $1.24 billion, will go for such equipment in 1981. Of this amount, about $100 million represents the value of electronics—up 10% over last year. This gain is but one component of the machine tool market which is feeling the impact of microelectronics as it becomes increasingly economical to add electronic controls to ever simpler machines.

Although the market for electronic energy management systems is difficult to define, since it overlaps with fire and security systems, *Electronics* estimates that $190 million was spent in 1980 in this area. With Government tax incentives stimulating the market, reluctance to part with money that does not go directly into increasing manufacturing output is beginning to fall away. Nevertheless, as an area of application for energy management systems, the industrial community ranks after schools, offices, public buildings, and hospitals.

A much smaller market, although one with tremendous growth potential, is that of industrial robots. That market was $45 million in 1979 and shot to $60 million in 1980. The 1980 figure represents about 1,500 robots, for a total of about 4,000 robots in operation.

FEDERAL

Growing electronics percentage hitches up with rising defense expenditures

The proportion of electronics in weapons and military support systems is climbing steadily, and so, too, are outlays for defense electronics. Of the $25.3 billion to be spent on electronics by all Federal agencies in calendar 1981, the military's share will be $23.3 billion—a gain of $2.2 billion from last year that more than offsets the relatively flat demand of some other agencies.

The consensus among Federal budget specialists is that the new Reagan Administration will be unable to raise significantly the military electronics total before 1982, even if it does restore development of a strategic bomber to replace the B-1 canceled in 1977 by President Carter. One Pentagon budgeteer points out that even if money for technology is increased, the services might have difficulty in spending it on new programs with contractors that already have large backlogs and are short of personnel.

The effort to improve defense readiness in the near term will be reflected in some significant increases in electronics procurement that will top $12 billion in 1981, a 17% growth, with the biggest gains coming in strategic missiles and space systems, communications and intelligence, and ordnance. These accounts will rise by 22%, 21%, and 18%, respectively, compared with 1980. Emphasis on readiness will also be reflected in a 10% rise in operations and maintenance funds for electronics. Paying part of the price for these increases will be funds for research, development, test, and engineering, which will rise by a mere 4% to just under $7.2 billion.

Also suffering will be expenditures on the National Aeronautics and Space Administration's Civilian Space Program, still a low congressional priority, as well as on education, energy, and health care electronics programs. Federal Aviation Administration programs will fare somewhat better than the others, but not much. The long-term FAA outlook is brighter as the agency begins to upgrade its national air-traffic control network. □

U. S. MARKETS FORECAST 1981

Market estimates represent industrywide consumption (at the factory level) of goods shipped by U.S. and foreign manufacturers for the U.S. market. Some product categories have been added, deleted, or redefined. Therefore, these totals are not directly comparable to those of previous years.

COMPONENTS

(millions of dollars)	1979	1980	1981	1984
COMPONENTS, TOTAL	**9,225.5**	**10,094.0**	**10,924.4**	**14,438**
Resistors, total	**769.7**	**803.3**	**832.1**	**1,028**
Fixed, total	236.4	238.7	240.6	277
Composition	62.3	62.6	60.0	63
Deposited carbon film	23.1	21.0	20.5	26
Metal-film	79.0	81.0	83.0	102
Wirewound	72.0	74.1	77.1	86
Variable, total	279.2	285.6	297.0	346
Potentiometers, wirewound	50.0	51.0	55.0	65
Potentiometers, nonwirewound	109.7	112.0	115.0	135
Trimmers, wirewound	24.5	25.5	27.0	31
Trimmers, nonwirewound	95.0	97.1	100.0	115
Thermistors	56.5	60.2	64.3	76
Resistive networks, total	177.6	197.8	205.0	279
Thin-film	79.0	88.0	90.0	116
Thick-film	98.6	109.8	115.0	163
Chip	20.0	21.0	25.2	50
Capacitors, total	**1,004.8**	**1,105.4**	**1,180.2**	**1,463**
Paper	89.3	90.4	94.0	102
Film	119.0	121.4	125.6	132
Electrolytic, total	364.0	407.0	432.9	483
Aluminum	181.0	205.7	211.4	226
Tantalum	183.0	201.3	221.5	257
Mica	31.0	33.1	34.7	39
Glass and vitreous enamel	8.7	10.1	11.7	12
Ceramic (except chips)	310.7	346.4	368.7	541
Variable	27.7	29.0	31.0	37
Chip	54.4	68.0	81.6	117
Relays, total	**499.0**	**547.4**	**593.6**	**734**
General-purpose	177.3	195.0	219.7	297
Telephone-type	34.0	36.7	40.1	48
Crystal-can	78.0	88.2	93.1	103
Rf	97.0	98.6	101.0	107
Reed	41.5	47.2	51.4	66
Stepping and impulse	4.6	4.2	4.0	3
Time-delay	31.1	35.5	37.3	44
Solid-state	35.5	42.0	47.0	66
Switches, total	**643.6**	**710.1**	**782.4**	**1,059**
Small-movement snap-action	84.5	88.5	93.7	108
Lighted	89.0	94.1	105.1	157
Push-button	100.0	109.4	117.3	150
Toggle	30.2	33.2	36.7	48
Slide	50.6	56.6	62.7	80
Rotary	91.7	100.5	108.7	135
Coaxial	22.0	25.1	28.4	42
Thumbwheel	26.0	27.5	30.3	40
Dual in-line	30.6	36.2	40.0	54
Keypads and keyboards, total	95.0	109.9	124.2	183
Single-key	15.0	16.4	18.5	26
Keyboard assemblies (incl. capacitive)	80.0	93.5	105.7	157
Solid-state (incl. Hall-effect)	24.0	29.1	35.3	62

(millions of dollars)	1979	1980	1981	1984
Magnetic, total	**552.1**	**556.6**	**567.1**	**618**
Ferrite components (coil forms, cores, etc.)	63.0	50.4	41.1	9
Power transformers, total	298.0	316.2	328.9	392
Laminated	193.2	205.3	210.4	240
Toroidal	62.3	65.2	68.5	82
Pulse	42.5	45.7	50.0	70
Af and rf transformers, coils, and chokes	14.7	13.0	12.7	9
TV magnetic components (yokes and flybacks)	176.4	177.0	184.4	208
Electron tubes, total	**1,334.6**	**1,392.7**	**1,451.3**	**1,659**
Receiving	104.3	94.5	78.3	50
Power and special-purpose, total	437.8	464.8	498.9	592
High-vacuum	77.1	81.3	85.4	99
Gas and vapor	22.5	23.8	25.0	29
Klystrons	55.2	58.7	62.0	69
Magnetrons	54.5	58.4	62.5	76
TWTs (incl. backward-wave)	116.1	126.3	141.7	176
Light-sensing (incl. photomultipliers)	16.0	17.3	18.2	21
Image-sensing (incl. vidicon and orthicon)	38.6	41.2	44.2	55
Storage	10.5	8.5	7.8	5
Cathode-ray (except TV)	47.3	49.3	52.1	62
TV picture, total	792.5	833.4	874.1	1,017
Black and white	30.5	29.1	24.0	13
Color	762.0	804.3	850.1	1,004
Microwave hardware, total	**159.8**	**179.8**	**190.5**	**264**
Mixers	11.7	12.5	14.1	47
Detectors	7.5	8.3	9.4	11
Amplifiers	29.8	35.0	36.9	45
Passive components, total	42.0	46.0	47.4	55
Waveguide	9.0	10.0	10.6	13
Coaxial and strip-line	33.0	36.0	36.8	42
Switches, total	34.8	38.0	43.2	64
Waveguide	11.8	13.0	14.5	22
Coaxial and strip-line	23.0	25.0	28.7	42
Ferrite devices	27.0	32.3	32.0	35
Power limiters	7.0	7.7	7.5	7
Readout devices, total	**212.0**	**246.7**	**284.9**	**403**
Single-character, total	49.1	53.8	58.6	75
Incandescent	4.8	5.0	5.3	6
Fluorescent	2.3	2.6	2.8	3
Light-emitting-diode	42.0	46.2	50.5	66
Multiple-character, total	162.9	192.9	226.3	328
Gas-discharge, total	72.0	84.3	98.4	149
Segmented	38.5	44.1	51.0	77
Dot-matrix	33.5	40.2	47.4	72
Fluorescent	6.1	7.1	8.0	10
Light-emitting diode	53.2	60.6	65.4	82
Liquid-crystal	31.6	40.9	54.5	87
Transducers (electronic), total	**195.7**	**217.7**	**243.3**	**344**
Pressure (incl. air, liquid, mechanical)	53.0	58.3	64.8	89
Temperature (exc. thermocouples, thermistors)	36.9	44.3	53.3	93
Motion, linear (acceleration and displacement)	31.8	33.4	35.2	41
Motion, angular (acceleration and position)	30.0	32.1	34.1	41
Vibration	44.0	49.6	55.9	80
Crystals, total	**105.1**	**110.2**	**114.3**	**132**
Discrete, total	43.1	46.2	48.2	60
Communications	29.0	33.0	35.1	43
Color TV	2.7	2.8	2.7	3
Watches	7.1	6.0	5.5	5
Other	4.3	4.4	4.9	8
Assemblies (incl. mounts and ovens)	62.0	64.0	66.1	72
Passive filters and networks, total	**336.4**	**363.2**	**384.9**	**476**
Rectifier assemblies	177.2	183.5	188.7	210
LC filters	42.0	42.8	43.2	45
Electromechanical filters, total	46.3	51.2	53.7	64
Crystal	34.5	39.0	40.6	46
Ceramic	8.5	8.7	9.1	12
Other	3.3	3.5	4.0	6
Rfi and emi filters	44.4	53.2	59.7	84
RC networks	13.0	14.5	15.9	21
Delay lines	13.5	18.0	23.7	52
Hybrid and modular components, total	**182.1**	**226.1**	**279.2**	**498**
Operational amplifiers	36.0	38.1	40.2	54
Instrumentation and isolation amplifiers	13.0	15.7	20.0	31
Data conversion, total	88.1	114.6	146.6	297
D-a converters	43.0	56.0	69.9	130
A-d converters	31.0	39.1	51.0	109

(millions of dollars)	1979	1980	1981	1984
Multiplexers	5.0	6.8	8.8	15
Sample-and-holds	5.0	6.8	8.9	18
Converter subsystems	4.1	5.9	8.0	25
Analog-I/O (data-acquisition) boards	11.2	16.0	21.0	32
Functional circuits	16.9	18.7	20.0	23
Signal sources (incl. oscillators)	2.6	2.8	3.2	5
Active filters	10.2	12.0	13.2	18
Miscellaneous custom functions	4.1	8.2	15.0	38
Connectors, total	**1,164.0**	**1,231.3**	**1,303.8**	**1,700**
Coaxial, total	77.0	78.5	83.7	105
Standard	55.5	56.0	59.2	70
Miniature	21.5	22.5	24.5	35
Cylindrical, total	237.8	249.5	264.4	323
Standard	72.1	75.5	80.0	86
Miniature	102.7	107.5	111.4	126
Subminiature	63.0	66.5	73.0	111
Rack-and-panel	214.0	233.1	244.8	317
Printed-circuit edge connectors, total	395.2	402.4	417.2	519
Card-insertion	245.0	250.0	255.7	316
Two-piece, metal-to-metal	150.2	152.4	161.5	203
Flat-cable	93.8	106.5	122.9	207
Fiber-optic	4.0	6.0	8.1	20
Flexible-circuit	7.0	7.8	8.2	9
Special-purpose	135.2	147.5	154.5	200
Printed circuits and interconnection systems, total	**1,478.8**	**1,768.7**	**2,004.0**	**3,133**
Printed circuits, total	1,153.6	1,402.9	1,562.3	2,341
Rigid boards, total	1,087.3	1,329.4	1,479.7	2,225
Single-sided	124.3	129.4	139.7	180
Double-sided	641.0	825.0	910.0	1,395
Multilayer	322.0	375.0	430.0	650
Flexible circuits	66.3	73.5	82.6	116
Interconnections, total	325.2	365.8	441.7	792
Sockets and socket panels for DIPs	202.0	221.0	275.0	537
Backplanes	123.2	144.8	166.7	255
Wire and cable, total	**587.8**	**634.8**	**712.8**	**926**
Coaxial cable	160.0	172.5	194.1	243
Flat cable	135.0	150.0	180.0	241
Hook-up wire	133.1	137.2	144.6	158
Multiconductor, shielded	89.2	97.6	107.9	139
Multiconductor, unshielded	56.5	58.0	59.1	64
Fiber-optic cable	14.0	19.5	27.1	81

SEMICONDUCTORS

(millions of dollars)	1979	1980	1981	1984
SEMICONDUCTORS, TOTAL	**5,036.9**	**6,326.3**	**7,436.9**	**12,704**
Discrete semiconductors, total	**1,136.8**	**1,216.6**	**1,316.3**	**1,693**
Diodes, total	442.8	482.0	526.4	683
Signal	48.2	51.1	54.2	60
Rectifier	218.6	245.5	270.6	330
Arrays	13.5	13.9	14.8	18
Zener, total	113.4	118.5	129.3	198
Voltage regulator	88.3	91.5	98.2	156
Reference	25.1	27.0	31.1	42
Special-purpose, total	49.1	53.0	57.5	77
Microwave	40.0	43.2	47.3	65
Varactor (less than 1 GHz)	8.0	8.6	9.0	11
Tunnel	1.1	1.2	1.2	1
Transistors, total	562.5	589.9	627.9	804
Bipolar, total	514.4	534.1	566.5	698
Small-signal (less than 1 W)	180.1	185.0	189.4	203
Power (1 W or more)	240.2	245.1	258.9	355
Duals and arrays	10.0	9.0	9.1	8
Rf	84.1	95.0	109.1	132
Field-effect, total	48.1	55.8	61.4	106
Junction, total	26.7	27.8	28.8	36
Small-signal (less than 1 W)	26.0	27.0	28.0	35
Power (1 W or more)	0.7	0.8	0.8	1
MOS, total	21.4	28.0	32.6	70
Small-signal (less than 1 W)	15.4	16.0	17.0	20
Power (1 W or more)	6.0	12.0	15.6	50

(millions of dollars)	1979	1980	1981	1984
Thyristors	131.5	144.7	162.0	206
Protection devices (incl. varistors)	17.3	17.5	20.1	29
Integrated circuits, total	**3,626.5**	**4,804.2**	**5,770.3**	**10,399**
Standard logic families, total	1,047.9	1,298.0	1,501.5	2,215
RTL	4.2	4.0	3.7	4
DTL	20.0	16.0	12.0	9
TTL, total	728.5	893.9	1,004.0	1,388
Standard TTL	408.0	428.5	432.0	440
Schottky TTL, total	320.5	465.4	572.0	948
Standard (S)	106.7	150.4	179.0	280
Low-power (LS)	213.8	315.0	393.0	668
ECL	56.5	74.0	91.0	188
C-MOS	238.7	310.1	390.8	626
Microprocessor, microcomputer families, total	385.5	576.7	795.2	1,749
Microprocessors, total	107.5	166.2	254.9	646
MOS, total	92.4	138.1	213.4	576
8-bit	68.4	100.6	138.4	299
16-bit	24.0	37.5	75.0	277
Bipolar, total	15.1	28.1	41.5	70
Bit-slice	12.4	22.1	33.0	48
Full CPU	2.7	6.0	8.5	22
One-chip microcomputers, total	169.0	252.5	348.7	693
4-bit (controllers)	80.0	100.0	122.3	180
8-bit	81.0	121.5	160.4	283
16-bit	8.0	31.0	66.0	230
LSI peripheral chips, total	109.0	158.0	191.6	410
Support devices	36.0	52.2	63.8	121
Peripheral equipment controllers	73.0	105.8	127.8	289
Dedicated LSI circuits	185.5	257.0	309.6	617
Semicustom logic (incl. gate arrays, etc.)	26.2	47.1	58.8	193
Memories, total	1,307.3	1,840.2	2,194.1	4,029
Random-access, total	734.7	1,103.7	1,287.5	1,865
Dynamic, total	385.6	636.2	733.8	884
4-K	91.5	38.8	18.4	1
16-K	283.5	490.1	548.2	311
32-K (partial or hybrid)	9.2	87.1	104.0	76
64-K	1.4	20.2	63.2	472
256-K	0.0	0.0	0.0	24
Static, total	349.1	467.5	553.7	981
Bipolar	123.0	147.6	163.8	211
n-MOS, total	199.1	244.4	287.6	413
Fast (less than 70 ns)	78.8	103.2	128.0	201
Slow	120.3	141.2	159.6	212
C-MOS	27.0	75.5	102.6	357
Read-only, total	522.1	667.5	824.4	1,963
Mask type	136.3	174.9	210.6	503
Fuse-link type, bipolar	138.8	166.5	198.0	315
Erasable programmable type, total	247.0	326.1	415.8	1,145
Ultraviolet (E-PROM)	230.6	296.1	358.5	901
Electrical (EE-PROM)	16.4	30.0	57.3	244
CCDs (memory only)	14.5	21.5	27.0	38
Magnetic-bubble (incl. support circuits)	36.0	47.5	55.2	163
Linear ICs, total	674.1	785.2	911.1	1,596
Analog switches	37.1	39.0	41.1	53
Operational amplifiers	130.0	154.7	172.0	300
Instrumentation and isolation amplifiers	6.0	7.9	10.0	20
Comparators	23.0	26.0	28.2	50
Voltage regulators	52.0	59.4	72.0	100
Timers	48.0	52.0	66.6	77
Other (incl. functional ICs)	12.0	13.5	15.0	30
Data conversion, total	116.5	151.7	196.8	430
D-a converters	58.5	77.5	100.7	260
A-d converters	34.5	47.5	64.1	120
Multiplexers	15.5	17.5	21.0	31
Sample-and-holds	8.0	9.2	11.0	19
Interface	68.0	90.0	103.0	215
Communications	60.0	72.0	85.7	139
Entertainment	121.5	119.0	120.7	182
Consumer product ICs, total	221.0	272.0	311.0	506
Calculator chips	54.0	50.0	46.0	31
Watch chips	60.0	68.0	65.0	75
Game chips	55.0	75.0	100.0	200
Other (incl. cameras, toys, organs, etc.)	52.0	79.0	100.0	200
Optoelectronic devices, total	**256.3**	**288.0**	**330.2**	**583**
Photovoltaic (solar) cells	15.0	17.0	22.0	45
Photoconductive cells	9.5	11.0	13.0	23
Light-emitting diodes (discrete)	155.0	170.0	190.0	300
Laser diodes	3.3	5.5	8.0	18
Photodiodes (incl. arrays)	9.0	10.5	12.7	25
Phototransistors (incl. arrays)	17.0	18.0	20.0	35
Optically coupled isolators	47.5	56.0	64.5	137

INDUSTRIAL AND COMMERCIAL MARKETS

(millions of dollars)	1979	1980	1981	1984
INDUSTRIAL AND COMMERCIAL, TOTAL	**39,202.4**	**45,079.6**	**52,235.1**	**83,764**
Test, measuring, and analytical instruments, total	**3,213.3**	**3,611.0**	**4,068.2**	**6,011**
General test equipment, total	**1,920.6**	**2,188.5**	**2,503.9**	**3,763**
Analog voltmeters, ammeters, multimeters	15.5	15.0	14.5	14
Digital multimeters, total	75.0	87.6	95.9	126
3½-digit and below	27.0	34.2	38.0	53
4½-digit and above	48.0	53.4	57.9	73
Multimeter probes and accessories	3.5	3.9	4.1	9
Panel meters, total	112.6	122.5	129.0	144
Analog	81.6	88.0	92.0	100
Digital	31.0	34.5	37.0	44
Counters, time and frequency	69.7	76.7	86.0	125
Microprocessor development systems	129.8	161.7	218.4	448
Logic analyzers	41.6	53.3	65.5	135
Logic probes	2.5	3.1	3.6	5
Word generators	4.7	5.2	5.9	14
Oscilloscopes	279.1	306.6	347.0	474
Network analyzers	23.5	26.4	29.0	38
Spectrum analyzers	66.0	74.7	82.1	106
Frequency synthesizers	48.7	52.3	57.5	92
Function generators	38.0	42.7	48.7	77
Signal generators	62.9	70.1	77.1	118
Sweep generators	62.0	68.5	75.4	101
Pulse generators	17.2	19.6	21.5	30
Oscillators	18.5	18.7	20.2	27
Waveform analyzers, distortion meters	39.8	44.3	48.6	65
Power meters, below microwave frequencies	3.8	4.4	5.0	7
Calibrators and standards, active and passive	28.4	30.2	32.5	45
Noise-measuring units (except sound-level meters)	6.6	7.5	8.1	11
Temperature-measuring instruments	19.0	22.0	25.3	33
Phase-measuring equipment	27.9	30.9	33.2	44
Amplifiers	42.8	46.5	51.2	63
Impedance bridges	13.3	13.5	13.9	16
Recorders and plotters, total	184.1	202.3	215.8	258
Strip- and circular-chart	71.0	77.0	79.0	84
X-Y	43.0	48.2	52.6	74
Magnetic-tape	70.1	77.1	84.2	100
Component testers	209.5	242.0	288.0	460
Pc-board testers, total	195.5	247.0	300.0	525
Bare-board	11.7	13.6	16.5	26
Completed assemblies	183.8	233.4	283.5	499
IEEE-488 bus controllers	48.0	55.2	63.4	104
Microwave impedance-measuring equipment	21.9	24.1	26.5	35
Microwave-power-measuring equipment	8.3	9.3	10.4	14
Microwave wavemeters	0.9	0.7	0.6	0
Specialized test equipment, total	**700.5**	**760.2**	**820.5**	**1,157**
Automotive diagnostic	297.0	300.0	300.0	420
Communications test (incl. data communications)	349.1	398.6	448.5	632
Radiation-detection and -monitoring	21.2	28.3	36.1	56
Other	33.2	33.3	35.9	49
Analytical instruments, total	**592.2**	**662.3**	**743.8**	**1,091**
Chromatographs, total	145.2	159.0	179.0	268
Gas	68.0	79.0	91.0	138
Liquid	77.2	80.0	88.0	130
Spectrophotometers, total	168.9	190.5	214.6	298
Infrared	32.1	34.9	38.6	50
Ultraviolet-visible	37.5	44.7	49.2	63
Atomic absorption	35.3	42.9	51.8	95
Other	64.0	68.0	75.0	90
Mass spectrometers	44.0	48.0	53.0	75
Nuclear magnetic-resonance spectrometers	24.0	26.5	29.3	38
Electron microscopes	12.0	13.0	13.0	14
pH meters and ion-selective electrodes	30.0	33.0	36.0	50
Spectrofluorometers	13.0	15.5	18.8	34
Spectropolarimeters	1.3	1.3	1.3	2
Thermal analyzers	14.0	19.0	24.0	46
X-ray analyzers	50.0	52.0	55.0	69
Emission spectrometers	21.5	27.7	38.8	75
Elemental analyzers	2.3	3.0	4.0	8
Other	66.0	73.8	77.0	114
Data-processing systems, peripherals, and office equipment, total	**26,637.7**	**30,733.8**	**35,951.6**	**59,322**
System shipments, total	12,548.0	14,030.0	16,189.0	25,881
Desktop computers	675.0	945.0	1,262.0	3,000
Small (less than $100,000)	1,650.0	1,996.0	2,415.0	4,350
Medium ($0.1 to $1 million)	3,360.0	3,746.0	4,289.0	6,025
Large (greater than $1 million)	6,863.0	7,343.0	8,223.0	12,506

(millions of dollars)	1979	1980	1981	1984
OEM micros and minis, total	1,207.9	1,500.7	1,902.7	3,797
OEM microcomputers	209.9	268.7	362.7	797
OEM minicomputers	998.0	1,232.0	1,540.0	3,000
Memory systems, total	718.2	759.0	863.8	1,320
Mainframe add-on systems	396.0	431.6	483.4	679
Minicomputer add-in/on systems	76.2	94.4	115.0	160
OEM systems, total	246.0	233.0	265.4	481
Core	120.0	84.0	71.0	49
Semiconductor	126.0	149.0	194.4	432
Data-storage subsystems, total	2,353.1	2,803.8	3,392.7	5,881
Disk pack	839.0	869.0	908.1	992
Fixed-disk	525.0	656.0	819.7	1,598
Combination fixed/cartridge disk	400.0	500.0	675.0	1,166
Flexible-disk	227.0	306.0	413.1	1,129
Reel-type magnetic-tape	318.0	395.0	481.9	833
Cassette and cartridge magnetic-tape	44.1	77.8	94.9	163
Input/output peripherals, total	2,543.3	2,895.4	3,364.3	5,453
Card-read/punch	103.0	93.0	80.0	50
High-speed line printers	186.9	226.3	271.6	542
Medium-speed printers	700.0	781.0	874.7	1,330
Low-speed serial printers, total	713.4	855.2	1,006.0	1,626
Impact	559.0	643.7	731.0	1,063
Nonimpact (thermal, electrostatic)	154.4	211.5	275.0	563
Large nonimpact printers	114.0	140.0	189.0	465
Computer output microfilm	185.0	208.0	238.0	362
Optical character and mark readers	378.0	403.0	478.6	802
Magnetic character and mark readers	19.0	18.0	17.1	14
Electromechanical plotters (on/off line)	99.0	121.0	154.0	198
Digitizers	16.0	18.9	24.3	34
Paper-tape devices (readers and punches)	29.0	31.0	31.0	30
Key entry	275.3	256.6	241.9	203
Data terminals, total	1,810.9	2,225.8	2,776.1	5,507
Teleprinter terminals	305.3	379.5	454.0	725
CRT terminals, total	1,278.0	1,577.0	1,999.6	4,108
Intelligent	595.0	780.0	1,029.6	2,533
Other	683.0	797.0	970.0	1,575
Graphics terminals, total	180.1	225.3	282.5	641
Storage and refresh	120.0	153.0	181.7	364
Raster-scan	60.1	72.3	100.8	277
Remote batch and job-entry terminals	47.5	44.0	40.0	33
Source data-collection equipment, total	1,335.0	1,533.0	1,749.8	2,586
Point-of-sale systems	419.0	465.0	525.5	738
Banking systems	234.0	268.0	298.6	413
Industrial data-collection systems	93.0	110.0	130.3	217
Other specialized terminal	589.0	690.0	795.4	1,218
Office equipment, total	3,846.0	4,729.5	5,471.3	8,694
Nonconsumer calculators	298.0	358.0	408.5	903
Word processing	1,090.0	1,398.0	1,705.6	3,022
Dictation	263.0	302.5	310.0	454
Copying	1,850.0	2,257.0	2,573.0	3,600
Facsimile transmission	48.0	59.0	71.0	124
Typesetting	297.0	355.0	403.2	591
Communications equipment, total	**4,158.2**	**4,716.3**	**5,346.0**	**7,532**
Radio, total	1,653.4	1,835.7	2,029.3	2,632
Aviation mobile (incl. ground support)	54.7	65.1	71.2	90
Marine mobile	34.0	35.1	37.0	47
Land mobile and base stations	1,084.3	1,191.2	1,313.1	1,662
Amateur (mobile and base stations)	23.1	25.5	27.8	33
Citizens' band (mobile and base stations)	64.7	72.5	76.0	81
Microwave (incl. antennas), total	199.6	228.5	256.1	361
Analog	175.0	195.7	213.8	275
Digital	24.6	32.8	42.3	86
Broadcast (a-m and fm, incl. antennas, etc.)	51.0	55.5	59.4	71
Satellite earth stations	142.0	162.3	188.7	287
Radar (incl. weather and navigation), total	162.5	170.1	178.8	235
Telemetry (industrial only)	63.8	70.0	76.5	99
Voice-switching systems, total	453.0	509.0	567.5	768
Central office	410.2	452.0	498.0	652
PABX	42.0	57.0	69.5	116
Data-switching systems	16.0	22.0	30.0	86
Fiber-optic communications systems, total	38.7	89.0	153.0	400
Modules and subsystems	6.1	23.5	39.3	127
Complete systems	32.6	66.5	113.7	273
Pocket pagers, total	62.0	81.0	97.0	140
Tone only	55.0	71.0	84.0	120
Tone plus voice	7.0	10.0	13.0	20
Data-communications equipment, total	1,242.5	1,420.3	1,640.1	2,420
Modems, total	334.5	405.0	487.5	800
Low-speed (less than 2,400 b/s)	107.0	122.5	150.0	250
High-speed (2,400 b/s and over)	227.5	282.5	337.5	550

(millions of dollars)	1979	1980	1981	1984
Multiplexers	114.9	145.0	188.7	327
Programmable concentrators	114.1	131.0	150.6	210
Front-end communications processors	505.0	552.3	609.2	826
Message-switching systems	174.0	187.0	204.1	257
Facsimile terminals	132.0	148.3	166.3	236
Television equipment, total	334.3	370.9	407.5	516
Broadcast equipment, total	115.3	123.3	131.4	160
Transmitters	17.3	18.1	19.5	25
Antennas	16.3	18.7	21.2	30
Cameras	33.7	36.0	38.1	44
Auxiliary equipment	48.0	50.5	52.6	61
CATV, total	173.3	197.0	218.2	276
Studio and head-end	33.5	46.5	55.0	71
Distribution	80.0	88.0	98.0	132
Transmission lines and fittings	31.7	33.0	33.7	35
Converters	28.1	29.5	31.5	38
CCTV, total	45.7	50.6	57.9	80
Cameras	31.0	33.6	37.9	51
Monitors	14.7	17.0	20.0	29
Industrial electronic equipment, total	**2,413.4**	**2,823.5**	**3,259.4**	**5,387**
Motor controls (speed, torque)	240.1	280.1	313.7	659
Numerical controls, total	90.0	100.0	111.0	156
Inspection systems, total	60.4	65.2	68.7	80
Ultrasonic	18.3	20.5	22.0	27
X-ray	33.0	34.9	36.1	40
Infrared	7.0	7.5	8.1	10
Ultraviolet	2.1	2.3	2.5	3
Thickness gages and controls, total	120.7	129.4	134.5	151
Photoelectric	88.7	93.6	97.1	108
Radiation-based	32.0	35.8	37.4	43
Data-acquisition systems	13.5	14.0	14.6	19
Process controllers	115.0	129.6	138.9	190
Semiconductor production, total	731.9	917.3	1,147.5	2,251
Wafer preparation (crystal growers, etc.)	30.0	32.5	37.4	57
Mask generation	57.6	66.7	79.4	123
Lithography, total	285.3	408.6	518.0	1,004
In-line handling (scrubbers, coaters, etc.)	25.3	29.6	36.0	59
Aligners, total	260.0	379.0	482.0	945
Projection	150.0	195.0	218.0	358
Direct wafer-stepping	65.0	129.0	192.5	423
Electron-beam	45.0	55.0	71.5	164
Wafer processing	155.2	180.0	247.5	519
Assembly (wire bonders, etc.)	145.0	161.0	185.0	424
Testers	58.0	68.5	80.2	124
Process recorders and indicators	90.1	102.8	114.3	148
Sequence controllers, total	167.5	216.4	271.5	414
Programmable	151.6	201.6	258.9	401
Hard-wired	15.9	14.8	12.6	13
Ultrasonic cleaning	17.6	21.0	23.4	28
Pollution-monitoring	236.0	240.6	242.3	341
Induction and dielectric heating and sealing	64.5	71.0	73.9	83
Welding controls	28.3	32.6	34.8	39
Process-control computer systems, total	229.5	253.4	278.0	359
Digital	190.0	211.9	232.4	304
Analog	39.5	41.5	45.6	55
Energy management	163.3	190.1	211.3	270
Robots (mechanical manipulators)	45.0	60.0	81.0	199
Power supplies, noncaptive, total	**390.6**	**435.8**	**480.4**	**580**
Switching, total	143.6	160.6	184.4	315
Pc-board-mountable (encapsulated)	8.0	8.9	10.5	15
Open frame and card	45.2	50.5	57.2	96
Rack-mountable and other system	90.4	101.2	116.7	204
Conventional (nonswitching), total	247.0	275.2	296.0	265
Pc-board-mountable (encapsulated)	9.5	9.5	10.8	15
Open frame and card	80.5	92.7	107.1	108
Rack-mountable and other system	140.5	156.5	159.1	118
Benchtop	16.5	16.5	19.0	24
Medical equipment, total	**1,979.8**	**2,221.8**	**2,453.5**	**3,670**
Diagnostic, total	821.7	894.8	965.6	1,223
X-ray (incl. computer tomography)	482.1	490.3	487.3	400
Ultrasonic scanners	169.6	214.4	271.7	545
Nuclear imaging	54.7	60.2	63.5	77
Automated blood analyzers	72.1	83.3	92.8	138
Electrocardiographs	43.2	46.6	50.3	63
Therapeutic, total	952.7	1,095.7	1,216.4	2,072
X-ray	61.4	66.3	72.4	95
Electrosurgery	36.3	41.5	45.2	60
Defibrillators	56.0	67.3	80.9	141

*Includes domestic-made equipment, off-shore products sold under U. S. labels, and domestic- and foreign-label imports.

(millions of dollars)	1979	1980	1981	1984
Diathermy	10.7	11.7	12.7	16
Pain suppression and biofeedback	77.4	106.7	157.2	588
Dialysis units	180.6	194.5	207.6	248
Pacemakers	383.0	456.2	480.1	726
Hearing aids	147.3	151.5	160.3	198
Patient-monitoring equipment	205.4	231.3	271.5	375
Lasers and related equipment, total	**105.1**	**128.2**	**158.8**	**233**
Gas lasers	74.2	92.4	116.4	157
Semiconductor lasers	7.1	8.5	10.6	32
Other (incl. ruby, neodymium-doped, etc.)	23.8	27.3	31.8	44
Automotive electronics, total	**304.3**	**409.2**	**517.2**	**1,029**
Engine control systems	184.9	234.0	283.1	484
Electrical systems	24.2	26.0	27.8	34
Convenience features	27.9	50.0	72.1	149
Safety and security systems	9.9	17.2	27.6	151
Dashboard	57.4	82.0	106.6	211

FEDERAL ELECTRONICS

(millions of dollars)	1979	1980	1981	1984
FEDERAL ELECTRONICS, TOTAL	**20,419**	**22,850**	**25,307**	**29,653**
Defense, total	**18,605**	**20,890**	**23,255**	**27,369**
Procurement, total	9,060	10,290	12,012	14,823
Communications and intelligence	1,525	1,708	2,061	2,680
Aircraft, related ground equipment	2,412	2,894	3,328	4,259
Missiles and space systems	2,914	3,271	3,990	4,788
Mobile and ordnance	549	625	737	886
Ship and conversions	1,660	1,792	1,896	2,210
Research, development, test, and engineering	6,275	6,922	7,198	7,702
Operations and maintenance	3,270	3,678	4,045	4,844
NASA	**836**	**886**	**901**	**956**
Transportation, total	**455**	**495**	**534**	**665**
FAA procurement	270	287	307	390
FAA research and development	121	138	154	200
Highway and transit systems	64	70	73	75
Health and Education agencies, total	**425**	**462**	**490**	**511**
Education systems	112	118	120	123
Health-care electronics	313	344	370	388
Department of Energy	**98**	**117**	**127**	**152**

CONSUMER ELECTRONICS

(millions of dollars)	1979	1980	1981	1984
CONSUMER ELECTRONICS, TOTAL*	**11,848.8**	**12,429.1**	**13,459.6**	**16,896**
Television receivers, total	4,091.3	4,079.0	4,203.0	4,577
Black and white	543.3	506.0	511.0	510
Color	3,548.0	3,573.0	3,692.0	4,067
Consumer audio equipment, total	**3,364.3**	**3,318.0**	**3,435.7**	**4,028**
Radios, total	956.3	900.7	910.4	1,205
Table, clock, and portable	461.3	439.0	445.2	570
Automobile	495.0	461.7	465.2	635
Phonographs and radio-phonographs	725.0	700.0	735.0	720
Tape recorders and players	778.0	791.3	829.8	1,010
Hi-fi audio systems, total	905.0	926.0	960.5	1,093
Components (incl. receivers, tuners, etc.)	755.0	806.0	840.5	953
Consoles	150.0	120.0	120.0	140
Other consumer electronic products, total	**4,393.2**	**5,032.1**	**5,820.9**	**8,291**
Antennas, (TV, CB, and radio)	122.0	119.0	120.0	129
Home video cassette players/recorders	360.0	480.0	599.3	733
Home video cameras	43.0	63.5	95.3	160
Home video disk players	6.2	24.2	85.7	400
Home video projectors	68.5	80.4	191.3	500
Electronic organs, other electronic instruments	441.5	478.0	492.2	545
Intrusion alarms	235.0	255.0	295.0	520
Microwave ovens	1,147.0	1,400.0	1,612.0	2,300
Smoke detectors	87.5	98.0	103.4	119
Telephone-answering devices	88.0	115.0	148.7	250
Electronic games, total	506.4	634.0	762.2	1,131
Video games	70.0	84.0	96.7	120
Nonvideo games and toys	436.4	550.0	665.5	1,011
Calculators, hand-held	645.0	625.0	611.0	626
Teaching aids	4.1	5.0	5.8	10
Electronic watches (digital and analog display)	564.0	570.0	605.0	736
Digital clocks	75.0	85.0	94.0	132

EUROPE'S MARKETS

Oil, inflation, unemployment lead the way toward recession

List the ills that beset business throughout Western Europe as 1981 gets under way, and the result is a catalog of practically everything that can go wrong in industrial economies.

For starters, the oil that traditionally fueled industrial growth has been priced nearly out of sight by the Organization of Petroleum Exporting Countries (OPEC) and the giant oil corporations that market it. Then just when the impact of one price hike has been more or less absorbed, OPEC and company jolt the industrialized countries with still another one. And as if this were not enough, supplies are always threatened by the explosive situation in the Middle East.

Then there is inflation, barely in check in countries such as Italy and Spain and under reasonable control only in Switzerland and West Germany. It distorts the spending patterns of consumers and the investment plans of industrialists. Perhaps worse, it prevents governments from launching broad programs to stimulate their economies.

The list goes on and on—unemployment at downright dangerous levels in some countries, bankruptcies on the rise everywhere, crushing competition from Far Eastern producers of industrial goods, unsettled currency markets, mounting balance-of-payments deficits, and general dissatisfaction with the governments now running things.

All this and more has tilted Western Europe's economies into a decline that dips perilously close to recession. The gross national product for the dozen main countries of the region will grow only 1% this year, many forecasters figure, compared with 1.5% for 1980 and better than 3% for 1979.

With overall growth pegged so low, the spread among national growth rates this year obviously cannot be very much. Furthest down the decline is the United Kingdom, where Prime Minister Margaret Thatcher and her Conservative Party monetarists have sent the British economy tumbling into negative GNP growth in an effort to curb inflation. West Germany, the economy that sets the tone for Western Europe, cannot count on much more growth than 0.5%. "We will just be skirting a recession," explains Manfred Beinder, chief economist at the ITT affiliate Standard Elektrik Lorenz AG. However, prices are forecast to rise only 4%, a level that should quell the atavistic anxiety Germans have about inflation. Italy, with heavy earthquake damage to cope with in addition to the standard woes, will be hard put to push its growth figure above 1%.

That leaves France, among the Big Four, to edge up the aggregate—but not much. The official statisticians now say the 1981 growth rate will slip slightly to 1.6%. Nongovernment economy watchers put the figure even lower. Spain, however, expects to do better, with its GNP rising by 2.5%.

There is no doubt that the ebbing economies in Western Europe will wash away some markets for the electronics industries. Yet they figure to register decent growth for bleak times. "From the point of view of both public and private spending, we expect no serious discontinuity between 1980 and 1981," says J. Edouard Gigonis, who is international vice president for Thomson-CSF, the ranking French electronics firm.

After its annual survey of 11 Western European countries, *Electronics* forecasts that electronic equipment markets will add up to $51.28 billion in 1981 and components markets to $12.28 billion (the table below may differ from the detailed chart on p. 143 because of rounding).

That works out to a rise of 9.7% over last year's $46.74 billion for equipment. Unfortunately, it also works out to a lower rate than the 10.5% gain logged in 1980. Like the overall economy, electronic equipment markets are now plagued by dwindling growth rates.

So are components markets. They performed surprisingly well last year, hustling upward 8.6% to $11.60 billion largely because of a spurt in integrated-circuit sales. The forecast climb to $12.28 billion is a more modest 5.5% rise.

As in the recent past, much of the slower growth can be traced to near-stagnant markets for traditional consumer equipment, particularly color television and radios. Credit the computer makers—and in lesser measure, communications equipment manufacturers—for slowing the slide.

And remember that the figures in the charts generally distort the rise in markets, making them look better than they really are. This is because participants in the 11-country survey, conducted in October and November 1980, were asked to make their estimates in local currency at prevailing prices. The estimates were converted into dollars at the rates prevailing in mid-November and no adjustments were made for inflation or fluctuations in currency exchange rates—a nearly impossible task since price rises vary so much from product to product and country to country. In other words, the market figures in the chart reflect outright price rises (and for some items, price drops), as well as market growth.

WESTERN EUROPEAN ELECTRONIC EQUIPMENT MARKETS
(millions of U.S. dollars)

	1979	1980	1981
West Germany	11,989	12,798	13,724
France	8,648	9,788	10,932
United Kingdom	8,638	9,789	10,910
Italy	4,198	4,649	5,214
Benelux	3,297	3,636	3,872
Scandinavia	2,423	2,663	2,927
Spain	2,031	2,290	2,484
Switzerland	1,061	1,130	1,217
Total	42,285	46,743	51,280

MARKET REPORT EXCHANGE RATES
(The rates below are the ones used to convert European currencies into U.S. dollars)

Belgium: 30 francs/dollar
Denmark: 5.8 kroner/dollar
France: 4.4 francs/dollar
Italy: 905 lire/dollar
Netherlands: 2 guilders/dollar
Norway: 5 kroner/dollar
Spain: 77 pesetas/dollar
Sweden: 4.2 kroner/dollar
Switzerland: 1.7 francs/dollar
United Kingdom: 41 pence/dollar (£1 = $2.40)
West Germany: 1.9 marks/dollar

COMPUTERS

Hard times spur users to upgrade systems as small businesses buy their first machines

The marvelous machines that computer makers keep bringing to market seem to guarantee them double-digit growth, even when business generally is so bad that economists start to quibble over definitions of recession and depression.

Right now, the guarantee is doubly backed, for in hard times, the drive to stay competitive forces established companies to upgrade their data-processing systems with high-performance hardware. In addition, small businesses are turning massively to computers, because new desktop models with stunning price-performance levels have slashed the entry fee for data processing. As Hartmut von Voigt, an official at the Data Processing Systems division of West Germany's Siemens AG, puts it, "The computer industry is feeling the economic pinch. But it is not feeling it as much as other sectors."

In fact, *Electronics*' survey suggests that, by and large, computer suppliers in Western Europe should wind up the year feeling quite good about their sales. Markets for computers and related equipment are forecast to rise a solid 12.4% during 1981. The gain will lift the sector to $19.21 billion, making it by far the dominant one. Just as significant, this year's projected growth rate is just a shade over last year's, when the computer category grew an estimated 12.3% to reach $17.09 billion.

All the same, the computer makers will feel the pinch—in profits. They will "limp behind" in sales, estimates Jochen Rössner, a marketing specialist at Sperry Univac in Sulzbach, West Germany. No one at Britain's International Computers Ltd. would dispute Rössner's reading. Reporting his company's fiscal year results last month, ICL chairman Philip Chappell announced that turnover had moved up 15% but profits down 46%. The erosion will continue, he expects.

Meanwhile, sales will climb, mainly because of the spectacular increase in the past two years or so of the data-processing power that can be had for a franc, a mark, a pound, or a peseta. The impact has been most visible at the very low end of the range. Although Apple II, Radio Shack TRS-80, and Commodore Pet (to cite a few personal computers) cannot be classified as household names in Western Europe, neither are they completely unfamiliar. Sales of desktop computers climbed 30% last year to hit $778 million and will edge past $1 billion this year, according to the survey.

These growth rates will perhaps look low to some purveyors of personal computers. IDC Europa, a London-area market research house, for example, spots the gain currently at 43% in the projected UK market. Whatever the exact figure, the market for desktop computers looks so lusty that major Continental companies like CII-Honeywell Bull in France, Siemens in West Germany, the Data Systems division of NV Philips Gloeilampenfabrieken of the Netherlands, and Ing. C. Olivetti & C. in Italy all have gone to market with desktop machines in an effort to stake out market shares before American firms dig in too deeply.

Despite the delirium over desktops, the bound upward in price-performance ratios has actually had its most noticeable effect on computer makers' revenues among long-standing users of data-processing systems. They have upgraded their systems, often spreading the computing power throughout their organizations. "Demand seems to be increasing for small and medium-sized computers, for customers who want to incorporate them into even larger systems," says François Sallé, deputy general manager for planning at CII-Honeywell Bull.

Thus, although under pressure from upwardly mobile (in performance) small computers on one side and from downwardly mobile (in price) large machines on the other, the middle class manages to hold its own. Markets for these medium-power systems will expand by 10.8% this year to $4.09 billion, the survey predicts. They may do even better next year. Quantum Science Corp., which follows Western European computer markets closely from its London office, expects an upturn for this class of computer in 1982 or 1983.

CONSUMER

Market figures remain large, but the rate of growth is slowing down

Good news will be hard to come by this year for Western European producers of traditional consumer electronic hardware such as television sets, audio equipment, and radios. Their market numbers remain huge; but they no longer are the hugest and the fastest-rising market sector.

For 1981, sales of the dozen consumer categories covered by the survey will total $14.80 billion, if the forecast is on target. That is a not very impressive gain of 5.7% over the estimated $14 billion for 1980, when the rise was somewhat better at 7.4%.

Decoded, these market numbers read "stagnation," and the causes are apparent to everyone in the business. Color television receivers, the mainstay of the market, hover around an annual sales level of 11 million sets, and it is hard to see how they can rise much above that plateau in the next few years. Market saturation has stunted sales of radios, another major market segment, as well. Hi-fi equipment, the second-largest sector of entertainment electronics, will continue to do well this year, with markets edging up just past $2 billion. Even so, the forecast growth rate—9.17%—will be a lttle lower than last year's. For entertainment electronics action, look to videotape machines.

There will be some stirring about in national TV

A look at the future. For growth markets in entertainment electronics, manufacturers in Western Europe will have to look at such advanced items as video cassette recorders. Here, VCRs undergo final testing at Grundig plant after 20 hours' continuous operation.

markets even though the totals for Western Europe will not budge much. In the UK, for example, sales of color sets actually went up last year when almost everyone said they would dip. St. John C. Jackson, product marketing manager for Thorn Consumer Electronics Ltd., expects the market to hold up again in 1981.

In France, saturation is still several years off, but color set sales have slowed nonetheless. On the other hand, monochrome set sales have not dropped off as sharply as expected. "Real household income is expected to be flat, and instead of buying color sets, many consumers are opting for cheaper black and white models," explains Jean-Philippe Dauvin, assistant director of the Bureau d'Information et de Prévisions Economiques, a quasi-governmental market research agency.

In Italy, there are some 500 local privately owned TV stations as well as the state-run official network to keep the airwaves in ferment. Even so, the market stalled in 1980 and inventory piled up so fast that four companies—Indesit, Voxon, Autovox, and Emerson—were in peril of lengthening the list of vanished set makers. No real improvement seems possible this year.

In West Germany, the marketing men at Grundig AG, the country's leading entertainment electronics producer, note that small-screen portables accounted for about a quarter of color set sales (in units) last year. And they expect portables to pick up substantial market share this year and next.

The same sort of shift to small-screen sets is under way in Scandinavia and the UK as well. To put it another way, small screens now count heavily in countries where the saturation level is so high that replacements and second sets are the mainstay. This tilt in the mature markets is mainly to the advantage of the Japanese producers. They dominate the small-screen market with imports (650,000 sets last year) and with products from their European plants. Hitachi, Matsushita, Mitsubishi, Sanyo, Sharp, Sony, and Toshiba, to mention only the giants, have solidly set up shop in Europe. Their impact will grow as they hit the market with large-screen sets made in Japan.

Meanwhile, Japanese producers already dominate the Western European market for video cassette recorders, which surged last year to reach $715 million and seems set for another rush upward to nearly $900 million this year. "The market is tremendous, growing faster than anybody expected," exults Willem den Tuinder, commercial manager for video equipment at Philips in Eindhoven, the Netherlands.

Less exalting is a look at the market shares. Den Tuinder estimated that half the million-odd VCRs sold throughout Western Europe last year were Video Home System (VHS) types and another 20% were Beta format machines. That meant only 30% for the European VCRs made by Philips and Grundig, which at the outset had the market all to themselves. But den Tuinder is convinced the European pair can regain market share. They are counting on their eight-hour machine, the V2000, to turn the trick. "We were limited in 1980," he explains, "because production did not start until spring." The limitation now lifted, Philips expects to move its market share up to 40% this year and then up to 50%.

As for other new-wave video products, they have yet to make a heavy imprint on Western European markets. The survey turned up a forecast of only $54 million for 1981 sales of video cameras, to cite one example. And projection video sales will total just over $190 million, estimates Admerca AG, a Zurich market-research firm that keeps tabs on such things.

COMMUNICATIONS

'Networks' is the buzz word and the key to fundamental changes in the market

Producers of communications equipment still do most of their business with a handful of customers—the government agencies that run the telecommunications networks and the defense forces in Western Europe. But for telecommunications gear, that clubby style will change drastically during the decade ahead. The surge in integrated-circuit technology has made it feasible to put computer power in all sorts of hardware. And as that hardware is tied together in networks, the markets for telephones, telex machines, copying machines, facsmile machines, paging equipment, and perhaps even TV sets, will meld into one.

That is good news and not so good news for the traditional telecommunications equipment people. The wide customer base will cushion them when governments hold back on investment programs. At the same time, the shifting market will force changes in the way hard-

Past meets future. In the Tuileries garden of the Louvre palace in Paris, workmen install a high-capacity 7-kilometer fiber-optic line linking two exchanges in the central portion of the city. While such links are not yet much of a market, their day will soon come.

ware is sold and attract a lot of new competition, particularly in computer-related office machines.

The evolution has already started to bolster the market through equipment like modems, facsimile machines, and paging systems. Also, there is still considerable network improvement under way and new services coming on line in northern Europe. Following the UK, for example, several countries have started viewdata trials or plan to do so this year. Finally, *Electronics* tallies hardware like radar and navigation aids as communications equipment, and that adds strength to the sector.

All this will be enough to push communications equipment deliveries this year to $10.78 billion, according to the survey. This forecast works out to a gain of 10.7% over last year's estimated $9.73 billion. It must be noted, of course, that last year's rise was 12.2%. Despite the slowdown, communications equipment ranks as a major growth force for the electronics industries.

For communications equipment, particularly, the tag "Western Europe" applies to a set of hardly homogeneous national markets. So as always, the totals reflect a variety of national outlooks.

In France, the Direction Générale des Télécommunications continues its drive to build the phone network to 20 million lines by 1982. But it has hit a high plateau—some 2 million lines a year—after four years of rapid growth. Deliveries of switchgear—mostly digital—will run $682 million this year, according to the forecast, and there will be another $341 million for carrier gear.

Actually, telephone network equipment represents roughly 47% of communications markets in France. That means a big chunk of business will start winding down next year. Luckily, the slowdown at home will be offset by a bound upward in exports, which was the second major goal in the government's telephone plan. CIT-Alcatel, a subsidiary of the Compagnie Générale d'Electricité, leads the list. The company has export orders for 750,000 digital-exchange lines. Thomson-CSF, its main French rival, reports its export backlog includes 800,000 lines, mostly digital. Both companies have long-term turnkey-plant projects that involve millions of additional lines.

Meanwhile, there is a similar situation for military equipment like radar, navigation aids, and avionics. Prospects both at home and abroad are strong for several years. All told, communications markets should run $2.56 billion this year, up a solid $11.2% over the estimated $2.30 billion for 1980.

The outlook is not as buoyant, but nonetheless not bad, in West Germany. The Bundespost plans to spend some $4.2 billion for communications facilities this year, about the same as last year. Only part of the money goes for equipment, of course, and the way the post office will allocate funds this year means a drop in growth—from 10% last year to around 6% this year. A big reason: demand for telephones is tapering off as the goal of telephones in 90% of all West German households by 1985 approaches. For the whole communications sector, the forecast is a 5.8% rise to $2.17 billion.

In the UK, where British Telecom has a massive $4.8-billion-a-year investment program under way, it looked as if the country's telecommunications producers would have a banner year in 1981—until Prime Minister Margaret Thatcher started slashing government spending. A 10% cutback in the program last year slowed orders for TXE-4 semielectronic exchanges. And the government budget cutters presumably will ordain further surgery this year.

TEST & MEASUREMENT

Microprocessors have opened the way to innovation and new customers

Makers of test and measurement instruments come in all shapes and sizes. But they do have things in common: they moved fast to put microprocessors in their hardware and have been on a binge of product innovation in the past five years. Also, they have been finding new customers.

As a result, sales curves for this sector have been steadily upward bound for the past five years, and this year should see more of the same. The forecast for 1981 is markets totaling $1.18 billion, a very solid 14.4% gain over the estimated $1.03 billion logged last year. To be sure, what is forecast to happen this year means some slight slowing of the growth rate, which ran 14% in 1980. But this troubles few people in the business since most see several more good years ahead.

One reason is the solid underpinning for automated test equipment, which now rivals oscilloscopes as the major market segment. ATE sales, the survey forecasts, will grow to $185 million this year, from last year's estimated $156 million. More than a quarter of the ATE buyers are firms that were not at all interested in such equipment a few years ago, figures Philip Handtschoewerker, who heads Hewlett-Packard Co.'s instrumentation group in France.

Still another reason for the medium-term optimism lies in the instruments needed to design and service equipment built around microprocessors. Sales of microprocessor development systems soared last year and will soar this year, *Electronics'* survey shows.

The figures: a near-45% rise to $87 million last year and a similar hike to $126 million this year. Credit this spectacular growth to those turning to microprocessors for the first time, as well as to those upgrading their machines.

Conventional instruments, like oscilloscopes, counters, and timers, obviously cannot match the growth rates of the newcomers. But they are getting a lift from the pervasiveness of electronics, too. Specifically, the future for oscilloscopes should not be discounted too heavily, for they are still the major market segment with sales of $192 million forecast for this year. "There is an enormous future for scopes coupled with digital applications," says Bill Whitward, international marketing manager for test and measurement instruments for Philips' Science and Industry division in Eindhoven.

COMPONENTS

Difficult first half is ahead, but low inventories presage pickup later

Few components suppliers in Western Europe will escape spending a good part of 1981 fretting at a high level of anxiety. Harbingers of hard times abounded as 1980 ended with business generally on the decline almost everywhere, consumer electronics producers faring poorly, and growth rates diminishing—luckily not drastically—for telecommunications and computer makers. "The first half of 1981 will be very tough," warns Ferdinand Rauwenhoff, senior managing director for Elcoma, the components division of Philips in Eindhoven. In large part because component inventories are low at equipment makers, Rauwenhoff expects that "the telephones will start ringing sometime during the year." But he adds, "I cannot say when."

But that probably will not happen soon enough to make 1981 anything more than mediocre. *Electronics'* chart for all kinds of components—active and passive—forecasts sales of $12.28 billion this year. That is 5.5% higher than the $11.60 billion estimated for 1980. More significant than the nominal gain, though, is the slide in growth. Last year it was 8.6%.

Needless to say, the overall figures cover a wide spectrum of specific component outlooks. Color picture tubes account for an overwhelming share of the tube business. So the overall markets should stay dead flat at just under $1.90 billion, despite reasonable gains for microwave tubes and non-TV cathode-ray tubes. The market is listless, as well, for discrete semiconductors. There, the forecast is for a rise of just 2% to $1.27 billion.

Discrete optoelectronic devices, by contrast, will do much better. Hans-Georg Höhne, director of worldwide marketing at AEG-Telefunken's semiconductor establishment in Heilbronn, West Germany, figures that such parts will post gains above 10%. The survey is somewhat more optimistic, prognosticating a 12.8% rise to $200 million.

Passive parts are forecast to hold up reasonably well, climbing 5.9% to $6.52 billion. Again, that is considerably down from the 1980 growth figure, which finished the year at a sound 8.5%.

In most years, ICs shine brightly through any economic gloom. That will not be the story this year, or anyway the glow on the horizon does not seem to be so bright. After a surprising spurt of 22% last year, sales of ICs figure to mount only 11% this year. That will push their markets to $2.39 billion.

Most anxious among the IC crew will be the memory makers. Rüdiger Karnatzki, marketing director for continental Europe at the Freiburg, West Germany–based ITT Semiconductor Group, foresees very strong demand for memories during 1981. "But by the middle of the year," he says, "there should be a balance between supply and demand." Prices for 16-K random-access memories, some suppliers figure, will tumble by half during the year as those ubiquitous Japanese producers vie for a market share. As a result, the markets for MOS and complementary-MOS memories are forecast to move up only 14% in dollars, although the piece count will of course surge much more.

Microprocessor and microcomputer chips are expected to fare considerably better than memories even though a sharp drop in growth is projected—from 45% last year to 22.9% this year. That means a market of $216 million, according to the survey. "It is now coming to mass applications, with some kinds of chips selling on the order of 100,000 or more per year," notes Hans de Haan, market research administration manager at Texas Instruments GmbH in Freising, West Germany. You can count on microprocessors for a lift, when the chips, in a manner of speaking, are down. □

JAPAN'S MARKETS

At $25 billion, equipment consumption for 1981 will grow by less than 10%

The Japanese economy continues to suffer from the doldrums, with a gross national product gain of 4% in real terms last year and about the same forecast for this year. The nation's balance of payments is expected to be in the red again. Moreover, the government has insufficient funds to prime the pump as it has done in previous years. Prime Minister Zenko Suzuki's administration will, in fact, try to cover a revenue shortfall this year by increasing taxes on business and by adding excise taxes on consumer products such as video cassette recorders.

Looking overseas, the Japanese fear a wave of protectionism that could hurt exports, especially of automobiles. Moreover, manufacturers cannot hope to take up the slack domestically because consumers have less money to spend. This year wage increases could surpass inflation slightly, but not by enough to cause a buying spree.

Nevertheless, the electronics markets are looking up. Total equipment consumption in Japan increased over 13% last year and should gain nearly 10% this year, according to the 11th annual Japanese market survey conducted by *Electronics* (see table, p. 143). At the same time, exports of some new products, including VCRs and video cameras, are increasing so fast that production cannot keep up.

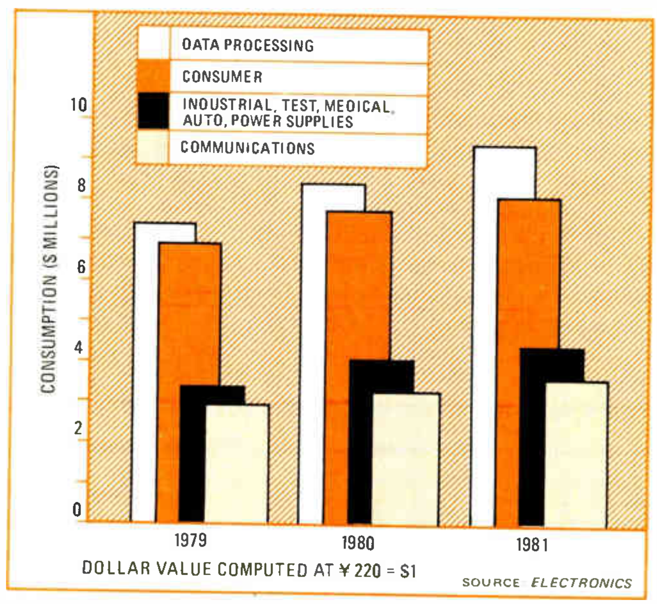
Though a total growth of 10% in domestic sales is still well below what most Japanese companies are accustomed to expect, there are several pockets of prosperity. Data-processing and office equipment should bound ahead by nearly 13%, to $9.4 billion. Electronic data-processing systems in all categories are piling on solid gains, albeit not up to the percentages experienced a decade ago. Markets to watch in this sector are microcomputers and small systems, due to register well over 11% and 14% gains, respectively. Slated for growth of around 18% are data-entry and -output equipment.

After a 10% gain in 1980, communications equipment is also expected to jump another 11% this year. Always a good performer in Japan, facsimile equipment should increase over 18% in 1981 to $414 million. And a newcomer, fiber-optic communications equipment, should experience 50% growth.

The all-important consumer electronics sector, however, is not doing much better than the overall economy. With a little over 6% growth projected for the year, this category should inch up to about $8 billion. As usual, however, Japanese consumer electronics firms have a raft of new products to entice the public. Though still just about one third of the total value of color television receivers, video cassette recorders are fulfilling the promise of bolstering the home video market. And video cameras seem to be riding on the coattails of the VCRs. Audio tape players seem not to know market saturation as each year consumption increases. This year, however, the gain is a modest 7%, to $900.9 million.

On the components front, sales of integrated circuits and optoelectronic devices are expected to grow 16.5% and 17.6%, respectively. Discrete semiconductors, however, should only gain by 6.5% this year. Overall total components consumption, including passive devices, semiconductors, and tubes, should ring up sales growth of around 11%, for a total of $11.8 billion.

Upward struggle. The Japanese equipment market, pegged at $23 billion last year, will move up a little less than 10% this year to $25 billion, according to the *Electronics* survey. Once again, data-processing equipment will pull up the sluggish consumer sector.



COMPUTERS

'Waiting-for-IBM' jitters past, market resumes solid growth

Data-processing systems resumed their upward climb last year after International Business Machines Corp.'s announcement of its long-awaited 4300 series and its System/38 removed a large element of uncertainty from the market. Furthermore, both IBM and domestic competitors had hardware to deliver. In fact, they had much more to deliver than was indicated by the 10% growth shown in the *Electronics* table because the new hardware sells for much less than its predecessors.

This year the market is set for a similar increase, since with IBM's announcement of its 3081 late last year there is even less uncertainty. Fujitsu Ltd. and Hitachi Ltd. already have their relatively new Facom 200 and Hitac 200H similar-size systems in place, and Nippon Electric Co. jumped the gun and announced its still larger ACOS-1000 two months before IBM.

Competitors Fujitsu and Hitachi also plan larger systems than they now have, though they will not say when they will be available. All three Japanese companies are working on supercomputers, a line IBM leaves to others.

Although the large CPUs generate most of the excitement, they no longer generate the profits they once did. Instead, peripheral and terminal equipment is more profitable and growing faster. The two categories of data-storage and data-terminal equipment together had an average growth of 16% in 1980 and are forecast to grow another 17.5% this year. At nearly $2.8 billion, their total sales this year will be almost three fifths those of data-processing systems.

The large increase in terminals and peripherals indicates a shift to distributed processing that was slow to develop in Japan. This trend may get a further boost from the start of digital switching at the end of 1979 and packet switching in mid-1980. Furthermore, there has been a rapid increase in the number of work stations and peripherals used with all computers, including entry-level small-business computers and small mainframes.

The meteoric rise of small-business computers is said to have settled down to about a 20% to 25% yearly growth. Industry sources list Nippon Electric, Toshiba Corp., and Mitsubishi Electric Corp. (not necessarily in that order) as the leaders in market share. However, Fujitsu claims that the market lead is really shared by four firms, with a company group consisting of it and its subsidiary Uchida Yoko Co. Ltd. as the fourth member.

Meanwhile, Hitachi is also trying hard to expand small-business computer sales and work its way into the top group. It is placing more reliance on dealers for sales and software assistance to customers, rather than depending only on direct sales as previously.

Just entering the business computer arena is Nippon Data General Corp., formerly a Japanese company named Nippon Minicomputer Corp. that built computers under license to Data General until it was taken over by that firm last year. The firm is working with software houses to increase their ability to convert original-equipment-manufacturer minicomputers from Data General into small-business systems. This strategy has been almost unknown in Japan because leading mini makers also offer their own small-business systems.

One reason Data General can try this tactic is its method of converting Japanese text input from a keyboard in phonetic form into a combination of Chinese characters and Japanese syllabary characters. Rival Digital Equipment Corp. does not have this capability, nor does Yokogawa-Hewlett-Packard Ltd. Improvements in Japanese language input, for which there are at least five distinct methods—only one of which is standardized—should further boost demand for office computers.

A biggie. Nippon Electric Co. jumped the gun on IBM when it introduced its ACOS-1000 ahead of the long-awaited H series. There are a small and a large version, with respective throughputs of 15 million and 29 million instructions per second.

CONSUMER

VCRs provide only peak on otherwise flat horizon

Developments in consumer electronics equipment are often so rapid that products undergo marked changes before they have a chance to mature or to saturate the market. Video cassette recorders are a good example. They have spawned portable and low-cost video cameras. Cameras featuring semiconductor image sensors are scheduled to hit the market this year, to be followed by camera-VCR combinations in a few years. Video disks will be along toward the end of the year as well.

For the high-end audio customer, pulse-code-modulation adapters for VCRs and even separate PCM decks are expected to challenge open reel recorders. And before the year is out there will probably be an audio version of a video disk 26 centimeters in diameter and featuring three sound channels. The mass market will take a year longer to emerge.

At the very low end of the audio sector, deck receivers, a new category in Japan, are increasing their market share at the expense of modular stereo—single units with a built-in record player. So new that its market share cannot be measured yet is microcassette stereo, including earphone-only portables, portable radio-cassette combinations, and decks. Total sales of audio tape recorders and players should record rather modest growth this year, from $839 million to $900 million.

The leader in sales growth last year and this year is the VCR, which climbed by 42% last year and is expected to leap another 34% this year to just over $790 million. Of course its manufacture is export-driven, with production last year of almost 4.3 million units, about double that of the previous year. Total value was up about 80%, and this year unit production will race ahead of color television production. Still, the saturation index in Japan at the end of the year was only about 6%, so there should be a large demand for many years to come. About 25% of the systems shipped last year were portable, and that number is expected to increase to about 30% this year.

Most of the portables are the Video Home System (VHS) type originally introduced by Victor Co. of Japan Ltd. In fact, the market share of all VHS model VCRs appears to be increasing in Japan, though Sony Corp.'s sales of Betamax are also up sharply. The reason for this apparent paradox is that many consumers equate Betamax with Sony, and the other firms making machines in this format are not doing too well. In the VHS ground, Sharp Corp. carved out a big niche by selling low-priced one-speed machines. This window has closed, however, especially since Matsushita Electric Industrial Co. cut the price of its multiple-speed units.

Since the color television boom occurred eight to nine years ago, replacement sets make up somewhat more than half of today's sales. These are to a large extent 20- and 22-inch sizes, measured diagonally, with electronic tuning and multiplexed sound.

Second TV sets for households in 14-in. and smaller sizes are the next best sellers. These are low in cost, although Sharp has also had success with more expensive sets with multiplexed sound earphone output. About 8% of the demand comes from first-time buyers. A $2.3 billion total color TV sales this year will show no growth.

Electronic range sales have been simmering at around $373 million a year, but perhaps the introduction of microprocessor control this year will help get them boiling. Manufacturers have been developing various sensors for checking that food is cooked—including those for steam, smoke, and smell—because the Japanese do not like to impale food on temperature probes.

After years of bringing out new features, calculator manufacturers have not found a new formula to increase sales. But they are creating a new market for language translators. These companies are also developing new products using voice synthesis.

COMMUNICATIONS

Digital conversion, facsimile terminals flash busy signals

Communications equipment continues its steady growth of more than 10% last year and 11% this year. Everything is going digital, except for subscriber lines and the telephone sets. In March, Nippon Telegraph & Telephone Public Corp. (NTT) will announce standards for time-division electronic private automated branch exchanges (EPABX), and strong competition among domestic and foreign suppliers is expected for this new market.

Japan's digital exchange network was started with circuit switching for 4 cities at the end of 1979 and packet switching for 7 cities in mid-1980. By the end of this year circuit switching will be available in 13 cities and packet switching in a total of 30, which should foster increased demand for data-communications terminal equipment.

As usual, the Japanese market in facsimile terminals is climbing steeply with a projected 18.62% increase to $414.09 million. NTT's plan to start a facsimile exchange service this year could bring an additional boost. The present market mix is about evenly split between 3- and 2-minute analog G-II machines and high-speed digital G-III machines, with many machines featuring dual- or multi-mode performance. The 6- and 4-minute G-I mode is offered in many G-II machines for communication with installed units, but new G-I sets are becoming a vanishing breed. There are now at least 19 manufacturers in the competition, with Toshiba, NEC, Matsushita, and Ricoh Co. out in the forefront. Hitachi and Mitsubishi are very aggressive, and Fujitsu is coming on strong in G-III, however.

COMPONENTS

Discretes show renewed vigor, though ICs still fly high

The bubble has burst in the 16-K dynamic random-access memory market. Japanese manufacturers have been adding capacity to supply the U. S. market as if it were a bottomless hole.

But U. S. demand has saturated and prices have fallen to less than $2 in some cases. The home market is still expanding, although much additional dynamic RAM capacity is coming on line to build 64-K devices. Meanwhile, the price of 16-K RAMs will remain low.

Some manufacturers are switching part of their 16-K dynamic RAM facilities to the production of static devices. Although the unit sales are only perhaps one third those of the dynamic RAMs, the dollar value is at least two thirds as much because prices are higher. Moreover, this market should grow as large-capacity devices become available.

The latest products being brought on line by all manufacturers are 2-K-by-8-bit programmable read-only memories that are nominally pin-compatible with the popular 2716 PROMs. Some manufacturers have n-MOS versions for low cost and complementary-MOS for battery backup, although this is not universal. Unlike dynamic RAMs, there was no U. S. prototype to adopt for the 2-K-by-8-bit parts, so specifications differ even though pinouts do not. By the end of the year, however, it should become apparent what the users want. Total memory consumption in Japan jumped almost 50% last year and manufacturers expect another good year in 1981. According to the *Electronics* survey, MOS devices should reach nearly $500 million this year.

Microprocessor sales, at $296 million in 1980, are rising rapidly, too, with 4-bit types still out ahead. Applications range from air conditioners and electronic ranges to calculators and toys.

Although Intel-type devices produced by domestic manufacturers lead in the 8-bit market, giant auto maker Nissan Motor Co. uses 6802 processors produced by Hitachi. Mitsubishi now makes the 6801 for internal use, and Matsushita Electric makes the 6802 for sale. Hitachi makes a full line of Motorola-type chips and uses the 6809 in its latest microcomputer. As for 16-bit devices, a number of firms are currently using the 8086 or trying out the 8088, while the 68000 and Z8000 are still in the sample stage.

The lion's share of linear ICs goes into consumer equipment and should grow even faster as VCRs and digital audio take off. *Electronics* pegs the 1981 linear IC market at $566.6 million, a 12.98% increase.

The insatiable demand of the Japanese electronics industry for discrete semiconductors and passive components is one of the most noteworthy happenings in the components sector. Much of the increased demand for discrete devices, expected to reach $1.2 billion this year, is coming from VCRs, which use 200 to 300 devices each, plus healthy quantities of passive components.

Because of the small boom in discrete devices, some firms are making an additional investment in the production of small-signal transistors. But these moves are made cautiously lest the pendulum swing the other way.

The same caution is apparent among passive component makers. Funds that in the past would have been used for capital investment in new facilities by passive component manufacturers are being used for research and development and automation. Thus, planning differs from the past, reducing the danger that a slowdown will lead to dumping of passive components.

TEST & MEASUREMENT

IEEE-488 bus arrives for ATE, VCRs perk up consumer test gear

Test and measurement equipment excluding analytic instruments is doing well with a growth of over 14% last year and one of almost 15% forecast for this year. It is being driven by the high growth in equipment and component markets and by the tendency of many users to opt for automatic test equipment controlled by the IEEE-488 bus.

Tops in sales are integrated-circuit testers, which grew almost 25% to $84.66 million last year and are forecast to grow about 22% this year. Growth is also apparent in sales of printed-circuit board testers, which jumped about 25% last year to $22.73 million and are projected to gain another 50% this year, according to *Electronics*.

Microprocessor development system sales are soaring, but Japanese test equipment firms have left the field to semiconductor manufacturers and joint-venture test equipment firms such as Yokogawa-Hewlett-Packard and Sony Tektronix Corp. Domestic test equipment firms are doing well in logic analyzers, though, which are pegged at almost $10 million this year.

In the consumer field, the meteoric growth of VCRs, which could double again this year, has increased the consumption of many categories of test equipment, including spectrum analyzers, oscilloscopes, and signal generators. Video disks this year will add fuel to the fire, and digital audio equipment will fan sales of word generators to consumer firms.

On the other hand, the availability of low-cost integrated circuits and displays for implementing digital panel meters, and even counters, has taken some of the steam out of these products.

INDUSTRIAL

As process control goes digital, sales rise faster than the GNP

The industrial sector grew at a healthy rate last year, paced by the giant process control sector, which registered a 19% gain to $840.91 million. This year's growth could be much better than the near 7% indicated in the chart, even though the general economy is dull.

Although few large new installations are booked, replacement controls are needed for rationalization and changed product mixes, which could keep sales humming even during the recession.

Digital controllers have become the industry's main product, but the expected decrease in sales of analog controllers has not occurred. The falling off may come this year, especially as firms improve digital units. A major beneficiary of the switch to digital has been Toshiba, which has used the new technology to leverage itself into a position among the leaders.

Hokushin Electric Works Ltd. has made a bid to increase sales by supplying its one-loop controllers to Meidensha Electric Manufacturing Co., which has a different customer base, on an OEM basis. Its hardware will be almost the same as its standard line, but Meidensha will change the software. Early this year single-loop digital controllers should be anounced by Yokogawa Electric Works Ltd. and Yamatake Honeywell.

Steel production, which was down two years ago, picked up last year as firms invested in continuous casting and energy-saving systems, including power generator controllers. At the other end of the process control spectrum is a growing investment in food processing. □

JAPAN/EUROPE MARKET FORECAST 1981

	JAPAN			WEST EUROPE		
	1979	1980	1981	1979	1980	1981
COMPONENTS, TOTAL (millions of dollars)	**9,064.0**	**10,497.3**	**11,845.5**	**10,683.20**	**11,604.50**	**12,281.80**
PASSIVE AND ELECTROMECHANICAL, TOTAL	**4,279.0**	**4,806.5**	**5,448.8**	**5,658.8**	**6,140.9**	**6,523.3**
Capacitors, fixed	738.8	865.9	1,015.5	1,023.3	1,103.3	1,146.0
Capacitors, variable	45.5	55.8	78.9	58.9	60.5	61.6
Connectors, plugs, and sockets	262.5	285.0	333.3	899.6	985.7	1,067.5
Filters, networks, and delay lines	170.7	192.7	211.4	110.7	121.5	128.9
Keyboards and keypads	227.3	250.0	272.7	41.8	55.0	65.5
Loudspeakers, OEM type	227.3	257.0	284.8	166.7	176.1	185.1
Microphones, OEM type	67.3	70.3	77.7	41.4	43.0	44.5
Microwave components	159.1	168.2	177.3	—	—	—
Potentiometers and trimmers, composition	314.0	363.6	435.6	212.6	224.5	230.9
Potentiometers and trimmers, wirewound	14.6	15.2	15.8	68.4	71.2	72.7
Printed circuits	422.7	481.4	577.7	1,169.6	1,301.3	1,417.0
Quartz crystals (incl. mounts and ovens)	94.2	123.2	146.9	115.7	125.3	139.4
Relays (for communications and electronics)	196.4	214.3	232.5	452.7	483.0	506.0
Resistors, fixed (incl. wirewound)	259.1	290.2	324.9	337.4	352.3	362.8
Resistors, nonlinear	29.6	31.8	36.4	50.8	56.3	60.2
Servos, synchros, and resolvers	54.6	59.1	54.6	73.9	78.6	84.8
Switches (for communications and electronics)	217.4	233.4	264.6	338.8	370.6	392.9
Transducers (incl. pressure, strain, temperature, etc.)	20.5	27.6	41.5	—	—	—
Transformers, chokes, coils, TV yokes, and flybacks	757.4	821.8	866.7	496.5	532.7	557.5
SEMICONDUCTORS, TOTAL	**3,379.5**	**4,192.1**	**4,881.4**	**3,088.6**	**3,576.5**	**3,861.6**
Discrete, total	**982.6**	**1,140.7**	**1,220.0**	**1,177.0**	**1,246.4**	**1,272.9**
Microwave diodes, all types (above 1 GHz)	8.2	9.3	10.3	38.0	42.8	44.7
Rectifiers and rectifier assemblies	210.9	237.3	249.0	240.4	254.8	257.6
Signal diodes (rated less than 100 mA, incl. arrays)	93.2	113.6	120.8	90.3	93.5	93.7
Thyristors (incl. SCRs and triacs)	80.6	91.0	97.2	141.3	154.9	160.3
Transistors, bipolar power (more than 1-W dissipation)	203.5	240.7	255.6	224.8	241.2	251.9
Transistors, bipolar small-signal (incl. duals)	217.3	255.3	272.6	297.5	303.4	301.6
Transistors, field-effect power and small-signal	27.3	34.1	37.7	—	—	—
Transistors, rf and microwave	90.9	100.0	113.6	32.3	34.7	39.5
Tuner varactor diodes (less than 1 GHz)	20.3	24.0	26.0	27.3	27.9	27.5
Zener diodes	30.4	35.4	37.2	57.9	62.1	63.0
Integrated circuits, total	**2,072.1**	**2,680.4**	**3,211.3**	**1,764.2**	**2,152.4**	**2,388.2**
Hybrid ICs, all types	227.2	258.9	298.4	214.1	255.7	289.9
Linear ICs (except op amps)	389.6	501.5	566.6	330.9	374.4	399.5
Op amps (monolithic only)	40.8	53.7	63.3	77.4	90.8	98.8
Logic circuits, bipolar (general-purpose)	204.3	290.0	324.9	316.2	370.5	396.6
Logic circuits, MOS and C-MOS (general-purpose)	137.1	199.3	243.5	320.1	402.0	441.4
Memory circuits, bipolar	42.2	54.6	67.7	64.2	75.3	83.5
Memory circuits, CCD	31.8	35.0	38.6	—	—	—
Memory circuits, magnetic-bubble	14.1	27.3	45.5	—	—	—
Memory circuits, MOS and C-MOS	228.7	357.9	496.3	256.5	332.6	379.0
Microprocessor and microcomputer chips	254.6	295.8	362.9	121.3	175.9	216.2
Special-purpose LSI	501.7	606.4	703.6	63.5	75.2	83.3
Optoelectronic, total	**324.8**	**371.0**	**450.1**	**147.4**	**177.7**	**200.5**
Circuit elements	57.5	36.6	40.1	43.7	51.9	58.7
Discrete light-emitting diodes	93.7	130.3	166.2	39.0	44.5	49.9
Image-sensing arrays, area and linear	12.2	15.1	26.6	—	—	—
Laser diodes	4.6	9.6	11.4	—	—	—
Readouts	155.6	178.1	204.4	59.7	72.4	80.2
Solar (photovoltaic) cells	1.2	1.3	1.4	5.0	8.9	11.7
TUBES, TOTAL	**1,405.6**	**1,498.7**	**1,515.3**	**1,935.8**	**1,887.1**	**1,896.9**
Cathode-ray tubes (except for TV)	41.5	56.5	73.5	70.1	76.0	83.9
Image-sensing tubes (incl. camera tubes and intensifiers)	88.6	129.6	140.0	68.9	72.6	75.3
Light-sensing tubes (incl. photomultipliers)	5.5	5.9	6.4	31.9	32.9	34.5
Power tubes (below 1 GHz)	12.3	12.6	13.0	125.7	131.1	136.2
Receiving tubes	10.6	10.2	9.1	56.8	49.0	42.1
Microwave tubes (incl. cooking)	334.9	267.5	260.6	162.3	173.5	187.8
TV picture tubes, black and white	61.4	60.0	53.3	71.2	62.3	58.4
TV picture tubes, color	850.8	956.4	959.4	1,348.9	1,289.7	1,278.7

	1979	1980	1981	1979	1980	1981
EQUIPMENT, TOTAL (millions of dollars)	**20,381.1**	**23,027.6**	**25,248.9**	**42,296.10**	**46,741.6**	**51,281.0**
CONSUMER, TOTAL	**6,903.9**	**7,656.5**	**8,134.3**	**13,025.6**	**13,995.8**	**14,798.1**
Audio tape recorders and players	706.5	838.9	900.9	648.7	697.7	724.2
Electronic games and toys	318.9	318.0	334.7	—	—	—
Electronic ranges (microwave ovens)	348.5	373.6	386.4	177.6	192.4	267.8
Hi-fi component equipment	784.1	977.5	1,049.9	1,715.4	1,914.4	2,103.1
Phonographs and phono/radio combinations	185.3	149.8	170.7	518.2	528.7	532.4
Pocket calculators (personal and professional)	183.9	192.6	191.6	399.5	410.1	416.5
Radios (incl. car radios)	306.4	270.0	277.5	1,392.0	1,371.3	1,413.1
Radio/recorder combinations	551.8	666.2	736.3	661.1	718.3	775.6
Radio/TV/recorder combinations	90.9	145.5	163.6	—	—	—
Telephone-answering devices	15.4	16.3	16.7	—	—	—
TV sets, black and white	61.2	46.0	37.0	742.0	700.6	641.7
TV sets, color	2,274.3	2,287.5	2,270.1	5,791.7	6,124.1	6,327.8
Video cameras (consumer)	82.6	149.9	133.6	30.1	43.4	53.6
Video projectors	15.7	61.9	65.7	—	—	—
Video tape machines (consumer)	415.0	591.3	790.7	437.0	715.8	894.7
Watches and clocks (electronic)	563.4	571.5	608.9	512.3	579.0	647.6

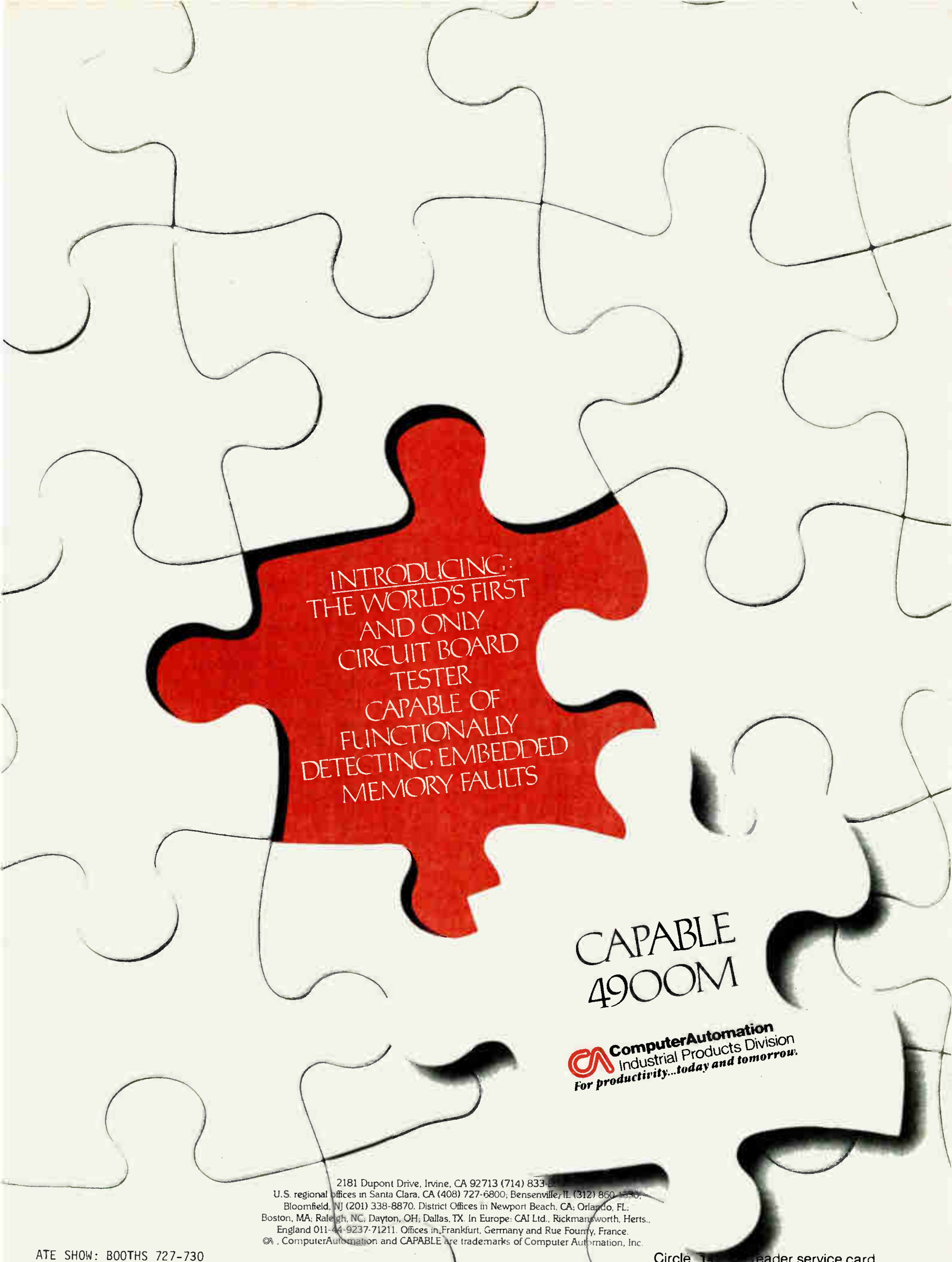
	JAPAN			WEST EUROPE		
	1979	1980	1981	1979	1980	1981
COMMUNICATIONS EQUIPMENT, TOTAL	**2,947.8**	**3,255.6**	**3,619.0**	**8,668.3**	**9,730.6**	**10,774.7**
Broadcast equipment	95.2	102.4	114.7	326.6	358.6	392.2
Cable TV	60.7	61.8	62.3	—	—	—
Closed-circuit TV	73.0	90.1	111.4	123.2	134.9	152.2
Data communications	114.1	143.6	175.0	229.2	271.5	311.2
Facsimile terminals	279.5	349.1	414.1	31.5	42.4	54.9
Intercoms and intercom systems	51.6	56.8	60.2	127.6	137.8	148.2
Microwave relay	160.9	176.8	190.4	244.1	240.4	241.9
Navigation aids (except radar)	63.3	64.4	66.7	792.0	948.0	1,072.4
Paging systems	—	—	—	71.7	81.0	86.6
Radar (airborne, ground, marine)	106.5	118.3	130.5	1,313.1	1,465.3	1,645.5
Radio communications (except broadcast)	750.9	804.7	868.4	1,434.7	1,599.7	1,752.8
Satellite earth stations	—	—	—	36.9	36.6	45.9
Telemetry (industrial)	65.6	72.7	86.4	—	—	—
Telephone and data switching, private[1]	50.0	63.6	81.8	810.0	887.2	937.1
Telephone and data switching, public[1]	361.4	400.9	496.4	1,913.1	2,223.6	2,561.9
Video recorders and players (nonconsumer)	35.5	37.5	39.1	—	—	—
Wire-carrier equipment (incl. FDM and PCM)	675.0	703.8	708.0	1,214.6	1,303.6	1,371.9
COMPUTERS AND RELATED EQUIPMENT, TOTAL	**7,378.5**	**8,355.9**	**9,408.9**	**15,213.2**	**17,090.9**	**19,212.4**
Data-processing systems, total[2]	3,916.0	4,306.9	4,735.7	9,589.4	10,775.7	12,210.6
Microcomputers (chasis value less than $1,500)	109.1	118.2	131.8	—	—	—
Desktop computers (less than $25,000)	340.9	363.6	386.4	596.8	778.1	1,001.5
Small (system value less than $420,000)	554.6	654.6	744.7	3,056.9	3,541.3	4,103.0
Medium ($420,000 to $1,680,000)	1,009.1	1,102.3	1,202.3	3,412.7	3,686.1	4,086.5
Large (more than $1,680,000)	1,902.3	2,068.2	2,270.5	2,523.0	2,770.2	3,019.6
Add-on memories	189.6	215.5	242.5	88.6	100.3	110.5
Data acquisition	74.2	80.1	86.9	204.0	227.4	250.3
Data entry/output	658.5	777.0	908.4	693.5	779.8	868.2
Data mass storage	926.1	1,143.6	1,352.1	—	—	—
Data terminals	1,043.3	1,201.1	1,404.9	1,391.3	1,680.8	1,964.6
Office equipment	452.5	485.2	512.3	3,031.2	3,286.2	3,541.9
Point-of-sale	118.3	146.5	166.1	215.2	240.7	266.3
INDUSTRIAL, TOTAL	**1,432.8**	**1,700.0**	**1,747.3**	**2,608.3**	**2,895.8**	**3,195.8**
Computer typesetting	9.4	10.4	11.7	—	—	—
Inspection and gauging equipment	40.0	44.1	48.2	51.6	55.3	59.8
Machine-tool controls	172.7	250.0	227.3	154.6	170.3	186.7
Motor controls	190.9	204.6	190.9	216.1	224.8	234.9
Photoelectric controls	—	—	—	54.0	57.0	58.1
Pollution-monitoring equipment	31.4	32.5	31.8	19.0	17.6	17.3
Process-control systems	704.6	840.9	897.3	2,025.8	2,277.7	2,539.0
Ultrasonic equipment	88.3	100.9	110.5	32.9	36.5	39.0
Welding controls	195.5	216.6	229.6	54.3	56.6	61.0
MEDICAL, TOTAL	**561.4**	**735.3**	**820.2**	**1,553.9**	**1,633.3**	**1,715.8**
Diagnostic equipment	118.2	127.3	150.0	329.5	347.7	366.0
Patient-monitoring	41.7	52.0	62.9	150.4	167.8	179.0
Prosthetic	22.5	24.3	28.4	183.6	193.0	209.2
Surgical support	18.9	21.7	25.4	—	—	—
Therapeutic (except X-ray)	28.2	31.3	34.9	76.0	83.8	89.1
X-ray equipment, diagnostic and therapeutic	331.9	478.7	518.6	814.4	841.0	872.5
POWER SUPPLIES, TOTAL	**133.40**	**155.50**	**177.00**	**322.3**	**363.7**	**404.7**
Bench and lab	25.0	31.8	38.2	34.8	37.6	40.9
Industrial heavy-duty	25.0	29.2	35.0	81.2	88.4	96.7
OEM and modular, conventional	25.7	27.8	29.6	94.4	100.6	104.4
OEM and modular, switching type	57.7	66.7	74.2	111.9	137.1	162.7
TEST AND MEASUREMENT, TOTAL	**419.5**	**477.2**	**547.6**	**904.5**	**1,031.5**	**1,179.5**
Amplifiers, lab type	14.9	16.4	18.0	12.9	13.5	13.9
Analog voltmeters, ammeters, and multimeters	27.3	29.1	30.9	43.3	45.0	46.6
Automatic component testers	4.6	5.5	6.8	31.0	37.9	43.0
Automatic IC testers	68.0	84.7	103.1	42.8	47.5	54.1
Automatic pc-board testers	18.2	22.7	34.1	54.4	71.1	87.8
Calibrators and standards	7.3	7.7	8.2	11.9	12.9	13.4
Counters and timers	17.0	18.1	19.7	47.0	52.1	57.2
Digital logic (probes, analyzers)	7.6	9.9	12.5	34.1	42.9	50.0
Digital multimeters (incl. accessories)	16.3	17.9	19.5	56.1	61.6	67.3
Microprocessor/microcomputer development systems	7.7	10.9	14.8	60.1	87.0	126.3
Microwave test instruments	—	—	—	73.2	84.6	96.0
Oscillators	25.0	26.6	28.2	32.8	25.3	27.7
Oscilloscopes and accessories	57.6	62.2	68.6	164.8	179.4	192.4
Panel meters, analog and digital	37.8	40.6	44.9	—	—	—
Phase-measuring equipment	2.5	3.0	3.0	—	—	—
Power meters	3.4	3.3	3.6	6.7	7.1	7.8
Recorders	45.2	52.5	58.2	107.7	117.8	130.7
Signal generators	42.3	46.1	50.2	82.1	93.1	104.0
Spectrum analyzers	16.8	20.0	23.3	43.6	52.7	61.3
Temperature-measuring instruments	36.4	43.2	50.0	—	—	—
ANALYTICAL INSTRUMENTS, RESEARCH OR CLINICAL, TOTAL	**443.2**	**495.5**	**543.2**	—	—	—
AUTOMOTIVE ELECTRONICS, TOTAL	**160.6**	**196.1**	**251.3**	—	—	—

[1]Electronic or semielectronic only.

[2]Includes stand-alone minicomputers but not computers that are integral parts of process-control and similar systems.

— No estimate available.

Figures in this chart are based on an 11-country survey made by *Electronics* in October and November 1980. They show consensus estimates for consumption of components, valued at factory prices, used to produce equipment for both domestic and export markets, and for consumption of electronic equipment, with domestic hardware valued at factory sales price and imports at landed cost.



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Circle 14 ... eader service card

Protecting optical data links from electromagnetic interference

Ingenious design minimizes the susceptibility of the fiber-optic receiver to man-made noise

by Vincent Mirtich, *Motorola Semiconductor Products Inc., Phoenix, Ariz.*

☐ Man-made electrical noise, which can limit the performance of any fiber-optic data link, degrades wideband systems most. The design of the optical transmitter and receiver should minimize whatever noise they generate internally. But that still leaves electromagnetic interference from the link's associated electronic equipment to be dealt with.

Such man-made noise invades the link at the optical data receiver and artificially raises its noise floor. Elsewhere, it has little impact. At the transmitter's interface with the cable, the noise immunity of the TTL devices normally used is more than adequate. The rest of the transmitter is even less sensitive because of the large signals and small impedances it uses. And of course, the dielectric optical-fiber cable is totally insensitive to emi.

This emi has diverse sources (see "Where is all that noise coming from?"), but its effect on an optical receiver can be minimized by clever circuit design techniques. Some of these, such as grounding procedures, are classic and come from the radio-receiver realm. Others, such as drive circuit design, are specific to fiber optics.

If the designer fails to reduce the optical data receiver's susceptibility to external emi, then the data link will perform poorly. But if he or she succeeds, then the signal-to-noise ratio at the receiver's amplitude detector will be determined by the receiver's intrinsic noise only and the bit error rate for the given input signal level will be the best possible.

Lots of ways to couple

The noise generated by interfering waveforms is either radiated or conducted to the optical receiver. In the former case, voltage transients are coupled through stray inter- and intra-board capacitance to the susceptible nodes in the receiver. As these stray capacitances are typically tenths of picofarads and less, they combine

Where is all that noise coming from?

The man-made noise that can affect a fiber-optic receiver's performance has a variety of sources. Part of the noise arrives over the 5-volt bus used to power the receiver. Usually a TTL system, the receiver includes microprocessors, memories, crystal oscillators, frequency dividers, and clock drivers, and every node in it that switches TTL current levels produces a voltage transient on the 5-V bus. This multitude of transients adds up to a bus noise level typically much higher than the receiver's sensitivity. Worse yet, if the receiver is powered from the same 5-V bus, these transients will be conducted directly into it.

Neighboring TTL systems also affect the receiver by radiation. Every one of their nodes that has a voltage swing between it and ground also has a time-varying electric field around it that is capacitively coupled to any adjacent circuitry. These radiated signals must be rejected by the receiver. Although all of the transients occur at different times, they are probably in synchronization with a master clock somewhere in the system and therefore will couple glitches into the amplitude detector at the same time that data entering this detector is going through zero crossings. Worse yet, this man-made synchronous noise will often not manifest itself as a problem until after an optical data link has been installed.

An example of man-made noise that is not synchronous with a master clock is the radiation of the horizontal sweep signal in a cathode-ray-tube terminal. At the CRT's high-voltage rectifier input, these pulses can be 10 kilovolts or more and have widths of 10 microseconds and repetition periods of 60 μs. Such a high-voltage pulse generates spectral components at 16-kilohertz intervals, with the first envelope zero crossing at 100 kHz. As a fiber-optic receiver may find itself placed inches away from such signals with only a plastic housing around it, it must also be capable of rejecting this signal radiation.

Yet another source of emi is the optical transceiver itself. After all, the optical receiver's output and the optical transmitter's input are typically those same digital signals that modulate the system power supply and radiate from printed-circuit cards close to the receiver. This emi can radiate back to a linear amplifier's input and cause waveform ringing that may be detected as data transition, at the amplitude detector. The transmitter's digital input may radiate or conduct synchronous noise to the receiver amplitude detector input so that detectable transitions and thus bit errors are inserted into the data stream. Worst of all, the transmitter's light-emitting-diode driver may be switching currents of 200 milliamperes or more with rise times of 10 nanoseconds or less and thus cause unwanted power-supply modulation.

with the susceptible nodes' shunt resistance to provide coupling with an abnormally short time constant—on the order of a nanosecond. Consequently, these radiated transients, if they are generated from TTL waveforms, have rise times of 10 to 20 ns and thus appear to the parasitic coupling networks to be ramps rather than step functions. This means that the induced transient (the output of the parasitic coupling network) is somewhat gaussian in shape for the duration of the TTL waveform transition time.

When conducted interference is a problem, current transients in the digital system are producing synchronous noise on the power-supply bus. This noise is conducted back to the optical receiver. Unfortunately, indiscriminate capacitive bypassing intended to solve this problem may route large ground currents through parasitic impedances that are also common to low-level ground-current paths. The large undesirable currents then cause a time-varying voltage drop across the parasitic impedance that in turn amplitude-modulates the desired low-level current flowing through the same impedance.

Depending on the relative phase of the two currents, this modulation can result in either circuit oscillation or bit errors. What's more, any parasitic inductance in series with the supply bypass capacitors will induce additional voltage transients on the supply. And finally, every component lead that handles large variations in current is a potential radiator of these currents because of its own parasitic inductance.

Most systems with which a fiber-optic data link must interface use TTL. Unfortunately, that logic family creates the most electromagnetic interference (see table). For example, TTL's 3-to-5-volt transition heights have a large enough amplitude and fast enough rise time to couple significant energy to a receiver through parasitic capacitances. Also, the large, fast current swings that TTL generates are even more troublesome because of the power-supply noise they generate and the induced voltage effects they produce when parasitic inductance is present anywhere in the circuits.

A typical receiver

A simple discrete-component fiber-optic receiver has four functional blocks, or partitions (Fig. 1a). It employs a discrete p-i-n photodiode, a wideband current-to-voltage converter (or transimpedance amplifier), a wideband voltage amplifier, and a line receiver or high-speed comparator serving as the amplitude detector—all components that are available from many vendors [*Electronics*, Oct. 9, 1980, p. 155].

Such a design exhibits a susceptibility to emi at the transimpedance amplifier input, across R_F, and also at the voltage amplifier's input, but this pickup can be reduced by implementing three of these functional blocks with one integrated circuit (Fig. 1b). Like the discrete version, the IC receiver can be put together from existing components.

In this IC version, however, the transimpedance amplifier's input node is still externally available and thus still susceptible to emi. Similarly, the feedback resistor, R_F, is external to the IC, so that it may be changed for

LOGIC FAMILY TRANSIENTS LIKELY TO AFFECT FIBER-OPTIC RECEIVERS

Logic family	Typical output voltage swing (V)	Typical output fall time (ns)	Typical differential power supply current (mA)	ΔV/Δt (V/μs)	ΔI/Δt (mA/μs)
Low-power Schottky TTL 74LS04	3.5	5	8	700	800
Complementary-MOS 14049UB	15	65	2.4	230	37
MECL 10 K 10101	0.9	2	0	450	0

systems with different bandwidths, and it therefore is also likely to be affected by emi unless put under a grounded shield. Moreover, since the configuration requires the IC input to be single-ended, it has no inherent common-mode noise rejection, and this is undesirable for wideband applications.

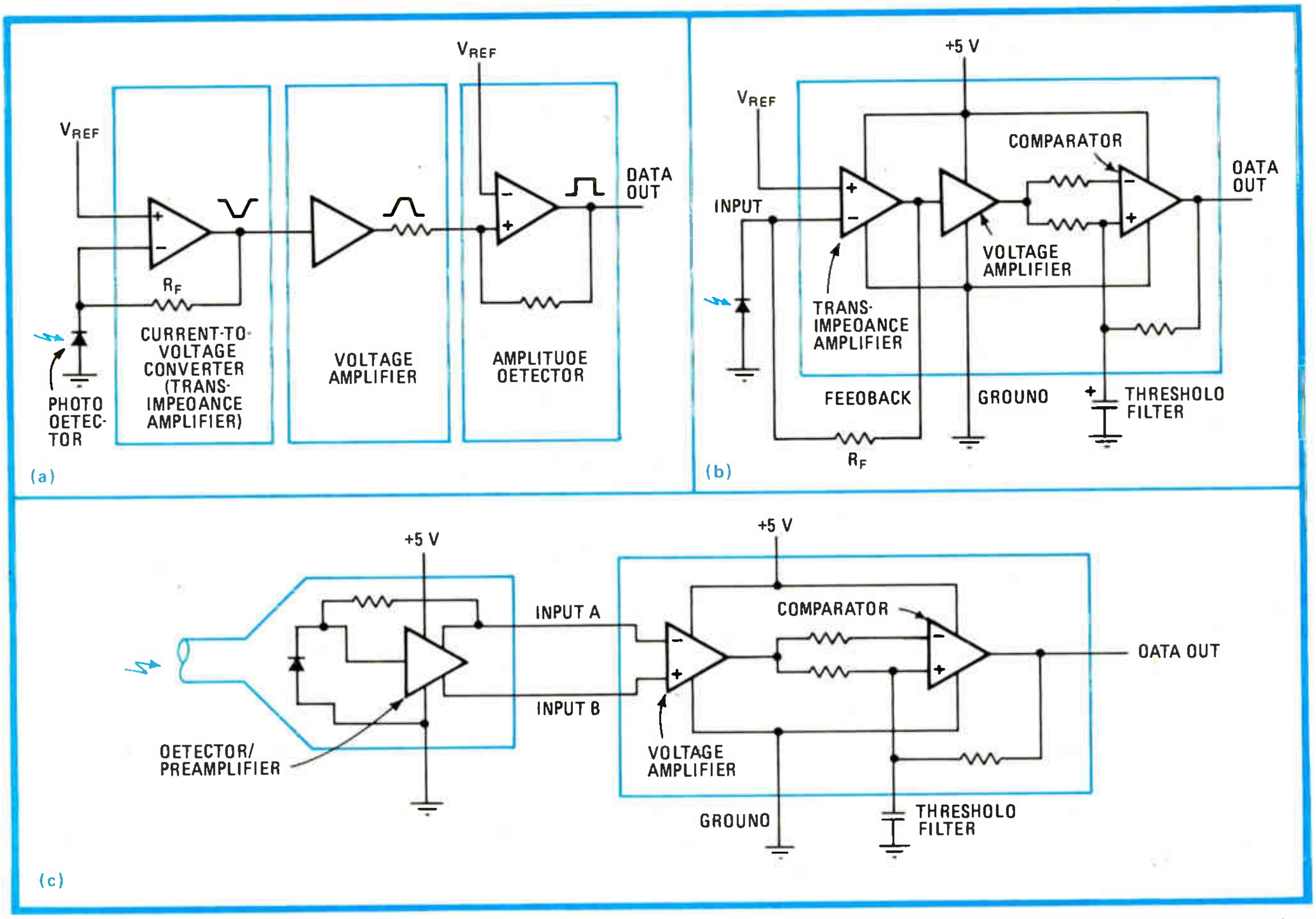
For the best emi receiver characteristics, two ICs should be used with a different partitioning (Fig. 1c). Here, the photodetector is not just a diode but a diode plus the transimpedance amplifier—in essence, a photosensitive amplifier. This integrated detector/preamplifier provides a low-impedance differential output.

Since the second IC function is designed with a differential input, its voltage amplifier will reject the common-mode signals induced by radiated emi. If the detector/preamp is in addition housed in a grounded optical connector that shields all the internal parts by acting as a waveguide below cutoff, the optical receiver will be almost totally immune to external emi.

Keep it narrow

As the required receiver bandwidth increases, the portion of the ambient emi spectrum that it can respond to also increases. For best receiver sensitivity, the system bandwidth should determine the receiver bandwidth, and the receiver bandwidth should in turn be determined by the transimpedance amplifier bandwidth, since that amplifier produces most of the significant noise generated within the receiver. By using a transimpedance amplifier that has only as much bandwidth as the system requires and no more, the noise generated in the receiver is minimized. Since the LED speed, fiber bandwidth, optical detector speed, and the receiver's voltage amplifier also contribute to the shrinking of the system bandwidth, they must all either be significantly faster or have a wider bandwidth than the transimpedance amplifier. If this guideline is followed, then the system will have the maximum gain margin and thus accommodate the largest loss budget possible for the particular system bandwidth, source, and optical detector chosen.

Sometimes the use of an LED that is too slow or a fiber that is too narrow in bandwidth for the application seems economically attractive. In this case, to meet the system bandwidth requirement, a wider-bandwidth receiver and thus better transimpedance amplifiers than would normally be needed must be used. This wider-bandwidth transimpedance amplifier will generate more noise and



1. Partitioning. The basic building blocks of a fiber-optic receiver may be defined as in (a). For immunity to man-made noise, however, (b) is somewhat better. The integrated-circuit approach in (c) is best of all since it keeps all electromagnetic interference to a minimum.

establish a higher noise floor that cannot be compensated for in succeeding stages. Worse yet, this systems approach, though seemingly good economics, may later prove only to have aggravated system problems and associated field testing and debugging because a wider-bandwidth receiver responds to fast ambient emi that would elude a narrower-bandwidth device.

In an optimum system design, the transimpedance amplifier, while being the most sensitive block in the receiver, has the narrowest bandwidth. The voltage amplifier block, on the other hand, has a much larger bandwidth while still being sensitive to small signals. Consequently, the portion of the receiver most sensitive to emi is one of these two components. With a well-shielded transimpedance amplifier and a single-ended voltage amplifier input, the voltage amplifier is probably most emi-sensitive. But if the input to the voltage amplifier is differential, even a well-shielded transimpedance amplifier can be the most emi-sensitive, because of interference conducted to it.

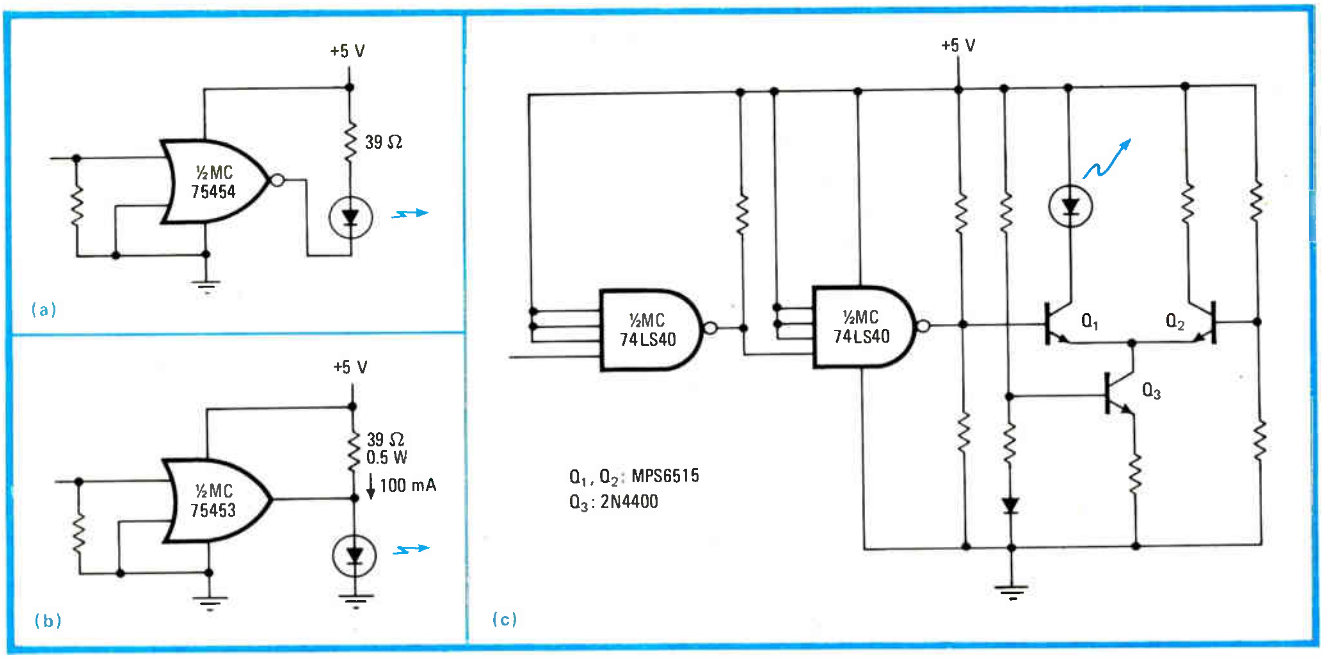
Regardless of which amplifier is the most emi-sensitive, its bandwidth relative to the speed of the $\Delta V/\Delta t$ and $\Delta I/\Delta t$ transients is critical. For instance, it can be shown that the amplifier must have a bandwidth of at least 35 megahertz before a TTL transient having a 10-ns rise time can be conducted through its input with unchanged amplitude. (Here, the amplifier is assumed to have a single-pole, low-pass response.) A bandwidth of less than 35 MHz will attenuate the transient, and the degree of attenuation, or selectivity, to be expected may be calculated from:

$$20 \log \frac{35}{(t_r)(BW_{3dB})} \qquad (2)$$

where t_r is the 10% to 90% rise time of the transient and BW_{3dB} is the amplifier's 3-decibel bandwidth.

The TTL voltage and current transients undergo other forms of attenuation besides that due to the amplifier selectivity. For example, there is attenuation limiting the conversion of the 800-milliampere/microsecond TTL current transient (see table again) into noise on the 5-V power bus and more attenuation of noise between the 5-V power bus and any susceptible amplifier input. The smaller the total attenuation of these transients, the harder it will be for the optical receiver to recover data without errors.

These difficulties make it necessary for the system designer interfacing optics to digital systems to minimize conversion of digital transients into power-bus noise, as well as to provide the needed attenuation of the conduction and radiation of such noise. This is done by employing adequate decoupling capacitance, by maximizing rejection of power-supply noise by using differential amplifiers, and by maximizing receiver selectivity by keeping bandwidth as low as the maximum data rate of the channel allows. As the required bandwidth of the



2. Transmitter implementation. For narrowband applications, the simplicity of (a) or (b) may be adequate, depending on the supply current step that can be tolerated. For wideband applications, keeping supply currents balanced is the key to success (c).

channel increases, so does the bandwidth of the emi-sensitive amplifier, until eventually no selectivity will be available to suppress transients. For TTL transients, this occurrence may be defined by setting Eq. 2 equal to 0 dB and solving it for bandwidth. For a 10-ns rise time, the result is the previously used 35-MHz bandwidth.

It is impossible to quantify the attenuation needed accurately enough to completely prevent the receiver from requiring special techniques to reject emi. However, if the designer decides that the receiver should reject all emi that has a peak amplitude of 10 times the peak input signal, then the receiver gain at the noise frequency must be 20 dB less than the signal gain. Thus, the selectivity has to be 20 dB.

If it is also assumed that the emi has a 10-ns rise time because it is generated by TTL current swings, then the designer can estimate a receiver bandwidth number above which special emi rejection techniques have to be used. This bandwidth is 3.5 MHz for 20 dB of required selectivity on a transient with a 10-ns rise time.

These figures are representative of a system that can transmit data at 7 megabits a second. Therefore, for the sake of clarity in discussing the problems of wideband systems, it is convenient to assume that the use of simple narrowband techniques is limited to TTL systems with less than 5-Mb/s rates. The use of more elaborate wideband techniques is required for TTL systems with data rates of 10 Mb/s and above. Which techniques are usable for TTL systems between 5 and 10 Mb/s depends on the particular system in question, the skillfulness of the design, and the kinds of emi present.

In designing an optical transceiver for a wideband fiber-optic data link, the first priority is to modulate the LED by providing the required current drive levels and to do so quickly enough not to degrade the system rise time or introduce excessive timing distortion. The second priority is to implement the first function while generating a minimum amount of electromagnetic interference.

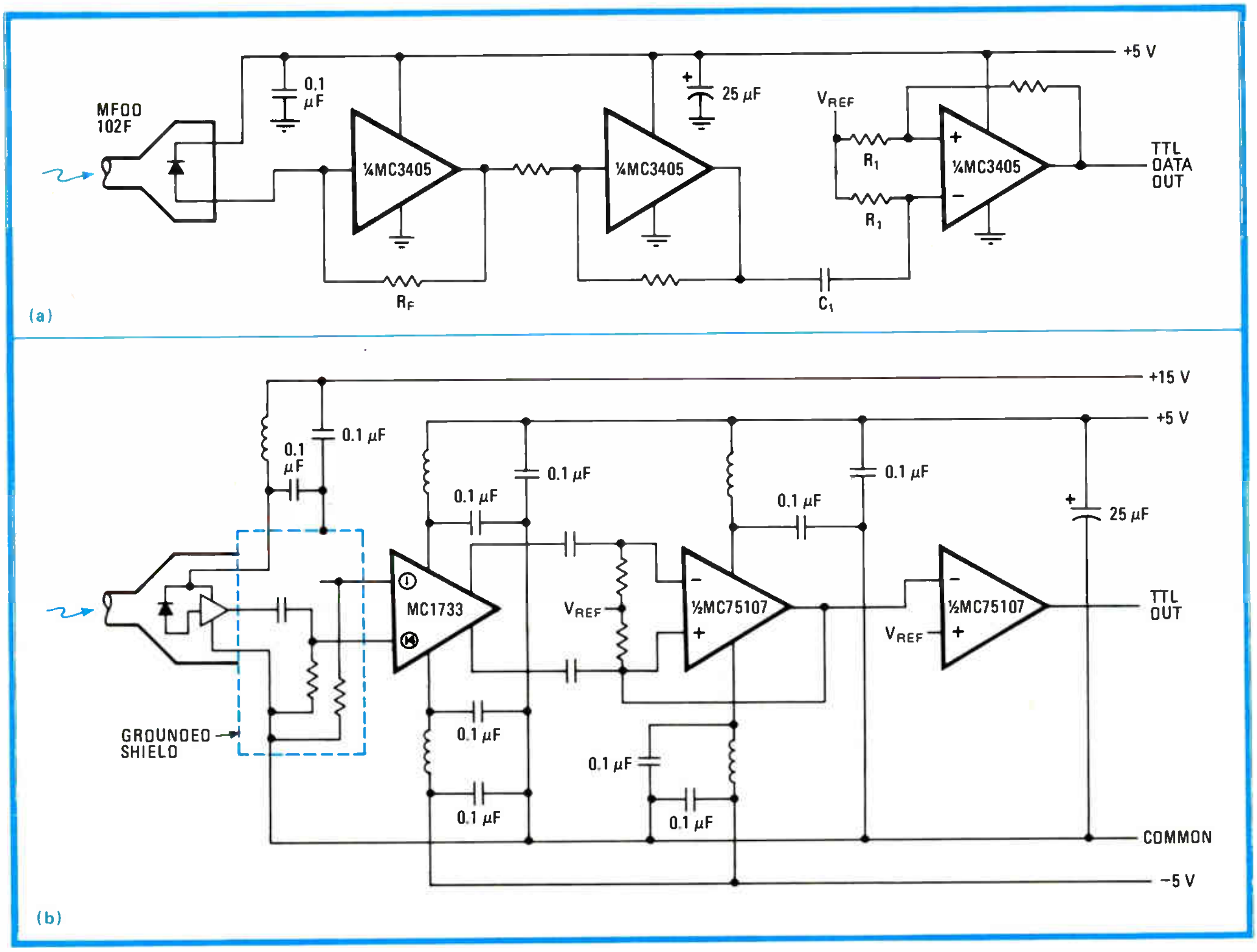
For narrowband systems, a simple, low-cost TTL fiber-optic transmitter may prove adequate even if configured alongside of an optical receiver. Care must also be taken with power-supply bypassing.

A simple design

The design illustrated in Fig. 2a uses the MC75454, a 300-mA peripheral driver capable of sinking the current normally flowing through an LED. The 39-ohm resistor, the LED forward voltage drop, and the regulated +5-V supply allow 100 mA to flow through the LED when the input is high. When the input is driven low, the MC75454's open collector output and the LED turn off. Besides driving the LED directly, the MC75454 interfaces the LED with the TTL family. What makes this a poor way of driving the LED for a wideband application is the step in supply current when the device turns on or off. In this case the step is equal to the LED current (100 mA, to be specific).

Figure 2b shows a variation of this simple transmitter that is also better from the standpoint of modulation of the 5-V bus. Here, the MC75453, another 300-mA line driver, is normally on when its input is low, so that current is shunted around the LED. When the input is driven high, the MC75453 open collector output is driven off, allowing current to flow through the LED. The +5-V supply, the LED forward drop, and the 39-Ω resistor once again set the LED current to 100 mA. When the input is low, the output is sinking 5 V/39 Ω, or 125 mA.

This 25-mA step in supply current (due to output switching) is far better than the previous 100-mA step. But it is still large enough to cause cross talk in wideband systems when the transmitter and receiver are powered off the same +5-V bus. Other problems associated with these single-ended saturating LED drivers become significant at higher data rates where the driv-



3. More complicated. For narrowband TTL applications, a simple optical receiver with a minimum of external components does the job (a). For wideband TTL applications, the receiver is far more complicated and demands a variety of external bypasses and chokes (b).

ers' asymmetrical rise and fall times and their differential propagation delay distort the waveform duty cycle.

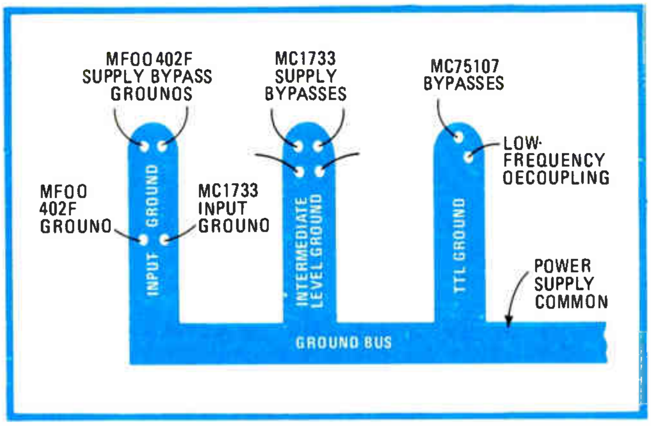
In a slightly more complex optical transmitter—which has the best emi performance of all—the LED is the collector load in one half of a differential amplifier driven by a pair of 74LS40 peripheral drivers (Fig. 2c). Here, when the TTL input is high, Q_1 and the LED are full on. When the input is low, Q_2 is full on. In either state, the drive transistor is not saturated, and the current being drawn from the supply is the current through Q_3. As long as nothing affects the Q_3 collector current, the sum of the currents through Q_1 and Q_3 is a constant, and virtually no power supply noise is produced. The diode at the base of Q_3 temperature-compensates the Q_3 collector current, so that it is essentially constant. This emitter-coupled circuit is inherently fast and the current-limited operation provides symmetrical rise and fall times.

Only one of the LS40 sections is required to drive the differential amplifier and to interface with the TTL circuitry. However, use of two of these NAND gate sections yields two advantages. The first is that with equal external pull-up resistors, the sink current on each section is the same. Hence there is no change in supply current with input logic state, and, as a result, very little power-supply noise is produced by the transmitter.

The second advantage is that each data edge will be processed as a low to high transition by one gate and as a high to low transition by the other. The effects of differential propagation delay on duty cycle distortion are thus minimized. Use of this transmitter circuitry for a TTL interface greatly reduces the amount of duplex cross talk encountered when power-supply noise is conducted back to the receiver. It also minimizes the timing distortion, generated in the transmitter, that is critical at high data rates. Finally, since the supply bus is not experiencing large excursions in current, the long printed-circuit board runners that are typically used for the bus and that act as antennas are radiating much smaller fields, in keeping with the reduced changes in current. Thus, with the balanced configuration, the emi generated is relatively low and is not sensitive to printed-circuit layout.

Some more ideas

A simple TTL receiver is also suitable for narrowband applications (Fig. 3a). It uses a p-i-n diode and a transimpedance amplifier implemented with an MC3405 operational amplifier. This drives a voltage amplifier having a gain of 100. Following this is a differentiation network (R_1, C_1) that passes the data edges but not the



4. Ground bus. For the wideband receiver, even the layout of the printed-circuit board ground bus is critical. The optical input grounds and the amplified signal grounds are not only kept separate from each other but are also separated from the TTL digital grounds.

data base line with its duty-cycle dependence. The comparator compares the amplitude of these differentiated pulses with a reference voltage that is adjusted to be midway between the TTL output levels. As long as the R_1C_1 product is chosen to be less than one fourth of the bit width and great enough to pass the input rise time without introducing excessive loss, this edge-coupled detector will tolerate any change in duty cycle. In this narrowband system, the use of a single comparator without the benefit of balanced currents, use of simple decoupling, and random grounding of component leads prove to be adequate.

In contrast, wideband receivers need more careful design. Figure 3b shows a 20-Mb/s TTL edge-coupled receiver. Here an integrated detector/preamp is used as the optical detector rather than a p-i-n diode. This device, the MFOD402F, while not of a differential design, does house the photodiode as well as a transimpedance amplifier. Following it is an MC1733 voltage amplifier having a differential gain of 100. Its input is the last point in the receiver that is a single-ended interface.

This amplifier's differential output is coupled to a TTL line receiver through two differentiation networks. The data transitions are all that couple through these networks to the line receiver, which, with its hysteresis, performs high-speed comparator functions. The differentiators and line receiver operate together as a latch.

A second line receiver section, which is available as part of a dual package, buffers the output swing of the first line receiver. The arrangement maintains constant hysteresis and also balances the TTL currents in the two logic states. The pairing of the inverting line receivers also tends to minimize any duty-cycle distortion due to differential propagation delay.

All amplifiers are decoupled from power supplies through pi networks consisting of a ferrite bead and two 0.1-microfarad ceramic capacitors. These bypass capacitors are not grounded indiscriminately but in accordance with a specific ground bus philosophy.

A ground plane structure designed to distribute ground currents and thereby reduce the effects of parasitic inductance is not used. Instead, the ground bus is used to control the direction of flow of the ground currents so that they are returned to the power supply via the proper bypass capacitors without sharing any common ground impedance with the ground currents of other stages.

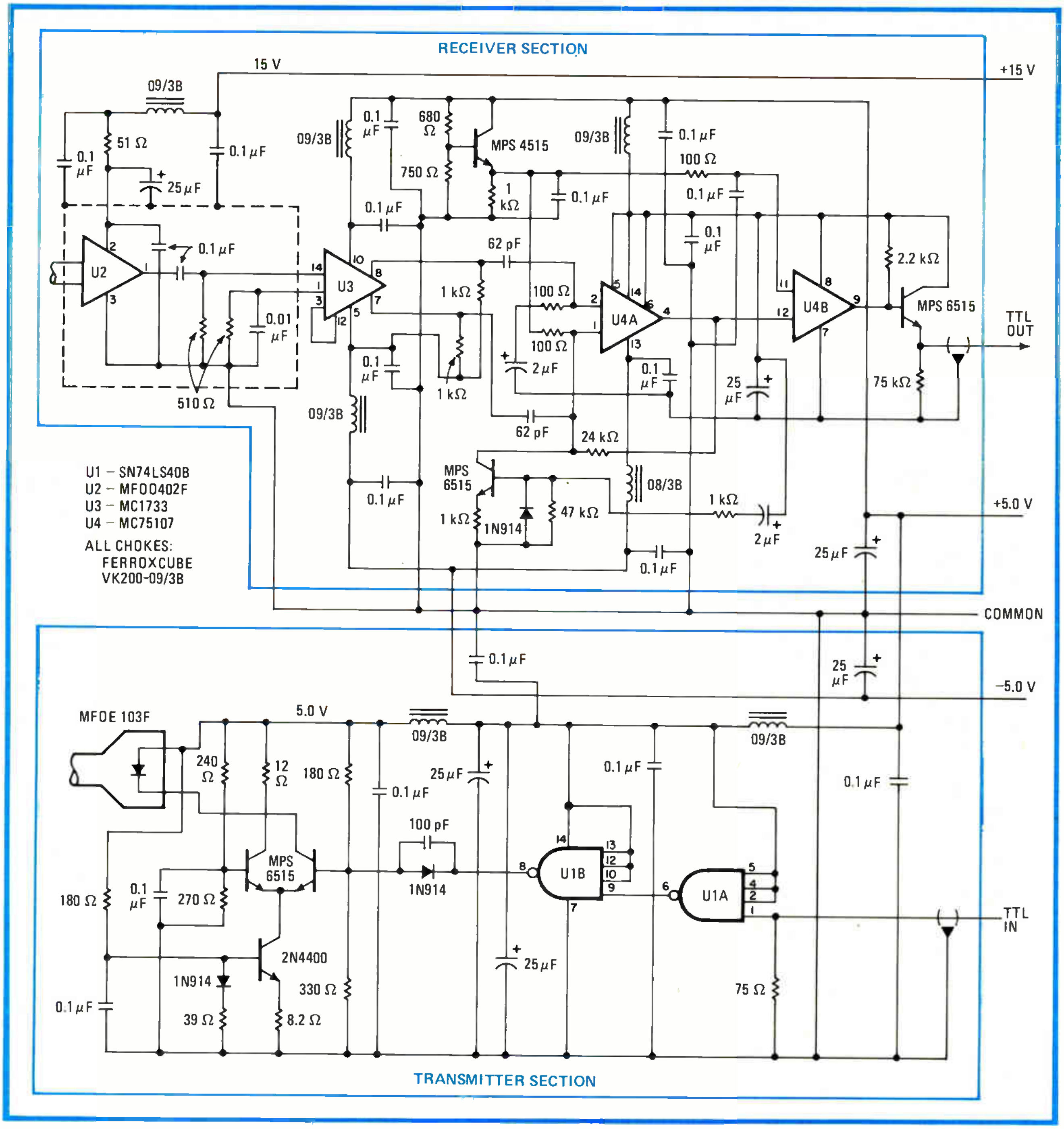
Such an approach is of particular importance at the input to the MC1733 voltage amplifier. This stage, having a single-ended input and high gain-bandwidth product, is particularly susceptible to any ringing that arises when large switching currents excite parasitic ground inductances. For this reason the input bypass capacitor from pin 1 to ground and the two input bias resistors to ground are all tied to ground bus between the detector/preamp and the MC1733 (Fig. 4). Similarly, the MC1733 supply bypass capacitors are tied to ground not near the MC1733 inputs but farther down the bus because of the larger currents they supply. Finally, the bypasses for the MC75107 are grounded even farther down the bus. This ensures that no portion of the TTL ground currents will split off and flow through the low-level ground before returning to the power supply.

The input shield is grounded to the MC1733 input ground bus. Allowing TTL ground currents to flow through this shield would only induce the undesired input signals that cause ringing and result in bit errors. But by fitting a shield into the slot of the grounded mounting bushing, by allowing only low-impedance leads to leave the detector/preamp, and finally by embedding the optical port in the grounded bushing, the emi immunity of the receiver front end is maximized.

With this grounding philosophy, none of the ground fingers is connected to any other, so that all ground currents are forced to return to the power supply locally rather than through impedances common to other stages. Also, by convention, the power-supply leads, including the common, are connected to the circuit at the high signal level end of the board. At any frequency where power-supply bypassing is ineffective because of component self-resonance, parasitic impedance, or too high a cutoff frequency on the power-supply filter, the ground currents must be returned to the power supply via the supply leads. The resulting impedance will be substantially higher than the normal bypass impedance and should be minimized for the largest ground currents. That is why the power leads are connected at the high-current end of the board.

Other considerations

Some other aspects of wideband receiver construction are essential to good system performance. For example, the MC1733 pin assignments (Fig. 3b) indicate that the inputs and outputs of the amplifier are at opposite ends of its dual in-line package, affording maximum isolation between them. Extending this concept to the entire receiver fabrication suggests that all ICs should be positioned on the board in the direction of signal flow, with optical inputs at one end and TTL output at the opposite end. Also, since the MC1733 input is sensitive to radiated emi, the TTL electrical interface should switch from twisted pair to coaxial cable as the designer shifts from narrowband to wideband systems. In addition, if the receiver is to be operated in a hostile emi environment, a



5. The whole thing. It is possible to make a fiber-optic transceiver on one printed-circuit board and still keep electromagnetic interference problems to a minimum. The details of this wideband circuit are described in Motorola Application Note AN-794.

shielded enclosure is required, to be placed around the entire unit.

The techniques discussed have been applied to a practical optical transceiver (Fig. 5). Here the receiver bandwidth is minimized and thus the selectivity is optimized for a 20-Mb/s data stream. As the data rate is lowered, the sensitivity remains the same, and thus there is the ever-increasing disadvantage that results from using a 20-Mb/s receiver for narrower-bandwidth applications. The receiver partitioning employed is optimum, given the fact that the differential-output detector/preamps and the receiver IC (MFOC600) were not available at the time for this design.

The transmitter and receiver circuits have been designed for optimal balancing of supply currents between logic states. The transmitter circuit resembles the one in Fig. 2c, and the receiver circuit the one in Fig. 3b. The receiver's individual amplifiers have been decoupled with pi networks and the component grounds have been laid out in a bus structure. All the circuitry has been laid out on a double-sided printed-circuit card without plated through-holes. □

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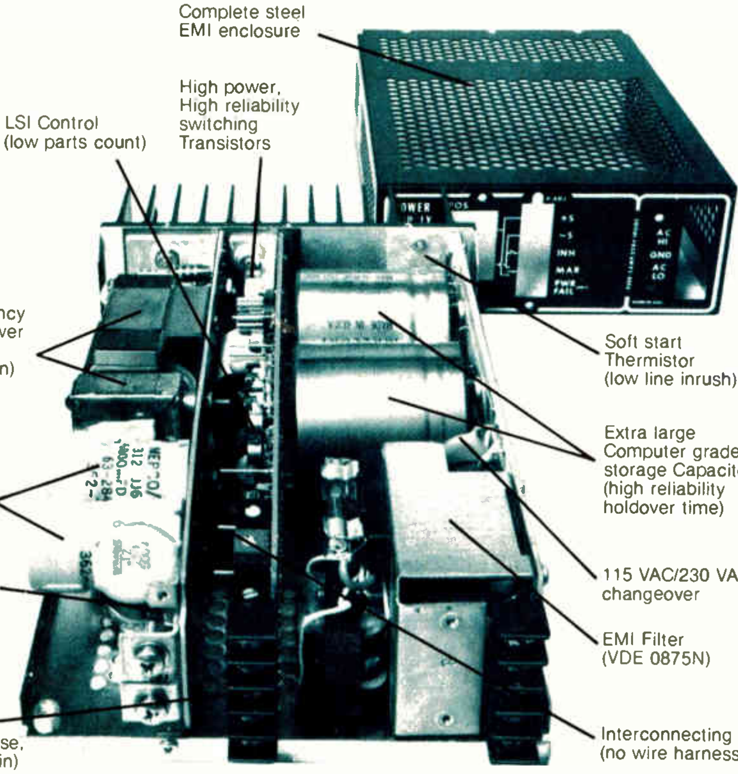

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6	8.0	9.0	25.0	50.0	—
12	4.5	9.0	13.5	27.0	31
15	3.6	7.2	10.8	21.0	25
18	3.0	6.0	9.0	18.0	—
24	2.5	4.5	7.0	13.0	15
28	2.0	4.0	6.0	11.5	—

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Circle 153 on reader service card

Low-power inverter ignites gas-discharge lamps

by Akavia Kaniel
Measurex Corp., Cupertino, Calif.

This inexpensive low-power inverter generates the high voltage required to ignite gas-discharge lamps of the mercury-vapor type and supplies the small current needed to maintain conduction. It also prevents the deposition of ions on the lamp's cathode that tends to shorten its operating lifetime. Using one integrated circuit, an operational amplifier, and two field-effect transistors, the inverter can be built for less than $30, including the cost of the unit's pulse transformer.

As shown, the SG3524 pulse-width modulator and transformer T_1 convert a 24-volt dc input into the 1,500-v potential required for turning on the Ultra Violet Products 11SC2 lamp. When switch S_1 is closed, the chip's E_a output goes high, thus inducing a high-voltage square wave across T_1's secondary.

As current begins to flow in the primary, feedback amplifier A_1 comes into play. Detecting the relative magnitude of the current through the 0.2-ohm sense resistor, A_1 automatically sets the width of the 20-kilohertz modulating pulses so that a constant ac current of 5 milliamperes is delivered to the lamp. Use of a push-pull output and the balanced transformer connection ensure that the switched square wave is symmetrical about the zero axis. This ac driving signal thus prevents the migration and subsequent buildup of ions around the lamp's cathode. □

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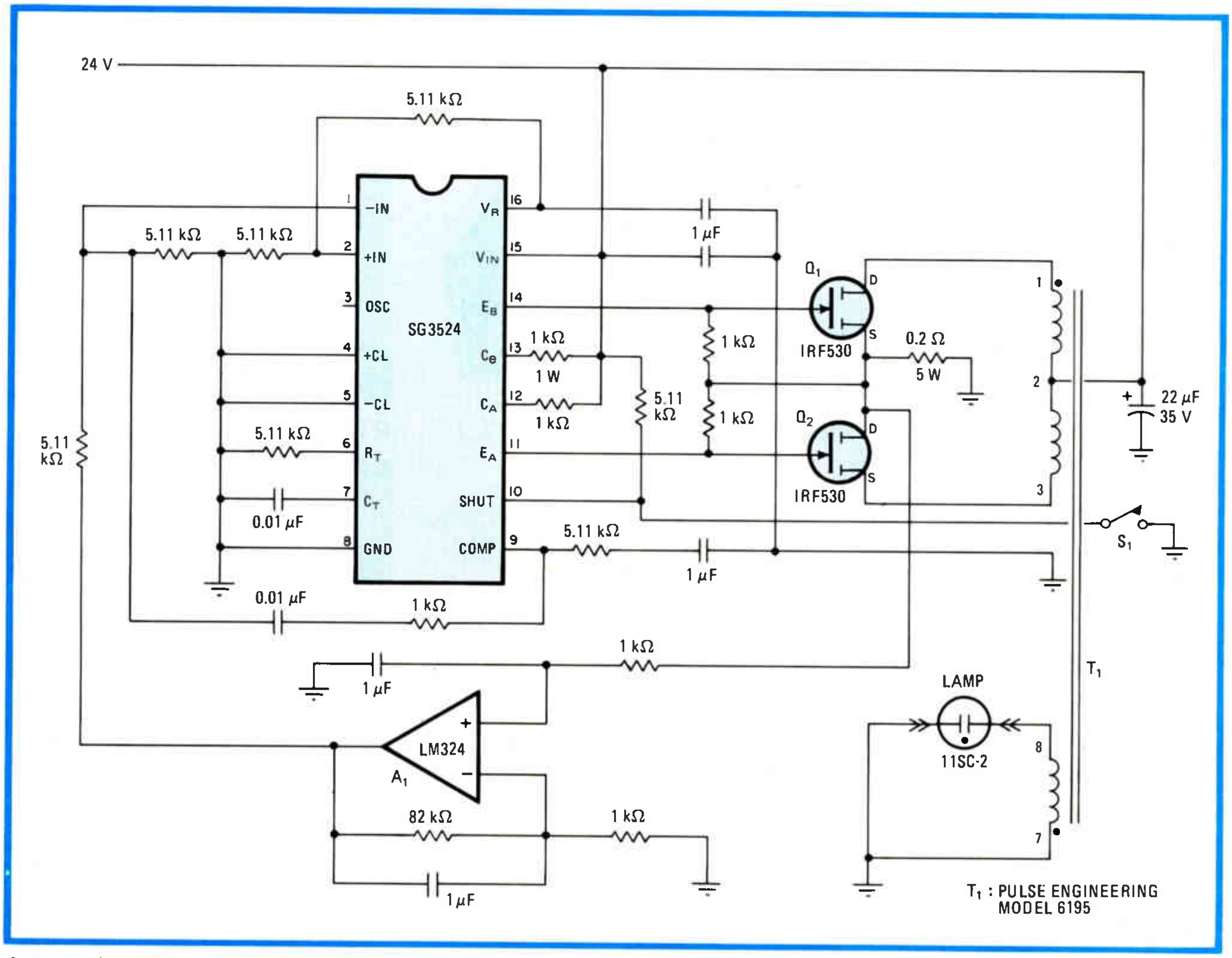


Arc-over. Low-power transistor-driven inverter generates high-voltage square wave to fire fluorescent and mercury-vapor lamps and provides low current to maintain ionization. Symmetry of inverter's output prohibits build-up of ions at lamp's cathode, thus increasing operating life.

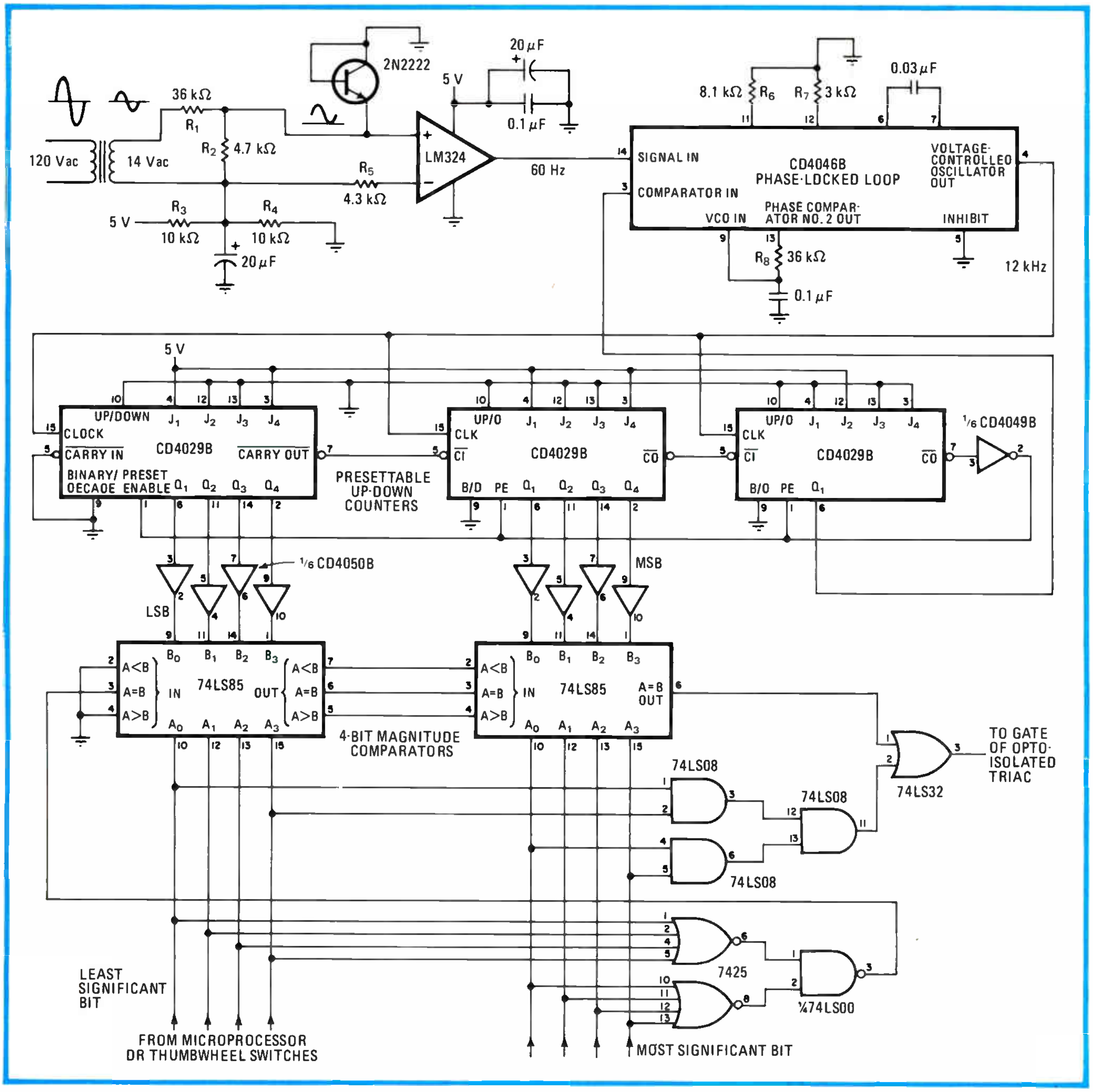
Lamp dimmer fades in equiluminous steps

by Mark E. Patton
Sanders Associates, Nashua, N. H.

This programmable light dimmer will serve particularly well as an intensity-control source for vision response testing and in theatrical lighting systems, where it can provide, as perceived by the human eye, a virtually linearly stepped increase or decrease in luminous output (the Munsell curve).[1] Using readily available chips, it can be built for less than $20.

In operation, a triac-driven lamp is triggered by the 60-hertz line input once during each half cycle, at a point determined by an eight-input binary-coded decimal control word derived from a microprocessor or a thumbwheel switch. Thus the lamp brightness may be easily selected and accurately maintained, or alternatively, it can be gradually diminished or increased as desired.

As shown, the LM324, biased to operate from a 5-volt dc supply, works as a comparator to provide 60-Hz square-wave pulses to the CD4046 phase-locked loop and as a buffer to suppress line transients. The PLL and the 4029 up-down counters working together act to



Linear lighting. Programmable lamp dimmer can provide intensity increments and decrements in near-linear steps (as perceived by human eye), virtually meeting Munsell curve specifications. BCD control word, derived from microprocessor, sets switching point on 60-Hz line input.

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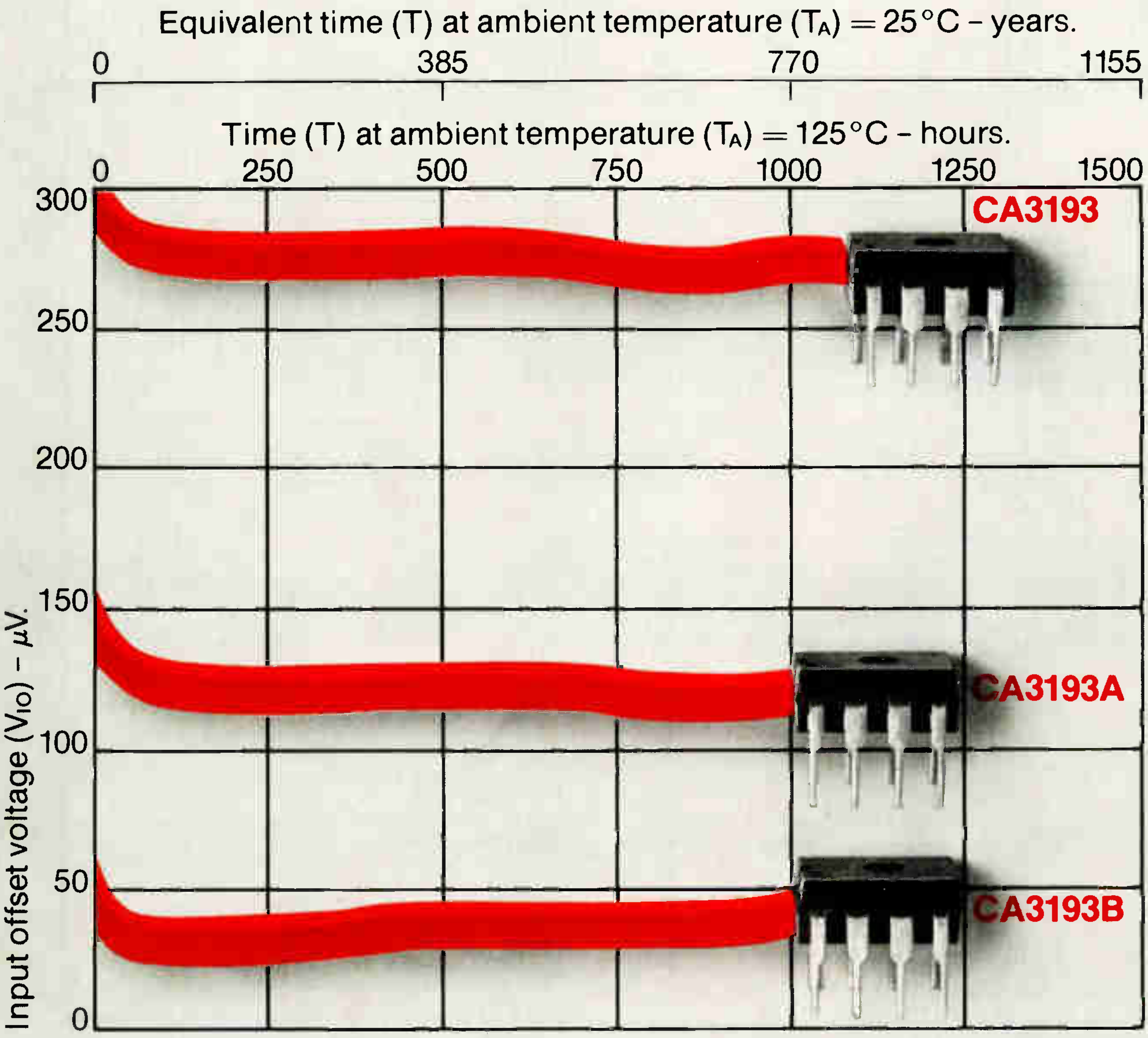

RCA

Circle 156 on reader service card

multiply the line input by 200, so that the counters decrement from 99 toward 0 at a 12-kilohertz rate. This rate permits the selection of 12,000/(60×2) = 100 brightness levels.

Meanwhile the two-digit BCD control word is introduced to the 74LS85 4-bit magnitude comparators, where it is compared with the output of the counters. When the line-synchronized output of the counter becomes equal to the control word, the opto-isolated triac, which is connected to the ac line, is fired.

The triac should be heavily filtered to prevent switching noise on the line from reaching the logic circuitry. Also, to increase circuit stability near the zero and maximum-voltage switching points of the 60-Hz input signal, the outputs of the 74LS85s are gated for a loaded BCD code of 99 and are disabled for a code of 0. □

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1. GTE Sylvania, GTE Sylvania Lighting Handbook, 5th ed., 1974.

Zero-crossing controller heats beakers noiselessly

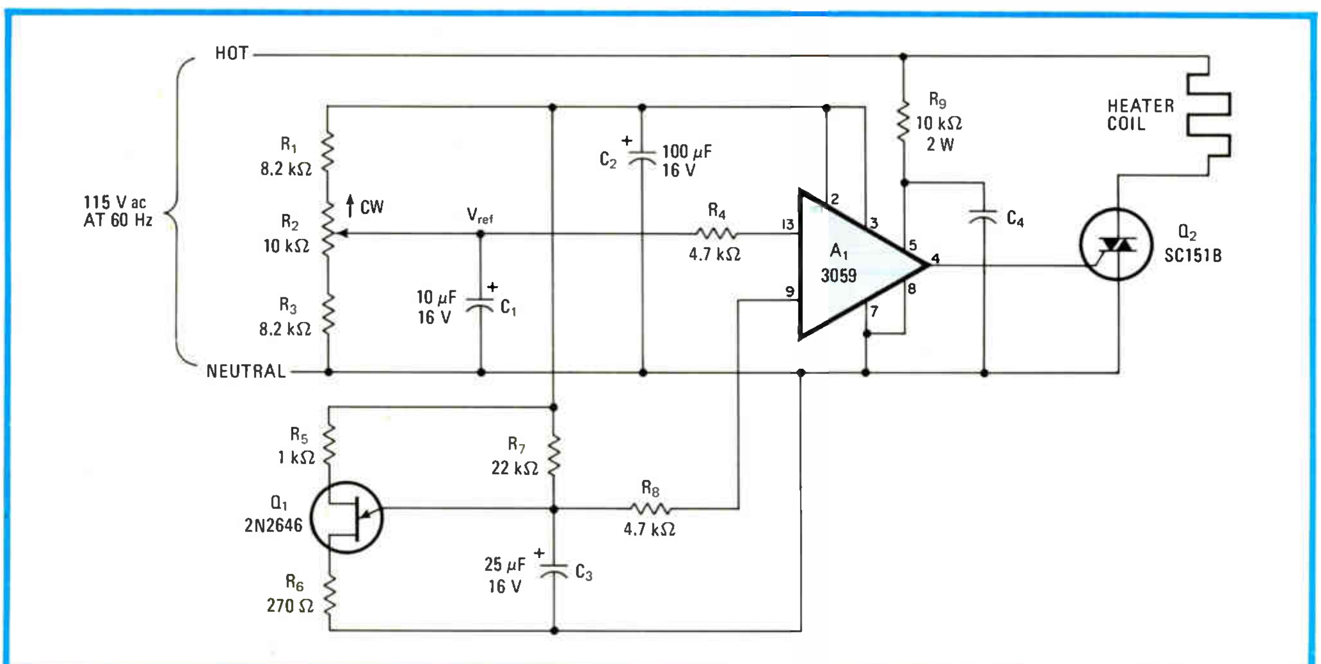
by Gerald D. Clubine
East Texas State University, Fine Instruments Shop, Commerce, Texas

Present-day low-cost heater/dimmer controls of the type used to warm the contents of laboratory beakers and flasks are primarily modeled after the hot-plate burners in electric stoves. Consequently, they feature thermal switches that generate unwanted electronic hash and noise spikes because of the make-and-break operation of the device under a varying thermal load. This circuit controls heat by varying the duty cycle of the heater coil—but it switches the coil on and off during the zero crossings of the 115-volt ac power line, thus eliminating all types of noise. In addition to offering solid-state reliability, it costs no more than the old hot plate. And it is far less costly than the widely used but unnecessary closed-loop controls that use a sensing element.

The heart of the circuit is the CA3059 zero-crossing trigger, A_1, which controls the solid-state switch, triac Q_2. As shown, the ramp output of the unijunction oscillator Q_1 is applied to the on/off sensing amplifier at pin 9. The ramp has a peak amplitude of ⅔ V_c and a time constant of R_7C_3, which is long compared with the 60-hertz line rate but relatively short with respect to the thermal response time of the hot plate.

A user-set reference voltage is applied to the other input of the sensing amplifier at pin 13. Potentiometer R_2 thus sets the temperature by control of the duty cycle, for when V_{ref} is greater than the instantaneous ramp voltage, A_1 and Q_2 are turned off, and vice versa. Note that the control calibration will be linear to the degree that the ramp voltage is linear. Power is applied to the heater coil during the zero crossings of the line input and removed during these times, too; as a result, switching is achieved at the zero power level, and no noise can be generated.

The choice of the triac will depend upon the amount of current required by the heater coil. In this case, a SC151B has been used, as the heater coil demand was only 6 amperes. □



Selective radiator. A triac fired by this controller applies power to and removes power from heater coil of hot plate during zero crossings of the 115-V ac power line, thus eliminating unwanted electrical hash and noise formerly caused by mechanical-type thermal switches. User sets temperature with duty-cycle control R_2, which turns on A_1 and triac when V_{ref} is less than the instantaneous ramp output of oscillator Q_1.

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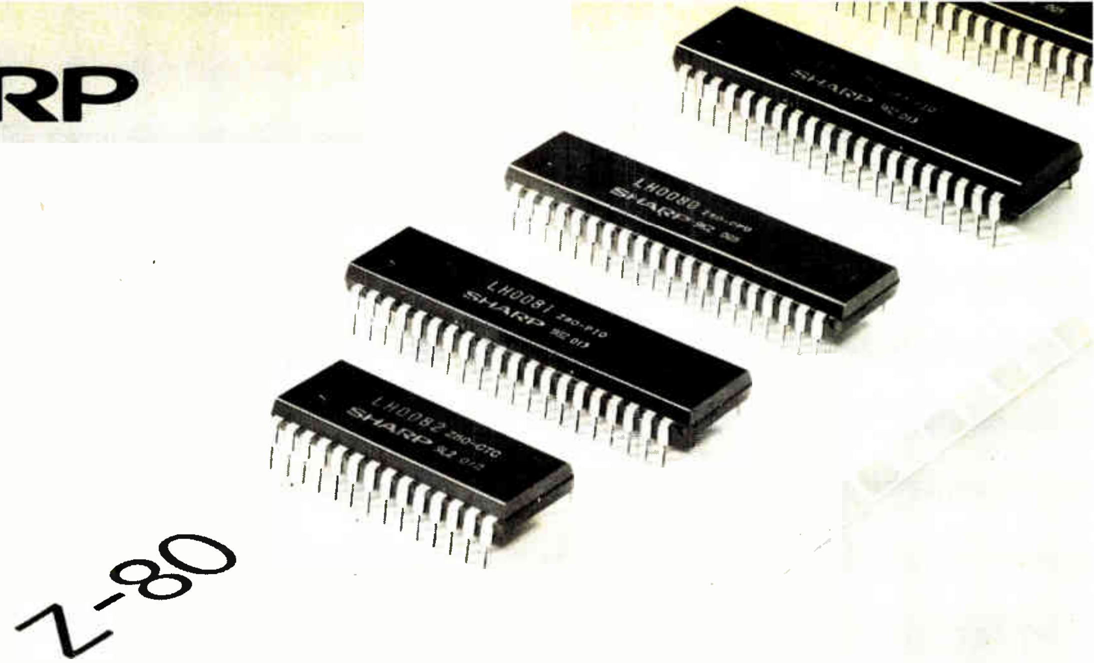

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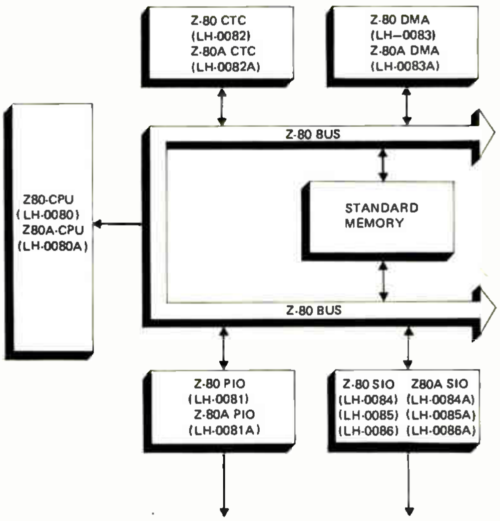

ZILOG	SHARP Type No.	Explanation	Features	Package
Z-80 CPU Z-80A CPU	LH-0080 LH-0080A	Central Processing Unit	• 158 instructions — includes all 78 of the 8080A instructions • Three modes of maskable interrupt plus a non-maskable interrupt • 22 internal resisters • •	40 DIP
Z-80 PIO Z-80A PIO	LH-0081 LH-0081A	Parallel I/O Controller	• Two independent bidirectional ports • Any one of the following modes of operation may be selected for either port: Byte input/output, Byte bidirectional bus, Bit Mode • •	40 DIP
Z-80 CTC Z-80 CTC	LH-0082 LH-0082A	Counter Timer Circuit	• Four independent programmable 8-bit counter/16-bit timer channels • Single phase clock • •	28 DIP
Z-80 DMA Z-80A DMA	LH-0083 LH-0083A	Direct Memory Access	• Single channel 2 port • Three classes of operation • 3 Modes of operation • Up to 1.25MB search rate • •	40 DIP
Z-80 SIO/0 Z-80 SIO/1 Z-80 SIO/2 Z-80A SIO/0 Z-80A SIO/1 Z-80A SIO/2	LH-0084 OH-0085 LH-0086 LH-0084A LH-0085A LH-0086A	Serial I/O Controller	• Two full duplex channels • Asynchronous operation • Binary synchronous operation • HDLC IBM SDLC Mode • 0 ~ 550k bits/Sec • •	40 DIP

Vcc (V): +5 • Z-80. clock frequency 2.5MHz Z-80A: clock frequency 4MHz

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Current protectors take on surges without resetting or replacement

With lower initial resistances than thermistors, conductive polymer switches also combine the advantages of fuses and resettable circuit breakers

by George Ballog, *Raychem Corp., Menlo Park, Calif.*

☐ The positive temperature coefficient of some thermistors, which increase in resistance in response to increasing current, is a circuit-protection phenomenon that has been successfully exploited for several years. But these devices could never handle large currents of a few amperes or more because of their high initial resistances. Fuses and circuit breakers can take on large currents but must be replaced or reset periodically. Now, recent advances in polymer material formation have made possible switching devices that can handle large currents and have the advantages of slow-blow fuses and resettable circuit breakers without their disadvantages.

The new devices, trademarked PolySwitch protectors, offer designers an attractive alternative to low-voltage fuses and magnetic or thermal circuit breakers for applications requiring high-current interruption, vibration resistance, slow-blow current limiting, remote-reset capability, and freedom from electromagnetic and radio-frequency interference.

PolySwitches rely on unique polymeric materials to duplicate in a more usable form the positive-temperature-coefficient switching effect of thermistors. They offer virtually unlimited design possibilities for surge-controller, energy-limiter, battery-discharge limiter, and time-delay-multiprotector circuits, to name just a few [*Electronics*, June 19, 1980, p. 42].

Reducing initial resistance

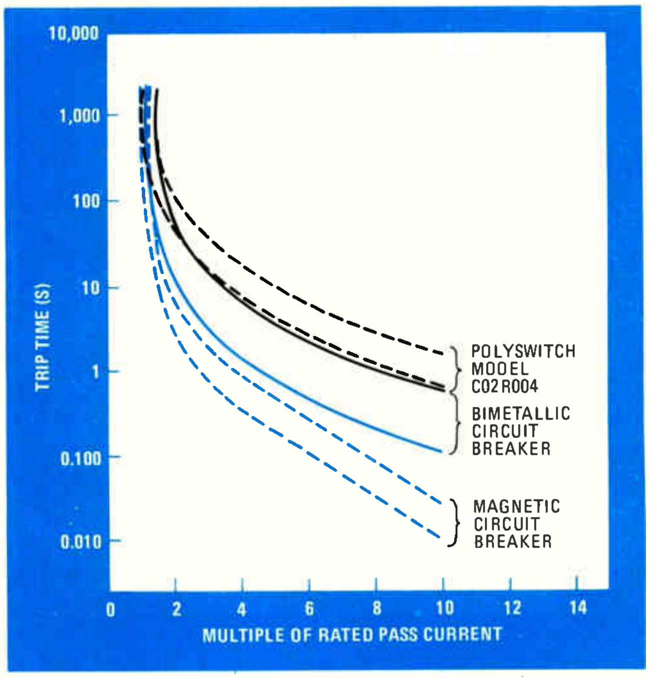
The most common positive-temperature-coefficient thermistors are made of doped barium titanate. Their resistance generally increases exponentially when their temperature exceeds a value known as the Curie point. This increase effectively cuts off power to the circuit a thermistor is operating in. The Curie point differs for each device, depending on its chemical composition.

Though the thermistor has good resistance behavior with temperature rises, its chief drawback is its initially high resistance. This resistance produces high I^2R heating sufficient to trigger a much higher resistance at currents as low as a few hundred milliamperes. The initial resistance is generally at least 10 ohms and restricts a thermistor's role in circuit designs to that of a sensor or heater.

As for fuses, even the slowest-acting generally blow within seconds at currents as low as two times the rated current. The positive tempco of PolySwitch protectors, however, is not limited by high initial resistance. These circuit protectors have a base-level resistance as low as 0.04 Ω, about 1/250 the resistance of generally available thermistors, making them nearly invisible in a power circuit and ideally suited for high-current operations.

A PolySwitch protector functions much like a resettable fuse, but unlike a fuse it offers a slow-blow behavior proportional to the amount of overcurrent passing through it. When exposed to an overcurrent, the device increases in resistance by up to seven orders of magnitude. Switching time can range from tens of milliseconds to 40 seconds or more, depending on the amount of current. Once the protector switches into the high-resistance state, it stays latched and will not decrease back to its base value unless there is a complete interruption of power.

During PolySwitch fabrication, radiation-crosslinked polymer material is mixed with a filler material to form



1. Protection. The slow-blow characteristics of a fuse and the resettable characteristics of a circuit breaker are combined in a PolySwitch. The resettable positive-temperature-coefficient device takes longer to trip due to overcurrents than other protective devices.

a pill-shaped object. Leads are then attached and an electrical-grade epoxy is applied as an encapsulant.

The choice of polymer and filler material and the exact geometry of the final part are the chief factors in determining the device's current rating. This relationship can be expressed by the basic resistance equation:

$$R = \rho L/A$$

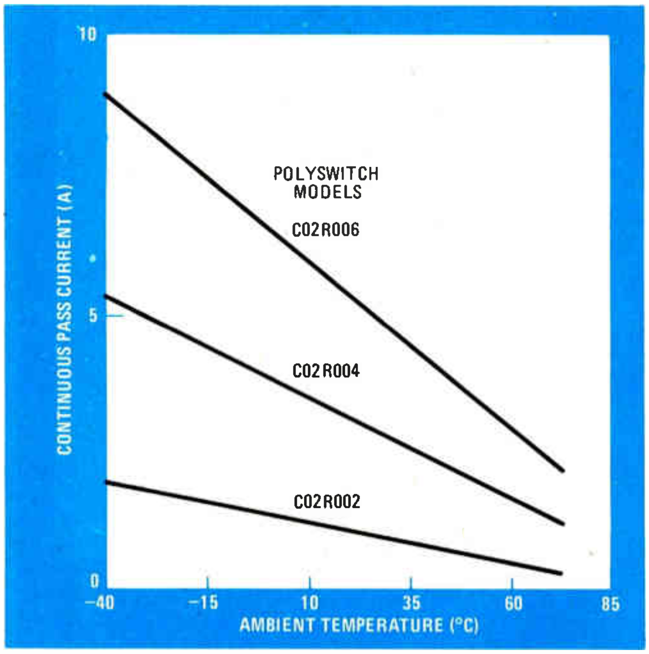
where

R = the device's resistance in ohms
ρ = the material's resistivity in ohm-centimeters
L = the device's length in centimeters
A = the device's area in square centimeters.

Here L corresponds to the device's thickness, since the current travels through it from one flat surface to another. As is seen in the equation, the larger the area of the pill-shaped device, the lower its resistance value, so a higher current will be needed to achieve the necessary power-dissipation level to raise its temperature to the switching point. All PolySwitch devices are designed to meet most MIL STD 202 test specifications.

Slow tripper

Figure 1 shows how the slow-blow characteristics of a PolySwitch protector compare with those of typical magnetic and thermal circuit breakers. Note that for increasing multiples of rated pass current, the device takes longer to trip than other circuit protectors. At twice the rated pass current, for example, it will require a minimum of 40 seconds to trip, whereas a bimetallic circuit breaker trips within as little as 15 seconds. At 10 times the rated pass current, its slow-blow characteristics are even more pronounced; it takes at least 600 ms to trip, compared with 100 ms for a bimetallic circuit breaker.



2. Temperature. Different PolySwitch models are rated for different continuous pass currents (in low-resistance states). All protectors decrease in current-passing capability with increasing ambient temperatures. Switching time increases with increasing currents.

Different PolySwitch sizes are rated to trip at different times for different currents. For example, the CO2R004 trips in 60 seconds at 6 amperes, 10 seconds at 12 A, and 2 seconds at 24 A. Higher currents produce even more rapid tripping times. Figure 2 shows the relationship of continuous pass current to ambient temperature for three different parts.

A PolySwitch operating as a circuit protector can best be illustrated by its use in series with a load in a simple circuit whose nominal load resistance is 40 Ω. In accordance with Ohm's law, the 50-volt circuit produces a current of 1.25 A and a power dissipation of 62.5 watts in the load.

Increasing power dissipation

With no power applied to the circuit, the PolySwitch protector is cool and exhibits an initial resistance of only 0.1 Ω, insignificant when compared with the larger load resistance of 40 Ω. In this untripped state, it dissipates only 0.16 W. If the circuit develops a short across the load, this causes an increase in current and, within seconds, an increase in the PolySwitch's resistance to 1,250 Ω, making it the primary load in the circuit. It can thus be seen that the power dissipation (V^2/R) across the device will increase to 2 W while that across the 40-Ω load drops to 0.06 W. More important is that current in the circuit is reduced to only 40 mA.

In the high-resistance state, a PolySwitch's continuous safe operating voltage is rated at 50 V, and its temperature remains around 100°C. The device must be allowed to cool to its initial low resistance for the circuit to reset, and the only way to do this is to interrupt the circuit's power completely. Trying to cool the part by external means while voltage is applied across it will only cause it to draw more power to maintain its temperature in the range of 100°C. Sufficient cooling down for resetting, once power is manually switched off, takes about 3 to 4 minutes.

Heat causes a PolySwitch protector to switch from a low-resistance to a high-resistance state. In operation, the switching is based on a complex relationship between power delivered to the device in the form of current and the power it dissipates to the environment as heat.

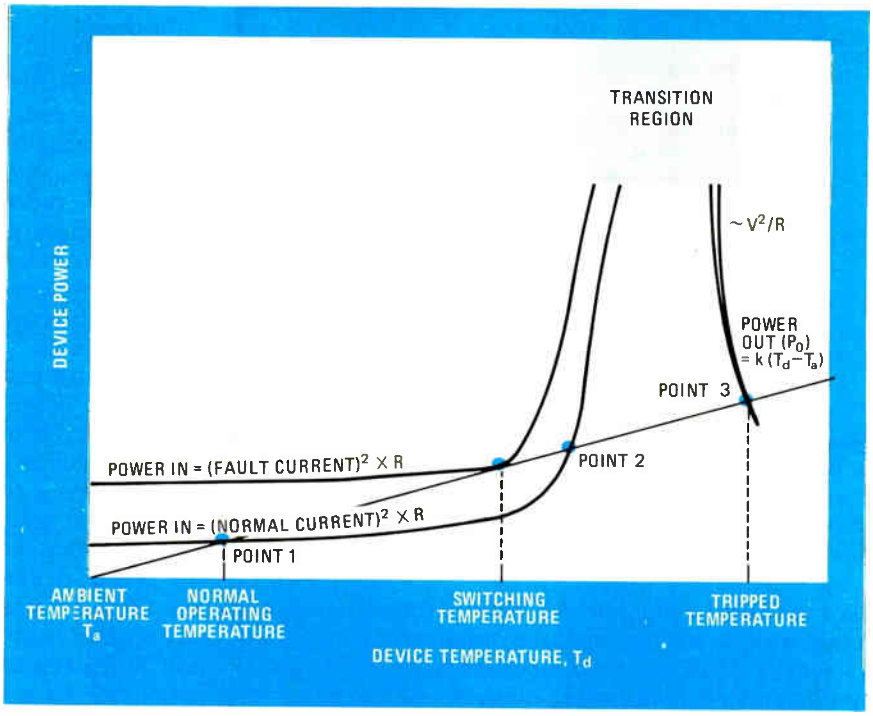
When plotted as a function of temperature, power input (power delivered to a PolySwitch) appears as a curve whose slope increases sharply at the device's switching temperature (Fig. 3). Power output (power dissipated to the environment) is a straight line whose slope intersects the X axis at a point corresponding to the ambient temperature. This line is known as the power-dissipation line and is straight because of the following relationship:

$$P_o = K(T_d - T_a)$$

where

P_o = the output power in watts
K = the device's heat-transfer coefficient (approximately 0.02 W/°C in still air)
T_d = the device's temperature in °C
T_a = the ambient temperature in °C.

The power-dissipation line's position relative to the input-power curve determines the operating state of the



3. Heat. A PolySwitch switches to a high-resistance state due to its current-induced heat rise. Heat dissipated to the ambient increases as the PolySwitch tries to maintain a body temperature of 90° to 100°C, increasing in resistance with increasing currents.

PolySwitch protector. Tracing along the input-power curve, note that each point of intersection with the power-dissipation line represents a stable (points 1 and 3) or unstable (point 2) equilibrium. The slope of the power-dissipation line is determined by the device's geometry and manner of cooling (by forced or still air, for example).

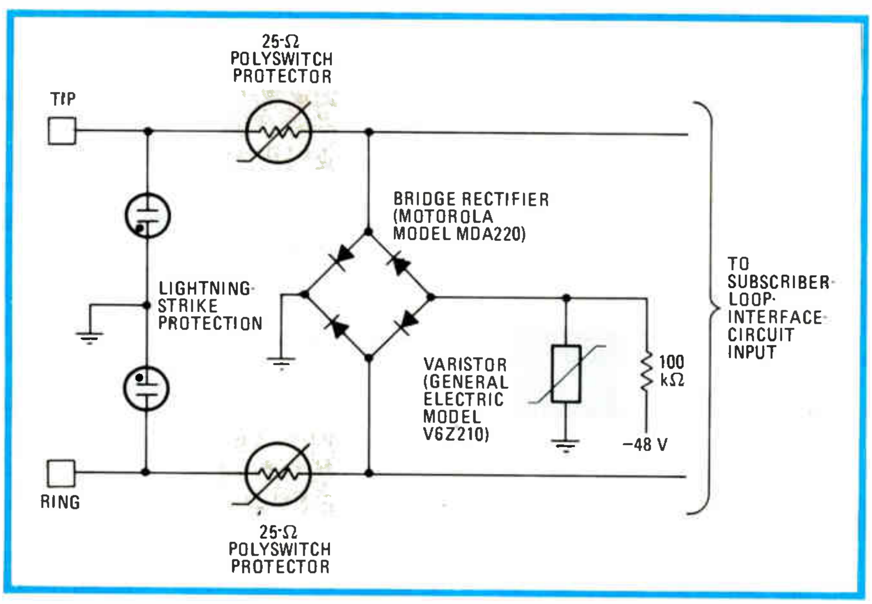
Point 1 on the curve, where input and output power are equal, represents the normal operating condition of the PolySwitch protector in a low-resistance state. When a short occurs in the circuit, input power to the device increases. When input power increases beyond the point where it is tangent to the power-output curve, the PolySwitch is in an unstable equilibrium and will rapidly shift its operating state to point 3 on the curve.

If an overcurrent does not raise the device's power-input curve sufficiently to separate the curve from the power-dissipation line, it will operate at a higher-temperature (point 1) equilibrium.

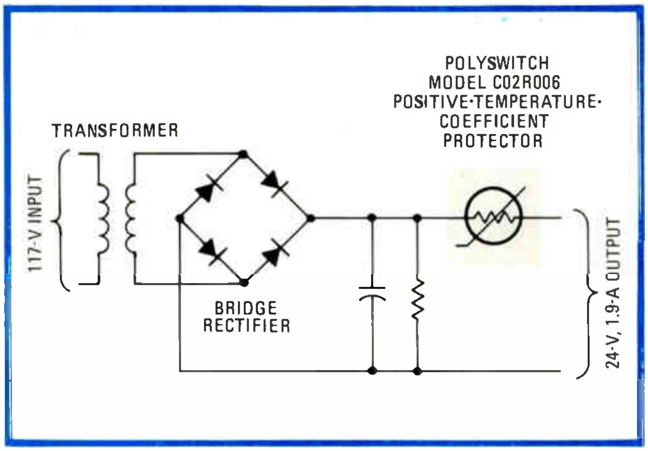
Point 3 represents the PolySwitch's high-resistance equilibrium state, a state in which input and output power are equal. At point 3, power to a circuit with a PolySwitch is effectively cut off and self-heating keeps the device at point 3 until power is completely interrupted.

Design possibilities abound

PolySwitch protectors have been used in several different circuits, improving performance at a lower cost than possible with other techniques. For example, they ensure intrinsically safe operation in an explosive environment in communications transceivers manufactured by Motor-



4. Telecommunications. Sensitive telecommunications components like subscriber-loop interface circuits can be protected against destruction by PolySwitches. They afford protection even when telephone and ac power lines accidentally touch.



5. Power supplies. PolySwitches find use in telecommunications power supplies that conform to Underwriters Laboratories Safety Standard 1012. Conventional ceramic PTC devices cannot pass typical operating currents before tripping into a high-resistance state.

ola Inc., Fort Lauderdale, Fla., where they are placed in series with a resistor and the transceiver load. PolySwitches replace a multicomponent circuit and operate over an ambient temperature range of −40° to 60°C.

In the Motorola transceivers, a PolySwitch protector functions as a resettable slow-blow fuse, passing the transceiver's 1-A transmitting, 90-mA receiving, and 8-mA standby currents while guarding against overcurrents of 2 A or more. Furthermore, the PolySwitch-resistor pair limits spark energy—an extremely important characteristic in an explosive environment.

Current and/or voltage surges are well-known enemies of semiconductor integrated circuits. For telecommunications circuits, such surges can result from lightning or from induction or direct contact between telephone and power lines. Figure 4 illustrates how two special high-voltage PolySwitches were used for secondary overcurrent protection in a circuit incorporated into subscriber-loop interface circuits (SLICs).

Special protection

In this circuit, gas-discharge tubes or carbon-block arresters give primary protection by absorbing lightning energy and limiting the peak-instantaneous voltage at the so-called tip and ring terminals to less than 1,000 V with respect to ground. The PolySwitch protectors, on the other hand, limit peak-instantaneous currents so that the maximum voltages at the SLIC input terminals are less than +3 and −150 V.

Induced transient voltages below the discharge tubes' breakdown voltage produce lower-level currents that result in lower-level output voltages. As long as their power-handling capabilities are not exceeded, the varistor and diode bridge will continue protecting downstream components from extended faults by limiting voltage. But only the PolySwitch protectors can keep the standard protective circuitry from quickly becoming overloaded if power and telephone lines come into sustained contact. When either protector is exposed to currents in excess of 100 mA for a specific period of time (depending on the model), it undergoes a reversible shift to a high-resistance state, decreasing the circuit current.

In operation, the steady-state application of a 240-V alternating current potential between either tip or ring terminal and ground causes the PolySwitch protector to switch to a resistance of approximately 95,000 Ω. This switching action severely limits circuit current to about 2.5 mA, causing approximately 0.6 W to be dissipated by the varistor and/or diode bridge. Consequently, the continuous application of power-line voltage will not damage these components, allowing them to continue limiting output voltages to very low levels.

When the power-line fault is removed from tip and ring terminals, the PolySwitch protectors cool down, returning to a low-resistance value of about 25 Ω.

Another telecommunications application for the protectors involves power supplies built to meet Underwriters Laboratories standards. UL Safety Standard 1012 for power supplies requires that telephone system supplies be limited in both maximum current and voltage-current outputs under short-circuit conditions. Based in part on the National Electrical Code requirements for Class 2 and Class 3 circuits, the standard specifies that approved power supplies must be limited in energy when overcurrent protection is bypassed (including fuses and circuit breakers). As a result, designers have been forced to continue with the only method available to them—that is, the use of costly energy-limiting transformers. A recent UL ruling, however, lets them substitute a reliable positive-tempco resistor in series with the secondary winding of a standard transformer, to comply with UL Safety Standard 1012 (Fig. 5).

But there is a catch. Conventional ceramic positive-tempco devices cannot carry the typical operating currents of telephone-type power supplies. For example, an existing six-key small-business telephone system draws from 0.6 to 1.9 A from its power supply during normal operation in an ambient temperature up to 70°C. At these current levels and temperatures, the devices, whose base-level resistance is seldom below 10 Ω, trip into a high-resistance mode.

A CO2R006 PolySwitch protector, rated at 40 milliohms at 25°C, solves this design problem by allowing normal operation of the system at 1.9 A up to 70°C. And in the event of a short circuit, it limits output power in compliance with the UL 1012 test procedure.

Whereas an energy-limiting transformer could add several dollars to the cost of a power supply, the PolySwitch protector adds less than a dollar. Typically, no other power-supply modifications are needed.

Protecting batteries, too

PolySwitch protectors have even found a niche in emerging battery technology. Lithium batteries are being considered for a variety of applications from electric automobiles to ICs and memories. But if discharged too rapidly, certain lithium cells overheat and vent potentially hazardous gases.

PolySwitch protectors are currently being tested in various lithium battery designs. While protecting against sustained high-rate discharges, the PolySwitch's slow-blow characteristic ensures that momentary current pulses will not shut off the battery, something that might very well happen with a fuse. □

C-MOS uncommitted logic arrays are part-digital, part-analog

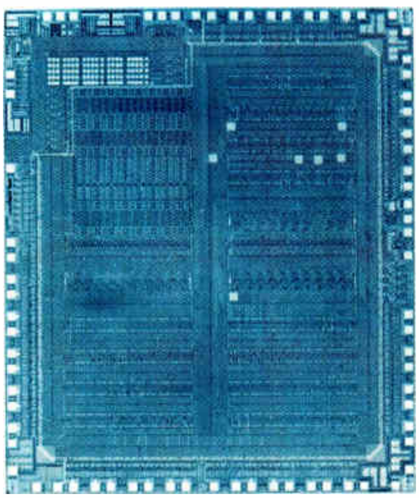
Basic cells for logic and specialized analog quadrants serve many applications; software customizes metalization and contacts

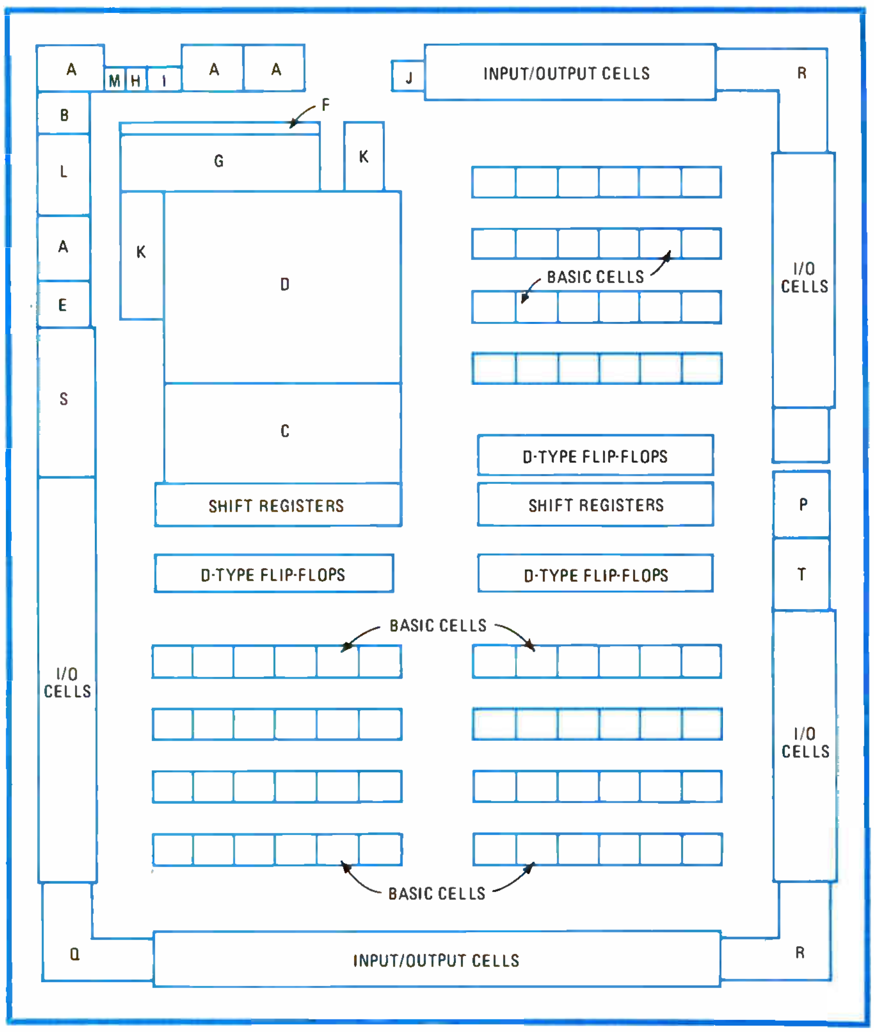
by Dan Yoder Jr., *Applied Micro Circuits Corp., Cupertino, Calif.*

☐ The uncommitted logic (or gate) array consists of a standard arrangement of active and passive devices that are interconnected by one or more final custom masks. It comes closer than any other chip to being the design engineer's ideal—a low-cost custom circuit with a fast turnaround time.

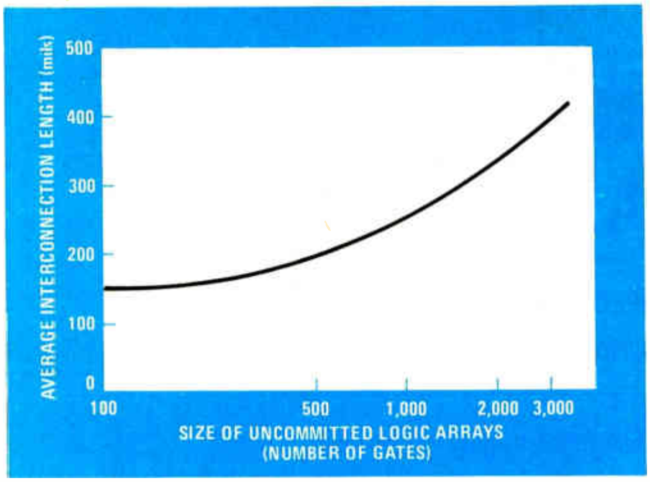
Few of the arrays now on offer, however, support analog circuitry with any readiness, and an outdated layout can make it impossible to use sizable numbers of theoretically available digital elements. Neither of these deficiencies affects the Quickchip series of uncommitted logic arrays, which are designed to satisfy the requirements of a broad range of applications.

The series consists of both low-power metal-gate complementary-MOS and high-speed bipolar devices. Two of the C-MOS chips—the Q400 (Fig. 1) and Q401—incorporate specialized cells dedicated to analog circuitry. The bipolar arrays, built with a standard Schottky process, surround a fast core of emitter-coupled logic with TTL input/output circuits in order to combine high

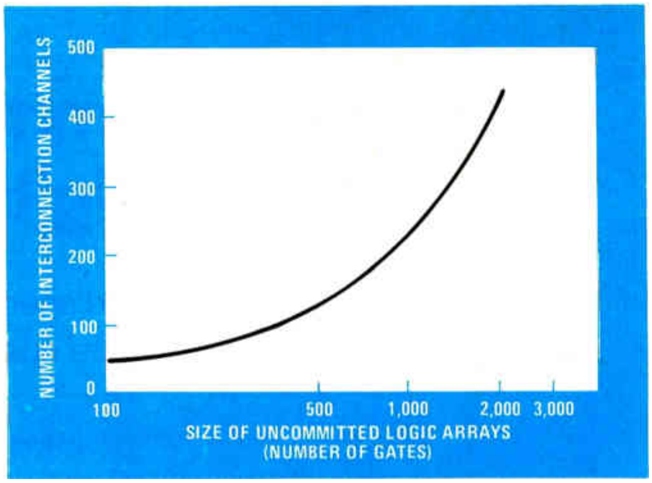




1. Quick yet custom. The Q400 complementary-MOS uncommitted logic array contains the equivalent of 1,500 gates. The die is partitioned into one analog and three digital quadrants to accommodate both linear and logic circuits. The lettered areas are defined in Tables 1 and 3, and the unlabeled sections constitute the wiring channels.



2. Growing longer. Interconnection lengths on an array increase with gate count. Also, many 1,000- to 2,000-gate chips use wiring channels that are far from compact and cannot be automatically routed, having been designed for much older and smaller arrays.



3. More channels. If an array is organized into rows of logic cells—the usual case—then the number of interconnection channels that traverse the chip can be estimated from this graph. Careful channel distribution will maximize percent utilization of the gates.

performance with easy interfacing to the rest of a system. On all of the arrays, dense interconnection channels are routed automatically between the basic cells.

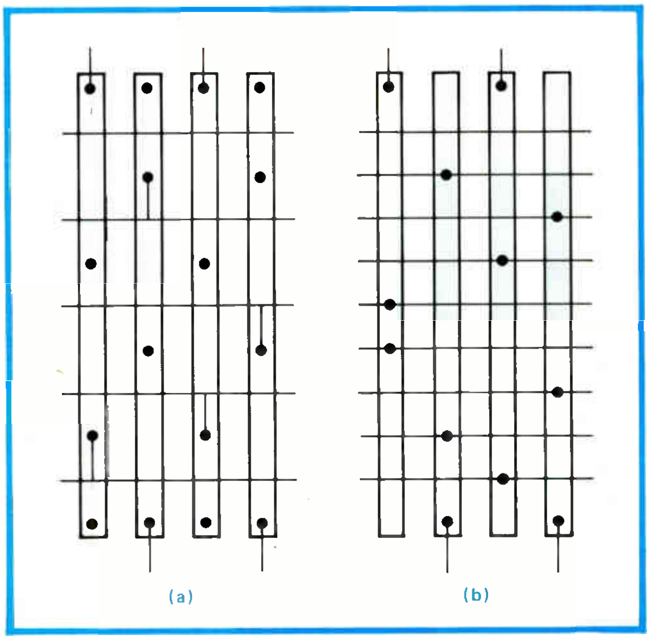
If properly designed, logic arrays are easy to use. There should be a correlation between the way a printed-circuit board is laid out and the algorithms used for the array's layout. Also, by making heavy use of elements called macrofunctions, or macros, which are designed to resemble small- or medium-scale integrated circuits, the manufacturer eliminates the need for specially skilled and costly personnel while simultaneously reducing array design time.

Computer support

Of more importance in reducing development time and cost is the availability of programs for automatically routing interconnections between macros. At present, however, few array manufacturers offer such programs. Most depend instead on various manual techniques such as taping the layout on sheets of transparent Mylar (as in a pc-board layout) or digitizing the layout from a worksheet. The customer may be required to do this work himself, and besides being tedious and somewhat liable to error, such techniques require him to acquire special skills. For the bipolar and C-MOS Quickchip series, however, the manufacturer or user performs the layout automatically, using Quickroute software to interconnect the various macros in accordance with the user's wiring list.

Automatic test-pattern generation is an equally important consideration in selecting an array because it further minimizes development cost and time. It is provided for the Quickchip family along with logic simulation, which is derived from the user's wiring list and the macro library. With the preprocessed wafers and automatic layout and test-pattern generation, working prototypes can be produced in less than six weeks from receipt of the customer's wiring list.

The size of an array is often expressed in logic gate equivalents, which usually refer to two-input NAND or NOR gates. To select the proper size of array, therefore,



4. More compact. The interconnection structure (a) is customized only with metalization; fixed vias to the vertical diffused underpasses thus space out the horizontal wiring tracks. In Quickchip arrays, the contact layer is also programmable, so that wiring is compact (b).

the user needs to know the logic gate equivalent of the system he plans to integrate.

The speed requirements of the system must also match the array's performance. Particular care must be taken in studying propagation delay for C-MOS chips, since several manufacturers' specifications are based upon a fan-out of one with little regard for loading due to interconnections.

The metal-gate C-MOS Quickchip devices have propagation delays of 15 nanoseconds at 5 volts with a fan-out of two and 50 mils of interconnection—a typical load in medium-sized to large arrays. To achieve 5-ns delays with the same load, the internal cells can be supplied with 15 V while the I/O sections are operated at 5 V. This feature is unique to the Quickchip family. In fact, different banks of logic elements can be operated independently of the rest of the chip at voltage levels ranging from 1.5 to 15 V. On-chip level-shifting elements translate the values of the internal signals as they move between sections.

In recommending an array size to a user, manufacturers often speak of percent utilization. This term is derived from the number of logic gates that can actually be used (as opposed to the number available on the array). As this percentage increases, so does the difficulty in interconnecting the gates.

With first-generation C-MOS arrays, for instance, there was no problem in achieving a 60% utilization, but it took careful planning to reach 70% and was extremely difficult to achieve 80%. That meant that a 500-gate system required an array with more than 700 gates.

The obvious objective is to increase percent utilization so that the smallest possible array can be used. However, it can only be done by adding to the number of interconnection channels, which in turn tends to increase die size and thus die cost. This problem intensifies as the gate count grows from the 100- to the 1,000- to 2,000-gate level because the average length of a connection on an array increases by an exponential factor.

Figure 2 shows how average connection length increases with gate count. These are empirical results—most arrays are not designed with this relationship in mind. Indeed, many of the 1,000- to 2,000-gate chips available today use expanded versions of an interconnection structure designed for 100-gate arrays. The result is a percent utilization that falls exponentially as gate count goes up.

Estimating wiring length

The length of the interconnections required for a given array can be estimated. For example, assume that each gate on a 1,000-gate chip makes three connections and the average length of each connection is equal to 2.5 times the pitch of each logic cell. A cell's pitch is given by the square root of its area, and 2.5 is a constant from an empirically derived formula called Rent's rule. Total interconnection length is then the total number of connections times their average length.

If the array is organized in rows of logic cells—the usual case—the number of interconnection channels that run across the chip in the X or the Y direction can be approximated with the graph in Fig. 3, which gives the relationship between them and the gate count. The distribution of these wiring channels is also very important in maximizing percent utilization.

In designing the interconnection structure for the Quickchip series, two objectives were set. One was to reduce the pitch of the logic cell without sacrificing speed, thereby minimizing the average connection length. The C-MOS arrays therefore employ a basic cell containing five logic gate equivalents, with interconnections on either side, that reduces the cell pitch significantly in comparison with other designs [*Electronics*, Sept. 25, 1980, p. 145].

The second goal was to reduce chip size by increasing the density of the interconnection channels. Figure 4a shows an interconnection structure for a first-generation C-MOS array. The diffusion and contact regions are fixed, and only the metal is programmable. To avoid unwanted connections, metal routing must therefore meander around these fixed contacts, making fewer channels available for routing.

With Quickchip C-MOS arrays, the contact layer is also programmable, dramatically increasing routing flexibility both in the channels and in the basic cells. Figure 4b shows the same interconnection scheme as Fig. 4a, but exploits the programmable contact layer. This example illustrates a dramatic 125% increase in the number of lines in an interconnection channel—from five horizontal channels to nine.

TABLE 1: CONTENTS OF ANALOG QUADRANT OF C400 UNCOMMITTED LOGIC ARRAY

*	Element	Quantity
A	internally compensated operational amplifiers	4
B	comparator	1
C	programmable logic array (PLA), organized as 4 (complementary) inputs × 16 minterms† × 8 outputs	1
D	programmable logic array (PLA), organized as 8 (complementary) inputs × 16 minterms† × 16 outputs	1
E	40-kΩ resistors, tapped every 5 kΩ	8
F	180-kΩ resistors, tapped every 5 kΩ	2
G	0.75-pF capacitors	105
H	bipolar npn transistors, with collectors tied to substrate	15
I	pn diodes	11
J	zener diodes	3
K	single-pole, double-throw tranmission gate switches	14
L	modular/bias current generators	6
M	p-channel current mirror array	1
—	input/output pads, with optional input protection	8

*The letters correspond to the areas called out in Fig. 1.
†Minterm = the output of the AND in the PLA's AND/OR structure.

Gates versus pins

Increased density is meaningless, however, without an appropriate gate-to-pin ratio. This is simply the ratio of logic gates to I/O pads, and it depends on several factors. One is the type of logic to be integrated. Obviously, an I/O-intensive circuit like a peripheral chip for a microprocessor will exhibit a lower ratio than a serial communications controller.

The partitioning of a system also has an effect on the gate-to-pin ratio. If a system must be divided among several arrays, or other ICs, the amount of I/O tends to increase. So, in general, smaller arrays should have a lower gate-to-pin ratio. The 250-gate bipolar Quickchip has a gate-to-pin ratio of 7, whereas the 800-gate C-MOS Quickchip has a ratio of 16.

Finally, yet another way of increasing the density of an array is to dedicate cells to common functions. For example, a D-type flip-flop can be implemented with the basic cells; however, the same function can be performed in less than half the area using a dedicated cell.

Care must be taken in choosing which functions—and how many cells of that function—are dedicated. Func-

TABLE 2: CONTENTS OF EACH OF THE Q400 ULA'S DIGITAL QUADRANTS	
Element	Quantity
Basic cells, each containing 10 n-channel and 10 p-channel devices	24
Input/output pads with optional input protection containing 6 p-channel and 6 n-channel devices to perform input pullup or pulldown, three-state output, latched/multiplexed liquid-crystal display driver, and bidirectional bus I/O circuitry.	19
Static D flip-flops	10
High-impedance resistors	2

TABLE 3: OTHER Q400 ULA ELEMENTS		
*	Element	Quantity
O	on-chip crystal oscillator	1
–	17-stage dynamic shift registers with parallel load	2
P	nonoverlapping clock generator for the dynamic shift registers	1
Q	high-current (28 mA at 5 V) n-channel drivers	4
R	high-current (8 mA at 5 V) p-channel drivers	8
S	voltage-level shifters	8
T	dynamic D flip-flops	4
–	high-impedance resistors	8

*The letters correspond to the areas called out in Fig. 1.

tions used in a minority of cases should be implemented using the macros. Special functions that cannot be practically implemented with macros may also be candidates for dedicated cells. C-MOS Quickchips use dedicated cells for static D flip-flops, dynamic shift registers, and special functions—particularly in the analog sections.

Metal-gate C-MOS provides many advantages in analog designs. N- and p-channel MOS transistors allow active loads to be used in high-performance operational amplifiers and comparators. They are also useful in building high-accuracy current mirrors for biasing and waveform generation. In addition, complementary amplifier output devices provide full power-supply output swings.

MOS devices can be configured for constant-current sources. The stable impedance of these enhance common-mode and power-supply rejection without elaborate feedback networks. With C-MOS, high-performance switches (transmission gates) can be built; and with a metal-gate process, high-quality linear capacitors, bipolar npn transistors, pn diodes, and zener diodes are also available. Precision voltage references and nonlinear analog circuits are readily built from these components.

C-MOS has many advantages in the digital domain, as well. It offers a wide power-supply range, high noise immunity, and low idle power dissipation, plus higher speed than n-MOS or p-MOS, flexible I/O capability, and easy conversion of logic levels. Dynamic logic is easily implemented in it, and densities equivalent to those of n-MOS or p-MOS can be achieved using ratioed logic and pull-up devices of the opposite polarity.

With its 1,500 equivalent gates, the general-purpose C-MOS Quickchip Q400 can be made to provide a wide variety of high-performance analog and digital circuits. It is partitioned into four basic quadrants, one analog and three digital. Other Quickchips use different combinations of analog and digital quadrants to allow users to choose the functional capabilities that are best suited to their needs.

Analog plus digital

The analog quadrant contains the resources listed in Table 1. These can be used to implement a wide variety of analog functions, such as:

- Digital-to-analog and analog-to-digital converters, including both the integrating and the successive-approximation types.
- Active filters, as well as switched-capacitor filters.
- Waveform generators.
- Nonlinear function generators (using piecewise linear approximation).
- Precision voltage and current sources, using zener breakdown or silicon bandgap references.
- Analog multiplexers.
- Sample-and-hold buffer amplifiers.

In addition, the programmable logic arrays in the quadrant may be used to implement digital sequential state machine controllers or decoder circuits.

Each digital quadrant contains the resources listed in Table 2. Besides a wide variety of digital functions, these can be used to implement precision current mirrors and simple operational amplifiers, further enhancing the analog capabilities of the Quickchip.

Table 3 lists elements included over and above those of the basic analog and digital quadrants. These additional resources enable the Q400 to drive light-emitting-diode or fluorescent displays, to generate precision clocks, or to enhance the testability of the chip.

The time spent on testing is costly to both the manufacturer in terms of engineering time and to the array customer in terms of its impact on die cost. The parallel-load shift registers included on the larger Quickchips uses the scan-test method to decrease testing time.

A case in point

Figure 1, in fact, shows how the shift register bank is located across the center of the Q400 and the interconnection channels are located below. Key nodes within the chip are routed to the parallel-load inputs of the shift register. The register can sample these inputs and shift them out through an output pad to reveal the internal status of the chip at any time. Every node in the system may be initialized to a known state to ensure ease of testing.

Separate power and ground distribution bases are provided around the periphery of the digital portions of the Q400 so that pins may be flexibly assigned with minimal bus noise. The chip's substrate and p wells may also be used for power distribution, but because of increased path resistance their use is limited to noncritical circuits. The power-bus routing makes possible an additional analog ground bus to minimize analog circuit noise. □

Applying CAD to gate arrays speeds 32-bit minicomputer design

Price-performance ratio of lower-end VAX-11/750 also is improved over that of older, compatible VAX model

by Robert A. Armstrong, *Digital Equipment Corp., Maynard, Mass.*

☐ The use of computers to design computers is growing into a fact of life, for these machines are as capable of benefiting the creation of their own kind as they are of aiding any number of scientific, industrial, and commercial tasks. In the case of the VAX-11/750, the second model in Digital Equipment Corp.'s 32-bit minicomputer family, computer-aided design was an obvious way to reduce design cost and time. Further, CAD, coupled with gate-array technology, produced a central processing unit with 60% of the performance of the CPU of the first family member, the VAX-11/780, for 40% of the price.

Before the VAX-11/750 development began, these performance and price achievements had been made the primary design goal. Indeed, those targets were as much a challenge as a goal, because at the time they were set the VAX-11/750 design group had no idea how they were to be realized.

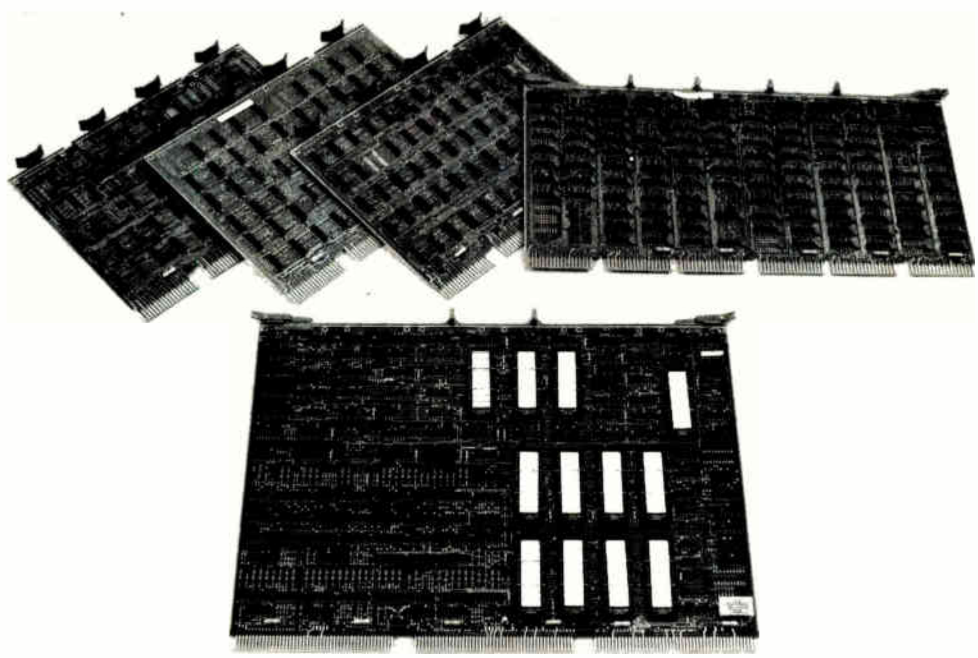
The VAX-11/750 is a 32-bit, virtual-memory minicomputer supporting a maximum physical memory of 2 megabytes, with an effective memory access time of 400 nanoseconds. It has 4-K bytes of cache memory, supports up to four input/output ports—one Unibus and up to three optional high-speed Massbuses—and offers an optional 1-K-by-80-bit user control store (see "Inside the VAX-11/750," p. 168).

The logic is implemented primarily with low-power Schottky large-scale integrated gate arrays designed and built in house—the company's first in-house integrated-circuit development and manufacturing project. In addition, development of a CAD system for gate arrays was established as a major activity in support of the VAX-11/750 program in order to provide a fast, low-risk design turnaround.

In comparison, the bigger and older brother, the VAX-11/780, has an effective memory access time of 280 ns, supports up to 12 megabytes of physical memory, has 8-K bytes of cache memory, and accommodates up to eight I/O ports—four Unibuses and four Massbuses. The VAX-11/780 logic is implemented with a combination of off-the-shelf Schottky TTL parts, with the addition of some emitter-coupled-logic and custom LSI circuits to optimize performance.

The scope of the design changes was limited by the firm objectives that the VAX-11/750 was to have the same basic VAX architecture, including the large address space, and essentially the same MOS semiconductor memory and was to be capable of running the same software as the VAX-11/780. Clearly, the substantial cost savings would have to be achieved in the CPU, which led to a search for an entirely new approach using LSI circuit design.

Four basic possibilities were considered: off-the-shelf



1. Saving space. The VAX-11/750 Massbus adapter, using 12 gate-array modules (the light rectangles), fits on one board (bottom). The PDP-11/70 Massbus adapter (top) takes up four boards.

Inside the VAX-11/750

The hardware architecture of the VAX-11/750 has these major components, as shown in the figure below: a central processing unit, a memory interconnection bus, a Unibus interface, a memory controller, Massbus adapters, and a console subsystem.

Within the CPU, the data-path module provides three major data-path functions:

- ☐ Register files.
- ☐ Arithmetic and logic unit.
- ☐ Microinstruction address generator.

Included in the ALU are integer, logical, and binary-coded decimal operations; a barrel shifter; and a special function generator to optimize the performance of variable bit-field operations and BCD-to-numeric string conversions. The microinstruction address controller contains conditional branch logic, the instruction decoder, and the microcode subroutine call and return stack.

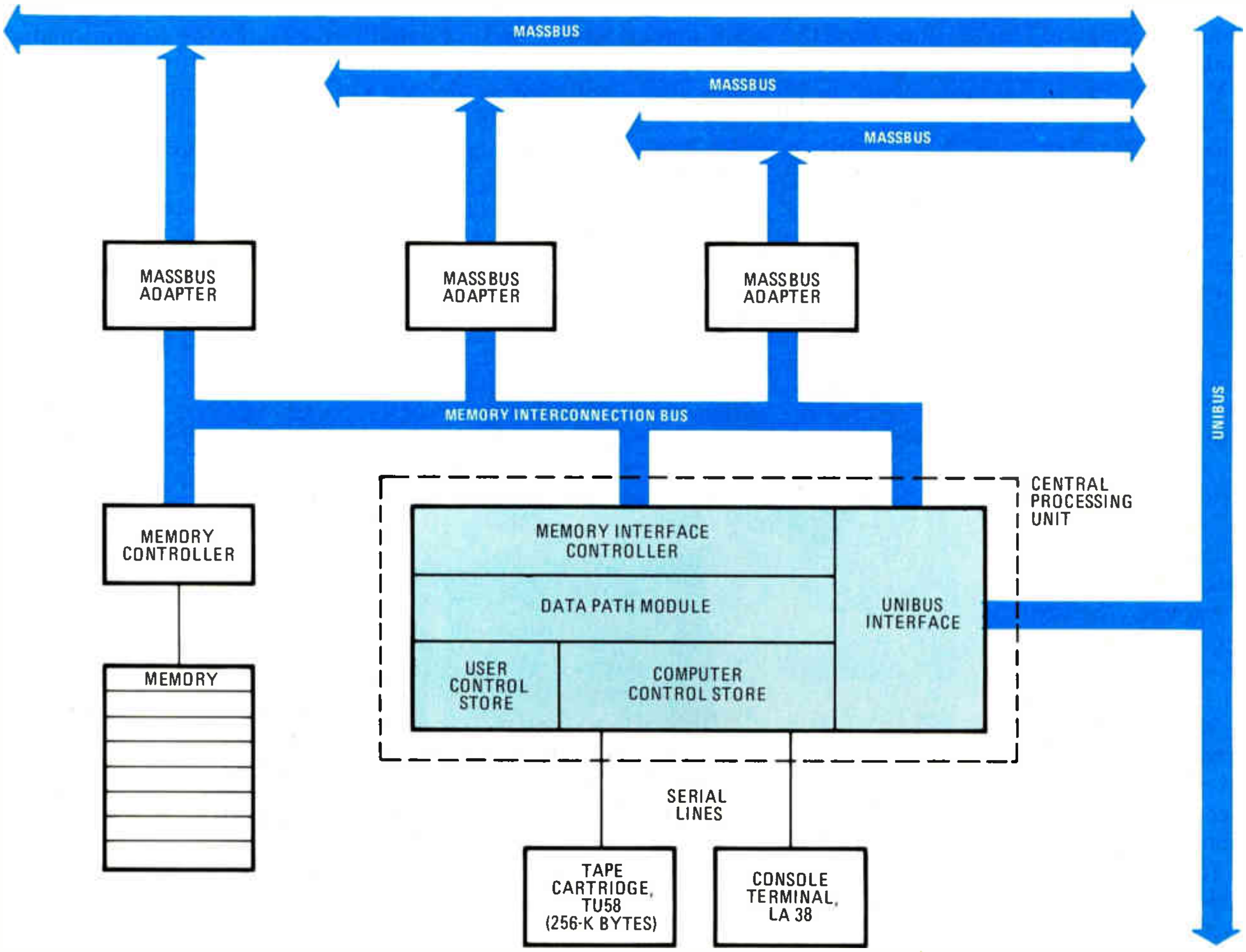
Also in the CPU is the memory interface controller. It provides address generation logic, the program counter, a translation buffer for virtual-to-physical-address mapping, 4-K bytes of cache memory, an instruction prefetch buffer, and memory data logic for rotation and alignment of instructions of different lengths.

The computer control store for the control microcode is a 6-K-by-80-bit programmable read-only memory. In addition, one zone of the computer control store module has pin connectors for attachment of the optional user control store daughterboard, which consists of a 1-K-by-80-bit random-access memory array. With this store, users can add their own microcode without occupying space on the backplane.

The CPU-to-memory interconnection (memory interconnection bus) is an etched-in internal bus that links modules in eight slots of the CPU section of the card cage. The memory controller module generates timing and control signals for dynamic management of up to eight 256-K-byte memory array modules and performs 7-bit error checking and correction.

The Massbus adapter is the interface between the internal memory interconnection bus and a Massbus, the means by which high-speed mass-storage devices are connected to the VAX-11/750. The Massbus adapter performs all control, arbitration, and buffering functions between the Massbus and the rest of the VAX-11/750. Address mapping is similar to that done by the Unibus interface. Up to three Massbuses and adapters can be connected to the VAX-11/750.

The Unibus interface allows input/output devices on the Unibus to access the main memory directly and provides access between these devices and the CPU. The standard CPU console terminal is the LA38 DECwriter IV desktop keyboard printer, but any ASCII terminal can be used for a console terminal. The 256-K-byte tape cartridge drive, model TU58, is part of the console subsystem.



components, custom LSI chips, a combination of off-the-shelf and custom parts, and gate arrays. After evaluating the technical and economical plusses and minuses, the Midrange VAX Systems development group decided that the company would not rely on outside vendors but instead would design and make its own ICs based on gate-array technology.

The results

Ninety percent of the VAX-11/750's logic is implemented with gate arrays. This technology, combined with extensive use of the CAD system, cut the time and cost for the design to about 15% of what it would have been using custom LSI parts. Production cost savings result from reductions in the size and number of the CPU components, printed-circuit boards, power supplies, cooling systems, and cabinets. Figure 1 shows an example of the space savings obtained with the gate arrays. The Massbus adapter module of the VAX-11/750 contains 12 gate-array ICs of 5 different types (in addition to the 27 types in the CPU and the memory controller) and 120 off-the-shelf Schottky parts; in contrast, there are about 350 devices on the four boards of the Massbus adapter in the PDP-11/70.

Then, too, the machine costs less to operate because it needs less space, power, and cooling. And since there are fewer components and interconnections with LSI gate arrays than with off-the-shelf parts, the machine is more reliable as well.

The gate-array IC is housed in a 2.5-by-0.6-inch, 48-pin package (Fig. 2). Although the packaged chip is approximately four times the size of a typical off-the-shelf IC, the customized gate array performs the same functions as 25 standard devices in about one sixth the space. As mentioned above, there are 27 different types of these low-power Schottky gate-array chips among the total of 55 devices in the VAX-11/750's CPU and memory controller modules.

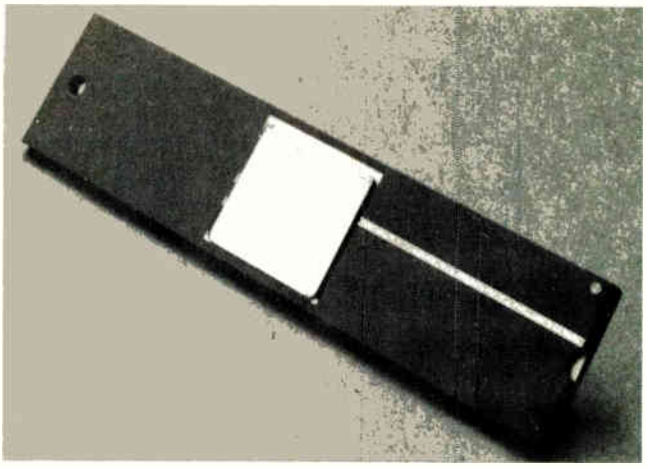
The benefits of gate-array technology over equivalent off-the-shelf chips can be summarized thus:

- Half the power dissipation.
- One sixth the module real estate.
- Four times the reliability.
- Half the cost.

Design goals

Besides the initial ones for cost and performance, the design team set goals for the circuit technology and the design system. One objective was to select a technology and a design system to employ it that would yield as natural a design process as possible for engineers experienced in logic design using standard TTL parts.

As is common in the computer industry, the company had many experienced logic designers and relatively few experienced semiconductor designers. With the gate-array approach, the only transistor-level design task, development of the basic gate cell, was well within the capability of the internal semiconductor design groups. From that point, the next steps, design of the blank IC containing the array of basic gate cells and the individual designs of the 32 customized ICs using the blank array, could be done by computer-design engineers and



2. Building block. Mounted in a 48-pin package 2.5 by 0.6 inches, this quarter-inch-square, 488-circuit gate-array chip is the basis for the integrated circuits in the 32-bit VAX-11/750 minicomputer. It performs the same functions as 25 standard devices.

would not require semiconductor specialists.

Two specific design goals for the technology were a propagation delay of between 5 and 10 ns and a significant fan-out—at least equal to the fan-out of 10 usually available with off-the-shelf TTL parts. (A fan-out of 10 means that a gate output can drive loads of as many as 10 other gate inputs.)

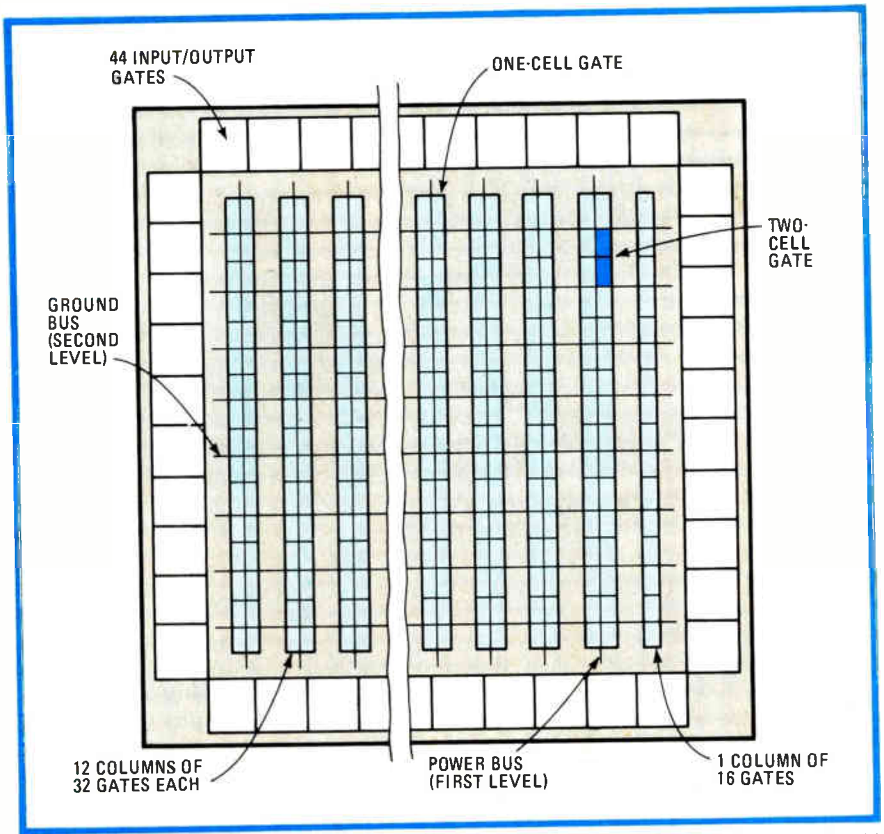
The CAD system selected was one already well established at the company for the design, layout, and production of pc boards. One reason was that the layout designers were experienced in using it. Another was the determination that it could be adapted to the design and production of gate-array ICs with only a little modification. Furthermore, all but one of the modules of the CAD system had been developed and refined in house over several years, and therefore there were people around who could easily modify it. A familiar design environment could thus be provided with existing tools.

Considering the options

A number of possibilities were originally considered in the search for the most cost-effective logic design to meet the goals. They involved decisions regarding chip technology, off-the-shelf versus custom design, internal vs external IC fabrication, and conventional vs gate-array chip design. If the same process were to take place today, advances in LSI technology might have changed the assortment and relative weight of some of the options, but the decision to use gate-array technology would have been the same.

The first option was to use off-the-shelf components. Schottky and low-power Schottky TTL chips had been used in the VAX-11/780 computer, and it would have been logical to do the same in the smaller machine. Also, the broader selection of standard TTL chips than was available when the VAX-11/780 was designed would have helped reduce cost. However, it would not have done so nearly enough to meet design goals.

The design team also considered standard parts using a faster technology with a simpler, more serial design. ECL circuits offered two to three times the speed of



3. Patterns. The gate-array chip layout contains 400 identical NAND gates surrounded by 44 I/O gates, all of which can be customized. The adjoining cells in the middle 14 rows (one pair is highlighted) are mirror images of each other and can be connected to make two-cell gates.

Schottky chips, but their memory density would have been much lower. As a result, the higher memory chip count would have increased the cost per bit, and the cost of the CPU's microcode would have become significant. The off-the-shelf ECL chips, moreover, were not nearly as varied as those then available in the Schottky and low-power Schottky families. In short, ECL technology, though excellent for strictly high-performance circuits, did not offer the most cost-effective design.

Custom chips

The second option was to have custom LSI chips designed and manufactured by semiconductor vendors. Preliminary analysis of the CPU circuitry by the design group indicated that about 30 unique chip designs would be required for the VAX-11/750. Several semiconductor manufacturers were asked to design 30 to 40 chips to meet the functional specifications. Each of the vendors stated that it did not have sufficient engineering resources for the parallel design of so many different custom chips. Furthermore, they said, staffing for such a large project would mean that they could not offer acceptable prices for the quantities projected. But even had their responses been positive, the custom chip approach had the unacceptable drawbacks of reliance on a single vendor and lengthy design time.

It was then suggested that only a few custom chips be designed for use in combination with a large number of standard ICs. However, it was readily apparent that this approach was the least desirable of the three considered so far, as it combined the disadvantages of the first two: the high cost of the first with the dependence on a single semiconductor manufacturer and lengthy system design time (although not as much as a completely custom approach) of the second.

Another option, gate-array technology, itself offered several possibilities. As with conventional chips, gate-array chips could have been purchased as either standard or custom parts. The off-the-shelf gate-array chips then available were integrated-injection-logic products with propagation delays of between 50 and 75 ns—10 times longer than the design goal of 5 to 10 ns. Custom gate arrays, on the other hand, could have been designed by the vendor in fast Schottky or low-power Schottky logic. That would have been done at the transistor level so as to achieve optimum IC design for the variety of functions involved in the VAX-11/750's CPU. IC vendors, however, were more interested in manufacturing and marketing commodity parts than special semiconductor circuits. Several would nevertheless have worked on custom designs, but they could not be guaranteed a large enough volume to ensure what they considered an adequate profit for their efforts.

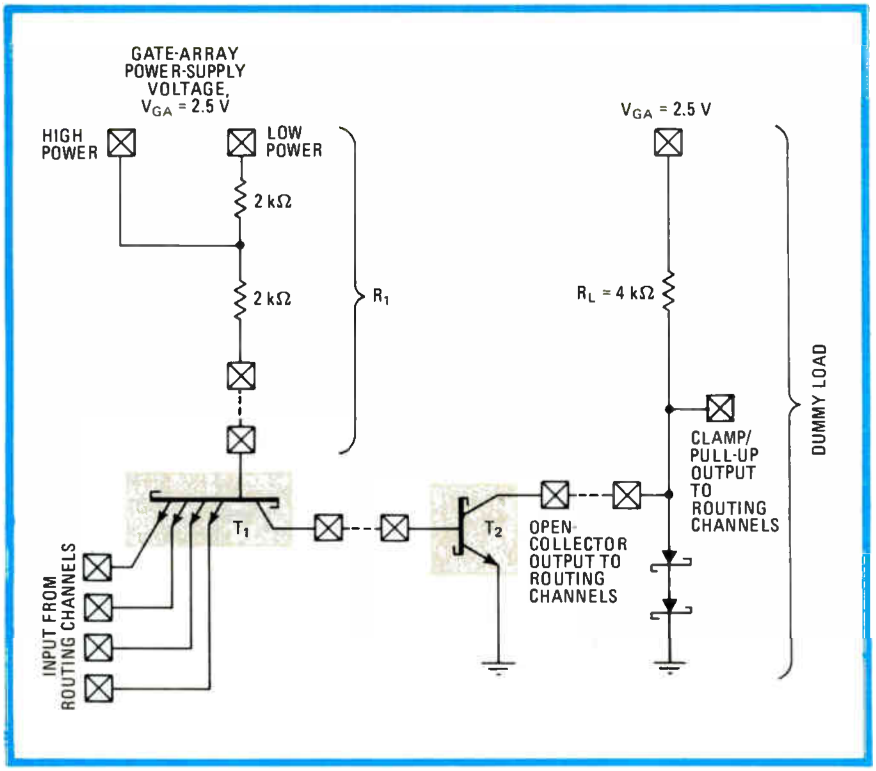
The last option, designing and manufacturing gate-array ICs in house, at first seemed beyond the company's resources. However, further study revealed not only that the resources were more than adequate—a designer for the basic cell, enough logic designers for the arrays, and the CAD system—but also that the in-house approach would produce the greatest cost advantage and the shortest design time.

The main reason was that the gate-array approach allowed the automation of all steps, from IC design to customized photolithographic masks. The time from an engineer's schematic until the tooling was produced for a customized gate-array chip was 10 to 12 weeks, compared with five to six months, in general, for fully customized chips; and the time from tooling to delivered parts was 2 or 3 weeks for the customizing layers on the gate array, versus about 13 weeks for a completely custom-designed IC.

Chip pattern

A gate array is a uniform pattern of hundreds of unconnected transistor-level gate cells. Connecting the cells, by adding interlevel contacts and intralevel routing at several wiring levels, converts the array into a custom IC. The design task for the basic array can be much simplified, as it was for the VAX-11/750, by repeating a single basic transistor-level cell throughout the array.

As shown in the schematic diagram in Fig. 3, each IC



4. Options. The standard two-transistor cell is a four-input NAND gate. Possible connection points are shown as boxes with Xs. The cell can be configured in four ways—as a high-power, fast gate or a low-power, slow gate, with or without a clamp/pull-up output.

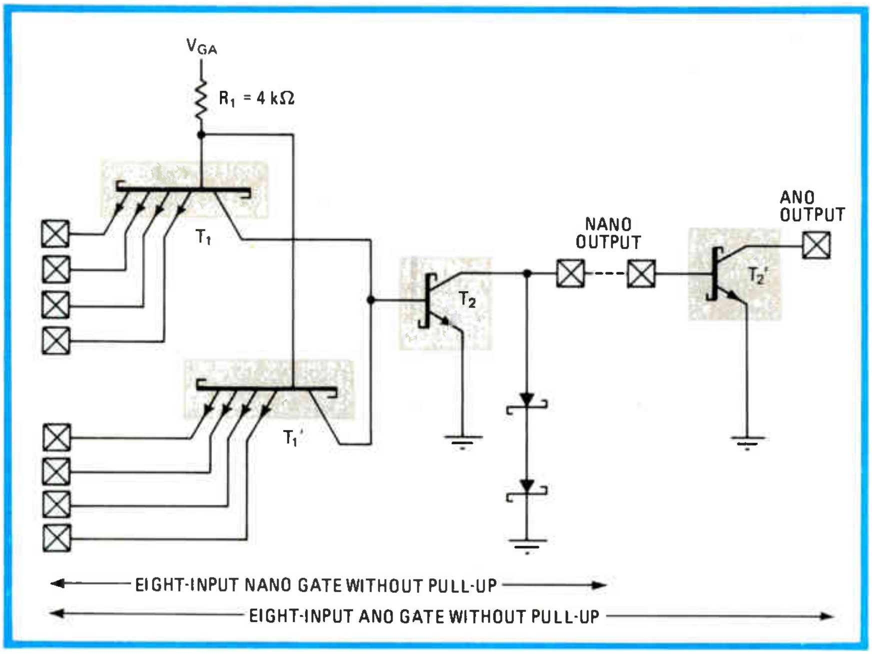
consists of 400 basic cells in a rectilinear pattern surrounded by 44 I/O transceivers, for a total of 488 circuits in a space less than a quarter inch square. The pattern of cells in the array was selected to make the contacts more accessible to the routing channels (power and ground buses) and to simplify placement and routing algorithms in the CAD system. Each subgroup of four basic cells is located between two ground buses on the second interconnection level and straddles a power bus on the first interconnection level. In each subgroup, the contact locations for each pair of cells on one side of the power bus are a mirror image of contacts on the other side of the bus, except for the one column of 16 single cells, which has its own power bus. The routing channels on the power and ground levels are brought down to the contacts on the transistor level through holes, called vias, in the dielectric layers.

The basic VAX-11/750 array cell, a two-transistor setup (T_1 and T_2), is a NAND gate with four signal input contacts, two alternative output contacts, and three power-swapping contacts (Fig. 4). Also in the cell are two 2-kilohm resistors for selecting either low or high power to T_1 and the clamp and pull-up output 4-kΩ resistor and diodes.

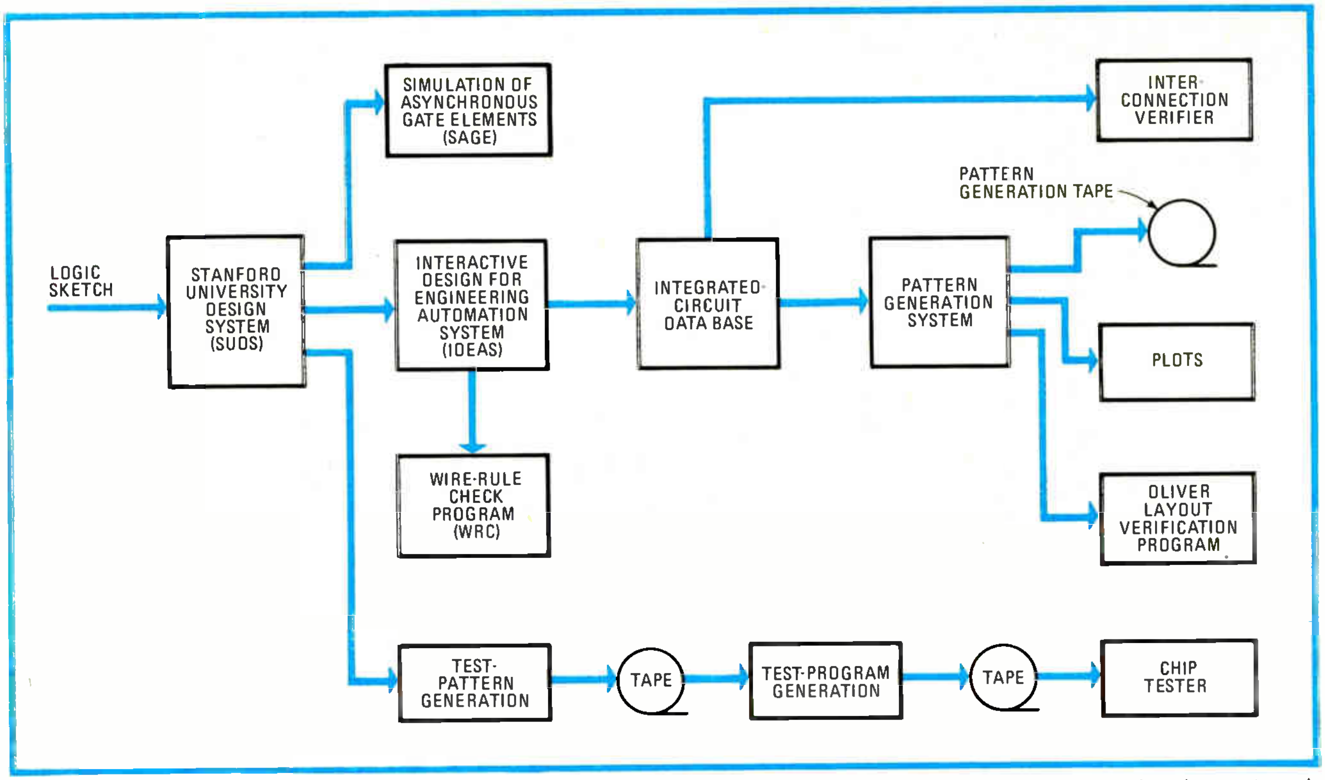
The basic cell had to have a fan-out of at least 10, as noted, and also had to perform consistently at all possible loadings, meaning that the propagation delay of about 5 ns would not change significantly with loads ranging from 1 to 10 gates. This propagation-delay stability was necessary so that the circuit design simulation would accurately predict the performance of the real circuits.

The basic cell can be configured to form any of four variations by making different contact connections during the customizing stages of fabrication. The four are a high-power, fast gate or a lower-power, slower gate, either with or without a clamp/pull-up output. The resistance R_1 can be either 2 or 4 kΩ by applying the input voltage at either the high-power or the low-power contact. When R_1 is 2 kΩ, the gate has the shortest propagation delay possible while still retaining the fan-out of 10. For the purpose of calculating fan-out, this fast, high-power gate counts as two loads.

The low-power connection with R_1 equal to 4 kΩ produces a slower gate but halves the loading on the input line, allowing more gates to be connected together. The low-power gate counts as one load. The output contacts can be selected to be an open collector without clamp/pull-up or a clamped output with a pull-up resistance of 4 kΩ. Each output pull-up counts as one load. A fan-out of 10 in this



5. More options. Using three of the four transistors on two adjacent cells (T_1, T_1', and T_2), an eight-input NAND gate can be created. By connecting the fourth transistor (T_2') into the circuit, an eight-input AND gate is made. CAD creates these gates automatically.



6. Silent partner. The computer-aided design system, the components of which are shown in this flow diagram, played an extremely important role in the VAX-11/750 project. Most of these elements already existed for printed-circuit design and required little modification.

case means that a gate can drive 10 low-power gates, 5 high-power gates, or any combination that adds up to a total loading of 10. The total power loading of an IC made with these gate arrays can be minimized by using fast gates and clamp/pull-up outputs only where needed to optimize performance.

Two-cell gates

An eight-input NAND gate is produced by combining two adjacent cells in the array grouping to form a double-cell gate (see Fig. 3 again). Figure 5 shows an eight-input NAND gate created by connecting three of the four transistors (T_1, T_1', and T_2) in the two cells. This two-cell eight-input gate would have cost a designer five cells—two four-input NAND gates and three inverters—if created discretely. The eight-input NAND gate is converted into an eight-input AND gate by using the fourth transistor (T_2'). Similarly, this gate would have required four cells to create discretely. Thus, by making connections at the transistor level rather than at the gate level, the total number of gates needed for a given circuit function can be substantially reduced.

These gate combinations are automatically created by the CAD system and so are transparent to the logic designer. The designer simply requests an eight-input NAND or AND gate at a certain location and the system makes the correct transistor-level connections in an appropriate two-cell gate.

Various combinations of one- and two-cell gates offer a total of 32 NAND gate variations and 24 AND gate variations. In addition, 24 I/O gate types can be made from the 44 basic I/O gates located around the edge of the chip (11 to a side): 4 kinds of receiver, 4 kinds of driver, or 16 transceiver combinations.

The CAD system was introduced in order to minimize design risk by minimizing human error, to reduce the design time, and to maximize the efforts of the trained people involved in computer design and layout. Figure 6 shows the system in block diagram form.

The entry point into the system for a circuit design is the Stanford University Design System, or SUDS, an industry-standard interactive graphics drawing system. Many of the other elements of the system are modules that were developed in house and have been used heavily for the computer-aided design of pc boards. Minor modifications of some of the modules and the addition of some translation software to go from a pc-board data base to an IC data base yielded a highly automated system for the design and testing of gate arrays. The four most important modules are: SAGE (for Simulation of Asynchronous Gate Elements), a logic simulator; Ideas, an interactive graphics design subsystem; WRC, a wire-rule check program; and Oliver, a layout verification program for the pattern generation system.

Into the data base

The logic circuits for a chip are converted from paper into a computer data base through SUDS. The computer schematics are "drawn" directly into the SUDS system at a cathode-ray-tube terminal by engineers and technicians, usually from rough notes and sketches, using a light pen (Fig. 7). Standard logic symbols associated with each gate variation are retrieved from a SUDS library file. Plot files, wire lists, and report files can be extracted from the data base, and reports on power consumption and gate usage are available. The SUDS program also performs some basic error checking, including tabulations of wire-list errors. After verifying the completed drawing visually, the terminal user can get a printout of the logic schematic for checking by the computer engineer.

The computer engineer then verifies the gate-level implementation of a specific logic function by feeding the circuit description directly from the SUDS data base into the SAGE logic simulation program. After debugging the circuit using SAGE, final verification is done by simulating both the gate-level model and a higher-level functional model. Their operation should be identical when stimulated with a diagnostic test pattern.

SAGE simulation

SAGE also performs several different checks of the circuit model derived from the SUDS data base. For example, all networks are dynamically surveyed for proper dc loading. At a low level, the gate outputs must sink the currents associated with all network loads. At a high level, network current sources (pull-up resistors) must supply all input and output leakage currents. The networks are also checked for illegal combinations of input connections.

Ideas—for Interactive Design for Engineering Automation System—converts a logic schematic in the SUDS data base into a physical gate-array chip layout. It was originally developed at DEC and has been widely applied in generating pc-board layouts. It was modified slightly for this project to produce gate-array chip layouts specifically (rather than ICs in general) but involves exactly the same design procedures as the staff has become accustomed to for pc boards.

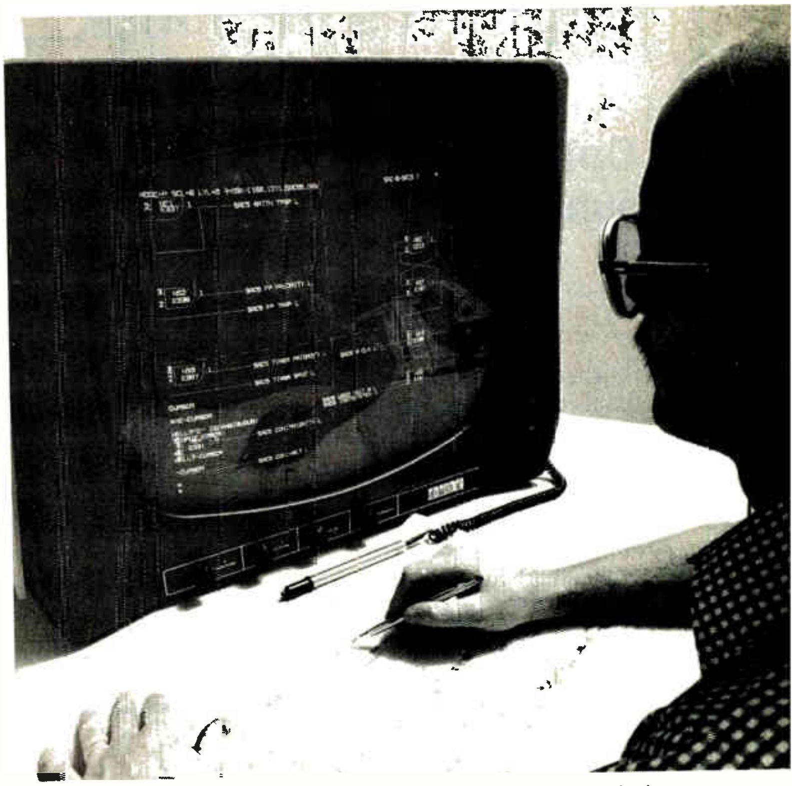
In converting a logic schematic into a physical layout, the cells are automatically assigned locations in the array that offer optimum routing between gates. Ideas then routes the metal connections according to rules for optimizing IC performance. The layout designer completes the process by manually specifying routing that the system cannot handle automatically.

A number of physical design checks are also performed in the Ideas subsystem. Space and continuity check programs determine whether design rules for width and spacing have been observed and whether the connectivity of the metal patterns matches the connectivity specified in the logic schematic.

The WRC program analyzes each network for loading, connection length, metal widths, and metal resistivity. Based on calculations of the IR drop between the network source and the inputs, the program reports networks on the chip that violate allowable maximums. Networks in violation are reworked by the layout designer to increase metal widths or reduce connection length.

Onto tape

The Ideas layout is converted into an IC data base for entry into a commercial IC design system, which produces the pattern generation tape. This system had previously been used at the company for IC design but did not automatically place or route, both of which can now be done by the modified Ideas subsystem. The pattern generation tape controls the automated equipment that



7. Computer drawing. Using the SUDS program, a CRT terminal, and a light pen, an operator transfers a circuit schematic drawing from paper to the computer. Standard logic symbols do not have to be drawn; instead, they are selected from a library file.

plots the photomasks for the customization levels of the gate-array IC.

Two final checks are made with the CAD programs on the tape to guarantee that it precisely represents the desired design. Although similar to the spacing and continuity programs run under Ideas, these final checks are performed on the full IC pattern rather than just on the cell-interconnection pattern. First, the Interconnect Verifier (IV) program compares a SUDS wire list with one that has been generated from the pattern generator and prints a difference list to identify open circuits, shorts, and other interconnection errors.

Checking mask rules

Secondly, the Oliver layout verification program analyzes the IC data base by running a series of checks concerned with the inter- and intra-photomask rules associated specifically with IC design. These rules include width and spacing limits within and between the geometries on the various masks used in the IC fabrication process.

The pattern generation tapes are sent to a photomask vendor. By the time the resulting masks are received, the transistors in the diffusion level have been grown and the blank gate-array ICs are ready for further processing. Contacts are then cut through the dielectric layers and metal is deposited in a standard IC production process. The CAD system also automatically generates diagnostics that can be used in computerized production testing of gate-array components. □

Optosensor limits shunt supply's no-load current

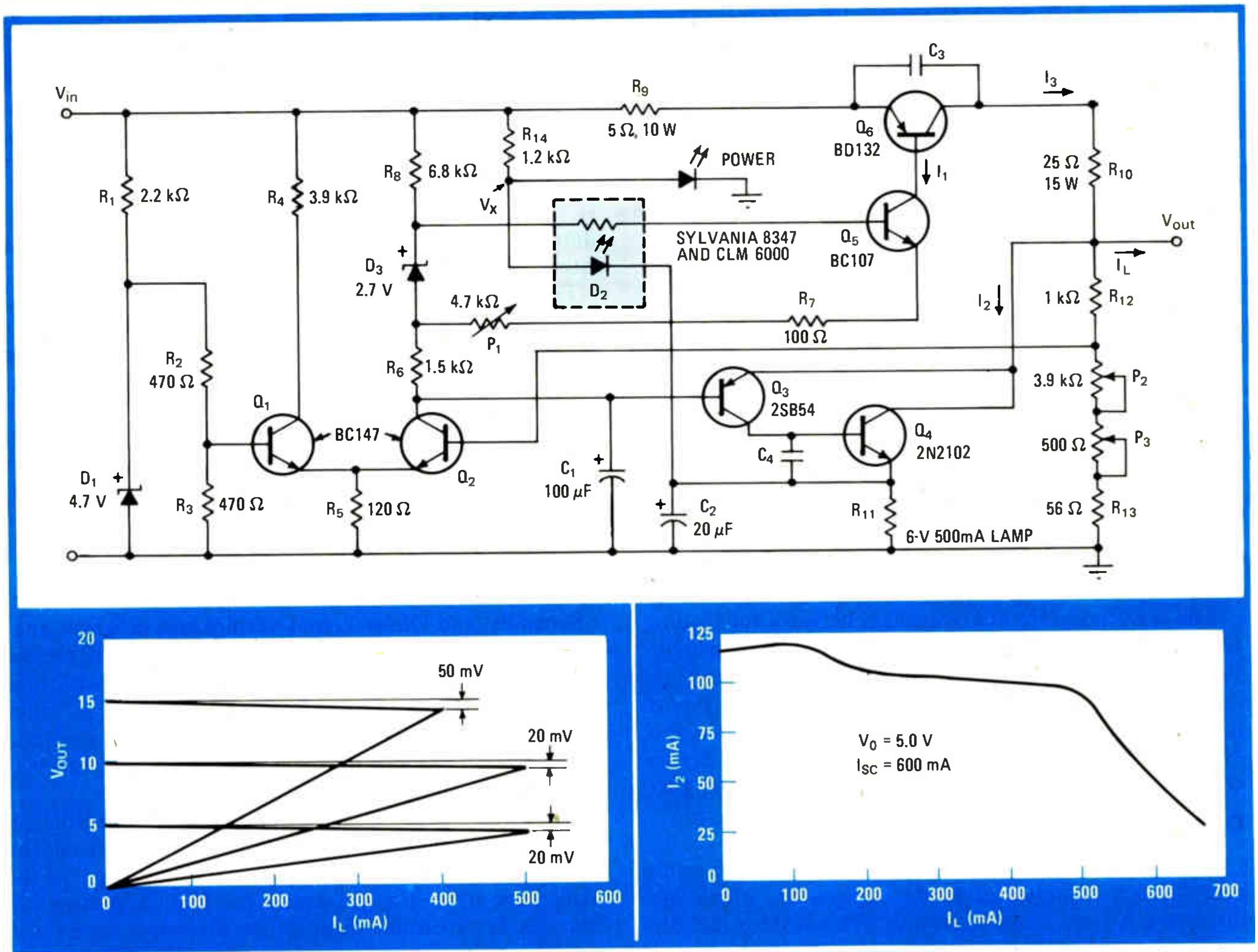
by A. D. V. N. Kularatna
Ratmalana, Sri Lanka

A shunt regulator's no-load current can be notably reduced with this circuit, which uses an inexpensive light-emitting diode and optocoupler in the supply's feedback loop to monitor current drain. Thus the supply's shunt transistor element no longer needs large heat sinks and its power-handling specifications for a given power rating are reduced.

The technique is applied to the general-purpose supply shown in (a), which provides a regulated output of from 4 to 22 volts at 100 to 600 milliamperes for a line input of 35 to 45 V. The supply has foldback characteristics (b) and, as expected in a shunt regulator, a low output impedance of about 0.1 ohm. The special feedback arrangement that includes the optocoupler and the LED light source reduces the supply's shunt current, which normally would be 600 mA under no-load conditions (c), to only 120 mA.

The basic supply includes a voltage reference formed by zener diode D_1 and resistors R_1 to R_3, differential amplifier Q_1–Q_2, and voltage-sampling chain R_{12}, R_{13}, P_2, and P_3. Q_3 and Q_4 serve as the main shunt element. Q_5–Q_6 act as a variable resistor to ultimately regulate the load voltage. In this particular configuration, $V_{out} = V_{ref}\{1 + [R_{12}/(R_{13} + P_2 + P_3)]\}$, with P_2 and P_3 used to set the desired output voltage.

Light-emitting diode D_2 and the optocoupler are placed in close proximity in the feedback network, ensuring the $I_1 = [V_{D3} - V_{BE\,Q5}]/[P_1 + R_7 + (R_O/h_{fe\,Q5})]$, where R_o is the resistance of the optocoupler and P_1 sets the design-maximum current. With this arrangement, the voltage across $D_2 = (V_x - I_2R_{11})$, where I_2 is the current



Light limiting. LED and optocoupler in feedback loop of 600-mA shunt-regulated supply inexpensively limit no-load current to 120 mA, thus eliminating need for heat sinks for shunt transistor elements Q_3 and Q_4. Design-maximum output current is set by potentiometer P_1; P_2 and P_3 between them set output voltage, which is adjustable over 4-to-22-V range for a 35-to-45-V input. Output impedance is 0.1 ohm.

flowing through the shunting Q_3–Q_4 combination.

When the load is disconnected, the current through Q_4 tends to increase and the voltage across D_2 decreases. This decrease reduces the amount of light emitted from D_2, which in turn causes the resistance of the optocoupler to increase and limit I_2 and supply current I_3. On the other hand, the voltage across D_2 increases and the resistance of the optocoupler decreases when load current is demanded.

Foldback protection is provided by D_3. If the load current increases suddenly due to a short circuit, the output voltage drops and transistor Q_2 moves into cutoff. This in turn reduces the voltage across zener D_2, and the base drive to Q_6 becomes virtually zero. □

Adapter aids emulator testing of I/O board

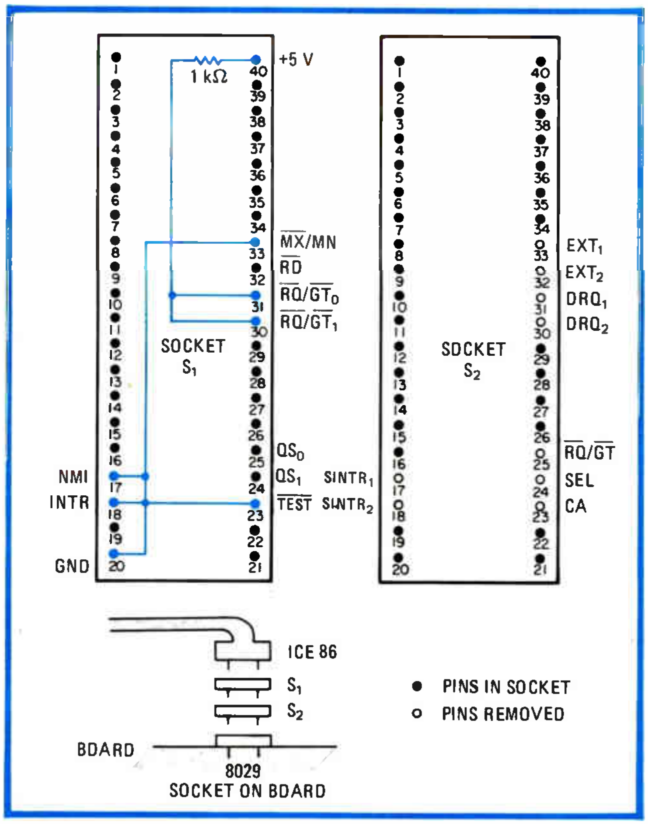
by Sharad Gandhi

Siemens AG, Components Division, Munich, Germany

With this simple adapter, Intel's ICE 86 and ICE 88 in-circuit emulators can be used to debug the popular 8089-based remote input/output board and so allow for easy testing of the system hardware. Only two 40-pin sockets and one resistor are required.

Socket S_1 is wired to handle the emulator signals and to activate the request lines ($\overline{RQ}/\overline{GT}$) from the system bus while ignoring the nonmaskable interrupt (NMI), interrupt (INT), test-for-busy ($\overline{TEST}$), and maximum/minimum-mode (MX/$\overline{MN}$) signals from the 8086 microprocessor, which ultimately drives the I/O board during normal operation. When plugged into the 8089 on-board connector through the slightly modified 8089 socket (S_2), S_1 transfers the control signals from the emulator to the I/O board. S_1 and S_2 are removed from the 8086 when the RBF-89 real-time breakpoint facility (an aid that is widely used for software debugging) is in use. New signals include the queue status (QS) and read-enable ($\overline{RD}$) inputs. Note that the pins corresponding to the interrupt-request (SINTR), channel-attention (CA), channel-select (SEL), request, direct-memory-access (DRQ), and external break (EXT) signals have been removed from S_2 to avoid simultaneous application of more than one signal to the 8089 connector.

If both the system bus and the I/O bus are 16 bits wide, the ICE 86 should be used for testing. If both buses are 8 bits wide, the ICE 88 is used. And if one bus is 16 bits wide and the other is 8 bits, ICE 86 should be used for the former and ICE 88 for the latter.



Plug in. Two 40-pin sockets provide emulator compatibility for debugging 8089-based I/O board (S_1), and simplify system hardware development (S_2). Both sockets are connected in piggyback fashion to 8089 I/O board. User simply disconnects the adapter in order to implement RBF-89 software-testing aid.

When the RBF-89 breakpoint facility is to be used, the user simply disconnects the adapter. The signals corresponding to the pins that are addressed by RBF-89 can thus be applied. □

Pulsed optosensor improves object-distance resolution

by K. Hotvedt

Redwood City, Calif.

Pulsed-mode operation increases the resolution of transmitter-receiver optosensors that use a reflection-lens arrangement to measure the size and range of a distant object. An example is Hewlett-Packard's HEDS-1000. This mode of operation also greatly extends the range of applications open to such sensors. In particular, it permits their use in a single-channel bidirectional communications system that has high speed, good range, and excellent noise immunity and may be easily aligned.

The HEDS-1000 (see figure) contains a light-emitting diode that radiates at 700 nanometers and a matched photodetector designed for optical reflective sensing. A bifurcated aspheric lens images the active areas of the

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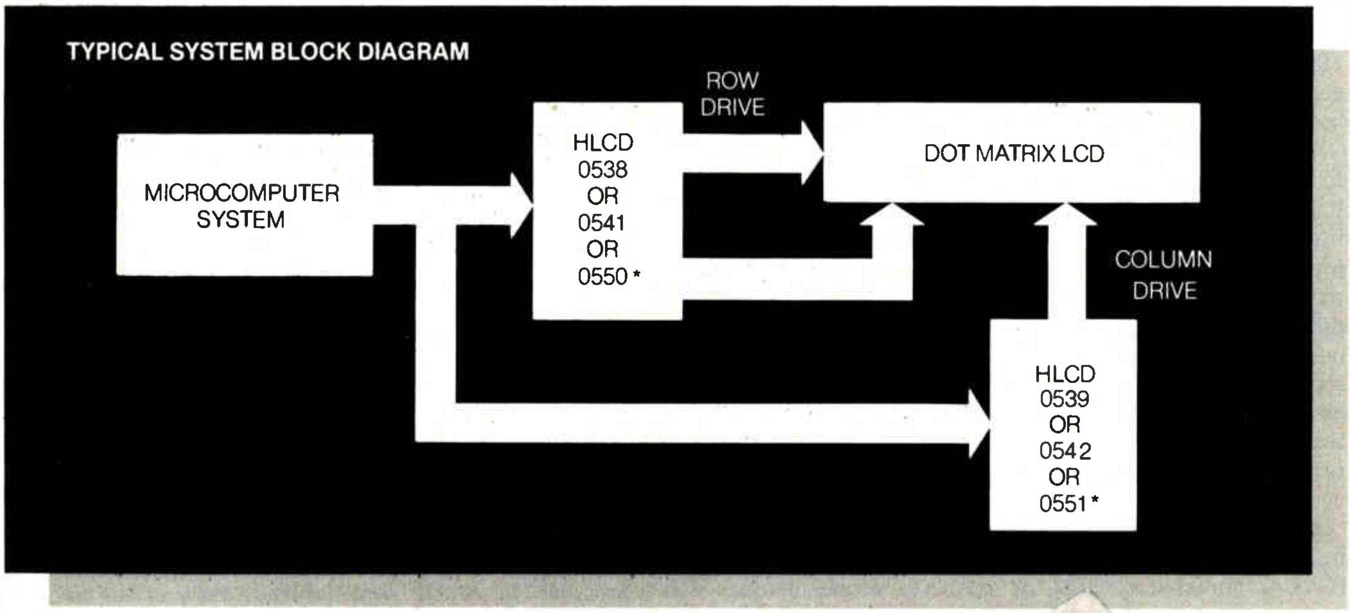

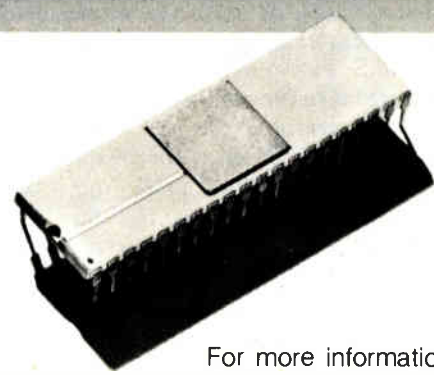

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emitter and the detector onto a single spot whose intensity is at a maximum only 4.34 millimeters in front of the package. As a result, a light beam only 0.190 mm in diameter can be resolved. Because the intensity of incoming (reflected) light is a function of the distance, l, of the reflecting object, the device is useful for locating lines and for paper-edge detection and tachometry.

Normally, the unit operates in the dc, or continuously on, mode. But if the driving current reaches the LED through a 4066 analog gate that is sampled at a given rate and pulse width, it is possible to use a greater instantaneous anode current and so increase the intensity of the light the LED emits. Smaller variations in l may then be detected because, for a given drive current and l, there will be a greater change in photodetector current.

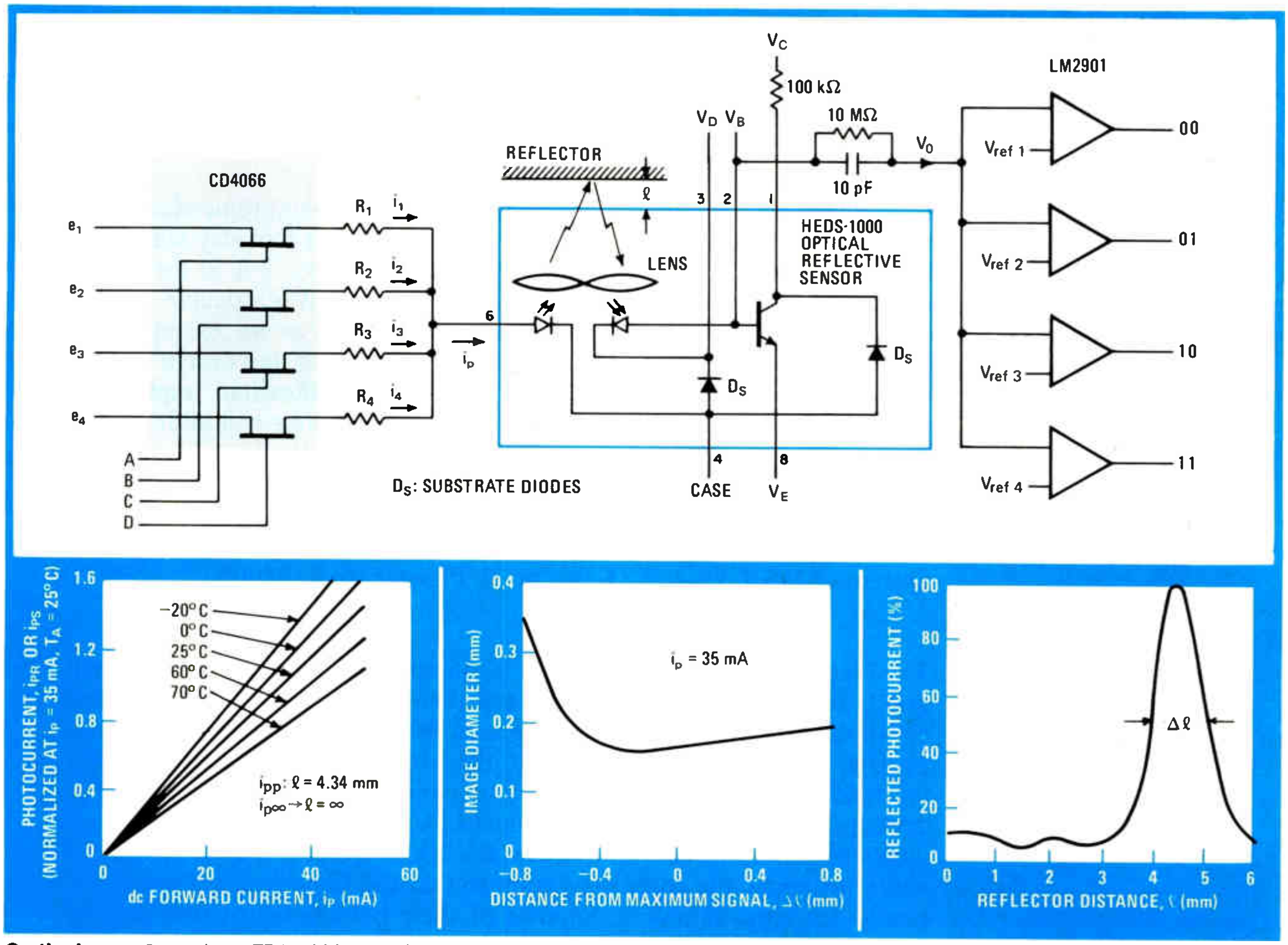
As for performance, the resolution will increase by approximately two (that is, from Δl to $\Delta l/2$) as compared to the dc condition, for an input current at 1 kilohertz having a pulse width of 300 microseconds and a peak amplitude of 75 milliamperes. That is, the circuit's ability to ascertain a given change in l is improved by the same factor. The curves shown give a good indication of the response to be expected under dc conditions and can be used to verify proper operation.

Alternatively, if a set of driving currents corresponding to a four-state data stream and four gates are added, an inexpensive optical communications system may be set up. At the receiver, a quad comparator and the appropriate voltage references can be used to pick off the levels corresponding to those that were transmitted. (Note that a second transmitter-receiver sensor would be needed to complete the two-way system.)

Two problems arise when the sensor is used in the pulsed mode. First, there are internal reflections from the lens system, so that a small signal is reflected even in the absence of a reflecting surface. Second, the unit is somewhat sensitive to stray capacitance, and the amount of stray capacitance is dependent on the device. These drawbacks contribute to offset errors and switching transients, which generate spikes on the rising edge of the incoming driving signal and consequent errors in the transmitted signal level.

The major problem, that of stray-capacitance anomalies, may be overcome by adding a 5-to-10-picofarad capacitor between pins 1 and 2 of the device, as shown. Only small degradation in slew rate for a given sampling rate will result. □

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



On the beam. Operating HEDS-1000 optical reflective sensor in a pulsed mode increases its resolving power in measuring the size and range of distant objects. Lens-focusing system can also be put to good use in inexpensive, medium-range optical data link, as shown, if four-state inputs are multiplexed. Curves, plotted for the dc (continuously on) mode, give indication of performance to be expected.

Engineer's newsletter

Microwave transactions cumulative index is now available

Design engineers engaged in any aspect of microwave theory or techniques, as well as those interested in the history of the field, will welcome the Institute of Electrical and Electronics Engineers' 27-year index of its Transactions on Microwave Theory and Techniques. The cumulative work of the publication, which has been the bible in the field since its inception, has **separate subject and author listings covering the years 1953–79,** plus a history of the transactions themselves, written by Theodore S. Saad. Copies are available for $5.00 to IEEE members or $10 to nonmembers. Write to the IEEE Service Center, 445 Hoes Lane, Piscataway, N. J. 08854, and request the November 1980 edition, Vol. 28, No. 11, Part 2.

Dice are probed over military temperature range

Manufacturers of military hybrid circuits can now get semiconductor dice that have been 100% electrically probe-tested at −55°, +25°, and +125°C. Hybrid Components Inc., Beverly, Mass., has developed a system that **tests semiconductors in either wafer or individual die form.** Call Art Pauk at (617) 927-5820 for more information.

Service company laser-machines metal parts

Need metal parts or foils precisely welded, cut, or drilled? Check with Laser Services Inc. The company can laser-machine **materials as thin as 0.002 in. or even less with a positioning accuracy to within ±0.0001 in.** It uses a pulsed 400-W yttrium-aluminum-garnet laser and will handle prototype to production quantities. Contact Bruce N. Beauchesne, 11 Esquire Rd., North Billerica, Mass. 01862; (617) 667-8358.

Honeywell to run seminar on Codasyl data base

Computer users who plan to implement the industry-recommended Codasyl data base in their machines might be interested in a four-day seminar to be conducted by Honeywell Information Systems, Feb. 3–6, at the Sheraton Greenway in Phoenix, Ariz. Not geared to any particular type of computer but using Honeywell's I-D-S II software as an example, the program will **discuss data-base architecture, planning and design considerations, steps in implementation, problem identification, application examples, and trends.** Workshop portions of the course will address case studies in which the students play the role of consultants, analyzing the problems and recommending solutions.

The fee is $625. For registration details, call (800) 528-5343 or write the Honeywell Registrar, Data Base Workshop, Honeywell Information Systems, M/S T-99-4, P. O. Box 6000, Phoenix, Ariz. 85005.

NBS wants research proposals

The National Bureau of Standards is soliciting proposals for two research **grants for precision measurement and the determination of fundamental constants** for 1982. The one-year grants, which have been awarded since 1970 to scientists in academic institutions for work in determining values for fundamental constants, investigating related physical phenomena, or developing new methods and instruments for making very precise measurements of physical quantities, are worth $30,000 each. The NBS has the option to renew the contracts for up to two additional years. Prospective candidates must submit summaries of their proposed activities and the appropriate biographical information by Feb. 15. For further information, contact Barry Taylor, Building 220, Room B258, National Bureau of Standards, Washington, D. C. 20234.

-Vincent Biancomano

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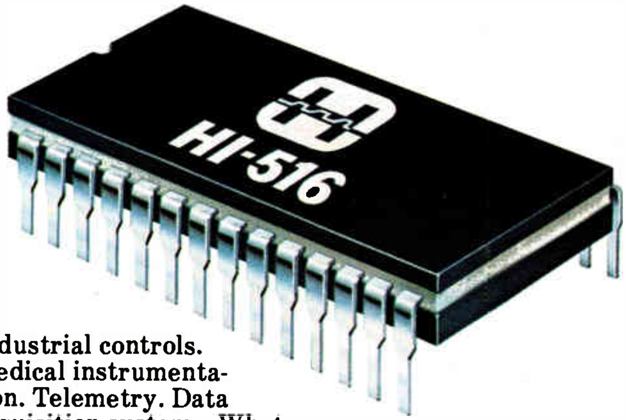

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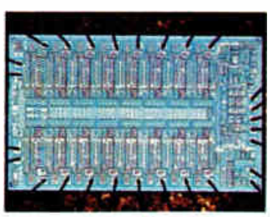

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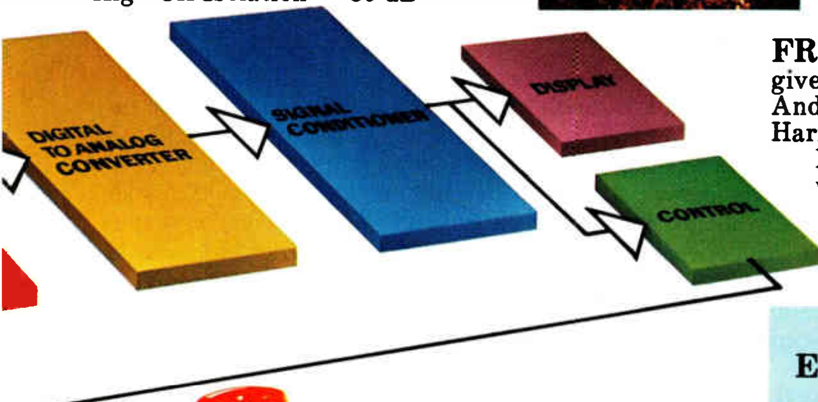
5. Standard, Dash 1 code



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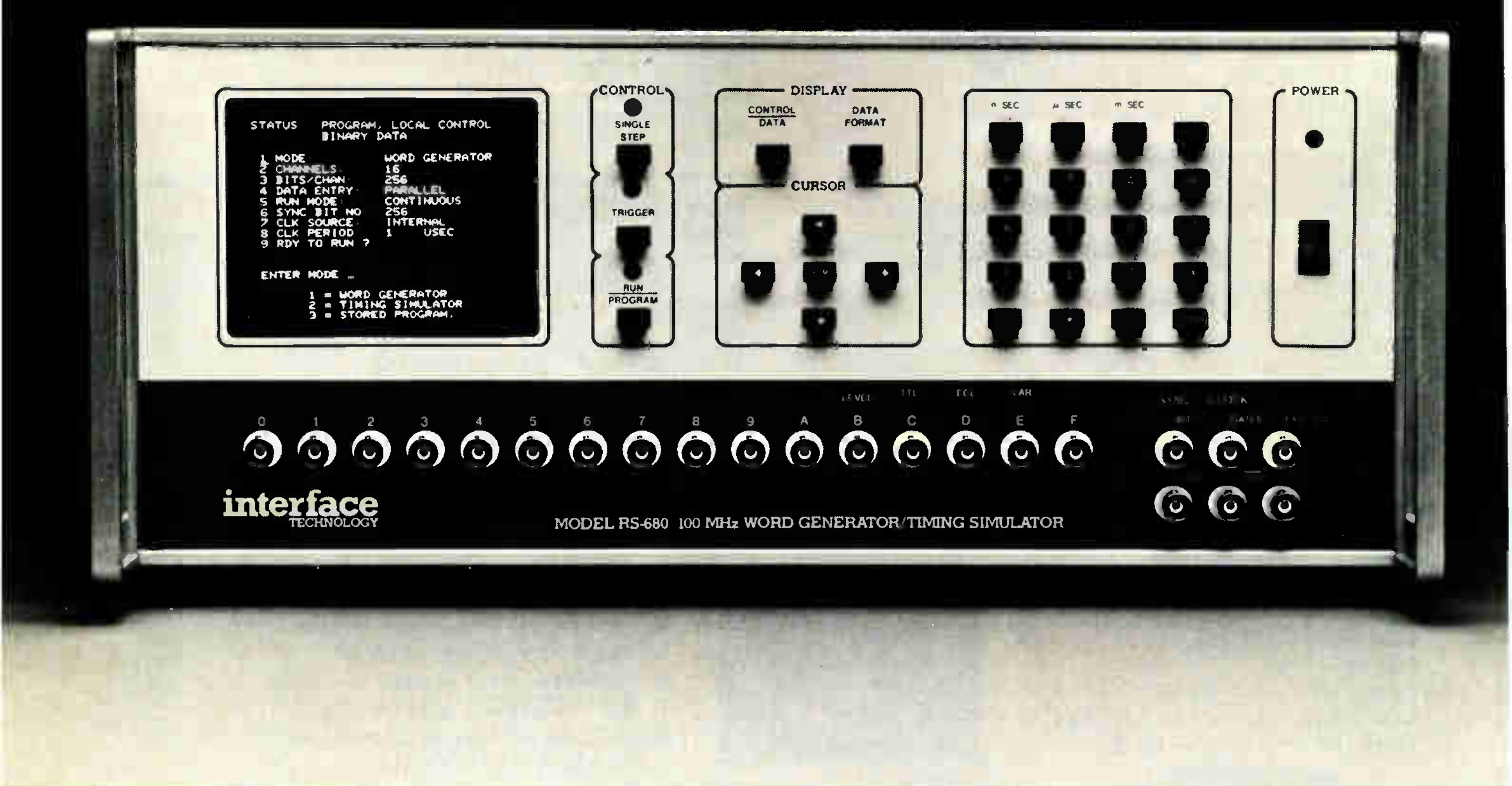

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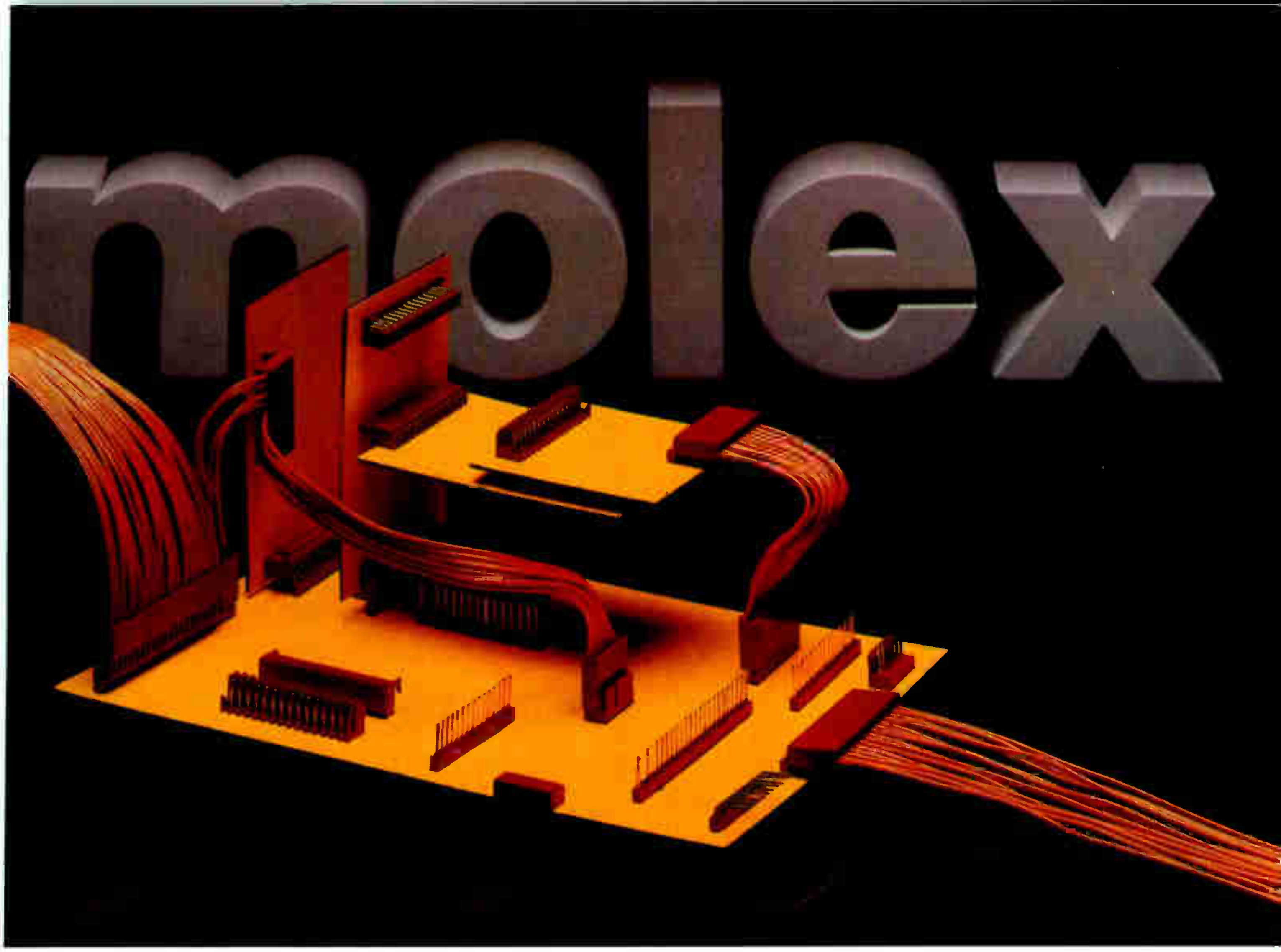

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Illustrated here are examples of typical applications, configurations and components. The KK® .100" (2.54mm) system consists of .025" (0.6mm) pins; right-angle, straight and polarized wafers; both crimp-type and P.C. board mount female connector housings and crimp or solder tail terminals; all featuring the Molex patented dual-cantilever terminal system. Non-flammable, 94 V-O material is used in all KK® 100 connector housing and wafer bases.

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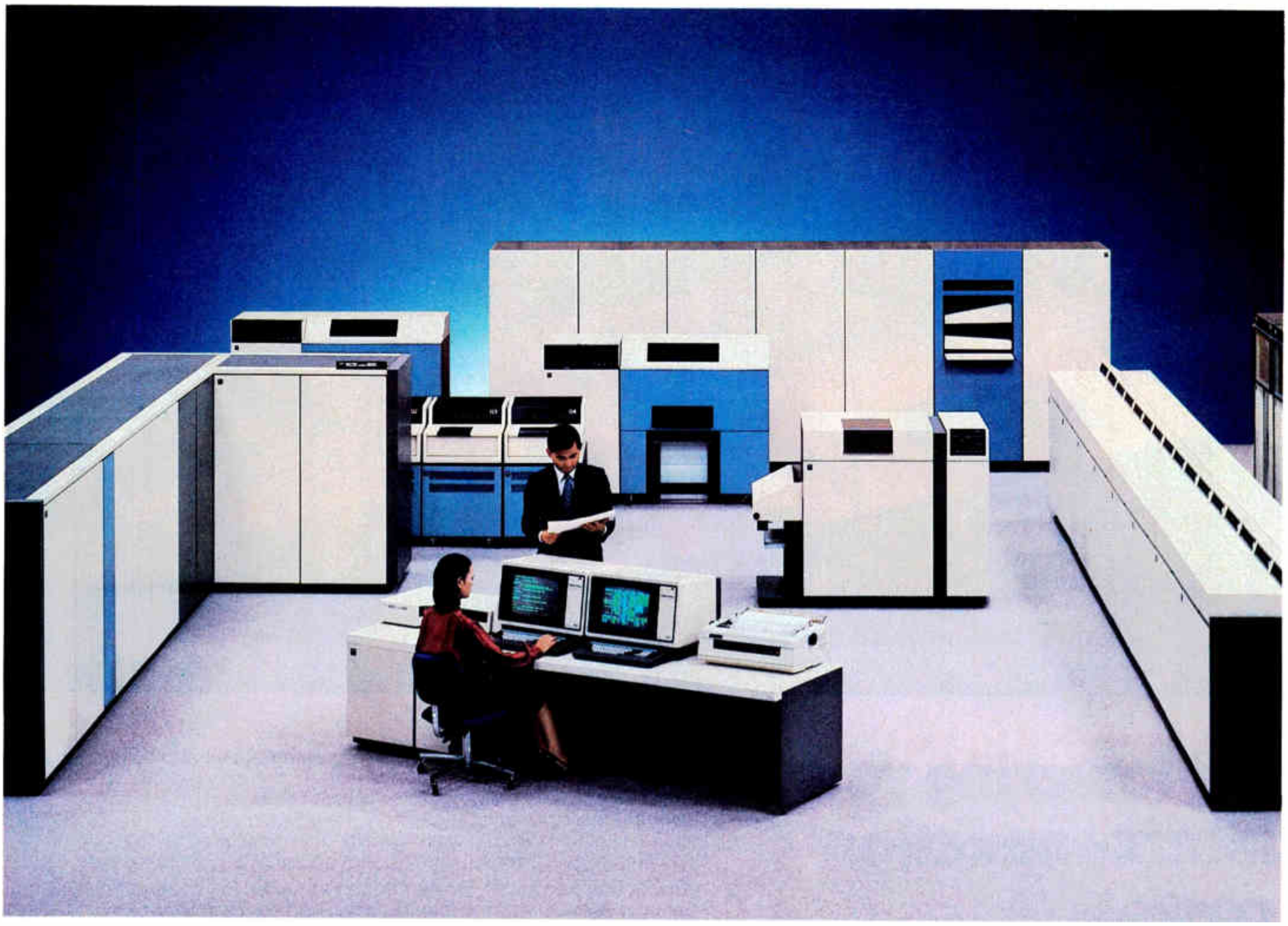


THE WORLD'S LARGEST AND FASTEST COMPUTER*

NEC recently unveiled an ultra-large general purpose computer called the SYSTEM1000. At present, it is the largest commercially available computer in the world. The SYSTEM1000 was developed to meet increasing needs for large-scale processing in on-line data base systems, engineering calculations and communications networks.

NEC SYSTEM1000 has a 64MB main memory, and a 128KB cache memory. No other commercial computer can match these figures for main memory, cache memory and processing speed.

To develop the SYSTEM1000, NEC made full use of its advanced LSI technology. The SYSTEM1000 incorporates high-speed logic LSIs, 64-kilobit/chip high-density MOS LSI memories, and LSI high-density packages with up to 60 chips mounted directly on a multilayered substrate.

A special feature of the SYSTEM1000 is a very large data array address function which gives direct access to a volume of data as large as 1 gigabytes by using a virtual memory. The execution processing unit incorporates an integrated array processor which can work out large-scale vector and matrix calculations very quickly.

*As of November 17, 1980.

NUMBER 115

SWEDEN TESTS 140MB DIGITAL MICROWAVE SYSTEM

The Swedish Telecommunications Administration is conducting field tests on an NEC-supplied two-hop 6.8GHz 8-phase 140MB digital microwave system. NEC is currently the world's only supplier of this type of system which features the highest bit rate recommended by the CCIR.

The system transmits CEPT hierarchy 140Mbps digital signals, using an 8-phase PSK modulation system, over the radio frequency band ranging from 6,430MHz to 7,110MHz.

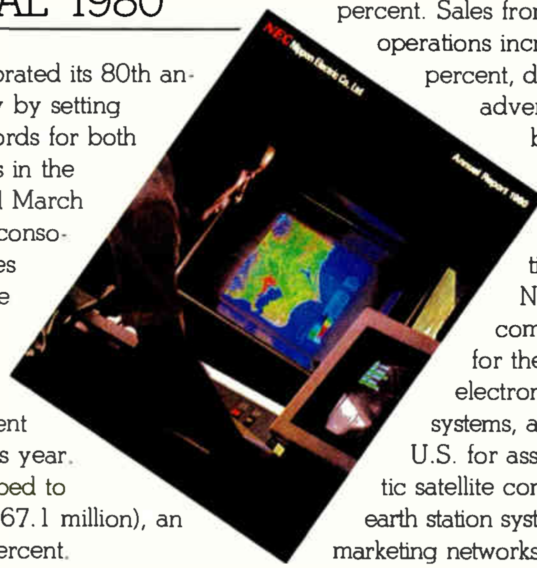
The digital capacity is equivalent to 1,920 PCM telephone channels.

The transmitter-receiver may also be used in analogue service with a capacity equivalent to 2,700 FDM telephone channels.

The system will be put into commercial use in the public telephone network next year after testing is completed.

NEC has also received orders for the system from Denmark and Switzerland. Many other European countries are taking great interest in the 6.8GHz 8-PSK 140Mbps digital system.

RECORD INCOME AND SALES IN FISCAL 1980



NEC celebrated its 80th anniversary by setting new records for both income and sales in the fiscal year ended March 31, 1980. On a consolidated basis, sales and other income for 1980 rose to ¥879.31 billion ($4.03 billion), a gain of 9 percent over the previous year. Net income climbed to ¥14.62 billion ($67.1 million), an increase of 85 percent.

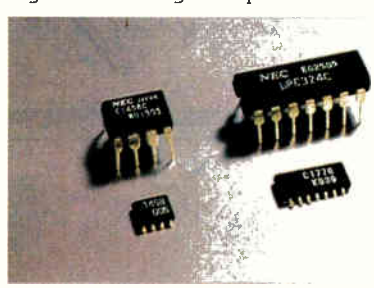
All four of NEC's major product lines recorded impressive growth in sales, with Telecommunications up 9 percent, Electronic Data Processing and Industrial Electronic Systems up 19 percent, Electron Devices up 35 percent and Consumer Electronics up 26 percent. Sales from international operations increased by 24 percent, despite a generally adverse international business environment.

To strengthen its international operations, NEC set up a new company in Brazil for the production of electronic switching systems, and a plant in the U.S. for assembly of domestic satellite communications earth station systems. In addition, marketing networks were expanded in both the U.K. and the U.S.

(In this article, ¥218=US$1.)

NEW FAMILY OF MINI ICs

To meet the need for smaller, more highly-integrated package ICs, NEC has begun marketing a new mini IC which is only 1/8 the size of standard package products.



The new package IC family is called the "Mini Flat Package Linear Series". It is offered in two types—one with 8 pins, the other with 14 pins.

Dimensions with the pins not included are 4.4 x 5.0mm for the 8-pin devices, and 4.4 x 10.0mm for the 14-pin products. Both types are a mere 1.5mm thick; pin pitch is 1.27mm, just half that of standard products.

The new ICs will be used in communications equipment, household appliances and consumer products. They will act as general purpose operational amplifiers or circuit modules in hybrid ICs.

NEC
Nippon Electric Co., Ltd.
P.O. Box 1, Takanawa, Tokyo, Japan

VLSI tester is highly modular

40-MHz general-purpose semiconductor test system, the first of a series, eases investment through modular hardware, software

by Richard W. Comerford, Test, Measurement & Control Editor

Brian Sear and the group of experienced automatic test equipment engineers he heads at GenRad have seen the time ripening for a new generation of test systems capable of testing the very large-scale integrated circuits that are and will be emerging in the 1980s. Now, following a year's monumental effort, Sear's group, known as GenRad Semiconductor Test Inc. [*Electronics*, Feb. 14, 1980, p. 14], is introducing the first of a series of semiconductor test systems.

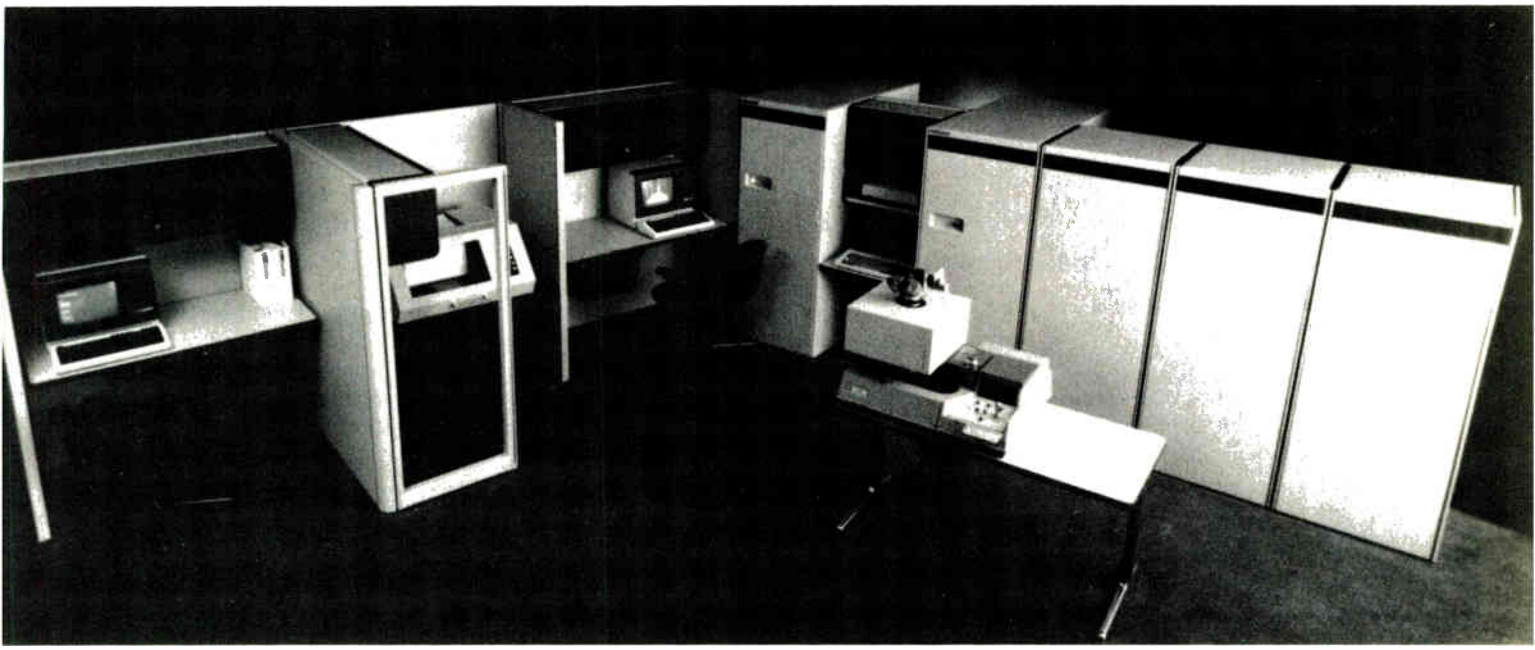
One of the more powerful units in the planned series, the GR 16 tests VLSI devices at cycle rates as high as 40 MHz. It is self-testing and calibrates itself automatically (calibration is maintained for up to 8 hours between automatic calibrations); these features are crucial to full utilization of the system, which has a base price that is set at $480,000.

But the system's most important feature, dictated by the past experiences of both users and manufacturers, is the highly modular architecture that allows it to cope with changing requirements. The GR 16 carries the concept of modularity to a higher level than has previously been seen in test systems; it is modular physically and functionally, in hardware—from test pin to card to cabinet—as well as software.

The four basic functional blocks of the tester are the computing system, the functional test system, the test-head assembly, and the user interface. The first of these, the computing system, has a unique architecture that permits very large programs to be managed at high speeds. It consists of two basic segments: the central processing unit and a special controller for the test procedures.

The GR 16's CPU is a standard PDP-11/34 working under Digital Equipment Corp.'s RSX-11M operating system. The basic system has 128-K words of main memory, two 0.5-megabyte floppy disks, and 5 megabytes each of fixed and removable hard-disk storage. The large amount of storage should prove particularly useful if the buyer chooses options allowing the system to work with a host computer or the GRnet network.

The CPU communicates and controls the test system's user interfaces. One or two interfaces can be provided, as well as two more stations for programmers. Programmers can write and edit test programs in the background while tests are being run in the foreground. But the CPU's major function is to share



the running of test programs with the test procedure controller (TPC).

The reason for this sharing, says the system's chief architect, Robert Albrow, is that "most minicomputers lack two essential ingredients for running test programs: memory and speed." Thus the GR 16 lets its CPU take care of the slower test plan (a definition of program flow, control, and input/output) and the TPC handles the fast, memory-intensive test procedure (as defined by the test plan instructions).

The CPU communicates with the TPC through a Unibus and downloads compiled test procedures to the TPC's memory. The basic TPC memory can store 128-K words but is expandable; an additional four 32-K-word cards can be added and 128-K-word cards can be swapped for all eight 32-K-word cards. Able to accommodate a mix of such cards, the TPC provides a significant boost in test-program storage ability.

High-speed bus. The TPC sends the functional test subsystem and the test-head assembly instructions by means of a special 64-bit high-speed bus. This bus forms a backplane that interconnects all the cabinets, or crates. Built using 100-MHz emitter-coupled logic, the bus distributes addresses and data to the appropriate elements of the system; 32-bit data words can be transferred to the functional subsystem or test-head registers at 5 MHz.

The functional test system consists of six major elements: the test pattern processor, the test pattern generator-analyzers, the phase-timing system, the pin-control table, the test-pattern selector, and the digital drive and comparison system. These elements are interconnected with separate high-speed buses. The first three elements work to create and analyze the test pattern; a 125-MHz crystal-controlled oscillator in the phase-timing system provides 16 phases, each of which can have up to 16 timing sets selectable in real time (without dead time). The functional system architecture allows the generator-analyzers to be changed at will, and STI plans to provide special ones—dedicated to random-access- and read-only-memory and serial pattern generation for testing level-sensitive-scan devices—sometime this year.

The pin-control table and the test-pattern selector work together to control pin functions at the device under test. Thus, with a 4-bit word, pin functions can be changed on the fly (at 40 MHz) letting the system test, for example, devices with multiplexed I/O schemes.

A significant feature provided by the dual-processor arrangement is that it permits parallel testing. Since the high-speed data bus communicates with the test-head assembly as well as the functional system, ac functional tests, for example, can be carried out at one test head while the parametric measurement unit in another head performs parametric tests. "The addition of a second test head typically improves throughput by 50%," Albrow states.

Two versions of the test-head assembly, each with a parametric measurement unit, are available, one with 96 pins and one with 48 pins, and both can be down-configured in 8-pin groups to meet users' needs. The pins handle the voltage levels needed for MOS, TTL, and ECL testing. For one shift (8 hours) following an automatic system calibration, time-measurement accuracy is to within ±1.0 ns under all conditions. By calibrating the system for an individual test program, accuracy within ±0.5 ns is achievable.

Test programs are written using a version of Pascal with special structures added for testing. Thus users can transfer test programs to other test systems without rewriting as configurations change. The system comes with a test-language and test-pattern compiler, and software in the works includes a computer-aided-design translator package and a pattern converter to translate tests from other testers.

Deliveries are scheduled to begin in April. A fully configured system, with dual heads and multiple programming stations, costs $950,000.

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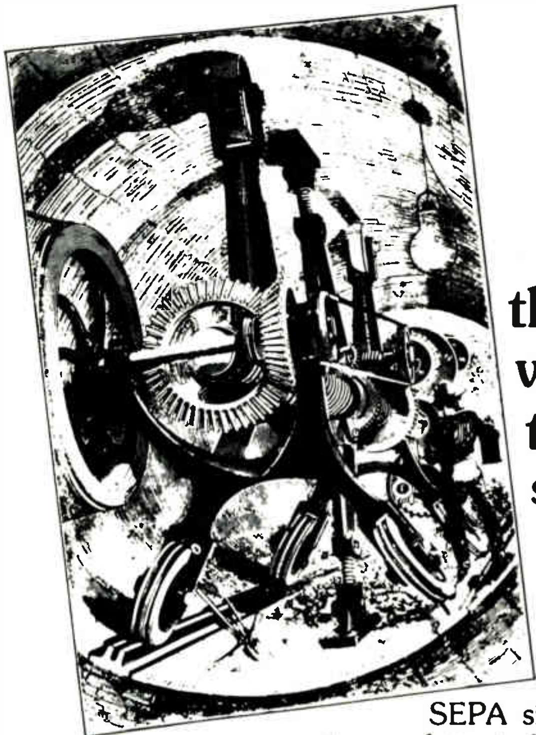

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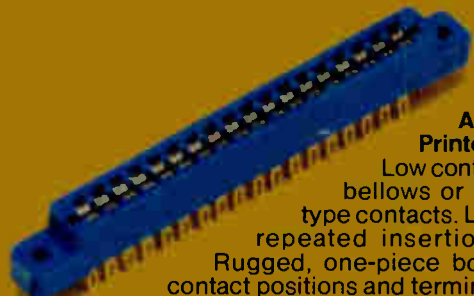

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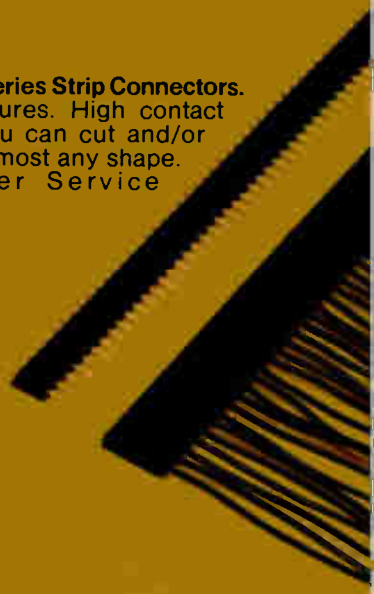

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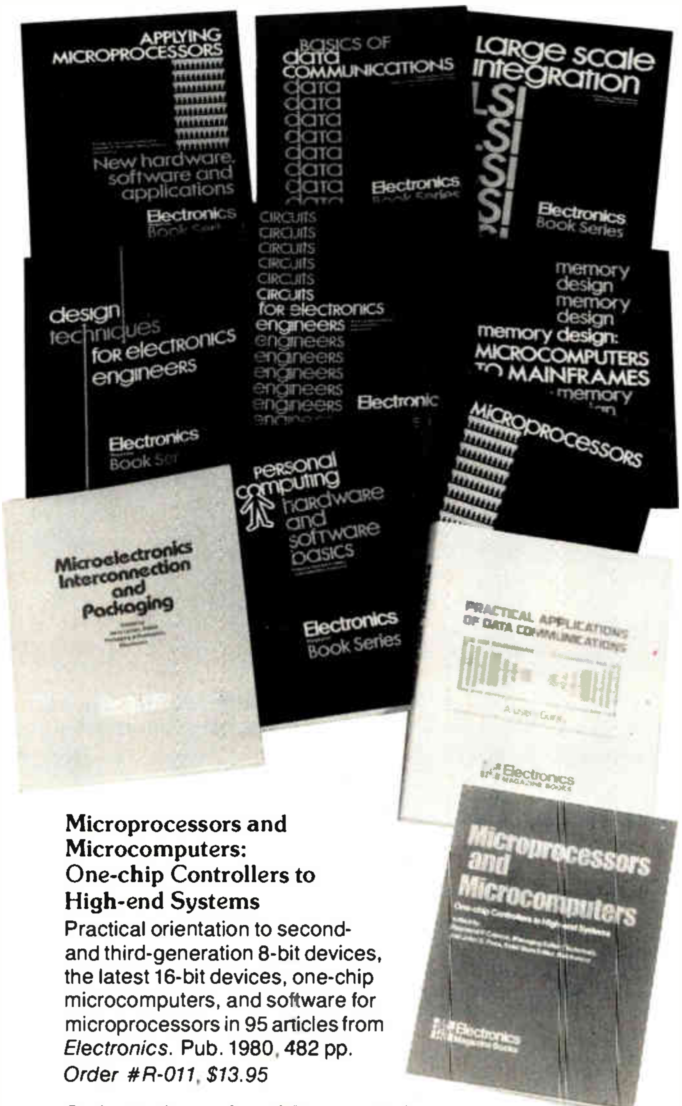

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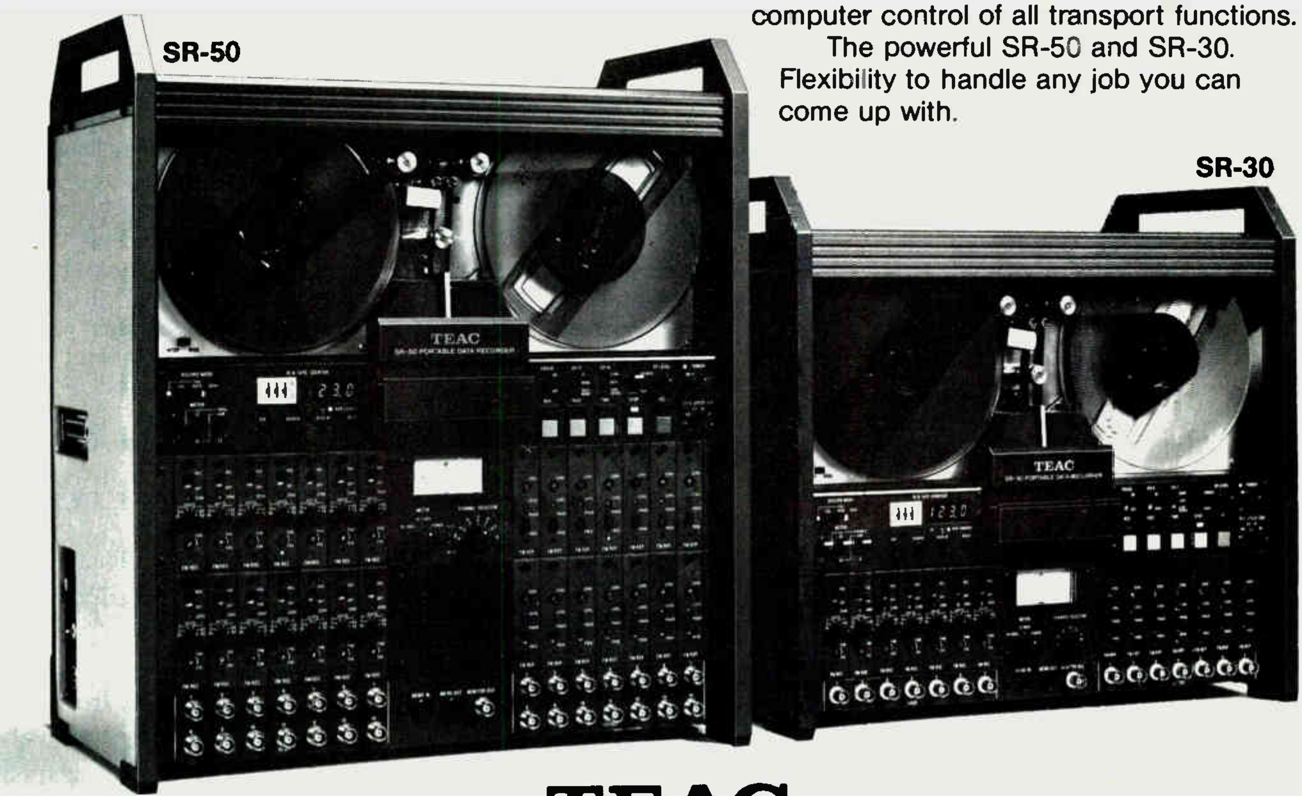

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Fast 16-K static RAM tolerates faults

55-ns RAM is made with double-polysilicon process, has three redundant rows to raise yield and polyimide to fight alphas

by Bruce LeBoss, San Francisco regional bureau manager

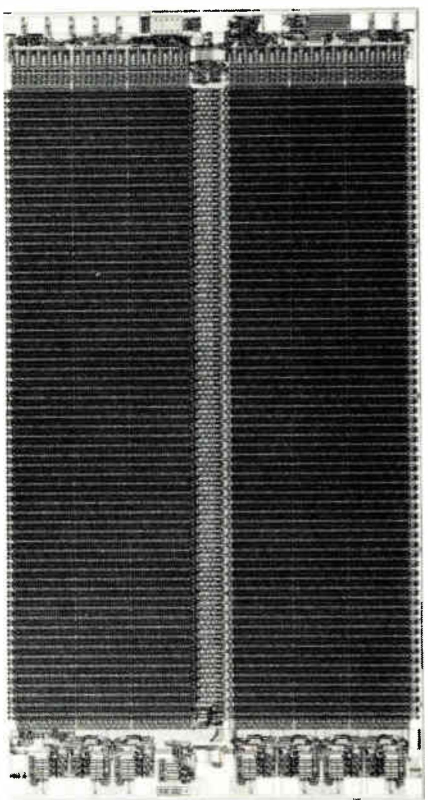
A high-speed 16,384-bit static random-access memory from Intel is neither the first, fastest, densest, nor least–power-consuming of its ilk. Nonetheless, the arrival of the long-awaited 2167 is a milestone inasmuch as the 16-K-by-1-bit RAM exploits no fewer than three of the latest processing techniques that point the way toward increased availability of complex chips at reasonable cost.

Offering four times the density of industry-standard 2147 4-K-by-1-bit static RAMs, plus lower power consumption per bit, the 2167 is the first Intel device to be fabricated using the firm's proprietary double-polysilicon H-MOS II (high-performance n-channel MOS) technology. Some earlier process changes simply shrank geometries, decreasing channel lengths and gate oxide thickness. The double-polysilicon H-MOS II process instead locates a second layer of polysilicon, containing two resistor loads, above the basic four-transistor cell, nearly halving cell dimensions (for a cell area of 1.6 mil²) and thus quadrupling density.

Additionally, the 2167 and a simultaneously introduced 64-K dynamic RAM (the 2164) are the first Intel products to use redundant designs [*Electronics*, Dec. 4, p. 108]. "The 2167 chip contains three extra memory rows not needed for basic functions," according to Kirk F. MacKenzie, strategic marketing manager for Intel's Memory Components division in Aloha, Ore. "If a defect is discovered when a chip is tested, a faulty row is replaced with a redundant row. The result is six to seven times the yield of error-free devices, which leads to improved delivery and availability."

Those benefits far outweigh the fact that the redundant circuitry increases die size approximately 6%, for a total of 42,400 mil², MacKenzie continues.

Had Intel not used redundant circuitry, the 2167's die size would have been about 39,900 mil², still somewhat larger than Inmos Corp.'s IMS1400 and other 16-K static RAMs that are beginning to surface [*Electronics*, Oct. 23, p. 135]. However, as much as a 3% increase in die area from that of the original samples of the 2167 is due to the addition of polyimide tape die coats intended to reduce soft-error rates caused by alpha particles. By using the measured flux of less than 0.002 alpha particle/cm²/h and accelerated testing, Intel estimates the 2167's soft error rate to be less than 0.01% per 1,000 hours, or nearly an order of magnitude better than uncoated 2167s.



This final version of the 2167 further guards against alpha-particle–induced errors by adding gate capacitance to the two driver transistors in each cell. This effectively adds capacitance from the polysilicon resistors to ground, thus damping transient energy surges induced in the load resistors. The capacitance slightly increases die area but does not degrade performance.

Primarily because of the redundant circuitry, the 2167 pays the penalty of a small access-time slowdown (approximately 8%) and an even smaller power increase (about 3%). Nonetheless, the 16-K-by-1-bit static RAM maintains the 2147's 55-ns maximum access time, which is also comparable to the access time of the IMS1400 [*Electronics*, Dec. 4, p. 22].

Its high speed, coupled with the fourfold increase in density, MacKenzie says, makes the 2167 "well suited for current 2147 high-speed mainframe and minicomputer applications, such as main memory, buffer, and cache." The 2167's 20-pin dual in-line package also means savings in board space over memories housed in 24-pin packages.

In all, the 2167 will be offered in four speed and power combinations. They include: a 2167-55 having a maximum access time of 55 ns, a maximum active current of 125 mA, and a maximum of 40 mA standby;

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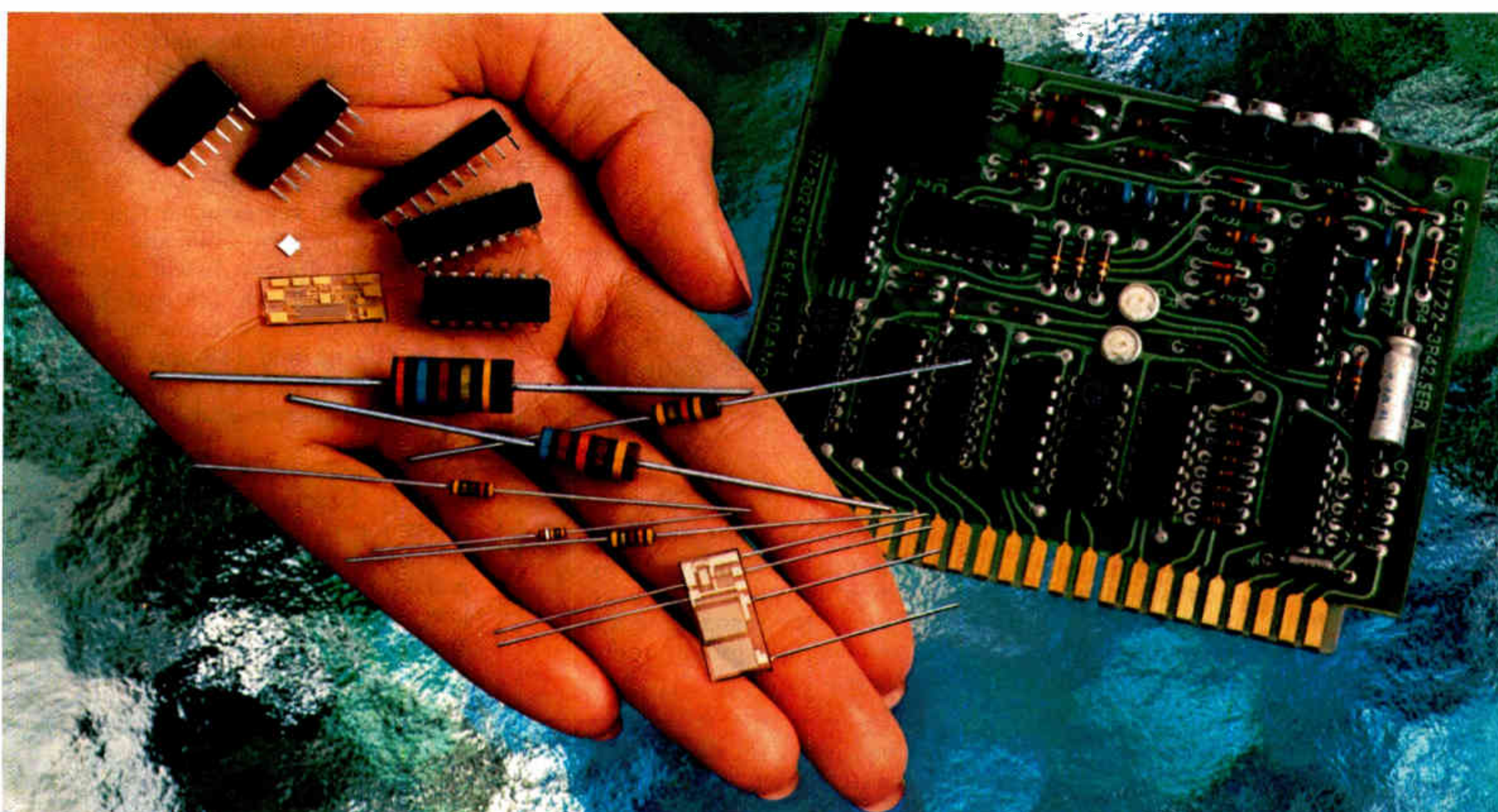

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Less power. Users who upgrade to the 2167 will markedly reduce their power consumption per bit, MacKenzie claims. For example, when compared with four standard 55-ns 2147s, the 2167 uses 83% less active power and 67% less standby power. The power-down feature maintains RAM operating speed and system data throughput and, he points out, does not require clocking or complex power-switching techniques.

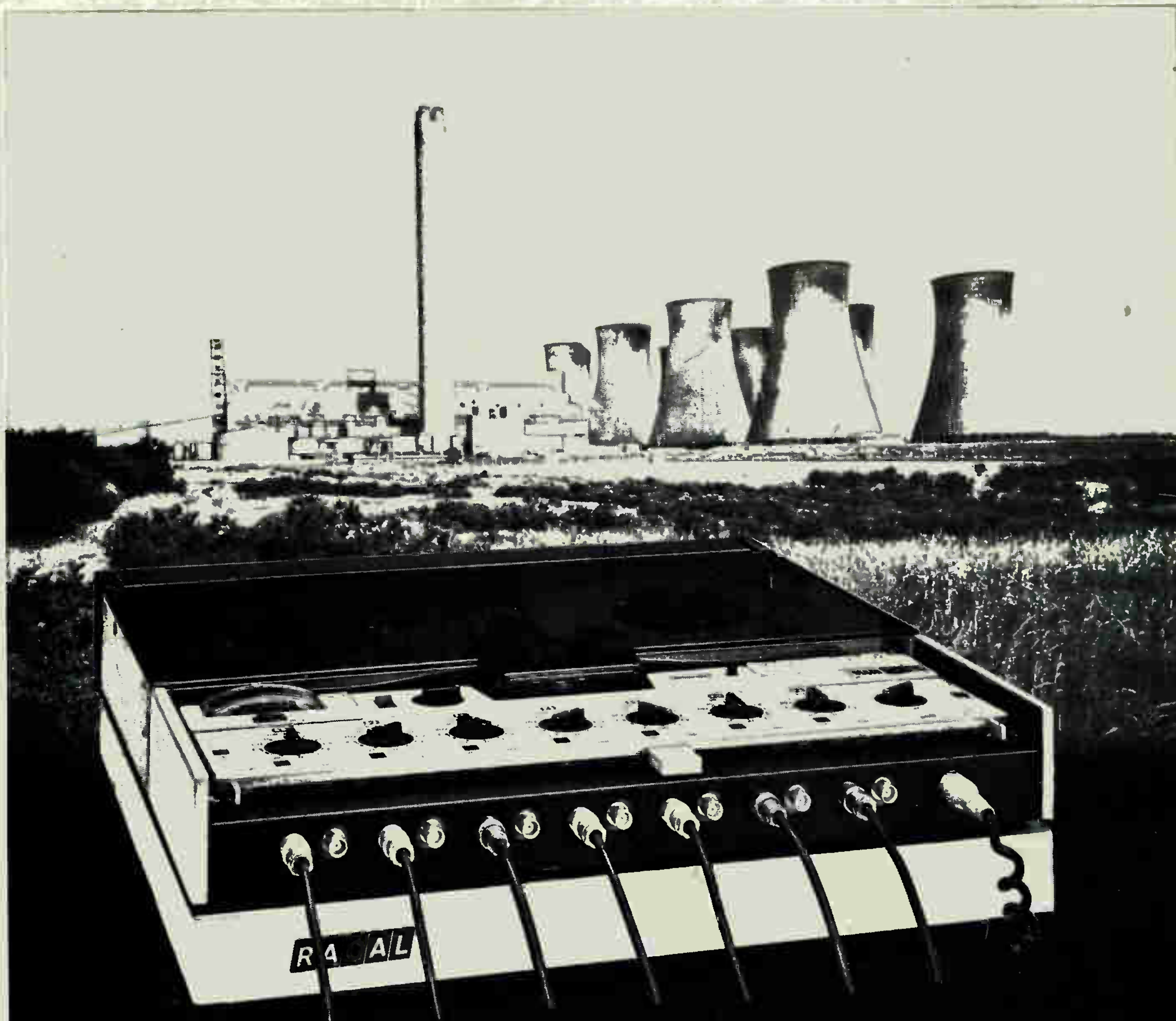
Unlike other classes of MOS RAMs, the 2167 requires no clocks or timing strobes. Its fully static operation and identical access cycle times ensure the highest system data throughput available at these access times, MacKenzie claims. What's more, the 2167's inputs and outputs are TTL-compatible and are unlatched to ensure simple static timing. No address setup and hold timings are needed.

Intel will soon be supplying samples of a 4-K-by-4-bit 2168 static RAM that will represent an upgrade choice for its own 2148 and 2114 1-K-by-4-bit devices. It will also be housed in a 20-pin DIP and have maximum access times ranging from 55 to 100 ns, and 180 and 30 mA active and standby current, respectively. Second-quarter 1981 availability is planned.

The 2167 will be available in quantity later this quarter. U.S. prices for the 2167-70 are $68.55 each in quantities of 100. There is a premium of about 3% for faster and lower-power members of the family and about a 15% discount for the slower device.

Also available this quarter will be a CM-92 memory module, a board that incorporates the 2167 into Intel's series 90 family of memory systems. Priced at $5,655 each in quantities of 10, the CM-92 is targeted for general-purpose computer applications.

Intel Corp. 3065 Bowers Ave., Santa Clara, Calif. 95051. Phone (408) 987-8080 [339]



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RACAL

Circle 707 on reader service card

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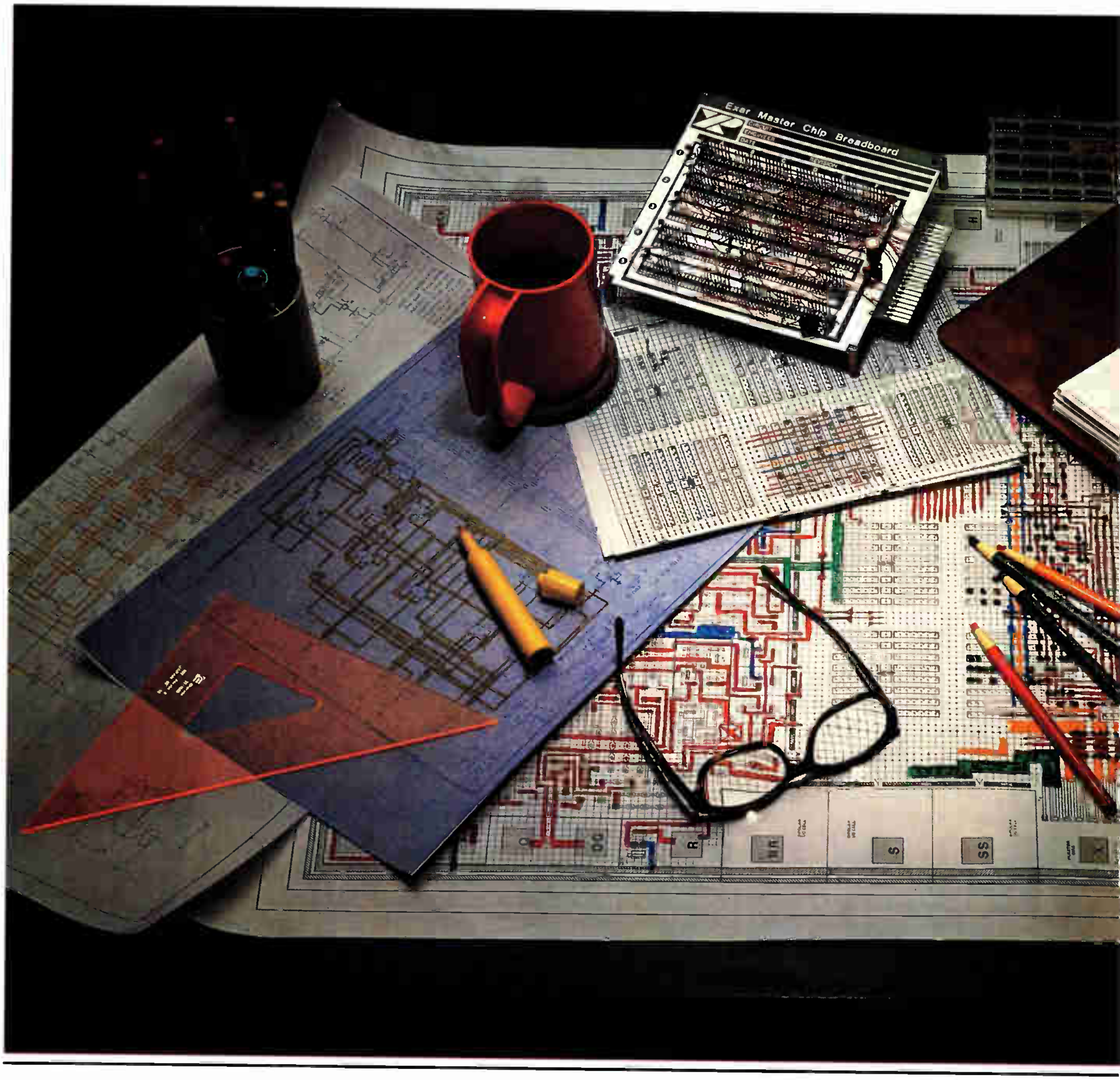

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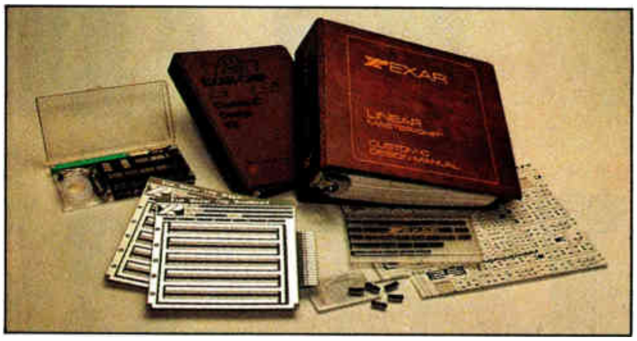

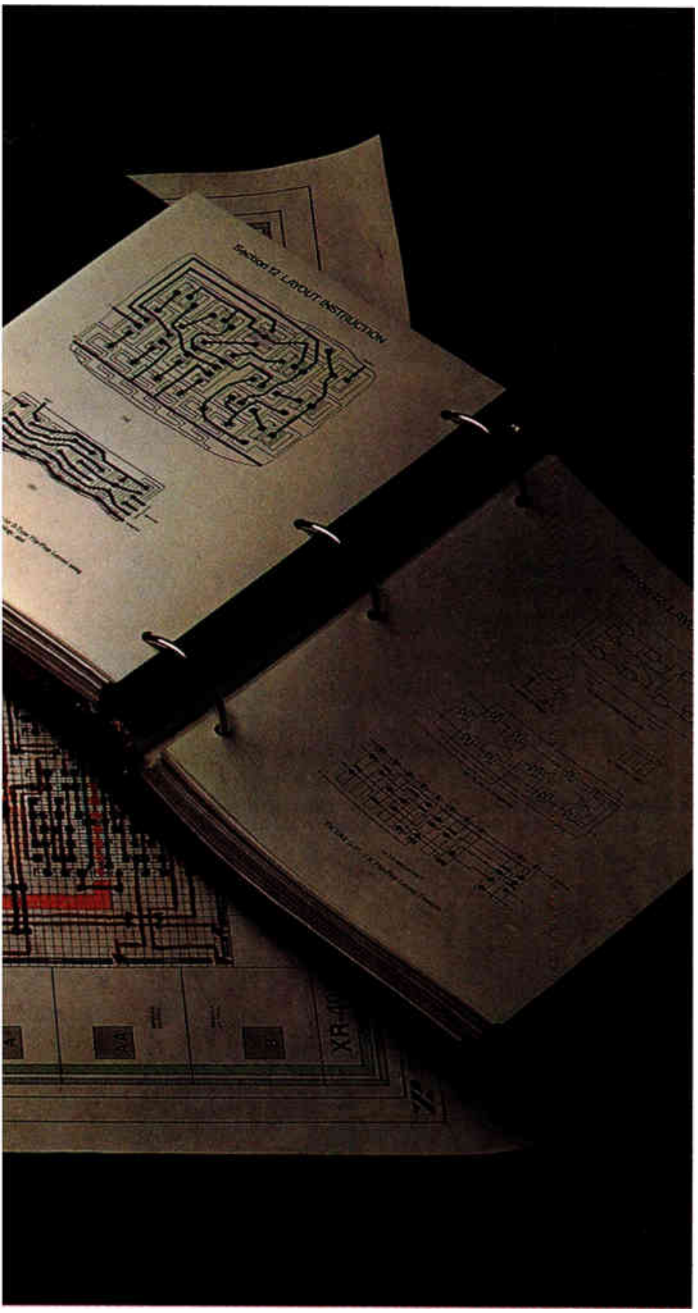

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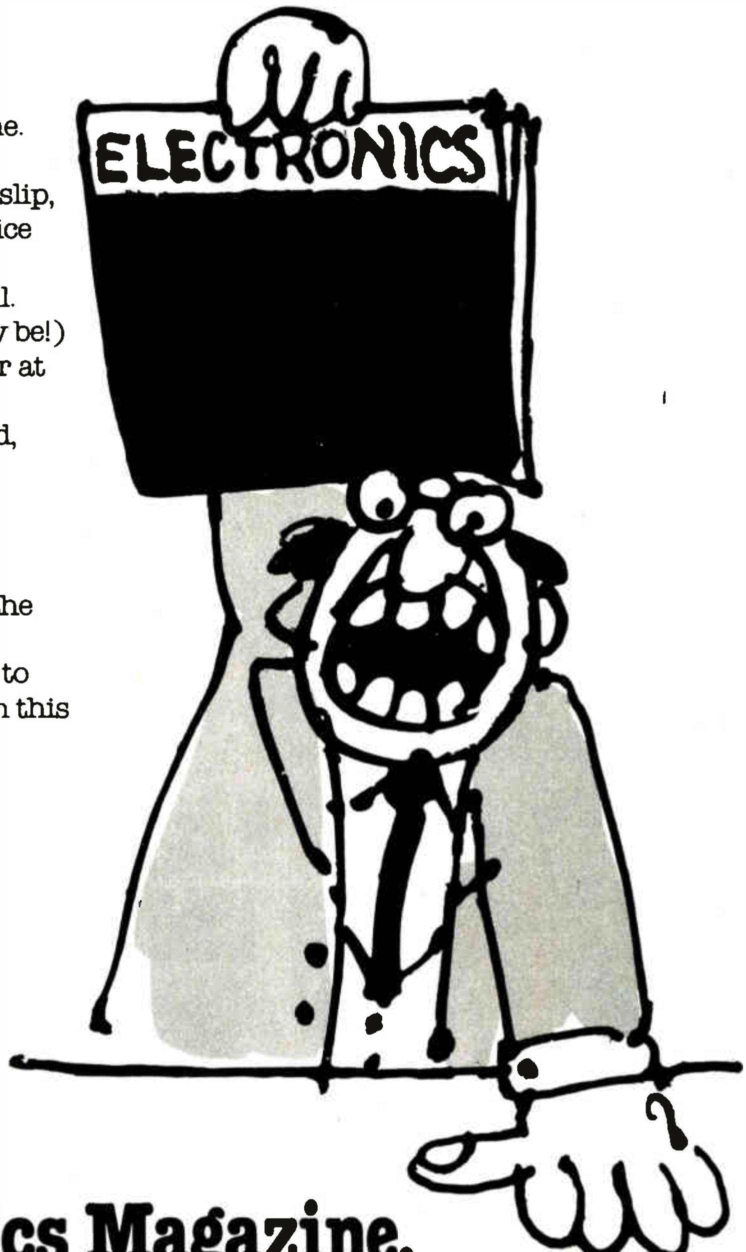
Who stole page 39?



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.

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TRIO

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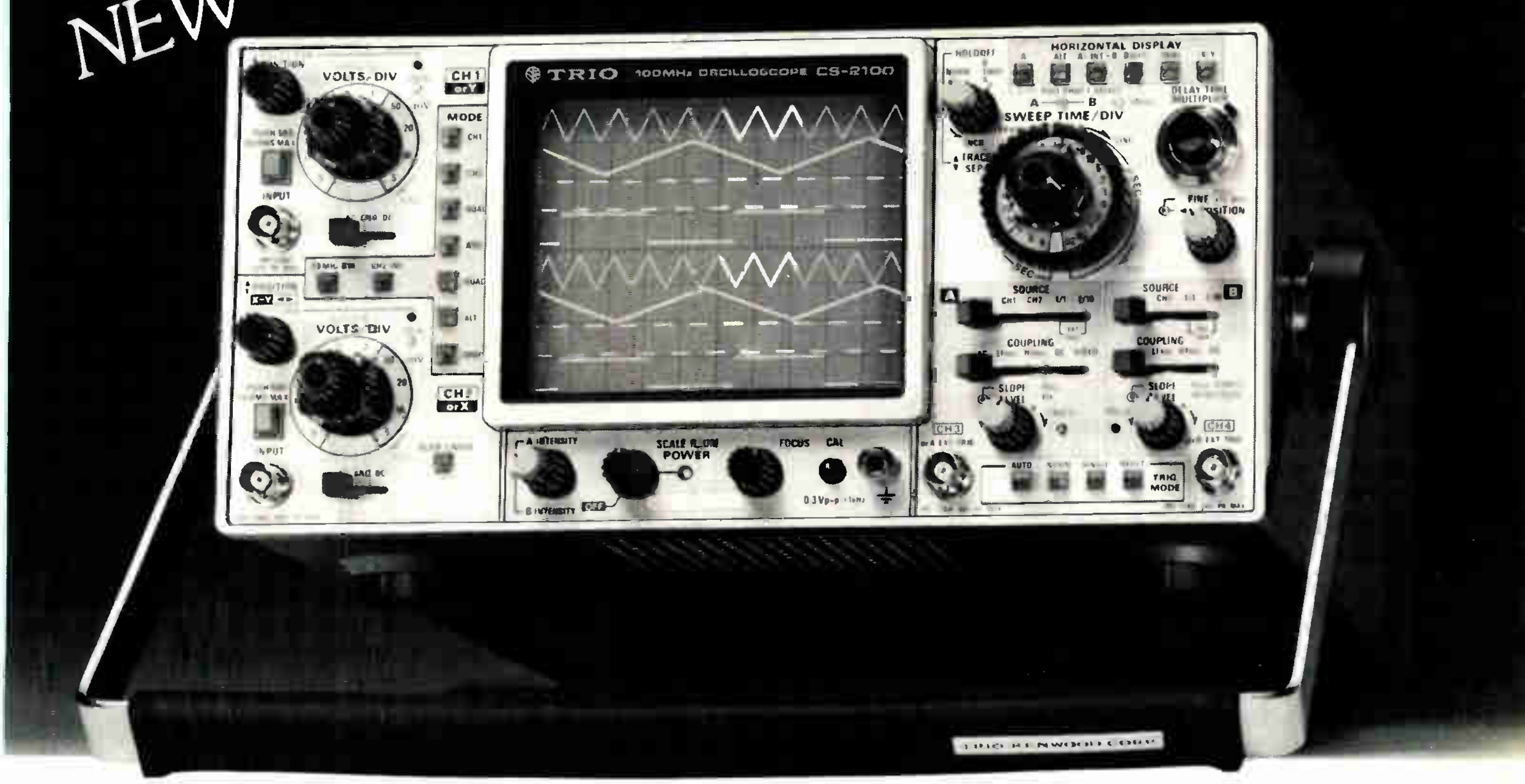
NEW



4 Channel 8 Trace Display

100MHz 4 Channel Oscilloscope

CS-2100

Trio, known throughout the world for its responsiveness to the tough demands of oscilloscope users, has developed a 100MHz scope that is destined to change your thinking about 100MHz oscilloscopes.
The compact, 100MHz CS-2100 offers 4 Channel/8 Trace display capability to solve even your trickiest display problems. The CS-2100 is the successful culmination of a development effort which sought to provide all the high frequency response and sensitivity demanded by today's state-of-the-art circuitry as well as a variety of features such as delayed, alternate and dual sweep display. The result of this effort is a full-feature 100MHz scope with designed-in solutions to your toughest problems.

- Up to 1 mV/DIV sensitivity usable all the way to 100MHz.
- Sweep times to 2ns/DIV with x 10 magnification for easy viewing of the fastest signals.
- Unique 4 Channel/8 Trace display.
- Indispensable Delayed Sweep feature allows simultaneous viewing of the delayed sweep and the main sweep.
- Completely independent A and B Sweeps for easy viewing of signals of widely different frequencies.
- 50Ω input impedance is selectable for observing fast pulses or signals on 50Ω lines without the need for bothersome terminations.
- Independently adjustable main and delayed sweep intensity.
- 16kV of accelerating potential and Auto-focus for a clear bright display.
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- Compact 28.4cm(W) x 13.8cm(H) x 40.0cm(D) package weighs only 7.4kg for true portability.
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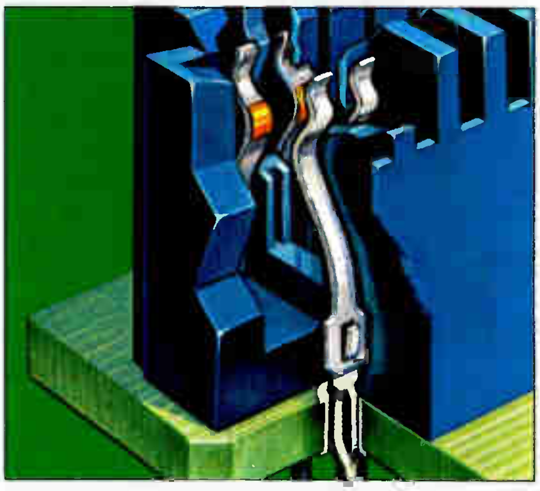
Circle 708 on reader service card



Accu-plate is a perfect match for our newest achievement in time-saving backplane connectors—the AMP PACE (Pre-Assembled Card Edge) connector. It puts a plating of nickel on the high-wear ramp, gold on the final contact and tin-lead on wrap-type posts.

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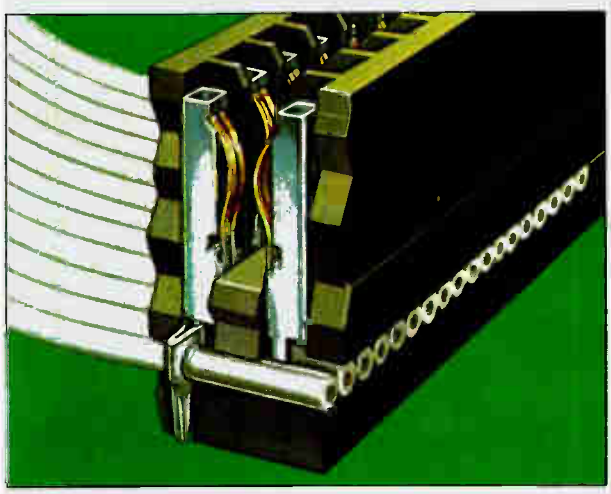
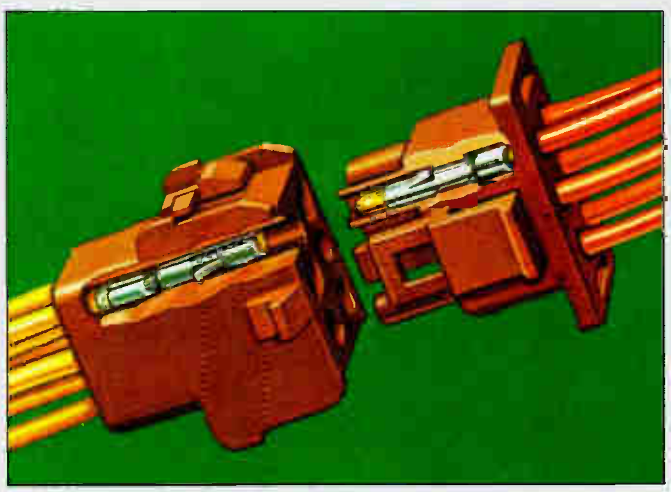


Accu-plate puts a plus in AMP-Latch connectors for terminating ribbon cable and small-gauge discrete wires. It enables us to precisely plate the receptacle with gold and the insulation displacing V-slot area with tin-lead.



Accu-plate does well for pin and socket connectors, too. We prestripe gold over nickel on unformed stock for sockets and tip-plate pins.

CIRCLE NUMBER 125

Graphics system handles data base

Dual-microprocessor design manipulates large high-precision color graphics data base to offload host computer

by Linda Lowe, Boston bureau

Computer-based systems incorporating interactive color graphics can expend a lot of their computing power on graphics-managing chores. The Graphics System 8000 raster color terminal from Lexidata eases the problem by offloading most of that work to its two internal microprocessors. One, Motorola's powerful 68000, with its 16 usable 32-bit instruction registers and 16-megabyte addressable range, can manage and manipulate a large, high-precision graphics data base. The other, a 12-bit bipolar bit-slice display processor built by Lexidata, controls the raster frame buffer, including raster conversion of vectors, circles, and filled areas.

The 8000 operates with a wide range of popular 16- or 32-bit minicomputers via either direct-memory-access parallel interfaces or an optional RS-232 link. Loaded with between 64-K bytes and 1 megabyte of random-access memory (with error-checking and -correction circuitry), the 8000 stores image data from the host computer and handles operator input and display output with minimal system interruption.

Preprogrammed into about 60-K bytes of memory is a set of graphics-function instructions common to most interactive-graphics applications, freeing users to concentrate software development efforts elsewhere. Lexidata modeled these functions after those recently proposed as industry standards by the Association for Computing Machinery, says David L. Grabel, manager of application software development. It further extended them to meet the particular capabilities of raster graphics and to respond to the needs of highly interactive computer-aided-design systems, he adds.

Its native intelligence should make the 8000 a boon to original-equipment manufacturers and designers of in-house CAD systems, believes Martin Duhms, Lexidata's marketing vice president. "By adding high-level graphics capabilities with so little drain on the host, it not only extends overall efficiency but also allows the system to support more terminals," he asserts. Duhms says the 8000 aims at such applications as the design of circuit boards and very large-scale integrated circuits, schematics and mapping, architectural engineering, and business graphics.

The 68000 controls all input devices, including keyboard, data pad, digitizers, trackball, and joystick. It echoes operator inputs directly on the 8000's 19-in. monitor and communicates keyboard commands line by line to the host computer rather than interrupting to transmit each keystroke. Preprogrammed input functions include screen echoing, tracking, and movement of a standard hardware cursor.

Update. The 68000 also controls a "world coordinate" system, which describes graphics primitives with a resolution of 2 billion addressable points per coordinate axis. The 8000 retains these object descriptions in its data base, which users can segment to permit incremental updating without depending on the host computer to reconstruct images after each design change. The 8000 thus can define multiple windows on the coordinate system, with quick update from only that part of the graphics data base affected.

The Lexidata bit-slice display mi-

We're keeping our promises.

We are now sampling the Z8000 CPU. Produced, like the Z80, using our own H-MOS process, in our own package and tested in house, our Z8000 is completely compatible with its Zilog equivalent.

We've also committed ourselves to supplying all the necessary support for the Z80, Z8 and Z8000, and we're doing it.

Our commitment isn't going to end here though. Following on the CPU SGS-ATES will produce all the Z8000 family components. That's another promise we shall keep.

SGS ATES

Circle 709 on reader service card

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croprocessor, which has a 112-ns cycle time, controls the 12-bit-resolution display. In color applications, screens are available with 640 by 512 picture elements (pixels) at between 4 and 10 bits of color data per pixel, or with 1,280 by 1,024 pixels at 4 bits per pixel. The former configuration has a 60-Hz noninterlaced refresh rate, whereas the latter refreshes at 30 Hz. Black and white displays have the same two pixel configurations refreshable at either 60 or 30 Hz each; noninterlaced refreshing of the larger configuration gives the 8000 the highest-resolution flicker-free black and white display currently available, says Grabel.

Rainbow. At 640 by 512 pixels, the system can display 1,024 different colors simultaneously from a palette of 16.7 million possible colors; 16 simultaneous colors from a 4,096-color palette can be displayed on a single 1,280-by-1,024-pixel monitor. A 10-bit lookup table holds user-selected values for color information, and can shift pixel data under user control to create new sets of colors. It achieves these changes by transmitting new values to three 8-bit video outputs, one each for red, blue, and green guns of the industrial-grade video monitor.

A software driver package and a library of Fortran-called subroutines accompany the 8000, for use with a variety of minicomputer operating systems via high-speed parallel interfaces. Eventually, says Grabel, this capability will expand to make the system operable with mainframes. Between 12-K and 24-K bytes of programmable read-only memory in the 8000 aids in system power-up and bootstrapping and in go/no-go diagnostic testing.

Base price for the Graphics System 8000 is $26,200; Duhms estimates a typically configured system would cost in the neighborhood of $40,000, with OEM quantity discounts available. First shipments are in mid-February; delivery takes 90 days from receipt of order.

Lexidata Corp., 755 Middlesex Turnpike, Billerica, Mass. 01865. Phone (617) 663-8550 [361]

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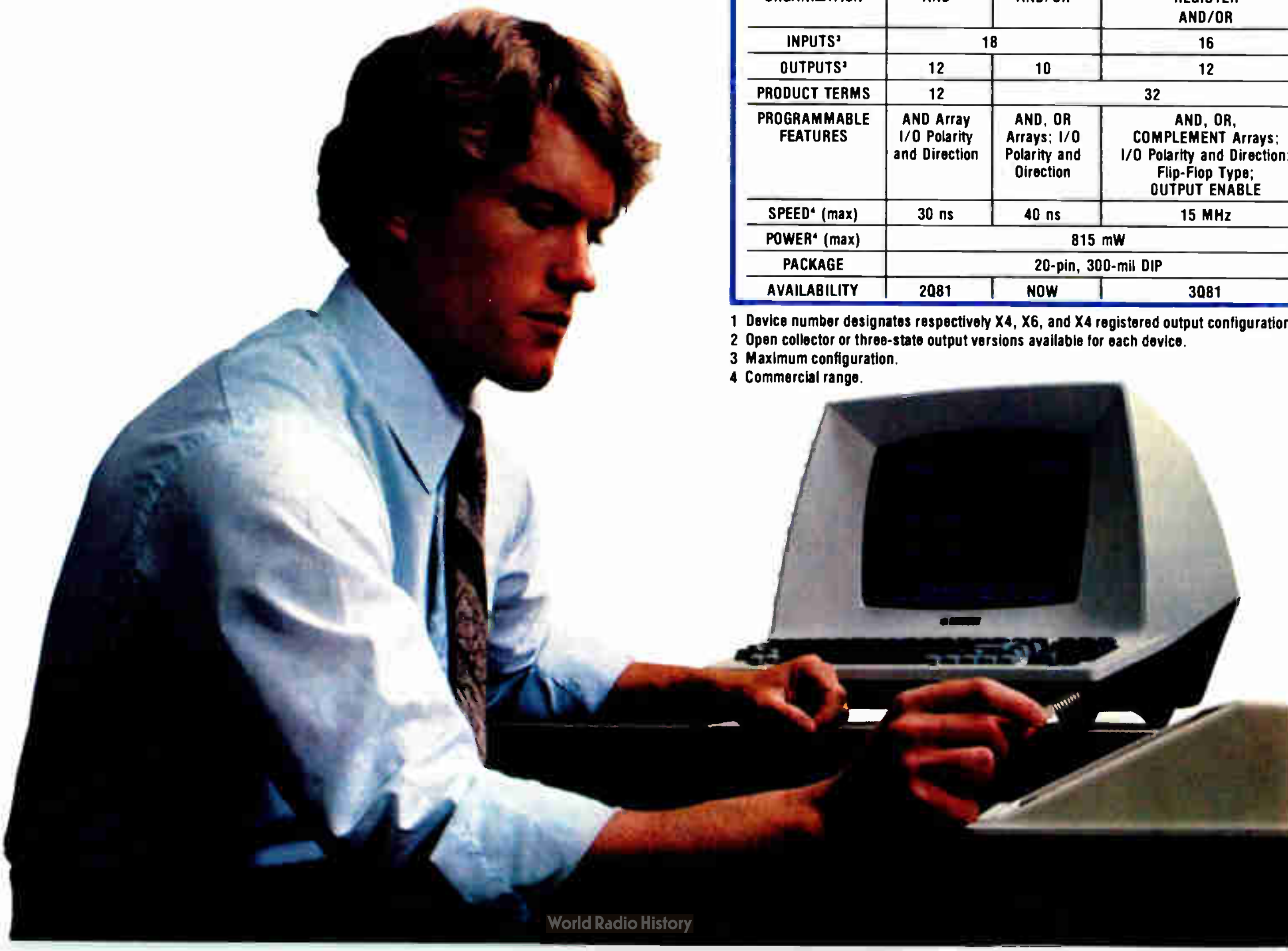
And thanks to open collector output options, IFL Series 20 lets you synthesize functions with greater complexity and faster switching speeds.

Series 20

	FPGA	FPLA	FPLS[1]
DEVICE[2]	82S150/151	82S152/153	82S154/155 82S156/157 82S158/159
ORGANIZATION	AND	AND/OR	REGISTER AND/OR
INPUTS[3]	18		16
OUTPUTS[3]	12	10	12
PRODUCT TERMS	12	32	
PROGRAMMABLE FEATURES	AND Array I/O Polarity and Direction	AND, OR Arrays; I/O Polarity and Direction	AND, OR, COMPLEMENT Arrays; I/O Polarity and Direction; Flip-Flop Type; OUTPUT ENABLE
SPEED[4] (max)	30 ns	40 ns	15 MHz
POWER[4] (max)	815 mW		
PACKAGE	20-pin, 300-mil DIP		
AVAILABILITY	2Q81	NOW	3Q81

1 Device number designates respectively X4, X6, and X4 registered output configuration
2 Open collector or three-state output versions available for each device.
3 Maximum configuration.
4 Commercial range.



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Series 28 

FPGA	FPLA	FPRP	FPLS
82S102/103	82S100/101	82S106/107	82S104/105
AND	AND/OR		REGISTER AND/OR
16			
9	8		
9	48		
AND Array I/O Polarity	AND, OR Arrays; I/O Polarity	AND, OR Arrays; INPUT Polarity	AND, OR, COMPLEMENT Arrays; INPUT Polarity
35 ns	50 ns	70 ns	11 MHz
895 mW			945 mW
28-pin, 600-mil DIP			
NOW			

Moreover, the Series 20 FPLS allows you to:

- Save I/O pins and minimize AND gates with on-chip complement array.
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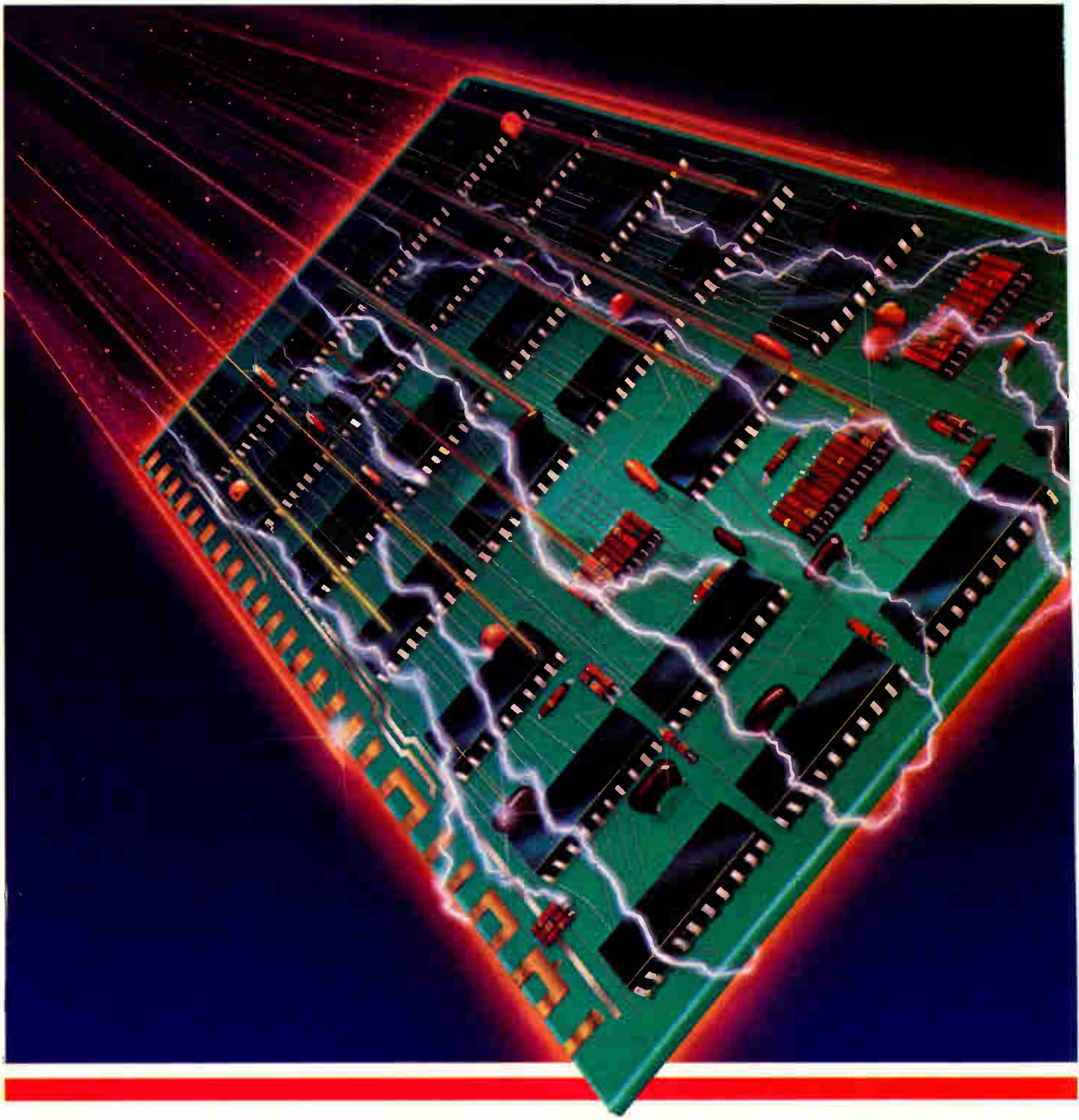

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You've already heard about the exceptional performances of Fairchild's FAST latches, flip-flops and counters. Now, here are a few FAST facts on some of our other fine devices that you can use to upgrade your logic systems.

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Shift Frequency . . 150 MHz typ
Clock-to-Output Delay . . . . 4.0 ns typ
ICC . . . . 33 mA typ

The 74F194 is 50% faster than Schottky and requires 65% less power. It's currently available in a plastic or ceramic package. And we have three octal shift registers planned for the near future: the 74F299, 74F322 and 74F323.

MULTIPLEXERS

Data-to-Output Delay

74F153
Dual 4-input. . . . 5.0 ns typ
74F253
Dual 4-input with 3-state outputs . . . . 4.4 ns typ
74157
Quad 2-input . . . 4.5 ns typ
74F257
Quad 2-input with 3-state outputs . . . . 4.0 ns typ
74F158
Quad input with inverted outputs . . . . 2.9 ns typ

Select-to-Output Delay

74F352/353
inverted versions of the 74F153/253. .6.3 ns typ

Our multiplexers are 30% faster than Schottky and require 70% less power.

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across the board.

Circle 213 on reader service card

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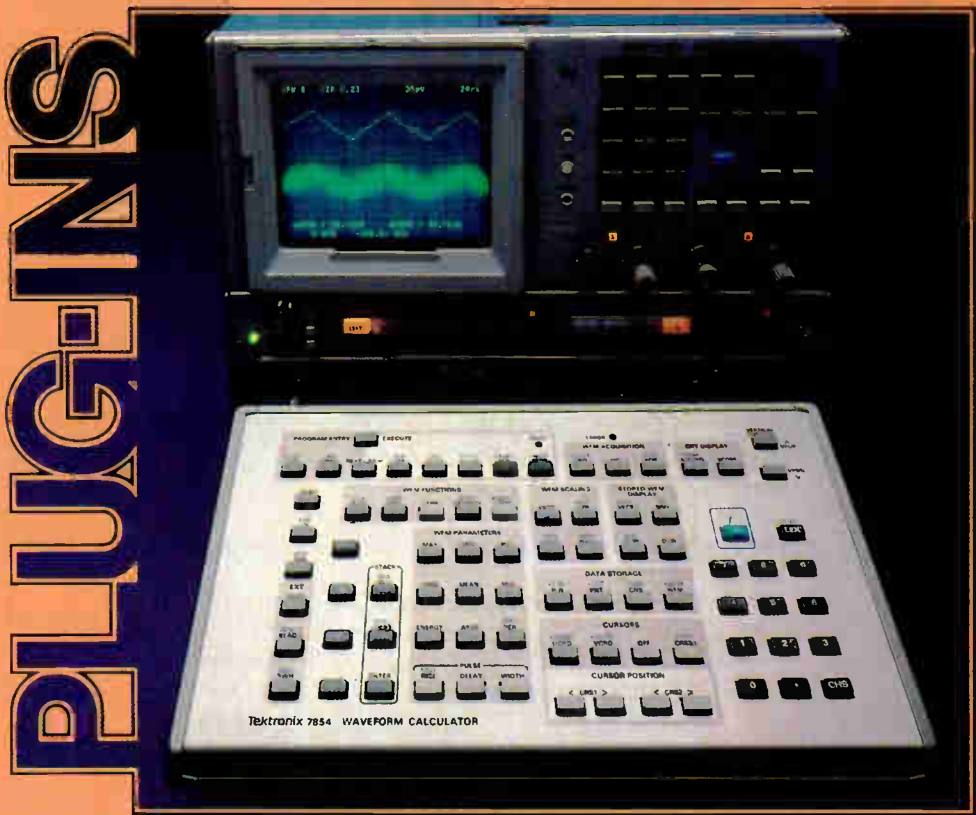

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And for the first time, you'll have a scope that can automatically perform arithmetic functions, integration, differentiation, smoothing and signal averaging. Plus there's a Cursor Mode to parameterize any area for measurement. It even provides Δ-Time and voltage readouts.

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It's as simple as a hand-held calculator. The keyboard lets you make several measurements automatically or generate routines for your own tailored measurement tasks. For example, you can use Keystroke Programming to automatically find the area of an X-Y display.

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Tektronix
COMMITTED TO EXCELLENCE

In-circuit logic tester identifies ICs

Unique hand-held analyzer scans extensive list of part numbers to identify IC and perform qualitative test

by Jeremy Young, New Products Editor

The Myriad/XK 440 from Hy-Tronix Instruments Inc. represents a major breakthrough in the field service industry. The hand-held instrument can automatically identify unlabeled integrated logic circuits—displaying the generic part number—and perform a qualitative go/no-go test on the part. It does this while the logic (in various packages with up to 40 pins) is wired in the circuit, using 16-, 24-, and 40-pin test clips on extender cables. Loose ICs can also be inserted in the socket on the instrument for testing.

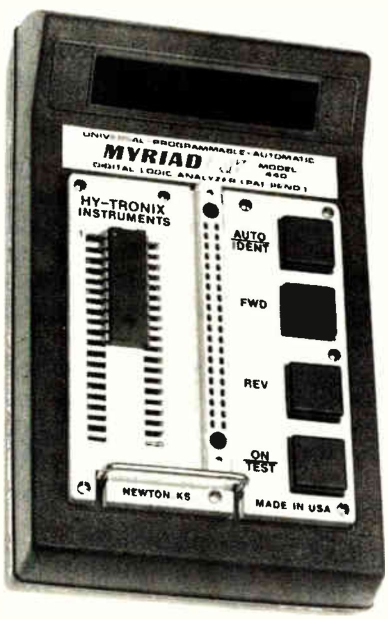
A long list of standard logic building blocks is covered by the 440's standard library of test patterns: more than 10,000 part numbers are on its list, though many of the listed parts overlap in function. And according to Robert Edgerton, president of Hy-Tronix, there is plenty of room left over for additional firmware for testing custom or specialized logic ICs. Custom firmware in erasable programmable read-only memories can be delivered in a short time at relatively low cost for field installation in the unit.

The 440's standard library does not include any emitter-coupled logic, microprocessors, memories, or programmable gate arrays. But the list of standard parts it can identify and test includes TTL, Schottky and low-power Schottky logic, MOS, complementary-MOS, resistor-transistor logic, diode-transistor logic, high-threshold logic, high-noise-immunity logic, ICs on the Joint Army-Navy Qualified Parts List, and European Pro-Electron logic. The 7400 and 5400 TTL series are covered, as is the 4000 C-MOS series. Manufacturers' renumbering of standard logic parts, a practice that has made it difficult for service personnel to tap other sources for replacements, will not have that effect if a 440 is on hand to identify ICs.

A voltage regulator that includes the tester's microcomputer as part of its control loop (patents are pending on this and other aspects of the 440) allows it to operate at the voltages of the several logic types it tests. The dedicated microcomputer also controls a programmable interface and runs self-diagnostics.

At $3,875 in single quantities, the 5.4-by-3.2-by-1.6-in., 15-oz instrument is not inexpensive, but the price includes the results of a sizable software effort. And the 440's automation allows its use by relatively unskilled operators.

The user need only locate pin 1 on an IC's package, attach the test clip, and push a single button. The 440 scans its list of parts to identify the IC, applies a complete logic truth table test, says Edgerton, and beeps if the part passes the test—all in less than 1 second. It puts the IC's part number on its eight-character alphanumeric light-emitting-diode display and indicates visually that the part is A-OK.



If the part does not match any of those in the 440's listing, the display tells the operator so. If the tester cannot identify the IC because the part is faulty and the part number is available, the operator can use the forward and reverse buttons to scroll through the 440's list of part numbers, stopping on the proper number and then pressing the test button. Holding the forward or reverse button down results in a progressively faster run through the roll table: some of the part numbers are skipped during fast rolling, but the user can back up if he goes too far.

Pinpoints faults. Once identified by man or machine, a faulty IC covered in the library can be tested and failure information obtained. This data includes the numbers of the pins on which failures appear, the function of each of these pins (input or output), and an indication of whether the pins are stuck at a logic high, low, or neutral. "Short" appears on the display if the power leads of the device are shorted.

The 440 is not a parametric tester; it checks only the logic function of the device. But the company, known for its model 900 in-circuit discrete semiconductor tester, specifies that the probability of the 440's classifying a good IC in its library as good is better than 99% and that the probability that a bad part from its list

New products

will be classified as good is less than 1%.

Tests run at a rate of 1,000 patterns per second; pulse width is programmable up to 10 μs. A typical test procedure takes 0.1 s. The 440 has 40 channels: 38 for logic, one for power, and one for ground. All its interface lines are protected from shorts to ground or power: the unit cannot be burned out by a faulty device, nor will it damage the device under test. Power is applied to that device only at the moment of the test, and it is cut off immediately if a fault is detected. Because power has to be supplied to in-circuit ICs and consequently other parts on the board, 1.5 A is available from the tester.

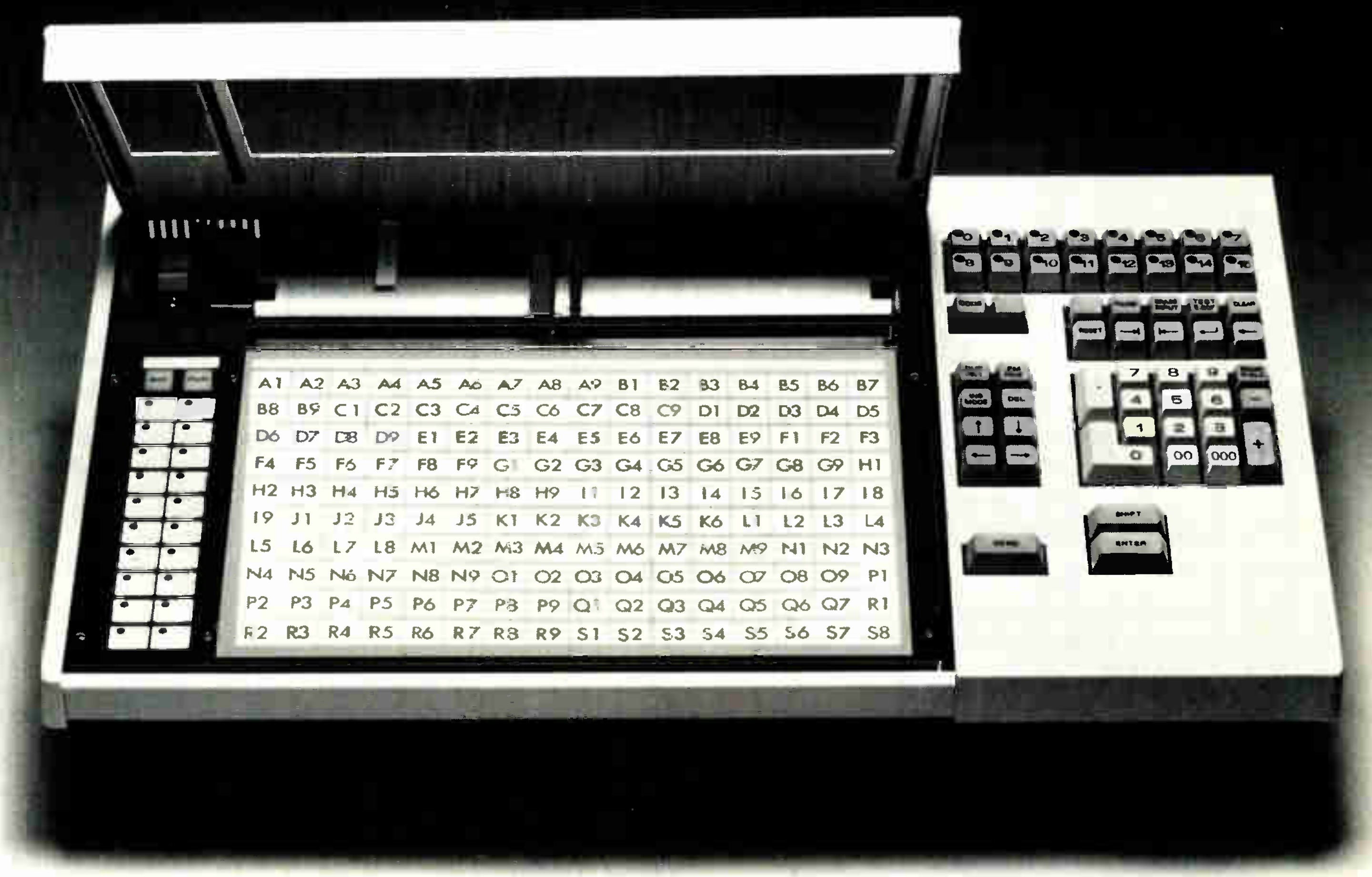
Versatile. An assortment of flat-pack adapters is available to augment the standard DIP clip leads. The 440, which can detect open-collector logic, can also handle many modules, including military Standard Electronic Modules (SEMs), Support Electronic Equipment Modules (SEEMs), Standard Hardware Packages, Standard Avionic Modules, and various special military packages. The socket pattern shown provides the capability of testing SEMs or SEEMs. The 440's versatility is assured by its ability to store 1½ megabits of firmware, less than 10% of which is occupied by the standard library.

The hand-held tester runs on its rechargeable nickel-cadmium battery, 9-V transistor radio batteries, other dc sources up to 28 V, or using ac adapters for 115- or 220-V 50- or 60-Hz line operation. If the battery voltage drops below a level permitting reliable testing, the condition is indicated on the display automatically. About 20 seconds of disuse invokes the unit's automatic shut-off facility.

Intended to pass military tests for ruggedness, the 440 has a main printed-circuit board ⅛ in. thick, plus two standard boards. It is available from stock to 120 days after receipt of order.

Hy-Tronix Instruments Inc., P. O. Box 827, 301 W. Fifth St., Newton, Kan. 67114. Phone (316) 283-5730 [340]

Fujitsu ROLLS OUT its latest 3200-item keyboard. The simplest yet!



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Compared to today's best known functional tester, Series 70 offers specifications that are truly impressive:

	Series 70	An older tester
SPEED	5 MHz	1.8 MHz
PROGRAMMABLE PULLUP RESISTORS	Yes	No
COMPUTER	Specially designed dual bus architecture 16 bits 64 K words memory (128 K bytes)	PDP-8 12 bits 32 K words memory (48 K bytes)
SIMULATOR	High accuracy Can be run on tester	Longer debug time Have to add memory
MASS STORAGE	12 or 24 MB disk	2.4 MB or 4.8 MB disk
SOFTWARE	Virtual memory	Overlay & linking
EDITOR	Continuous on-line operation	Call-up mode
SYSTEM INITIALIZATION	Totally automatic	Boot from TTY
DIAGNOSTIC CAPABILITY	Fault tracing to the component level with FLO-TRACER	No equivalent
ADVANCED LSI TECHNIQUES	Live data compression	No equivalent
HIGH-SPEED CLOCKS	8 phase with OR capability	No equivalent
HYBRID CAPABILITY	6 bus dual-pole throughout	Limited scanner

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Computers & peripherals

Roundup: Printers under $1,000 thrive

Recent crop of 80-column dot-matrix impact printers aimed at the personal computer market offers sophisticated features at low prices

by Ana Bishop, Assistant New Products Editor

The eight 80-column alphanumeric printers appearing on the chart on this page reflect a tendency predicted last year [*Electronics*, Jan. 31, 1980, p. 113] and growing even stronger this year: printers are costing less and less. All of these dot-matrix impact printers introduced in the last quarter of 1980, and the list is not comprehensive, sell for under $1,000 and are primarily aimed at the personal computer market.

Creative Strategies International, San Jose, Calif., in its new report, "Low Cost Computer Printers," predicts that by 1985, the U. S. market for low-cost computer printers will exceed $300 million, "reflecting a compound annual growth rate of 24%." The research firm goes on to stress that during this period, unit shipments will more than triple.

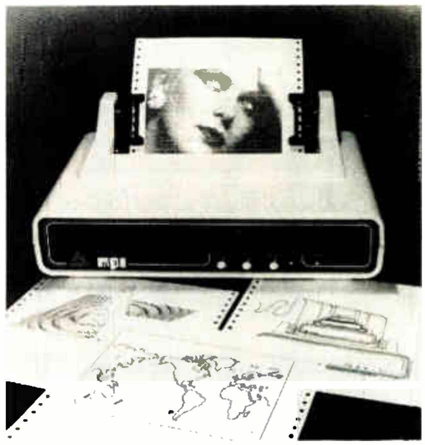
The report defines the low-cost market as those printers that print at least 40 characters per line and are available to the end user for $1,000 or less. "Serial impact matrix printers will account for approximately 80% of the low-cost printers sold in 1980."

This seems to be the case, due to the ability of these printers to provide multiple copies. The San Jose firm sees such technological advances as improved print quality as contributing to the 32% compound annual growth rate it forecasts for impact printers. In fact, all of the printers in the chart feature the ASCII 96-character set, with both upper and lower case, and many offer some sort of graphics capabili-

RECENTLY INTRODUCED LOW-COST MATRIX PRINTERS

Company and model	Column width (characters per line)	Dot matrix	Printing speed (characters per second)	Interfaces	Buffer size (characters)	Size (in.)	Extra features	Unit price
Axiom Corp. IMP2-Apple	80/96/132	7 x 7	80	for Apple II	512	3.5 x 17.5 x 8.75	• prints graphics • includes connectors	$895
Data Royal Inc. IBS-5000A	80/136	9 x 9	150	RS-232-C or parallel (optional: 20-mA current loop)	256	7 x 14 x 18.3	• has buffer that is optionally expandable to 2,000 characters	$1,060; below $735 in 100s
DIP Inc. DIP-85	80/96/132	7 x 7 or 14 x 7	100, bidirectional	parallel and RS-232-C	1,000	17 x 9.75 x 6.5	• prints graphics from cathode-ray tube	$625 in 100s
Epson America Inc. MX-80	80	9 x 9	80, bidirectional	8-bit parallel (optional: RS-232-C or IEEE-488)	80	4.2 x 14.7 x 12	• has $30 disposable print head • self-tests • prints graphics	$650
Facit Data Products 4520/4521	80	9 x 7	100, bidirectional	8-bit parallel and RS-232-C	712	14.6 x 6 x 15 or 14	• has low noise level (less than 60 dBA)	$1,000 or less
Micro Peripherals Inc. 88G	80/96/132	7 x 7	100, bi- or unidirectional	RS-232-C or TTL parallel (optional: 20-mA current loop or IEEE-488)	2,000	16 x 10.5 x 6.2	• offers optional graphics from CRT	$400 to OEMs; $799 with graphics
Microtek Inc. MT-80	80/132	9 x 7	125, bidirectional	(optional: 8-bit parallel or RS-232-C)	240	7.3 x 17.7 x 14.8	• has self-diagnostics	$795 to $895
Tandy Corp./Radio Shack Line Printer IV	80/132	not specified	50	for TRS-80	—	15 x 11 x 5	—	$999

SOURCE: *ELECTRONICS*



Picturesque. Micro Peripherals' 88G printer with graphics option costs $799.

ty. Some even provide hard copy from cathode-ray tubes—a still small but growing market need.

Of major importance is the fact that the printers offer a wide variety of features at their low prices. Most of the new printers offer the choice of 80-, 96-, or 132-column widths. Standard for the units are cartridge ribbons and printing heads with lifetimes of 100 million characters. Most of the printers handle both friction and tractor (pin) feeding of paper from roll or fan-fold stock.

Tradeoffs. Indicative of the influence of the personal computer market are the prices for printers aimed exclusively at the popular personal microcomputers, the Apple II and TRS-80. As noted on the chart, a printer for the Apple II from Axiom Corp. sells for $895 and one for the TRS-80 from Tandy Corp. retails for $999. These figures compare unfavorably with such low prices as the Epson America MX-80's retail price of $650. The Tandy Line Printer IV does not offer graphics, and its printing speed is 50 characters per second, while the MX-80's is 80 characters/s, bidirectionally. In fact, 50 characters/s is the lowest speed offered by any of the current crop of printers.

The TRS-80 itself, however, does have RS-232-C serial and Centronics 8-bit parallel printer ports available on expansion boards, so it could ostensibly handle printers that, like most of those featured on the chart,

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offer the RS-232-C or 8-bit parallel connection as standard features or as options. A user would have to consider whether the price of a low-cost printer added to the price of an expansion board, if he lacks one in his system, would be competitive with the price of the Line Printer IV.

Of course, matrix impact printers priced below $1,000 are not new to the market; such major printer manufacturers as Centronics, Anadex, and Computer Printer International (Comprint) have offered low-cost printers for some time. What is new is that the latest printers are offering more features at prices approaching the $600 mark.

Axiom Corp., 5932 San Fernando Rd., Glendale, Calif. 91202. Phone (213) 245-9244 [401]

Data Royal Inc., 235 Main Dunstable Rd., Nashua, N. H. 03061. Phone (603) 883-4157 [402]

DIP Inc., 745 Atlantic Ave., Boston, Mass. 02111. Phone (617) 482-4214 [403]

Epson America Inc., 23844 Hawthorne Blvd., Torrance, Calif. 90505. Phone (213) 378-2220 [404]

Facit Data Products, 66 Field Point Rd., Greenwich, Conn. 06830 [405]

Micro Peripherals Inc., 2099 W. 2200 South St., Salt Lake City, Utah 84119. Phone (801) 973-6053 [406]

Microtek Inc., 9514 Chesapeake Dr., San Diego, Calif. 92123. Phone (714) 278-0633 [407]

Tandy Corp./Radio Shack, 1800 One Tandy Center, Fort Worth, Texas 76102 [408]

$4,400 units yield hard copy from storage-scope tubes

The 4611 and 4612 electrostatic hard-copy units provide high-contrast black and white images on dielectric paper from storage tubes and raster-scan video signals. Available for $4,400, the small, lightweight copying devices use a dry carbon toner that contains carbon particles and wax to eliminate the seepage problems that can occur with liquid toners. Both units produce 8½-by-11-in. copies, with 256 by 171 overlapping dots per inch. The units are especially suited for

use with low-cost terminals and desktop computers. Discounts for original-equipment manufacturers are available.

Tektronix Inc., P. O. Box. 500, Beaverton, Ore. 97077 [363]

Dumb terminal offers smart terminal features for $995

The ADM-5 Dumb Terminal console provides standard features traditionally available only on smart terminals, and does so for $995. The unit offers reverse video and reduced intensity, in addition to limited editing capabilities and a gated extension port for selective transmission of data from the terminal to any serial RS-232-C peripheral device. The ADM-5 has a 12-in.-diagonal display screen and a teletypewriter keyboard with the ASCII 96-character set.

The terminal operates asynchronously in half- or full-duplex modes at any of 11 data rates from 75 to 19.2 kb/s. The word format can be selected to be the standard 7- or 8-bit words; with odd, even, or no

parity; and with 1 or 2 stop bits.

The ADM-5 terminal is software- and hardware-compatible with all popular computers offering RS-232-C or 20-mA current-loop interfaces selected via a switch.

Deliveries are scheduled to begin this month.

Lear Siegler Inc., Data Products Divison, 714 N. Brookhurst St., Anaheim, Calif. 92803. Phone (800) 854-3805 or (714) 774-1010 [364]

Quiet matrix printer prints 125 to 300 lines per minute

For small-business systems and distributed data processing, three versions of a quiet matrix tabletop printer provide printing rates between 125 and 300 lines per minute, depending on the number of characters per line.

A 14-wire dual-column print head with an expected life of 300 million characters prints a standard ASCII 96-character set in a seven-by-seven half-dot matrix. The print head and ribbon cassettes are easily changed.

The printers use standard fan-folded, edge-punched, continuous-form paper 3 to 16 in. wide. They can produce an original plus five copies.

The three versions are: the model 4355, which includes a programmed input/output controller and is designed to run under Data General's Real-time Disk Operating System (RDOS), Microprocessor Operating System (MP/OS), or the diskette-based disk operating system (DOS); the model 4356, which contains a data-channel controller; and the model 4354, which includes a serial I/O interface. The three versions of the new matrix printer are priced at $6,650, $7,000, and $6,450, respectively. All units operate with the Nova and Eclipse computers, and, in addition, the model 4354 works with the microNova.

Quantity discounts are available, and delivery is 90 days after receipt of order.

Data General Corp., Rte. 9, Westboro, Mass. 01581. Phone (617) 366-8911 [366]

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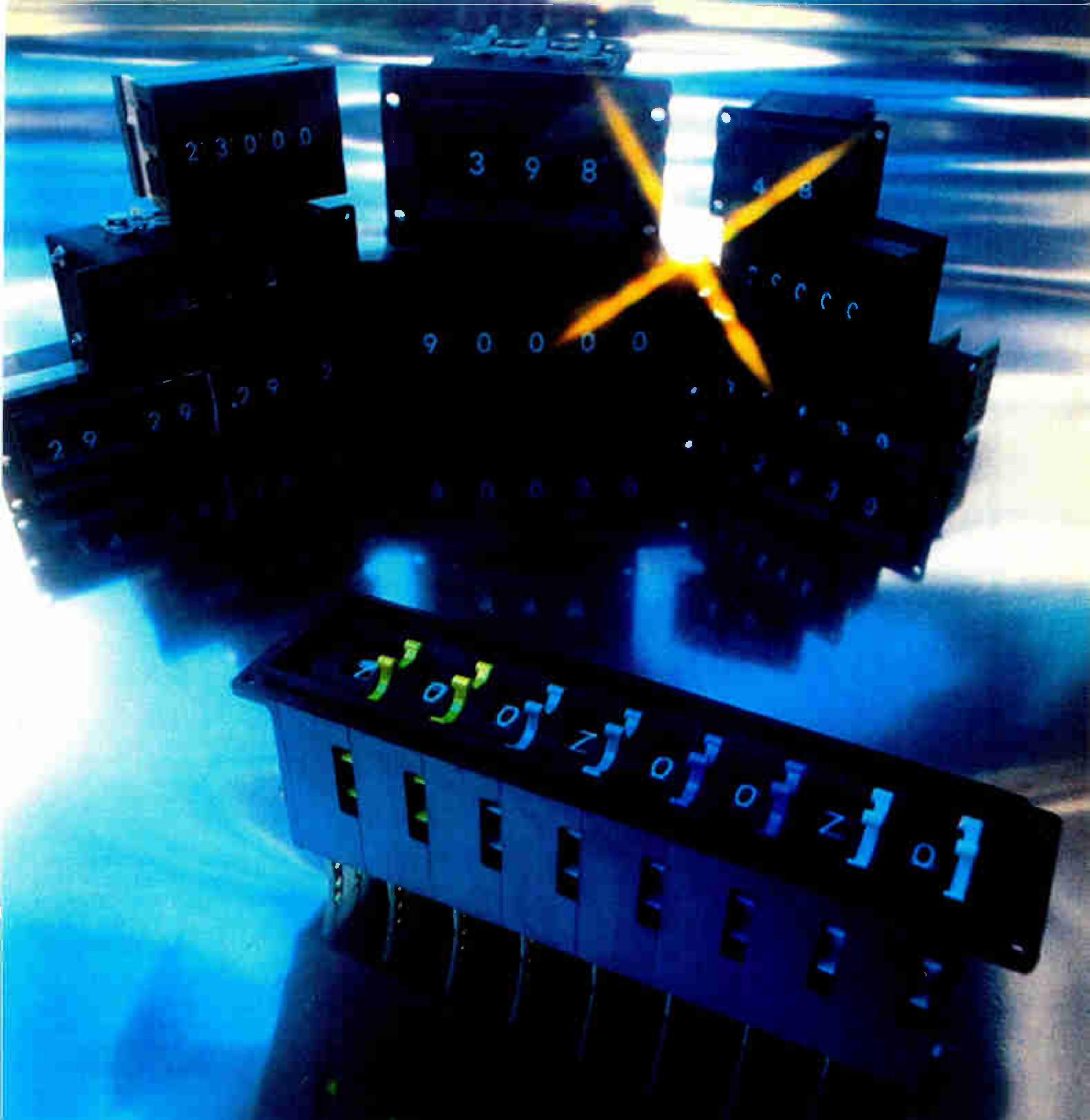

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Semiconductors

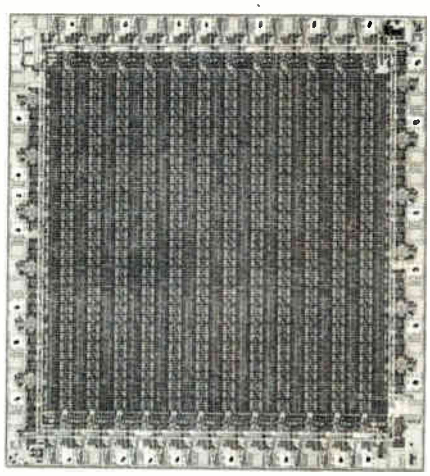
C-MOS arrays interface with TTL

300- to 1,260-gate arrays have 5-ns gate delays, are also compatible with MOS

A family of power-saving high-speed complementary-MOS gate arrays has been designed for TTL compatibility. Offering 5-ns gate propagation delays, the arrays include interface circuitry to translate between TTL and C-MOS levels for inputs and outputs. The interfaces are fully specified for both TTL and MOS.

Fabricated using oxide-isolated silicon-gate C-MOS technology, currently available master slices number six, ranging from the 300-gate HC 310 to the 1,260-gate HC 1260. The 540-gate HC 540 is shown. The maximum number of pins ranges from 40 to 78 on either dual in-line packages or chip-carriers. Unmounted chips are also available. Operating voltage is 3 to 12 V; Schottky TTL speeds can be matched with a 10-V supply.

A number of useful standard features can be specified: three-state bidirectional bus drivers, oscillator drivers, high-current npn emitter-follower outputs, pull-ups and pull-downs, zener diodes, and high-impedance bias resistors. An operating temperature range of −55° to +125°C is available, as is high-reliability processing and screening.

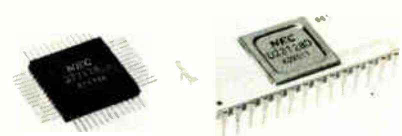


Customization inputs can range from circuit specification to database tapes. Costing $4,500, development takes from 4 to 14 weeks, depending on circuit complexity. Production prices are from 2 to 4 cents per gate.

California Devices Inc., 282 Kinney Dr., San Jose, Calif. 95112 [411]

128-K ROM comes in both n- and C-MOS versions

NEC Microcomputers has developed both n-channel and complementary-MOS 128-K read-only memories. The μPD23128 is an n-MOS device pack-



aged in a 40-pin dual in-line package using the Joint Electron Device Engineering Council's type B pinout for compatibility with the widely used 2764 64-K erasable programmable ROMs.

The clocked device accesses in 250 ns and has a standby mode that reduces its operating power from a 275-mW maximum to 82.5 mW. Targeted applications for the μPD23128 are computer terminals, communication-control equipment, electronic translators, and voice synthesis. The unit, which will be in production early in the second quarter of the year, will sell for under $30 in 1,000-unit quantities.

The C-MOS 128-K ROM, the μPD73128, is a +5-V device packaged in a 52-pin flat housing and aimed at low-power-consumption applications like language translators. It accesses in 4 μs and requires a maximum of 30 mW. It, too, will be available in the second quarter.

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CANNON ITT

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Circle 241 on reader service card

New products

NEC Microcomputers Inc., 173 Worcester St., Wellesley, Mass. 02181. Phone (617) 237-1910 [412]

Chip generates tones for low-cost electronic organ

West Germany's Intermetall GmbH, lead company of the ITT Semiconductors Group, has come up with a low-cost single-chip circuit for inexpensive electronic organs. Made with p-channel silicon-gate technology, the SAA 1900 offers a frequency accuracy of within ±0.07%. The number of external devices needed for a typical application is about 15. The chip scans the organ's 56 keys, which are divided between "solo" and "accompaniment" keyboards, and produces 56 basic tones.

To prevent abrupt dc jumps when one or more solo keys are pressed from producing audible clicks in the output, the 1900 has current sources that keep the mean value of the square-wave output constant. To detect closed keys, the IC produces pulses that are sequentially applied at a rate of about 28 kHz to each of the on-chip scanner's eight outputs. Pulses are fed via the key matrix to the scanner inputs. Each crosspoint of the matrix is a key contact in series with a diode; the presence of a pulse at the scanner inputs indicates that the key is closed. A clock driver (using an external oscillator), a top-octave tone generator, and frequency dividers generate the tones.

Housed in a 24-pin plastic package, the SAA 1900 sells for less than $5 in quantities of 10,000 or more.

ITT Semiconductors, 500 Broadway, Lawrence, Mass. 01841

Intermetall GmbH, 7800 Freiburg, P. O. Box 840, West Germany [413]

8- and 16-K bipolar PROMs access in less than 50 ns

Two superhigh-speed bipolar fuse-link programmable read-only memories—a 16-K and an 8-K chip—are in full production at Supertek as the

"My Datalogger 3000 and these little cassettes give me everything I need to acquire, compute, record and use data..."

"THE DATA I NEED – IN A FORMAT I CAN USE. I can acquire data and/or alarms on fixed, floating or computed limits, deviations-from-a-mean, rates-of-change and integration. Data is easily understandable by individual labels and group headings, and messages provide precise description or spell out alarms and instructions. Data can selectively be sent to the alphanumeric printer, the cassette, the historical memory, to the fixed or scrolling portion of the "split-screen" CRT, or to the serial, parallel or video outputs. I can even format the data for recording up to 132 columns wide . . ."

"IT DOES THE WORK OF 16 DATALOGGERS! The Datalogger 3000 can operate like 16 different, organized 'loggers.' I can set up different inputs in each of the multiple 'loggers' or I can have the same inputs shared in multiple 'loggers' but processed differently in each. The data from one 'logger' can even affect the program execution in another. The flexibility is incredible! . . ."

"THE 3000 HANDLES EVERY INPUT I HAVE – analog, digital, pulses, contact closures, it even excites and balances strain gage and load cell inputs automatically . . ."

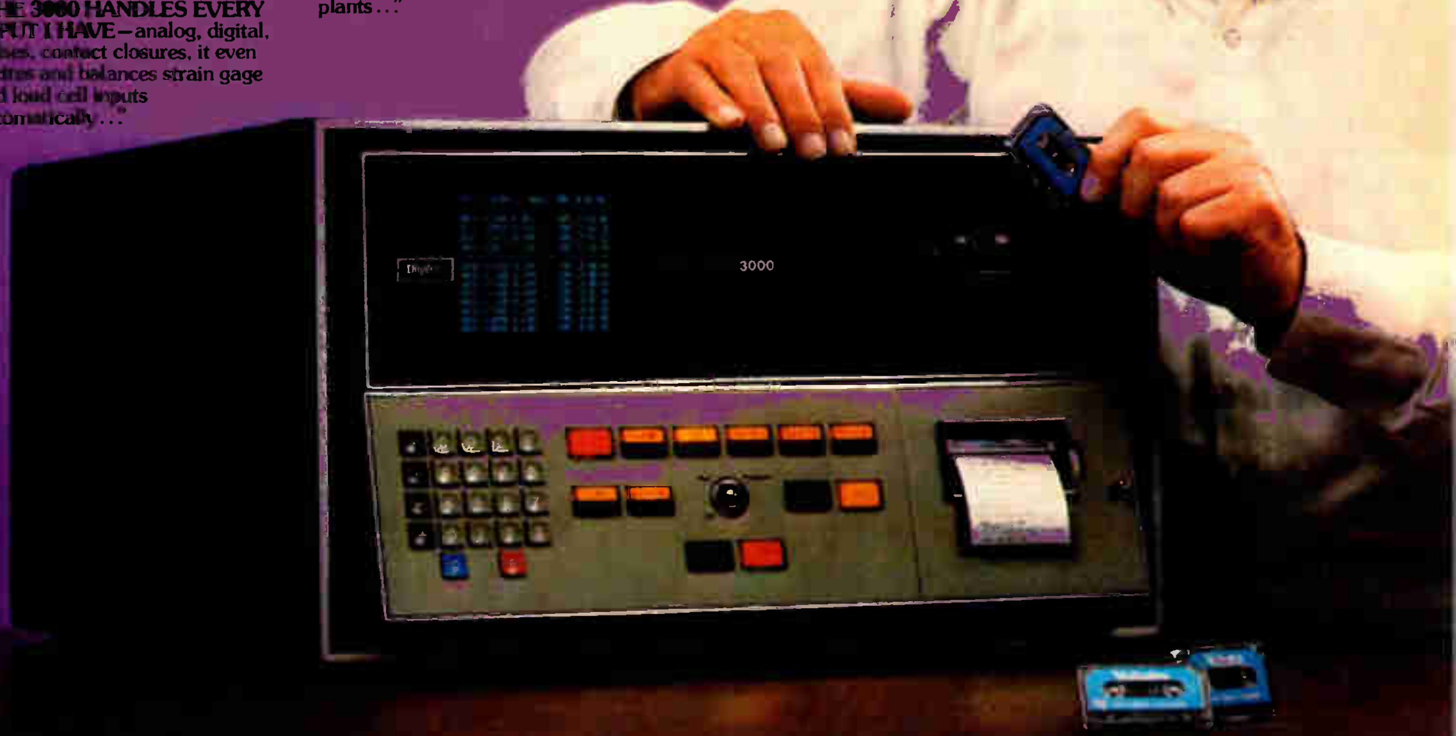
"EVERY CALCULATION I NEED IS STANDARD. I simply use the front-panel keypad like a calculator. I can compute all types of averages, including moving window, deviations-from-a-mean, standard deviations, efficiencies, flow rates – everything I need . . ."

"PROGRAMMING MY DATALOGGER 3000 IS EASY. I'm no computer technician and I don't want a list of unfamiliar programming terms. With the Datalogger 3000 I just follow the step-by-step prompting on the CRT. It automatically sequences through the set up procedure by asking simple questions in plain English. It's the quickest and most accurate program entry I've found . . ."

"IT PROGRAMS ITSELF. Once I've set up my Datalogger 3000 for an application, I never have to program it again. I just store the program on the cassette. I've created a file of application cassettes so using the Datalogger in any application is as quick and easy as inserting a cassette. I can even send programs to our other plants . . ."

"A NEW CASSETTE MEANS A NEW DATALOGGER. While my Datalogger 3000 is 2 years old, it has the latest software technology. United Systems just introduced 2 new Operating programs. Since they are on cassettes, I simply load one into my hardware and I have a new datalogger – with even more capabilities. Next year, if I want, I can upgrade it again. United Systems is constantly expanding software capabilities . . ."

To find out how the Datalogger 3000 can make your process more efficient, increase productivity, or provide better test data, send for complete information. Better yet, arrange for a demonstration to see it for yourself.



DigiTec

UNITED SYSTEMS CORPORATION

918 Woodley Road, Dayton, Ohio 45403
(513) 254-6251, TWX (810) 459-1728

first in a family of PROMs. The 16-K part, the SM82S190/191-1, is organized as 2 K by 8 bits. Claimed to be the smallest chip for this density, it has an address access time of 35 ns typically and 50 ns maximum. A version that meets military specifications, the MM82S190/191-1, has a 60-ns access time. The 8-K PROM, the SM82S180/181-1, is organized as 1 K by 8 bits and accesses typically in 30 ns and in 45 ns maximum. Its military version, the MM82S180/181-1, has a maximum access time of 55 ns over the full military temperature range. Both parts come in 24-pin ceramic packages and are pin-compatible with the industry standard set by Signetics. The devices are now available in both sample and volume quantities. The 16-K parts are priced at $69 each in 100-unit quantities, but prices have not been set on the 8-K PROMs.

Supertex Inc., 1225 Bordeaux Dr., Sunnyvale, Calif. 94086 [414]

Power V-FET comes in 1-kW, 800-V version

A power vertical field-effect transistor based on static-induction-transistor logic is available with 300-W and 1-kW power ratings and can withstand 600 or 800 V. Developed by Tohoku Metal Industries in Japan, the V-FET can be used in high-frequency switching power supplies for direct commutation of rectified line voltage and in ultrasonic generators, high-frequency power oscillators, broadcast transmitters, and other high-power applications.

Both the 600- and the 800-V transistors come in versions that drain either 20 or 60 A, operating at either 10 or 5 MHz, respectively. Turn-on times are 200 or 250 ns and turn-off times are 250 or 300 ns.

The 1-kW device is housed in a 60-mm-diameter, 21-mm-thick ceramic disk package, and the 300-W device comes in a modified TO-3 package. Single-unit prices for the V-FETs vary from $50 to $330, and large-quantity prices (over 100

Using Wavetek's Model 175 Arbitrary Waveform Generator is like drawing on your oscilloscope. You have a 256 x 255 point grid to work with. Time is along one axis, amplitude is along the other. Simply program the waveform, point by point, either from the front panel or via the GPIB bus. ARB stores the shape you've programmed and will duplicate it at any frequency and amplitude you select. You can also edit point by point if you decide to change the wave shape later on.

Circle #245 for demonstration

Operational modes include continuous, triggered, and even triggered burst—which will take care of almost any application.

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Circle #184 for literature

Wavetek San Diego, 9045 Balboa Ave., P.O. Box 651, San Diego, CA 92112. Tel: (714) 279-2200; TWX 910-335-2007.

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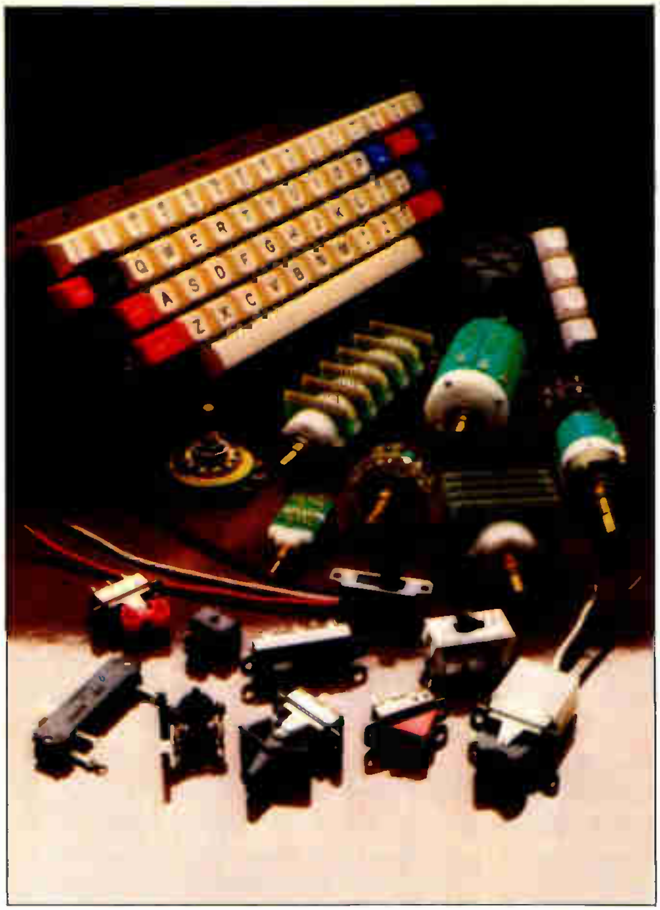

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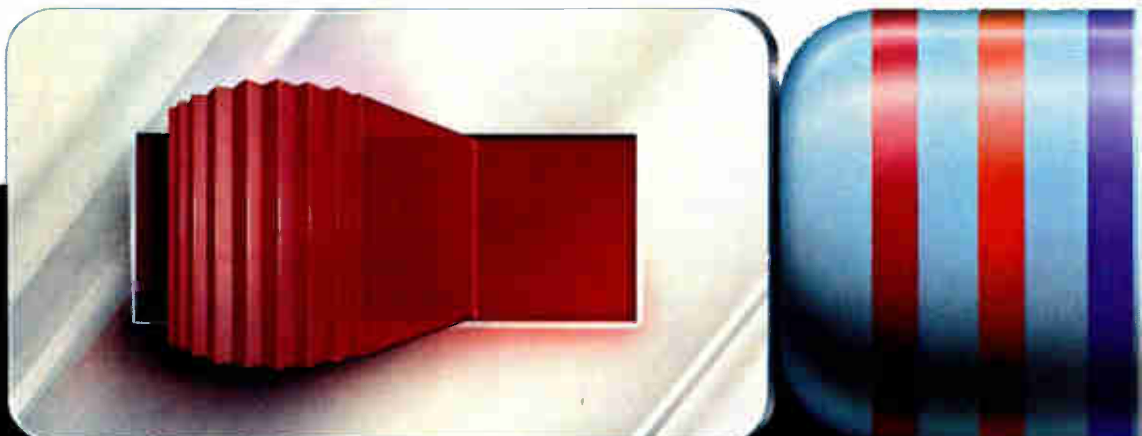
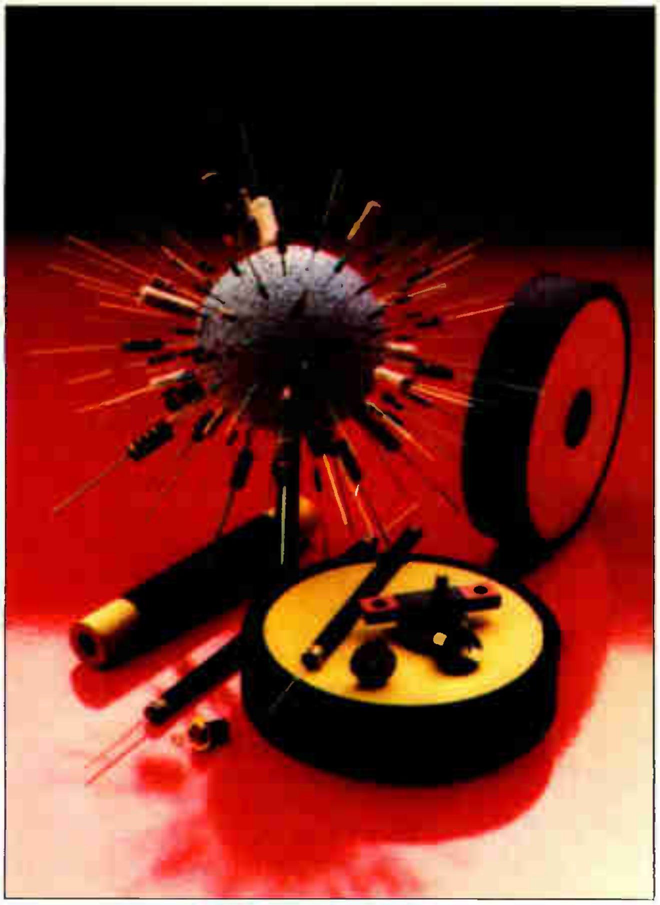


SWITCHESRESIS



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Circle 247 on reader service card

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units) range from $38 to $240.
Energy Electronic Products Corp., 6060 Manchester Ave., Los Angeles, Calif. 90045. Phone (213) 670-7880 [415]

Manchester codec draws only 12 mA at 1 Mb/s

A complementary-MOS digital Manchester encoder-decoder, the HD-6409 allows 1-Mb/s serial data communication over the industrial temperature range, from −40° to +85°C. It draws, in the worst case, only 12 mA (5 mA, typically) from a single 5-V (±10%) power supply. The chip provides clock recovery from the received signal. Manchester code is used in applications such as magnetic tape recording and fiber-optic communication, where data accuracy is imperative.

The HD-6409 is manufactured using the manufacturer's self-aligned silicon-gate technology. In a 0.3-in.-wide, 20-pin dual in-line package it sells from stock for $8.36 each in lots of 100.

Harris Semiconductor Products Division, P. O. Box 883, Melbourne, Fla. 32901 [416]

272-bit EE-PROM is word-erasable

The entire content or a selected word can be erased from the MN1218 272-bit electrically erasable programmable read-only memory. The fully decoded n-channel MOS part has individual input and output ports and transfers data in a 4-bit format. Besides the main 16-by-16-bit array, it has a separate one-word (16-bit) register. Three power-supply voltages are needed: +5, −5, and −28 V dc. The EE-PROM survives a minimum of 10^4 write cycles and 10^6 read cycles. Data is retained on average for 10 years.

Prices for original-equipment manufacturers are available on request. Deliveries are from stock.

Electronic Component Division of Panasonic Co., One Panasonic Way, Secaucus, N. J. 07094 [417]

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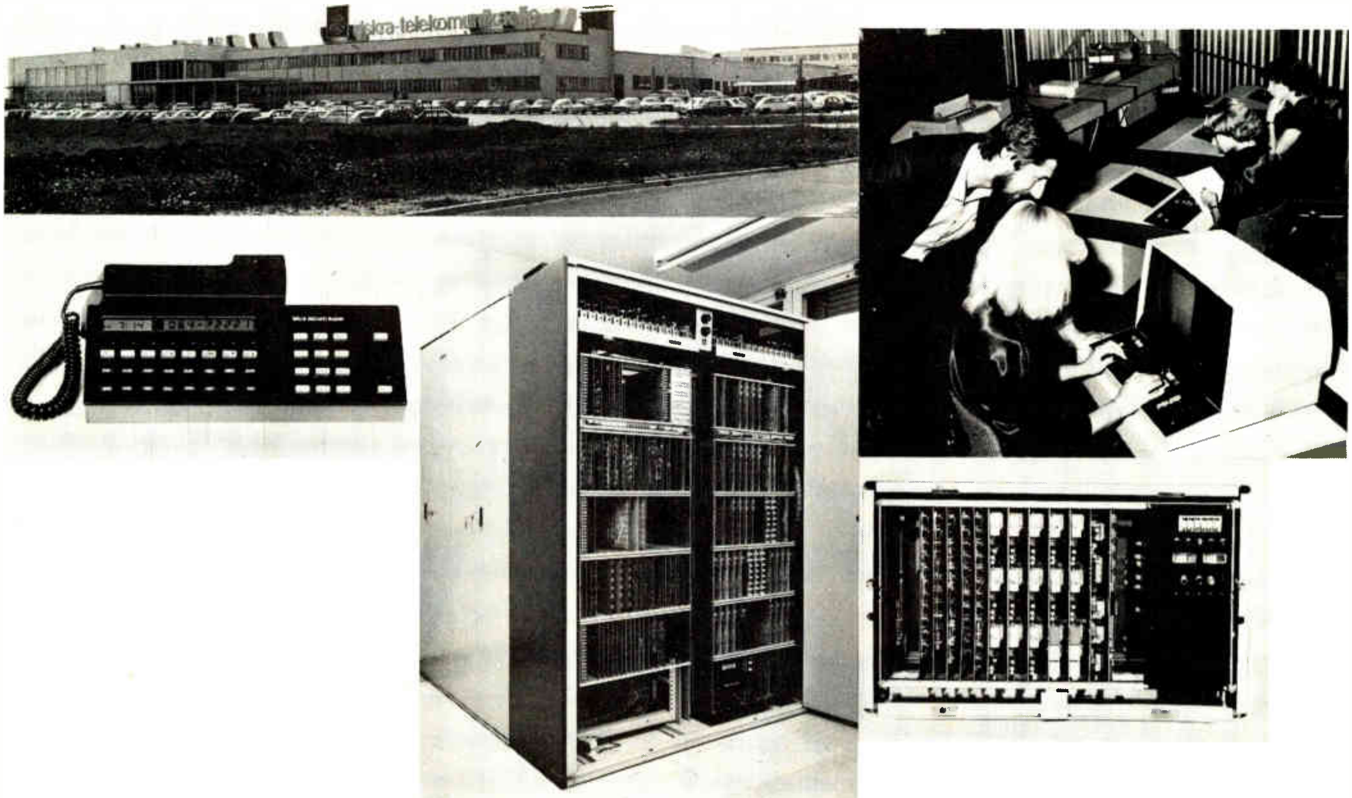

Iskra group has some 29,000 employees including 2,000 research and development engineers in 81 factories, research, marketing and other organizations, and the most up-to-date technologies to work with. With a total turnover of 1.294 billion dollars last year, it has been classified among 16 largest manufacturers of electronic products in Europe.

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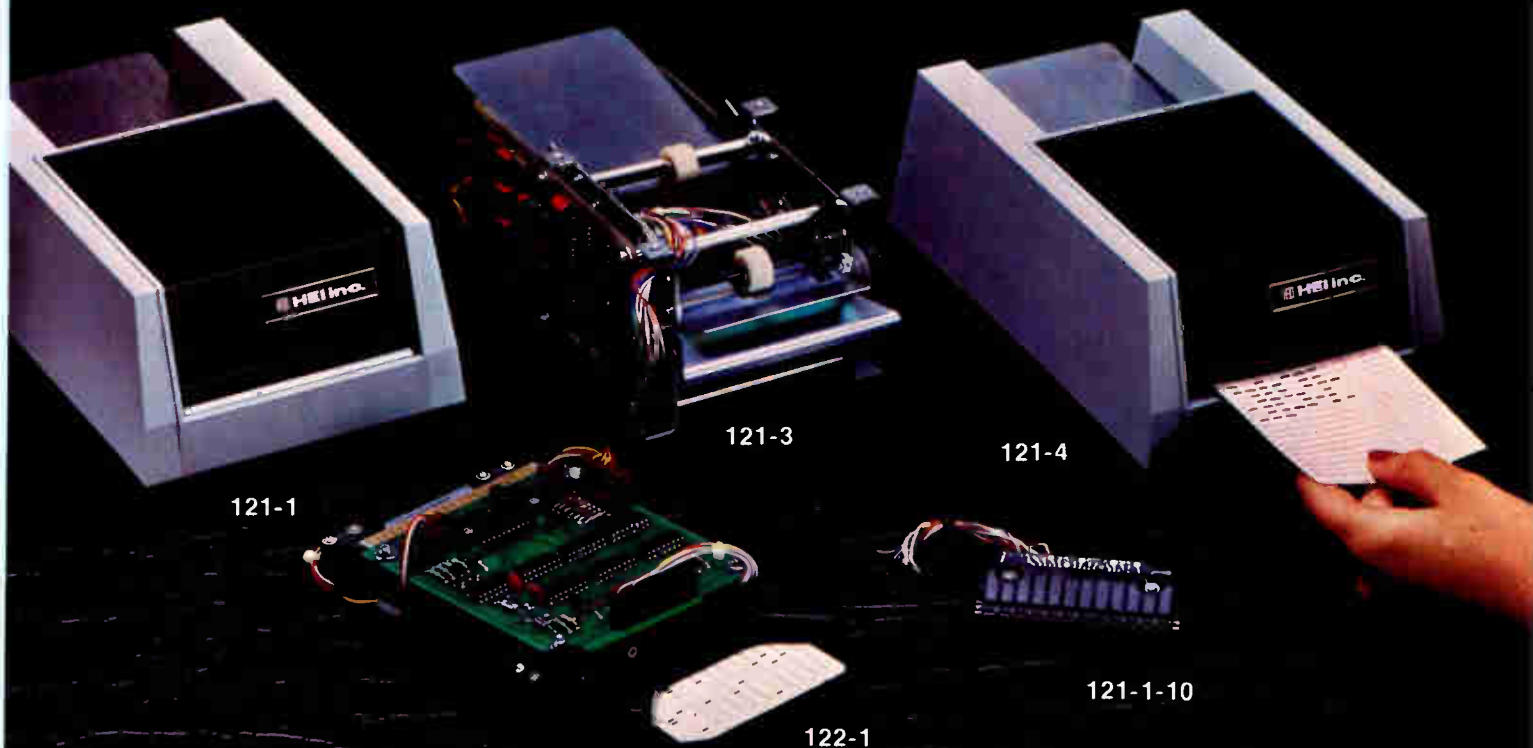

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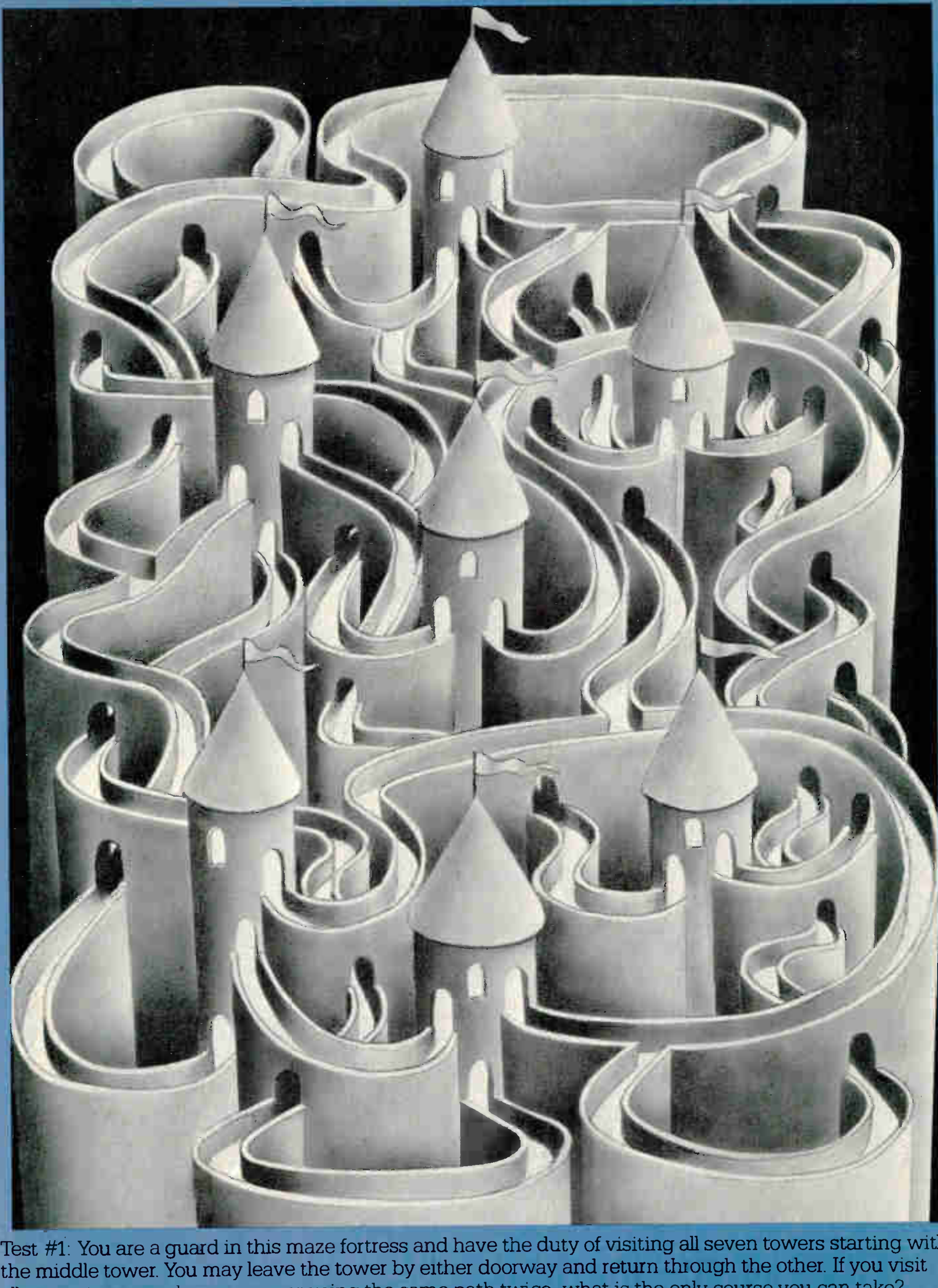

Test #1: You are a guard in this maze fortress and have the duty of visiting all seven towers starting with the middle tower. You may leave the tower by either doorway and return through the other. If you visit all seven towers only once, never using the same path twice, what is the only course you can take?

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And consider our credentials. GenRad has been a leader in testing for 65 years. And our sales are now over $150 million. But perhaps the best testimony to our commitment to our customers is the fact that we have more board testers in use worldwide than anybody else.

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GenRad makes both functional and in-circuit testers. A lot of our customers use both advantageously. No matter which you choose, what's important is how long it takes to do a test program. And how much help the system gives you automatically.

The advantages of a GenRad functional system.

When it comes to functional testers our systems give you plenty of help. A good-sized library of functionally modelled IC's, for example, can save a lot of time in developing a test program. We just happen to have the largest library in the business. Over 2000 SSI and MSI devices and over 100 LSI devices.

Also an accurate simulator can keep you from going down a lot of blind alleys while working on a test program. So does the ability to prepare programs incrementally and do nodal verification. You'll find all of these things on a GenRad functional tester. But not on anybody else's.

The GenRad 1795 Functional Test System

The GenRad 2270 In-Circuit Test System

When it comes to troubleshooting, isolating faults directly to a single IC can be a tremendous timesaver. Our special beyond-the-node software linked to a diagnostic resolution module lets you do just that.

The advantages of a GenRad in-circuit system.

You want pretty much the same things in an in-circuit system that you want from a functional system—simple program prep and comprehensive diagnostics to maximize throughput. Look for a test system that does more than dump out a rough first pass of a test program.

Look for one with software so automatic you get a program that's almost ready to run as is.

In that regard, you're going to be interested in these exclusive GenRad features: Automatic Bus Disable which frees the programmer from having to manually write a lot of extra tests in order to isolate the IC under test from the effects of other ICs on the bus; feedback squelch to automatically deal with troublesome spikes; and memory behind each pin to allow patterns to be applied and sensed in parallel. Go ahead and check out other systems, but you won't find these exclusive features on any of them.

One final thing to keep in mind. If you're going to design with two kinds of logic (and who isn't today?) your tester ought to be capable of testing two logic families simultaneously, right? Both our in-circuit and functional testers can.

The logical conclusion. And an offer that's hard to pass up.

If you've followed us this far, it ought to be pretty clear whose system can do the best job of testing your printed circuits. Now how about a wall-size version of our labyrinth to show the world your mental circuits check out okay, too? We'll send you a giant poster if you drop us a note on your letterhead. And, by the way, if you'd like to know more about a GenRad System, the best course of action is to call us.

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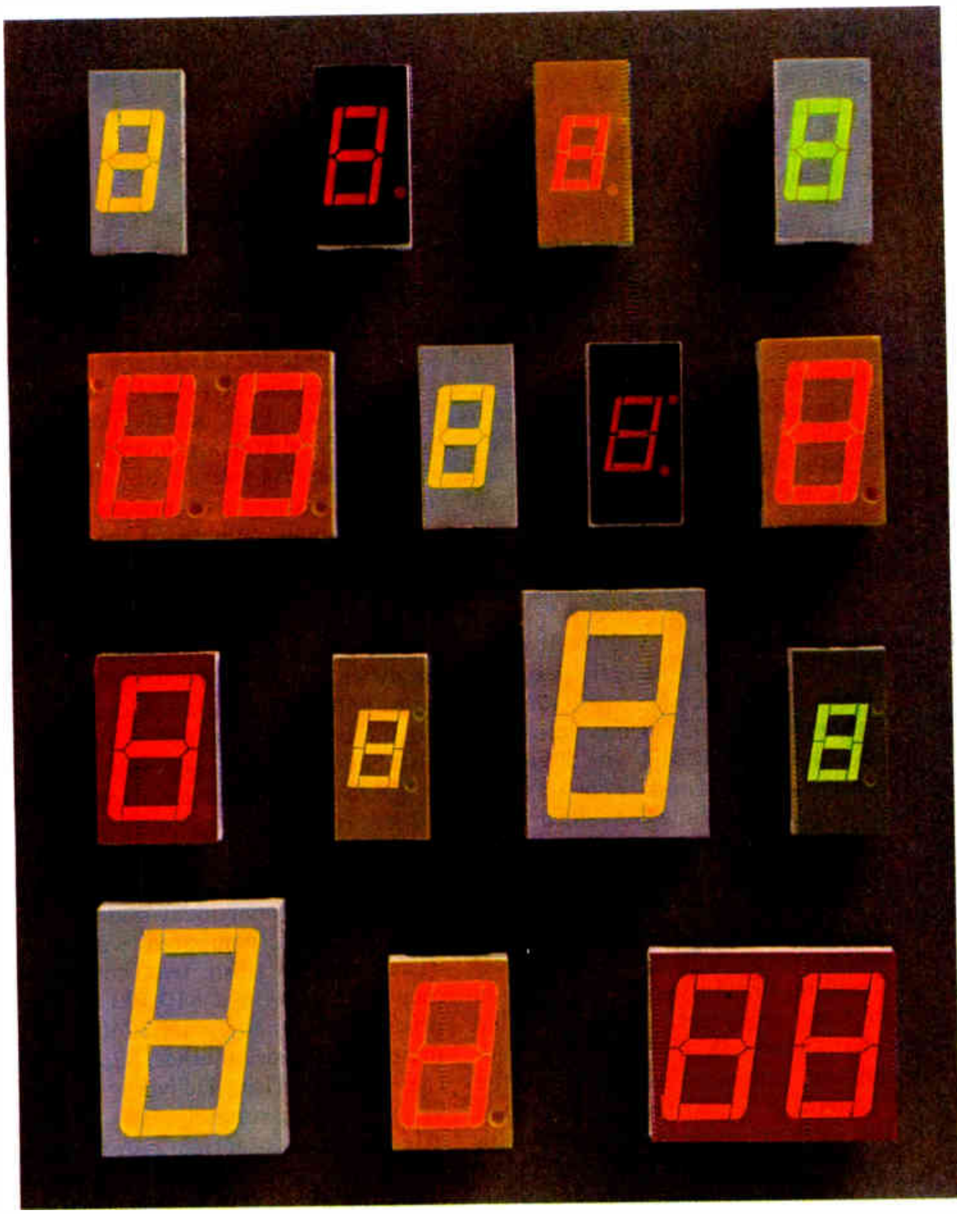

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Circle 255 on reader service card

Instruments

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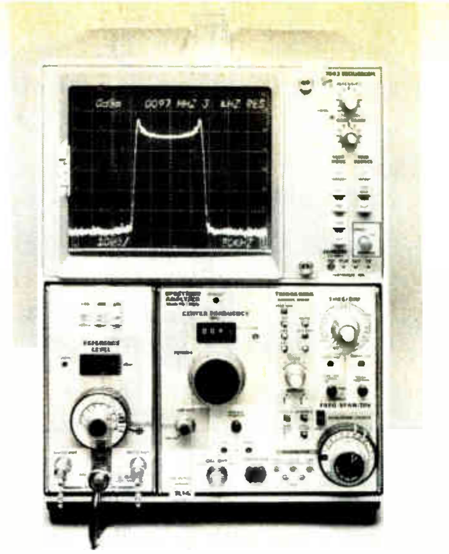


The Tektronix 7L14 spectrum analyzer adds digital storage to the features of the previously announced model 7L13. The 7L14's frequency range, 10 kHz to 1,800 MHz, is slightly short of the 1-kHz-to-1,800-MHz coverage of the 7L13, but the storage capacity adds significantly to the instrument's flexibility.

Digital storage allows the user to retain a reference waveform in the 7L14's memory and to compare it with waveforms measured in real time. Most system response errors, for example, can be subtracted out in the 7L14 by using the "B minus save A" feature, where "save A" is the reference waveform and the B waveform is measured in real time. The total digital memory available for waveforms is 1,024 points across the screen, each digitized with 8-bit resolution. When comparisons of reference and real-time waveforms are made, each waveform can have 512 points across the screen.

No flicker. Another advantage of digital storage is the elimination at all sweep speeds of the flicker that is found on low-duty-cycle displays on previous analyzers. Flicker-free display is achieved, in fact, using a nonstorage cathode-ray tube with the standard P31 phosphor, rather than the more expensive storage CRT with variable persistence used on the 7L13. The storage also makes possible a new feature, the "max hold" control. It allows the user to capture either a maximum signal level or maximum noise level among a long series of measurements. The analyzer can continue to sweep while updating the memory with the changes. "It's an excellent way to plot signal drift over time," notes Stuart Fox, product manager for the 7L14.

The 7L14 can also perform digital averaging on waveforms. It can, for example, sample a waveform 100 times, sum the responses, and divide the result by 100.

To protect the analyzer's critical first mixer, the 7L14 has a built-in limiter that does not degrade the analyzer's distortion-measurement capabilities. As a result, signal levels up to 1 W can be connected to the input without damage. The limiter can also protect the mixer from line-frequency signals up to 50 V that may be present.

The distortion specifications of the analyzer are very good, with all spurious and intermodulation distortion 70 dB below the signal. The 7L14 also has a 70-dB on-screen dynamic range, a −130-dBm sensitivity, and 30-Hz resolution, as well as 4:1 shape-factor resolution filters and CRT readout of control settings.

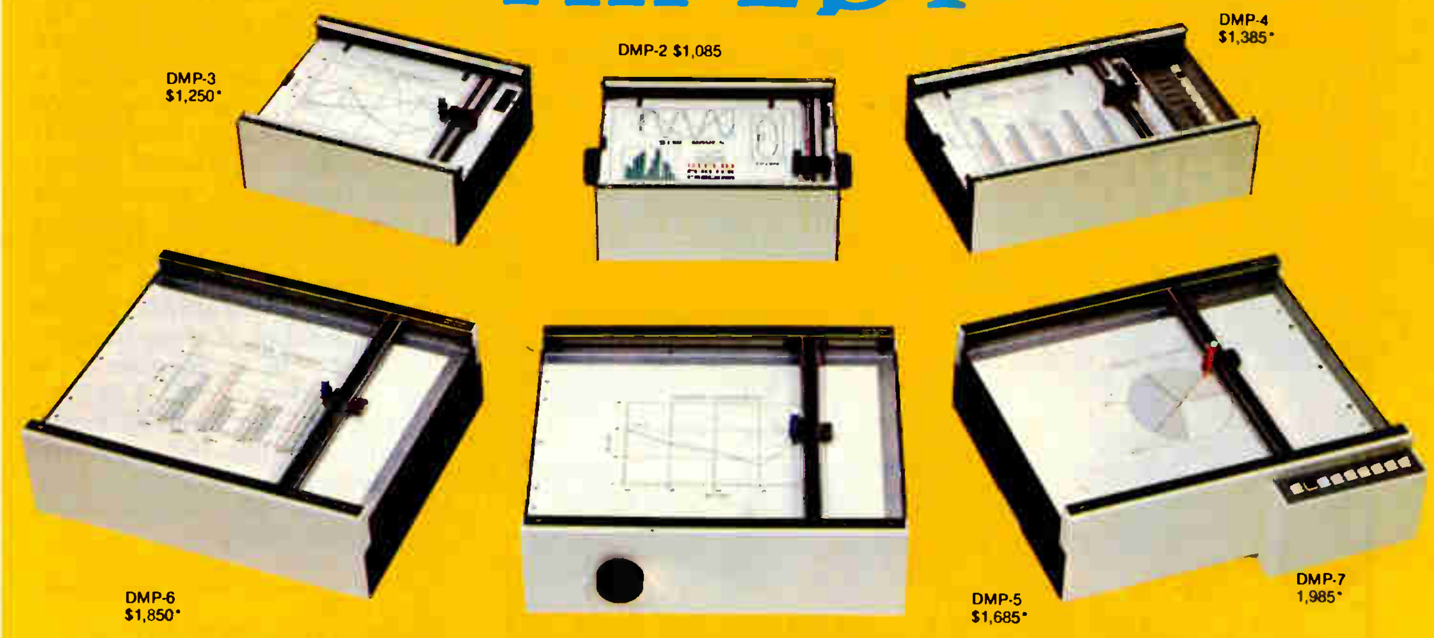
The two-compartment–wide 7L14 costs $15,000, compared with the 7L13 plug-in (also two compartments wide) with a $10,500 selling price. The commonly used 7603 CRT mainframe adds another $2,260 to the system price. Delivery of the 7L14 is approximately four weeks after receipt of order.

Tektronix Inc., P. O. Box 1700, Beaverton, Ore. 97075. Phone (800) 547-1512 [351]

Wideband video amp slews at 5 kV/μs

The CLC102, a linear amplifier with a fixed gain of 15 dB, has a symmetrical slew rate of over 5 kV/μs, so it

Look what's happened to HIPLØT™



It's grown into a complete family of quality low cost digital plotters

*Yes, they are UL listed!***

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The HIPLØT DMP Series is a new family of digital plotters with both "standard" and "intelligent" models available with surface areas of 8½" x 11" (DIN A4) and 11" x 17" (DIN A3). For the user needing a basic reliable plotter, we have the "old standard" DMP-2 (8½" x 11") and the "new standard" DMP-5 (11" x 17"). For those needing a little more capability, there are the DMP-3 (8½" x 11") and the DMP-6 (11" x 17")—both microprocessor controlled and providing easy remote positioning of the X and Y axes (perfect for the OEM). For those who want this intelligence plus the convenience of front panel electronic controls, we've provided the DMP-4 (8½" x 11") and the DMP-7 (11" x 17").

The "standard" plotters come complete with an RS-232-C and a parallel interface. The "intelligent" DMP plotters accept data from either an RS-232-C or Centronics data source. For the "standard" plotters, software is available from our ever expanding "Micrographic Users Group." The "intelligent" HIPLØTs use our exclusive DM/PL™ language which minimizes plot software to a fraction of that normally associated wth digital plotting.

With the new DMP Series, high quality digital plotting can now be a part of your system. It just doesn't make sense to be without this valuable tool when there is a DMP plotter with the plot size, speed and capabilities that are exactly tailored to your specific needs...and your budget.

Prices for the DMP series range from $1,085* to $1,985*.

For complete information contact Houston Instrument, One Houston Square, Austin, Texas 78753. (512)837-2820. For rush literature requests, outside Texas call toll free 1-800-531-5205. For technical information ask for operator #5. In Europe contact Houston Instrument, Rochesterlaan 6, 8240 Gistel, Belgium. Telephone 059/27-74-45.

houston instrument

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*U.S. suggested retail prices only.
**DMP 2, 3 and 4 UL listed
DMP 5, 6 and 7 UL listing pending

Circle number 187 to have a representative call

Circle number 257 for literat

can offer pulse rise and fall times of 1.6 ns for a 10-V step into 50 Ω, with less than a 2% overshoot. At full power, the unit's −3-dB bandwidth is typically 220 MHz while driving a 50-Ω load at 10 V peak to peak. At lower power levels, the bandwidth is over 300 MHz. Since rolloff past the −3-dB frequency is approximately 15 dB per octave, the frequency response remains very flat from dc to near the −3-dB frequency. Typical gain flatness to 100 MHz is ±0.2 dB and the deviation of phase from linear is ±2°. The settling time of the amplifier is 150 ns. The 3-by-3-by-1.175-in. unit sells for $270, including BNC connectors. Delivery is from stock to six weeks.

Comlinear Corp., 514 Railroad Ave., Loveland, Colo. 80537 [353]

Rack-mountable computer fits into automated tester

The HP 9915A modular computer is a small box that contains the central processor, memory, operating system, and input/output ports of an HP-85 desktop computer. It has been packaged as a rack-mountable unit that can be easily integrated into instrument systems and that runs programs developed on the HP-85. Thus, it makes it economical to add intelligence to test or measurement systems—the cost is $1,675 per module in the U. S. System software developed on the HP-85 can be transferred to the HP 9915A via erasable programmable read-only memory or magnetic tape. The module can accept up to 32-K bytes of E-PROM–stored information al-

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The LTS-2000 is a lot more than a simple tester. It's a powerful instrument you can use anywhere in your plant for almost any kind of test from basic go/no-go to full-blown Discrepant Material Reports. And it can not only test DAC's and ADC's but a wide variety of linear components, including Op Amps, regulators, comparators, bifets, etc. Test results are immediately displayed and printed, and full reports including statistical analysis, data log and summary sheets are available through the integral 20 column printer.

Interface to peripherals, like line printers, CRT terminals or a HOST computer are easily accomplished via the IEEE-488 interface or either of the RS232 ports.

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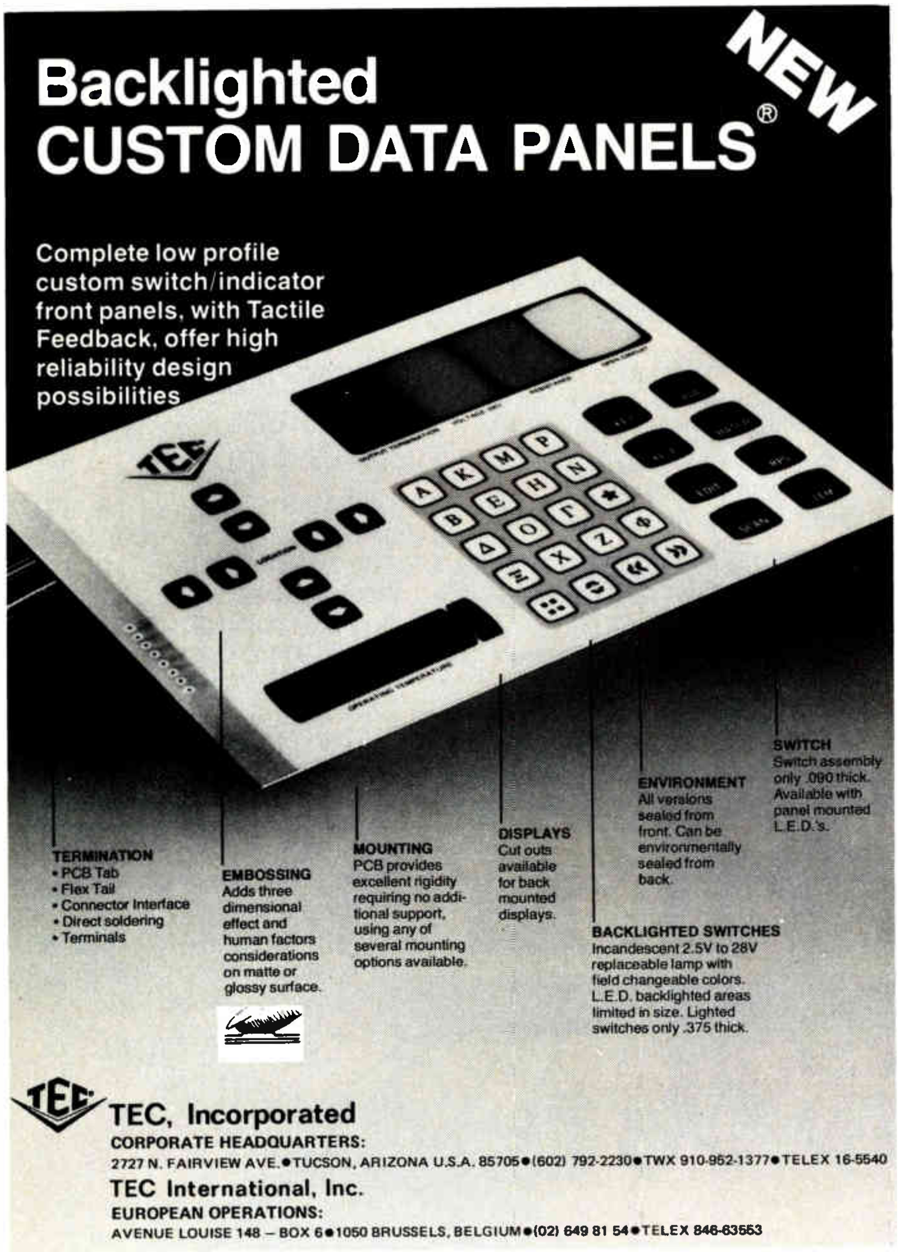
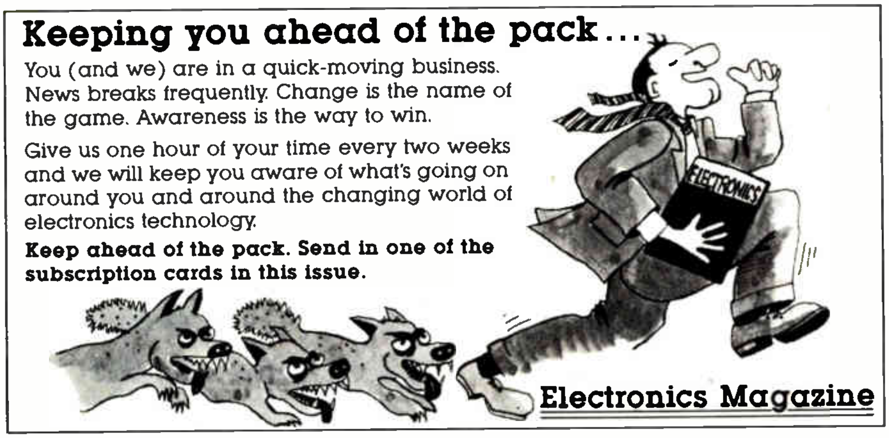
Circle 259 on reader service card





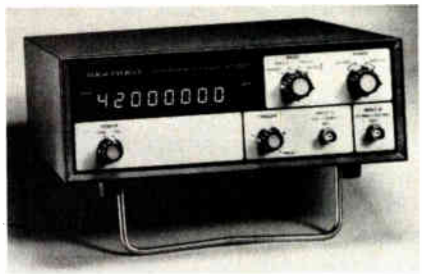
New products

though the standard HP 9915A comes with 16-K bytes of read/write memory available to the user. With an optional 200-K-byte cartridge tape unit ($425), the HP 9915A can exchange programs and data with HP data cartridges. An optional operator interface for adding custom keyboards and displays adds $350 to the module's base price. Deliveries of the modular computer take eight weeks from receipt of an order.

Hewlett-Packard Co., 1507 Page Mill Rd., Palo Alto, Calif. 94304 [354]

$300 512-MHz counter has ±0.1-ppm time base

A 512-MHz digital frequency counter, the portable model SM-2420 features four rate times and eight-digit resolution for precise readings. The



unit's crystal oven temperature is proportionally controlled to keep the internal time base within 0.1 ppm over a wide temperature range.

The long-term stability of the instrument's crystal-controlled time base is less than 1 ppm per year, says the manufacturer. In addition, the frequency counter makes provision for using external time-base signals. The eight-digit light-emitting-diode display has the resolution needed to measure ultrahigh-frequency signals, and the unit's typical 4-to-15-mV sensitivity allows the counting of low-level signals.

A factory-assembled and tested SM-2420 sells for $299.95. For $239.95, a kit version of the frequency counter, model IM-2420, is available, complete with an assembly manual.

Heath Co., Benton Harbor, Mich. 49022. Phone (616) 982-3210 [355]

A LITTLE GOOD NEWS FOR DATA GENERAL OEMS.

Look what we've put together for you. A desk top computer that doesn't take up the whole desk.

It's called MPT.

And look what's inside this little thing; a 16 bit microNOVA™ computer. 60 K bytes of memory. 80 column by 25 line screen. Full keyboard with 10-key numeric pad. And up to 716 KB of on-line storage on two 358 KB mini diskettes. (Also available with one diskette. Or none.)

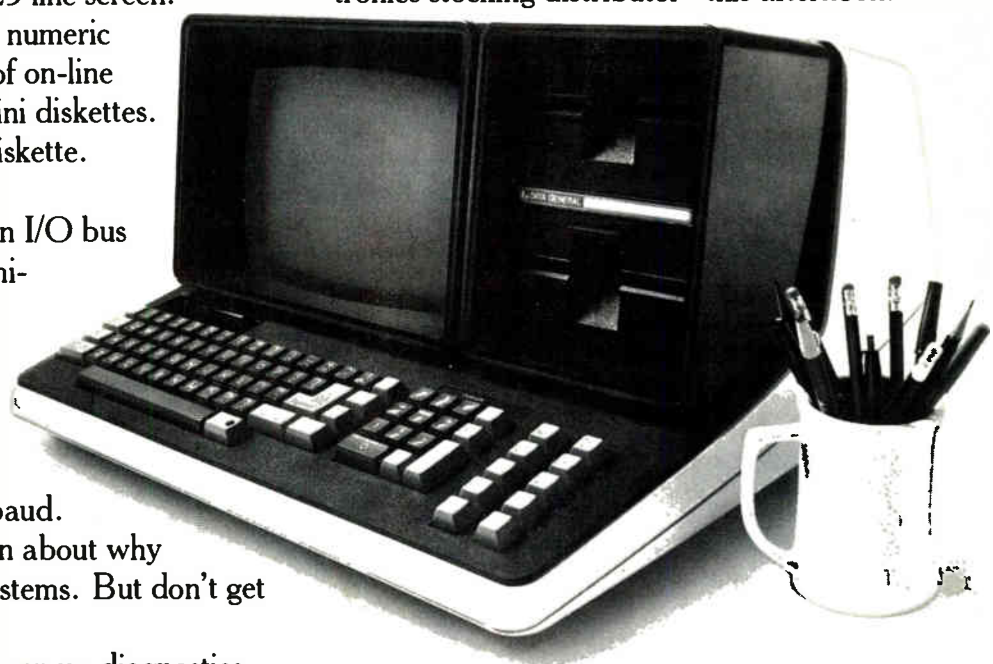
Out back you'll find an I/O bus that accepts the standard microNOVA peripherals. As well as your own interfaces. And two synchronous/asynchronous communications ports, programmable to 19.2K baud. Standard. (We could go on about why that's an option on other systems. But don't get us started on that.)

Also standard are power-up diagnostics that check out the whole system before it accepts your diskettes. So you and your software shouldn't be accused of hardware problems.

MPT is upwards compatible with the microNOVA, NOVA® and ECLIPSE® computers you're probably using now. And because it uses a run-time version of MP/OS, you're going to be able to develop your software with your MP/OS and AOS operating systems. In PASCAL, FORTRAN, BASIC.

You can get to work on your MPT software now. By calling your local Data General sales office. Or writing us at MS C-228, 4400 Computer drive, Westboro MA 01580.

Or if you really want to move, you can pick one up at your local Data General industrial electronics stocking distributor* this afternoon.



You'll find MPT very easy to take. Partly because of the $4899 price (USA price, 2 diskette version, OEM quantity 20). And partly because the whole thing weighs just 30 pounds.

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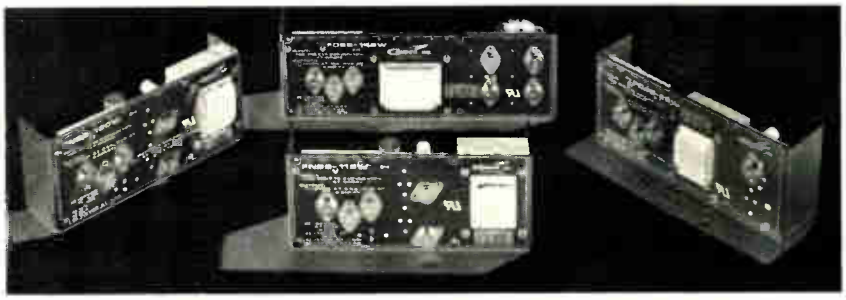

SPECIFICATIONS

Input:	100/115/215/230V ± 10% 47-440 HZ
Line Reg:	.02% for a 10% input change
Load Reg:	.02% for a 50% load change
Ripple:	3.0 MV PK-PK max., 20V to 200V .02% PK-PK max
OVP:	Output #1
OVLD Protect:	Auto. Current Limit, foldback
Temp:	0 to 50°C at full current
Temp. Co-efficient:	±.01% 1°C max.

See EEM-Pg. 3324 & Goldbook, Vol. 1-Pg. 423

Model	Output 1	Output 2	Output 3	Output 4	Output 5	Case	1-9 Pr.
FDBB-149	+5V@15A	+24V@2/4.5A PK	+12V@.8A	−5V@.8A	−12V@1A	DBB	$169.00
FNBB-119	+5V@9A	+24V@2/4.5A PK	+12V@.8A	−5V@1A	−12V@1A	NBB	140.00
FCBB-89	+5V@6A	+24V@1.5/4.5A PK	+12V@.8A	−5V@.8A	−12V@.8A	CBB	130.00
FDBB-148	+5V@15A	+24V@2/4.5A PK	N/A	N/A	−5V or −12V@1.2A	DBB	149.00
FNBB-120	+5V@7A	+24V@3.5/5.5A PK	N/A	N/A	−5V or −12V@1.2A	NBB	120.00
FNBB-118	+5V@9A	+24V@2/4.5A PK	N/A	N/A	−5V or −12V@1.2A	NBB	120.00
FCBB-88	+5V@6A	+24V@1.5/4.5A PK	N/A	N/A	−5V or −12V@.8A	CBB	110.00

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Circle 262 on reader service card

Communication Arts, Huntington Beach, Ca.

2SPBT

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Technical Magic 17742 Mitchell Avenue, Irvine, California 92714 (714) 556-2380

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The Model 528 is the new performance leader at less than $1,000.00 providing 30 Volt P-P open circuit output, .001 Hz to 20 MHz frequency range, linear and log sweep, gate, trigger, pulse and burst modes.

The Model 500SL shatters the under $500.00 price/performance barrier with superior features such as: .005 Hz to 5 MHz frequency range, 3 decade linear and 4 decade logarithmic sweep, start and stop sweep limit controls to allow up and down frequency sweeping, gate and trigger modes, sine, square, triangle and haversine waveforms.

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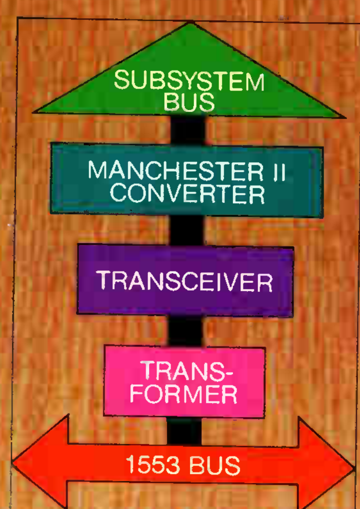

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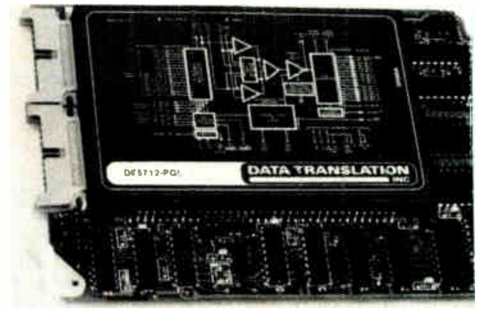
Circle 265 on reader service card

Data acquisition

Modules spawn input card line

Data-acquisition modules are used in three analog-input card families for STD bus



Already strong in products compatible with DEC, Intel, and Computer Automation mini- and micro-computers, Data Translation Inc. established a beachhead in the Mostek/Pro-Log STD-bus market in 1979 [*Electronics*, April 12, 1979, p. 255]. Now, three analog-input card families are being added to an STD line that, by mid-1980, already included five multichannel analog-input, 8- and 12-bit analog-output, three input-multiplexer, and a pair of dc-dc converter cards capable of deriving ±15 V from the STD bus's 5-V supply.

The new cards take the line to higher resolutions. They are based on the firm's 14-bit DT5714 and 16-bit DT5716 data-acquisition modules. Modular construction makes such market entries relatively straightforward; DT need only design the appropriate 6.5-by-4.5-in. card and mount the requisite data-acquisition module on it. But some tight engineering is necessary, since the modules themselves measure 3 by 4.6 in. The three new input card families are: the high-level DT2742 family, the DT2744 family for lower-level inputs, and the DT2745 isolated-input cards.

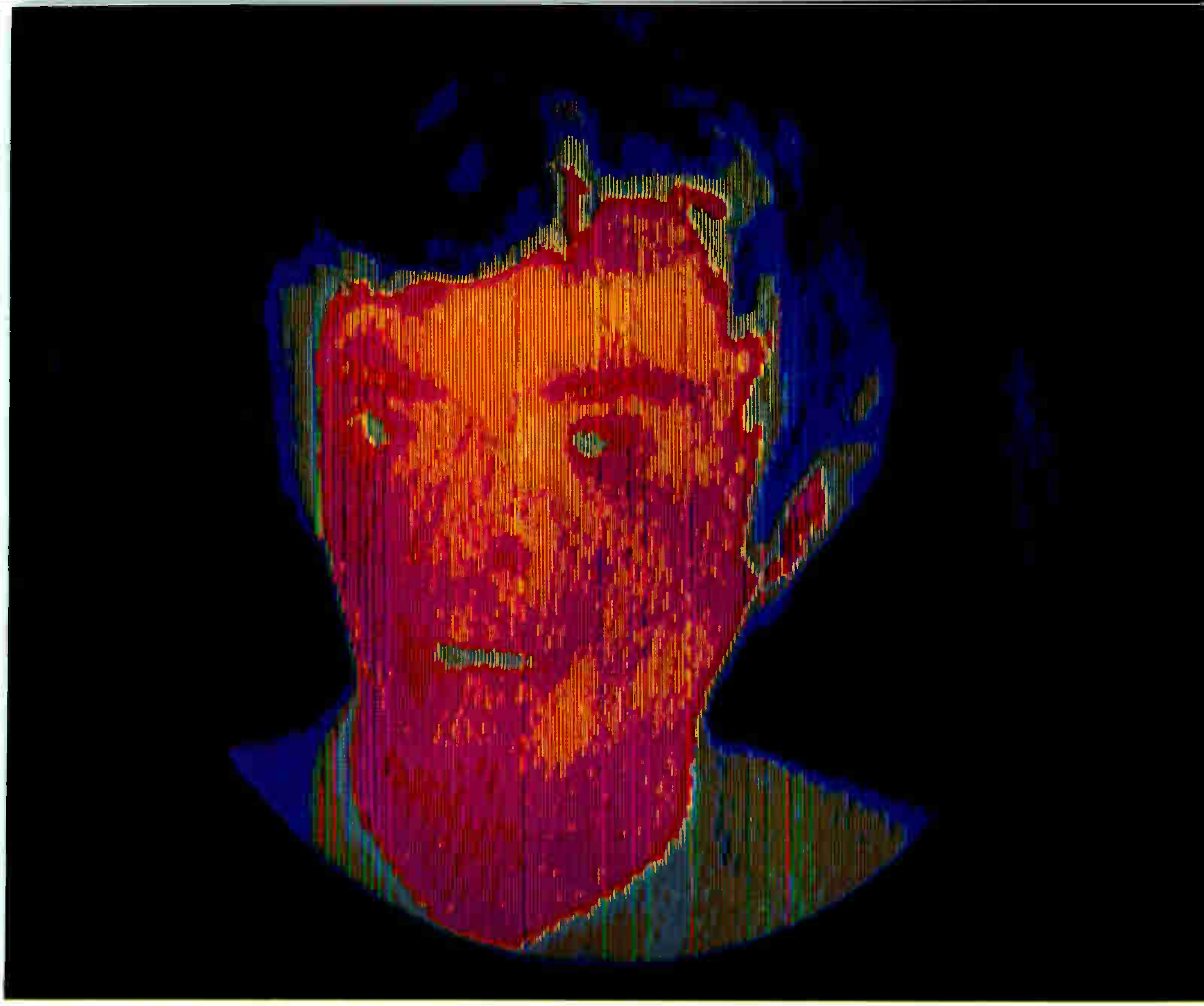
The DT5716, on which the 16-bit offerings are based, is specified to have linearity within ±0.006%, differential linearity within ±1 least significant bit, ±10 ppm/°C converter temperature coefficient, 100-MΩ input impedance, and 50-μs conversion time. For the 14-bit DT5714, linearity is within ±0.009%, differential linearity is within ±½ least significant bit, converter temperature coefficient is ±20 ppm/°C, input impedance is 100 MΩ, and conversion time is 30 μs. Each module includes a 16-channel multiplexer, multiplex register and counter, control logic and clock, sample-and-hold network, analog-to-digital converter, +6.3-V reference, and (optionally) a programmable-gain amplifier.

Potential users face a sizable array of available configurations. In the DT2742 high-level family, for example, users can select among 12-, 14-, or 16-bit resolutions and 8 differential or 16 single-ended inputs; they may request programmable gain on most models and resistor-set gain on any; and they may specify 20-mA current-loop output. They have a choice of ±12- or ±15-V power and of unipolar input ranges of 0 to +5 and 0 to +10 V, or ±5- or ±10-V bipolar ranges.

The alternatives in the high-level card family number more than 20; the same goes for the low-level DT2744 family. The only basic difference is in input ranges: unipolar ranges of 10 mV to 5 or 10 V full scale and bipolar ranges of ±10 mV to ±5 or ±10 V full scale are available. Power-supply requirements, resolutions, inputs, and gain programmability are identical with the high-level family's.

Isolation. The DT2745 isolated-input boards form the smallest family, numbering about 10. The user is limited to four isolated differential inputs, ±12 or ±15-V supply voltages, 12-bit resolution, and the option of a 20-mA current-loop output. The isolation rating is ±250 V and the common-mode rejection ratio is specified at 160 dB at 60 Hz.

Thus the new STD-bus offerings, in all their permutations, number



Color-coded, TV-standard image obtained with a Pyricon pyroelectric-target imaging tube.

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Circle 267 on reader service card

4107

about 50. Sources in the company feel that this makes DT's the broadest line of analog input and output cards tailored to the STD bus.

The boards' base prices range from $525 to $595 each. Options and variations from standard configurations—14- or 16-bit resolution, programmable gain, and so on—add from $100 to $900 per unit. Delivery takes five days.

Data Translation Inc., 100 Locke Dr., Marlboro, Mass. 01752. Phone (617) 481-3700 [381]

16-bit converters digitize position data to ±40 s

The SDC-502 series of 16-bit synchro-to-digital and resolver-to-digital tracking converters has a standard accuracy to within ±1 minute, but a ±40-second option is available for higher accuracy requirements. The manufacturer says that the high accuracy and jitter-free output of the converters are due to a patented control transformer algorithm. The converters' broadband input frequency covers the 350-to-1,000-Hz range and can be extended to 10 kHz by using a voltage-follower buffer-input option. One of the five models in the series is for direct input, two take synchro inputs, and two take resolver inputs. Two operating temperature ranges are available—from −55° to +105°C and from 0° to +70°C.

Each converter is mounted in a standard 24-pin module. Delivery takes 30 to 90 days. A single unit sells for $750 in the U.S., $863 abroad.

ILC Data Device Corp., 105 Wilbur Place, Bohemia, N.Y. 11716. Phone (516) 567-5600 [383]

Data logger has low-level preamp and scan start clock

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(714) 546-7750. TWX: 910-595-1721.

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cassette data logger has optional instrumentation-amplifier inputs and a start clock for automatic scanning. The battery-powered (±12-v dc) unit can store 120,000 16-bit samples per cassette, whether they are 12-bit analog data points from an internal analog-to-digital converter or external 16-bit complementary-MOS latched parallel data from the user's clock or counter. The 4-by-4.5-by-7-in. device consumes 120 μW of power while on standby and 80 mA while recording at a rate of up to five samples per second. With the instrumentation amplifier ($165 additional), the LPS-16 has eight differential channels. An optional onboard C-MOS clock ($100) allows selection of scanning intervals of up to 2 hours between scans. The basic model, the LPS-16-12B, is $1,360 without clock and preamp options. Delivery takes 15 to 30 days.

Datel Intersil, 11 Cabot Blvd., Mansfield, Mass. 02048. Phone (617) 339-9341 [384]

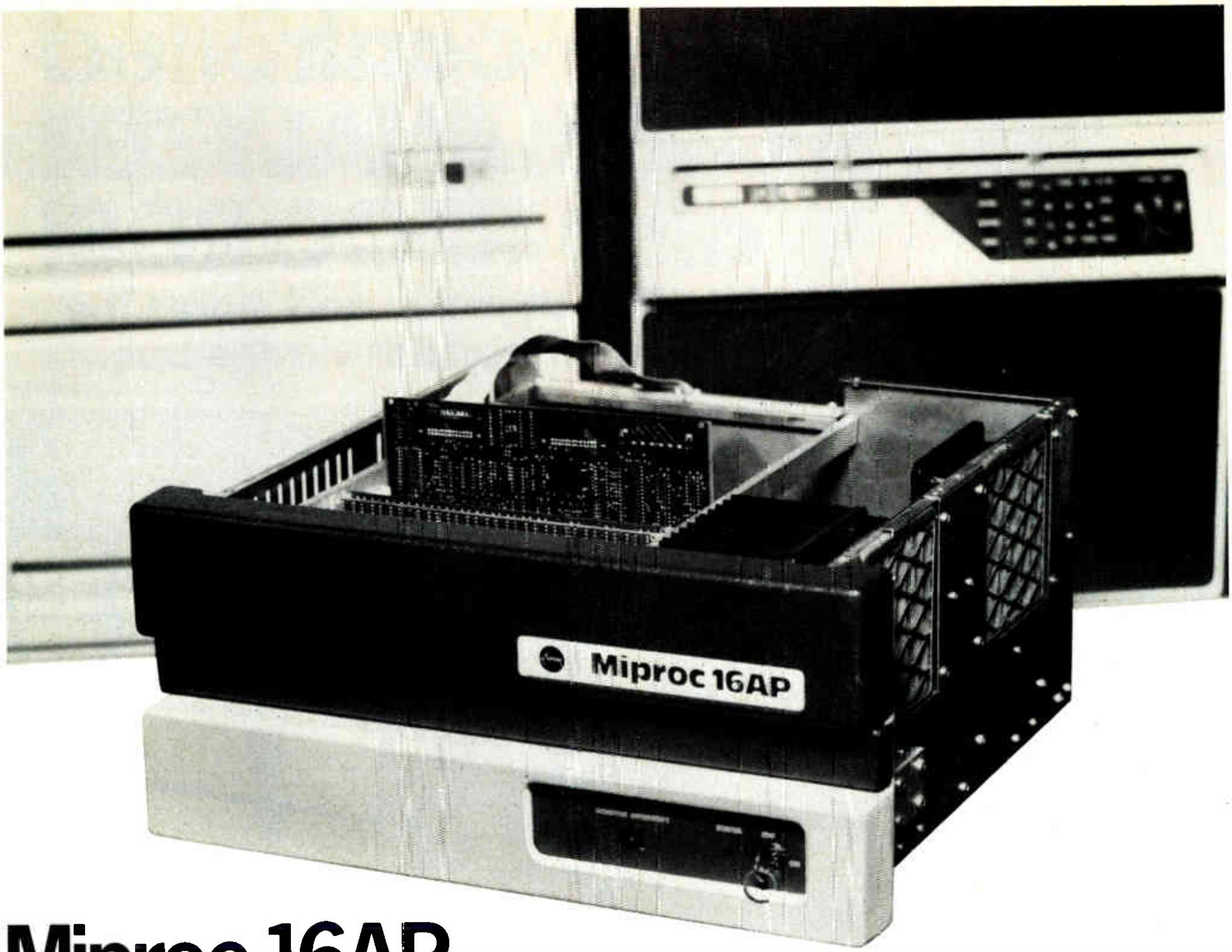
Data-logging system is priced at $4,500

The Fidac series 7240 data-acquisition and control system includes Basic and assembly-language programming, a cathode-ray-tube display, a full typewriter keyboard, and program- and data-storage capability for as little as $4,500. As $300 to $400 options, the 7240 has a range of plug-in function cards for analog and digital signals, plus a 5¼-in. flexible-disk memory with a 340-K-byte capacity and an impact printer. An IEEE-488 controller allows other compatible instruments to be integrated into the system for automated electronic testing.

A basic system incorporates a 12-bit analog-to-digital converter with input multiplexer, digital input and output, and pulse counter for $4,200. The mainframe assembly communicates by an 8-bit bidirectional parallel port to leave the IEEE-488 bus free for simultaneous communication with peripheral devices.

FI Electronics, 968 Piner Rd., Santa Rosa, Calif. 95401. Phone (707) 527-0410 [385]

World Radio History



Miproc 16AP
A cost and space saving associate processor for PDP-11* systems

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You get all the compute power of a PDP 11/70.* At a third of the price.

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● Integer Add, from memory	0.6	0.6†	.25	.25
● 32 bit floating point Add	0.9	2.52	1.25	3.50
● 32 bit floating point Multiply	1.8	3.44	2.50	2.75

Min/max times, all in microseconds. †Mode 1 source address.

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But that's not all you save. With the Miproc 16AP, your system occupies a fifth of the usual space, at the very most. Just great for OEMs!

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Plessey Microsystems Limited
Water Lane, Towcester, Northamptonshire, United Kingdom NN12 7JN. Tel: Towcester (0327) 50312 Telex: 31628 and at 19546 Clubhouse Road, Gaithersburg, Maryland 20760, Tel: 301-948-2791. 1641 Kaiser Avenue, Irvine, California 92714, Tel: 714-540-9931.

*Digital Equipment Corporation trademarks

0654 2 0136

Packaging and production

System generates board tests fast

Test-pattern generator with schematic-editing graphics handles boards with 400 ICs

Systems that automatically generate patterns to test integrated-circuit–laden boards are perhaps the most powerful tools available for checking the functioning of complex circuitry. Nonetheless, rapid increases in board size and complexity have test engineers hard-pressed to develop test programs fast enough. To speed the development of such programs, Computer Automation's Products division will soon make available a new system that, it claims, is the industry's fastest automated test simulator for loaded circuit boards.

To be formally unveiled at the Automatic Test Equipment seminar/exhibit in Pasadena, Calif., Jan. 19–22, Sprint is compatible with the company's Capable family, already recognized as the fastest test simulators available in the industry.

"We have significantly enhanced both hardware and software to achieve performance levels upwards of three times faster than our existing line," states Douglas Cutsforth, division vice president and general manager. Sprint, he adds, can generate comprehensive test programs for boards with 400 or more ICs, or 30% to 50% more circuit capacity than prior simulators could handle.

According to Richard A. Garlic, division director of engineering, "one of the biggest problems facing test programming engineers is trying to simulate complex circuit boards with upwards of 1,000 nodes." Whereas it presently "takes days to do just one simulation," he points out, the new Sprint system will enable users to reduce that time to several hours.

Sprint achieves its speed largely through its new central processing unit, an LSI 2/120, whose expanded instruction set significantly improves block-mode operations by consolidating statements. The Sprint processor can now do in one statement what its predecessors may have executed in as many as 60 statements.

"The result is a tremendous improvement in throughput, software efficiency and programming productivity," says Cutsforth.

Moreover, in purely hardware terms, Sprint's CPU is not only twice as fast as the LSI 2 in the company's prior simulators, but also has a new memory management unit to enlarge the processor memory space, as well as a 50-ns cache memory of 1-K words (2 bytes each) to improve access times. The system has a standard physical memory of 256-K words, in contrast with the earlier models' 96-K words. With these hardware enhancements, Garlic claims Sprint "can execute instructions an order of magnitude faster than was possible before."

Among other major improvements incorporated into Sprint is a screen editor, a newly developed software tool that allows editing at the system's cathode-ray-tube terminal in a word-processing, cursor-controlled fashion. It is designed specifically to provide programmers in testing applications with more control and editing capabilities as data is entered, notes Garlic.

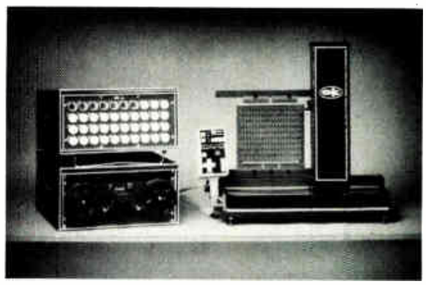
Another proprietary software tool is a schematic editor with which users can enter and update data-base information in actual schematic format—"a tremendously fast and error-free means of entering circuit design specifications," notes Garlic.

Sprint, which will be priced at approximately $132,000 for the complete hardware/software package, also comes with a new CRT that handles full graphic capabilities through the addition of 64 graphic character controls. The first deliveries are scheduled for April, and it will be generally available by June.

Computer Automation Inc., Industrial Products Division, 2181 DuPont Dr., Irvine, Calif., 92713. Phone (714) 833-8830 [391]

Semiautomatic wire-wrapping system costs $4,995

The SW-101 semiautomatic wire-wrapping system with microprocessor control sells for $4,995. The sys-



tem features a 20-by-20-in. wiring area and can wire boards at a rate of 10 in./s, moving the wiring head in 0.025-in. increments across the board. The display shows the operator such parameters as sequence number, positioning, bin and pin number, and routing direction. The system includes a 40-tube wire bin. Its paper-tape transport contains its own microprocessor and buffer to ensure fast and accurate data transfer, as well as smooth tape handling. The SW-101, which reads tapes in the ASCII or the Electronic Industries Association code, can also read tapes prepared either for absolute or for incremental positioning. As a special service, the maker will program the unit's microprocessor to read tapes in the format of any wire-wrapping machine manufacturer to provide complete software compatibility with existing equipment.

A less expensive version of the unit, the SW-101F, comes with a reader for fan-folded tapes instead of the tape transport and costs $4,495. Both systems are available for immediate delivery.

OK Machine & Tool Corp., 3455 Conner St., Bronx, N. Y. 10475 [393]

68-lead socket accepts Jedec leadless type-A chip carrier

Maintaining the low cost and small size needed by production sockets yet offering the durability of a test socket, a new 68-lead socket has been designed to accept the Jedec leadless type A chip-carrier package. In addition, the socket footprint is in accordance with the Joint Electron Device Engineering Committee's standard, which requires a 0.100-by-0.100-in. grid. The socket's lid acts

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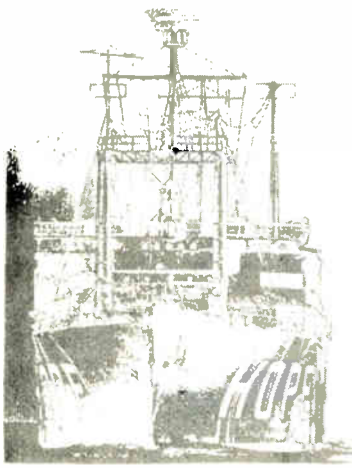

as a heat sink, but the socket can also be adjusted to take a device-mounted heat sink. It has a low profile (0.342 in.) for mounting on 0.500-in. centers. The contacts are of beryllium-copper, and the socket body of Underwriters Laboratories–approved material; the leads are gold-plated. In quantities of 1,000, the socket is priced at $5.79 each and will be delivered in eight weeks.

3M Textool Products Department, Electronic Products Division, 1410 W. Pioneer Dr., Irving, Texas 75061. Phone (214) 259-2676 [394]

Low-insertion-force sockets have special contacts

The machined contacts on a family of sockets, with pins on 0.100-in. grids, have been specially designed

so that only very low insertion and extraction forces are needed to accommodate planar-gate-array and similar plug-in chip packages. A patent is pending on the contacts, each of which is housed in a completely enclosed sleeve to prevent solder wicking or flux contamination. Sockets for 64-, 72-, and 120-pin packages are already being manufactured; other sizes are available on request.

Augat Inc., Interconnection Components Division, 33 Perry Ave., Attleboro, Mass. 02703. Phone (617) 222-2202 [395]

Leads from 64-lead ceramic package are on 50-mil centers

A 64-lead high-density Diapak uses one half the area of conventional side-brazed packages, Cerpacks, or Cerdips because its external leads are on 50-mil centers with rows

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World Radio History

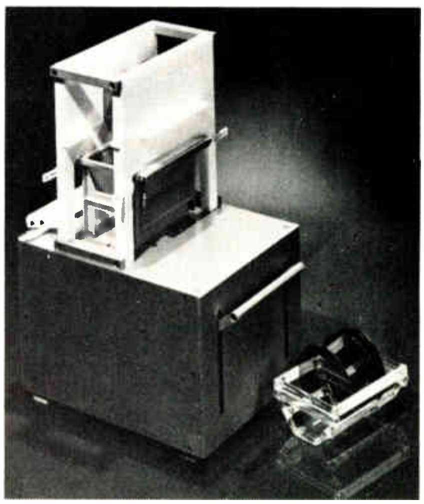
Circle 20 on reader service card

spaced 600 mils apart. The new package can be reflow-soldered directly to a circuit board, or it can be inserted in a new dual in-line package socket which has a 100-mil pin pattern for soldering to a circuit board. The Diapak is hermetically sealed and has a low-temperature frit-sealed lid and aluminum wire-bond fingers. The planarity of the bond fingers meets or exceeds requirements for automatic wire bonders, the manufacturer says. The high-density package is also produced in 48- and 40-lead models, which are immediately available in sample quantities.

Diacon Inc., 12810 Hillcrest Rd. No. 209, Dallas, Texas 75230. Phone (214) 233-2538 [396]

System transfers wafers in under 60 seconds

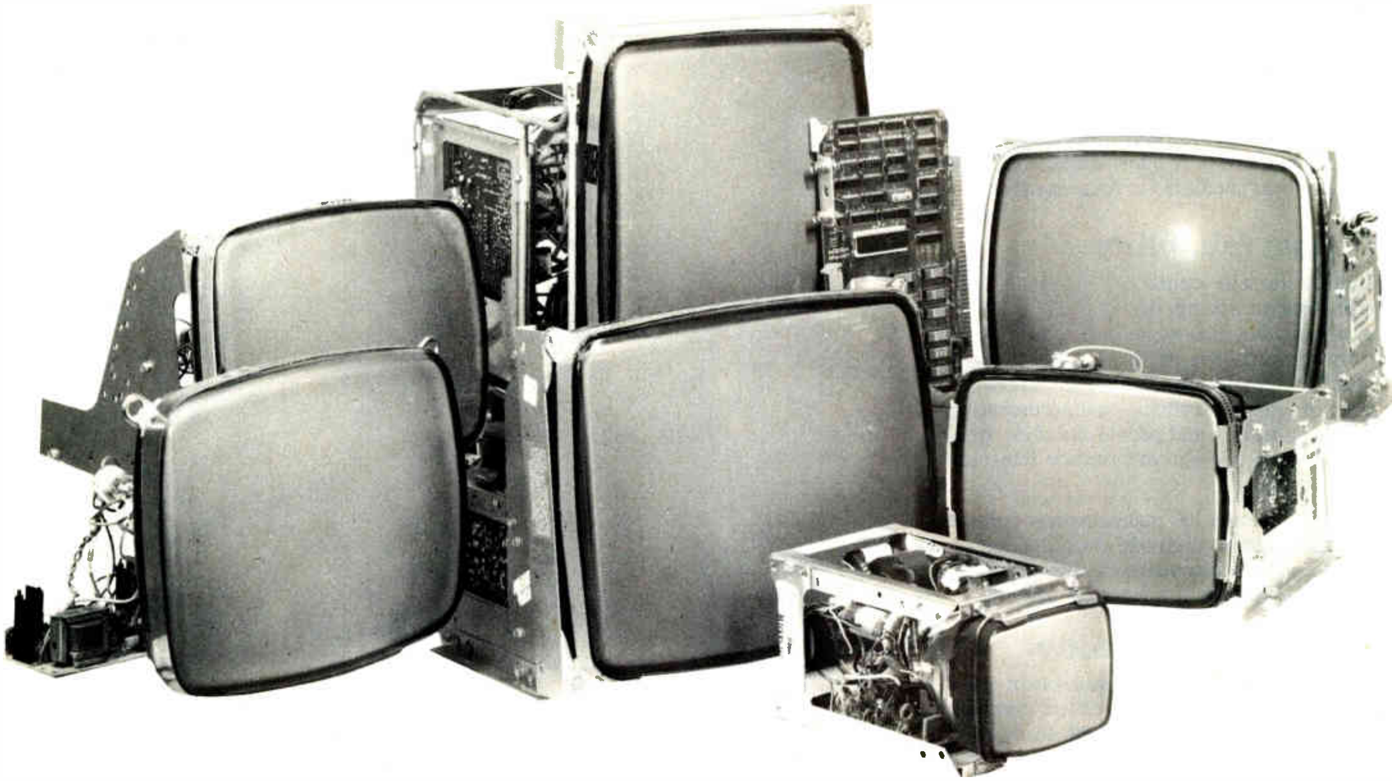
Making it easy to adapt from one carrier or wafer size to another, a manually operated unit transfers 3-, 4-, 5-, and 6-in. square or rectangu-



lar wafers back and forth between 25-position plastic carriers and 50-position quartz diffusion boats in less than 60 seconds. The VTS-8015 vertical transfer system is designed to operate without damaging the fragile components. The 1-ft^2 unit requires no electrical or pneumatic hookups.

Fluorocarbon Co., U. S. Quartz Division, 17 Madison Rd., Fairfield, N. J. 07006 [398]

Motorola matches the display module to your application and budget



Every Motorola module, from 5″ to 23″, is available in a variety of configurations and electrical specifications to meet the most diversified customer needs. It is this flexibility—adapting basic design to individual user specs—that has kept Motorola in the forefront of CRT display technology.

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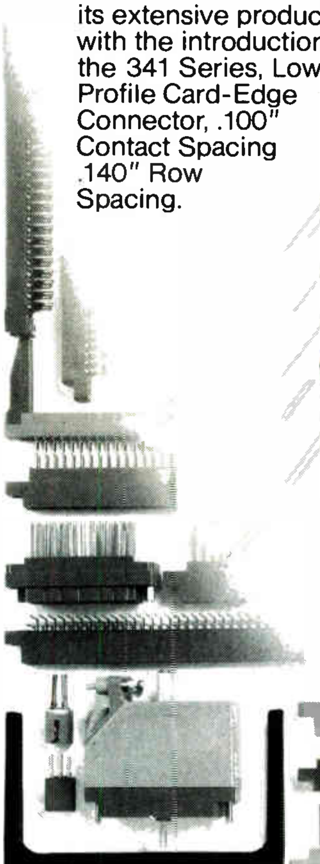

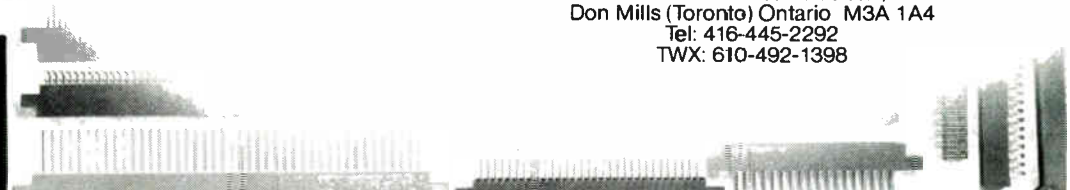

HUNTRON TRACKER, Model HTR 1005B-1S, an advanced instrument for trouble shooting solid state components and circuits.

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Microcomputers & systems

CPU eases move to Pascal, Ada

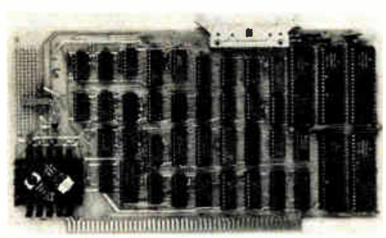
Two-processor board set for S-100 bus is CP/M-compatible

An S-100–compatible computer board set from Digicomp Research combines 8- and 16-bit microprocessors. The Pascal-100 central processing unit has a Z80 8-bit processor on one board and Western Digital Corp.'s 16-bit Pascal Microengine on another; together they make a potent pair.

Since the IEEE standardized the S-100 bus about a year ago, makers of S-100–compatible computer subsystems have seen their market's center of gravity moving steadily toward original-equipment manufacturers. Now, with 16-bit microprocessors and higher-level languages becoming available, Digicomp sees a need for a system that can offer 16-bit performance without making obsolete the vast amount of software already developed for S-100 systems based on the Z80, 8080, or other microprocessors supporting the CP/M operating system. The Pascal-100 does that and adds user-friendly languages as well.

The Pascal-100 initially will run version III UCSD Pascal, including a screen-oriented editor, compiler, linker, filer, and other utilities. The CPU also supports the large program library already available for the Z80 and 8080 using CP/M.

Since the Microengine executes Pascal p-code directly as machine language, it is a fast processor.



Clocking at 3 MHz, it is from 7 to 12 times faster at a given task than Pascal-programmed microprocessors using software interpreters. The firm claims that the Pascal-100 can be as much as 1.5 times faster than Digital Equipment Corp.'s PDP-11/45.

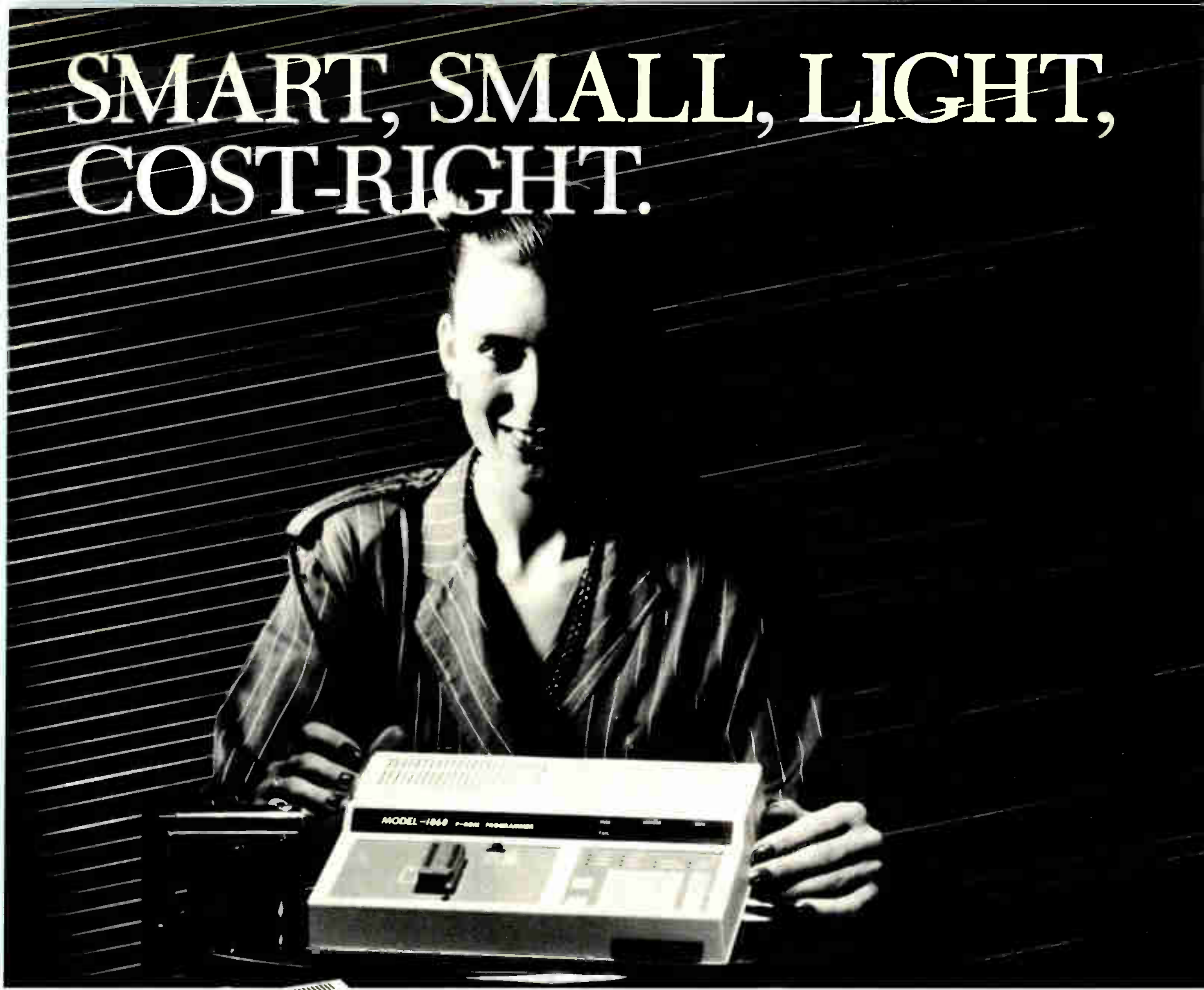
And there are other advantages. Work is now under way that would make programs written in Fortran, Basic, and Cobol use p-code too, and James Elkins, vice president of the firm, expects the Pascal-100 to be supporting these languages this year.

Languages like the Defense Department's Ada as well as LISP will be available in 1981 also, he adds. Elkins expects the Pascal-100 to be one of the first CPUs in its market to support either language, and they will be especially valuable in military, laboratory, and educational applications.

A typical Pascal-100 addresses 128-K bytes of paged memory directly and there is a mapped, 1-megabyte direct-address option using the extended-address feature of the IEEE bus standard. Important to cost-sensitive OEM applications, a 4-K-byte block of main memory is available that would otherwise have been used for a Pascal interpreter, something the Microengine does not need. The 100 is also capable of 32-bit IEEE-standard floating-point mathematics at a higher speed than machines using Pascal interpreters.

Though UCSD Pascal and the CP/M operating system are not usually compatible, there is some functional overlap in the Pascal-100. The Z80 subsystem handles all interrupts and input/output operations in Digicomp's release of Pascal. Thus the Pascal-100's operating system can adapt to any user environment for which a standard CP/M basic input/output system (BIOS) is available—and that means virtually all S-100–compatible disk and terminal controllers.

I/O routines also can be written directly in Pascal and installed in the operating system. Some users of hard disks and direct-memory-access disk controllers will find this an advantage. But, though both the Z80 and Microengine can address 512



Model 1860
P-ROM Programmers

Model 1861

		Model 1860	Model 1861
Programmable devices		i2716 (i2758), i2732, i2732A, i2764, TMS2532, TMS2564, i8755A, i8748A, i8741A and compatible.	Exclusively for simultaneous ganged programming of 8 MOS. i2716, i2732, TMS2532, and compatible.
Interface	Serial	RS-223C and 20mA current loop (or TTL level) switch selectable.	RS-232C, 20mA current loop, or TTL level selectable as specified when ordering.
		Baud rate: 110, 300, 600, 1200, 2400, 4800, 9600	
	Parallel	PTR parallel interface	
Size, weight		280 (W)×208 (D)×65 (H) mm, 2.5kg	280 (W)×208 (D)×75 (H) mm, 3.5kg

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New Series 1860 P-ROM Programmers.
New Model 1860 Series for the age of P-ROM diversification Minato Electronics New Series 1860 P-ROM programmers meet the demands for wide applications. They are super compact, light weight and inexpensive.

Model 1860 has two standard interfaces.
MOS and bipolar P-ROM can be easily programmed by simply changing personal modules. Serial I/O data editing, optional high-speed 400ch/sec. PTR, and other economical, efficient, and flexible functions are provided.

Model 1861 simultaneously programs 8 ganged MOS.
Model 1861 is a special program-only programmer for simultaneous ganged programming of 8 MOS. Data editing, PTR and other specifications are identical to those of the Model 1860.

Circle 42 on reader service card

I/O ports, the Z80 is expected to do most of the housekeeping.

So the bottom line is compatibility. An OEM or end user with a large library of CP/M-based software can upgrade to 16-bit performance levels without loss simply by using existing software and the Z80 during a transitional phase. Meanwhile, he or his customers can use Pascal now, and Fortran, Cobol, Basic, LISP, and Ada soon, to generate applications software. Indeed, the Z80, because of the Pascal-100's extended addressing, can now handle larger programs and data bases than were typical before.

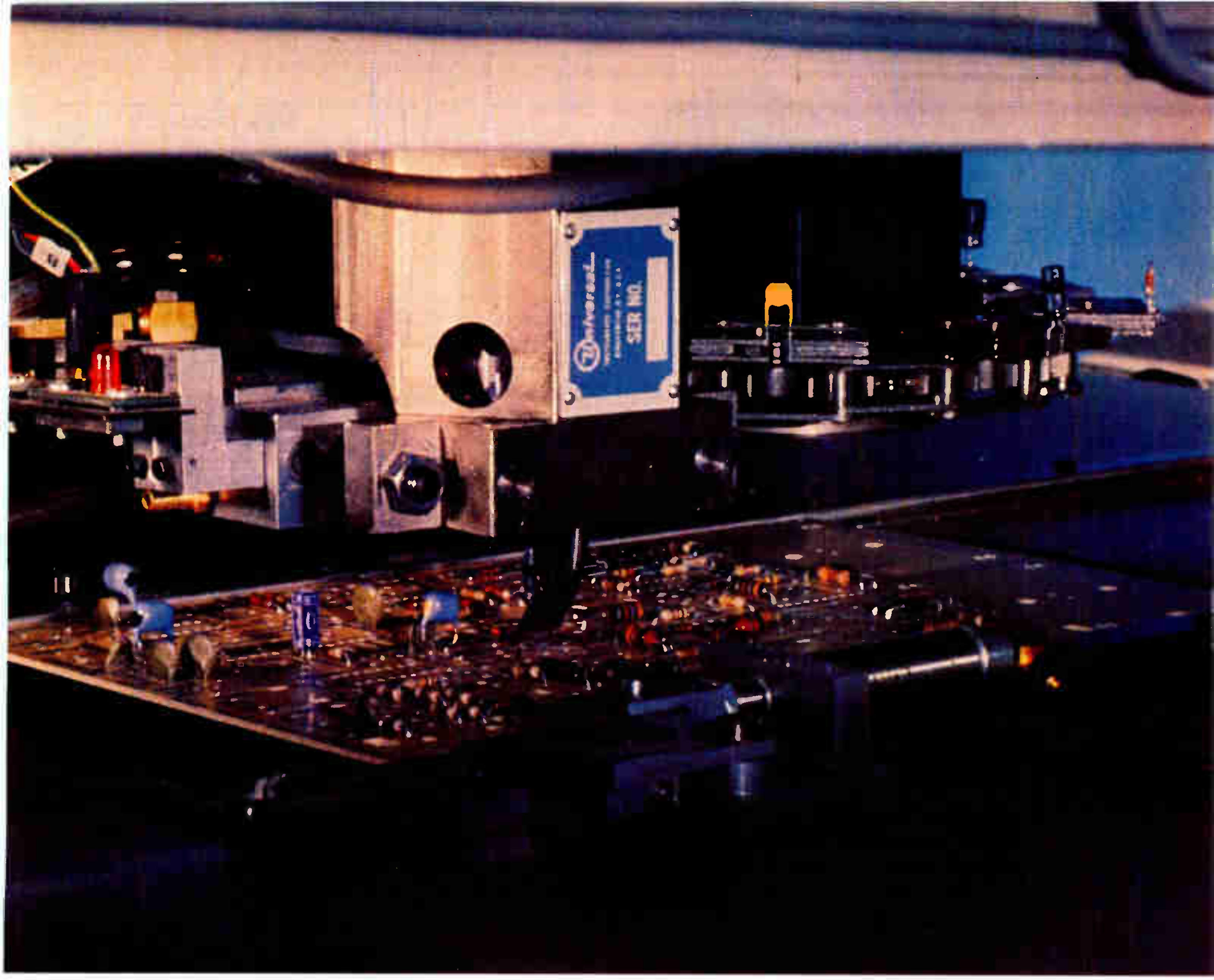
Nor will insertion of the Pascal-100 make other subsystem boards obsolete. With memory, for example, the Pascal-100 shuttles data into or out of memory in either 16-bit words or single bytes, depending on the memory's organization. Though the use of byte-oriented memory cuts processing speed, the operation is transparent to the user, with the CPU handling the interfacing automatically. Memories organized either way can be mixed within one and the same system.

The Pascal-100 costs $1,485 in single units, with volume discounts bringing the price down as much as one third. For an added $250, also discountable, users get a UCSD-Pascal software package. The megabyte memory option costs $100. Delivery takes two to six weeks.

Digicomp Research Inc., Terrace Hill, Ithaca, N. Y. 14850. Phone (607) 273-5900 [371]

One-card computer reports for I/O tasks

The model IOP input/output processor is an 8-bit computer readied for work as a slave in microcomputer systems using the S-100 bus. It comprises a Z80A microprocessor, 16-K bytes of random-access memory, and up to 32-K bytes of programmable read-only memory on a single card. To the host processor, the IOP appears as two output and two input ports. It can be used alone or with other IOPs. It can also be used to



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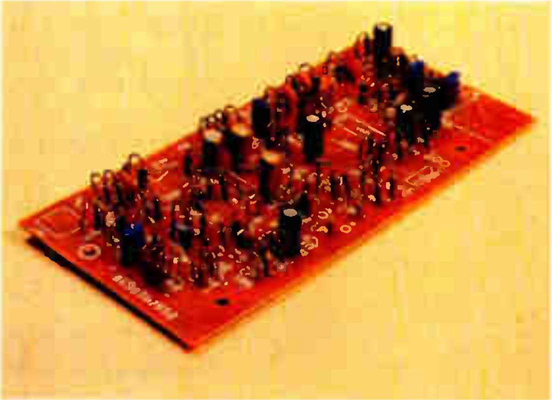
For greatest possible productivity, the Model 6341 can be equipped with Universal's new Pass-Thru™ automatic board handling system. This keeps the machine's X-Y table supplied with fresh boards while delivering assembled boards to a magazine loader. If the versatility and speed of the Model 6341 are more than you need, we can equip you with the 40-station 3,600 an hour Model 6385.

Ask your Universal sales engineer to show you our Radial Lead Insertion video tape, or send for literature on these remarkable new machines.



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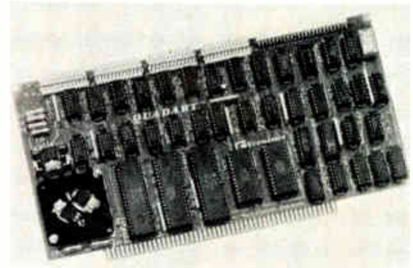
Circle 48 on reader service card

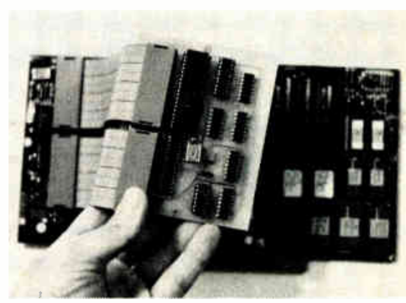


interface the S-100–compatible central processing unit with peripheral devices controlled over a new bus from Cromemco, called the C bus, that operates independently of the S-100 bus. In fact, the IOP is intended primarily for control of the C bus. Assembled and tested, it is available for $695.

Cromemco Inc., 280 Bernardo Ave., Mountain View, Calif. 94043. Phone (415) 964-7400 [373]

Modules boost throughput of 8080A-based systems

The series II microprocessor-enhancement modules increase throughput in 8080A-based systems between 50% and 250%, depending on system memory access time. Using a code-compatible 8085A-2, the modules perform 8080A in-circuit emulation. They are installed in only a few minutes by replacing the system's 8080A processor and



status latch with connectors housed in dual in-line packages. Thanks to flat cables, the modules can perform in tight spaces.

The clock frequency of the Intel 8085A-2 is 5 MHz. Wait states for the module of from zero to three machine cycles are strap-selectable to accommodate memory access

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Companies reduce their capital risks by renting equipment from Rental Electronics. You can, too . . . and could enhance your bottom line performance. When you rent electronic equipment, terminals or desktop computers, you save money. You get the equipment you need — and pay for that equipment only for the time you have it. You can rent one product or 1,000 for periods from 30 days to three years.

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REI, 19525 Business Center Dr., Northridge, CA 91324

GSA Contract # GS-04S-23560

Circle 50 on reader service card

times of from 350 to 950 ns. Since target systems vary in hardware for the status latch associated with the 8080A, the series II comes in three versions, geared for 8228, 8212, or 74LS273 status latches, respectively.

The price for original-equipment manufacturers is $350; an evaluation design kit is available for $500. Delivery takes six weeks.

Paragon Systems Inc., P. O. Box 2050, Corvallis, Ore. 97330 [376]

Board adds error-correction capability to S-100 systems

Although not an error-correcting memory by itself, an S-100–error-correcting board creates a complete error-correcting memory, operating in parallel with the existing system memory. The board, which can be plugged in easily, monitors the existing system random-access memory via the bus signals, intervening to correct erroneous bus data before it is accepted by the central processing unit. The board corrects all 1-bit memory errors and flags all 1- or 2-bit errors. Operating at up to 4 MHz, it protects 64-K bytes of memory and is compatible with most static and dynamic memories.

The manufacturer suggests that the board, which is available now, can be plugged in on an emergency basis to help troubleshoot memory problems, in addition to being used continuously. In single quantities, it sells for $1,295.

Correlation Systems, 81 Rockinghorse Rd., Rancho Palos Verdes, Calif. 90274 [374]

Board multiplies, accumulates 32-bit result in 15 ns

A multiplier-accumulator board, compatible with the SBC bus, facilitates the use of such sophisticated arithmetic procedures as matched filtering and fast Fourier transforms in real-time applications. It multiplies 16 by 16 bits and accumulates the full 32-bit result in 15 ns. For ease of use, data and control bytes

Testing loaded boards is as easy as plugging in the series 55.

When you plug in an Everett/Charles Test Equipment Series 55 Shorts and Continuity Test System, you automatically find circuit opens, shorts or faulty resistors. It's that easy.

Self-programmed from a known good board, the Series 55 can test over 1,600 assemblies in eight hours, 2048 test points in less than seven seconds — including handling time. Auto dwell, auto ranging and auto zeroing provide simplistic programming to make testing fast, operation simple.

When positioned after flow soldering and prior to in-circuit and/or functional test equipment, the Series 55 off-loads more complex equipment plus increases throughput. And as we all know, early detection of shorts and opens lowers manufacturing costs, speeds production.

In addition, the Series 55 uses the highly dependable Series 33 test fixturing with interchangeable test heads. The same Series 33 test head can be used through the entire in-circuit and functional test process for reliable testing, with lower fixturing costs.

When you plug in E/C Test Equipment's Series 55 Shorts and Continuity Test System, you plug into loaded board testing that's easy, fast and cost effective.

EVERETT/CHARLES TEST EQUIPMENT, INC.
We're here to help.

Circle 52 on reader service card

are memory-mapped. The multiplicands are written into four consecutive memory addresses and the product is available in the next five memory locations sooner than the controlling central processing unit can perform a memory fetch, says the manufacturer. Available operations include addition, subtraction, multiplication, and accumulation on normal or sign-extended data. Results can also be sign-extended from 8 to 32 bits, and functions can be performed in 2's complement, fractional, or integer notation.

Adaptronics Inc., 1750 Old Meadow Rd., McLean, Va. 22102. Phone (703) 893-5450 [375]

Board shares software with Intel development system

To compensate for the shortage of programmers, and the rising expense of developing software, the ZX-85 single-board development system shares software with the Intel MDS series II development system. In fact, the ZX-85 sports the architecture of the Intel development system and supports various standard disk operating systems.

The ZX-85 comes with an 8085A central processing unit clocked at 10 MHz, for execution of 8-bit code. It has a system bootstrap program and monitor in erasable programmable read-only memory and 64-K bytes of random-access memory governed by an 8202A dynamic-RAM controller. Its two RS-232-C channels feature model 8251A universal synchronous/asynchronous receiver-transmitters. The board also contains a timer and two 8259A interrupt controllers.

In another version—the ZX-88—the CPU in the ZX-85 is replaced by an 8088 for execution of 8086 code over the 8-bit Multibus. The monitor on the board may be exchanged for one compatible with the CP/M-86 operating system available from the ZX-85's manufacturer.

A single ZX-85 costs $2,660 and is available in four weeks.

Zendex Corp., 6680 Sierra Lane, Dublin, Calif. 94566. Phone (415) 829-1284 [377]

Thinking about Color for Avionics Displays? Think Syntronic Deflection Yokes

Cockpit displays in color are the hottest thing in avionics. Why? Because color increases the amount of information a pilot can absorb in a finite time frame. Think of the myriad uses of color. Emergencies or targets highlighted by red. Normal status is white or green. Sky shown in blue with the ground in brown tones. Almost anything displayed mechanically now can be displayed on a color CRT, with no parallax, a condensed format and less clutter on the instrument panel.

But color displays are many times more complex than monochromatic displays because of the critical interface between CRT, yoke and circuitry. And avionic quality displays are too demanding for conventional color TV type yokes.

That's where Syntronic helps the display engineer. For several years, Syntronic Instruments, Inc., the leader in precision yokes for military and industrial displays has been working with major international manufacturers of full-color shadow mask tubes to develop high performance color yokes. High resolution, color purity and convergence, along with faster speed for more display information, all combine to make deflection yoke design a truly challenging task. Syntronic now offers the yoke design capability *and* the technical assistance needed for today's and tomorrow's top quality color avionics displays.

If you're thinking *color*, think Syntronic Instruments. Call Dave Brown at 312—543-6444 for more information.

syntronic Precision yokes for exacting displays

Syntronic Instruments, Inc., 100 Industrial Road, Addison, IL 60101 (312) 543-6444

Circle 87 on reader service card

The assignment: offer a reliable switch element capable of evolving into a variety of specialized key- and rocker switch designs.

The result: ITT Schadow's Disc Switch.

At ITT Schadow, we specialize in taking basic switch designs and changing them to fit your specific applications. We've built a reputation on our awareness that the first two syllables of "customer" are "custom."

Customized adaptations work best when they're based on products with a proven record of reliability. Our popular Disc Switch is a case in point. When depressed, its upper dome-shaped diaphragm flattens to make positive contact with a lower diaphragm over a broad circular contact area. This simple, sturdy design has a rated service life of up to 10,000,000 cycles. Schadow's Disc Switch is available as a basic switch element, in a variety of standard packages as shown, and in custom packages. You can choose from a selection of colors and graphics.

Over the past two decades, we've made millions of pushbutton, key-, rocker, and rotary switches for some of America's largest consumer and industrial OEM's. We are your "creative switchmaker" with the ability to design, adapt, and manufacture switches for nearly every requirement.

Your ITT Schadow manufacturer's representative or distributor can tell you more. Or contact ITT Schadow Inc., a subsidiary of International Telephone and Telegraph, 8081 Wallace Road, Eden Prairie, MN 55344. Phone 612/934-4400, TWX 910-576-2469, Telex 29-0556.

ITT Schadow

Circle 68 on reader service card

Software

ISO Pascal puts out 8080 code

Compiler conforming to new standard runs on GenRad and Tek development systems

Pascal compilers had been making the rounds way before the recent approval of a Pascal compiler standard by the International Standards Organization. But if those established compilers are to meet the new standard, some backtracking is necessary. Cogitronics Corp. is among the first to offer an ISO implementation of the Pascal language and is doing so with microprocessor system software development applications specifically in mind.

Cogitronics Pascal is available for GenRad 2300 and Tektronix 8002A and 8550 development systems, using their standard environments. The Cogitronics compiler now produces the assembly language of 8080, 8085, and Z80 processors, but expansion to other popular 8- and 16-bit target processors is currently under way.

Cogitronics Pascal allows modular compilation, dynamic memory allocation and deallocation, external procedures, and numeric operations conforming to the IEEE standard for single-precision floating-point math. The language statements are compiled directly into the assembly language of the target processor with no intermediate steps.

Using block-structured programming techniques, users of the compiler can design Pascal procedure modules that can be developed individually and compiled separately into assembly language. They can then be assembled, debugged, and integrated into the system under development.

A complete Pascal run-time support subsystem is included with the compiler. Its modular segments can be tailored by users to fit particular system applications. The segments include run-time stack definition, data-manipulation routines, dynamic memory allocation and deallocation procedures, real-number manipulation routines, error-handling routines, and either standard or customized input/output procedures.

Operating modes. Cogitronics Pascal has two modes of operation: error scan and full compilation. On a Z80-based GenRad 2300 system, the error-checking mode can scan the source code to detect syntax errors at the rate of 2,200 Pascal source lines per minute. On the same system, the full compilation mode produces both assembly language and listing outputs at the rate of 800 lines/min. The listing output contains a symbol cross-reference table.

The price for a single-system license for the Cogitronics Pascal is $2,000. This includes the compiler on a suitable medium, a Cogitronics notebook, installation and operating instructions, and a reference manual. Included in the license price is the right to distribute products that are created with the compiler. Leasing arrangements are also available. Customer demonstration kits that allow users to write small Pascal programs, compile them, and assemble, link, and execute the compiler output on their development systems are priced at $50. They include a demonstration diskette and programs. The Cogitronics Pascal Reference Manual, which is included in the kit, is also available separately for $15.

Cogitronics Corp., 5470 N.W. Innisbrook Place, Portland, Ore. 97229. Phone (503) 645-5043 [341]

ISO Pascal serves 16-bit microcomputers

For systems designers who already use a GenRad 2300 universal development system and who want to develop programs for such 16-bit microprocessors as the Motorola 68000 and the Intel 8086, GenRad is offering a Pascal compiler that, like the Cogitronics compiler featured, conforms to the Pascal standards of the International Standards Organization. The compiler, which produces assembly source code as its output, can be added to the 2300 at approximately $1,500 per copy. Additional software support for the 16-bit processors includes an object program linker, screen-based editor, interactive debugger with disassembly and symbolic debugging, and command control language. Write to GenRad Development Systems Division, 5730 Buckingham Parkway, Culver City, Calif. 90230, or phone (213) 641-7200. [342]

VisiCalc with graphics offered for HP-85 computer

A program that simplifies arranging and manipulating data in tables, VisiCalc from Personal Software Inc., is now being offered for the HP-85 personal computer as VisiCalc Plus. The new version allows users to turn VisiCalc tables into four-color graphics. It also features more than 20 functions not available on other VisiCalcs, including financial, statistical, and math functions such as internal rate of return, standard deviation, and variance. The program will be sold in tape cartridge and disk form for $200 by computer stores and dealers that sell the HP-85. A 16-K-byte memory module must be plugged into the computer to run VisiCalc Plus, in addition to an external plotter. The program is supplied under license from Personal Software Inc.

Hewlett-Packard Co., 1507 Page Mill Rd., Palo Alto, Calif. 94304 [344]

Tektronix adds nine programs for 4050 desktop computers

Tektronix is adding nine new programs to its Plot 50 library of software written especially for use with its 4050 series of desktop computers. Included in the offering are programs for creating graphs, drawing,

preparing documents, doing statistics, planning, management, and digitizing. Since the programs in the Plot 50 series have standard file formats for data and pictures, information can be shared among several of them without reformatting the data sets or reentering data for different programs.

The new products in the line are user-oriented. Most are menu-driven or include built-in tutorials so they can be learned by a first-time user within an hour.

The programs are sold separately at prices between $800 and $4,000. For example, the project management package (distributed under license from Sheppora Software Co.) sells for $4,000; the document preparation package sells for $800; and the interactive digitizing package and picture composition software are priced at $1,500 apiece.

Tektronix Inc., P. O. Box 500, Beaverton, Ore. 97077 [343]

Microcomputer PL/1 gets record-retrieval system

The BT-80 is a comprehensive single-user record-retrieval system designed for use with the PL/1-80 language, the first microcomputer adaptation of the PL/1 originally designed for IBM mainframes. BT-80 is to be used in PL/1-80 applications where single- or multi-keyed access to data records is required. The facilities of the new system may be accessed from PL/1-80 or assembly language application programs via two BT-80 system procedures that handle all data file and index maintenance. This frees the user to concentrate on application details.

The BT-80 record-retrieval software program runs on CP/M version 2, MP/M, and CP/Net operating systems and requires the PL/1-80 runtime library and Link-80 linkage editor to operate. It is available now for $200. The manual costs $25.

Digital Research, P. O. Box 579, 801 Lighthouse Ave., Pacific Grove, Calif. 93950. Telephone Curt Geske at (408) 649-3896 [345]

THIS NEW DATA I/O 6800 FAMILY TESTER CAN SAVE YOU A LOT MORE THAN IT COSTS.

Reject bad devices before they get into your production line. Everytime a faulty microprocessor or peripheral chip slips into one of your products it costs you profit in troubleshooting and replacement.

With the new Data I/O Model 1500A, you can set up a low-cost incoming inspection program to detect faulty 6800 family devices before they get loaded into boards.

Comprehensive testing detects problems in 6800, 68A00, 68B00, 6802, 6808, 6810, 6821 and 6850 devices. The Data I/O 6800 family tester performs a full-functional test on devices under worst case load and supply voltages at real time speed in less than one second.

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Reduce parts shortages and ease device returns. You don't have to reject an entire lot because of a few bad components.

With the 6800 family tester you can quickly and efficiently screen all devices to make the best use of the components you have.

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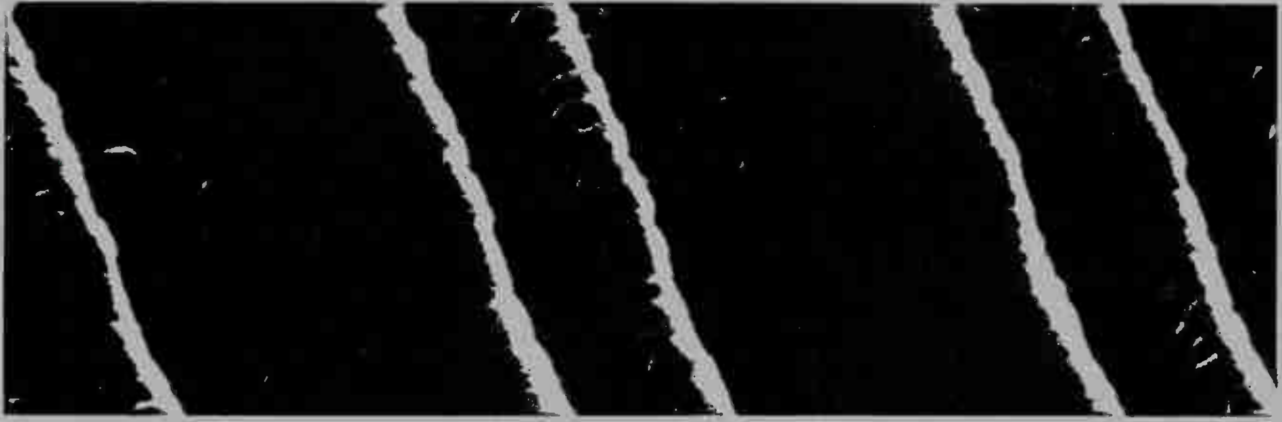
Backed by Data I/O's commitment to quality and performance. We've put the same care and engineering skill into the Model 1500A that we put into our entire range of PROM and logic device programmer products. The Model 1500A has been evaluated by device manufacturers and recognized as a viable test method. Each unit is backed by Data I/O's worldwide network of sales and service personnel.

Find out more about this remarkable new approach to testing by circling the reader service number or contacting Data I/O, P.O. Box 308, Issaquah, WA 98027. Phone 206/455-3990 or TOLL FREE 800/426-9016.

DATA I/O

Circle 84 on reader service card

UV-3...higher resolution with the Micralign® 200 Series.



1.0 micron lines over 0.8 micron aluminum steps.

Now you can achieve 1⅛ micron resolution with Perkin-Elmer's Micralign 200 Series Projection Mask Alignment Systems with the new UV-3 option. It provides an exposing wavelength of 3000Å by capitalizing on:

- The diffraction-limited, all-reflecting projection optical system
- Specially designed optical coatings
- UV emission of the mercury lamp

The UV-3 option provides 1⅛ micron resolution while maintaining good process latitude and the high thruput that is characteristic of Perkin-Elmer Micralign systems.

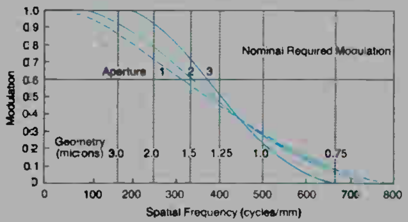


Figure 1. Model 200 (4000 Angstroms)

With diffraction-limited optical systems, resolution is inversely proportional to the exposing wavelength without a sacrifice in depth of focus. Figures 1 and 2 illustrate the improved resolution, as a function of partial coherence, of the UV-3 option as compared to a

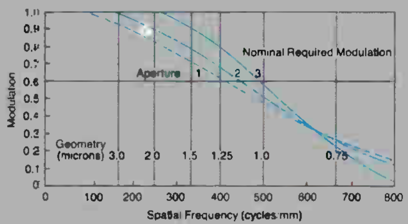


Figure 2. Model 200 UV-3 (3000 Angstroms)

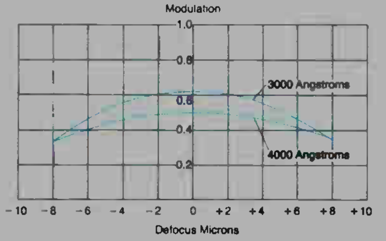


Figure 3. Diffraction-limited modulation. 1.5 micron lines and spaces (333 cycles/mm) with incoherent illumination

standard 200 Series exposing at the standard wavelength. The modulation for very small feature sizes is significantly improved.

Figure 3 illustrates the critical fact that the use of shorter exposing wavelength to obtain greater resolution does not sacrifice depth of focus.

The UV-3 option can be ordered on any model of the Micralign 200 Series. This lets you select the correct Micralign instrument for your application.

You would expect a higher performance feature like the UV-3 to come from Perkin-Elmer. Improvement to current models, as well as development of the next generation of IC production equipment, are major on-going activities at Perkin-Elmer.

The UV-3. A technological advance that gives you the competitive edge — from Perkin-Elmer. For more information, write the Perkin-Elmer Corporation, Microlithography Division, 50 Danbury Road, Wilton, Connecticut 06897, or call (203) 762-6057.

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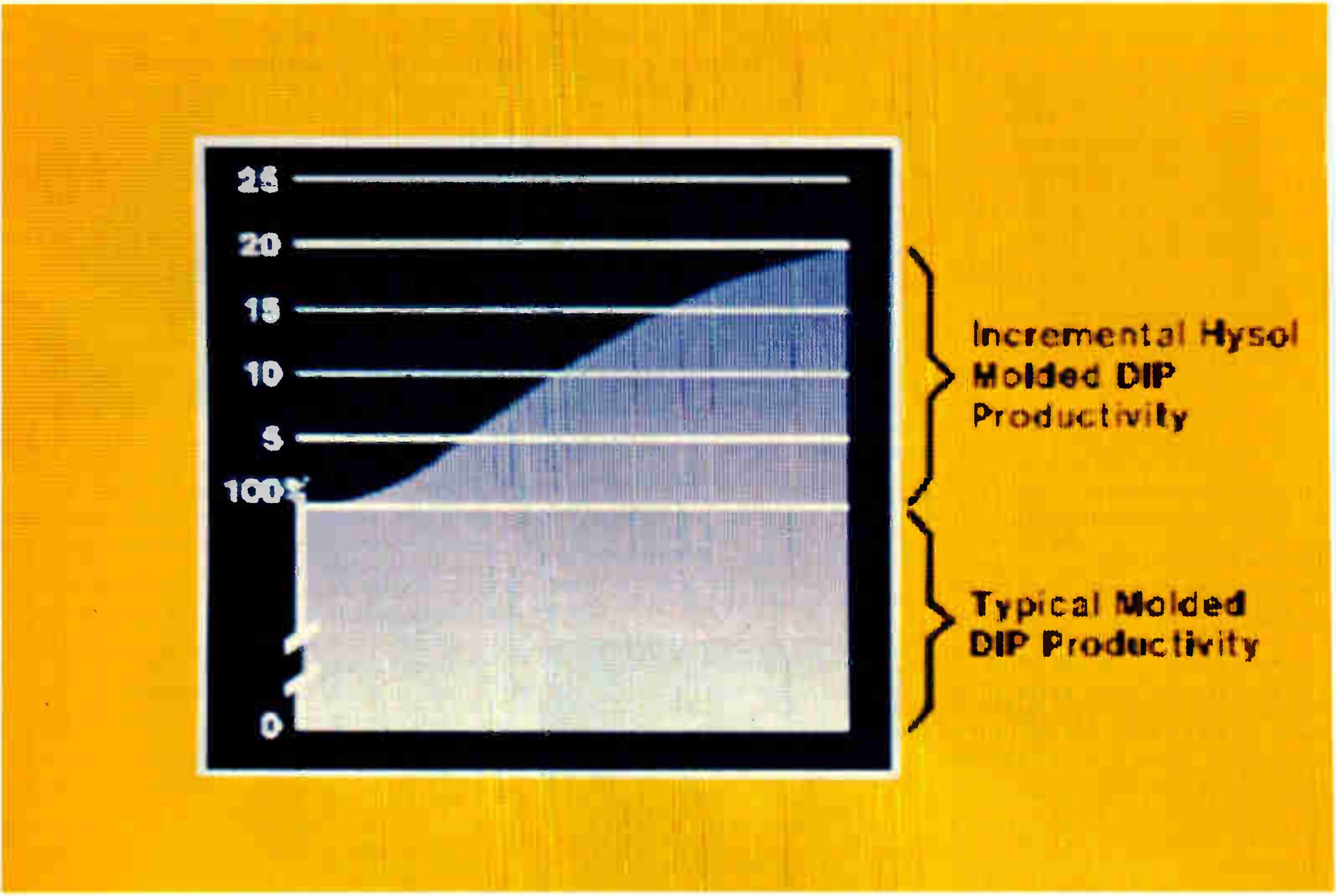

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Circle 110 on reader service card

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TRA-CON Inc., 55 North St., Medford, Mass. 02155. Phone (617) 391-5550 [477]

A nickel-graphite adhesive coating, Plasticoat EC-136 is made of nonoxidizing, chemically inert graphite and nickel particles, antioxidants, adhesion promoters, and wetting agents blended in an oxidation-resistant polymer. The coating is designed to provide electromagnetic and radio-frequency interference shielding in a frequency range not completely covered by either graphite or nickel coatings. The graphite portion of the coating protects in the 50-to-450-MHz frequency range; the nickel portion protects at higher frequencies.

Plasticoat EC-136 adheres to most polymeric surfaces without pretreatment and is resistant to abrasion and environmental conditions.

Plastic Systems Inc., 88a Ellsworth St., Worcester, Mass. 01608. Phone (617) 799-2600 [478]

A thixotropic plastic adhesive, Aremco-Bond 515 can adhere to ceramics, glass, mica, and many other plastics. It can be used as an electrical insulator and in joining dissimilar materials such as ceramic or glass and metal. Aremco-Bond 515 has a thick, butterlike consistency, so it can be applied to vertical surfaces without dripping. It is cured at 450°F in 15 minutes. It can be spread with a spatula or injected using automatic dispensers and is available from stock at $30.00 per pint, $45.00 per quart, or $135.00 per gallon.

Aremco Products Inc., P. O. Box 429, Ossining, N. Y. 10562. Phone (914) 762-0685 [479]

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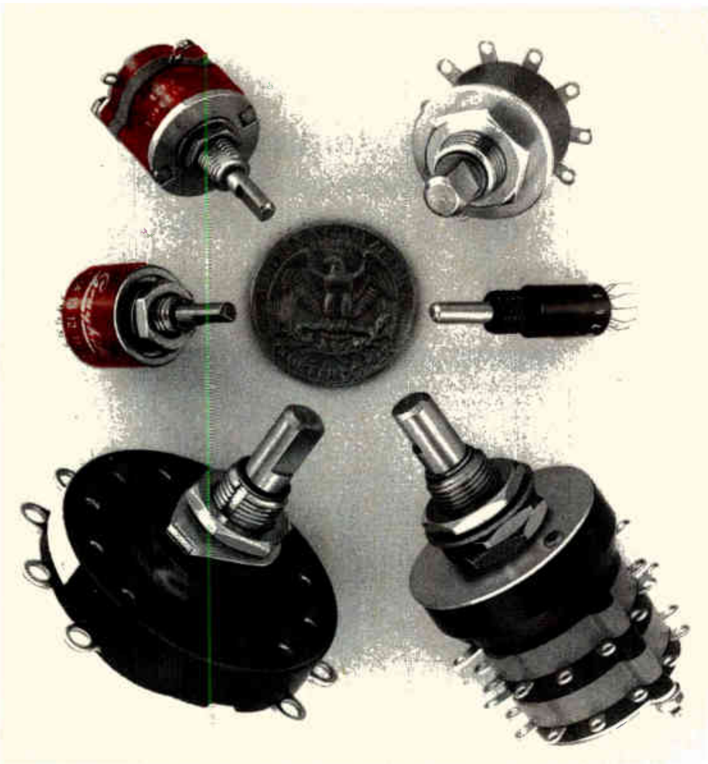

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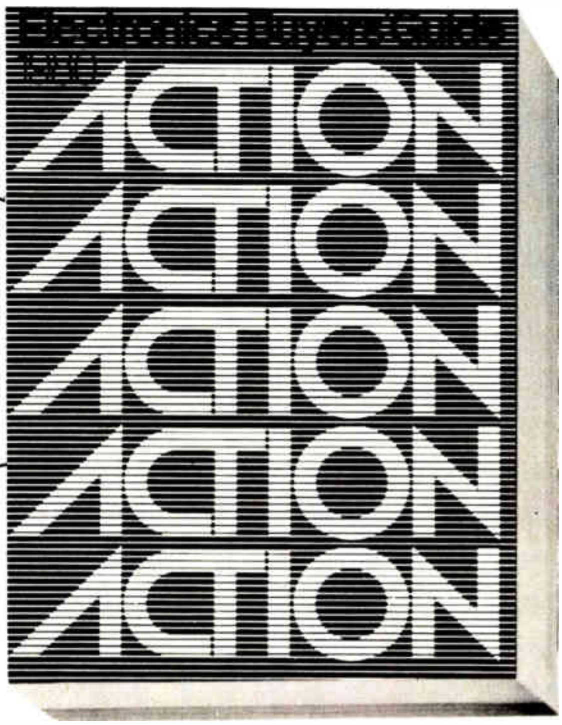

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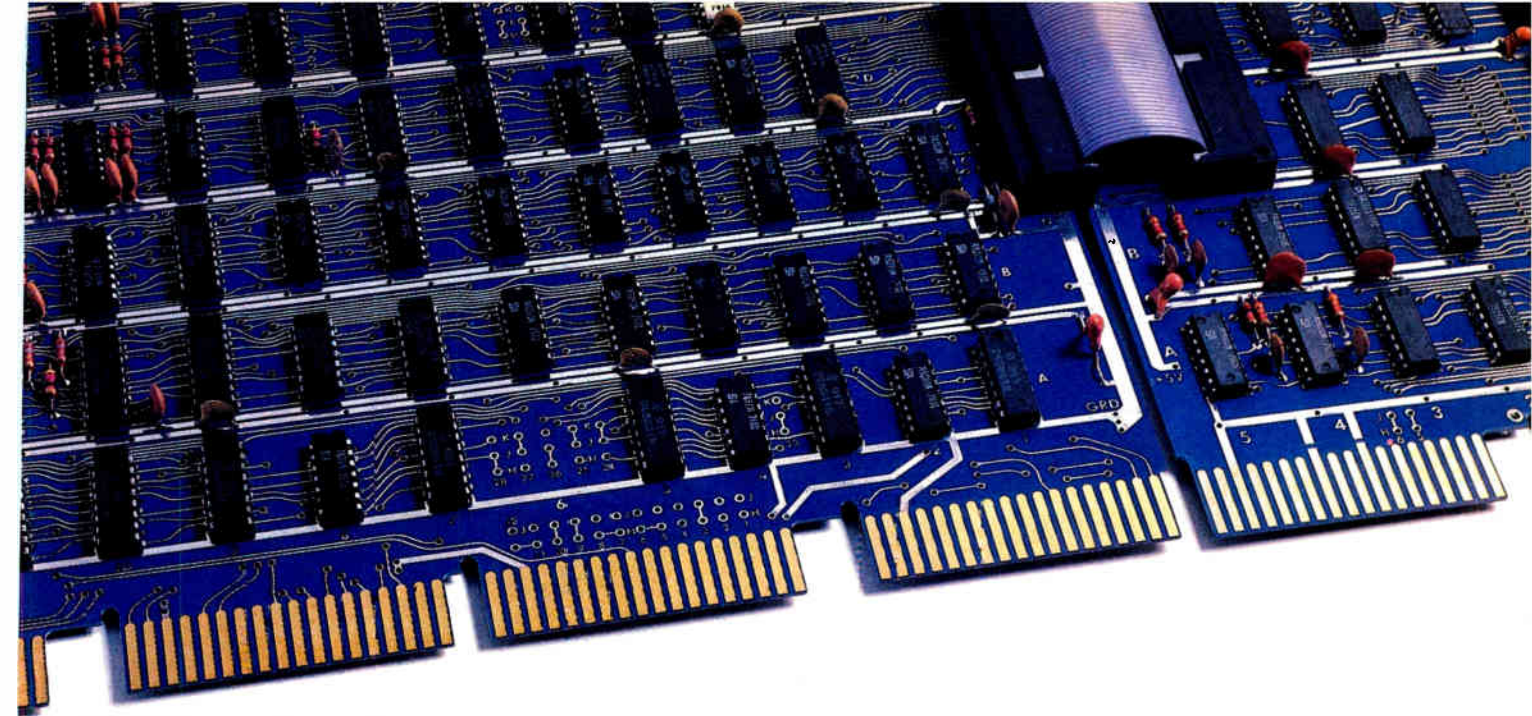

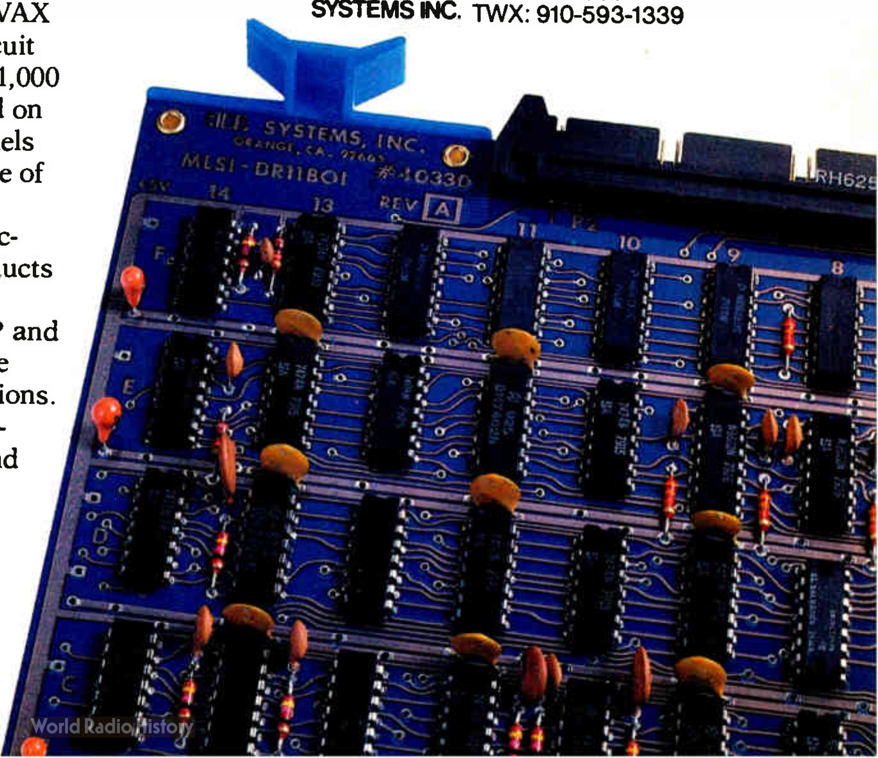

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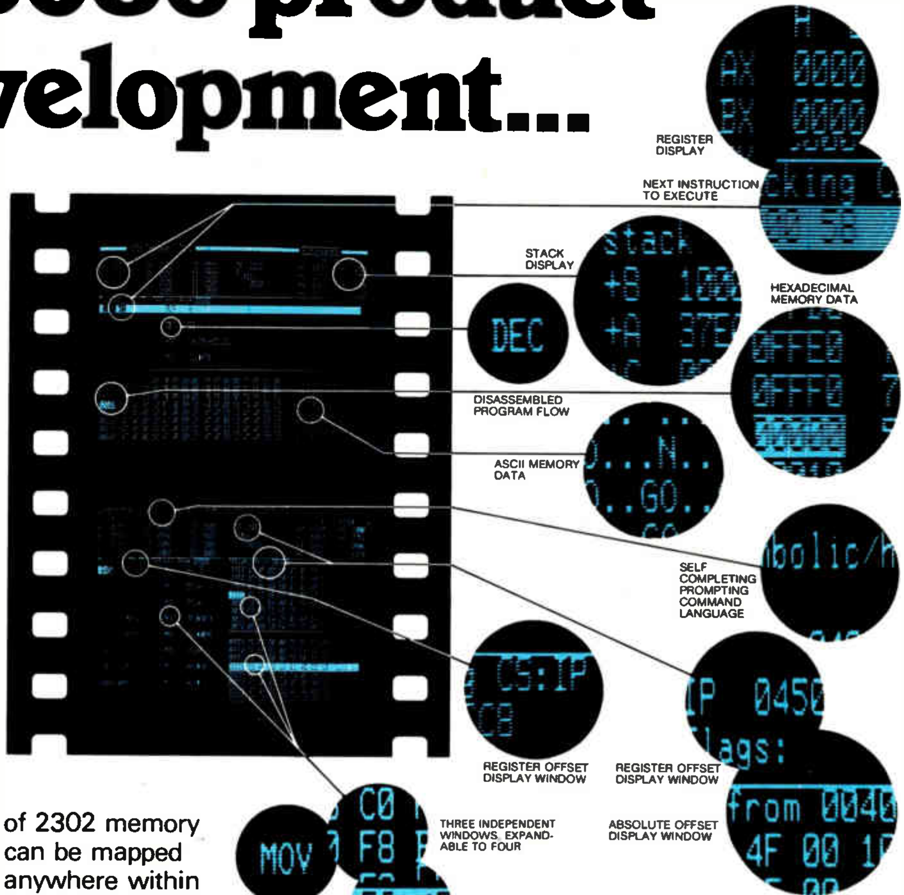

the GenRad Slave Emulator

Our slave emulator thinks and acts just like the 8086 microprocessor. At the same speed. Without interruption. And so transparently that your prototype may never know there's an "actor" in the circuit. In fact, no other emulator can play this 16-bit part so well. Because the 2302 accesses its "lines" via a separate processor-memory bus. Emulator and development system (or network station) operate independently and simultaneously. The resources of your target processor aren't needed for debugging. Programs are executed at full 8086 speed from an internal or prototype clock. Without wait states or other timing constraints. Up to 512k bytes of 2302 memory can be mapped anywhere within your prototype's address space. Without restrictions on control line use or interrupts.

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The 2302 allows you to view your program in single-step, snapshot or logic analyzer modes. In a format that matches your needs even for the most complex memory segmentation, interrupt driven or multi-processor environments. With the 2302 your stage is set for bigger and better hardware developments. For simultaneous emulation of multiple processors. For other 16-bit parts (68000), 8-bit parts (6809) and for processor cessors in the wings (Z-8002).

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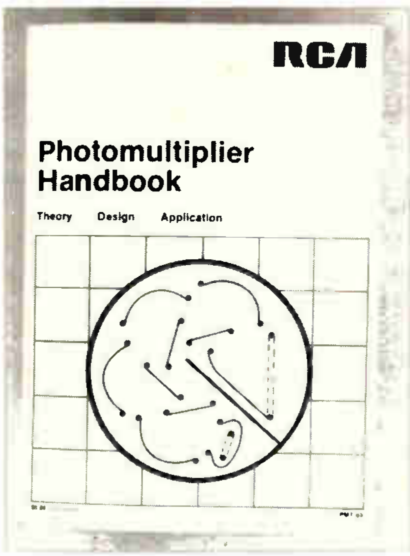
New literature

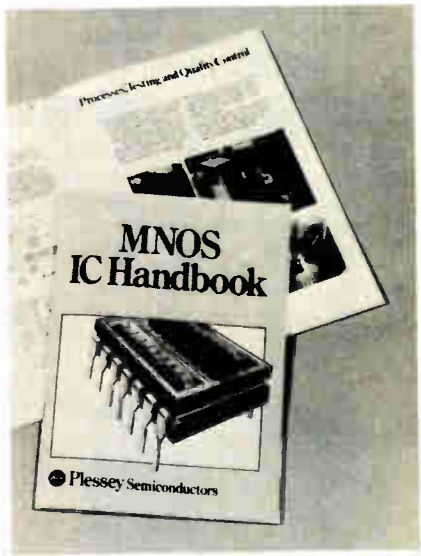
Switches. A 32-page catalog describes a line of thumb-wheel, lever-wheel, and push-wheel switches. It covers operating principles, actuation, mounting, wiring, switch characteristics, electrical loads, legends, color, and finish and includes drawings and specifications for 23 different types of switch. A "Quick Select" reference chart with ordering information such as output codes, truth table identification, number of switch positions, and part numbers will be included with the catalog. For a copy of catalog No. CE-666, write to Cherry Electrical Products Corp., 3600 Sunset Ave., Waukegan, Ill. 60085. Circle reader service number 421.

Photomultipliers. "Photomultiplier Handbook" discusses the design, construction, and operating theory of photomultipliers, as well as their



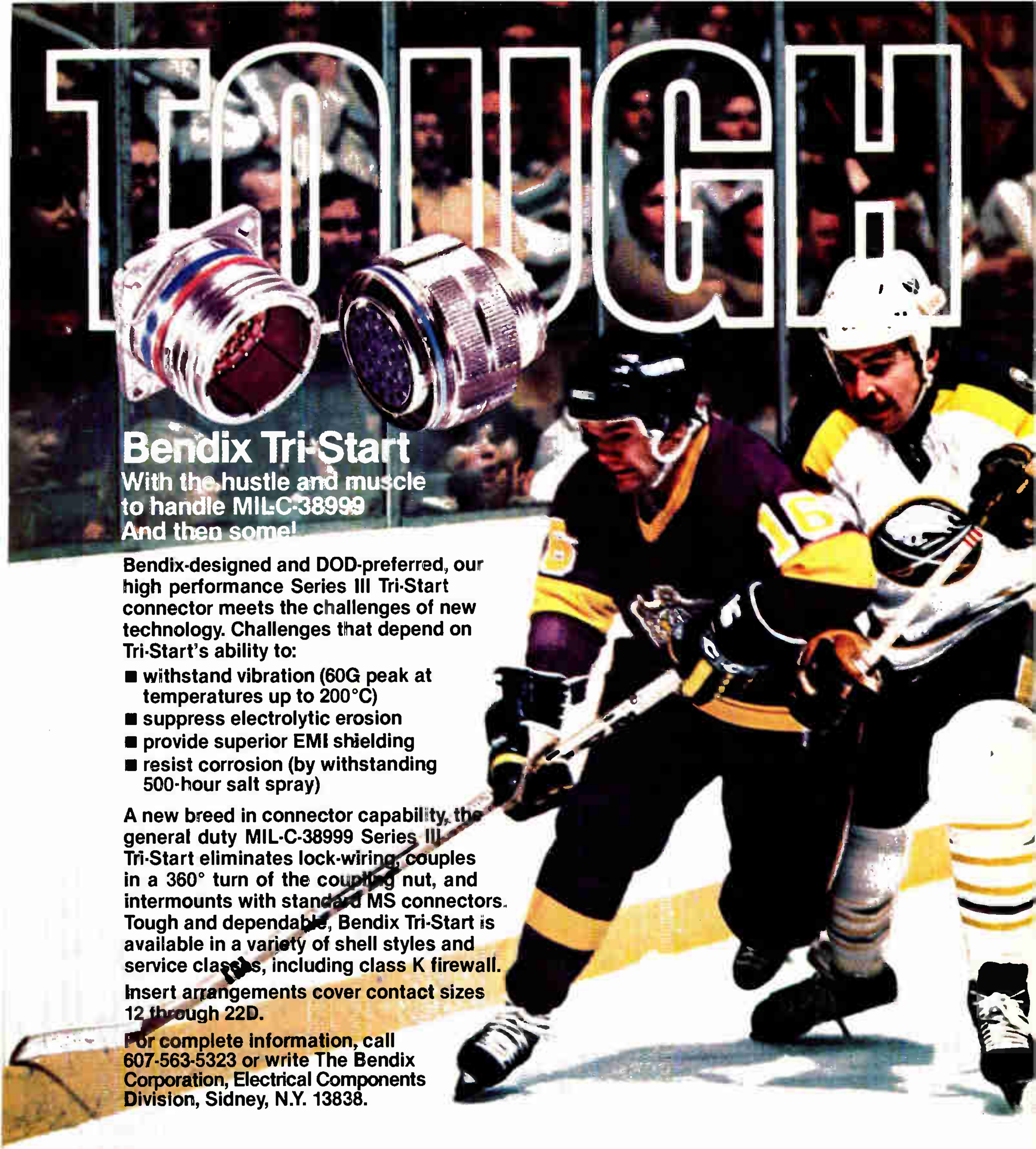
characteristics relating to the photocathode, gain, dark current and noise, time effects, pulse and scintillation counting, and environmental conditions. It presents, in 180 pages, applications including Cerenkov radiation detection, time spectroscopy, oil-well logging, gamma-ray cameras, computerized tomographic X-ray scanners, positron cameras, photometry, spectrometry, Raman spectroscopy, fluorometry, laser range finding, and image scanning. The appendix contains: a glossary of terms; sections on light and radiant energy measurement, spectral response designation systems, photometric and radiometric units, spectral matching, and radiant energy sources; and a selection guide. A copy of the handbook, PMT-62, can be obtained for $5.00 by sending a check or money order to RCA Electro-Optics and Devices, Box 3200, Somerville, N. J. 08876 [422]

Integrated circuits. "MNOS IC Handbook" contains information on metal-nitride-oxide-semiconductor integrated circuits and discusses the



applications of nonvolatile logic. The 60-page handbook covers power-on and power-off circuits, elapsed time indicators, last program memories, and eight- and six-decade counters. Technical data on nonvolatile logic—such as electrical characteristics, operating notes, antistatic precautions, package details, absolute maximum ratings, and switching characteristics—is provided. Block diagrams, graphs, and tables illustrate the book. Plessey Semiconductors, 1641 Kaiser Ave., Irvine, Calif. 92714 [423]

Computer graphics. The Harvard "LAB-LOG 1980" describes and explains nine different programs and more than 70 publications related to computer graphics and geographic information systems and lists avail-



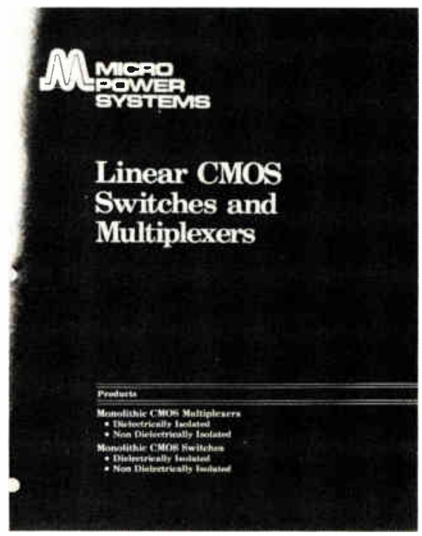
We speak connectors.

Bendix

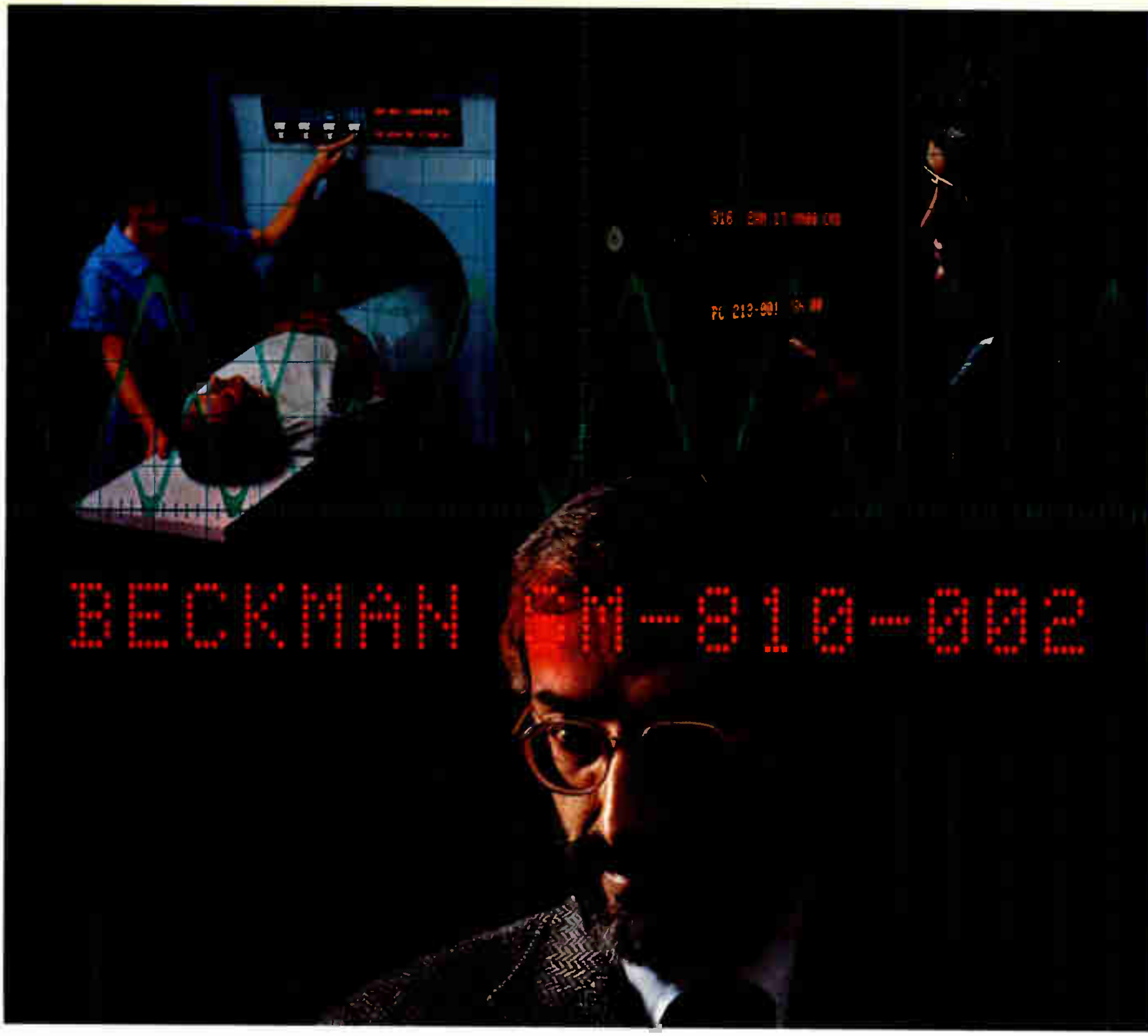
New literature

able cartographic data bases. Some of the programs are KWIC, a general-purpose bibliographic processing system; Gimms, a general-purpose, user-oriented thematic mapping system; and MDS(X), a collection of multidimensional scaling algorithms linked together under one command language. The 32-page catalog provides general background information such as the history and capabilities of the Laboratory for Computer Graphics and Spatial Analysis. For a free copy, contact the aforementioned laboratory at the Graduate School of Design, Harvard University, 520 Gund Hall, Cambridge, Mass. 02138 [424]

C-MOS switches and multiplexers. Monolithic complementary-MOS multiplexers and switches, both dielectrically and nondielectrically isolated, are listed in a 56-page catalog. The switches and multiplexers are compatible with TTL and diode-transistor logic, as well as with C-MOS.



"Linear C-MOS Switches and Multiplexers" gives detailed information on each device, including features, functional diagrams, truth tables, ordering information, performance and switching characteristics, test circuits, and absolute maximum ratings. The catalog also contains packaging dimensions and bonding diagrams; it describes the advantages of C-MOS and the dynamic performance of C-MOS switches. Terminology and typical C-MOS switch applica-



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The SM-810-002 is the second in a series of dot matrix display systems. Its field of 20 half-inch characters provides outstanding viewability as a result of 75fL typical brightness and a 130° viewing angle. Like its predecessor, the 40 character SM-810-001, it is microcomputer controlled. It can be used in process control, instrumentation applications, business equipment and a variety of terminal, as well as other OEM designs, including point-of-sale equipment, industrial controls and computer peripherals.

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All of the operational features of the SM-810-002 are the same as those of the 001; however, the larger characters of the 002 appear brighter and, of course, can be read from greater distances.

Both display systems have the ability to blink a field that includes 96 standard ASCII symbols and the degree sign, plus the Greek letter "Mu." In addition, the SM-810-002 accommodates left-to-right data entry. Mounted on a compact PC board, it incorporates a custom masked μC with 1K of ROM. Powered by a single 5V supply, the SM-810-002 dissipates only 8.75W (typ).

The microcomputer's built-in intelligence simplifies the setup of special messages: An operator can completely blank, and then unblank, the display to generate a message immediately; or, can scroll a message from right-to-left. A self-test feature is also included.

For complete details, write: Display Systems Division, Beckman Instruments, Inc., 350 N. Hayden Road, Scottsdale, AZ 85257.
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tions are discussed. Micro Power Systems Inc., 3100 Alfred St., Santa Clara, Calif. 95050 [425]

Circular connectors. Amphenol 97 and 69 series standard circular connectors are featured in a 36-page catalog. "Amphenol standard circular connectors" contains a guide to circular connector selection that includes considerations about environmental capabilities, wire gauges, plug and receptacle requirements, shell-type needs (solid or split), socket location, and finish options. A chart summarizes circular connector styles such as wall, cable, and box receptacles, and straight, quick-disconnect, and angle plugs. Amphenol North America Division, Bunker Ramo Corp., 2122 York Rd., Oak Brook, Ill. 60521 [426]

Data converters. An eight-page catalog describes more than 65 data-conversion products. Technical data and specifications for analog-to-digital, digital-to-analog, synchro-to-digital, and resolver-to-digital converters are given. Also covered are data-bus products, sample-and-hold and track-and-hold amplifiers, control transformers, and synchro instruments, with a description of ILC Data Device Corp.'s capabilities and facilities. Postage-paid cards are provided for additional information or assistance. This short-form catalog can be obtained from the Marketing Department, ILC Data Device Corp., 105 Wilbur Pl., Bohemia, N. Y. 11716. [427]

Digital signal-processing designs. The differences between a discrete Fourier transform and a fast Fourier transform are explained in a 45-page catalog. "An Introduction to Digital Spectrum Analysis including a High Speed FFT Processor Design" by Richard J. Karwoski, describes the decimation-in-time FFT, the design of a high-speed FFT processor, the address-generation system, and the design of FFT sequencers using single-chip microprogram sequencers. TRW LSI Products, 2525 E. El Segundo Blvd., El Segundo, Calif. 90245. [428]

MIL-SSR UPDATE

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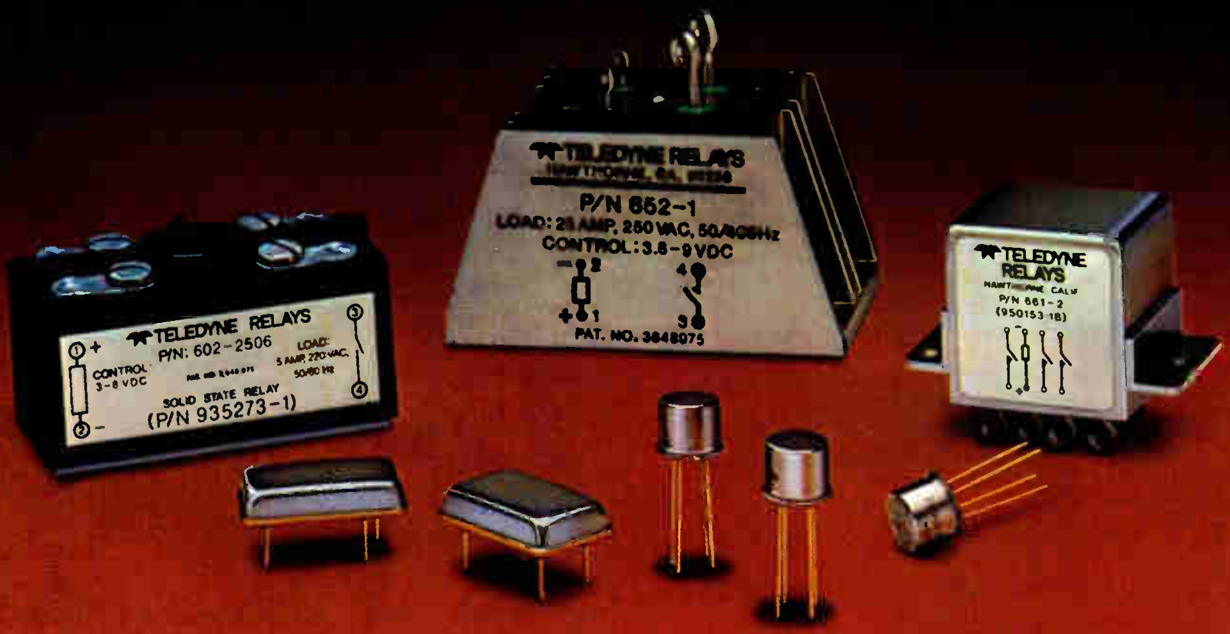

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Circle 140 on reader service card

Products Newsletter

National provides development support for NSC800

National Semiconductor Corp. will soon make available development support for its NSC800 8-bit microprocessor family, which combines the powerful instruction set of the Z80 with the compact bus structure of the 8085 in chips made with a new high-performance double-polysilicon complementary-MOS (P^2C-MOS) process. The support offering **includes: an integral in-system emulator (ISE) package** that plugs directly into the Santa Clara, Calif., firm's Starplex development system and consists of two boards giving the user 32-K bytes of tracing and mapped memory; and an emulator package, consisting of a target board and cable pod that provide the physical and electrical interface between the ISE package, Starplex, and the NSC800-based system under development.

Cherry will make Exar's I²L master slices

Exar Integrated Systems Inc. of Sunnyvale, Calif., has entered into an agreement with Cherry Semiconductor Corp. for the Cranston, R. I., firm to second-source Exar's integrated-injection-logic master slices by March 1981. The family of four semicustom chips, designated XR-200, -300, -400 and -500, are **customized into monolithic large-scale integrated circuits with the addition of three custom mask layers** and can accommodate circuit complexities of from 200 to 500 gates.

Burndy's DIP sockets can now be inserted by machine

To meet the particular demands imposed by machine insertion, Burndy Corp.'s Components division in Norwalk, Conn., has made minor modifications on its DILB sockets for dual in-line packages. The changes, which involved a strengthening of the standoff and its relocation inward to reduce lead length, have not increased the cost of the sockets, nor have they affected their use in hand-assembly operations. Instead, the changes ensure that **the sockets will be accepted by all the machines made by the three leading insertion equipment suppliers:** Universal Instruments, Dyna/Pert, and Amistar Corp. The contact design of the sockets provides gas-tight, high-pressure interconnections for as little as 0.5 cent per line, says the manufacturer.

Price changes

- **Semi Processes Inc., Santa Clara, Calif.,** has reduced prices by as much as 55% on its SP7010 and SP7005 uncommitted logic arrays fabricated using the firm's proprietary selective-oxidation silicon-gate complementary-MOS process. The SP7010 1,000-gate devices in 40-pin plastic packages have gone from $45 to $36 apiece in quantities of 10 to 99 and from $18.50 to $12 in lots of 5,000 to 9,999. In similar quantities, the SP7005 544-gate arrays have gone from $40 to $20 and from $16 to $7.20, respectively. At the 2,500-piece level, the 2-cent-per-gate price for the 7010 rivals that of low-power Schottky TTL, yet the ULAs consume even less power.
- **Xicor Inc., Sunnyvale, Calif.,** has again reduced the prices of its X2201 5-V 1-K-by-1-bit nonvolatile random-access semiconductor memory from $48.75 to $25 each for purchases of 100-unit quantities.
- **Micro Switch, Freeport, Ill.,** has announced a 4% to 10% price increase on its manual products (including keyboards), basic switches, solid-state sensors, industrial products, and photoelectric and proximity controls. No price increases are being applied to pressure transducers.


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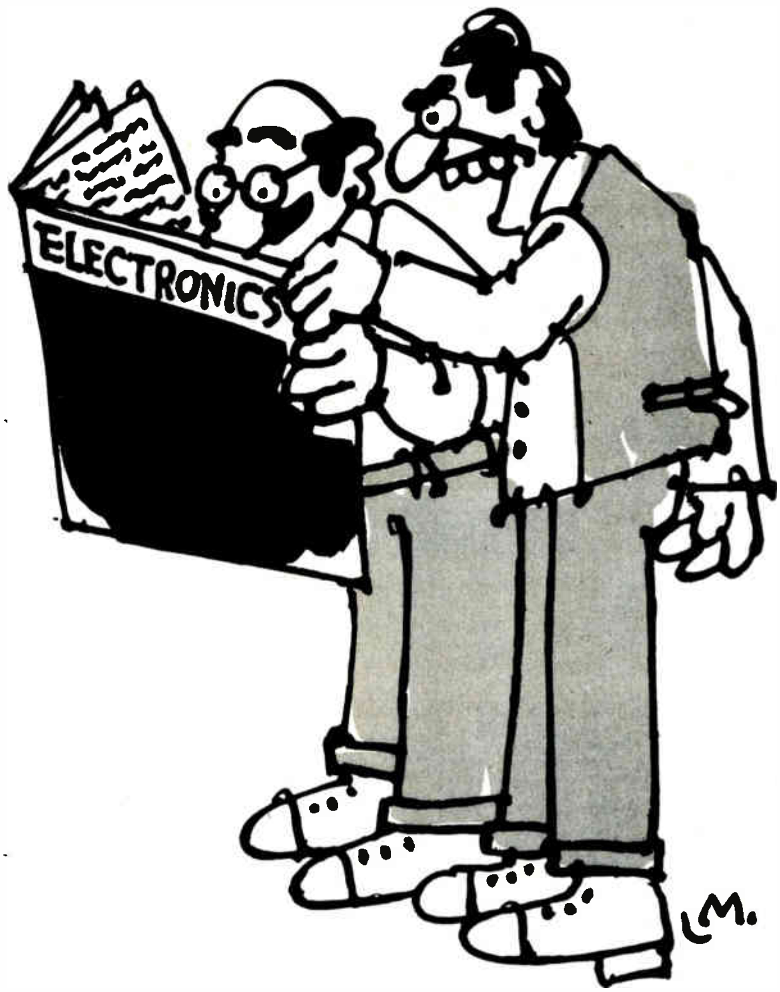

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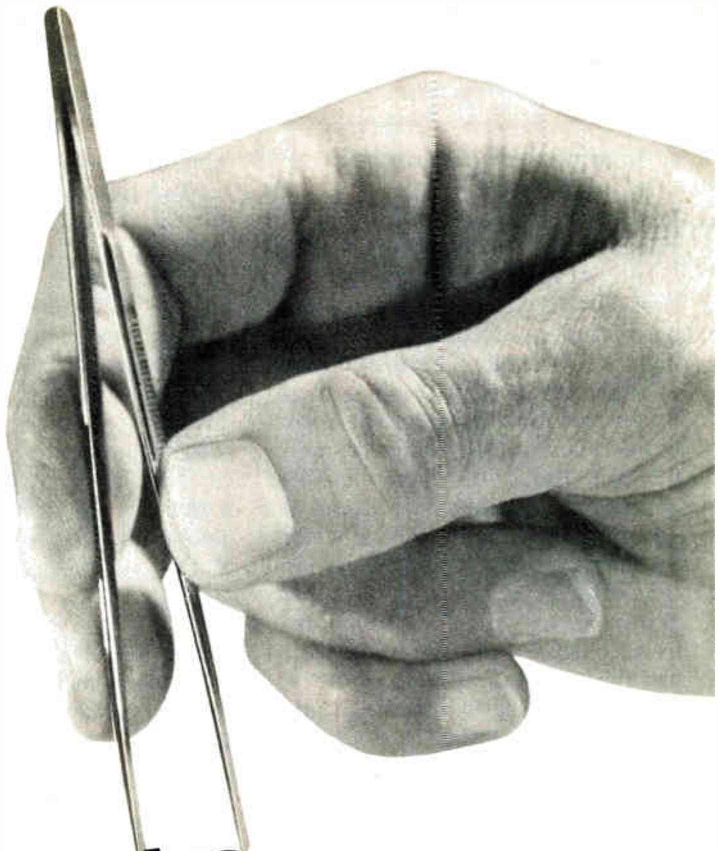

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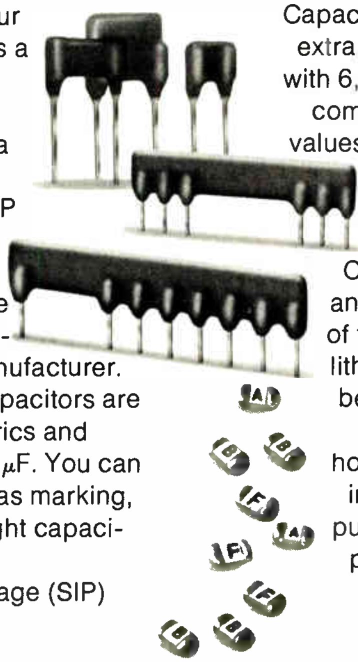

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Circle 151 on reader service card

Amendment causes uproar

■ A proposed amendment to the constitution of the Institute of Electrical and Electronic Engineers to create the office of president-elect and to move control of election timing from the members to the board of directors has passed, but just barely and amid a great deal of controversy among the tellers' committee, the board of directors, those opposed to the amendment, and the general staff at IEEE headquarters. The fuss started when the method of tabulating the votes came under close scrutiny and was found very loosely defined in the constitution and the bylaws.

Technically, it is possible to tabulate in one of two ways: the yea, nay, and blank ballots may comprise the total to be counted; or just the yeas and nays may be used, omitting the blank ballots. For an amendment to pass, two thirds of the ballots must be yeas.

In the case of the recent amendment, using the first tabulation method, 35,335 yea, nay, and blank ballots were cast, of which 23,333 were in favor of the amendment.

That represents somewhat less than the two thirds needed to pass. If the second method is used, leaving out the blank ballots, a total of 32,487 votes was cast, with over 70% in favor of the amendment.

This creates a dilemma for the tellers' committee, which is the body appointed by the IEEE's board of directors to oversee the election and referendum process. "We were specifically informed [according to the manual] to count the blank ballots," notes Robert E. Anderson, chairman of the committee. Furthermore, he notes that not only do the committee members have a responsibility to the board, but also to New York State as election inspectors to ensure that the election conforms to whatever state laws may be applicable in such cases.

The tellers' committee sought legal advice through the general staff at IEEE headquarters on the problem; the lawyers cited cases found in common law, such as public elections, where blank ballots are not counted.

The committee took a straw vote of 9 to 3 against passing the amendment because it did not receive two thirds of all ballots, including the blanks, cast.

The general staff thought differently and, interpreting the legal advice in another way, issued a statement that the amendment had passed. "We followed tradition by plugging in the numbers the tellers' committee gave us, and then sending out the results. The product of the tellers' committee has always been a count rather than an interpretation of what that count means," says Eric Herz, who has been general manager for the past two years.

Not so, argues Anderson, who points out, "I think a mistake was made, and they're covering it up. The board of directors did not meet before the announcement went out, and I think the decision was illegally reached."

Arbiter. To settle the dispute, the board of directors took the matter up at its general meeting in early December. After a 2-hour debate with legal counsel present and all sides given a chance to offer their views, the board voted 20 to 3 with 3 abstentions to pass the amendment. "The board of directors is the ultimate source of authority for the IEEE, and the board took the position that the amendment had passed," notes Leo Young, 1980 president of the institute.

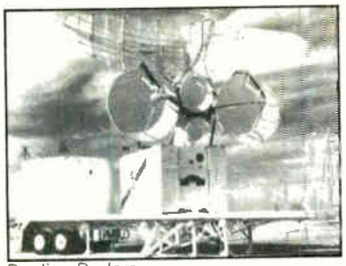
Members not happy with the outcome are appealing the decision using a variety of means. For Robert A. Rivers, an IEEE Fellow opposed to the amendment from the beginning [*Electronics*, Aug. 28, p. 337], the solution lies with the New York attorney general.

"I filed a complaint with the attorney general and I expect that other people will be joining me," says Rivers. His complaint lists a number of points:

- That 23,333 votes in favor of the amendment is not the required two thirds of 35,335 ballots.
- That the general manager caused statements to be issued saying that election officials verified passage of the amendment though the tellers' committee does not agree with these statements.
- That the general manager failed to withdraw his unauthorized statements.
- That improper parliamentary procedures were used by the board of directors at its meeting in December.
- That the board of directors has usurped the authority of the tellers' committee in upholding passage of the amendment.

Alex Gruenwald, a member of the tellers' committee, is working within the IEEE to find a solution to the problem. He has petitioned the board of directors to turn the matter over to the credentials committee to adjudicate. The credentials committee, appointed by the board, can declare the amendment void and call for another referendum if it finds the results were arrived at unsatisfactorily, notes Gruenwald. "The request to the credentials committee is an attempt to try to police our own affairs and get this mess cleaned up," he says. "Outside legal suits would be like washing dirty linen in public." **-Pamela Hamilton**

ELECTRONICS ENGINEERS: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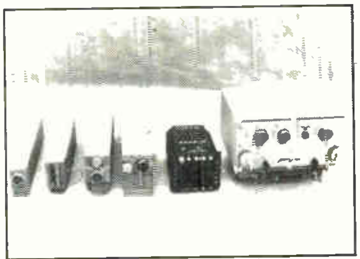
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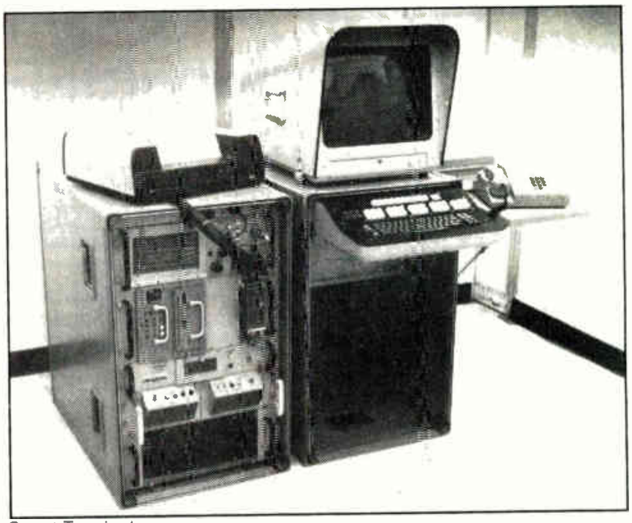
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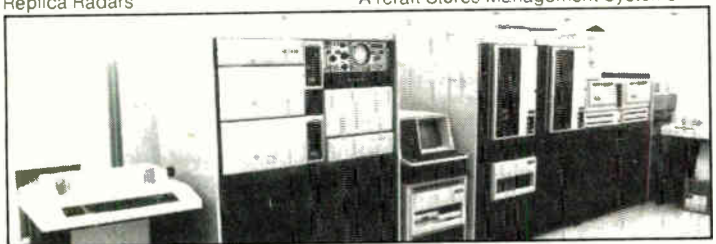
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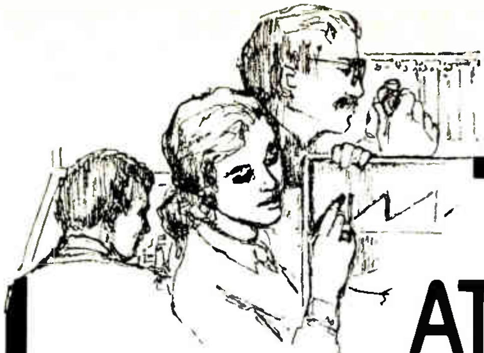

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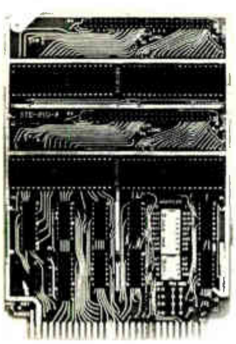

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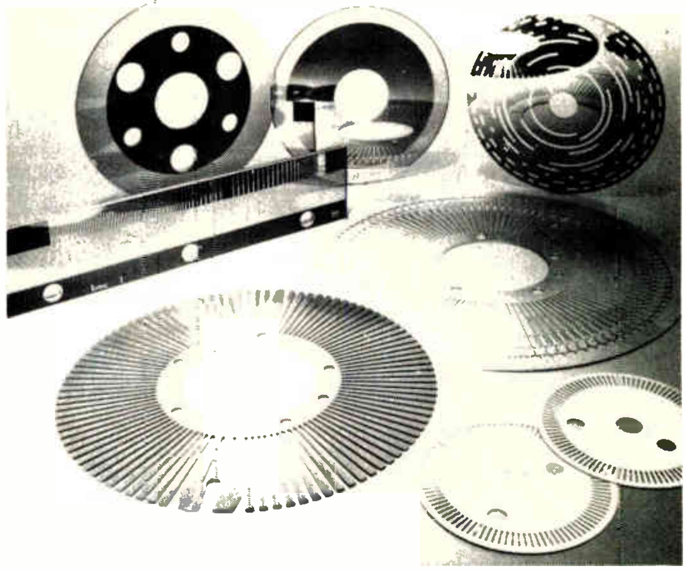

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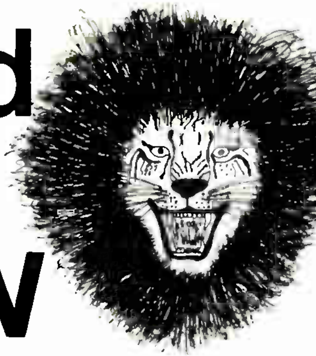

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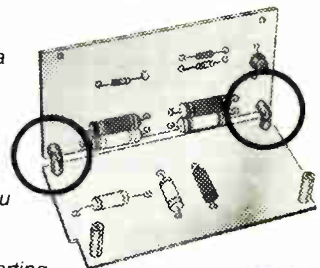

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1 16 31 46	61 76 91 106	121 136 151 166	181 196 211 226	241 256 271 348	363 378 393 408	423 438 453 468	483 498 703 718
2 17 32 47	62 77 92 107	122 137 152 167	182 197 212 227	242 257 272 349	364 379 394 409	424 439 454 469	484 499 704 719
3 18 33 48	63 78 93 108	123 138 153 168	183 198 213 228	243 258 273 350	365 380 395 410	425 440 455 470	485 500 705 720
4 19 34 49	64 79 94 109	124 139 154 169	184 199 214 229	244 259 274 351	366 381 396 411	426 441 456 471	486 501 706 900
5 20 35 50	65 80 95 110	125 140 155 170	185 200 215 230	245 260 275 352	367 382 397 412	427 442 457 472	487 502 707 901
6 21 36 51	66 81 96 111	126 141 156 171	186 201 216 231	246 261 338 353	368 383 398 413	428 443 458 473	488 503 708 902
7 22 37 52	67 82 97 112	127 142 157 172	187 202 217 232	247 262 339 354	369 384 399 414	429 444 459 474	489 504 709 951
8 23 38 53	68 83 98 113	128 143 158 173	188 203 218 233	248 263 340 355	370 385 400 415	430 445 460 475	490 505 710 952
9 24 39 54	69 84 99 114	129 144 159 174	189 204 219 234	249 264 341 356	371 386 401 416	431 446 461 476	491 506 711 953
10 25 40 55	70 85 100 115	130 145 160 175	190 205 220 235	250 265 342 357	372 387 402 417	432 447 462 477	492 507 712 954
11 26 41 56	71 86 101 116	131 146 161 176	191 206 221 236	251 266 343 358	373 388 403 418	433 448 463 478	493 508 713 956
12 27 42 57	72 87 102 117	132 147 162 177	192 207 222 237	252 267 344 359	374 389 404 419	434 449 464 479	494 509 714 957
13 28 43 58	73 88 103 118	133 148 163 178	193 208 223 238	253 268 345 360	375 390 405 420	435 450 465 480	495 510 715 958
14 29 44 59	74 89 104 119	134 149 164 179	194 209 224 239	254 269 346 361	376 391 406 421	436 451 466 481	496 701 716 959
15 30 45 60	75 90 105 120	135 150 165 180	195 210 225 240	255 270 347 362	377 392 407 422	437 452 467 482	497 702 717 960

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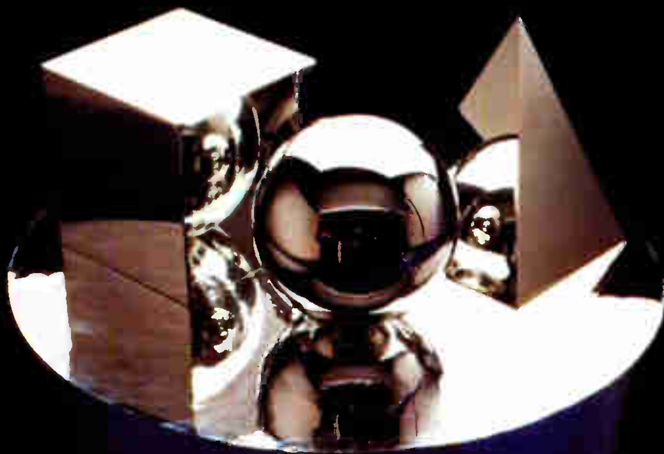

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