JUNE 9, 1977

HIGHLIGHTS OF THE NATIONAL COMPUTER CONFERENCE/164

Wider test set for cellular mobile communications/75

Microprocessors in action: a radio navigation system/147

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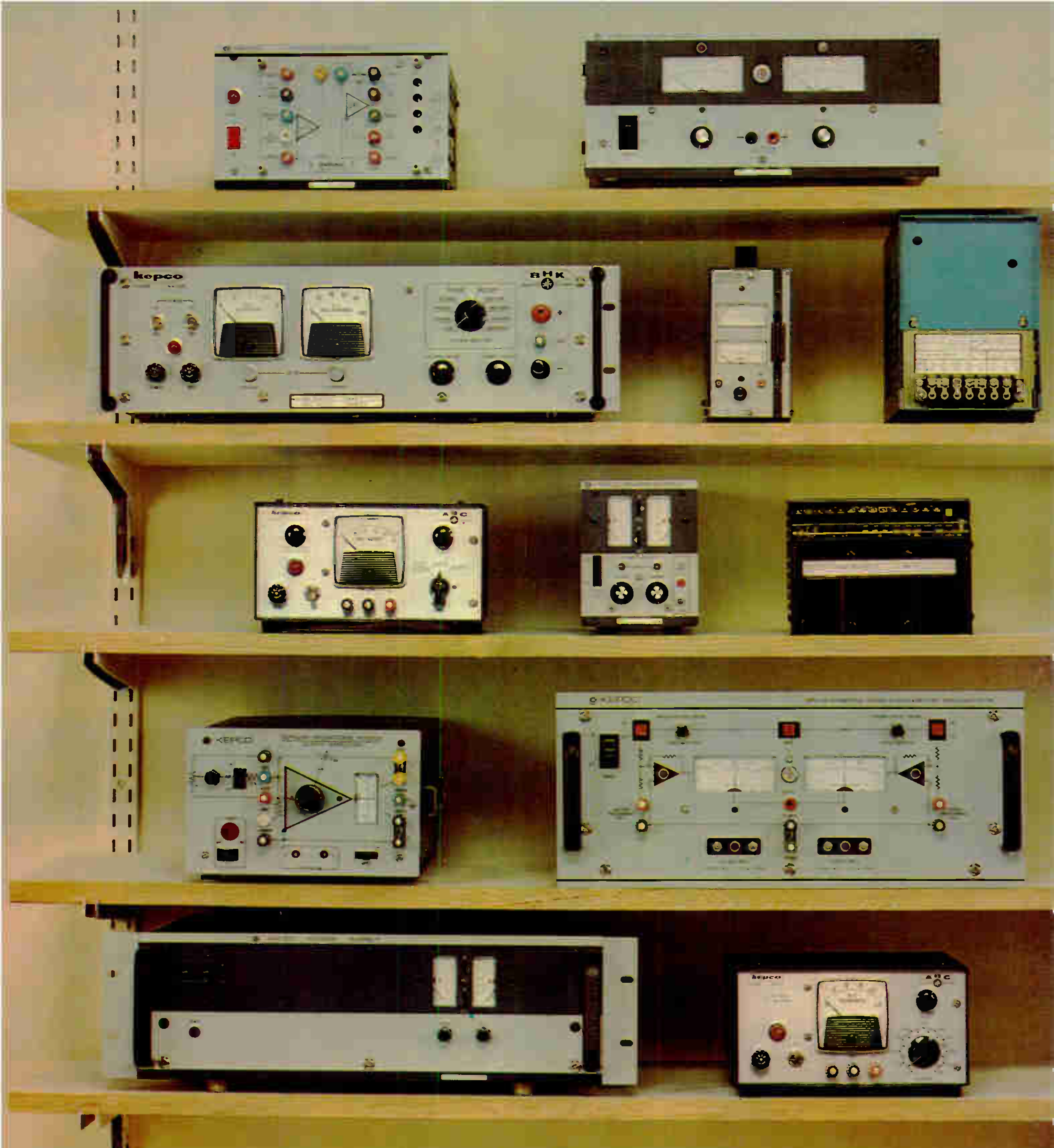

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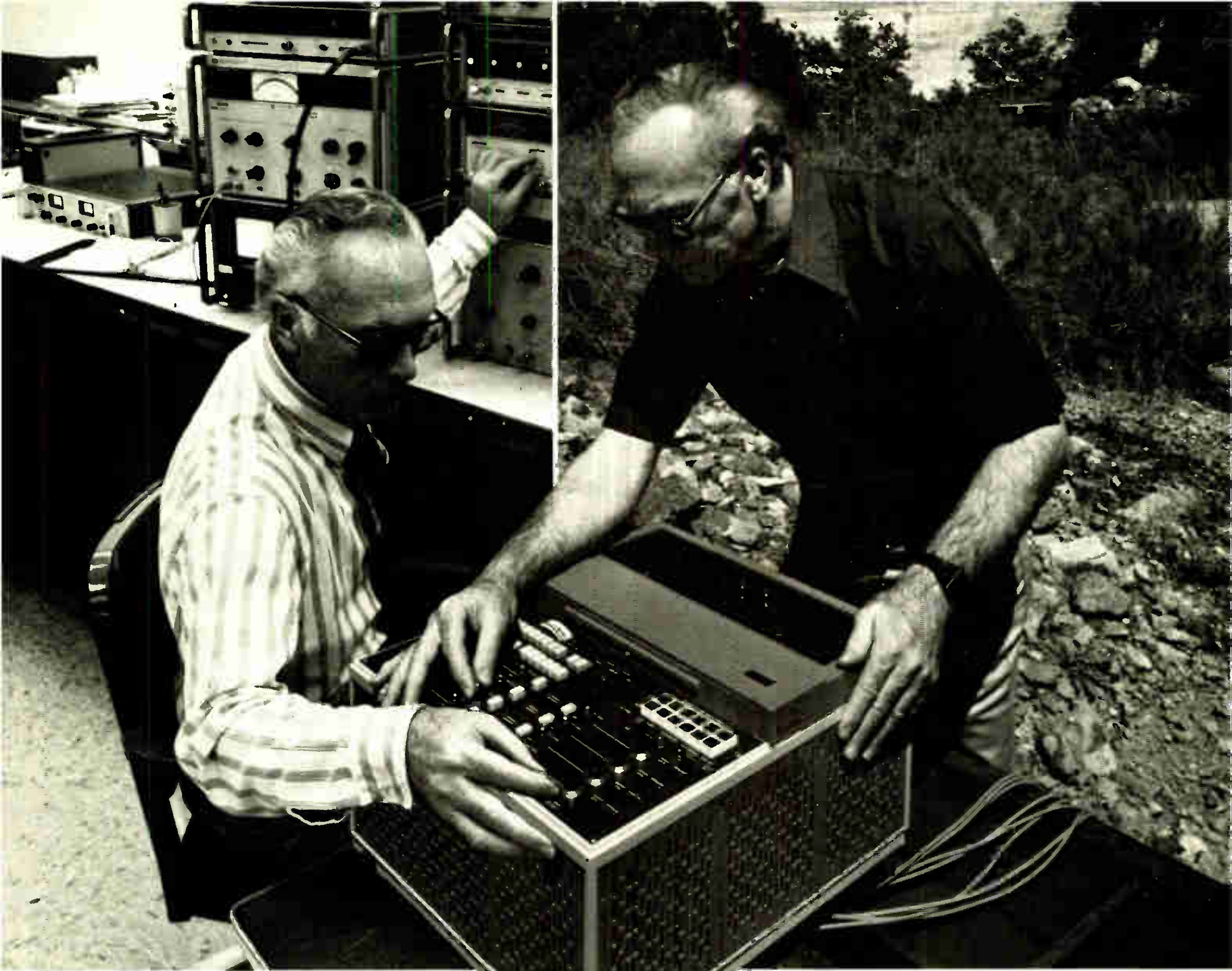

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Electronics
The International Magazine of Electronics Technology
Vol. 50, No. 12 • June 9, 1977

Highlights

Cover: Japan pushes digital development, 99
Intensive development has produced Japanese state-of-the-art memories and microprocessors that their makers hope will win them a major position in export markets. Electronics firms in Japan also are mounting a cooperative development effort of very large-scale-integrated technology.

■ Part 1 of this special report reviews the current position of the Japanese and outlines their development plans.

■ Part 2, which begins on page 106, gives an overview of the semiconductor industry and introduces a number of the country's leading electronics researchers.

■ Starting on page 110, part 3 goes into detail on the directions taken by Japanese VLSI development.

■ Part 4, which begins on page 118, focuses on the memories and microprocessors that Japan is using for its near-term assault on the world markets.

Cover illustrated by Assistant Art Director Paula Piazza.

Mobile-phone market heats up, 75
Even as AT&T is getting tests of its cellular mobile-telephone system under way in Chicago, the FCC is weighing whether to approve two rival systems, one of them noncellular.

NCC to look at data organizing, 164
This year's National Computer Conference will devote a number of program sessions to the architecture and data-base management of computer systems that process all kinds of information. This preview of the sessions is followed on page 171 by a report on some of the products to be introduced at the conference.

And in the next issue . . .
A product development profile of a low-cost digital multimeter . . . a pair of articles on a pair of 16-bit microprocessors.

Publisher's letter

For some time now, a growing number of people concerned about the world's electronics industries have been watching the progress that is being made in Japan at the leading edge of electronics technology. Although to some, the Japanese strides may seem to threaten a potential takeover of world markets, a more realistic assessment is simply that a new and important competitor has arrived—and it will have to be reckoned with in the already volatile semiconductor world.

On page 99 of this issue, you'll find a major 24-page special report on technology in Japan. Put together by our Solid State Editor, Larry Altman, and our Tokyo bureau manager, Charlie Cohen, it is based on extensive reporting and interviewing in Japan by them and Editor-in-Chief Kemp Anderson.

The major conclusion of the weeks of reporting, and of the special report itself, is that Japan's government-sponsored as well as privately supported research programs are putting Japanese producers among the leaders in digital technology. As Altman and Cohen say in the report: "Their goal is nothing less than a major position in the worldwide digital electronics market."

And speaking of our cover story, that eye-catching painting on the cover is the work of our Assistant Art Director, Paula Piazza. Paula is a graduate of the School of Visual Arts in New York City, where her major specialty was advertising. Before joining us last August, she had been art director for an industrial magazine. Before that, she had worked in illustration, graphics, package design, and advertising and public-relations campaigns. As for the cover assignment, she says it fit in quite well with her taste for things Japanese, from Japanese design to Japanese food.

Once again, the National Computer Conference is set to open its doors, and once again the fast pace of technology is reflected in the wide range of topics covered in the technical sessions, as well as in the new hardware and software packages being shown at the Dallas convention center.

While nothing quite equals being at such a show, the next best thing is to read the preview that we are publishing in this issue. First, on page 164, we are presenting a detailed look at what you expect to see and hear at the show's technical sessions. As you would expect, microprocessors are the one single item having the biggest impact. From their effect on architecture and data-base setups to their boosting of the personal computer toward calculator-like prominence, microcomputers come in for a lot of discussion.

Then, on page 171 begins a special section describing some of the more significant new products that will have their market debut at the National Computer Conference. From high-speed printers to interactive terminals, some of latest computer and peripheral gear is previewed. We hope you don't miss the show, but if you can't make it, don't miss our show coverage.

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Readers' comments

What's lacking is cooperation

To the Editor: I believe that the mismanagement situation at American manufacturers is more serious than you suggested in the last sentence of "On Fukuda, Carter, trade, and mismanagement" (Washington Commentary, March 31, p. 48). One very important reason for the success of the Japanese is not discussed in our journals. I mean the cooperation between management and employees in working toward a common goal.

In 50 years as an employee or other associate with 14 companies with activities ranging from steel manufacturing, paint making, chemical production, pharmaceuticals, medical electronics to printing, I have not found one in which management respected and trusted the lower-level employees, accepted their advice, and cooperated with them fully. Technically incompetent managers second-guessed the competent workers and, thereby, made first-class work impossible.

I noticed that the same managements were suckers for the con men on their staffs who promised the world on a platter if given just a few more months to work on a project. Productivity of the competent was reduced because they spent so much time trying to repair damage done by others.

Management spends its time extinguishing small fires and does not take steps to prevent fires—small or large. The talents needed to climb the corporate ladder are not necessarily those required for proper operation of the corporation.

A mechanical engineer has said that his experiences matched mine.

Our society is characterized by antagonisms. These dominate our law, media, corporate organizations, and social relations, and they are destructive of quality of product and life. First-class products are unlikely from large, unionized U. S. companies. A series of articles could be written on the reasons the Japanese can compete with our manufacturers—and not necessarily on price.

Frederick Kavanagh
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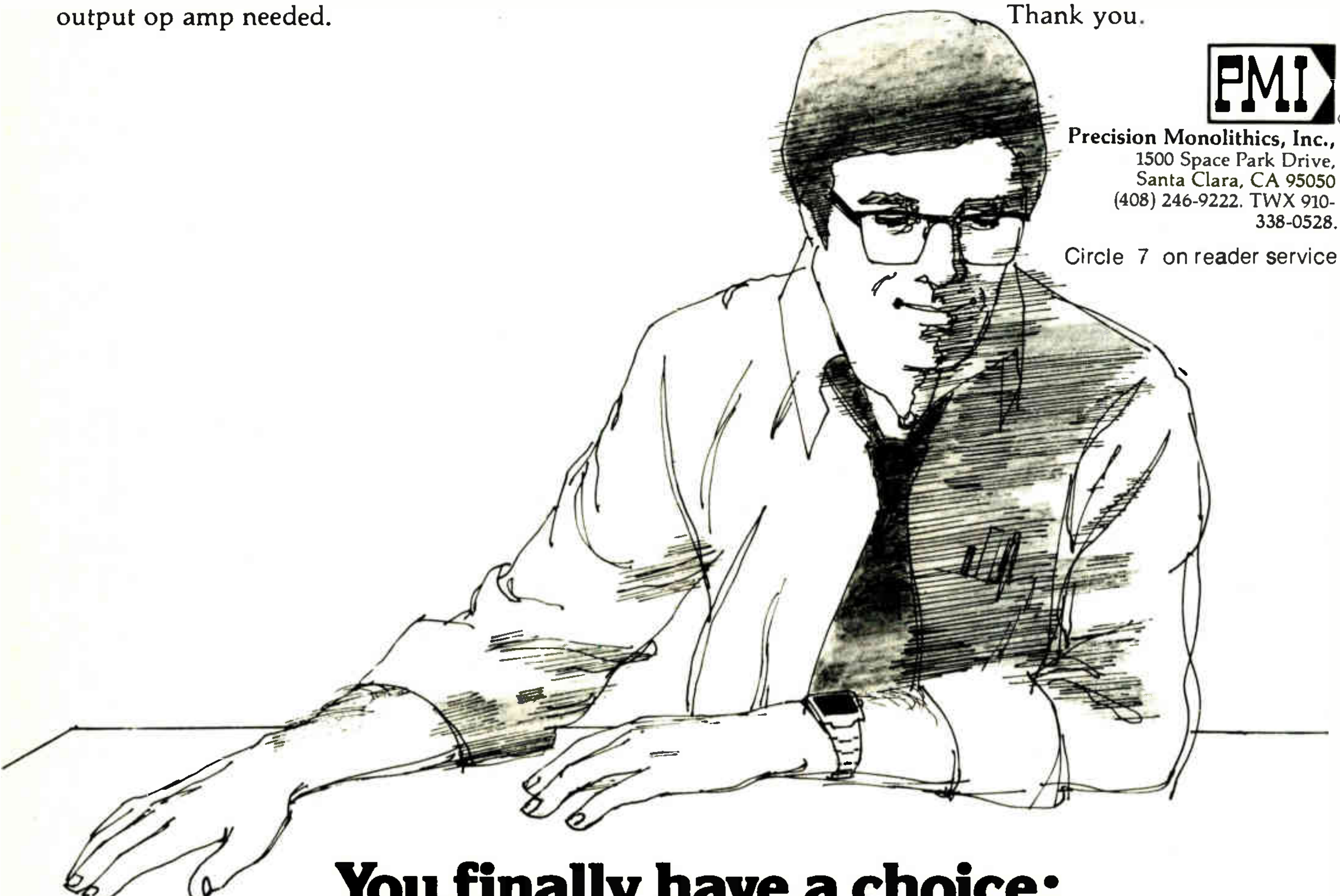

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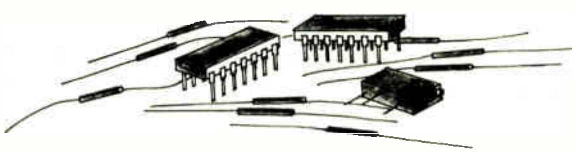

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News update

■ Last spring, in the best tradition of the season of renewal, rebirth, and hope, a new electronics trade association was born on the West Coast. Its ambition was to provide lobbying power to manufacturers of consumer electronics products; its name was the Association for Contemporary Electronics [*Electronics*, May 13, 1976, p. 26]. The association's first president was Don C. Hoefler, publisher of a newsletter, Microelectronics News, that chronicles the action in and around California's semiconductor-manufacturing locus known as Silicon Valley. Among the initial directors of the association were American Microsystems Inc. chairman Howard Bobb, Atari Inc. chairman Nolan Bushnell, and Intersil chairman and venture capitalist Fred Adler.

The association's rise and fall was quick. The group managed to sign up only eight members. President Hoefler resigned last November because of his concern over possible conflict of interest between that role and his job as newsletter publisher, he says. Frank Burge, an account executive at an advertising agency, became president and resigned in January—presumably to himself, because by then there were no members left.

The group initially had found it difficult to attract members, so Hoefler decided to offer a trade show to create interest and revenue. Eight companies put up about $10,000 in deposits for booths for the show, scheduled for March in Long Beach, Calif. The money has been spent, says Burge, and the companies that planned to exhibit are upset. So ACE, although defunct, may have to seek protection under the bankruptcy laws to avoid litigation over the $10,000. But Burge says that he does not know at this point what will happen to those bad debts.

Burge says ACE failed because it did not get a broad base of support. He adds that soon after he came to the group he told the agency promoting the projected trade show to stop all spending and not to accept any more exhibitors' deposits. ■

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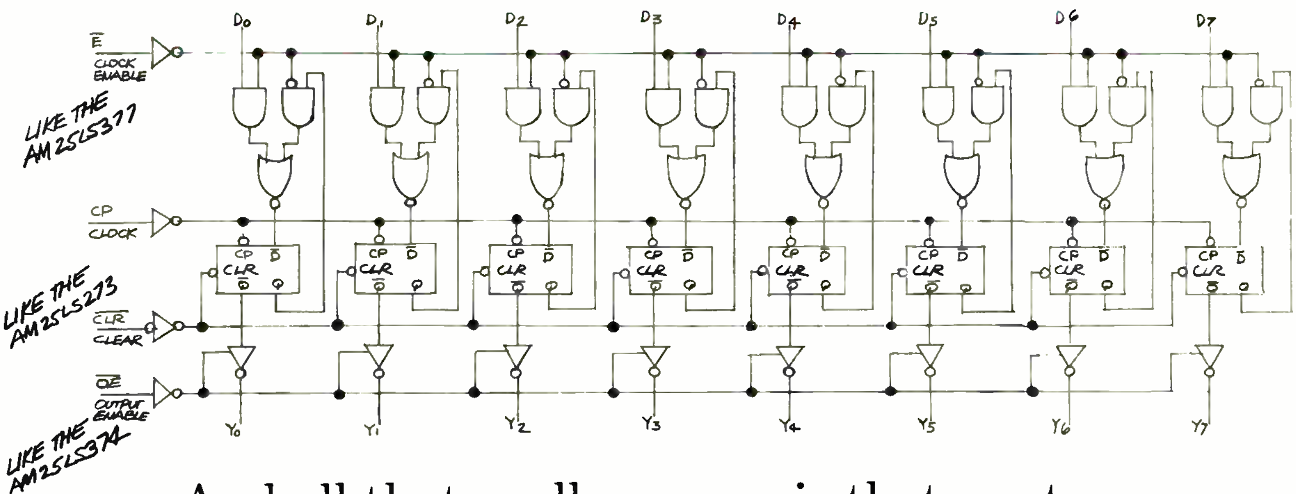

And all that really means is that next time you're thinking about registers, low-power Schottky and TI, you should also be thinking about AMD. Or calling. Or writing.

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Editorial

Countering Japan's cooperative technology

With an impressive single-mindedness of purpose, the Japanese have focused their sights on the rapidly developing data-processing markets, both in Japan and abroad. Witness the Japanese government's decision to sponsor a well-financed cooperative effort among major computer companies, the goal of which is an advanced computer technology based on very large-scale-integrated circuitry.

In addition to this, individual firms have in-house crash programs of their own in VLSI and are putting increasingly larger fractions of their revenues into advanced semiconductor design and production technology. The aim is the same: deep penetration of the world's high-technology markets by 1981.

Their program is certainly in keeping with the postwar tradition of Japanese industrialization. Starting from scratch in 1945, Japan has joined the world's premier manufacturing nations, and its industrial companies bring to their job some qualities that are found nowhere else in the world. For one, they are organized toward a common end: exporting. Then, too, they have strong government backing, and the country is behind them. Their workers, from boardroom executives to the lowest assembly-line technicians, rank among the most dedicated.

They have been brilliantly successful, dominating ship building, becoming No. 3 in the world's steel production, flooding the world's markets with the output of an automobile industry that is the fastest-growing of any, and supplying 70% of the world's consumer electronics gear.

As the Japanese turn their proven abilities to the design of data-processing components and equipment, some American firms are reacting in a way that could have a corrosive effect on the industry. Since the most advanced technology and the biggest EDP markets are in the U. S., these voices are counseling defensive measures, such as increased tariff barriers, buy-American campaigns, Government-subsidized programs, cooperative development and technology exchanges—in short, all the things they themselves criticize in the Japanese programs.

We think this represents a short-sighted view. While the Japanese move in digital technology encompasses some aspects that cannot be countered directly by American companies—such as joint technology programs that go against antitrust laws and increased tariff barriers that are complex political questions largely beyond the spheres of individual companies—the best course for American companies is to continue doing what they do best, which is pursuing innovation in a free-enterprise environment.

If anything has put American digital technology in the lead, it is independence and innovation, and not government support, defense programs, tariff barriers, or fear of foreign competition. Rather it has been the fiercely independent semiconductor and computer industries and their employees who have first piled innovation on innovation in staggering progression and then applied these innovations quickly to new opportunities in calculators, watches, computers, and so on.

While the Japanese are bound to score some solid successes through their cooperative programs and government support, the best defense against a technology assault is an aggressive technology offense—new microelectronic structures and materials, submicrometer-pattern generation, automatic production equipment, and innovative chip and computer-system design. That is what the best American semiconductor and computer manufacturers have always done, and that is what the best of them are doing now.

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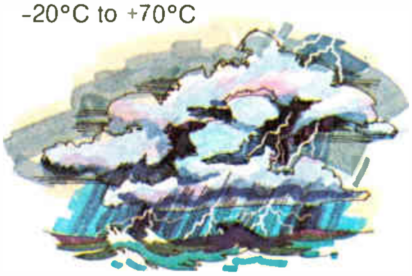

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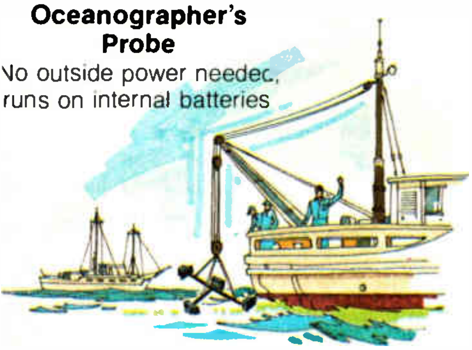

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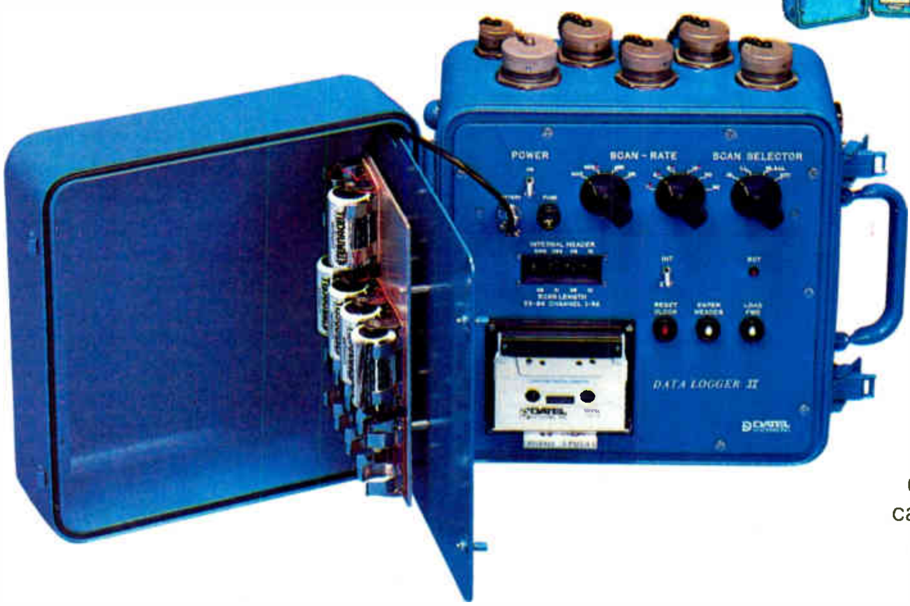

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People

Computer Automation means high volume for Marshall

Frank Marshall had a good reason for switching jobs three years ago from a secure post in the aerospace industry to a small company in the minicomputer business. "My life ambition was to work on a product commercially producible in high volume," something not possible for the military, he explains.

Computer Automation offered him the chance because it was, "in the mainstream of the commercial marketplace." Within a year, his move paid off and Marshall, as computer development manager, was in the middle of developing a brand-new three-machine line of minicomputers, introduced last month [*Electronics*, May 26, p. 139]. Eventually he directed a 16-person task force.

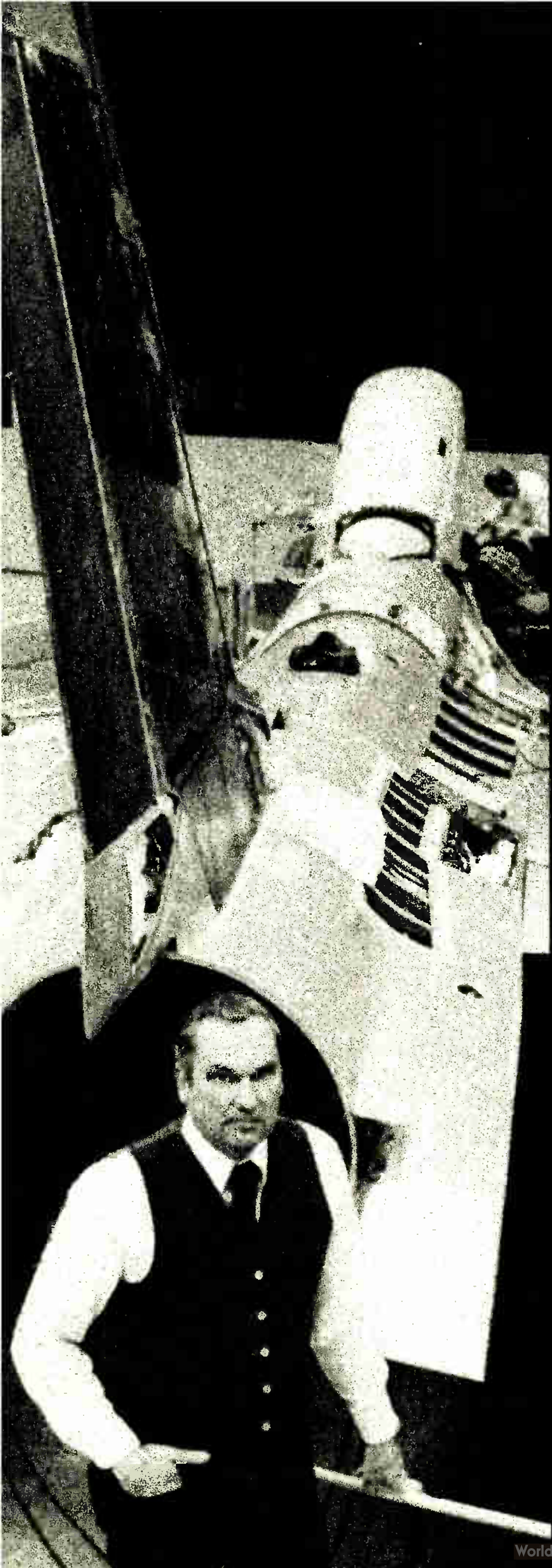
The big difference in building the new minicomputers was that "cost and producibility, not technology were the main considerations" Marshall says. "Management set cost and performance goals and we had to meet them. Such constraints represent a far cry from new computer lines developed by most companies, which seek to incorporate all the latest semiconductor technology.

Marshall, however, shudders when asked why did he not consider such exotic semiconductor approaches as silicon-on-sapphire, very large-scale integration, and the like. "We had to have an industry standard process, second-sourced all the way," he says. This means n-channel metal-oxide-semiconductor technology, which the design team used in two processor chips built for the company's low-end minicomputer, the 4/10. The medium-level 4/30 has conventional medium-scale-integration logic and the top 4/30 employs transistor-transistor-logic circuitry.

As perhaps the riskiest part of the early design process, Marshall singles out commitment to a chip size of less than 200 mils, without knowing at that time exactly what was needed. "We came within 2% since the final size ended up in the 190-mil-square range."

For a project so important to the Irvine, Calif., company's fortunes, the 30-year-old Marshall says it was a "well-controlled orderly process. Although we worked some weekends and nights, there was none of the crash-program stuff." While he says top management didn't ride herd on the project on an hourly basis, its

Differences. For Frank Marshall, the move to commercial work from aerospace brought a shift in emphasis away from technology.



People

interest was intense. "Dave Methvin, the president, for instance, would walk into the lab and intently watch us probing wafers."

Jacobson's route to success lies in European subsidiaries

Many U. S. computer firms have decided the way to boost sales faster is to cross the Atlantic and sell to the Europeans. Not many executives of companies turning over only $13 million a year, though, have taken the plunge of setting up their own subsidiaries in Europe.

But Roy Jacobson, 55-year old president and cofounder of Anderson Jacobson, based in Sunnyvale, Calif., did just that three years ago. About to post 1976–77 revenues of more than $20 million, the company is the world's largest independent supplier of printer-keyboard terminals, he reckons.

Jacobson, who majored in engineering at Yale University, is a Harvard Business School graduate and read economics and political science at Oxford. He insists that the way to go is to set up wholly owned subsidiaries wherever viable.

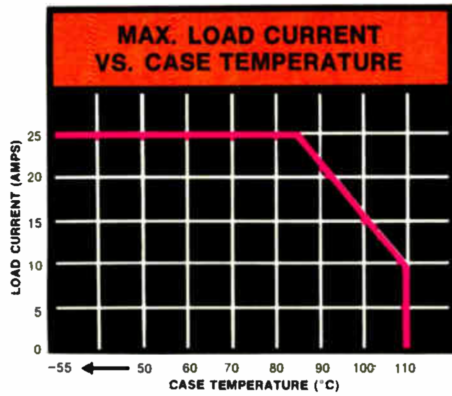
Sitting in the Paris suburb offices rapidly being outgrown by the company, Jacobson says: "I don't know any data-processing companies our size—or even a good deal larger—that have set up their own independent operations in Europe. Why do it? It's part of our philosophy."

He notes, too, that "it gives better control of the total operation. We also get better feedback on what users need and can put this information into designing products and improving services. It's also a basis for larger growth."

For relatively small companies, this is an expensive approach to adopt. But its two European subsidiaries, in France and England, made profits last year, and it was the second profitable year in France. So far, European sales reach only 11% of total company turnover, but Jacobson is expecting this to grow rapidly to 25%.

MIL-SSR UPDATE

Ready for military service: Our new AC power SSR.

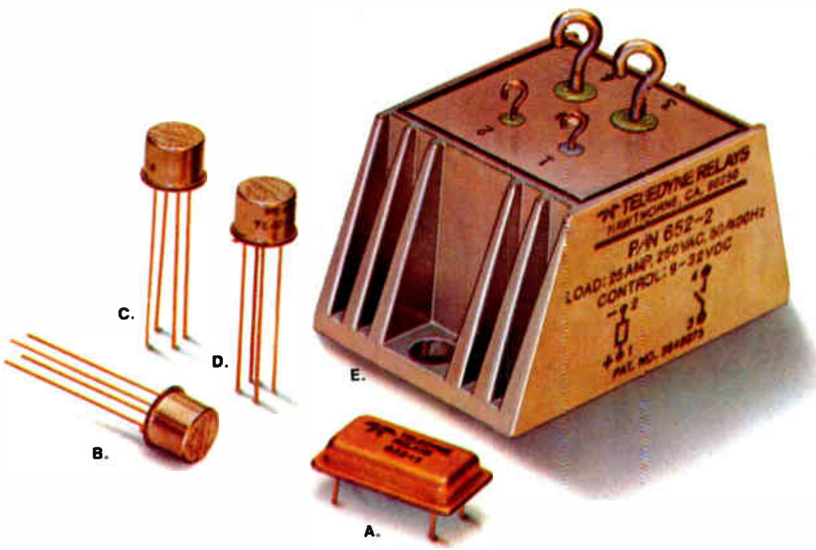


Commercial relays are no match for severe military or aerospace environments. But there's no doubt about our new 652 Series. Designed expressly for military and aerospace applications, this new AC SSR is packaged in a rugged, hermetically sealed aluminum case with the internal circuit assembly encapsulated to resist shock and vibration. What's more, all circuit components are military grade including the inverse parallel SCRs that provide reliable output switching — up to 25 Amps — over the frequency range of 45-440Hz.

Other features include logic compatible input drive circuitry, optical isolation, and zero voltage turn-on to reduce EMI.

To top it all off, our 652 Series is designed to meet MIL-R-28750 and all categories of MIL-STD-704A, with an operating ambient temperature range of −55°C to +110°C.

For complete specification data, contact your nearest Teledyne Relays sales office listed in EEM, Gold Book and Electronics Buyers' Guide. You'll find we have the experience, products, and technical support to meet all your SSR needs — including a quick reaction capability to design SSRs specifically for your application.



TELEDYNE'S MILITARY SSRs

A. **P/N 683-1 DC SSR**
DIP package, with output rated at 600mA/50VDC

B. **P/N JM640-1 Bi-polar SSR**
Mil P/N M28750/5, TO-5 package, with bi-polar (AC/DC) output rated at 60mA/40V

C. **P/N JM643-1 DC SSR**
Mil P/N M28750/6, TO-5 package, with output rated at 300mA/40VDC

D. **P/N JM643-2 DC SSR**
Mil P/N M28750/7, TO-5 package, with output rated at 100mA/250VDC

E. **652 Series AC Power SSR**
Output rated at 25A/250VRMS

TELEDYNE RELAYS

3155 West El Segundo Boulevard, Hawthorne, California 90250
Telephone (213) 973-4545

Circle 17 on reader service card

Designers say we have the lead in edge connector design.

And the performance to keep it.

The reason why is clear. The contacts for AMP wrap-type edge connectors have unique strength and stress relaxation characteristics that assure long-term top performance. And they come in either leaf spring or cantilever types. Each incorporates full bifurcated design to achieve effective contact redundancy. A choice of contact alloys and selective gold platings is available too. The result is premium reliability and performance at a cost as low as 2 cents a line in quantity.

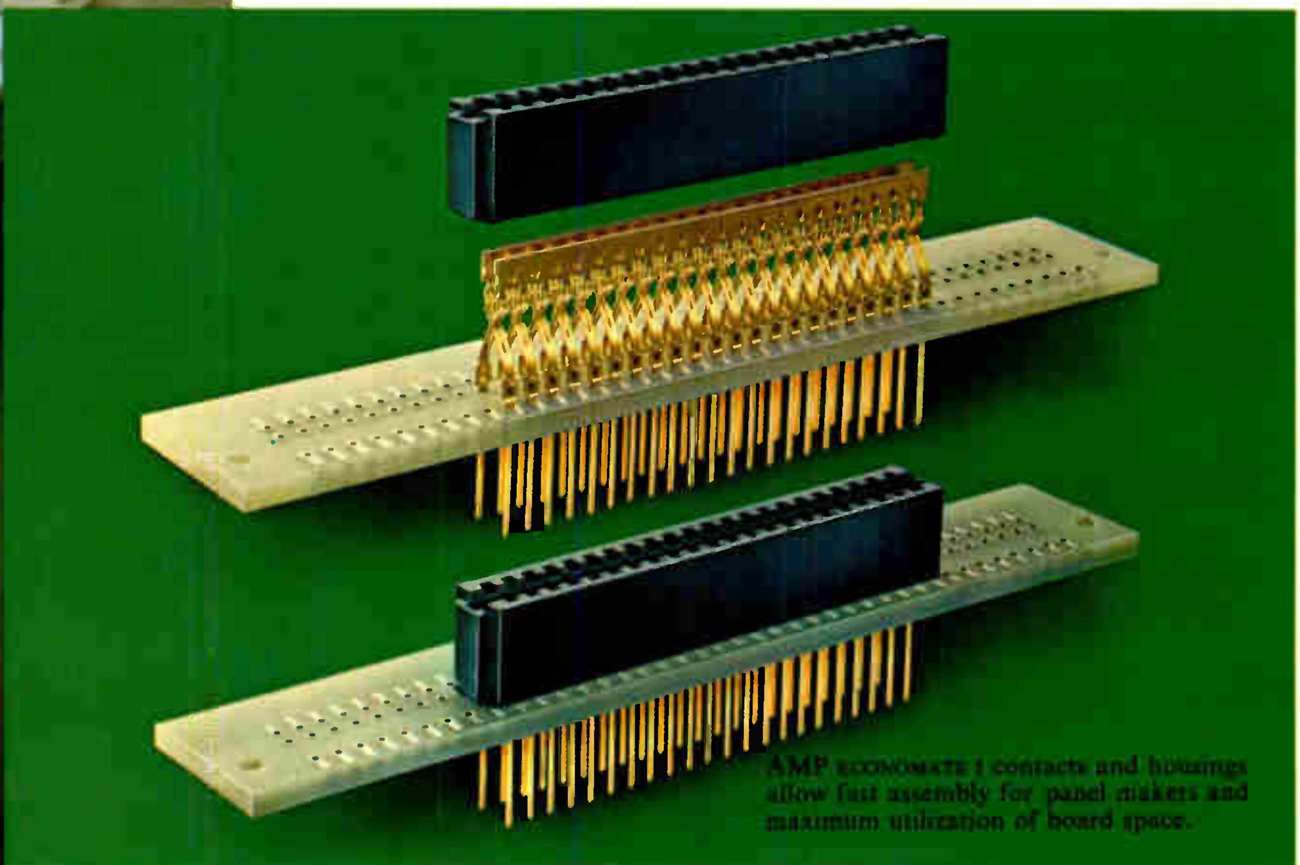
There's another reason you're ahead with AMP edge connectors, or any other AMP product for that matter. It's called technical support. It means you can call on us for assistance in research, product design, and production. We feel the professional engineer is entitled to it. After all, when he puts his confidence in us, we can do no less than back him fully.

There are other advantages, too, with these AMP edge connectors. You can select from types for either rack or solder-to-board mounting. And if you're a panel maker, we've got ECONOMATE I connectors with outstanding insertion speeds and space savings.

For more information on these wrap-type printed circuit edge connectors, just call AMP Customer Service at (717) 564-0100. Or write AMP Incorporated, Harrisburg, PA 17105.

AMP has a better way.

AMP
INCORPORATED



AMP ECONOMATE I contacts and housings allow fast assembly for panel makers and maximum utilization of board space.

Circle 19 on reader service card

Meetings

Joint Automatic Control Conference, IEEE *et al.*, Hyatt Regency Hotel, San Francisco, June 22 – 24.

35th Annual Device Research Conference, IEEE, Cornell University, Ithaca, N. Y., June 27 – 29.

International Symposium on Fault-Tolerant Computing, IEEE, University Hilton Hotel, Los Angeles, June 28 – 30.

1977 Electronic Materials Conference, AIME, Cornell University, Ithaca, N. Y., June 29 – July 1.

Computer-Aided Design of Electronic and Microwave Circuits and Systems, IEEE, University of Hull, Hull, England, July 12 – 14.

International Conference on Nuclear and Space Radiation Effects, IEEE, College of William and Mary, Williamsburg, Va., July 12 – 15.

IEEE Power Engineering Society Summer Meeting, IEEE, Maria Isabel Sheraton and Camino Real Hotels, Mexico City, Mexico, July 17 – 22.

Summer Computer Simulation Conference, ISA, IEEE, *et al.*, Hyatt Regency O'Hare Hotel, Chicago, July 18 – 20.

International Conference on Integrated Optics and Optical Fiber Communication, IEEE *et al.*, Tosho Building, Tokyo, Japan, July 18 – 20. (Post-conference meeting on fabrication technologies at Senri-Hankyu Hotel, Toyonaka, Osaka, Japan, July 22.)

1977 International Conference on Crime Countermeasure Science and Engineering, IEEE *et al.*, Oxford University, Oxford, England, July 26 – 29.

ACM-Pacific 77 — Exploring the Small Computer, ACM, LeBaron Hotel, San Jose, Calif., July 28 – 29.

Electromagnetic Compatibility Symposium, IEEE, Olympic Hotel, Seattle, Wash., Aug. 2 – 4.

WAFERTRAC. STILL STEAMING AHEAD!

Since GCA introduced the revolutionary WAFERTRAC™ a few months ago–the completely automatic, microprocessor-controlled wafer processing system, 9 out of 10 of the world's largest manufacturers of semiconductors have purchased their WAFERTRAC systems. Why?

WAFERTRAC provides higher yields in less facility space.

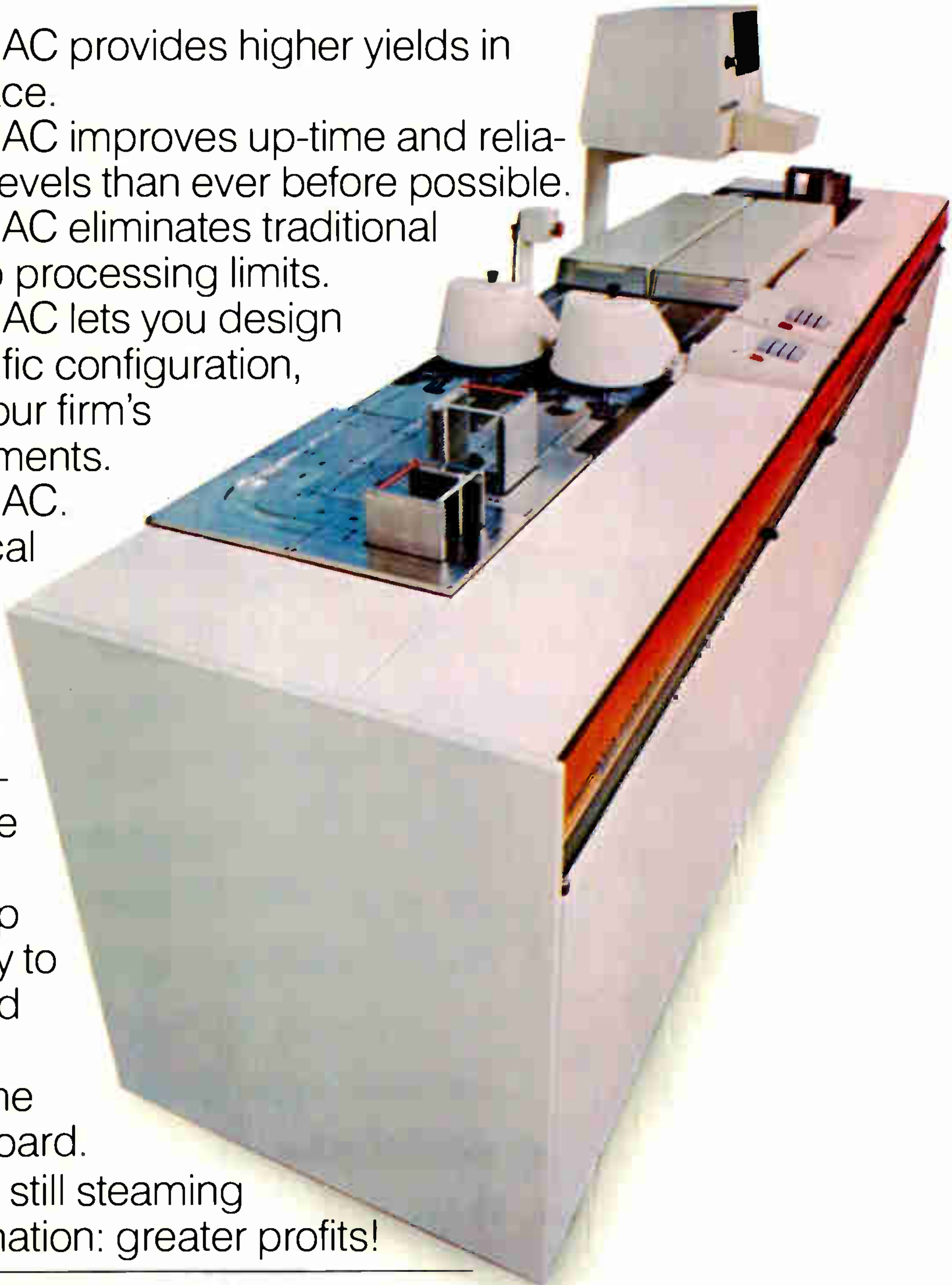
WAFERTRAC improves up-time and reliability to higher levels than ever before possible.

WAFERTRAC eliminates traditional 25-wafer group processing limits.

WAFERTRAC lets you design your own specific configuration, according to your firm's unique requirements.

WAFERTRAC. The first practical application of the microprocessor to semiconductor processing, requiring only a single person in your processing loop ...and *then* only to load and unload carriers.

Don't be the last to get on board. WAFERTRAC's still steaming ahead...destination: greater profits!



GCA/SUNNYVALE DIVISION

PART OF THE GCA/IC SYSTEMS GROUP
1050 Kifer Road, Sunnyvale, Calif. 94068 TWX: 910-339-9211 (408) 732-5330

Mostek SDB-80.
Z80 Power and

The solution for OEM applications.

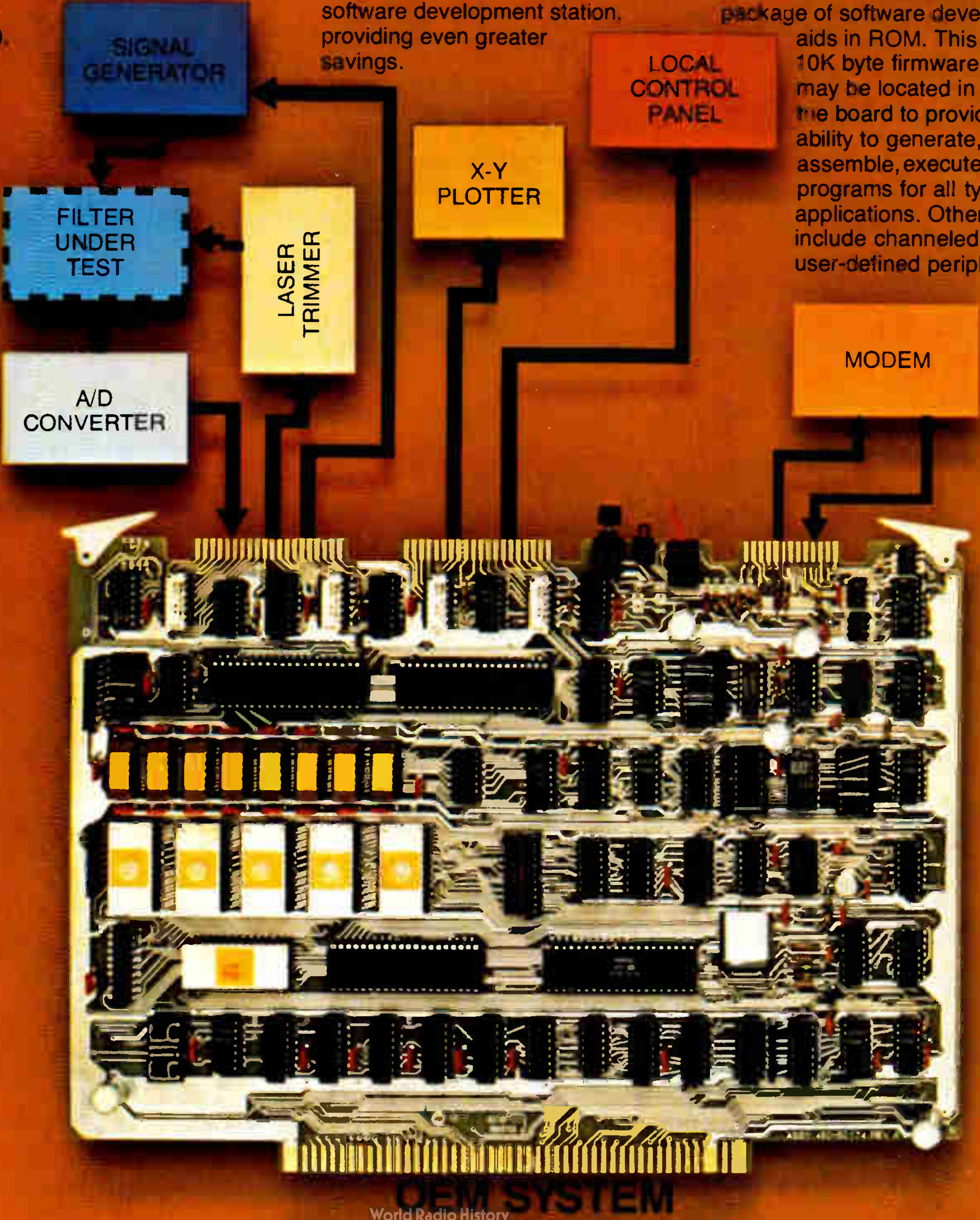
For OEM applications the SDB-80 is one of the most powerful, yet low cost microcomputers available in the industry today. For $995 (single unit quantities) the SDB-80 single board microcomputer includes Mostek's Z80 CPU (MK 3880), eight MK 4116 16K RAM memories, two PIO's (MK 3881), one CTC (MK3882), serial ASCII interface (110—9600 baud) sockets for up to 5K bytes of PROM or 20K bytes of ROM, plus a fully buffered and highly sophisticated system bus for complete expandability (including multi-processor applications).

These features are not only important in the user's final system, but also permit the SDB-80 to be used as an extremely powerful software development station, providing even greater savings.

High level languages such as BASIC are also easily supported wit the SDB-80 by loading either Z80 or 8080A based interpreters/compilers into the 16K bytes of on-board RAM

The solution for softwar development.

For software development, the SDB-80 is available with a complete package of software development aids in ROM. This optional 10K byte firmware package may be located in sockets or the board to provide the ability to generate, edit, assemble, execute, and debu programs for all types of Z8 applications. Other features include channeled I/O for user-defined peripheral



The $995* solution. 16K Bytes of RAM.

drivers, relocatable object module generation with a corresponding linking loader, a complete set of console routines for examining and/or modifying memory and port locations, and a set of driver routines for various standard peripheral devices.

For users requiring even greater system capabilities, the SDB-80 is fully expandable through the use of optional add-on boards. In this way the user may configure his system to include whatever amount of PROM, ROM, RAM or I/O desired, plus add such features as in-circuit emulation, floppy disk interfaces, and PROM programming capability.

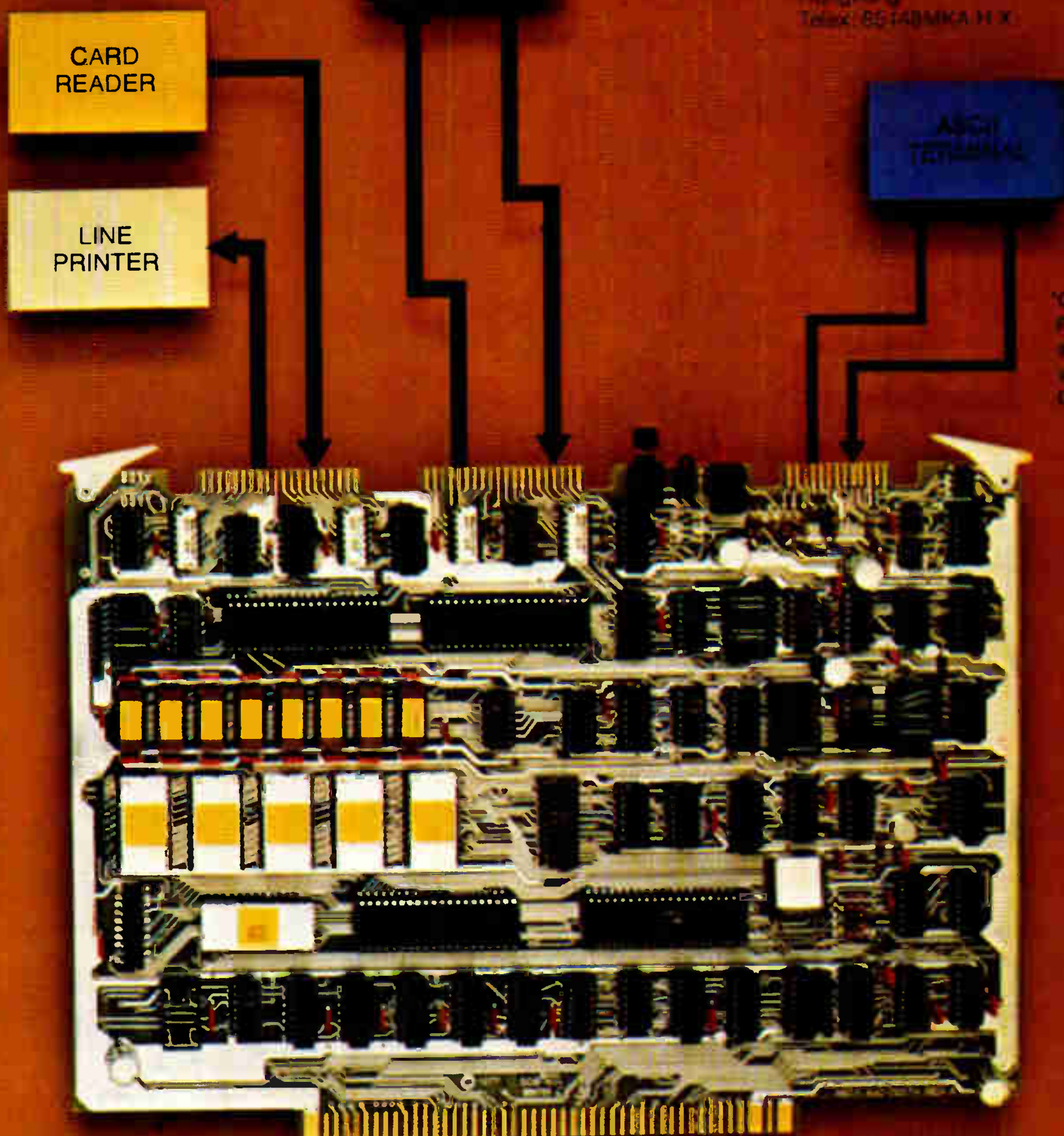
Non-resident software development is also supported through the use of Z80 Cross Assemblers which are available for both Fortran IV and 8080A systems. The resultant object code can then be loaded into the SDB-80 for execution and debug.

PAPER TAPE READER/ PUNCH

For more information on the SDB-80 and the complete range of optional support boards, software, and boxes, contact your local Mostek sales office or representative.

MOSTEK

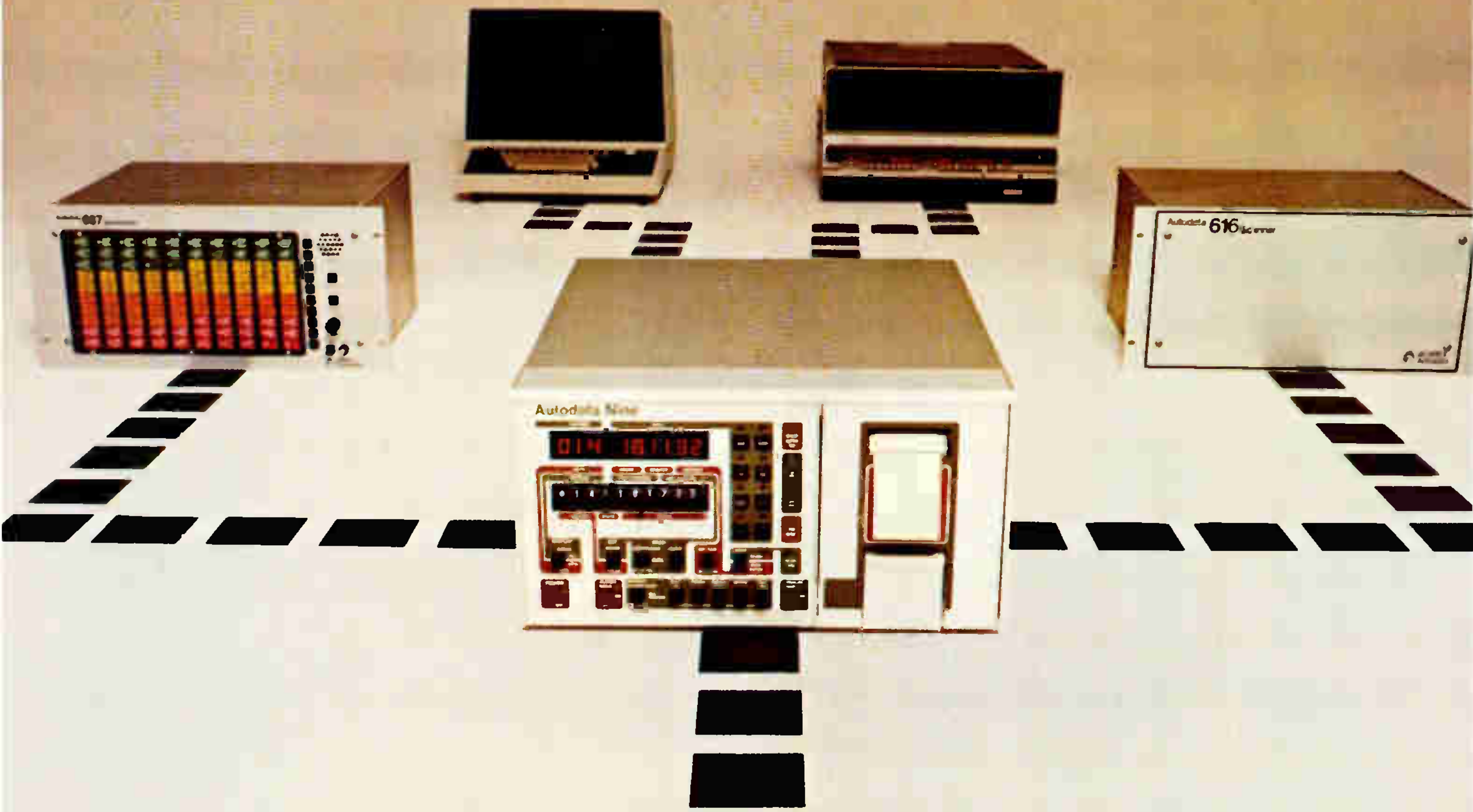
1215 West Crosby Road
Carrollton, Texas 75006
(214) 242-0444
In Europe, contact:
MOSTEK GmbH W. Germany
Telephone: (0711) 701096
MOSTEK ASIA
Hongkong
Telex: 85148MKA H.X.



*One piece quantities. Prices apply within the U.S. and Canada. Eurocard version available. Contact Mostek GmbH.

DEVELOPMENT SYSTEM

Circle 23 on reader service card



YOU DRAW THE LINE.

Monitor/alarm/control applications simplified: The Autodata Nine flexibility allows you to tailor a system to your needs by selecting the right options - just draw a line. Almost any line — from the Autodata Nine to computers, to CRTs, to Annunciator Panels, to Remote Scanners and to what you require. Here's how some of our customers draw their lines:

A major government agency needed a line on agricultural **data acquisition**. By plugging in an Autodata Nine they now measure (and record on paper tape) such diverse input as solar activity, soil moisture levels and weather data — over *several* hundred channels.

The engineers at a West Coast power plant are concerned about preventing excessive motor bearing, winding and boiler tube temperatures. **Process monitoring** is a natural for the Nine. And at this installation, it performs two-out-of-three logic for alarming and automatic shutdown, and informs the operator of problems through annunciator panels, and data printout.

We lined up another Nine for a marine biology study. The intent was to determine the effects of heat on marine life by varying water temperature in 30 tanks using cost effective **supervisory control**. Again, through a single Autodata Nine, temperatures were sampled, read and — when required — corrected by the incremental control of valve positioning.

We placed Autodata Nines at each of several engine test stands for one customer. He then drew a line from each to his central computer. Now they serve as **smart front ends** acquiring and manipulating data on temperature, pressure and flow under computer control (or manually if the computer is down). And since less software was required in the computer, the system was on line fast at the lowest cost.

These examples only begin to indicate the Nine's versatility. Get the Autodata Nine into your diagram — just draw a line around our number on the bingo card.

ACUREX Autodata Formerly Vidar Autodata

485 CLYDE AVE., MOUNTAIN VIEW, CA 94042 (415) 964-3200 (TWX) 910-379-6593

Circle 24 on reader service card

Mostek to show its first entries in memory system field

Mostek Corp. is using the edge it has in 16,384-bit random-access memories to wedge its way into the memory systems business. Its first four products, to be unveiled at next week's National Computer Conference in Dallas, will include **the largest memory board to date,** a 15.4-by-11.75-inch printed-circuit card populated with 192 16-k RAMs. Aimed primarily at large computer systems, the MK8000, as it's called, can be configured to yield 131,072 words of 24-bit memory on a single board.

Other boards that the firm will announce are a 64,536-by-18-bit board for DEC's LSI-11 and a 131,072-by-17-bit system that will take Data General's Nova 3 to its maximum storage capacity with a single memory card.

Sandia decides to buy several concentrator models

The process of selecting a prime contractor to build Sandia Corp.'s 10-kilowatt photovoltaic optical concentrator array has taken a new turn. Instead of naming a single winner from among nine bidders [*Electronics*, Feb. 3, p. 44], **Sandia picked two firms to come up with evaluation prototypes and likely will add one more.**

Both Martin Marietta Aerospace of Denver and Spectrolab Inc. in Sylmar, Calif., received contracts to deliver prototype arrays, in the 100-to-300-watt range, by Oct. 31. Negotiations are continuing with a third firm, a spokesman says. Martin Marietta got a $256,000 contract, and Spectrolab, a subsidiary of Hughes Aircraft Co., is working under a $277,000 award.

Rockwell sees megabit bubble chip within 2 years

An experimental million-bit bubble-domain memory chip could be in production within two years. John L. Archer, manager of the applied magnetics branch at Rockwell International's Electronics Research Center, says the megabit bubble chip, while "not fully speced yet," **already has proven the necessary technology.** Its density of 1.6×10^6 bits per square centimeter on a 10-by-9.5-millimeter chip gives a capacity 10 times that of any solid-state memory device reported to date, he says.

Fast, powerful multiplier coming from Monolithic

Monolithic Memories Inc. is gearing up to produce **an 8-by-8-bit multiplier with what is probably the industry's best speed-power product.** Designated the MMI 67558, the 40-pin combinational device has a typical speed of about 100 nanoseconds and a power consumption of only 1 watt. By comparison, Advanced Micro Devices' 8-by-1-bit multiplier is specified at 450 ns and 1.2 w, its 8-by-8 at 400 ns and 1 w. TRW Semiconductor has an 8-by-8 on the market that is specified at 130 ns and 1.8 w.

HP takes wraps off watch-calculator

Hewlett-Packard Co. executives have just announced what they call an entirely new product area for the Palo Alto, Calif., originator of the hand-held calculator—the HP 01, a sophisticated wristwatch-cum-calculator based on improved versions of the integrated circuits that run the HP-35. **Containing two calculator ICs, a watch chip, and new memory chips,** The 6-ounce HP 01 will be sold as a high-fashion piece of jewelry, at about $650 to $750 retail. It will have more than 30 to 40 computing and timing functions.

Electronics newsletter

TI develops $3.90 monolithic a-d converter

Texas Instruments has developed a low-cost, monolithic analog-to-digital converter **designed specifically for use with microprocessors.** The part, the TL505, will be in production at the end of this month, priced at $3.90 each in lots of 100.

Designed to interface directly with TI's TMS1000 family of 4-bit p-MOS microcomputer chips, the part integrates an operational amplifier, comparator, voltage reference, analog switches, and switch drivers onto a single bi-MOS chip that runs from a 9-volt power supply. The 8-to-10-bit part (0.1% accuracy) is aimed at a wide range of low-speed conversion applications, such as process controls, microwave ovens, and automotive systems. It will handle up to 20 conversions each second.

Intel producing $600 "math board"

Looking to take advantage of another market created by its line of single-board SBC microcomputers, Intel Corp. is going into production with the SBC 310, a $600 high-speed bipolar "math board" based on its Schottky bipolar 3,000 bit-slice family. Acting as a slave unit to any SBC 80 microcomputer, the SBC 310 extends the mathematical number-crunching capability **an order of magnitude beyond what is now possible with the 8080 alone.** On command it performs fixed-point-integer and floating-point arithmetic. An SBC 80/20 with an SBC 310 can perform a fixed-point multiply in 70 microseconds, roughly equivalent to the performance of an LSI-11.

Xerox bases printing system on mini, laser

Xerox Corp. has announced an all-electronic printing system intended as a high-style alternative to the inelegant fan-fold computer printout. Dubbed the 9700, the printer uses a Digital Equipment Corp. PDP-11 minicomputer and a laser to produce letter-quality 8½-by-11 sheets, putting out two pages a second. At $295,000, the 11-ft-long 9700 is actually a printing factory using xerographic principles to print on mixed weights of paper. Aimed at the data-processing industry, the printer eliminates all the steps between the computer and the high-quality printed page.

Mass storage system for minis uses video disk idea

Optical videodisk technology is being applied to a mass storage system for minicomputers at Philips Laboratories, Briarcliff Manor, N.Y. According to Philips consulting scientist Frits Zernike, confidence is growing that **in another year Philips will have a prototype demonstrating actual transfer of data** to and from a minicomputer system. "I could not have said that six months ago," he notes, but continuing developments on the system now make him "reasonably confident that an error rate of 1 in 10 billion is attainable."

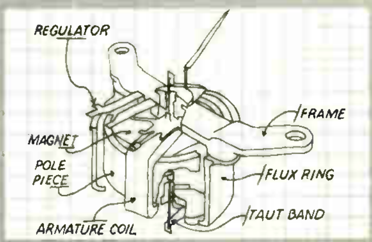
Basically, the system works with a helium-neon laser delivering about 10 milliwatts of optical power to the disk, which is coated with a thin tellurium film. The laser creates a micrometer-sized hole to record the presence of a data bit. The disk measures 30 centimeters in diameter and, in its 40,000 tracks, can hold 10 billion bits. Thus, the expected error rate is equivalent to one error per disk. Once written, the data cannot be erased, so the system is intended for archival storage or where a great volume of data is accumulated and must be played back on-site.

Specify the panel meter you'd be proud to have designed yourself

Panel meters from General Electric can add a lot to the overall quality of your product. Accuracy. Reliability. Attractiveness.

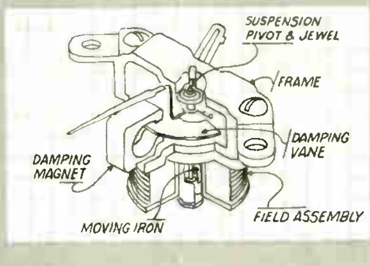
How do you design this kind of quality?

Start with the *suspension system*. The moving parts. You'll want one of two kinds (depending on what kinds of physical abuse your panel meter may be exposed to). In a *taut band suspension system*, the moving mechanism is suspended between two ribbons of platinum-nickel alloy welded securely to a resilient, shock-resistant anchor. This suspension system design keeps friction to an absolute minimum.



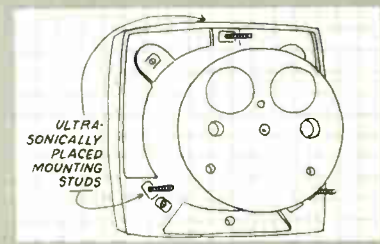
The aluminum pointer is attached to an oversized, high-torque armature coil of fine copper wire, for fast response and accuracy you can count on.

Pivot-&-jewel suspension maintains high performance and reliability in high vibration environments. The armature assembly is supported by highly polished, hardened-steel pivots selected for wearability. The pivots are designed with a radius that will minimize friction level to give maximum performance. The 1/10-carat jewel bearings are of ceramic material that is stronger than glass jewels and has greater scratch and impact abrasion resistance.



Pointers are tapered to a radius point as small as .38 mm, combining high readability with superior reading accuracy. Scales on the meter face are available with mirror backing that will align the reader's eye perpendicular to the face, eliminating parallax error.

Self-protecting features are important, too. All GE panel meters are housed in a tough, *molded case* of high-impact styrene. Special gaskets are available for assembly in BIG LOOK® type panel meters between the window and case to keep out contaminants. Ultrasonically placed mounting studs assure that the meter will fit your panel exactly. Choice of meter styling (BIG LOOK® or HORIZON LINE®) lets you pick the shape and appearance that will best enhance your product. (Color masks are also available for HORIZON LINE® in red, blue, green, black, yellow and white.)



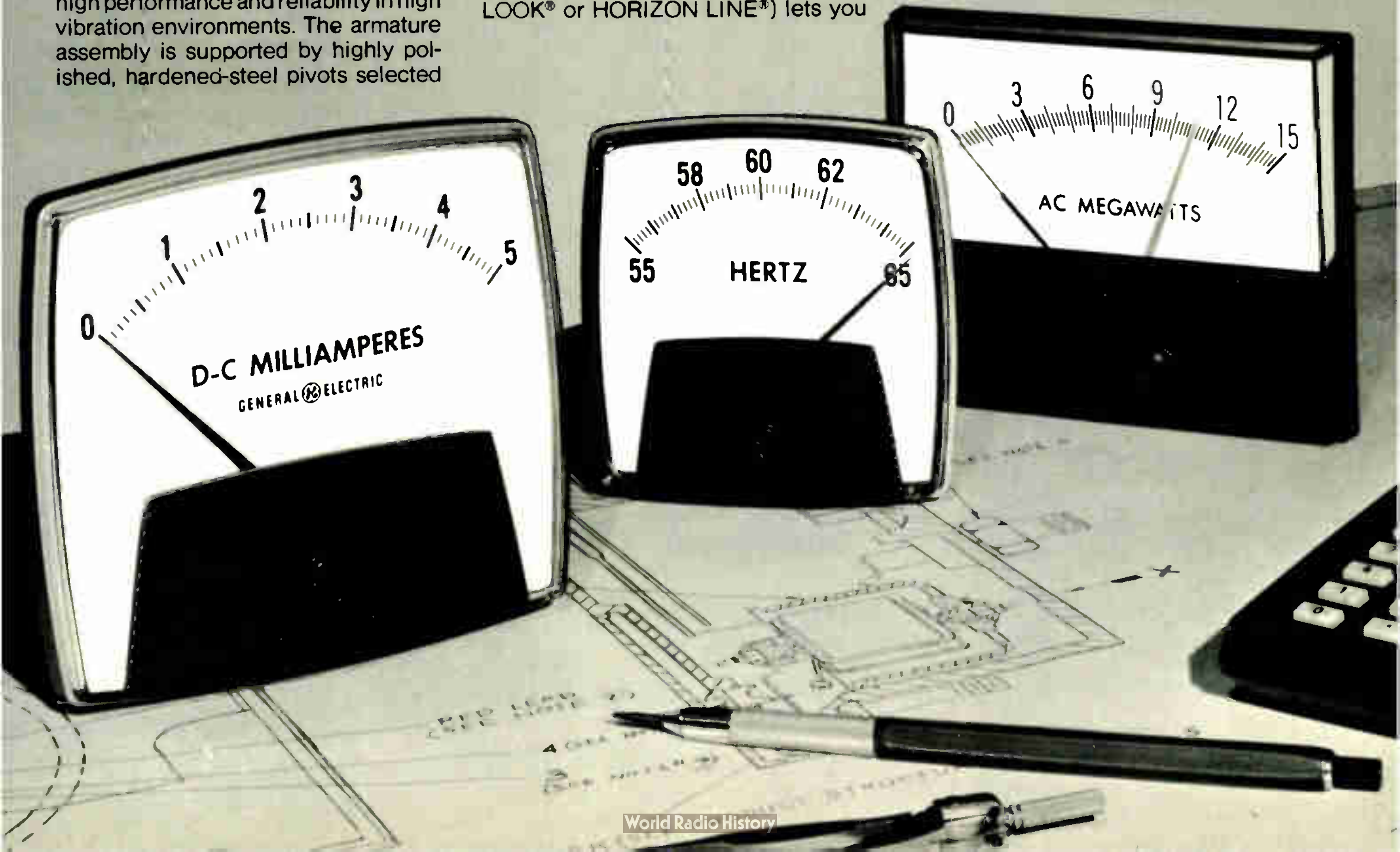
Hundreds of GE panel meters are available for almost any conceivable monitoring or measurement task.

And when you buy a GE panel meter, you also get more than 80 years of meter manufacturing experience and a sales network that is literally worldwide. For a free guide entitled, "Pick the Right Panel Meter," write to General Electric Co., Section 592-82, Schenectady, N.Y. 12345.

Specify General Electric... Just for good measure.

GENERAL ELECTRIC

Circle 27 on reader service card



HP's Terminals: smart, but simple.

With 10,000 sold in just two years, Hewlett-Packard's CRT line has made a considerable impact on the terminal market. The secret? Human engineering.

By designing our smart terminals around a microprocessor, we've managed to uncomplicate difficult jobs and make simple tasks a piece of cake.

But that was just the beginning. We wanted to make our terminals easy to maintain and expand. And we wanted to make them easy on the eyes, both from the operator's point of view and as pieces of office furniture.

We did it all. Our terminals won design awards for their appearance. And our exceptionally clear, high-resolution displays have won the hearts (and eyes) of everyone who has to spend long hours in front of a CRT.

Reducing operator fatigue.

For our screens, we use a 9x15 character cell, with dot shifting to provide exceptionally clear definition. You don't have to peer at tall, skinny letters. Ours look like the best typewriter printing, with the right spacing and descenders below the line.

By using white characters rather than green, we've made the display brighter and easier to read. (Have you ever tried watching black and green television?)

Several other screen features simplify an operator's life. Inverse video, optional half-brightness, underline or blinking characters can be used to stress important information, and reduce mistakes in transmission.

Plug-in modules for quick changes.

That's the simplest way of adapting a terminal to your job. So we offer a variety of components that pop in and out.

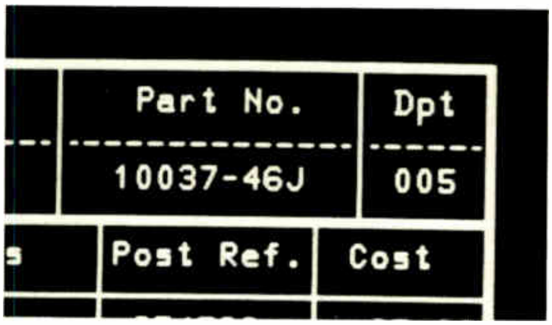
All our terminals have plug-in character sets to cover a wide range of computer languages. And a plug-in Forms Drawing option lets you generate almost any form your company uses.

Our smartest terminals let you plug in fully integrated mass storage. This takes the form of twin cartridges, each able to store up to 110,000 bytes of data or programs.

You can use this information locally (the terminal's "soft keys" save a lot of time and effort on off-line jobs) or transmit it to your central computer.

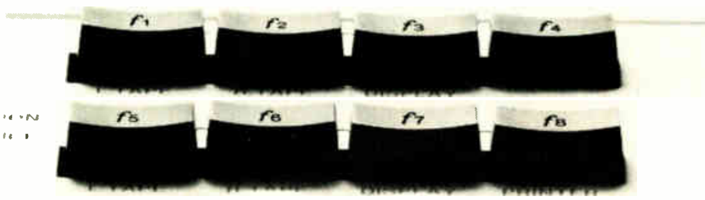
Another new terminal, the ultimate "have-it-your-way" design, should be extremely popular with OEMs. You can pick and choose from a variety of hardware modules, and write your own firmware. Everything plugs together for a virtually custom display station.

Some intelligent ideas for smart terminals:

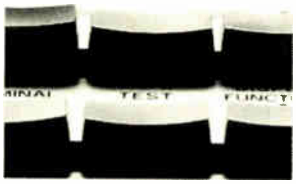


An exceptionally clear display eases long sessions at the CRT. A Forms Mode aids accurate data entry.

Plug-in mass storage: you can get up to 110,000 bytes per cartridge.



The "soft keys" on our smartest terminals let you execute complex operations with a single keystroke and eliminate many repetitive jobs.



Problems? The self-test key helps pinpoint them for you.

Maintenance is a snap.

Unsnap a couple of catches and our terminal is wide open. The plug-in PC boards are right there. What could be easier for changing options or speeding up repairs by our servicemen?

Not that downtime is a problem. Our terminals have such a good MTBF that we've lowered our maintenance price twice in the past 18 months.

And when you do need service, you've come to the right company. We have more than 700 Customer Engineers ready to

give you support, documentation and training.

So when you're choosing a terminal, think of your people first. Then think of the terminals that are smart enough to be almost human. Your local Hewlett-Packard sales office can give you complete information. Or mail us the coupon and we'll send you the facts.

HEWLETT hp PACKARD

Smart doesn't have to mean complicated: eight HP terminals that prove the point.

The HP 2640B Interactive Display Terminal. Even our simplest terminal has many intelligent features, including an enhanced high-resolution display, plug-in character sets, dynamically allocated memory, microprocessor control, full editing, self-test, forms mode and more. It's a lot of terminal for the money.

The HP 2640C Cyrillic Display Terminal. This has everything you like about the B version, but it speaks Russian too.

Cyrillic *Swedish* *Arabic*

The HP 2640N is fluent in Danish or Norwegian.

The HP 2645S completes our Scandinavian coverage with Swedish or Finnish.

The HP 2645R. Designed for an application in Iraq, this model enters Arabic characters from right to left. It also works from left to right for standard computer languages.

The HP 2645A Display Station. Our smartest terminal, it can transmit at rates up to 9600 baud, has a forms mode, user definable "soft keys," and optional fully integrated mass storage. A very intelligent choice.

The HP 2641A APL Display Station. This is modeled after the 2645A, but also includes a full 128 character APL set, plus an APL 64 character overstrike set.

The HP 2649A Mainframe Terminal. This data station is ideal for OEMs. It lets you design custom firmware for your special application and pick the hardware modules your system demands. Available with all of the 2645A's advanced features.

I want to know more about HP's terminals.

- ☐ Contact me to arrange a demonstration in my office.
- ☐ Let me know dates of the HP Terminals Seminar to be held in my area.
- ☐ Send me complete information about the following terminals:

____

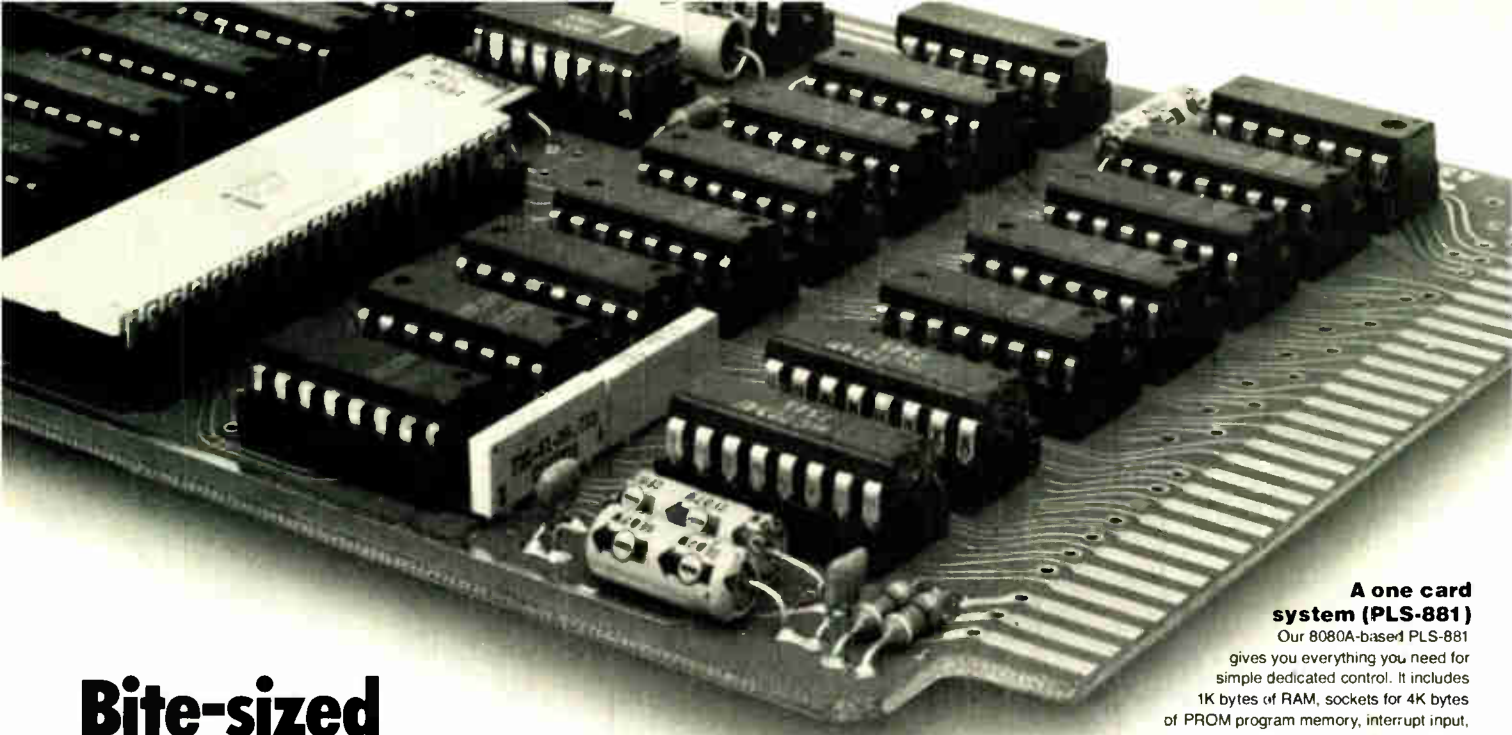
Name ______________________________

Company ______________________________

City/State/Zip ______________________ Phone ______________

Mail to: Ed Hayes, Hewlett-Packard, 11000 Wolfe Road, Dept. 603, Cupertino CA 95014

42702HPT3



A one card system (PLS-881)
Our 8080A-based PLS-881 gives you everything you need for simple dedicated control. It includes 1K bytes of RAM, sockets for 4K bytes of PROM program memory, interrupt input, crystal clock, power-on and external reset, three 8-bit output ports, and two 8-bit input ports. It costs only $195 in 100 piece quantities.

Bite-sized 8080A systems make big boards hard to swallow.

Simple, flexible, standardized Pro-Log 8-bit microprocessor systems a best buy for OEM's.

We sell 8080A and 6800 microprocessor cards two ways; as single and multicard systems, or as individual CPU and support cards so you can build a system of your own.

Our cards are all standard 4.5″ by 6.5″ with 56 pin edge connectors. They fit into standard card racks. To keep you from being tied to a specific semiconductor manufacturer for parts, delivery and pricing, our 8080A and 6800-based systems use only second-sourced parts.

Buy 250 of any particular card and we throw in free its manufacturing and assembly plans and non-exclusive rights to manufacture it, allowing you to build your own hardware, relying on us as an established and dependable second source.

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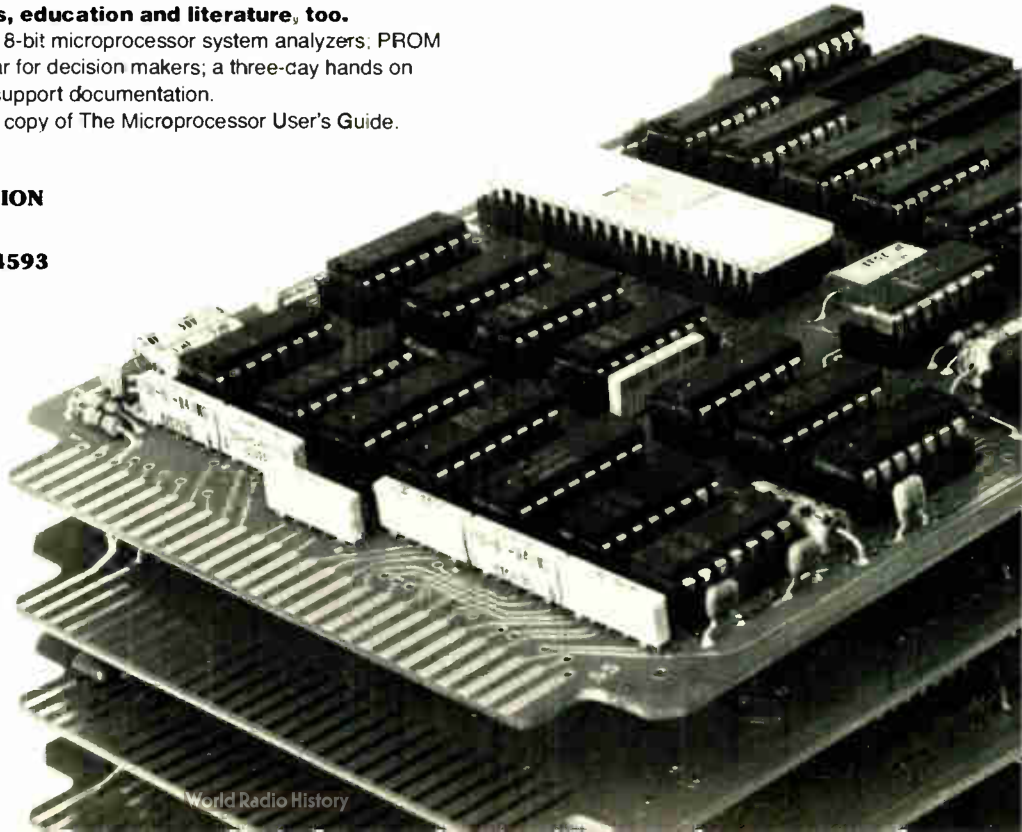

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Microprocessor runs military repair system

Interactive display console, floppy-disk mass memories are the key elements in transportable package

From any viewpoint, maintaining complex military electronics systems poses a headache. The contractor has to write and update costly manuals running to thousands of pages, and the services constantly have to train technicians—many reading at sixth-grade level—to fight rapid turnover. Attacking this problem from a new angle, Hughes Aircraft Co.'s Ground Systems group has built a microprocessor-based troubleshooting and repair system that it claims almost anyone can operate with little training.

Called the Technician's Maintenance Information System, it consists of an interactive display console, a 6800 microprocessor, two 256-kilobyte floppy-disk mass memories, and a programmable read-only memory.

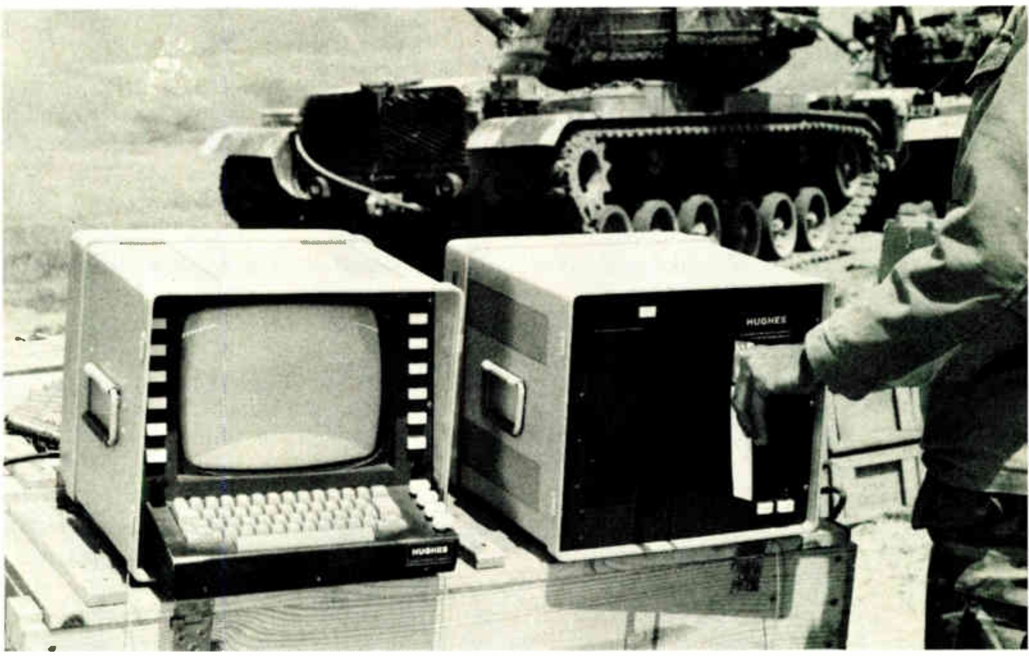
"What the system does is replace a trained, experienced technician," says Arthur Harris, head of the development project at the Hughes group, Fullerton, Calif. As he describes it, the system works by storing maintenance data about a specific piece of equipment on the floppy disks, then displaying the proper action when an operator enters a malfunction's symptoms as an English language statement via the keyboard. Depending on the trouble, the console might respond with further queries. In any case, it would narrow down the list of possible causes to one corrective action.

"Not only can the system pinpoint the failure from answers the technician provides, but it tells him which part needs replacing and pictorially depicts where it is located and how to change it," Harris says. If necessary, the transportable unit will indicate what are the proper tools and test equipment for the job and explain how to use them.

Language. Heart of the system is a hybrid computer language, combining elements of cobol and IBM Assembly Language. It was developed by Hughes to allow managing a large data base with microprocessor architecture. With English as the input language, operators do not have to be trained in programming.

"We tailored it to the lowest possible reading level," Harris says, which is the sixth-grade range. To guard against imprecise phasing and even misspellings of trouble descriptions, the system has algorithms that pick out key words. "It would recognize the word 'transmitter,' even if nothing else were understandable, and give the right response," Harris claims.

The prototype system is built to troubleshoot one of the Hughes radars being evaluated by the Navy for target acquisition on destroyers. The prototype troubleshooter has been demonstrated to all the services and has sparked lively interest, Harris says. "It's not just aimed at replacing maintenance people in the field, but also at simplifying techni-



On the go. With Hughes-built microprocessor-based repair system, faults in complex electronic gear can be diagnosed in the field by relatively unskilled technicians.

cian training and improving parts inventory control."

Although other firms have talked about such a microprocessor-based system, the Hughes unit has reached the hardware stage. The company has had a five-person team working on it for 18 months in the system engineering group of its support equipment section. In large production runs, the system could sell for $5,000 each, Harris estimates, and would be flexible enough for any kind of electronic equipment. □

Citizens' band

Kit has all parts for 40-channel radio

A 40-channel amplitude-modulated citizens' band radio using a complete kit of parts supplied by a semiconductor maker is going to the Federal Communications Commission this month for type acceptance. The radio, manufactured by Palomar Electronics Corp., Escondido, Calif., was built entirely from a Plessey Semiconductor kit that included all the components—from printed-circuit board to switches—needed to put together the radio, which was also designed by Plessey.

Plessey does not plan to supply the entire kit, which includes non-Plessey parts, to all potential customers. But it is gearing up to give CB makers a kit containing a lot more material—complete details on pc-board layout and detailed lists of actual components needed—than many other vendors supply.

The complete kit will cost $38 if purchased in 100,000-lot quantities, according to Bill Bradford, manager of CB Radio systems applications at Plessey in Irvine, Calif. "We have done the total design from the ground up," says Bradford. "All the manufacturer has to do is buy the parts we've specified."

His firm's main interest, of course, is getting its integrated circuits into CB sets. Its IC package for the a-m radio includes a SL1610 radio-frequency voltage amplifiers, two SL1641 chips for first and second mixers, three SL1612 intermediate-frequency voltage amplifiers, a SL1624 a-m detector and automatic-gain-control amplifier, a two-chip bipolar synthesizer using a SP8921 and either a SP8922 for binary-channel entry or a SP8923 for binary-coded-decimal channel entry, a SL1626 audio amplifier with over-modulation protection, and a SP1648 voltage-controller oscillator or a SL1610 plus a discrete field-effect-transistor oscillator.

Plessey claims that the a-m radio's performance exceeds all FCC requirements, with a sensitivity of 0.5 microvolts for a 10-decibel signal-to-noise ratio in a 6-kilohertz bandwidth. Adjacent channel selectivity is greater than 65 dB, 10 kHz away, and agc action is excellent over at least a 30-dB change in received transmission, the firm says.

In the works. The company is planning some new ICs for the fourth quarter of this year. Its designers are combining the rf amplifier and first mixer into a single-chip and are putting two of the i-f amplifiers onto another. Other ICs will provide either double- or single-conversion capability, as well as i-f amplification at 455 kHz and audio-derived agc for feed-

Fluke widens line with digital meter

In a major move to broaden its product line and customer base, John Fluke Manufacturing Co. is going after the service technician and home experimenter with a $169 portable digital multimeter.

Putting the company for the first time in competition with such multimeter manufacturers as Simpson, Triplett, and Weston, the model 8020A is a 3½-digit meter that uses a liquid-crystal display and is based on a custom complementary metal-oxide-semiconductor chip made for the Mountlake Terrace, Ore., company by Intersil Inc. Because of the lower power consumption possible with the LCDs and C-MOS, the meter runs off an alkaline battery, which will give 200 hours of operation, according to Fluke.

"We hope to get a much broader recognition of the company among customers who may not have heard of us—opening doors for the future," says Fluke president John Zevenbergen. "This is the first time we have had a meter that can be almost totally supported by the person who owns it. Although we specify the calibration period as one year, we feel it will more typically go for three years before it needs recalibration. And with about 100 service locations around the world, we hope to be able to service the meter on the spot if the user brings it in or to turn it around in 48 hours if he sends it in."

Zevenbergen says that he hopes to sell considerably more 8020As than his most popular DMM, the $299 8000A bench-top model, which is selling at about 20,000 units a year. "We expect to at least double that," he says.

The new hand-held meter is in a case measuring 7 inches long, 3½ in. wide, and 1½ in. high and weighs 13 ounces. It measures dc voltage to 1,100 volts, ac voltage to 750 V, ac and dc current to 2 amperes, and resistance to 20 megohms. A new feature to the field is its ability to measure conductance directly, allowing resistance measurements up to 10,000 megohms.

forward operation, adjustable squelch and s-meter output drive, and a noise-blanker chip that uses rf or i-f sensing for blanking and has shaped-switching response to eliminate i-f ringing.

Other semiconductor companies are offering ICs for CB radios. But they have not gone as far as Plessey in putting it all together. National Semiconductor Corp., for instance, has a four-chip set but does not include the modulator, rf transmitter chain, and the first mixer and rf amplifier. Toshiba has a similar lineup, and other companies offer selected chips.

Another view. Although these companies pose competition to Plessey's aim of becoming a market leader in supplying all the needed ICs, Texas Instruments Inc.'s recent entry into the CB market [*Electronics*, May 12, p. 31] could change its complexion. Bradford thinks that the automatic clarifier feature of TI's microprocessor-controlled combination a-m and single-sideband radio, which does away with the bothersome task of having to tune in each transmission to achieve intelligible speech, could revolutionize the market.

SSB radios effectively triple the number of talking channels over a-m only. Bradford says that Plessey is busily putting the final touches on their own SSB radio kit and is developing an automatic clarifier circuit that could end up using charge-coupled-device technology.

Industry observers think that TI could crank their sets through its calculator production lines and sell them for $49.95 if they wanted to. Even at twice that price, the set would be cheaper than most others now on the market, and it offers many extra features to boot. As a result, many CB manufacturers are rushing for help to ready their own IC-implemented SSB radios, which Plessey feels it can supply for about $55 for the complete radio. ☐

Packaging & production

Electron beam ups wafer throughput

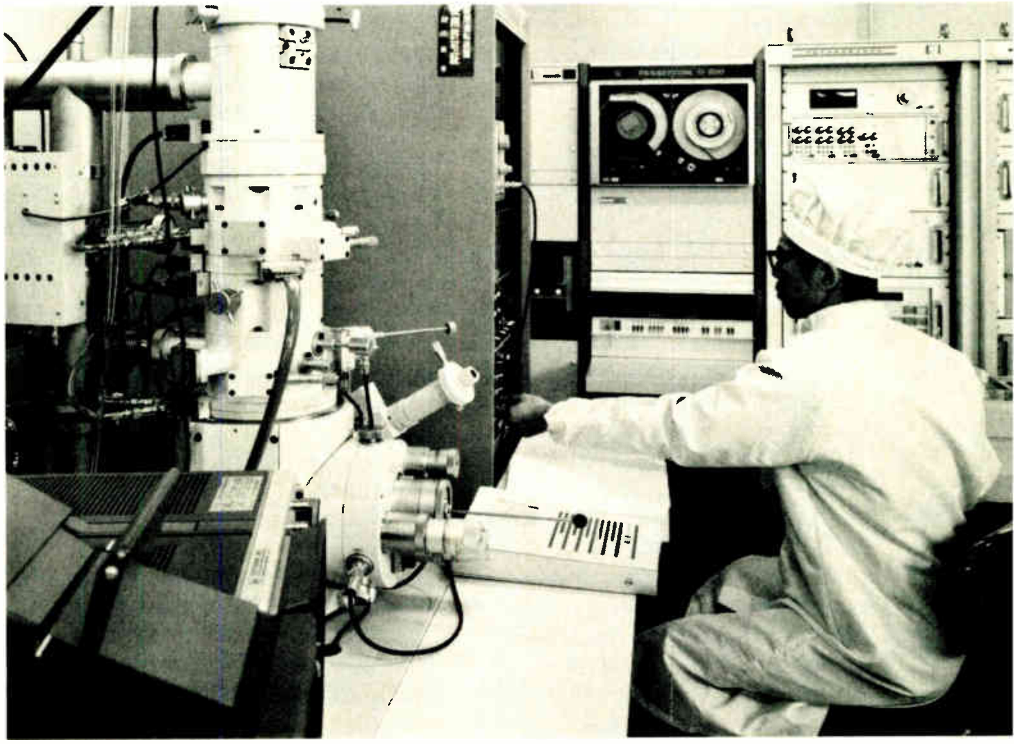
Researchers at Japan's Cooperative Laboratory have come up with an electron-beam fabrication system that completes a pattern in a tenth of the time needed by conventional equipment. The system is one result of Japan's push in VLSI (see report, p. 99).

Compared to other electron-beam systems, says the lab, it is about twice as fast as Bell Laboratories' MEBES and about as fast as IBM's EL-1—based on line widths of 2 micrometers. But, Japanese spokesmen add, the time required by the American units increases as the reciprocal of the resolution squared. Because the Japanese unit has much higher resolution to begin with, it does not incur a time penalty when submicrometer line spacing is required. The new system, using a variable-area rectangular technique that can be used to make integrated-circuit masks or to expose patterns directly on wafers, has fabricated 3-inch wafers in the lab in 30 minutes to an hour.

It can expose rectangular areas with sides ranging from 1 micrometer to 25 μm, meaning that most features in a cell of an LSI circuit can be fabricated in a single exposure, rather than with many overlapping circles or squares. In one experiment, the mask for a memory cell was completed in 12 exposures rather than the 4,400 dots necessary in conventional systems. Although each individual exposure takes longer with the new system, the overall time is still reduced.

The electron gun in the new system produces a broad beam that a flood lens focuses into uniform density over an area larger than the aperture in the beam-shaping plate. Below this plate, which is perpendicular to the beam, are pairs of beam-shaping deflection plates perpendicular to each other. Below them is the projection lens and then another beam-shaping plate with a square aperture. All lenses in the system are magnetic electron lenses.

The first beam-shaping plate gives the beam a square cross section; the projection lens focuses it so that its area just corresponds to the aperture



On target. Aimed to up both resolution and the speed of wafer processing, $1.5-million electron-beam machine from Japan is due on market next year.

in the second beam-shaping plate. If it is not deflected, the beam merely passes through the second plate unaltered. If it is deflected in only one direction, the square beam becomes a rectangle with the length of its short side decreasing as deflection is increased. Deflection by the other set of beam-shaping plates can shorten the rectangle in the other direction, too.

The shaped beam then passes through a reduction lens, which focuses it on the wafer or mask, and through beam-positioning deflection plates, which position the rectangle on target. The reduction lens serves to make the beam edge sharper than with raster-scan or vector-scan systems.

The initial proposal for the unit was developed by the Institute of Physical and Chemical Research and Fujitsu Ltd. Fabrication was undertaken by JEOL and Fujitsu. Final assembly, adjustment, and experimental operation were done at the Cooperative Laboratory.

The machine, dubbed model JBX-6A, is due on the market in September 1978. Price will be about $1.5 million. A factory prototype of the system will be ready in three months, according to JEOL. □

Military

Terminal radar upgrades Pershing

The U. S. Army wants to improve the accuracy of its Pershing tactical missile so that it can use nuclear warheads with greatly reduced yields. These would destroy their assigned targets, while doing minimum damage to adjacent areas and civilians.

Toward that end, Martin Marietta Aerospace's Orlando, Fla., division is well along in advanced development of Pershing II, which would replace the aging Ia version of the 400-mile-range missile now deployed in Europe. The chief improvement of Pershing II is a reentry vehicle that uses a newly developed radar for terminal guidance. The Pershing Ia, has a purely ballistic reentry vehicle.

Martin Marietta's Orlando division is prime contractor for Pershing and has received more than $65 million for advanced development of the new version. Goodyear Aerospace Corp., Akron, Ohio, is building the radar area correlator, which is being tested in a prototype warhead carried under the wing of an aircraft that simulates the missile's reentry trajectory.

The converted jet fighter has made more than 150 flights, diving at angles between 45° and 90° from altitudes as high as 40,000 feet. While the accuracy improvement over the Pershing Ia achieved in those tests is classified, Martin Marietta's James Bogard is convinced that six flight tests set for this fall aboard a real missile will be successful. Bogard has been manager of the Pershing II captive flight tests, and he says they have met or exceeded the Army's accuracy specifications.

Those tests aboard the fighter are continuing at Huntsville, Ala., after earlier fights at Orlando and at White Sands Missile Range, N. M., where this fall's missile flights will take place. The reentry vehicle is a prototype, but Bogard expects only minor alterations before the missile flights commence.

So far, so good. In the captive tests, an image of the target area is stored in the radar's correlator unit on 35-millimeter film. As the aircraft dives, the Goodyear mapping radar scans about an inertially derived nadir axis to derive video data stored in a flashlight-sized tube called a Correlatron. The radar scans at a mapping rate of 0.5 second, with another 0.5 s required to correlate the radar-derived image in the Correlatron with the stored film image.

The 35-mm film target image is back-lighted and projected to the Correlatron tube, generating an electron image on the photocathode. The two are correlated through electron multiplication, which results in the best match in terms of the $X-Y$ position from the target. Any disagreement between the inertially derived reentry-vehicle position and the correlator-derived position is sent to the reentry vehicle's on-board computer in a digital format.

The computer aboard the Pershing II in actual missile flight tests would then correct any detected navigation errors and generate commands for the vehicle's fin-control system. The control hardware is not used in the captive tests because the reentry vehicle is never launched. But a portable distance-measuring system is being used to determine the accuracy of the combined inertial/correlator subsystem to calculate their position to within 6 meters. □

Microprocessors

Unit diagnoses many 8-bit devices

As a multitude of 8-bit n-channel metal-oxide-semiconductor microcomputer-based systems enters high-volume production, there is a growing need for a powerful, portable diagnostic and maintenance tool designed especially for field servicing of microprocessors.

Intel Corp. is introducing just such a system, designated the model 820 μ-Scope, at the National Computer Conference. The new microprocessor console is portable enough to fit into a large brief case but powerful and adaptable enough for use with any 8-bit microcomputer-based system, says Thomas Jones, product line manager for instrumentation and test systems at Intel.

To date, logic analyzers or microcomputer development systems, such as the Intellec MDS, fitted with special diagnostic modules have frequently been used for field servicing and maintenance of microprocessors. "But the major drawbacks to these partial solutions are expense and lack of portability," Jones says. In addition, many such diagnostic aids do not test in real time or at the normal operating speed of the system under scrutiny. Then, too,

Speed. To use µ-Scope to test any microcomputer-based system, service personnel need only remove the microprocessor from its socket and insert the µ-Probe connector in its place.

such systems are designed for specific microcomputers and are not easily adaptable for use with other types.

The Intel 820 µ-Scope is small enough to fit in a 19-by-15.5-by-7-inch carrying case. What's more, when it becomes available in September, it will be priced in single-unit evaluation quantities at under $2,500, economical even for small-volume users, says Jones.

Outside control. The µ-Scope provides complete real-time control over the microprocessor in the system under test. The user's central processing unit can be forced to halt, single-step, reset, run real time, or run real time with periodic display-data collection, without loading the system or changing its speed while being tested. All tests are conducted at the microcomputer's normal clock rate. Thus, unlike many existing diagnostic aids, the 820 tests the CPU as a part of the total system.

Most important, says Jones, the µ-Scope is intended to work with many of the microprocessors available today through the use of a variety of hand-held µ-Probes. Able to drive a 6-foot cable, each probe plugs directly into the µ-Scope and comes complete with a personality read-only memory, which defines and interprets control signals specific to each type of microprocessor.

First of the 820 aids will come with a µ-Probe designed for the Intel 8080A CPU. Probes for most of the other microcomputer types now on the market will follow in the next few months.

New board. Key to the power and portability of the Intel 820 is the use of a newly developed single-board maintenance processor built around Intel's new n-channel microcomputer system, the MCS-85 [*Electronics*, May 12, p. 109]. The 8085 CPU and its peripheral circuitry fit on a single 18⅞-by-15.5-in. board that fits in the bottom of the 820 carrying case.

Also contained on the board are 256 by 32 bits of trace memory, 128 by 8 bits of overlay random-access memory, breakpoint logic that allows execution of a number of different diagnostic operations, and a fully regulated dc power supply.

A front-panel zero-insertion-force socket is provided for mounting 2,048-bit ROMs or programmable ROMs that serve as storage for preprogrammed test subroutines. The actual usable program space of the ROM/PROM is 1,920 bytes. The remaining 128 bytes of storage are used by the µ-Scope to identify as many as 16 separate subroutines and to define the specific instrument states and conditions under which the subroutine can be called. These 16 subroutines can be used by a particular customer to tailor the 820 for a specific application. □

Standards

Microprocessors hurt Army standardization

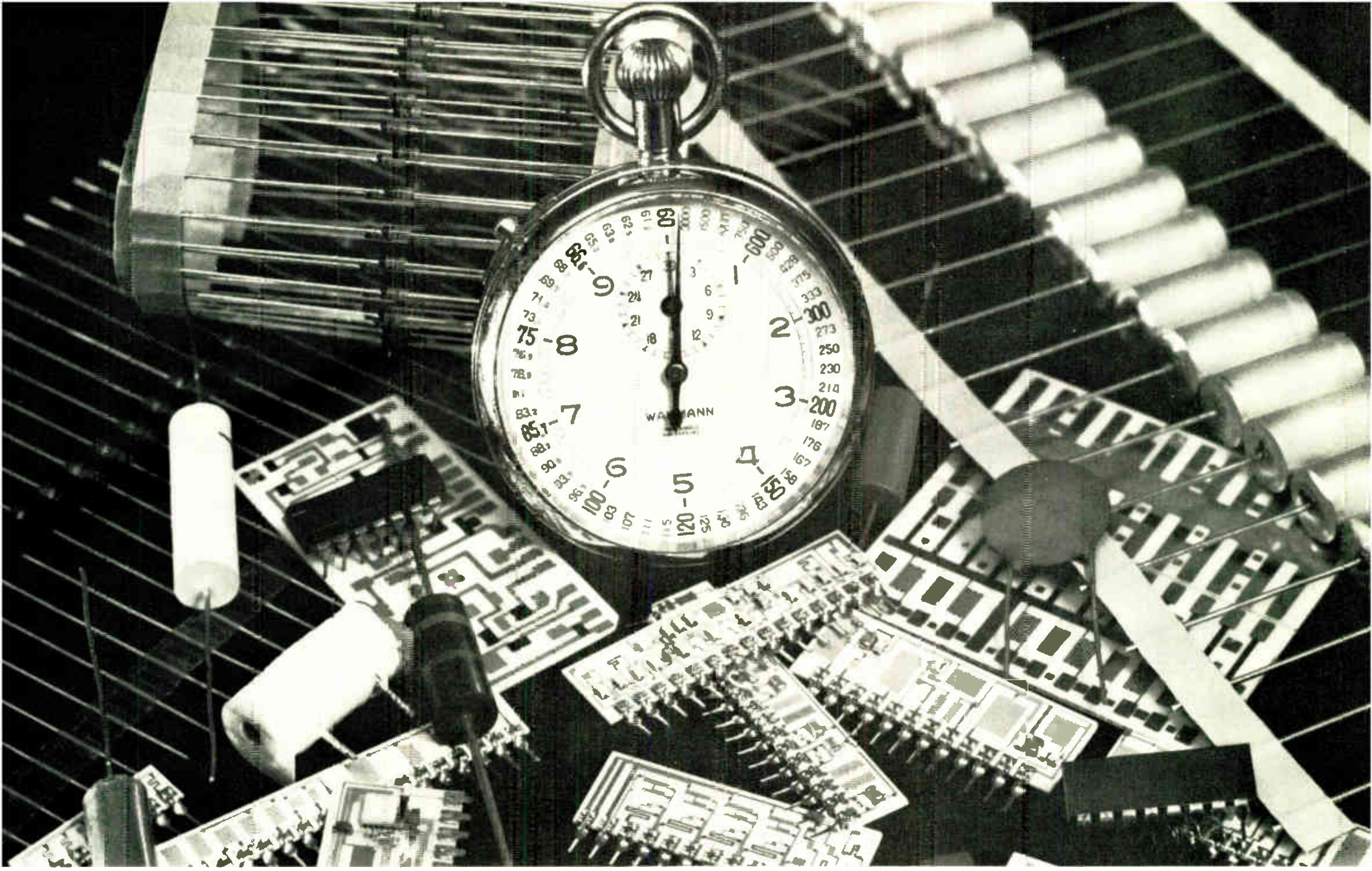
The desire in military circles for standardization is running into an unexpected obstacle: the microprocessor. Devices that can emulate 16-bit and 32-bit computers are posing a formidable challenge to the need for standards as the semiconductor industry enhances distributed processing by cramming more capacity onto a chip, including memory, and slashing the cost per bit.

Army-Navy standards advocates are finding their position increasingly difficult as they realize that large-volume commercial and industrial markets—not low-volume military users—now call the shots in microprocessor technology.

These conclusions emerged after two days of intense discussion and disagreement among 132 government and industry participants in the IEEE Computer Society's microprocessor workshop at the end of May. The meeting was cosponsored by the Naval Air Development Center, Johnsville, Pa., and Johns Hopkins University's Applied Physics Laboratory, Laurel, Md.

It was the Control Data Corp.'s 480 family of microprogrammable computers that sparked much of the argument. A subset of the 480 has been chosen as the Navy's first standard airborne computer, the AN/AYK-14 (V), for use on the F-18 air combat fighter now in development at McDonnell Douglas Corp., St. Louis, and the Mark III version of the helicopter called Lamps (for Light Airborne Multipurpose System).

The CDC 480 is using pluggable



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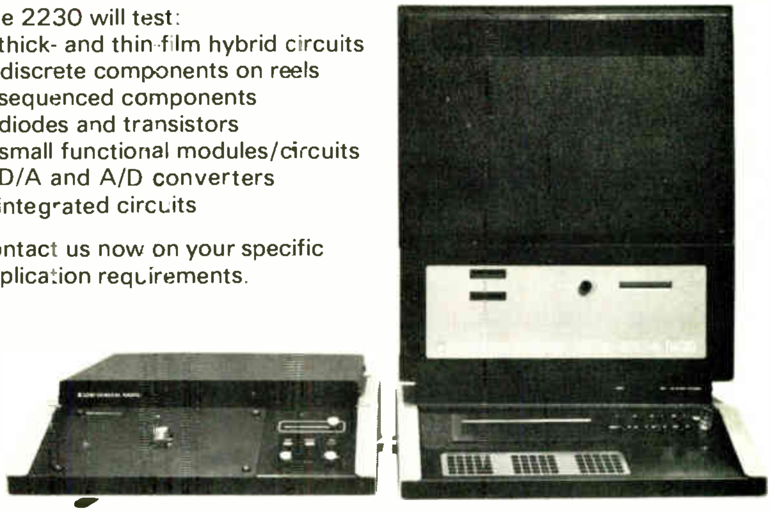

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Circle 37 on reader service card

6-by-9-inch cards and "can emulate any 16- or 32-bit computer," according to the firm's Will Kenney, with the latter configuration achieved by using two modules in parallel. Configurations range from a two-module dedicated processor to 32-bit, high-speed multiprocessors with 16 modules and as much as 512,000 words of memory, and extensive input-output capability with 256 ports available for each function.

Opposition. The Naval Air Systems Command is pushing hard for microprocessor standardization and expects to develop newer systems for the family of vertical/short take-off and landing aircraft that it wants a decade from now. Yet Navair's standardization concepts are being challenged even within the service.

"All standards become passé in three to five years," observed NADC's William Norr, program chairman. System designers "don't care what is on a chip. They only care about its function" and such physical characteristics as its power requirements and the number of pins, he argued. "A standard interface is okay until it begins to get in the way."

Countering Norr's view was Navair's Bernard Zempolich, who also chairs the Computer Sciences Resources Council, formed last fall by the Naval Material Command. "Standards can be beneficial," Zempolich contended, but only if definitions of terms can be established first. "What is a microprocessor? What is firmware?" Answers to these questions that can be accepted by government and industry need to come first, he said.

Languages. Zempolich, also an advocate of a standard high-order language for Navy computers, disclosed that his council has indicated a preference for the SPL-1 language and has moved it into advanced development for the Navy's interim high-order language over the other candidates: CMS-2M used in the AN/UYK-20 shipboard tactical system and compatible with an AYK/14, the SMS-2Y in the Navy tactical data system's AN/UYK-7, Cobol, and Fortran.

But the military's need for a standard high-order language was also challenged from the floor by questioners who cited the rapid development of small bubble memories. Their ability to permit more distributed processing in subsystems eliminates the need for constant central-processor control and thereby high-order language, they said. A registrant from National Semiconductor Corp. said a high-order language "takes us back to minicomputer dark ages."

Economics. The fact that major semiconductor circuit makers have written off many low-volume military users as a principal influence on design is a matter of economics, according to Joseph Kraeger of Advanced Microdevices Inc., Sunnyvale, Calif. To arouse industry interest in designing circuits with high-order arithmetic functions, a military customer would have to have at least $50,000 and be ready to order 100,000 devices.

But Raytheon Co.'s Frank Langley advanced the argument that semiconductor makers should not overlook the high-volume market for expendable, air-launched tactical missiles, as he detailed a company study on possible standardization of missile microprocessors. Missiles, like Raytheon's air-to-air Sparrow are bought by the "tens of thousands compared to buys of 400 to 500 planes," he said. □

Components

Current mirror ups bi-FET performance

Look for some strong competition for National Semiconductor Corp. in high-precision bi-FET operational amplifiers from Precision Monolithics Inc., which has primarily been a high-precision linear bipolar house specializing in op amps, comparators, and data converters.

The Santa Clara, Calif., firm is moving aggressively into the mixed-process marketplace by using a new ion-implantation process, by second-sourcing National's LF155/156/157 series of bipolar-field-effect-transistor op amps, and by producing a new, improved second-generation series called the OP-15/16/17. All these bi-FET devices are mixed-process chips, having junction field-effect transistors up front and a bipolar output stage.

Compared with even National's higher-precision A series, the new family, says George Erdi, design engineering manager at Precision Monolithics, has lower bias currents at high temperature—0.9 nanoamperes versus 5 nA at an ambient temperature of 70°C and a fourfold improvement in offset voltage—0.5 millivolt. What's more, it has higher slew rates—16 vs 12 volts per microsecond, typical for the OP-15—and a lower maximum supply current—4 vs 7 milliamperes. Moreover, the die area of 64 by 45 square mils is 20% smaller than comparable standard bi-FET parts, he says.

Cancellation scheme. A significant contributor to the improved performance of PMI's family, particularly in regard to bias currents, says Shelby Givens, staff applications engineer, is a proprietary gate-leakage-current-cancellation scheme used in the FET input stage of these mixed-process devices.

"As a common rule, the input current on most bi-FET-type devices is the leakage current of a FET gate, typically an isolation pocket in which an epi layer extends down to the substrate and vertically to the isolation walls," says Erdi. Approximately 90% of the leakage is from the epitaxial layer to the substrate, and the other 10% is from the gate to the drain of the device. The bias current that results is about 50 mA at a junction temperature of 25°C, doubling every 10°C.

Erdi and his engineers have reduced the amount of leakage by the use of a current-mirroring technique, in which another isolation pocket is fabricated next to the FET gate, with a leakage that is approximately equal in magnitude but opposite in charge. The result is a bias current that increases less than one third as fast with increasing temperature to 150°C. Bias current on the

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SCIENCE/SCOPE

Meteorologists will be able to paint a three-dimensional picture of the earth's cloud cover -- and improve long-range weather forecasting -- when a new instrument, aboard geostationary meteorological satellites, is launched around 1980. The instrument, to be built by Santa Barbara Research Center, a Hughes subsidiary, is called VAS (Visible Infrared Spin-Scan Radiometer Atmospheric Sounder).

The VAS will take vertical soundings of the earth's atmosphere, examining the water vapor and carbon dioxide absorption bands, in order to obtain data on temperature and humidity at various altitudes. This vertical profile is then compared to the measured temperature of adjacent cloud tops to determine the altitude of the clouds. By observing the direction and speed of these clouds, meteorologists can determine wind movement at various heights, adding this information to the two-dimensional picture obtained by the earlier VISSRs.

This will be the first time that vertical soundings will be made from a geostationary satellite, so the VAS will provide previously unattainable information on atmospheric circulation patterns, a vital part of weather forecasting.

The invisible fabric that weaves diverse and complex hardware into today's major weapon systems is software, which is the programming of computers within these systems. More than 25 years ago -- that's even before software was called software -- the Hughes initial entry into the specialized technology of software was an airborne, digital, fire-control system for the "Century" series of interceptor aircraft. As systems became more sophisticated to meet growing threats, Hughes software teams were formed with specialists in programming the fire-control systems.

Today, the nearly one thousand team members provide software for such diverse programs as the Navy's AWG-9 fire-control system, the Air Force's F-15 airborne radar, the Army's AN/TPQ-36 and -37 mortar and artillery-locating radars, SURTASS antisubmarine-warfare program, the NATO NADGE air-defense systems, and JTIDS (AN/ARC 191), a joint service program to provide a secure, real-time communication network.

Hughes needs communications-satellite engineers, at all levels of experience, to design and develop advanced digital-communications hardware. There are opportunities in circuit, logic, and unit design for phase-lock loop demodulators and bit synchronizers; spread-spectrum and PSK demodulators; DFT- and FET-hardware design; and microprocessor control design, primarily below 100 MHz. Also openings for microelectronic design engineers in logic and circuit design and layout of custom CMOS/SOS microcircuits, for high-reliability space applications, advanced CCD memories, signal-processing devices, and tradeoffs of CMOS/SOS, ECL, I^2L, PMOS, TTL, CCD, and GaAs technologies. US citizenship and a degree from an accredited institution are required. Please send resume to Don H. Haycock, Hughes Aircraft Company, PO Box 92919, Los Angeles, California 90009. An equal opportunity M/F/HC employer.

Reduced energy consumption and extended equipment life will result from a new facility-management system being developed by Hughes for installation at the Air Force's Arnold Engineering Development Center. The system will monitor and control most of the heating, ventilating, and air-conditioning equipment in the Center's 42 buildings. The system can be programmed to shut down nonessential operations automatically during periods of peak-power requirements.

Data is transferred between remote terminals and a computer-controlled central station via time-division multiplexing. Other functions, such as closed-circuit TV, can be added. It is estimated the system will result in savings of $200,000 annually in energy and labor costs and will pay for itself in four years.

Creating a new world with electronics

HUGHES

HUGHES AIRCRAFT COMPANY

OP-16, for example, is 11 nA, more than a thirteenfold improvement over present devices, says Erdi.

According to Erdi, if traditional thermal-balancing techniques of circuit design had been used, the additional circuits needed would have resulted in a chip that measured some 10% larger than the present die, and on-chip zeners for trimming to reduce offset voltage by a factor of 4 to 16 would have resulted in an even larger one, says Givens.

In thermal balancing, circuit elements are placed symmetrically around a center line on the die, so that the heat flow from one side balances the other. However, thermal balancing has been used with little thought given to the actual thermal contribution, Erdi says. "As a result, present circuit designs are loosely laid out, with much wasted space."

What PMI engineers have done, he says, is analyze each element in detail. If there is a significant thermal contribution, it is balanced. If not, more consideration is given to saving chip area.

National Semiconductor, not to be outdone, is reportedly redesigning its higher-precision parts to improve the specifications in the same areas PMI has. "But we've got the jump on them as far as the high end of the market is concerned," says Erdi, "and we've still got a few tricks up our sleeves." □

Calculators

National's belated programmable ready

After a half-year slippage, National Semiconductor Corp.'s programmable calculator is about to make its debut. Originally scheduled for Christmas 1976 release [*Electronics*, June 10, 1976, p. 29], the all-semiconductor-memory 7100 has undergone a massive software overhaul. Only awaiting the completion of software programs and documentation it should hit the market within a few weeks.

"Essentially, the hardware was all done. We had a working calculator a year ago," explains Robert Johnson, director of advanced calculator development at the Santa Clara, Calif., firm. "But after much study and playing with the machine we found that the way we had done it really wasn't the best way."

Before the software changes, the 7100 had operated in algebraic-type mode, like the machines of Texas Instruments Inc., but had no hierarchical structure for the operations. Moreover, the method of addressing memories was criticized by potential users as too cumbersome, Johnson says.

Thus, the microprogramming was restructured, and what was supposed to have taken six weeks took six months. Explains Johnson: "The microcoding was a bear—but wc think now we've got a really smooth calculator. It handles nicely, it's fully merged, it has algebraic hierarchy, and you can access all the registers easily."

Since the initial description of the 7100 at the Electro76 convention in Boston, little has been changed in the calculator hardware itself. According to Johnson, some additional read-only memory has been added—three 16,384-bit ROMs were replaced by two 32,768-bit units. Aside from slight changes in cosmetics and keys, the calculator is virtually the one announced last year at this time: 240 merged program steps, 32 addressable data-storage registers, and a line of factory-programmed plug-in library cartridges.

Johnson credits the increased smoothness and useability of the machine to a special series of test sessions that National arranged. During them, the calculator was extensively tested by typical users. "In the last stages of microcoding the ROMs, we brought in experts in calculator use to get their reactions and to see if there were things they would like any different," says Johnson. "We took action on nearly every comment that came in."

The calculator boasts some features not found on competitive programmables, such as an input/output port for which National has big plans—for tying in peripheral equipment and even interfacing to the SC/MP microcomputer line also manufactured by the firm.

With a scheduled price of around $400—$100 more than the newest programmable from Texas Instruments, the SR-59 [*Electronics*, May 26, p. 42]—National may be at a price disadvantage. Johnson explains, however, that marketing of the 7100 will follow a whole new strategy. The programmable calculator will be kept apart from National's other consumer products, which include watches, calculators, and other digital items. "Being a semiconductor company, we normally go after the products that are only high volume," he says, "but the 7100 is not a low-end calculator." □

Packaging & production

Plasma processors handle aluminum

Plasma technology is rapidly becoming an important factor in integrated-circuit processing at major U. S. firms, and it was taken a step further last month at Semicon/West 77 with the introduction of the first two machines capable of dry-etching aluminum. With this new capability for dry etching, most of the operations of the "wet room" that processes ICs could be eliminated, thus streamlining production.

A plasma is a highly ionized gas with a nearly equal number of positive and negative ions, plus free radicals. The free radicals are electrically neutral atoms or molecules that can form chemical bonds. These free radicals do the actual etching on the surface of a processed wafer.

Plasma etching was first introduced in the microelectronics industry about five years ago. By now it is commonly used in forming patterns in silicon, silicon oxide, and silicon nitride on wafer surfaces because, unlike acid-based wet etching, plasma etching is dry and safe. Also, it can achieve the finer resolution

News briefs

Arizona highway signs to get solar electric power

The Arizona department of transportation plans to use silicon solar-cell arrays to provide battery-recharging power for 40 signs warning of dust storms on two state highways. The decision follows a successful system demonstration supported by the Energy Research and Development Administration. The solar energy systems used to recharge each sign's batteries will replace propane-fueled, 60-watt generators. While the initial outlay for the system will be high, the agency says that annual operating costs of the signs will be cut nearly in half to $12,400 by reduced fuel costs and maintenance.

Upgraded Mostek RAM is faster

Even before competitors were able to sample second-source versions of its original 16,384-bit random-access memory, Mostek Corp. began shipping samples of a newer, higher-speed part. Unveiled late last month at the firm's annual users' forum in Dallas, the MK4116-1 is essentially an optical shrink—die size has been reduced from 27,700 square mils to 23,000—but minor design changes make requalification by users necessary. Maximum access time has been cut to 120 nanoseconds from 150 ns, and cycle time is down to 320 ns from 375 ns.

TI to require engineers to use calculators?

Acting on its claim that programmable calculators will enhance productivity, Texas Instruments Inc. is reportedly requiring that all its salaried engineers learn to use them. To carry out the mass training, the firm's Learning Center is setting up a six-hour videotape-and-seminar course. Billed to the employee's profit center, the course comes with a Programmable 59 calculator that the students keep. The recently announced calculator [*Electronics*, May 26, p. 42] accepts 3-inch magnetic program strips as well as plug-in read-only-memory cartridges.

Better polarizers coming for LCDs

The iodine-based polarizers that have been available for use with field-effect liquid-crystal displays have been the major limitation in extending the use of such LCDs to outdoor applications involving extremes of temperature and humidity. After extended exposure to such environments, the H-type iodine-based polarizers have severely darkened as they absorbed moisture. Now, Polaroid Corp., Cambridge, Mass., says it is ready to reintroduce a polarizing material that was withdrawn a couple of years ago for lack of a market. Polaroid is resuming production of its K-type polarizer, which is based on dehydrated polyvinyl alcohol.

Control Data, Yugoslavia sign computer deal

Control Data Corp. of Minneapolis and Iskra ZP, an association of automation and telecommunications equipment producers and marketers in Yugoslavia, have agreed to a 10-year program of business and technical cooperation in the fields of computer-related technology and marketing. The initial agreement calls for cooperative efforts involving the design, development, production, and marketing of minicomputer systems and the purchase of computer peripheral equipment.

Digital Equipment Corp. unveils its lowest-priced computer

A new generation of the PDP-8 minicomputer, this time a large-scale-integrated version with 16,384 words of random-access memory, was introduced late last month by Digital Equipment Corp. The new diskette-based system, named the DECstation 78, is priced at less than $8,000 for the PDP-8 CPU, a video terminal, and dual floppy disks. Included as standard in the VT78 video data processor are a real-time clock, disk interfaces, and high-speed input-output—features that ordinarily are options on PDP-8s. The Maynard, Mass. minicomputer maker calls the DECstation 78 its lowest-priced computer system.

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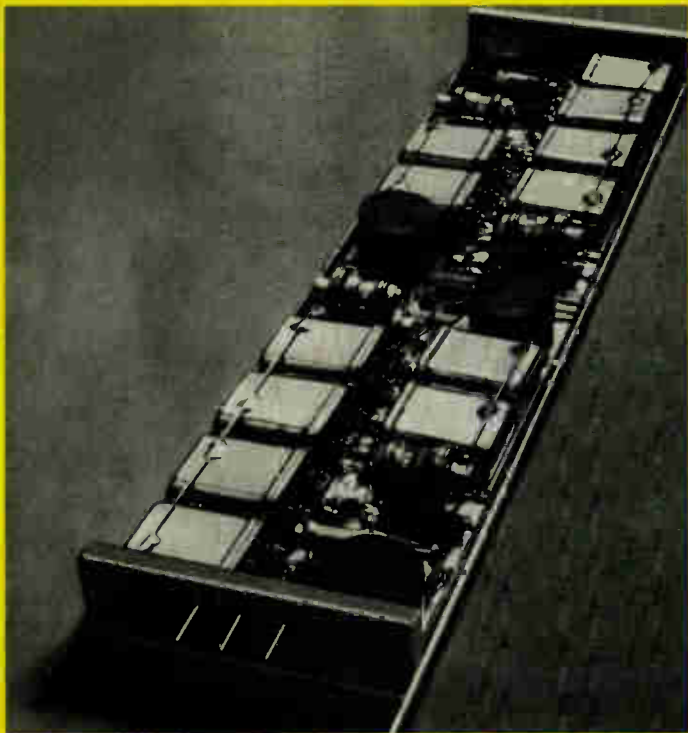
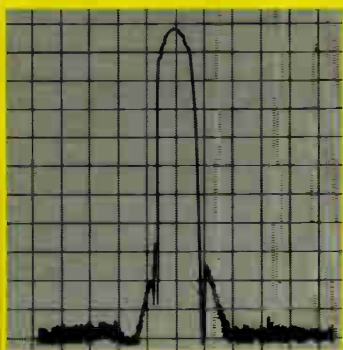
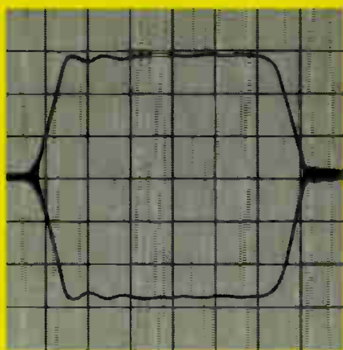


Complex crystal filter shown with typical attenuation and time response characteristics.



Frequency response



Time response

Crystal Filters
- Bandpass filters—shape factors to 1.15:1 (60 to 3dB)
- Band reject filters—shape factors to 1.5:1 (60 to 3dB)
- Upper sideband filters—shape factors to 1.11:1 (60 to 3dB)
- Lower sideband filters—shape factors to 1.11:1 (60 to 3dB)
- Gaussian (linear phase) filters—shape factors to 5:1 (60 to 3dB)
- Phase (or delay) compensated filters (to ± 1%)—shape factors to 1.15:1 (60 to 3dB)
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- Percent bandwidth range: .005 to 5.0

Discriminators—Frequencies/bandwidths similar to filters

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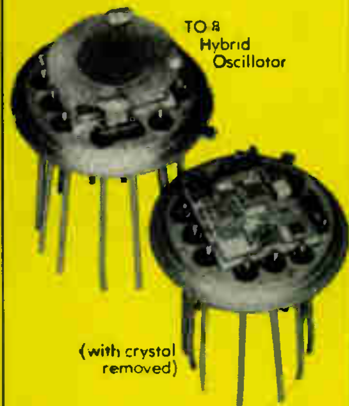
- Computer synthesized selection of components
- Small size, light weight, low power drain, instant warmup
- Frequency range: 1 Hz to 200 MHz
- Frequency stability: ± 1 ppm over −55° to +85°C or ±.1 ppm over 0° to +70°C

TC/VCXOs
- Frequency range to 200 MHz
- Frequency deviation to ± 3000 ppm
- Deviation sensitivity to ± 250 ppm/volt, or as desired
- Linearity to ± 1% of best straight line
- Short term stability to ± 1 ppm/sec.
- Frequency stability: ± 1 ppm over −55° to 85°C or ± .1 ppm over 0° to +70°C

Hybrid Oscillators
- TO-5, TO-8, E-7, DIP configurations
- TTL, CMOS compatible
- Frequency range: 1 Hz to 40 MHz
- Frequency stability: ± 40 ppm over −55° to +125°C
- Capable of meeting MIL-STD-883



Note: Input voltages from ± 5 VDC to ± 50 VDC are acceptable for all oscillators. Input power, dependent on application, can be as low as 10 mW.

All Hughes' filters, discriminators and oscillators are capable of meeting military, commercial or space-qualified environments.

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needed for upcoming large-scale-integrated designs. Finally, plasma processing creates no pollution problems with its by-products.

Up to now, though, dry etching could not handle the forming of the aluminum interconnects of a processed silicon wafer. But the two new plasma etchers from International Plasma Corp., Hayward, Calif., and D. W. Industries, Sunnyvale, Calif., can dry-etch aluminum as well as silicon oxide and nitride.

IPC's series 5000 costs about $39,500 and can etch 2,000 angstroms per hour into aluminum on 10 3-inch wafers at a time. The D. W. Industries model 335, priced at $49,500, etches at the same rate but can process 35 3-in. wafers at once.

Planar reactors. Both of the units use parallel-plate plasma reactors, a departure from the concentric-cylinder, or barrel, reactors used in older equipment. The parallel-plate, also called planar, reactor generates its plasma, and therefore its free radicals, right at the wafer, while the plasma generated in a barrel reactor is generated at the reactor wall. The planar reactor's free radicals thus have a longer lifetime, the key to successful etching of aluminum.

Planar reactors have a number of other benefits, so that other companies are turning to them even without adding aluminum-etching capabilities. For example, planar reactors for depositing silicon nitride were shown at Semicon/West by Applied Materials Inc., Santa Clara, Calif., and Tegall Corp., Richmond, Calif. For one thing, the uniform field of the planar reactor gives much more even etching, and the etching rate versus time is constant rather than increasing, as is typical of barrel reactors. Also, the plates of the planar reactor can easily be water-cooled to provide the stable temperature necessary for uniform etching.

In the future, says Richard Reichelderfer, senior scientist at IPC, planar reactors will have much larger wafer capacities and cassette rather than the present manual wafer loading. □

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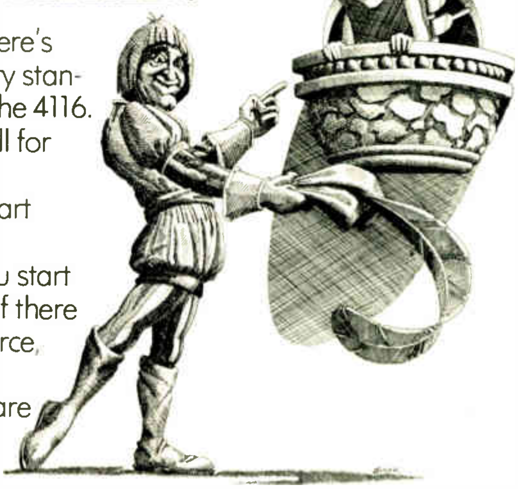

We understand there's already an industry standard 16K RAM—the 4116.

Okay. We're all for standardization.

You have to start someplace.

But, before you start designing it in, as if there were no other source, we'd like to offer a suggestion: Compare it against our new F16K RAM.

Form, fit and function, you'll find there's no difference.

TO THINE OWN SPECS BE TRUE.

We know. You'll need a little proof. So, here's a sample.

The F16K is a 16,384-word by 1-bit MOS RAM. Random access speed ranges from 150-350ns, with faster access times available in page mode. Power requirements are low — less than 600 mW. Of course, the outputs are in the standard unlatched configuration. All inputs are low capacitance and TTL-compatible. The device provides input latches for addresses and data-in, common I/O capability, two-dimensional selection using $\overline{RAS}$ and $\overline{CAS}$, plus flexible timing with Read-Modify-Write, $\overline{RAS}$-only Refresh and Page-Mode capability. The F16K also provides 3-state TTL-compatible output data valid to end of cycle. And, it features ± 10 tolerance on all power supplies (+ 12V, + 5V, —5V). The F16K comes in a standard 16-pin DIP with pinouts and timing suitable for easy upgrade of 4096 on 4027 based systems.

There's more. But we think these specs give you a pretty good idea of the potential cost-effectiveness of our new 16K RAM.

WHAT'S OURS IS YOURS.

At the very moment you are reading this ad, Fairchild is shipping prototype quantities of F16K to eager recipients throughout the industry. (The phone number or address at the bottom of this page will get you prototypes of your very own.) Once you try our new 16K RAM in your system, we know you'll want more. Which gets us to our next point:

When you're ready to order F16Ks in quantity, we'll be ready to ship them in quantity.

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There are two very good reasons we're confident about our delivery capabilities.

First, we've got a three-year jump on the industry using the Fairchild double poly Isoplanar™ process. The remarkable manufacturing process gives us higher yields resulting in better delivery at lower cost.

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INTERFACE POWER*

Device	Input	Drivers per package	Output Current	BV_{CEX}	$LV_{CE\,(SUS)}$ @ 100 mA	Gain Stages	Clamp Diodes	Package
ULN-2061M	TTL	2	1.75A	50V	35V	2	Yes	8-pin DIP†
ULN-2062M	TTL	2	1.75A	80V	50V	2	Yes	8-pin DIP†
ULN-2064B	TTL	4	1.75A	50V	35V	2	Yes	16-pin DIP
ULN-2065B	TTL	4	1.75A	80V	50V	2	Yes	16-pin DIP
ULN-2066B	MOS	4	1.75A	50V	35V	2	Yes	16-pin DIP
ULN-2067B	MOS	4	1.75A	80V	50V	2	Yes	16-pin DIP
ULN-2068B	TTL/MOS	4	1.75A	50V	35V	3	Yes	16-pin DIP
ULN-2069B	TTL/MOS	4	1.75A	80V	50V	3	Yes	16-pin DIP
ULN-2070B	MOS	4	1.75A	50V	35V	3	Yes	16-pin DIP
ULN-2071B	MOS	4	1.75A	80V	50V	3	Yes	16-pin DIP
ULN-2074B	TTL/MOS	4	1.75A	50V	35V	2	No	16-pin DIP
ULN-2075B	TTL/MOS	4	1.75A	80V	50V	2	No	16-pin DIP

† Mini-DIP, .375" long

*Only Sprague can supply dual and quad 1.75A, 50/80V Darlington Switches

Sprague Series ULN-2060 and ULN-2070 offer the highest power ratings available. They are 1.75 amp 50/80 volt Darlington switches and have guaranteed $LV_{CE\,(SUS)}$ minimums of 35/50 volts. No other IC manufacturer offers voltage-current combinations of this magnitude.

A pioneer in both high-current interface and copper alloy DIP lead frames, Sprague possesses extensive experience with plastic DIPs which offer greatly improved thermal characteristics. All quad switches in this series utilize the webbed-pin "B" DIP package. Lower thermal resistance ratings offer increased device limits, reduced junction temperatures, and improved reliability.

Many high-power interface problems are simplified and solved with Sprague Darlington Switches. Typical uses include interface with solenoids, relays, motors (dc and stepping), LEDs (MUXed numeric or matrix), lamps, and other applications in search of 1.5 A IC hardware.

For complete data, write for Engineering Bulletin 29305A and WR-172 'Quick Guide to Interface Circuits' to: Technical Literature Service, Sprague Electric Co., 35 Marshall St., North Adams, Ma. 01247.

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Washington newsletter

AT&T plans subsidiary to buy equipment from independents

Independent telecommunications equipment producers got a boost with the American Telephone & Telegraph Co.'s disclosure to the Federal Communications Commission that it will set up a separate subsidiary for central procurement of products from "non-Bell System manufacturers." The AT&T action was in response to an FCC March 1 order that the company file a plan to insure that its operating companies have autonomy to buy equipment from independent suppliers as well as from Western Electric Co.—AT&T's manufacturing arm.

Thomas E. Bolger, AT&T executive vice president, said the as-yet-unnamed subsidiary will be headed by a chief executive of equal rank to Bell operating company presidents and will take over functions now assigned to Western Electric and to Bell's Purchased Products division. But Bolger said that Bell System companies may still buy equipment separately and that **Western "will still be the primary source of telecommunications products"** for Bell affiliates because of the cost, performance, and high quality of its products. The subsidiary's size and location are still being determined, but preliminary estimates call for a staff of about 1,300 when the company becomes operational, 12 to 24 months after FCC approval.

Justice investigates possible antitrust actions by SBS . . .

The Justice Department has hit Satellite Business Systems and its three partners in its domestic digital satellite venture—Comsat General Corp., International Business Machines Corp., and Aetna Life and Casualty Co.—with investigative demands that could be the precursor to an antitrust suit. SBS confirms receipt of the demands for documents to find if there may have been, or may be, antitrust violations in connection with the establishment of SBS and the acquisition of the assets of its predecessors, CML Satellite Corp. and MCI Lockheed Satellite Corp.

Sources say the action **reflects the Justice Department's concern with the combination** of Comsat General and IBM, two of the potentially largest competitors in the digital communications satellite field. But the inquiry is separate from the antitrust suit against IBM's data-processing activities.

The investigative demand came a week before a Federal appeals court rejected a request by the Justice Department and prospective SBS competitors—including AT&T, Western Electric Co., and American Satellite Corp.—to review the FCC's refusal to reconsider its Feb. 8 approval of the SBS system. The commission ruled that public-interest benefits from rapid establishment of the system outweighed any potential anticompetitive concerns.

. . . but company sees no delay, asks for bids by Aug. 8

Satellite Business Systems says it doesn't expect the Justice Department investigation to obstruct progress on its domestic digital satellite system, and has asked U. S. satellite makers for bids on three 12-to-14-gigahertz spacecraft by Aug. 8 "in order to permit a contract award as soon thereafter as possible." **Two of the three satellites are scheduled for launch in the last half of 1980** to begin operation on Jan. 1, 1981. The third will be a spare. The system will operate in a time-division-multiple-access mode linking small customer rooftop terminals for voice, high-speed data, facsimile, and teleconferencing service.

Proposal requests call for satellites with 10 transponder channels each, with each channel having a 42-megahertz bandwidth and an output in excess of 20 watts. The spacecraft may be either spin-stabilized or three-axis-stabilized, but must carry solar arrays able to generate 1 kilowatt of direct current. Lifetimes must be several years. A request for proposals for the large number of rf ground terminals for the operational system will be issued soon, SBS says.

Airlines digital data, avionics specs coming in July

Watch for new standards defining future avionics packaging and aircraft racking plus a specification for digital data buses to emerge from the July 20–21 session of the Airlines Electronic Engineering Committee in San Francisco. The AEEC will act on the **two proposals for standards to be adopted by Aeronautical Radio Inc.,** Annapolis, Md., the engineering and telecommunications operation of the nation's airlines.

While the avionics packaging proposal will represent an evolutionary improvement of Arinc characteristics 404A, the specification for the system for digital-information transfer will be new. It will cover systems used for inertial reference, attitude and heading, vhf omnidirectional-radio range, instrument landing, air data, vhf communication, and Omega navigation plus radio altimeters, distance-measuring equipment, automatic direction finders, weather radar, and air-traffic-control transponders.

Solar electric craft is sought for 1985 Halley's Comet event

When Halley's Comet approaches the earth around Christmas Day 1985 for its 31st reported sighting since 467 B. C., NASA wants to meet it with a spacecraft using ion engines and powered by the first solar electric propulsion system. The propulsion system proposed by NASA's Marshall Space Flight Center in Huntsville, Ala., would use **reflectors to concentrate solar energy onto silicon solar cells and provide electric power to operate eight ion engines.**

The engines and power processors have been under development and test for several years at NASA's Lewis Research Center in Cleveland. The spacecraft being defined by the Jet Propulsion Laboratory, Pasadena, Calif., would carry a variety of instruments to study the comet's composition, an understanding of which is considered critical to unraveling theories on the origin of the solar system. Included would be an imaging system to transmit pictures to earth and possibly a separate probe to penetrate the comet's tail and approach the nucleus to determine its characteristics. Launch from an orbiting Space Shuttle between March and June 1982 is proposed for the 3½-year journey to the rendezvous point more than 600 million miles from earth. A headquarters decision on the effort is expected by August.

Addenda

Ruth M. Davis, director of the National Bureau of Standards' Institute for Computer Sciences and Technology, is being nominated to become deputy undersecretary of defense for research and advanced technology, **a new post in the Directorate of Defense Research and Engineering.** She will report to William J. Perry, recently confirmed as the new undersecretary for research, engineering, and system acquisitions. He is former president and a founder of ESL Inc. of Sunnyvale, Calif., specialists in reconnaissance and information systems . . . Robert A. Frosch, 49-year-old oceanographer and the Woods Hole Oceanographic Institution's oceanography applications chief, **has been nominated to head NASA,** confirming earlier reports. Frosch was assistant Navy secretary for R&D between 1966 and 1973.

There are two places in Wabash, Indiana with economical, high volume production capability.

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

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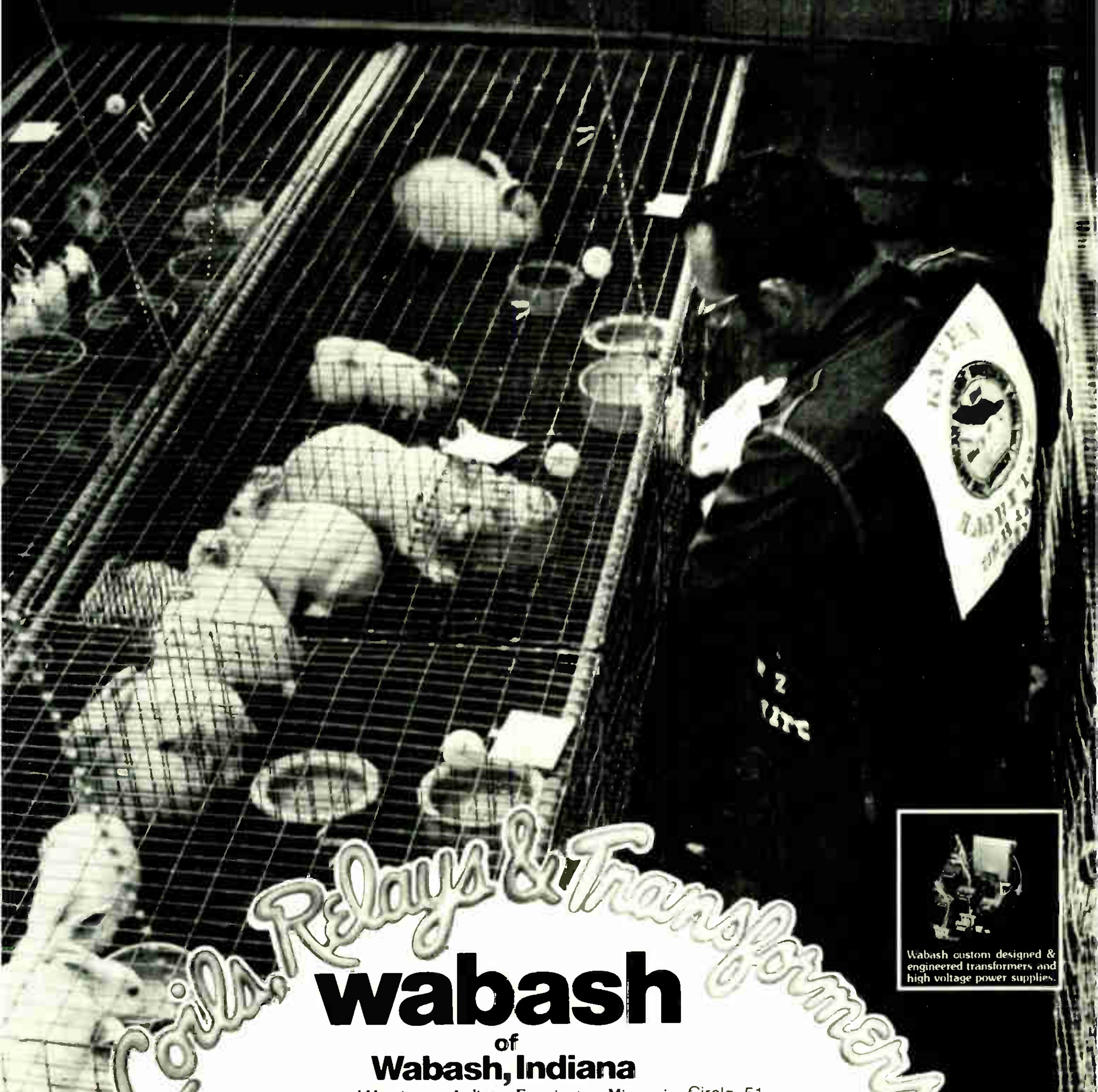
With their engineering expertise, sophisticated products, automated winding and high volume production capability, Wabash is a standout among the hundreds of transformer manufacturers. But, in turning out sheer numbers, Knee's Rabbitry is pretty stiff competition.



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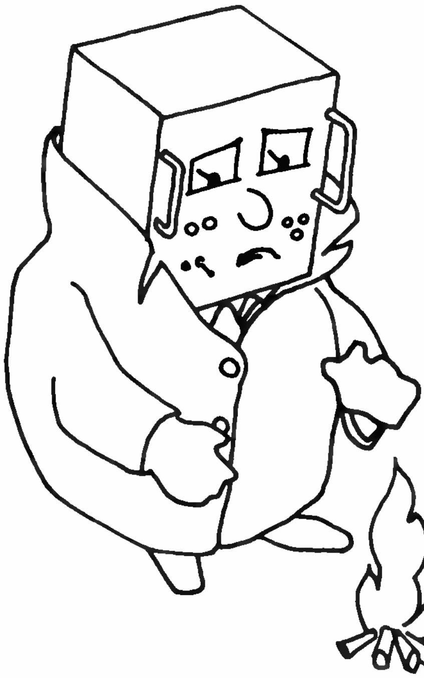

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International newsletter

Brain scanner with 20-second speed developed in France

The leading French medical-electronics firm, Compagnie Générale de Radiologie, **has developed a brain scanner capable of doing an examination in 20 seconds.** CGR, a subsidiary of Thomson Brandt, claims its ND 8000 provides flexible treatment of density and size though there is a tradeoff between the two. Objects as small as 1.5 cubic millimeters may be examined; contrasts as fine as 0.2% of the density difference between X rays taken through air and water can be shown. The kit includes a specially developed X-ray tube that CGR says is twice as efficient as current fixed-anode tubes.

British approve Viewdata for market trial

The British Post Office plans to push Viewdata, the interactive data display system, closer to regular service with a $6.9 million market trial beginning June 19, 1978. For the trial, which will include 1,000 terminals in London, Birmingham, and Norwich, the post office will create a London center using twin GEC 4080 computers and enlarge the present data base at its Martlesham Heath research labs. The trial will let users **select from 60,000 "pages" of alphanumeric information for display** on decoder-equipped TV sets via their telephones. Meanwhile, this August the West German Post Office plans to exhibit its version of Viewdata at the Berlin International Radio and Television Show using a newly acquired GEC 4080 computer system.

Siliconix challenges Hughes with C-MOS driver chip for LCDs

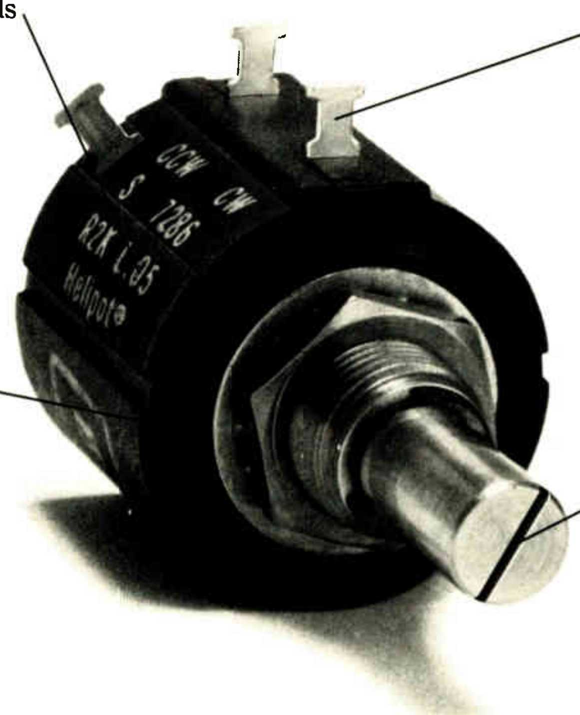
Hughes Microelectronics Ltd. of Britain won't have the growing European market in C-MOS LSI driver chips for liquid-crystal displays to itself now that Siliconix Ltd. is entering the fray (see Electronics International). Siliconix is shipping small quantities of its DF411 that, like Hughes HLCD 0012, **contains all the circuitry needed to drive four LCD digits.** Market targets for both low-power chips are large displays for higher-priced clocks, portable instruments, and lower-priced clocks—though Siliconix is concentrating on instruments, medical thermometers, automotive applications, and marine instrumentation.

Japanese printer delivers 10,000 lines per minute

An experimental nonimpact laser system is being developed at Fujitsu Laboratories in Kawasaki, Japan, **to print 10,000 lines a minute, at six lines per inch, with a resolution of 10 dots per millimeter.** The system uses a helium-cadmium laser with a wavelength that is compatible with the response of the selenium-tellurium coating of the photosensitive drum. A 12-faced polygonal mirror rotates and scans the beam across a parabolic mirror, which reflects the line onto the drum.

IBA shows all-digital TV studio

The coming digital revolution in color television studio techniques is being advanced by Britain's Independent Broadcasting Authority, which recently demonstrated the major components of an experimental all-digital studio to European broadcasting organizations. Claimed to be the world's first, the demonstration studio converted a camera's analog signals for digital vision coding and decoding, vision mixing and switching, video-tape recording, and the generation of the color-bar test signal. However, although the digital tape recording produced faultless half-width color pictures, further work is needed to produce full-width pictures, says IBA.



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Doped clear-plastic display collects enough light even when it's dim outside

Liquid-crystal displays passively reflect or transmit the light around them, which may be dim and is generally white. But neither limitation affects a new liquid-crystal display from West Germany that uses fluorescent plexiglass as its light source.

The plexiglass can make the liquid crystal glow as bright as any light-emitting diode, in any color in the green to red part of the spectrum, without adding to the new display's low power requirements, say its developers at the Institute for Applied Solid State Physics, which is in Freiburg.

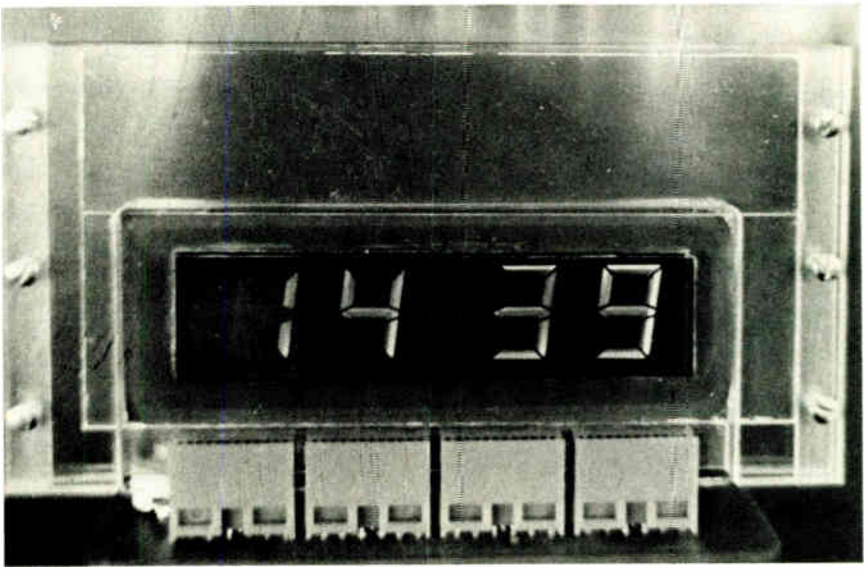
Called FLAD (for fluorescence-activated display), the display is in a prototype phase at Siemens AG in Munich and could go into production during the fourth quarter if customers like it, says Hans Krüger, project manager for liquid-crystal displays.

Start with time. Initially, FLAD will be made for digital timepieces like tabletop, wall, and alarm clocks, which could then be driven by battery instead of needing line voltage, Krüger points out. Other applications being considered for the new display include portable test and measuring instruments, pocket calculators, scales, and gasoline pumps.

FLAD's brightness depends on the ambient light that strikes it. This light enters the plexiglass, which has been doped during its manufacture with fluorescent organic molecules that belong to the fluorescein class and are similar to those used in liquid-dye lasers.

The color of the light produced by the display depends upon the dopant's composition. However, the light can only leave the display through the segments that make up the display's symbols, as shown in the figure.

Sandwich of brightness. Siemens uses a twisted nematic type of liquid crystal that is sandwiched between two polarization foils. As in an ordinary liquid-crystal display, light is transmitted through the display when a voltage is applied to the number segments.



Doing its job. The Siemens FLAD can glow in any color in the red to green part of the spectrum without using more power.

The back of the fluorescent plate has V-shaped grooves, placed directly in line with the electrode segments of the display. The grooves' walls are covered with a metallic reflective coating, and a similar coating covers the plate's two ends. On the front of the plate, directly opposite the grooves, are layers of light-scattering material.

In operation, ambient light absorbed in the plate excites the organic molecules. The resulting fluorescent light is trapped within the plate, for the most part, but some of it does emerge directly through the display segments.

This is augmented by ambient light striking the grooves and bouncing back from their shiny walls toward the plate's front, and then through the light-scattering layers. From that point, the light passes through the electrode segments to the observer's eye.

The symbols appear bright against a dark background. The light-scattering layers serve to increase the angle of observation.

The FLAD, Krüger says, collects enough outside light for operation even under dim ambient light conditions. For operation in complete darkness—as alarm clocks need to—a small light-emitting diode would be used to couple light into the fluorescent plate. The diode would connect to the same voltage supply employed for the LCD's electrode segments. □

Great Britain

Hughes plans C-MOS for LCDs

As European demand for liquid-crystal displays in clocks and instruments begins to pick up, Hughes Microelectronics Ltd. thinks it is time to turn to low-power complementary-metal-oxide-semiconductor, large-scale-integrated circuits, The company is introducing a four-digit decoder-display chip, completing an alarm clock chip, and planning to unveil a comparator chip with memory later this year to replace mechanical timers.

Next year's European market for LSI display chips alone could reach 50,000, depending on how soon the decorator clock market takes off, estimates Derrick Harding, marketing manager. If that stimulates further LCD business in instruments and low-cost alarm clocks, then he has a crack at 150,000 sets with two or three of the chips apiece, depending on the application.

Harding could be right, according to David Turner, optical-product marketing manager, Optical Equipment division, ITT Components Group Europe. Turner expects to be producing 1,000 LCDs a week by the end of the year, many of them 0.5-inch, four-digit units. That figure should rise to 5,000 a week when a new production line cranks up early next year, he declares.

Other firms are eyeing the market. Rank Optics in Britain plans to convert from pilot to volume production, according to Roy Lewis, a Rank research manager.

So far, the only other company active in the European market, which should total "hundreds of thousands" of displays next year, is Hamlin in the U.S., says Turner. But he acknowledges that other LCD module makers, such as American Microsystems Inc., Beckman Instruments, Motorola Semiconductor, and Siemens AG, could move in. Both Turner and Lewis admit, however, that the market is a classic chicken-and-egg situation among clock and instrument manufacturers, display suppliers, and chip makers like Hughes.

Meanwhile, Hughes is poised to exploit its versatile C-MOS chips not only for battery-powered instruments and clocks but also for other low-powered timing functions, such as domestic heating controls, Harding says.

In the display circuit, for example, besides drawing many times less current, "C-MOS produces better waveforms for LCDs than p-MOS," explains Richard Morcom, senior electronics engineer. Also, "no other chip takes the BCD input and actually decodes it on chip," he says. This means that it is "the only chip that can drive the whole display—all four digits—from only one driver."

Called the HLCD 0012, the versatile circuit can handle inputs from either a timer or a digital voltmeter. Basically a series of latches and a decoder, the chip also has three extra drivers for a.m., p.m., and decimal point, an on-chip oscillator providing the ac signal for direct drive to the LCD—important for long life—and zero detection and blanking of the first digit of the display.

To boost the market, Harding says, the display chip could be sold separately for about $1.50 versus about $4 in its 40-pin package. Further, he figures that that chip, the alarm clock chip, quartz crystal, and trimming capacitor could be mounted on a printed-circuit board at low cost. Eventually, such chips could be bonded into the back of the display as well, he says. □

France

Components makers to get $120 million in French government's 5-year plan

The French government has finally disclosed its $120 million, 5-year plan to bolster its electronics components industry. The state will pump the money into integrated-circuit research and development, which it hopes will spin off benefits for other sectors of the French electronics industries.

But the cash is only part of the total package. French policy is also clearly shifting toward collaboration with foreign firms—at least if they are willing to come to terms with French wishes to have development and production on home soil.

Government aid for components makers is not a new idea in France. In fact, there was a components plan as long ago as the mid-sixties. However, the present plan adds two newly important areas.

First, government and industry have seen the growing danger of foreign firms' grabbing bigger and bigger pieces from French electronics firms. Those firms traditionally have made a lot of their money from the discrete components in their finished products. But, with increasing integration, that source of revenue has been slipping away. The other potential problem is that French firms may not satisfy the growing demand for custom-built circuits; rather, they may be interested only in high-volume standard circuits.

The government admits that it would be "unrealistic to hope to set up over the next few years a French group which could compete with the world leaders." It believes that the best it can hope for is that most circuits bought by French companies will be produced on French soil.

It expects to achieve this by encouraging research centers in France. These, says the government, may be French- or foreign-financed, "as long as their work is directed toward production on national territory." Also, the government believes that one of the major directions might be toward very large-scale integration.

User companies will be encouraged to develop in-house capabilities for circuit design, and the government hopes to see agreements between users and suppliers of custom-built circuits for the study, development, and supply of special-purpose ICs.

While the government's new plans will be a welcome boost for the components industries, the proposed $120 million, at $24 million a year, will only be doubling the present state spending. And it is less than provided in a German plan to spend $30 million a year. □

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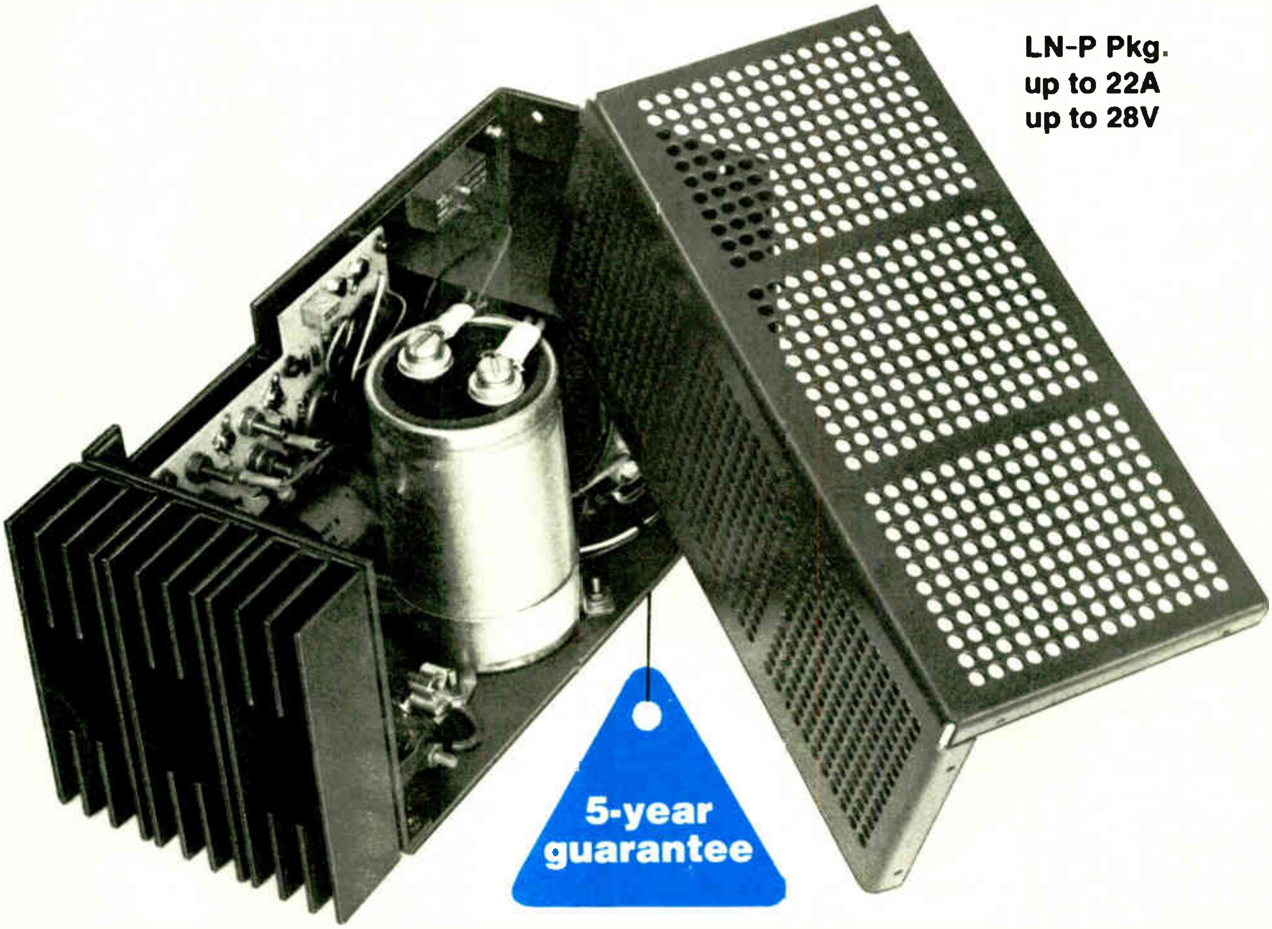

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• Vibration.	Method	514.2	Procedure	X, XI
• Shock	Method	516.2	Procedure	I
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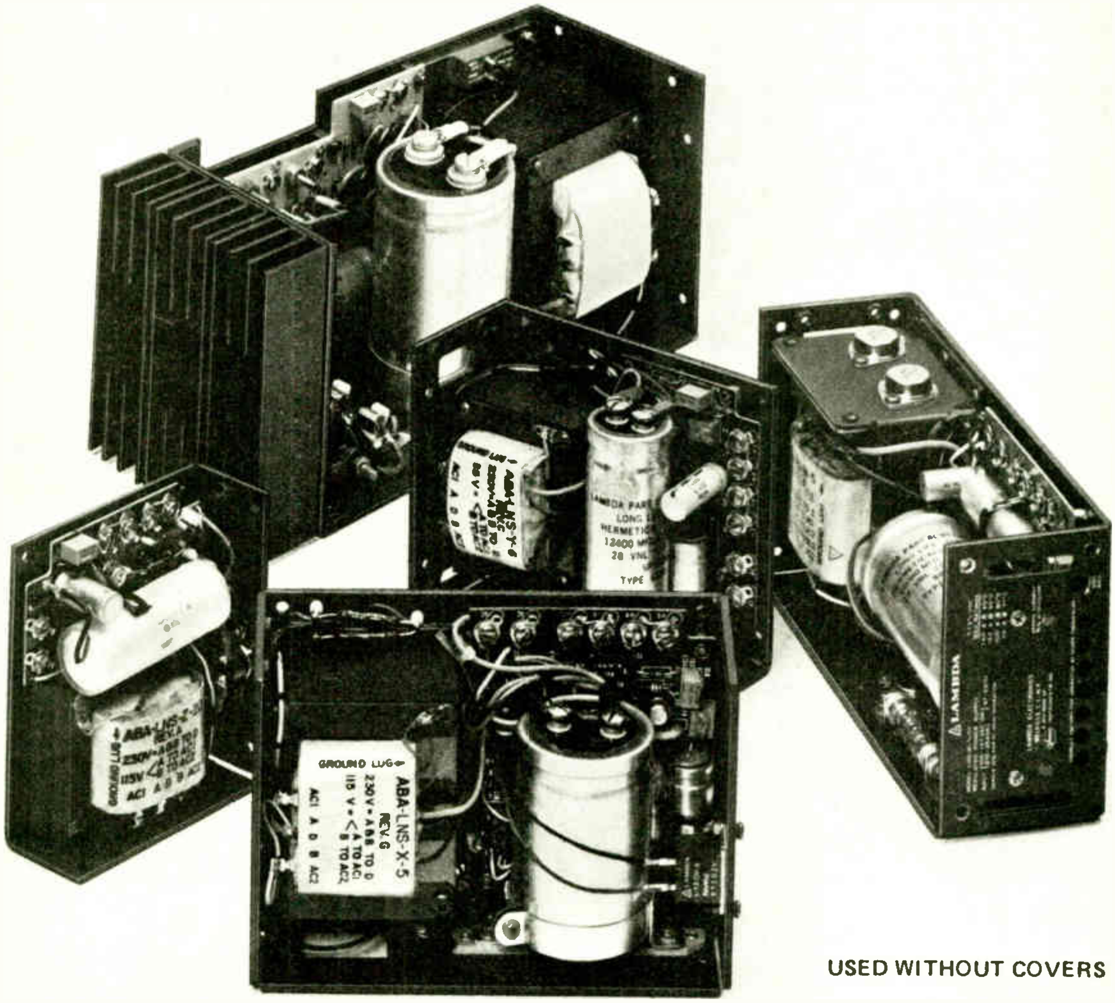

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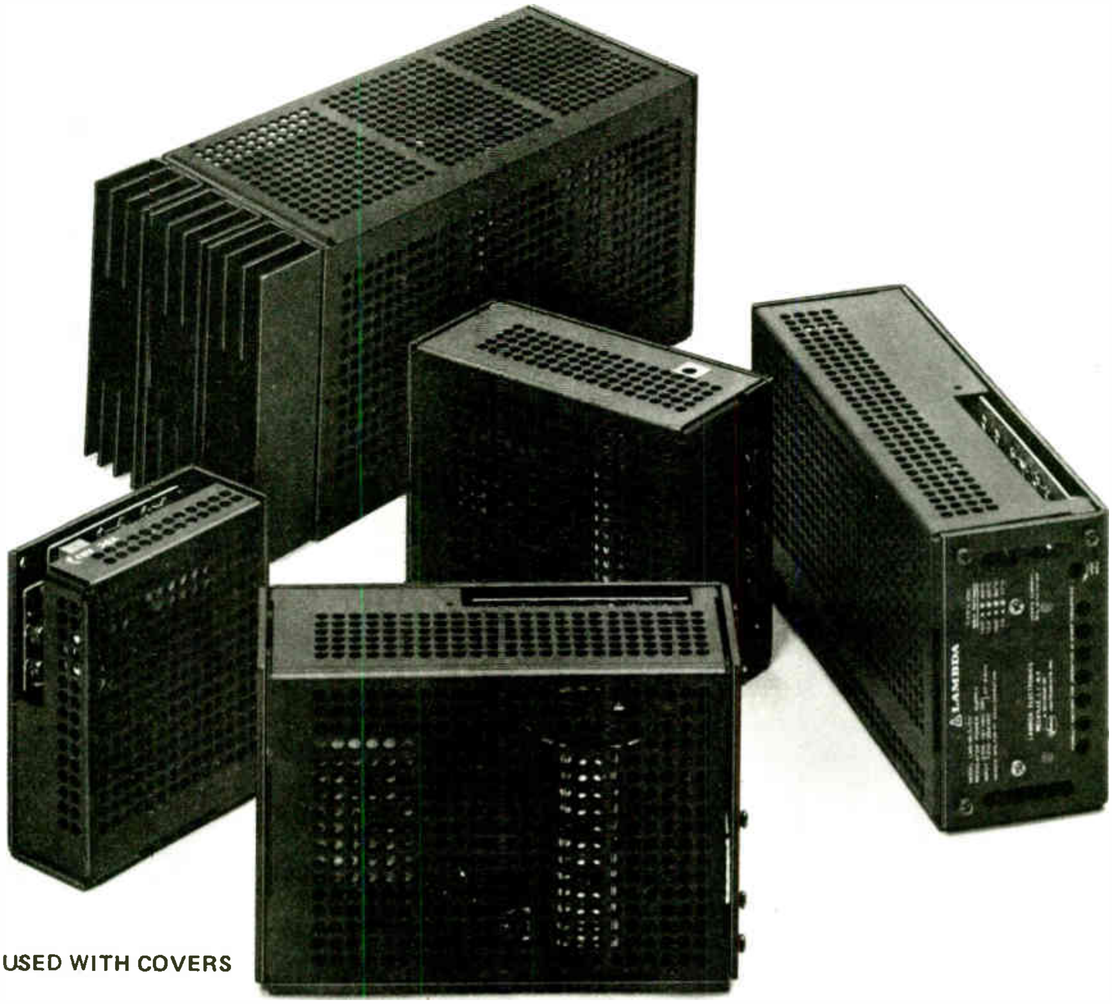

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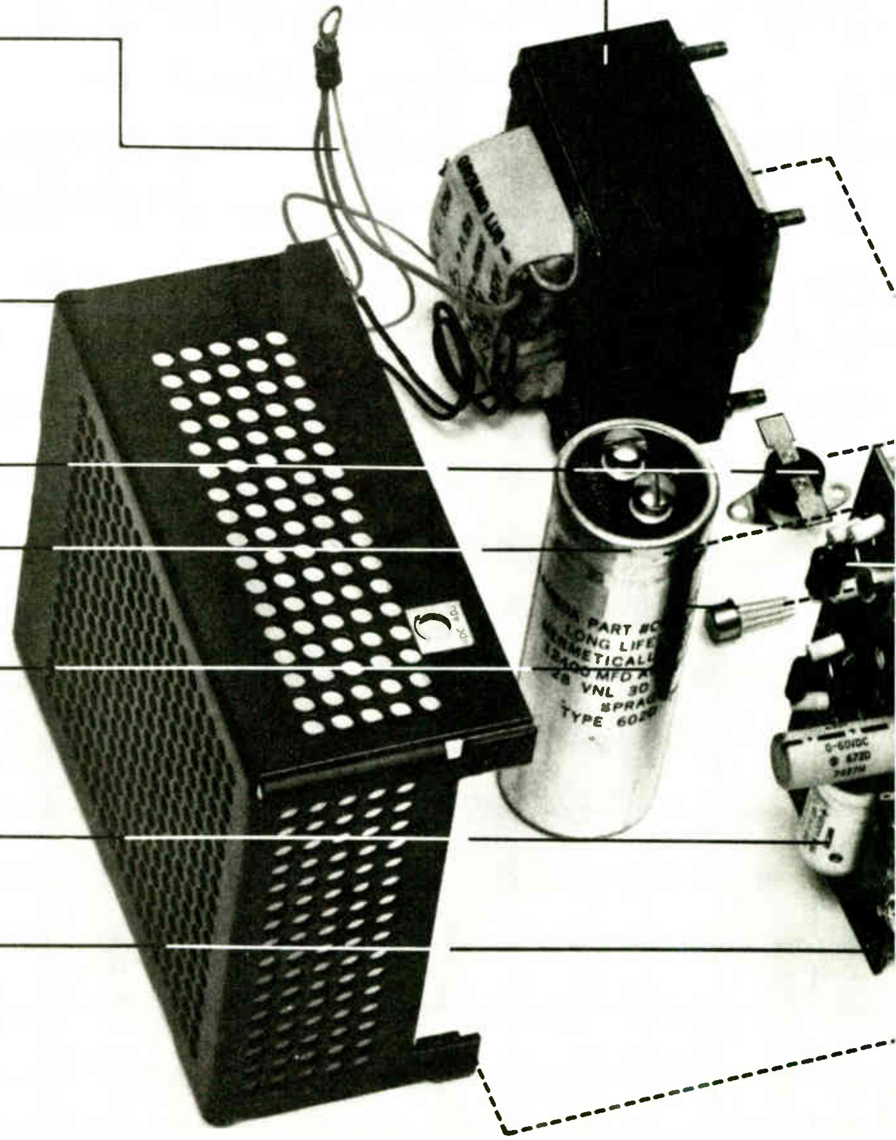

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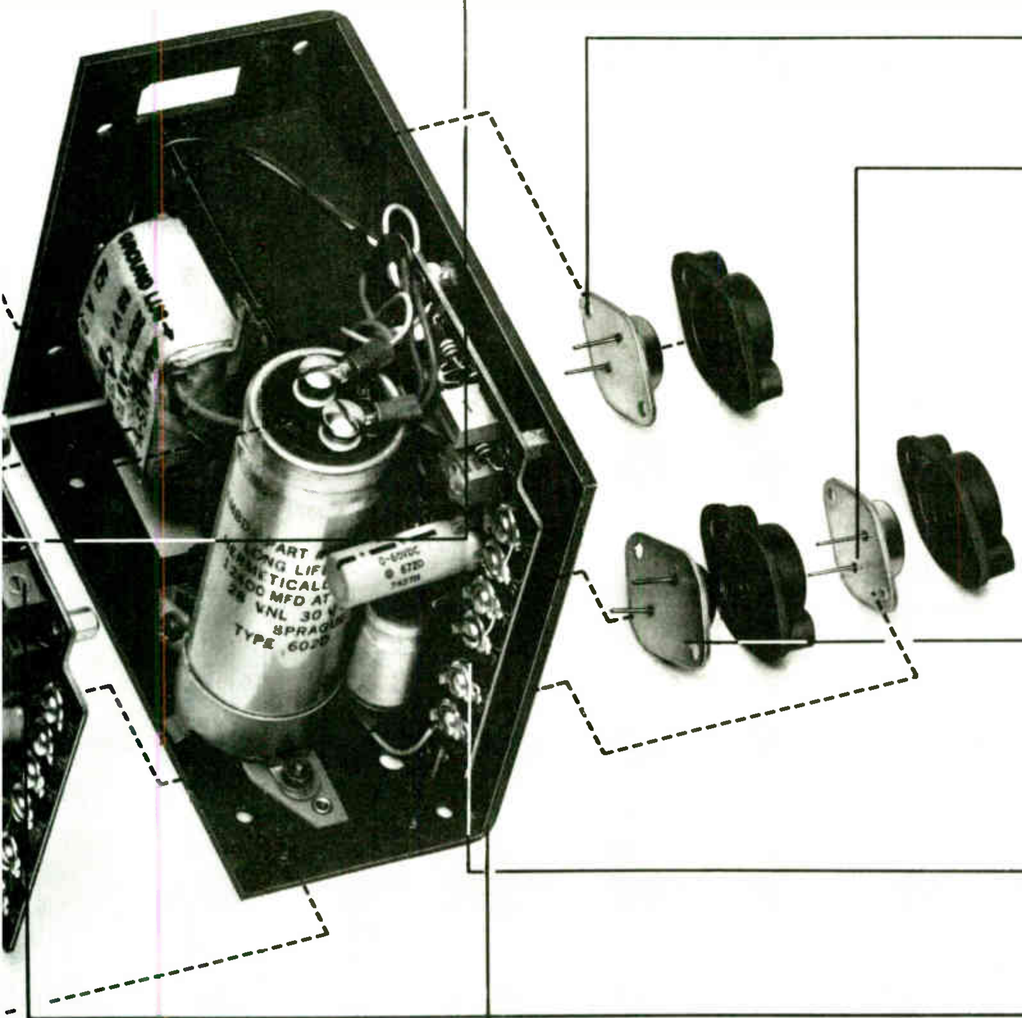

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LND-X-MPU [3]	0.1%	1.5	5±5%	7.0 (5.95)	6.0 (5.11)	4.7 (4.0)	3.2 (2.72)	X	7 x 4 7/8 x 2 7/8	$172
			9—12	1.2 (1.02)	1.1 (0.94)	1.0 (0.85)	0.8 (0.68)			

± 15 VOLTS TO ± 12 VOLTS ADJ

MODEL	REGULATION (LINE OR LOAD)	RIPPLE (RMS)	VOLT. VDC.	40°C	50°C	60°C	71°C	PKG SIZE	DIMENSIONS (INCHES)	PRICE
LND-Z-152	0.15%	1.5	±15 to	0.6 (0.54)	0.55 (0.5)	0.45 (0.41)	0.3 (0.27)	Z	4 7/8 x 4 x 1 3/4	$ 85
			± 12	0.6 (0.54)	0.55 (0.5)	0.45 (0.41)	0.3 (0.27)			
LND-Y-152	0.1%	1.5	± 15 to	1.4 (1.20)	1.2 (1.02)	0.9 (0.77)	0.6 (0.51)	Y	5 5/8 x 4 7/8 x 2 5/8	120
			± 12	1.2 (1.02)	1.1 (0.94)	0.8 (0.68)	0.5 (0.43)			
LND-X-152	0.1%	1.5	± 15 to	2.5 (2.13)	2.1 (1.79)	1.6 (1.37)	1.1 (0.94)	X	7 x 4 7/8 x 2 7/8	150
			± 12	2.3 (1.96)	1.9 (1.62)	1.4 (1.2)	0.9 (0.77)			
LND-W-152	0.1%	1.5	± 15 to	3.3 (3.0)	3.1 (2.8)	2.6 (2.34)	2.0 (1.8)	W	9 x 5 x 2 7/8	170
			± 12	3.1 (2.8)	2.8 (2.52)	2.3 (2.07)	1.6 (1.44)			

SINGLE OUTPUT

MODEL	REGULATION (LINE OR LOAD)	RIPPLE (RMS)	[1]MAX CURRENT AMPS AT 40°C	50°C	60°C	71°C	PKG SIZE	DIMENSIONS[2] (INCHES)	PRICE
5 VOLTS ± 5% ADJ									
LNS-Z-5-OV	0.15%	1.5	3.0 (2.7)	2.7 (2.4)	2.3 (2.1)	1.7 (1.5)	Z	4-7/8 x 4 x 1-3/4	$ 80
LNS-Y-5-OV	0.1%	1.5	6.0 (5.4)	5.1 (4.6)	4.2 (3.8)	3.1 (2.8)	Y	5-5/8 x 4-7/8 x 2-5/8	115
LNS-X-5-OV	0.1%	1.5	10.0 (8.5)	8.9 (7.6)	7.3 (6.2)	5.3 (4.5)	X	7 x 4-7/8 x 2-7/8	140
LNS-W-5-OV	0.1%	1.5	14.0 (11.9)	12.2 (10.4)	10.0 (8.5)	7.5 (6.4)	W	9 x 5 x 2-7/8	175
LNS-P-5-OV	0.1%	1.5	22.0 (20.9)	19.5 (18.53)	16.5 (15.68)	13.0 (12.35)	P	11 x 4-7/8 x 4-13/32	220
6 VOLTS ± 5% ADJ									
LNS-Z-6	0.15%	1.5	2.5 (2.25)	2.2 (2.0)	1.9 (1.7)	1.4 (1.3)	Z	4-7/8 x 4 x 1-3/4	$ 75
LNS-Y-6	0.1%	1.5	5.6 (5.0)	4.9 (4.4)	4.0 (3.6)	2.9 (2.61)	Y	5-5/8 x 4-7/8 x 2-5/8	110
LNS-X-6	0.1%	1.5	9.5 (8.1)	8.4 (7.15)	7.1 (6.0)	5.0 (4.25)	X	7 x 4-7/8 x 2-7/8	130
LNS-W-6	0.1%	1.5	13.0 (11.0)	11.2 (9.5)	9.3 (7.9)	6.8 (5.9)	W	9 x 5 x 2-7/8	165
LNS-P-6	0.1%	1.5	20.5 (19.48)	18.1 (17.2)	15.3 (14.54)	12.0 (11.4)	P	11 x 4 7/8 x 4 13/32	200
12 VOLTS ± 5% ADJ									
LNS-Z-12	0.15%	1.5	1.7 (1.55)	1.6 (1.45)	1.5 (1.4)	1.3 (1.2)	Z	4-7/8 x 4 x 1-3/4	$ 75
LNS-Y-12	0.1%	1.5	4.0 (3.6)	3.5 (3.15)	2.9 (2.6)	2.2 (2.0)	Y	5-5/8 x 4-7/8 x 2-5/8	110
LNS-X-12	0.1%	1.5	6.5 (5.5)	5.5 (4.7)	4.5 (3.8)	3.3 (2.8)	X	7 x 4-7/8 x 2-7/8	130
LNS-W-12	0.1%	1.5	8.5 (7.2)	7.2 (6.1)	5.9 (5.0)	4.2 (3.6)	W	9 x 5 x 2-7/8	165
LNS-P-12	0.1%	1.5	14.0 (13.3)	12.4 (11.8)	10.0 (9.5)	7.3 (6.94)	P	11 x 4-7/8 x 4-13/32	200
15 VOLTS ± 5% ADJ									
LNS-Z-15	0.15%	1.5	1.4 (1.3)	1.3 (1.62)	1.2 (1.1)	1.0 (0.9)	Z	4-7/8 x 4 x 1-3/4	$ 75
LNS-Y-15	0.1%	1.5	3.4 (3.1)	3.1 (2.8)	2.6 (2.35)	2.0 (1.8)	Y	5-5/8 x 4-7/8 x 2-5/8	110
LNS-X-15	0.1%	1.5	5.5 (4.7)	4.8 (4.1)	3.9 (3.35)	2.8 (2.4)	X	7 x 4-7/8 x 2-7/8	130
LNS W-15	0.1%	1.5	7.7 (6.55)	6.7 (5.7)	5.5 (4.7)	3.8 (3.15)	W	9 x 5 x 2-7/8	165
LNS-P-15	0.1%	1.5	12.0 (11.4)	10.6 (10.1)	8.5 (8.1)	6.3 (6.0)	P	11 x 4-7/8 x 4-13/32	200
20 VOLTS ± 5% ADJ									
LNS-Z-20	0.15%	1.5	1.0 (0.69)	0.85 (0.77)	0.65 (0.59)	0.45 (0.41)	Z	4-7/8 x 4 x 1-3/4	$ 75
LNS-Y-20	0.1%	1.5	2.7 (2.45)	2.5 (2.25)	2.0 (1.08)	1.3 (1.2)	Y	5-5/8 x 4-7/8 x 2-5/8	110
LNS-X-20	0.1%	1.5	4.4 (3.75)	3.6 (3.1)	2.6 (2.2)	1.6 (1.4)	X	7 x 4-7/8 x 2-7/8	130
LNS-W-20	0.1%	1.5	6.1 (5.2)	5.2 (4.4)	4.2 (3.6)	3.0 (2.6)	W	9 x 5 x 2-7/8	165
LNS-P-20	0.1%	1.5	10.0 (9.5)	8.9 (8.46)	7.5 (7.13)	5.5 (5.23)	P	11 x 4-7/8 x 4-13/32	200
24 VOLTS ± 5% ADJ									
LNX-Z-24	0.15%	1.5	0.9 (0.81)	0.75 (0.68)	0.6 (0.55)	0.4 (0.36)	Z	4-7/8 x 4 x 1-3/4	$ 75
LNS-Y-24	0.1%	1.5	2.3 (2.1)	2.1 (1.9)	1.7 (1.5)	1.1 (1.0)	Y	5-5/8 x 4-7/8 x 2-5/8	110
LNS-X-24	0.1%	1.5	3.8 (3.25)	3.2 (2.75)	2.4 (2.0)	1.4 (1.62)	X	7 x 4-7/8 x 2-7/8	130
LNS-W-24	0.1%	1.5	5.4 (4.6)	4.6 (3.9)	3.7 (3.1)	2.5 (2.1)	W	9 x 5 x 2-7/8	165
LNS-P-24	0.1%	1.5	9.0 (8.55)	8.0 (7.6)	6.7 (6.37)	5.0 (4.75)	P	11 x 4-7/8 x 4-13/32	200
28 VOLTS ± 5% ADJ									
LNS-Z-28	0.15%	1.5	0.8 (0.75)	0.65 (0.6)	0.5 (0.45)	0.35 (0.32)	Z	4-7/8 x 4 x 1-3/4	$ 75
LNS-Y-28	0.1%	1.5	2.0 (1.8)	1.8 (1.65)	1.5 (1.35)	1.0 (0.9)	Y	5-5/8 x 4-7/8 x 2-5/8	110
LNS-X-28	0.1%	1.5	3.4 (2.9)	2.9 (2.5)	2.2 (1.5)	1.2 (1.0)	X	7 x 4-7/8 x 2-7/8	130
LNS-W-28	0.1%	1.5	4.7 (4.0)	4.0 (3.4)	3.2 (2.75)	2.2 (1.9)	W	9 x 5 x 2-7/8	165
LNS-P-28	0.1%	1.5	8.0 (7.6)	7.1 (6.75)	6.0 (5.7)	4.5 (4.28)	P	11 x 4-7/8 x 4-13/32	200

Note: 1. Rating in Parenthesis for LN Series when cover is used
2. Dimensions include cover
3. Includes OV protection on both outputs (5V OV trip point is 6.6 ± .2V fixed; 9—12V OV trip point is 13.7 ± .4V fixed)

SPECIFICATIONS OF LN SERIES

DC Output

Voltage range shown in tables

Regulated Voltage

regulation, line	0.1% (0.15% for LN-Z)
regulation, load	0.1% (0.15% for LN-Z)
ripple and noise	1.5mv RMS, 5mV pk-pk with either positive or negative terminal grounded.
temperature coefficient	0.03% /°C
remote programming resistance	200 ohms per volt nominal
remote programming voltage	volt per volt

AC Input

line	105-127 VAC, 210-254 VAC (by transformer tap change) 47-440 Hz. Consult factory for operation at frequencies other than 57-63 Hz.
Efficiency (Typical)	30%-5V and 6V models, 42% 12V and 15V models, 49%-20V, 24V and 28V models. 42% for LN duals except LND-X-MPU which is 34%.

Ambient Operating Temperature Range

Continuous duty from 0° to +71°C with corresponding load current ratings for all modes of operation.

Storage Temperature Range

–55°C to 85°C

Overload Protection

Electrical

External overload protection, automatic electronic current limiting circuit limits the output current to a preset value, thereby providing protection for the load as well as the power supply.

Thermal

Thermostat — automatically reset when overtemperature condition is eliminated.

Overshoot

No overshoot on turn-on, turn-off or power failure.

Overvoltage Protection

Overvoltage protection module crowbars output when trip level is exceeded — standard on all 5V models and both outputs of model LND-X-MPU. For other models see back cover.

Input and Output Connections

Heavy-duty screw terminals on printed circuit board.

DC Output Controls

Simple screwdriver adjustment over the entire voltage range.

Tracking Accuracy (Dual Tracking Models Only)

3% absolute voltage difference, 0.2% change for all conditions of line, load and temperature.

Remote Sensing

Provision is made for remote sensing to eliminate effect of power output load resistance on DC regulation.

Mounting

Three Mounting surfaces, three mounting position. One mounting position for LN-P.

Convection Cooled

No external heat sinking or forced air required.

Transformer

MIL-T-27C, Grade 6; Electrostatic shield; 4000 VAC input/output isolation.

Isolation Rating

Minimum 10 meg-ohm isolation from DC to ground at 1000 VDC.

Fungus Proof

No fungi nutrient material used.

Military Specifications

The LNS series has passed the following tests in accordance with MIL-STD-810C:

1) Low Pressure — Method 500.1, Procedure I.
2) High Temperature — Method 501.1, Procedure I & II.
3) Low Temperature — Method 502.1, Procedure I.
4) Temperature Shock — Method 503.0, Procedure I.
5) Temperature — Altitude — Method 504.1, Procedure I. Class 2 (0°C operating)
6) Humidity — Method 507.1, Procedures I & II.
7) Fungus — Method 508.1, Procedure I.
8) Vibration — Method 514.2, Procedures X & XI.
9) Shock — Method 516.2, Procedures I & III.

MIL-I-6181D — Conducted and radiated EMI with one output terminal grounded.

Physical Data

Package Model	Weight Lbs. Net	Weight Lbs. Ship	Size Inches
LN-Z	3	3-1/4	4-7/8 x 4 x 1-3/4 (w/cover) 4-7/8 x 4 x 1-5/8 (w/o cover)
LN-Y	5	5-1/2	5-5/8 x 4-7/8 x 2-5/8 (w/cover) 5-5/8 x 4-7/8 x 2-1/2 (w/o cover)
LN-X	7-3/4	8-1/4	7 x 4-7/8 x 2-7/8 (w/cover) 7 x 4-7/8 x 2-3/4 (w/o cover)
LN-W	9	9-1/2	9 x 5 x 2-7/8 (w/cover) 9 x 4-7/8 x 2-3/4 (w/o cover)
LN-P	14	15-1/2	11 x 4-7/8 x 4-13/32 (w & w/o cover)

Finish

Gray, Fed. Std. 595 No. 26081.

UL/VDE

Designed for listing in UL Recognized Components Index.

Designed for listing in VDE Index.

Accessories

Overvoltage protectors (standard on 5V models and model LND-X-MPU).

Guaranteed for 5 Years

5-year guarantee includes labor as well as parts. Guarantee applies to operation at full published specifications at end of 5 years.

6 Amp Monolithic OV Protectors

$5.00 Qty 1 $3.40 Qty 1000

TO-3 PACKAGE, NO EXTERNAL COMPONENTS NEEDED

LAMBDA OVERVOLTAGE PROTECTORS
L-6-OV, L-12-OV, L-20-OV, L-35-OV Series

General Description

The Lambda overvoltage protector prevents damage to the load caused by excessive power supply output voltage due to improper adjustment, improper connection, or failure of the power supply. Load protection is accomplished automatically by effectively short circuiting the output terminals of the power supply when a preset limit voltage has been exceeded. The trip-point limit voltage cannot be adjusted. To reset overvoltage protector, remove AC input to power supply allow overvoltage protector to cool, and reapply power.

Overvoltage Protector Performance Specifications

PARAMETER	SYMBOL	L-6-OV SERIES		L-12-OV SERIES		L-20-OV SERIES		L-35-OV SERIES	
		MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX
On State Current	I_{DC}	–	6A	–	12A	–	20A	–	35A
On State Voltage	V_{OC}	–	2.5V	–	1.3V	–	1.4V	–	1.6V
Non-Repetitive Peak Surge Current*	I_p	–	150A	–	200A	–	260A	–	350A
Standby Current	I_S	–	25mA	–	5mA	–	5mA	–	5mA
Operating Temperature (Blocking)**	T_{CB}	-40°C	+100°C	-40°C	+100°C	-40°C	+100°C	-40°C	+100°C
Operating Temperature (Conducting)***	T_{CC}	-40°C	+150°C	-40°C	+140°C	-40°C	+140°C	-40°C	+140°C
Storage Temperature	T_S	-40°C	+150°C	-40°C	+125°C	-40°C	+125°C	-40°C	+125°C
Power Dissipation @ 25°C Derate @ 1.5W/°C above 50°C	P_D		150 Watts						
Thermal Resistance	$R_{\theta JC}$		1.0°C/W						

*For sinusoidal current duration of 8.3 milliseconds max.
**Case temperature for overvoltage protector in non-conducting or "OFF" state.
***Case temperature for overvoltage protector in conducting or "ON" state. Power must be removed and case temperature allowed to drop to 100°C before application of output voltage.

The overvoltage protector must be mounted on external heat sink to maintain case temperature below rated limit. When the overvoltage protector is used with a Lambda power supply, the power supply chassis acts as the heat sink. The L-12-OV, L-20-OV, L-35-OV, overvoltage protector is supplied with mating connectors for pins on overvoltage protector (+V and -V engraved on unit).

OVERVOLTAGE PROTECTORS

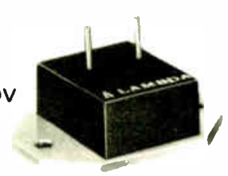
NOM SUPPLY VOLTAGE (VOLTS)	TRIP POINT VOLTAGE^A (VOLTS)	6 AMP MODELS	PRICE QTY 1	PRICE QTY 100	PRICE QTY 250	PRICE QTY 1000	12 AMP MODELS	PRICE QTY 1	PRICE QTY 100	PRICE QTY 250	PRICE QTY 1000
5	6.6 ± .2 (6.8 ± .2)^B	L-6-OV-5	$5	$4	$3.75	$3.40	L-12-OV-5	$10	$8	$7.50	$8.80
6	7.3 ± .2	L-6-OV-6	5	4	3.75	3.40	L-12-OV-6	10	8	7.50	6.80
9	10.5 ± .4	L-6-OV-9	5	4	3.75	3.40	L-12-OV-9	10	8	7.50	6.80
12	13.7 ± .4	L-6-OV-12	5	4	3.75	3.40	L-12-OV-12	10	8	7.50	6.80
15	17.0 ± .5	L-6-OV-15	5	4	3.75	3.40	L-12-OV-15	10	8	7.50	6.80
20	22.8 ± .7	L-6-OV-20	5	4	3.75	3.40	L-12-OV-20	10	6	7.50	6.80
24	27.3 ± .8	L-6-OV-24	5	4	3.75	3.40	L-12-OV-24	10	6	7.50	6.80
28	31.9 ± 1.0	L-6-OV-28	5	4	3.75	3.40	L-12-OV-28	10	8	7.50	6.80
30	33.5 ± 1.0						L-12-OV-30	10	8	7.50	6.80

NOM SUPPLY VOLTAGE (VOLTS)	20 AMP MODELS	PRICE QTY 1	PRICE QTY 100	PRICE QTY 250	PRICE QTY 1000	35 AMP MODELS	PRICE QTY 1	PRICE QTY 100	PRICE QTY 250	PRICE QTY 1000
5	L-20-OV-5	$14	$11.20	$10.50	$9.50	L-35-OV-5	$18	$14.40	$13.80	$12.30
6	L-20-OV-6	14	11.20	10.50	9.50	L-35-OV-6	18	14.40	13.80	12.30
9										
12	L-20-OV-12	14	11.20	10.50	9.50	L-35-OV-12	18	14.40	13.80	12.30
15	L-20-OV-15	14	11.20	10.50	9.50					
20	L-20-OV-20	14	11.20	10.50	9.50					
24	L-20-OV-24	14	11.20	10.50	9.50					
28	L 20-OV-28	14	11.20	10.50	9.50					
30	L-20-OV-30	14	11.20	10.50	9.50					

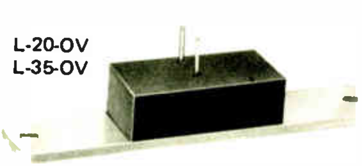
^A VOLTAGE TOLERANCE MAINTAINED OVER 0-71°C DUE TO POWER DESIGN   ^B FOR L-6-OV-5 ONLY

L-6-OV

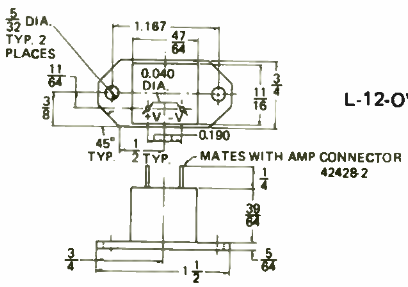
L-12-OV



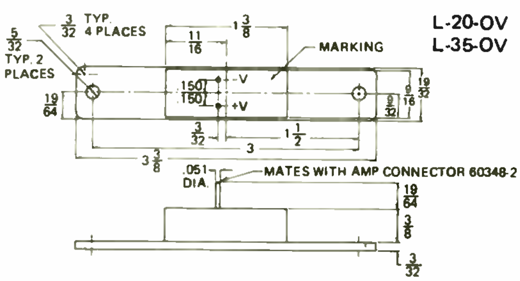
L-20-OV
L-35-OV



Outline Drawings

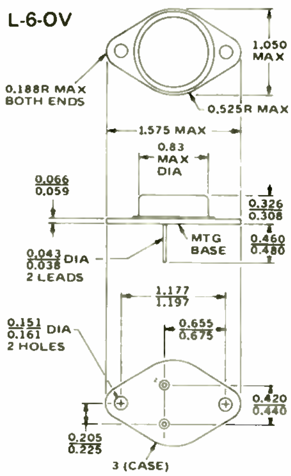


L-12-OV



L-20-OV
L-35-OV

L-6-OV



PIN CONNECTIONS

1. No connection – but this pin must be left floating for proper operation of OV
2. +V – disconnect to reset
3. (Case) – V

LAMBDA ELECTRONICS

DIVISION of Veeco INSTRUMENTS INC

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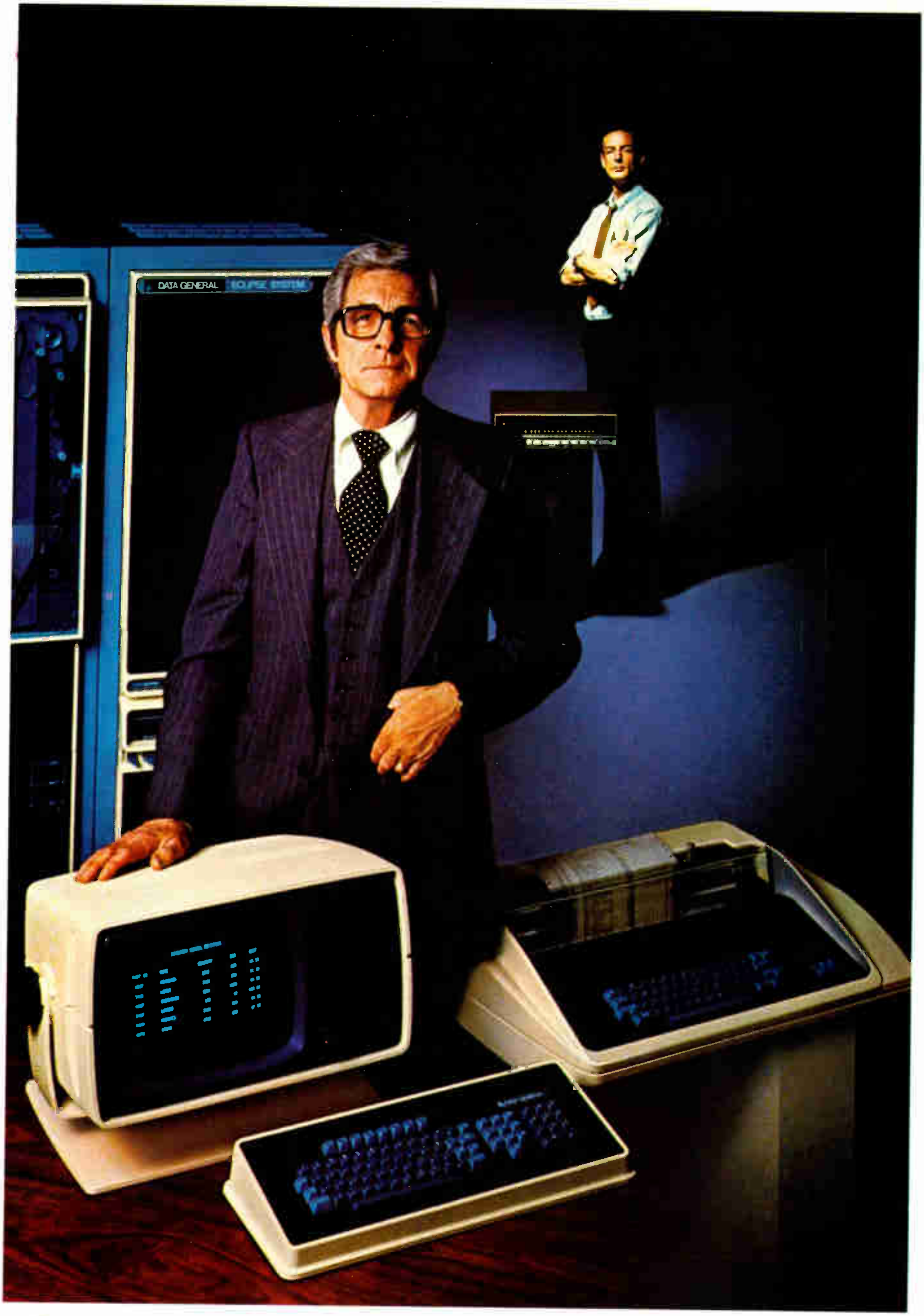
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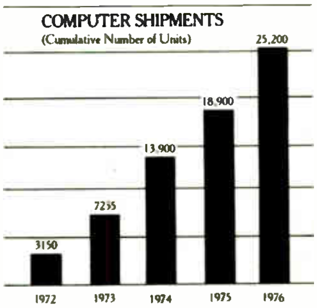

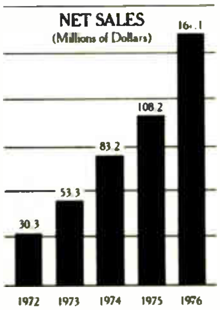

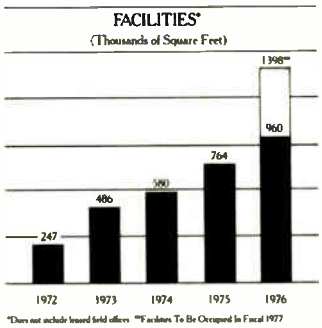

Last year we increased sales by 49% to $161 million. At the same time we also increased facilities by 80% and number of employees by 76%. And we put a higher percentage of revenues into research and development than any other computer company. Which enabled us to introduce a new product every 15 working days. Products that supply more useful technology to more users.

Unlike many other computer companies, Data General's only business is computers. We were the first small computer company to design and manufacture a 16-bit computer-on-a-chip. The first to provide high-level ANSI '74 COBOL, essential for business users. And the first to offer high-speed semiconductor memories. All of which increased performance and lowered costs.

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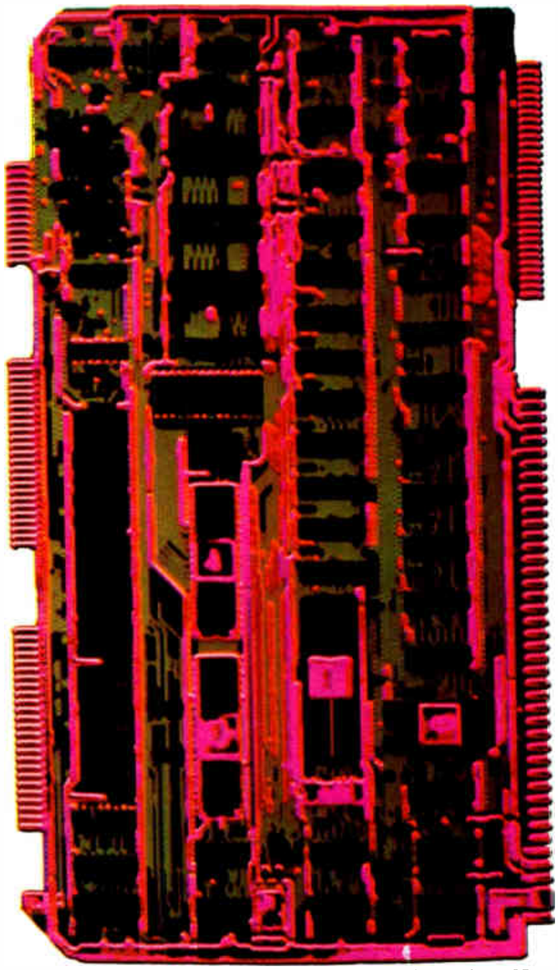

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National Semiconductor

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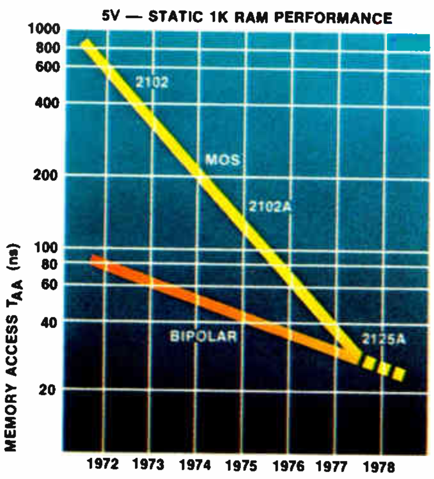
Convert to the Intel® 2115A and 2125A and enjoy MOS economy, bipolar speed and power savings up to 50%. These new NMOS RAMs offer 45 nsec worst case access time and a 100 quantity price of only $6.90. And that's just the beginning of the cost/performance advantages you can expect from Intel's new +5 volt, silicon gate static MOS RAMs.

The new 2115A and 2125A RAMs are pin for pin, plug-in replacements for the popular 93415 and 93425 bipolar RAMs. They offer all the same advantages. No need for external clocks or refresh circuits, fully TTL compatible, 16mA output sink current and operation from a single +5 volt supply.

In addition, the 2115A/2125A dissipate 20% less power and the 2115AL/2125AL 50% less power than the 93415/93425. This saves power supply and cooling costs which all adds up to additional savings in the cost of your system. And there's more. Unlike bipolar RAMs, the 2115A/2125A use only a single layer of metalization which means lower manufacturing cost and a more reliable process. So you can look for continued improvement in cost/performance. To put the cost potential in proper perspective, consider this: The 2115A/2125A chip is 35% smaller than Intel's industry standard 2102A. And the



to match bipolar speeds.

2115A/2125A are made on the same manufacturing line and with a process similar to the 2102A. If you've been following the 2102A price curve you'll understand the significance.

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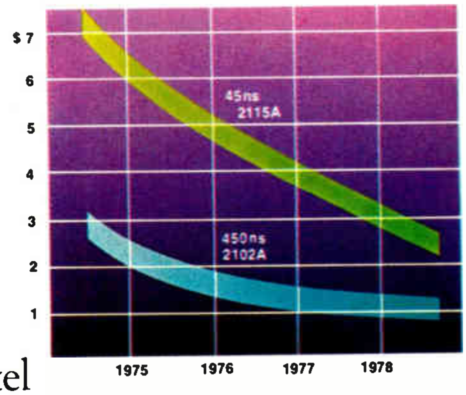

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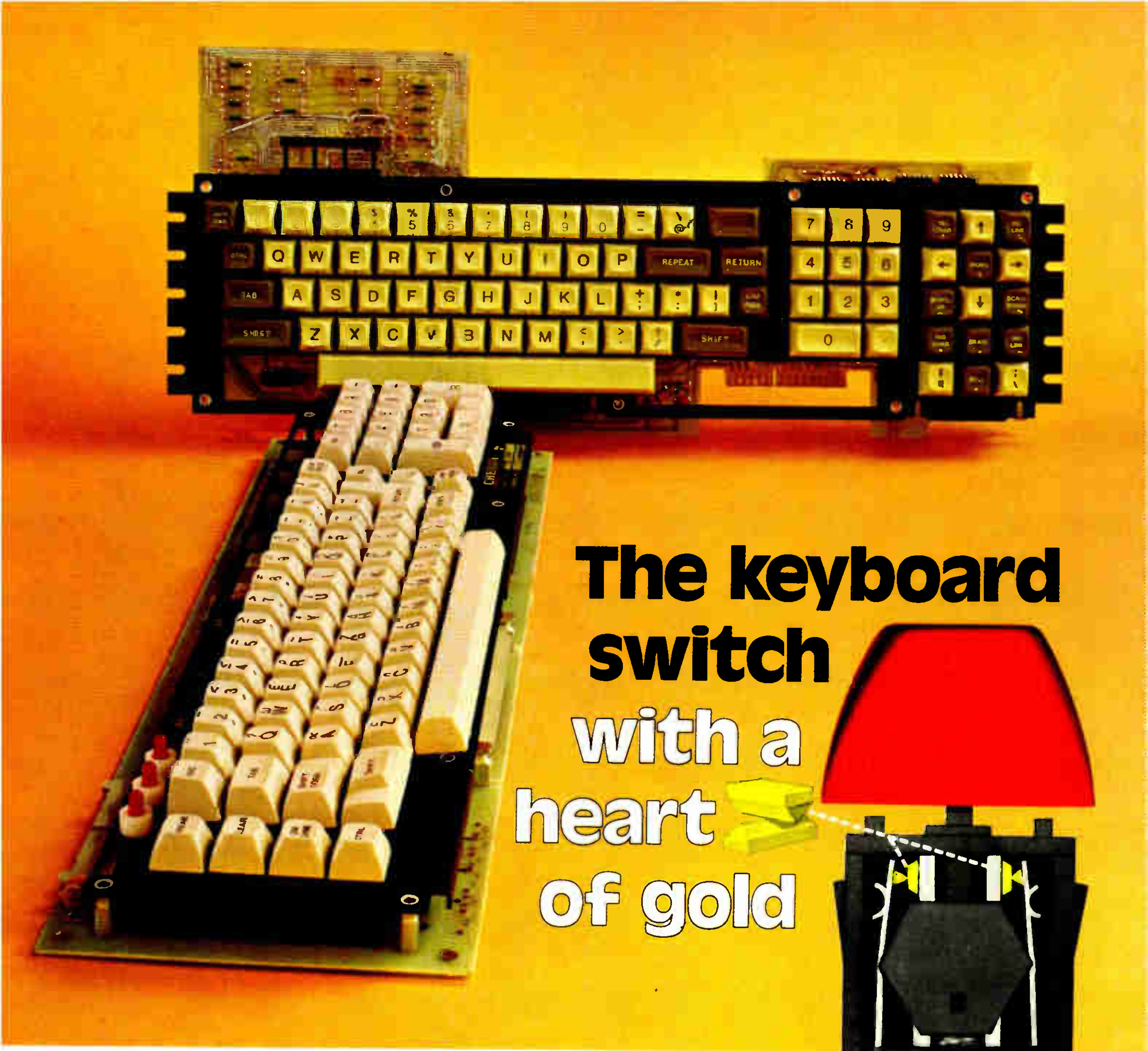

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Circle 74 on reader service card

AT&T starts tests of cellular mobile telephone system

by Richard Gundlach, Communications & Microwave Editor

The fight for shares in the mobile-telephone market will start in Chicago, where AT&T and Illinois Bell are setting up a developmental high-capacity cellular system (where low-power antennas cover small areas, called cells, that are packed together so that a channel used in one can be reused in another). At the same time, the Federal Communications Commission is weighing approval of two potential competitors: a system being built by Motorola Inc.'s Communications Systems division for the American Radio Telephone Service Inc. [*Electronics*, March 3, p. 38] and a noncellular setup from Harris Corp.'s RF Communications Systems division for ARCH, a joint venture of several radio common carriers [*Electronics*, May 12, p. 49].

But the American Telephone & Telegraph Co. is well ahead. The giant utility gained FCC approval three months ago, and it is moving quickly to solidify its lead. For the Chicago test, Western Electric Co. shipped the first production equipment on June 1 to Illinois Bell. When installed in the Canal Street facility, that equipment will handle the traffic in the first and largest of 10 operational cell sites for the technical trial of the system, which is scheduled to go into operation in 1978 with a 48-channel capacity serving up to 1,000 units.

Meanwhile, with the FCC holding that a wireline common carrier could not also make radio equipment for the cellular system, Bell was permitted to build only the switching, testing, and computer-control equipment. Major vendors involved in the total system are:

- E.F. Johnson Co., Waseca, Minn., for the cell-site channel transmitter and receiver modules, each usable on any one of 667 channels.
- Motorola Communications Systems division, Schaumberg, Ill., for the cell-site 40-watt channel power amplifiers
- Microwave Associates Inc., Burlington, Mass., for rf power distribution equipment for the cell site.
- Oki Electric Co. of Japan, for the handset and control unit that mounts in the automobile as well as the transceiver (including the audio processing and logic circuits) that is carried in the trunk.

Planning ahead, AT&T is ready to award contracts to three vendors to equip some 2,000 mobile units for the second test, the market trial, scheduled to begin in the first quarter of 1979. It is expected that Oki, E.F. Johnson, and Motorola will receive contracts for this equipment this month.

Then, if all goes well with the Chicago market trial, Bell is shooting to have a similar service operating in more than 25 cities by 1985. By 1990, about 100 cities and some 1 million subscribers will be using Bell's mobile telephone service. In the year 2000, Bell planners envision all major urban areas covered.

The start. The technical trial will include 10 cell sites and cover about 2,000 square miles in the Chicago area. Initially, 100 mobile units will be installed in Bell-owned vehicles. The startup system will use a cell radius of 8 miles, instead of the originally proposed 4 miles, with three omnidirectional antennas placed at alternate corners of each hexagonal cell. Then, as use grows, cell size can be halved and halved again down to a 1-mile radius.

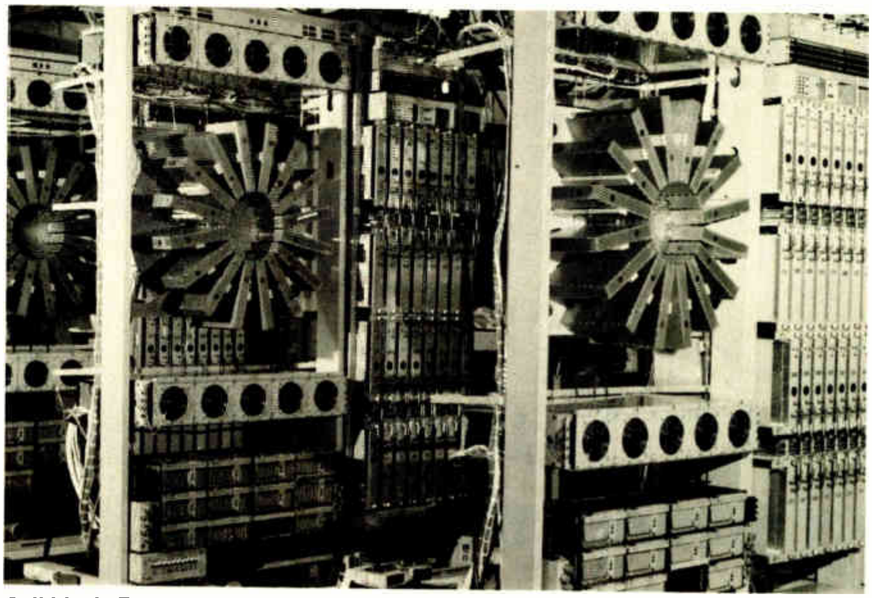
But Bell is not alone. ARTS, a Baltimore common carrier, petitioned the FCC early this year for permission to establish a cellular mobile radiotelephone service in the

Baltimore-Washington, D. C., area using Motorola's system. Later, ARCH, a joint venture of several radio common carriers, petitioned the FCC to establish a mobile radio service in the same area using Harris equipment. Their concept, however, differs radically from Bell's cellular approach. They proposed a centralized approach, which uses a single high-power TV transmitter and requires no switching. The Bell concept is a distributed approach using lower-power base stations and switching offices.

The Motorola system is compatible with Bell's. In fact, the meaningful differences are few. For one, Motorola uses a single antenna in the center of a cell. Each cell is divided into 60° sectors, which in effect, creates six independent cells. The cells are grouped in fours, and this pattern is repeated. Motorola uses both hexagonal and triangular shaped cells that vary in size; Bell uses only hexagonal cells of the same size in clusters of seven calls.

Another difference is in switching. Bell uses a single mobile telephone switching office equipped with its No. 1 ESS; Motorola uses a distributed switching approach because it wants lower startup costs. Finally, since Motorola expects to accommodate portable telephone units immediately, it is using antennas as high as 500 feet, taller than Bell's.

Another idea. The Harris system concept (no equipment has been built yet), has one high-power base station instead of the distributed approach of the cellular system, and requires no special multiple switching centers since there is no need to "hand off" a mobile unit leaving one cell and entering another. "It's a kind of brute-force approach," admits Lee Blanchowicz, director of engineering, short-range radio, for Harris's RF Communications division in Rochester, N.Y., "but it's simple to implement and very cost-effective. What's more, it doesn't require wireline interconnections except at a single point—which pleases the carriers since it doesn't require multiple leased lines from the telephone companies."



Cell block. Three frames of cell site equipment are shown. They give the Chicago test site a capacity of 48 channels. The fan-like objects combine outputs of channel amplifiers.

Harris plans to use a single 10-kilowatt TV transmitter in the base station and an antenna having a gain of 16 dB. This combination produces an effective radiated power of 367 kilowatts when feedline losses are considered. Transmission from base station would be wideband digital with some form of time-division, multilevel modulation techniques to minimize multipath problems (similar to the ghosts that show up on TV sets when signals bounce off tall buildings in all directions).

Although the mobile units will receive wideband digital transmissions, they will use conventional narrow-band fm to transmit back to the base station. Mobile transmissions on individual channels (the system will ultimately have 96 channels that Blanchowicz feels will handle upwards of 10,000 subscribers) will be picked up by remote receivers that translate the mobile channel frequencies to higher microwave frequencies and then retransmit to the base station using microwave techniques.

Conflict. Responses to the Harris/ARCH proposal were submitted to the FCC on June 1. Motorola/ARTS petitioned the FCC to dismiss the Harris proposal, according to Motorola's Martin Cooper, vice president and general manager of the Communications Systems division. He claims it conflicts with the intent of FCC Docket 18262 that calls for a cellular, frequency-reuse, high-capacity system. Also, says Cooper, Harris is planning to try out technologies that are uncertain, and a high-power approach that will pollute the spectrum.

Cooper says he is angered by the Harris plan, but what he fears most is that the FCC will hold meetings—to decide which system should be used in Washington—that could delay for years the onset of the cellular system. However, his biggest concern is the great advances the Japanese have made in cellular technology: "With the world accommodating mobile radio, the country that develops the technology will have a worldwide market," maintains the Motorola executive.

Bell personnel also question the technical viability of the Harris approach. According to Bell Labs engineers, it is difficult to provide reliable service at a 3-Mb/s transmission rate in an urban environment. "Bell Labs has done extensive testing in this area," says F. R. Blecher, director of the Mobile Telephone Laboratories in Whippany, N.J., "and has found out from tests conducted in Philadelphia and New York City that transmitting at greater than a 300-kilobit-per-second rate causes problems. Bell used a signaling rate of only 10 kb/s with a sophisticated coding scheme, employing quite a bit of redundancy to achieve reliable operation." □

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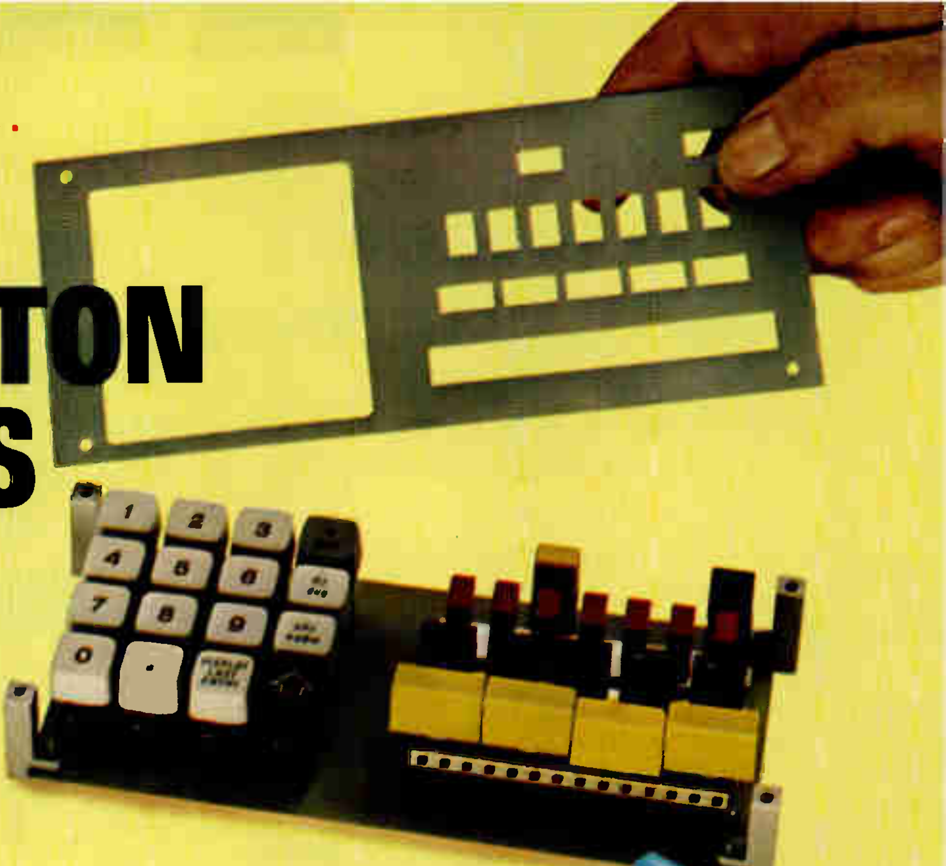

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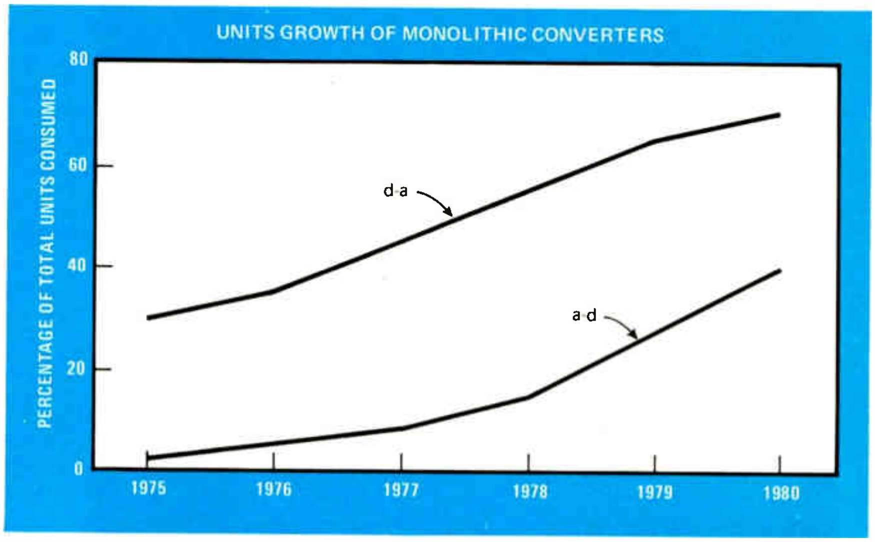
Components

Monolithic converters gain strength

With the advent of 12-bit d-a chips a year ahead of schedule, the performance lead enjoyed by hybrid devices shrinks still further

by Lucinda Mattera, Components Editor



Competition among producers of data converters is heated and getting hotter all the time, with the sharpest battle lines being drawn between monolithic and hybrid devices. Although monolithics still do not perform on a par with hybrids all along the line, the amazing recent advances of chips cannot be denied, and the coming year promises more startling developments.

High-accuracy, fast, 8- and 10-bit digital-to-analog chips are already here, and the 12-bit area is at last beginning to take form. That's a surprise, because 12-bit devices were not expected to arrive for another year or so. Yet, within the next six months, a number of 12-bit d-a chips will be on the market. Because speed is essential to many 12-bit applications, most of the devices will be bipolar rather than MOS.

The action in monolithic data converters is in two technologies—bipolar and MOS—with some firms doing both. The company with probably the most diverse capability is National Semiconductor Corp., which is making low-end bipolar, complementary-MOS, and p-channel MOS chips but will begin to concentrate on high-quality C-MOS designs. The only other firms currently producing both bipolar and C-MOS converters are Analog Devices Inc. and Motorola Inc. However, Analog tends to specialize in high-quality products, whereas Motorola serves principally the low-end markets. High-performance bipolar devices are the specialty of Precision Monolithics Inc. and Harris Semiconductor, a newcomer to the converter marketplace.

Texas Instruments Inc. and Signetics are just beginning to get their converter efforts under way, choosing high-quality products as their initial vehicles. Signetics, though, is leaning on its bipolar capability, while TI is going first with bi-MOS and I^2L integrating converters. Burr-Brown, a leader in hybrid converters, is also in the initial phases of its monolithic program. At Siliconix Inc. and Intersil Inc., the commitment is to charge-balancing integrating converters in C-MOS.

The major drawback of most monolithic d-a converters is that they require either an external voltage reference or an output amplifier, and sometimes both. Hybrid d-a converters, on the other hand, are almost always self-contained, which makes the engineering easier but the price tag higher. Rallying to remedy this situation, semiconductor producers are adding at least the voltage reference to their designs.

In certain respects, the monolithic challenge to hybrids is actually stronger as regards a-d converters. To assess the challenge properly, the a-d area should be divided into successive-approximation devices and integrating devices. Essentially, monolithics are on top in the latter category and running a commendable second in the former.

A successive-approximation a-d is nothing more than a d-a converter, a comparator, a logic register, and other trappings like a clock and a voltage reference. At this time, the only completely self-contained monolithic successive-approximation converters are 8-bit devices that are fairly slow, taking about 20 microseconds to complete a conversion. Some bipolar 10-bit units offer reasonably short conversion times, but none is self-contained. However, within the next few months, complete 10-bit bipolar chips will emerge that combine high speed and low power.

However, a 12-bit successive-approximation a-d chip still eludes the semiconductor makers. Some are content to let the hybrid people have the 12-bit a-d market for now, while others are producing sets of two or three chips, partitioning the converter into its analog and digital sections. Only one or two companies are hard at work on a direct approach. By year's end, though, there should be at least one full-fledged 12-bit bipolar a-d chip on the market and even a low-cost C-MOS device.

More important, perhaps, is the ability of the semiconductor industry to take a different tack altogether and turn to building low-cost converter subsystems for microprocessors. This direction is already in evidence, as a number of converter chips, both d-a and a-d devices, include on-chip three-state buffers for direct connection to a microprocessor bus.

In contrast, the upcoming converter subsystems would resemble the front end of a data-acquisition system, including a multiplexer, a d-a converter, a comparator, and perhaps a sample-and-hold circuit on the same chip. They would be designed to work with the microprocessor, using its logic for the control functions and for the successive-approximation register. Initial devices will probably have a six-channel capacity and a resolution of 8 bits.

Since monolithics are beginning to dominate 8-bit applications, some hybrids are starting to move up to the systems level at this low end. Complete eight-channel 8-bit data-acquisition systems, as well as self-contained 8-bit analog input/output systems for microprocessors, are appearing. Prices, however, are fairly steep, running about $150 to $200 for single-unit purchases. This systems approach will undoubtedly be the future direction for hybrids, especially as converter chips take over most 10- and 12-bit applications for single devices.

Integrating a-d converters is another story. Monolithics easily satisfy the moderate conversion speeds needed, and there is no troublesome resistor network to trim as there is with successive-approximation devices. Also, the external circuitry is minimal—only an outboarded capacitor and perhaps a voltage reference. Integrating converters are particularly suitable for instrument applications where speed is not critical.

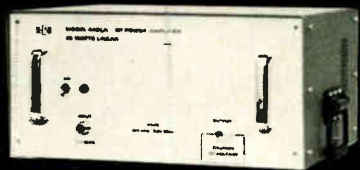
Uses. Monolithic dual-slope and charge-balancing integrating converters are quickly finding their way into digital panel meters for 3- and 3½-digit applications. Some of these chips even incorporate decoder/drivers for seven-segment light-emitting-diode displays. Higher-resolution units for 4½-digit applications are appearing, and several newer devices include three-state output buffers for microprocessor hookup. Moreover, in the near future, chips made with an MOS process will likely bring the integrator capacitor inside the package.

The real key to the improving performance of monolithic converters is simply the fabrication and trimming of the thin-film resistors needed for d-a and successive-approximation a-d converters. Semiconductor manufacturers have now learned how to adapt existing thin-film resistor technology to their needs, although opinions differ as to which trimming technique is best for their purposes.

Most producers are doing straightforward active laser trimming—that is, they directly laser trim the resistors for ratiometric accuracy with power applied. Several others are using a method popularly dubbed zener or diode zapping, where zener diodes connecting the resistors are selectively short-circuited under reverse bias.

All these methods work well for the companies using them. Probably the major difference between them is the continuous nature of the direct laser trimming versus the discrete, or step, nature of the zener-zap and metal-link trimming. Also, as its proponents point out, direct trimming permits simultaneous adjustment of both offset and drift.

Interestingly, a passive-component technology has largely been the stumbling block of monolithic converters. Most, if not all, semiconductor manufacturers would like to get rid of the network altogether, so the search continues for conversion techniques that better lend themselves to semiconductor technology. □



Navigation

Civilians to get Loran-C

As sea lanes approach saturation, Coast Guard speeds toward implementation—but major benefits may be on land

by Bruce LeBoss, New York bureau manager

As sea lanes approaching U. S. ports near saturation, the risk of vessel collisions and groundings grow. To prevent them, the U. S. Coast Guard is going full speed ahead to set up a precision positioning system for marine navigation. But the major benefits of the long-range navigation system, called Loran-C, may well come ashore.

By the end of this month, the Coast Guard hopes to have finished and in operation along the Canadian west coast and Gulf of Alaska new groups (or chains) of transmitting stations that consist of one master station and at least two secondary stations. Along with a new chain that went into operation along the U. S. west coast in April, this will end the first phase of a major upgrading of radio-navigation service in the zone from 200 miles offshore into the rivers and harbors.

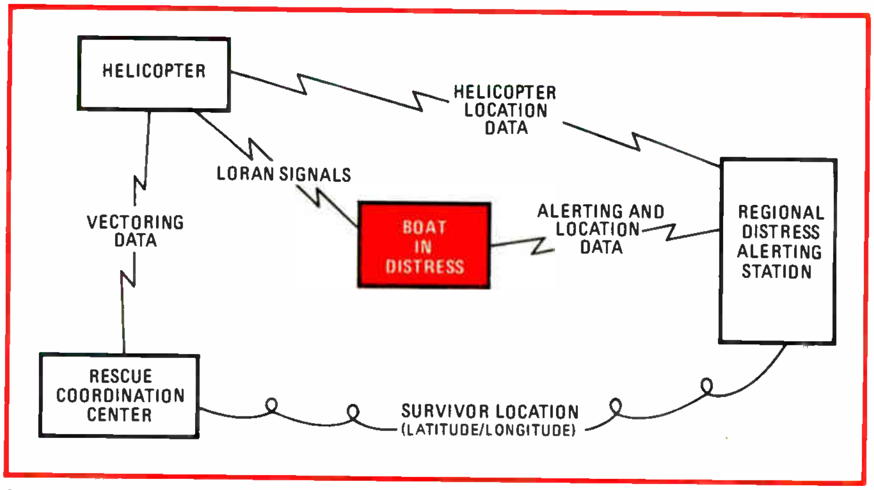
The next phases of the Coast Guard program call for expanding and upgrading an existing Loran-C chain on the east coast and adding a similar chain along the Gulf of Mexico, both of which are to be in place by the summer of 1978. The addition of yet another Loran-C chain in the Great Lakes area, to be operational in early 1980, would complete the nationwide system.

Like its predecessor, Loran-C is a navigation system in which the time difference between hyperbolic pulses is measured to fix a vessel's position. Whereas Loran-A signals are single pulses that give the system a fix accuracy of 0.5 to 2 nautical miles, the Loran-C pulse consists of a carrier that rapidly increases in amplitude in a carefully controlled manner and then decays at a specified rate. This provides a more accurate means of measuring time differences and a fix accuracy of 0.1 to 0.5 nautical mile, repeatable to 100 feet. Furthermore, Loran-A operating at 2 megahertz has a ground wave range of 700-900 nautical miles, whereas substantially increased ranges (1,200 to 1,500 nautical miles) are achieved with Loran-C, which transmits in the 90–110-kilohertz band. The low frequency of Loran-C also permits propagation of signals over land.

The cost of the new Loran-C stations, including electronic and power equipment and installation and construction, is about $5 million per station, says Commander Paul Pakos, chief of the Coast Guard's Systems Development branch in Washington, D. C. In addition, the cost of upgrading existing Loran-C stations to provide a signal-to-noise ratio of 1 : 3 or better (compared with 1 : 10 or greater for existing stations), "is $1 million to $1.5 million for the new electronics," Pakos adds.

The Coast Guard is in the throes of calibrating five of the eight Loran-C transmitters built by International Telephone & Telegraph Corp.'s Avionics division in Nutley, N. J., for the three chains that cover from the Pacific coastal waters of Mexico up to Canada and the Gulf of Alaska. All but one of the ITT transmitters are new versions of the vacuum-tube FPN-44, a 400-kilowatt peak-power system. But the new transmitters have solid-state, in place of vacuum-tube, power supplies and regulators, Pakos says.

The lone ITT transmitter not of the FPN-44 variety is a 1-megawatt-peak-power system designated the FPN-45. The reason for the 1-MW transmitters, explains Pakos, is that "sometimes, to get a good hyperbolic signal, the stations needs to be located inland where the attenuation is much more severe than over water." Another reason for the



Mayday. The new Loran-C long-range navigation system of "chains" along the U.S. coastline will operate in the manner shown above in a typical search-and-rescue operation at sea.

higher power, he adds, is because "certain stations are optimized for longer-range coverage."

There are no plans yet to replace the vacuum-tube Loran-C transmitters recently installed on the west coast with solid-state units, Pakos reports. But before the Loran-C systems can be effectively implemented, much more needs to be done, says John M. Beukers, president of the Wild Goose Association, an organization of more than 400 industry and government officials with a common interest in Loran systems.

For one thing, in its new navigation safety regulations, expected to be published this fall, the Coast Guard proposes to require Loran-C receivers on all vessels of 1,600 or more gross tons that enter U. S. waters. The receivers would be required to have features available on receivers selling today for $3,000 to $5,000.

In addition to the Loran-C receiver market on large vessels, Beukers notes there are an estimated 75,000 Loran-A receivers out among commercial fishing boats, "and they'll all have to convert to Loran-C. But they'll likely do it with the $1,000 manual receivers and not the $4,000 automatic ones."

An even larger potential marine market exists among the several million pleasure-boat owners, notes Beukers, "but I don't think the Loran-C receiver market will really open up to the pleasure-boat owner until the price of automatic receivers falls below $1,500.

But perhaps the biggest potential for Loran-C receivers is on land. When all of the planned chains are operational, the Loran-C signals will propagate over two thirds of the land mass of the continental U. S., covering about 95% of the population, says Commander William B. Mohin, chief of the Coast Guard's Loran-C Applications Project office. "Indeed, there's an enormous bonus to transportation and to other fields by making use of those highly stable signals coming inland," he adds. That's why the Coast Guard plans to request another $20–25 million to build three stations in Montana, Colorado, and Texas that would make a mid-continent chain. □

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TALLY

Companies

Rockwell hopes shake-up is recipe

Microelectronic Devices is downgraded from division status, gets new management, and signs second-source deal with MOS Technology

by Larry Waller, Los Angeles bureau manager

The optimist. Malcolm B. Northrup, who is the new man in charge of Rockwell's Microelectronic Devices operation, has a deal with MOS Technology to fuel his ebullience.

By any standard, Rockwell International's former Microelectronics Device division has undergone a thorough shaking up this year. Yet with a new status—downgraded from a division—different management, and a changed microprocessor development outlook, the old question remains. After many abortive tries, is it finally on the right track to workable n-channel metal-oxide-semiconductor devices?

"We have it this time, we're sure it's right," answers Malcolm B. Northrup, who was put in charge of the Anaheim, Calif., operation in February. Specifically, he is vice president of the microelectronic devices segment of the Electronic Devices division, created to pull together 10 separate circuit operations formerly scattered throughout the Electronics Operations group.

Northrup pins his plans on a licensing agreement with MOS Technology Inc. Announced without fanfare in April, it allows Rockwell to produce and market the n-channel 6500 family of microprocessors. The contrast between this deal and the much-ballyhooed 1975 exchange pact with National Semiconductor Corp. goes far beyond the difference in decibel levels, as Northrup explains it, for it confirms that the previous agreement is now "dead as a doornail."

"The National deal was an honest agreement," he says, "but we both got to the point where we couldn't figure out why we were second-sourcing each other." In other words, the technology, customer lists, and product lines of Rockwell and National Semiconductor just did not mesh.

When the agreement's unworkability became apparent, Northrup himself was called in last October to lead a "task force to find the solution." At that time he was managing mechanical-filter and MOS large-scale-integration business for Collins Radio Co., another Rockwell group. Several factors impelled Rockwell to make the MOS Technology decision in February. "We figured enough companies already were in the 8080 camp," Northrup says, "and we had the high-volume production and sales organization MOS Tech needed."

Prepared. With this decision, Rockwell prepared the technology transfer properly this time, instead of "grabbing the mask and running," as with National. One result is 98% of the technology and processes are in place at Anaheim, and the company already is producing in volume to meet the first contract this month. Rockwell's 6500 line initially covers 10 MOS Technology central-processing devices.

For memory devices to go with n-channel, Rockwell also is going outside, since its own program ran into problems. Here, it will build three read-only memories and four static random-access memories under license from Synertek of Santa Clara, Calif.

"We're not stopping p-channel," Northrup insists, "but we are working to make the 6500 a natural bridge to address the 8-bit market, on the way to an integrated product line." Interestingly, Northrup reports that the pressure to get n-channel devices does not come

Probing the news

from any present p-channel customer demanding it. "Rather, he has to look and see that n-channel is there, if and when he needs it," says the new vice president.

Although yet another reorientation of microprocessor plans gets most of the attention, Northrup thinks some other changes could be more important to the company in the longer run.

In particular, he singles out the move that brought the 300-person Electronic Research Center into the division from the Autonetics group. "Before, together we had so many resources, but organizational barriers kept us apart." Now, Northrup and his managers have stepped up programs aiming at the next generations of device technology. These include advanced n-channel work on very large-scale integration intended to match that of other semiconductor houses, as well as silicon-on-sapphire devices that are close to commercial level and bubble domain memories.

Northrup's ultimate goal, which he puts three to four years away, is a product line of off-the-shelf modules that can be put together in custom configurations at low cost. "These will be customized devices that vary the CPU, ROM, and RAM on the same chip," he foresees.

Collins flavor. Both Microelectronic Devices and the parent division have taken on a distinct Collins Radio flavor. Northrup has brought in colleagues, and division president Howard D. Walrath, a Collins veteran, has liberally staffed other segments of his command with Collins executives.

This infusion of proven Collins managerial talent is seen by many as central to the strategy of Donald R. Beall, Electronics Operations president, to get Microelectronic Devices moving quickly. Employing 1,900 of the more than 3,000 people in the division, it is by far the largest part. Beall himself, who ran Collins before being named to his present job about a year ago, was instrumental in making that company into a highly successful operation after it was acquired by Rockwell. □

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Circle 85 on reader service card

MDB SYSTEMS presents... The LSI-11 Connection

GP Logic Modules · Peripheral Controllers · Communications Interfaces · Special Purpose Modules · Accessory Hardware Plus: DEC's own LSI-11 Microprocessor Module.

Here are some MDB Systems connections to LSI-11 microprocessors:

- ☐ General Purpose Interfaces:
  Parallel for programmed I/O and DMA.
  Do-it-yourself dual and quad wire wrap for any DIP design.
- ☐ Device Controllers for most major manufacturer's
  Printers
  Card equipment
  Paper tape equipment
  Plotters
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  Asynchronous Serial Line
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- ☐ MDB Backplane/Card Guide Assembly (8 Quad slots)
  Rack mount chassis 5¼" front panel.
- ☐ Special Purpose Modules and Accessories
  System monitoring unit provides front panel switch addressing, power on/off sequencing; line frequency clock.
- ☐ Bus extenders/terminators.
  E-PROM and PROM modules.
  Bus connectors for backplane assemblies.

MDB Systems products always equal and usually exceed the host manufacturer's specifications and performance for a similar interface. MDB interfaces are software and diagnostic transparent to the host computer. MDB products are competitively priced; delivery is usually within 14 days ARO or sooner.

MDB also supplies interface modules for DEC PDP*-11 Data General NOVA* and Interdata minicomputers.

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1995 N. Batavia St., Orange, California 92665
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*TMs Digital Equipment Corp. & Data General Corp.

CIRCLE NO.267 FOR LSI-11;268 FOR PDP-11;269 FOR NOVA;270 FOR INTERDATA

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BENDIX BRISTLE BRUSH BUNCH.

Opens new horizons for PCB design.

Free and easy are now the bywords for board and board support design with the 70% to 90% reduction in mating and unmating forces offered by the new Bristle Brush Bunch connector series from Bendix.

The need for costly board support systems is minimized.

You get extended interconnection contact counts and versatility—up to 400 contacts per connector.

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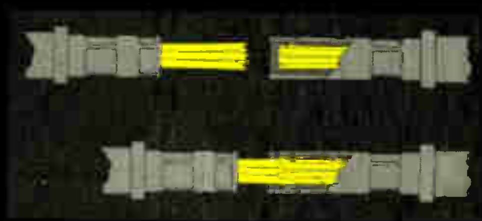
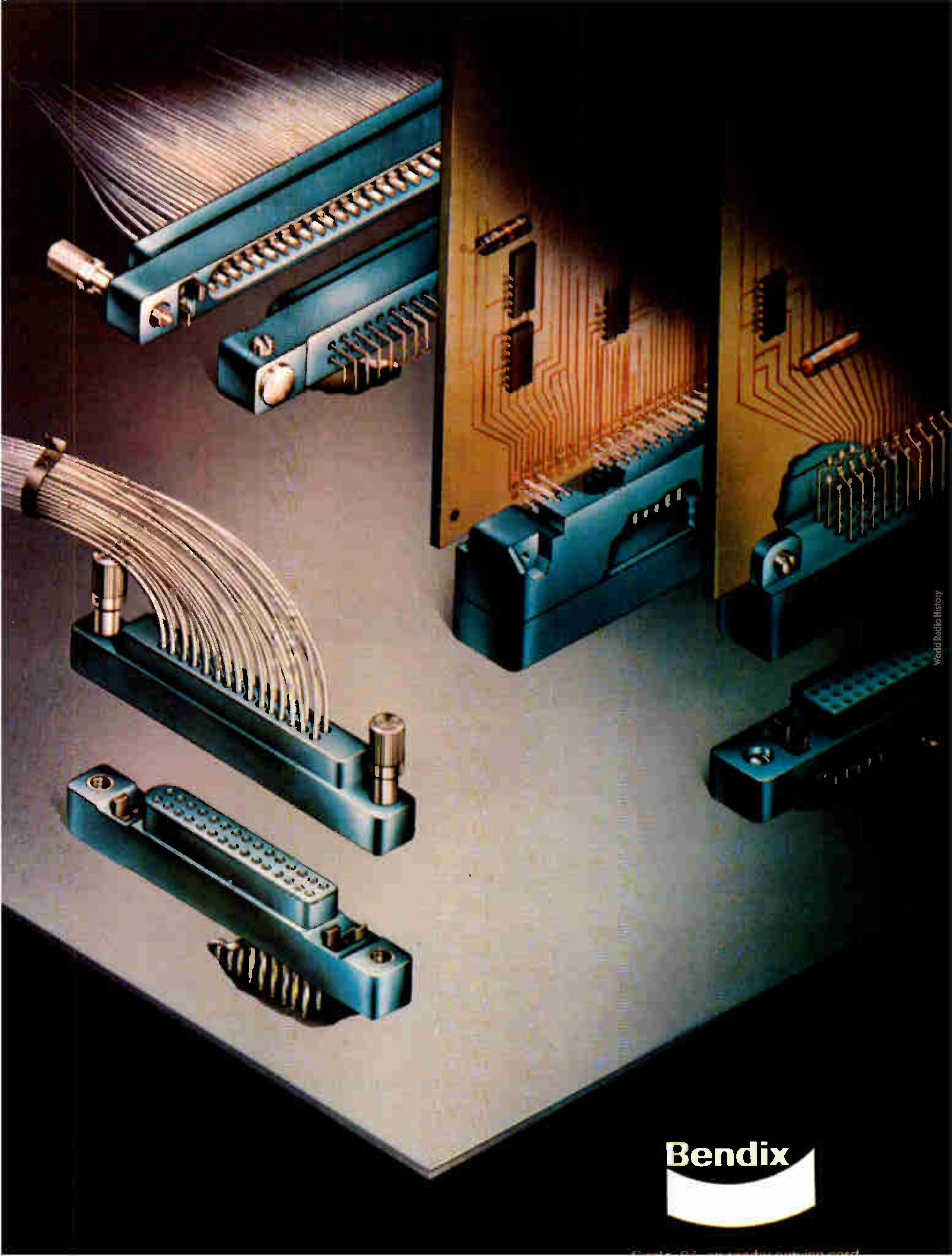


CONTACT INNOVATION


Bendix

Companies

HP Components group breaks the mold

By investing 10% of profits in R&D, selecting its market areas, and selling abroad, the group far outpaces the industry norm

by Bernard Cole, San Francisco bureau manager

According to traditional wisdom, the discrete semiconductor marketplace, which over the years has been losing its share of total semiconductor sales to integrated circuits, is not a place where a company will experience dramatic growth.

It is a market where the company doing $10 million to $50 million in sales a year is the norm and where 4% to 5% growth is considered spectacular. It is also a market where companies tend to focus on a particular segment and concentrate all their energies there to the exclusion of others.

But one organization seems to have violated all these rules—and to have done so successfully. With yearly sales now approaching the $150 million to $200 million level, it is larger than many traditional IC houses. Over the past five years, it has grown more than 30% in total sales. Moreover, net profit usually ranges from 8% to 10%, about double the profit margin of most IC houses. Finally, it is definitely not a one-product or one-technology company; its line spans the entire discrete market: light-emitting diodes, infrared detectors, optically coupled detectors, solid-state numeric and alphanumeric displays, microwave transistors, microwave diodes, radio-frequency and general-purpose diodes, and hybrids of various types.

The company is Hewlett-Packard Co.'s Components group in Palo Alto, Calif., the successor organization to the former HPA division, which succeeded HP Associates. The obvious explanation for its remarkable growth—internal sales to other HP groups and divisions—is not the answer. "That may have been the way we started out," says group manager David Weindorf, "but that reaches a steady state after a few years. Most of our sales—85%—are the result of orders from outside."

Strong to the outside. Components group manager David Weindorf says that 85% of its sales are outside Hewlett-Packard.

Components group products, he says, are sold to many major companies for a variety of applications, including space exploration, microwave ovens, cameras, automobiles, communications satellites, radios, radar, heart pacemakers, instrumentation, computers, and calculators. HP Components' customers include IBM, Hughes, Delco, and Chrysler.

The keys to the group's success, says Milton Liebhaber, group marketing manager, are technological leadership, careful selection of market areas, and an emphasis on international sales. "About 10% of our profits each year goes into research and development," he says, "and we apply this technology to market areas in such a way as to ensure a dominant share."

Among the first of its high-quality products, developed in 1964, was a hot-carrier Schottky diode for use in high-frequency diodes. In 1968, after extensive R&D, HP entered the optoelectronics field with the first commercially available light-emitting-diode technique.

The group's Microwave Semiconductor division has developed a low-cost double-balanced mixer that has high-volume use in such diverse areas as fm stereo and television receivers, cable TV converters, communications systems, high-level receiver front ends, up/down converters, and phase detectors. Late last year, the Microwave division also introduced a high-frequency, high-gain, and low-noise microwave transistor, using ion implantation and a variety of techniques new to discrete-semiconductor technology.

In the works, says Weindorf, are a new series of Schottky diode chips aimed at replacing germanium diodes in numerous applications, as well as a whole range of new products based on the group's newly developed gallium-arsenide field-effect-transistor technology. For the longer term, there is a whole new series of silicon-based microwave transistors.

According to Liebhaber, the group is eyeing a new market area: optical communication. "Fiber-optics technology has advanced to the point that long-range communication via light beams is now possible. What needs to be developed is the means to link the fiber optics more efficiently to existing electronic systems." Liebhaber sees this market as a definite opportunity for the group's gallium-arsenide-based LED and FET technology. □

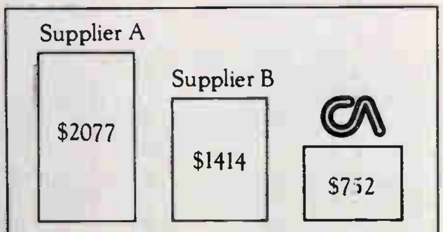
We figured a way to cut the cost of interface in half.

So what?

So OEM's are dancing in the streets, that's so what. At least the pros are.

And what makes it such a big deal is the magnitude of the cost savings—possibly 20% or more per computer system.

One reason is that interfaces are generally long on duplication and short on common sense. Most interfaces, for example, faithfully repeat half or more of the circuitry on all the other interfaces. And with multiple interfaces, that gets to be a pretty expensive proposition.



I/O System cost comparison

So we came up with the solution you see here: The Distributed I/O System. Designed to work specifically with our line of NAKED MINI® computers.

And once you get by its unorthodox appearance, the logic of it becomes pretty appealing. As do the cost savings.

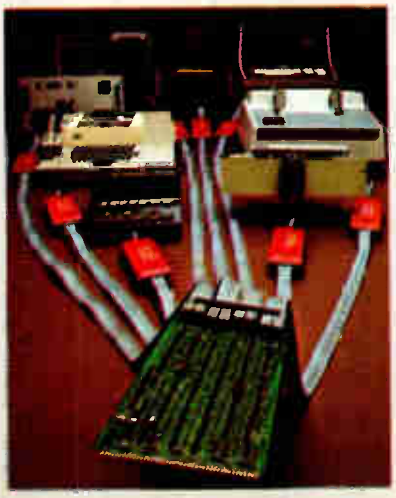
All the basic circuitry is located on a single half-card I/O Distributor, which can be shared by as many as eight "Intelligent Cables." Packaged into every cable is an integral PicoProcessor, which handles the functional control for each interface.

This arrangement allows much smaller computer packages, since only one I/O board is housed inside the computer cabinet.

And along with a smaller package, comes a smaller price.

The I/O cost comparison at left shows the savings on a typical four-interface system (2 CRT's, 1 line printer and 1 card reader). And since our System handles up to eight interfaces, imagine your savings using its full capability.

Consider ComputerAutomation's Distributed I/O System. It's an uncommonly sensible solution to a commonplace problem. From the price/performance people who brought you the NAKED MINI®



The Distributed I/O System

ComputerAutomation
NAKED MINI® Division
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Circle 89 on reader service card

The LSI-11 microcomputer is really getting the plastics business rolling.

There's a new computerized extrusion process control system for plastic sheet and film that improves material uniformity by up to 75%. It also decreases usage of expensive resins by up to 10%, while automatically maintaining close produce tolerances. Yet it's one of the most effective extruder control systems you can buy.

It's called the Measurex 2000/25.

And it's run by an LSI-11 — the highest performance, most software-supported microcomputer you can buy.

For Measurex Project Manager Dave Stepner, anything less than the LSI-11 simply wouldn't have been enough.

"We were looking to develop the most cost effective, full state-of-the-art system on the market," says Dave. "With the LSI-11, we got the computer power and 16-bit accuracy we needed, plus packaging flexibility."

What Dave Stepner liked most about the LSI-11 compared to other microcomputers, was its full 16-bit accuracy and hardware floating point option. "We have to do a great deal of high speed, accurate calculations to support our sensors and control algorithms. The LSI-11's 16-bit word length and floating point arithmetic let us accomplish this and not sacrifice response or performance."

The people at Measurex were also looking for real flexibility and expandability in their system. "Thanks to the LSI-11's capability, we were able to design a distributed architecture which links up to eight dedicated Measurex 2000/25 control stations, each with its own LSI-11, to a central intelligent data terminal for management reporting. And because of the LSI-11's low cost and single-board packaging, we can provide customers with a spare computer on site."

Dr. Dave Stepner,
2000/25 Project Manager, Measurex Corp., Cupertino, CA.

Dave Stepner concludes: "The LSI-11 really has everything going for it. The instruction set allows for very efficient coding — the technology has been tested and proven — and, of course, Digital has a mass production and delivery capability well matched to our needs."

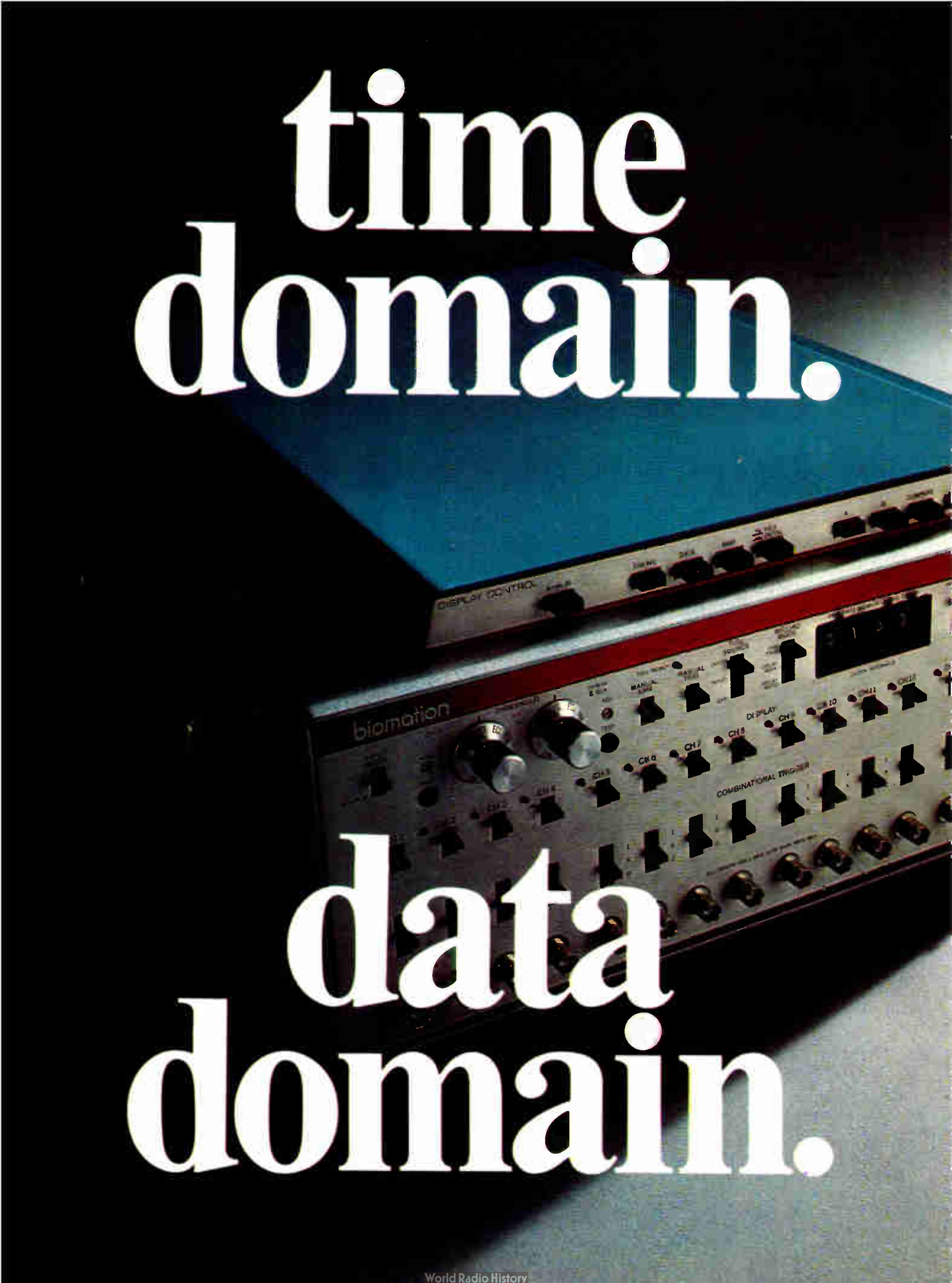
Why not do like Measurex's Dave Stepner and get in touch.

We'll show you how the LSI-11 can get your business rolling too.

(For 600 pages of solid technical information, plus our new brochure of microcomputer case histories, "Why Anything Less than the LSI-11 Wasn't Enough for Me," just call toll free 800-225-9480 (in Mass. 617-481-7400 ext. 5144), or write Digital Equipment Corporation, One Iron Way, Marlborough, Massachusetts 01752.)

digital
COMPONENTS GROUP

Circle 90 on reader service card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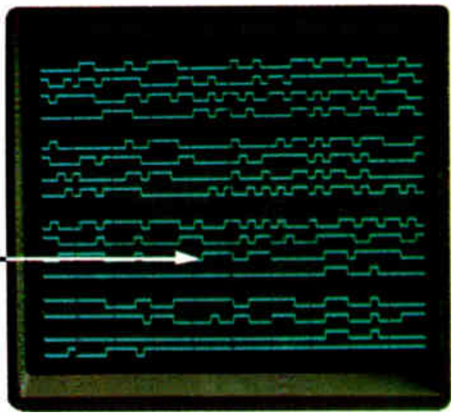
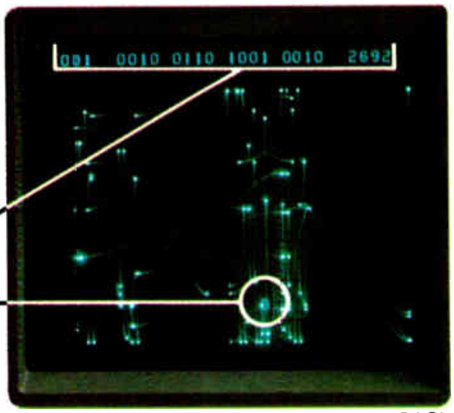
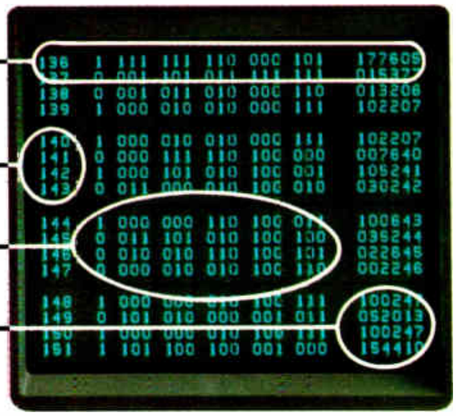


Biomation's new 1650-D produces a repetitive display output reconstructing precisely 500 bits per line for a 16-line timing diagram on a conventional oscilloscope or CRT display. Separate selection of individual channel outputs allows viewing of 1, 2...16 channels at one time with automatic vertical expansion.

Biomation's new logic analyzers give you both.



Map—each word in memory is transformed via two DAC's to form a unique dot which characterizes that word. All 512 words of the 1650's memory can be accessed for mapping. The cursor word is circled in the map as well as displayed at the top of the screen in alphanumeric form. The cursor may be moved to any of the points in the map for positive identification of that word. In addition, a map of only 16 words may be selected.



Logic state—provides memory address location, binary output of the 16 channels and selectable octal or hexidecimal translation. 16 words are displayed at one time with the cursor address location at the top of the screen. Movement of the cursor control allows accessing any 16 words of the entire 512 words stored in the 1650-D. The display control memory can store 16 words while a different set of 16 is selected from the 1650's main memory (or a new recording is made). These two sets of 16 words can then be overlayed on the CRT. *Any differences will blink* and be easily identified.

When your job is to interface, integrate and program a complex new digital logic system, you want as much information as you can get.

That's why we're providing a new set of tools which let you display timing information as well as logic word content—in the language of your choice.

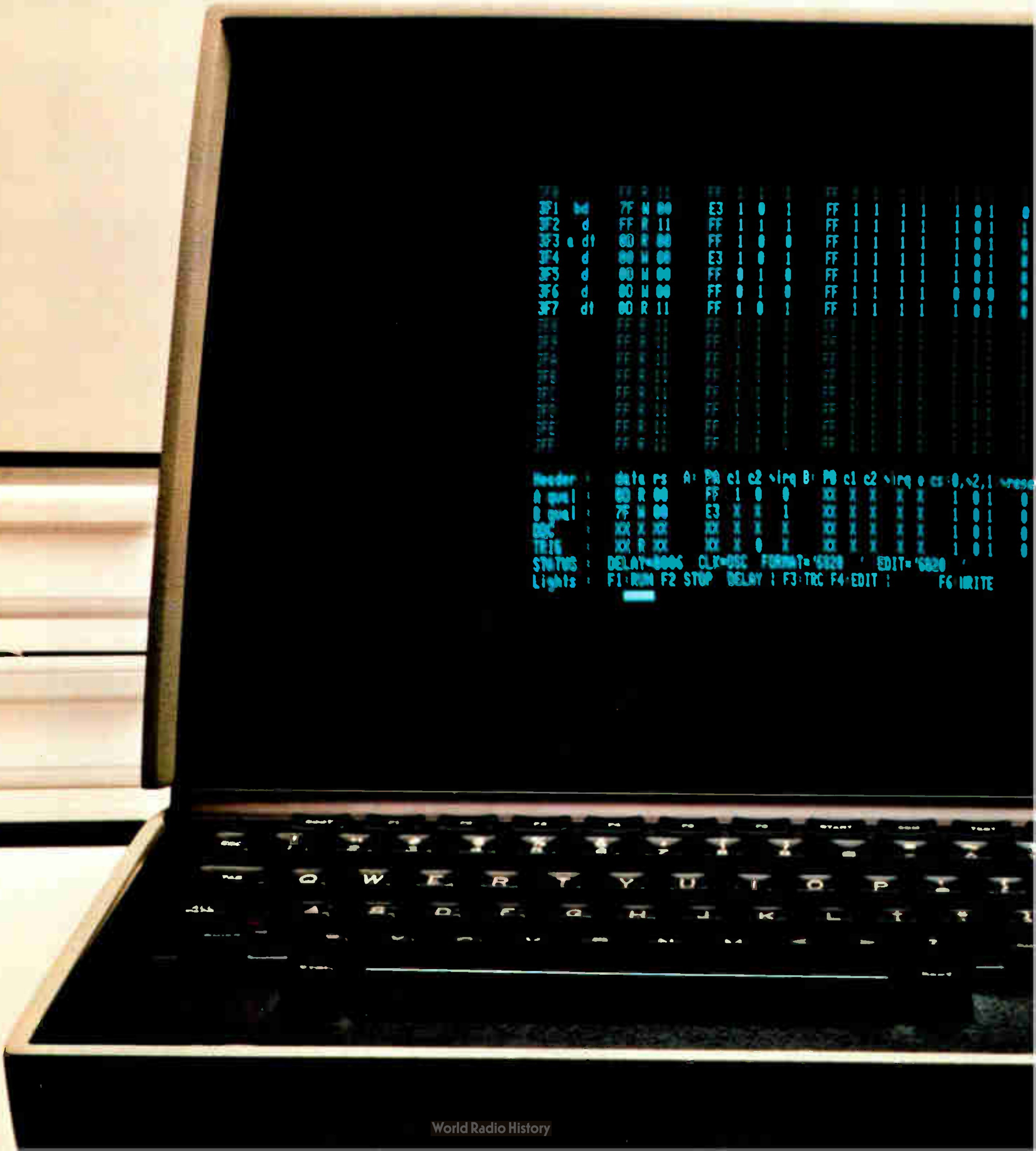
Our new 1650-D logic analyzer gives you 16 channels at 50MHz. Our 851-D gives you 8 channels at the same speed. Accessories can now give you a logic state (1's and 0's) display of any 16 stored words; hex or octal translation; and a vector map of memory contents. The 8 and 16-channel logic analyzers feature:

- Pretrigger and delayed trigger recording
- Trigger point can be easily identified
- Latch record mode for fast pulse capture
- Combinational triggering (true *or* false)
- Movable display cursor that stays with the data when you switch display modes
- Display expansion, mixed or full, X5, X10 or X20

These are complex instruments and we can't give you all significant details here. But please write, call, or use the reader service card. We want to get this useful information into your hands. Biomation, 10411 Bubb Road, Cupertino, CA 95014, (408) 255-9500. TWX: 910-338-0226.

biomation
Creating tools for technology

Try this on your old logic analyzer:



You can't, can you?

Your logic analyzer isn't software controlled. Ours is. As the latest addition to our Microcomputer Development Center, it's the only logic analyzer with computer power to do things your way.

Instead of a few buttons to give you binary, octal, hexadecimal or symbols, you can choose your own layout and format. Even disassembly.

We start you off with a floppy file of 6800 family formats for the MPU, memories and peripheral circuits, such as the PIA on the screen. You take it from there. Alter them, build your own right on the CRT while you check the captured data, even save new formats on the disk with the help of our analyzer's built-in text editor. And you can do it with any circuit or digital logic family.

What else is new? 40 channels. 1024 traced steps. Delay from 0 to 64K clocks. Four clock types with speeds up to 10 MHz. Two qualifiers to start the delay ticking, a third to define clock cycles and a fourth to trigger external equipment.

The cost of this digital design breakthrough is less than $4000. Considering our recent price cuts on the MDC (now $9600) and entire 6800 family, you're really getting a lot for your money.

Have some free BASIC.

We have some new software that comes absolutely free when you buy our Microcomputer Development Center. This includes full BASIC, Macro Assembler, and a display-oriented editor. Put it all together with our very smart CRT terminal, dual floppy disks and full debug firmware—and you have the easiest way of developing the best microprocessor on the market.

You'll find our logic analyzer, MDC and all the 6800 parts you need at your nearest AMI distributor or sales office. Or write us for complete details at AMI, 3800 Homestead Road, Santa Clara CA 95051. Phone: (415) 246-0330. It's the only logical way to go.

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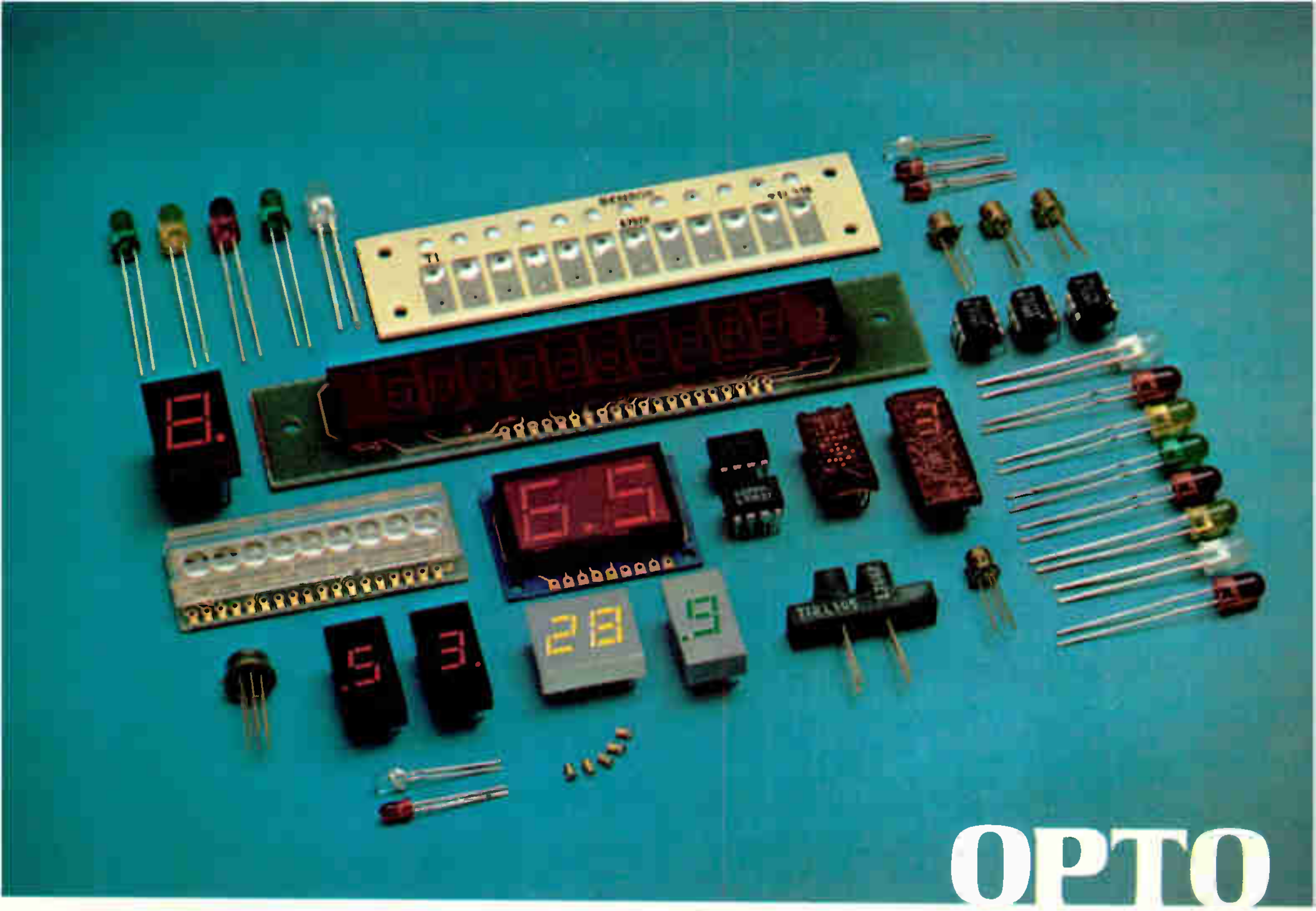

Highest quality at lowest cost. Optoelectronics... from Texas Instruments.

Quality need not be expensive. With TI's optoelectronics family you get both superior technology and the industry's lowest prices.

Compare cost and performance before you buy. Across the complete product spectrum, you can have the best for less from one of the industry's largest opto producers ... Texas Instruments.

Discrete VLEDs.
These reliable solid-state light sources, designed for use in both panel and pc board applications, are available in three colors and two package sizes.
Their solid epoxy bodies with diffused lenses afford maximum viewing angles, except for the TIL221 which has a water-clear epoxy body for pinpoint illumination.

Visible Light Emitting Diodes

Device	Source Color	Lens Color	Package Outline	Typical Brightness @ 20 mA	100-Piece Price
TIL209A	Red	Red	T-1	0.8 mcd	.17
TIL216	Red	Red	T-1	6.0 mcd	.28
TIL220	Red	Red	T-1¾	1.0 mcd	.20
TIL221	Red	Clear	T-1¾	1.2 mcd	.20
TIL228	Red	Red	T-1¾	8.0 mcd	.32
TIL212	Yellow	Yellow	T-1	4.0 mcd	.28
TIL224	Yellow	Yellow	T-1¾	6.0 mcd	.32
TIL211	Green	Green	T-1	1.5 mcd	.24
TIL222	Green	Green	T-1¾	1.6 mcd	.26
TIL232	Green	Green	T-1	3.0 mcd	.28
TIL234	Green	Green	T-1¾	5.0 mcd	.32

Low-Cost Displays

Device	Character Height & Color	Type Characters	Connection	100-Piece Price
TIL312	.3″ – Red	7 Segment – r&lhd	Common Anode	1.36
TIL313	.3″ – Red	7 Segment – rhd	Common Cathode	1.36
TIL327	.3″ – Red	±1 – lhd	Common Anode	1.36
TIL314	.3″ – Green	7 Segment – r&lhd	Common Anode	2.85
TIL315	.3″ – Green	7 Segment – rhd	Common Cathode	2.85
TIL328	.3″ – Green	±1 – lhd	Common Anode	2.85
TIL316	.3″ – Amber	7 Segment – r&lhd	Common Anode	2.85
TIL317	.3″ – Amber	7 Segment – rhd	Common Cathode	2.85
TIL329	.3″ – Amber	±1 – lhd	Common Anode	2.85
TIL321	.5″ – Red	7Segment – r&lhd	Common Anode	1.47
TIL322	.5″ – Red	7 Segment – rhd	Common Cathode	1.47
TIL330	.5″ – Red	±1 – lhd	Common Anode	1.47

Circle 97 on reader service card

High-Performance Displays

Device	Type Characters	Character Height	Package	100-Piece Price
TIL302-304	7 Segment	.27″	Standard	4.85
TIL305	5x7 Dot Matrix Alphanumeric	.30″	Standard	4.58
TIL306-309	7 Segment with Logic	.27″	Standard	9.15
TIL311	4x7 Hexadecimal with Logic	.27″	Standard	9.40
4N41 (TIL501)	7 Segment	.27″	Hermetic	47.37
TIL505	5x7 Hexadecimal with Logic	.27″	Hermetic	66.03
TIL506	7 Segment with Logic	.30″	Hermetic	57.41
TIL507	5x7 Alphanumeric with Logic	.30″	Hermetic	69.72
TIL560	3-Character 5x7 Alphanumeric with Logic	.50″	Hermetic	254.26

Circle 271 on reader service card

Seven-Segment Display Sticks

Device	No. of Digits	Character Height & Color	Feature	100-Piece Price
TIL361	2	.50″ – Red	PCB – Edge Conn.	4.05
TIL364	4	.50″ – Red	12-hr Clock	5.92
TIL370	4	.50″ – Red	24-hr Clock	6.15
TIL804	12	.27″ – Red	PCB – Edge Conn.	11.65
TIL807	2	.30″ – Red	CA – Plug-in Pkg	2.88
TIL808	2	.30″ – Red	CC – Plug-in Pkg	2.88
TIL809	2	.30″ – Amber	CA – Plug-in Pkg	4.35
TIL810	2	.30″ – Amber	CC – Plug-in Pkg	4.35

Circle 272 on reader service card

Opto-Coupled Isolators

Isolator Family	Part Numbers	Isolation Voltage	Package	100-Piece Price
P-DIP	TIL111 – TIL119	Up to 2.5 KV	6-Pin DIP	from $0.74
Dual	MCT6 & MCT66	Up to 1.5 KV	8-Pin DIP	from 1.69
JAN, TX, TXV	4N22 – 4N24	1.0 KV	TO-5 MC	from 5.19
Hi-Rel	TIL120, TIL121	1.0 KV	TO-72 MC	from 3.75
UL Listed	TIL153 – TIL157	3.5 KV	6-Pin DIP	from 0.93
Hi-Voltage	TIL124 – TIL128	5.0 KV	6-Pin DIP	from 0.99

Circle 273 on reader service card

Low-Cost Displays.
Continuous uniform segments, high contrast and brightness make the difference in TI's cost-effective single-digit VLED displays.

Red, green and amber .3″ characters are available in 14-pin dual-in-line packages. Large .5″ red devices are available in 10-pin DIPs.

High-Performance Displays.
Versatile capabilities for specialized applications. TI has a specialty display to fit the job you're doing.

- Alphanumeric
- Hexadecimal
- Built-in logic
- Hermetic packages
- Combinations

Seven-Segment Display Sticks.
Two-digit combinations for digital indicators including television and CB radio channel readouts. Four-digit sticks for 12 and 24-hour digital clocks. And the 12-digit TIL804 stick (red, .270″ characters); the most digits on a single stick.

Opto-Coupled Isolators.
Six complete families for any opto switching need: P-DIP couplers, metal-can devices, duals, high voltage isolators, JAN and UL listed parts. Call TI or your distributor for complete specifications.

IR Emitters/Detectors.
High efficiency, spectrally matched infrared emitters and photodetectors for card and tape readers, encoders, intrusion alarms, level indicators and more.

Also available: nine and 12-channel arrays for precise alignment in card and tape readers and single-package assemblies for counting, flow and weight control, position sensing, timing and speed control.

Take advantage of the savings and convenience you'll find in TI's complete opto capability. For more information write Texas Instruments Incorporated, P.O. Box 5012, M/S 308, Dallas, Texas 75222. Please identify the device you are interested in by giving its TI part number.

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Our "Georgia style" high voltage ceramic caps provide value and performance that are hard to beat . . . by anyone's standards. Ratings to 60 KVDC. Capacities to 9,300 pF. Epoxy resin encapsulation. Minimum size-capacity-voltage ratios. What's more, every capacitor is backed by Murata's 30 years of experience in the field and our "Georgia style" pride in a job well done.
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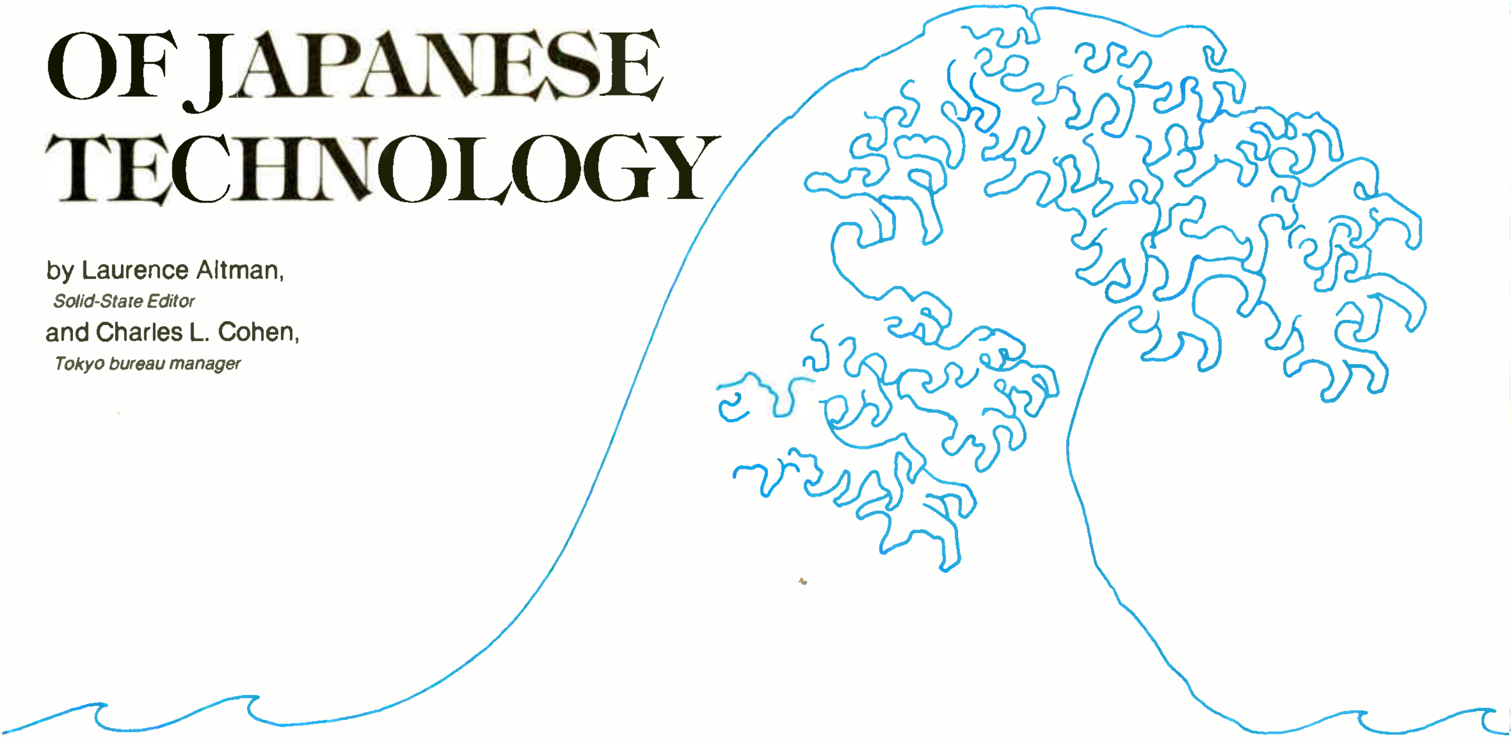
THE GATHERING WAVE OF JAPANESE TECHNOLOGY

by Laurence Altman,
Solid-State Editor
and Charles L. Cohen,
Tokyo bureau manager



☐ Japan's electronics manufacturers have embarked on massive development programs that are aimed at putting them on the leading edge of digital technology. Their goal is nothing less than a major position in the worldwide digital electronics market.

Today Japan supplies 4% of the world's computer and digital integrated circuits, but by 1980, the country's electronics makers intend to be major exporters of data-processing technology. With their consumer exports running into tougher tariff barriers and enforced quotas, they are looking to the multibillion-dollar data-processing market as their next growth sector.

There are two thrusts to the Japanese move into digital technology. First is an immediate attack on the digital components market now dominated by U. S. semiconductor manufacturers. Using n-channel silicon-gate technology developed over the past two years, individual Japanese companies are now ready to export large quantities of the most advanced 4,096-bit and 16,384-bit random-access memories, 4- and 8-bit microcomputers, and a host of digital large-scale industrial- and communications-control integrated circuits. To penetrate these markets quickly, Japanese suppliers are organizing American-style marketing and applications operations staffed by nationals in U. S. and European markets.

Even more consequential is a concurrent four-year government-sponsored program involving Japan's five major electronics firms: Nippon Electric Corp., Tokyo Shibaura Electric Ltd. (Toshiba), Hitachi Ltd., Fujitsu Ltd., and Mitsubishi Electric Corp., as well as personnel from Nippon Telegraph and Telephone Public Corp. and the government's Electrotechnical Laboratory. Called the VLSI project, for very large-scale integration, it has the goal of designing a line of computers 100 times more powerful than the technology represented by the IBM 370. The budget through 1980 is at least $250 million—some observers put it as high as $1.5 billion. (See "VLSI Japanese style," p. 101, for details of the project).

Ambitious goals

To achieve this goal, engineers are developing an advanced semiconductor technology capable of achieving 10,000- to 50,000-gate logic chips and 1-million-bit memories—an IC capability that dwarfs today's 5,000-to-10,000-gate microprocessor chips and 16-k RAMS. Participating companies will be free to use the resulting digital technology as they see fit, with no planned marketing restriction on either the computers or the ICs in Japan or abroad. If this VLSI capability is achieved and if it filters down through all component and equipment levels, it is bound to make Japanese electronics manufacturers formidable competitors in the world's digital electronics marketplace.

Although money is not everything in gauging success in the semiconductor industry, it is instructive to analyze the VLSI development budgets of the major Japanese manufacturers. For 1975 and 1976, they spent $150 million internally on IC developments, including salaries

SPECIAL REPORT

TABLE 1: MEMORY TYPES CURRENTLY AVAILABLE FROM U.S. AND JAPANESE MANUFACTURERS

Application	U.S.		JAPAN	
	Device type	Access time (ns)	Device type	Access time (ns)
Large mainframes	4-k n-MOS dynamic 16-k n-MOS dynamic 4- and 16-k I^2L dynamic	150 – 350 200 – 350 50 – 100	4-k n-MOS dynamic 16-k n-MOS dynamic –	100 – 300 150 – 300 –
Small mainframes and microprocessor-based systems	4- and 16-k MOS dynamic 4- and 16-k I^2L dynamic 1- and 4-k n-MOS static 1-k C-MOS static 1-k SOS static	150 – 350 50 – 100 75 – 300 300 – 500 100	4- and 16-k MOS dynamic 1-k n-MOS static 1- and 4-k C-MOS static – –	100 – 300 50 – 300 300 – –
Buffer and cache, etc. (all static)	256-bit ECL 1- and 4-k TTL 1- and 4-k n-MOS 4-k I^2L	10 – 30 40 – 100 50 – 70 75 – 150	256-bit ECL/TTL 1-k TTL 1-k n-MOS –	10 – 30 50 70 –
Peripheral systems	1- and 4-k n-MOS static 1- and 4-k I^2L static 1-k C-MOS 1-k SOS	75 – 500 75 – 150 300 100	1-k n-MOS static 1- and 4-k C-MOS static – –	75 – 500 300 – –
Small storage (1 to 5 megabytes)	CCD bubbles	100 μs 100 ms	– –	– –
Large storage	CCD bubbles	1 ms 10 ms	– –	– –

Source: Electronics

market. First they develop parts suitable for internal consumption, and then they redesign them for export.

For example, NEC, the leading supplier of Japanese memories both at home and abroad, began developing a 4-k dynamic RAM for internal consumption early in 1975—its computer and telecommunications divisions required a faster part than was available from U.S. suppliers. Using a proprietary high-speed n-channel process, engineers completed the design in eight months and then immediately turned to the requirements of the American market. Modifying their package to conform to the performance and pin-out of U.S. suppliers, NEC was able to begin shipping 22-pin TI-type 4-k parts by the end of 1975.

By the middle of 1976, the company was exporting both 18- and 22-pin 4-k chips at the rate of 250,000 per month, a production rate exceeding those of all but Intel, TI, and Mostek.

The same kind of activity is taking place in the American market for 16-k RAMS. Three Japanese manufacturers—NEC, Hitachi, and Toshiba—are already shipping 16-k parts to the U.S.

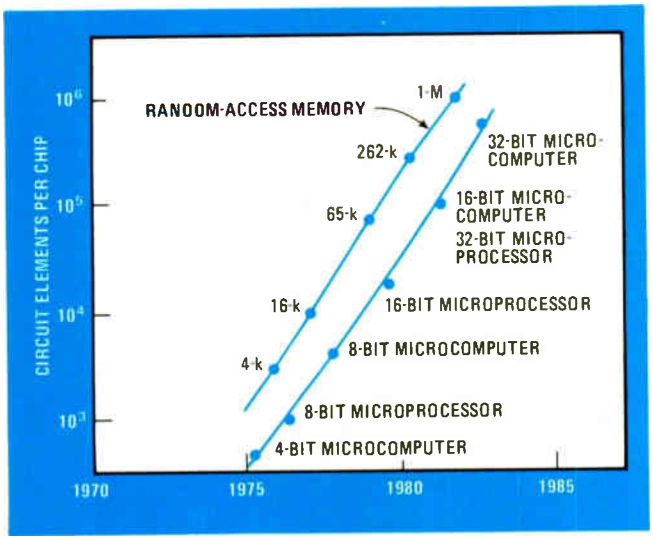
Indeed, Japanese semiconductor manufacturers have pulled even with their American counterparts in memory design (Table 1). For large mainframes, Japanese manufacturers can now compete head on with U.S. suppliers in both high-speed 4-k dynamic RAMS and 16-k dynamic RAMS. The same is true for buffer and cache systems, where the Japanese can match American suppliers in all but integrated-injection-logic design.

For peripheral equipment, the Japanese are also well represented, with 1,024-bit and 4-k n-channel metal-oxide-semiconductor static RAMS and the various dynamic types. In addition, NEC offers an 8,192-bit electrically alterable read-only memory for peripheral applications. While such parts are in intense development in the U.S., they are not yet available from American manufacturers.

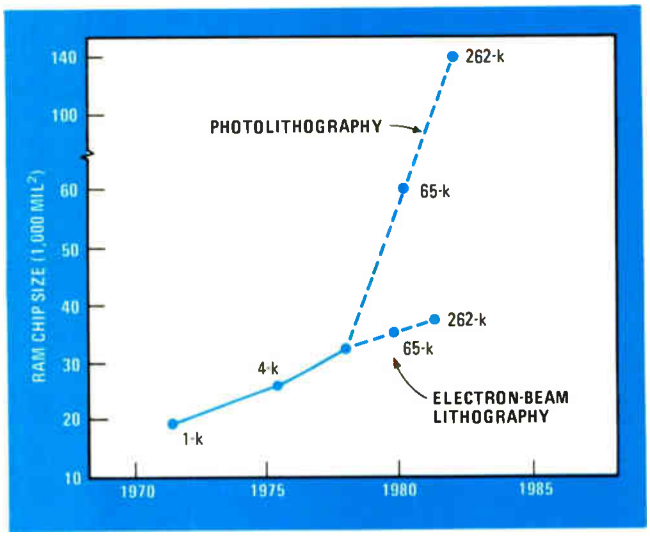
Where Japanese manufacturers appear deficient is in relation to small mainframes and microcomputer-based systems. High-speed static devices dominate this area, with Japanese manufacturers only now beginning to launch 4-k development efforts. The exception is Toshiba, which is manufacturing a 4-k complementary-MOS static part not yet available from an American supplier.

Nor do the Japanese have charge-coupled-device memories for disk and drum replacement beyond the early development stage. At least three American suppliers—TI, Fairchild, and Intel—have already made available 65-k CCD memory chips and are quickly developing CCD memory-board systems. The first Japanese-made charge-transfer memory probably will not be available in this country for 18 months.

Bubble memories are another area where American manufacturers lead. TI, with its bubble chips and systems, has no counterpart in Japan. True, Hitachi, NEC, and Fujitsu are working on bubble memories, but



1. Driving hard. Japanese manufacturers have this timetable for developing VLSI components and next-generation computers. Ambitious products, such as 262-k dynamic RAMs and one-chip 32-bit microcomputers, are on the drawing boards for 1981-1983.



2. Where electron beams fit in. Japanese technologists, factoring in their electron-beam plans for memory development, predict that 65-k and 262-k RAMS are achievable in the 1979–1982 time frame on chips not much larger than today's 16-k chips

these are either for in-house computers or for custom applications supported by Nippon Telegraph and Telephone Public Corp. There seems little prospect of seeing a Japanese bubble memory in the U.S. market for at least two years.

While Japanese memory exports abound, microcomputer shipments are scarce. With the exception of NEC, the Japanese have practically no products in the U.S. or in Europe. While other Japanese firms build American-type microcomputer chips, they have yet to market these products outside of Japan.

Marketing standard LSI

The difference in the availability of memory and microcomputers in the U.S. illustrates a basic Japanese strategy for penetrating foreign markets. While the country's manufacturers can make microcomputer circuits as well as they can make memories, selling them requires a large marketing and applications support staff to work closely with a large number of users. Memories, on the other hand, require practically no sales engineering force since the users are extremely sophisticated about their system requirements. Thus, the Japanese are making their immediate exporting thrusts in memory, both in the U.S. and Europe. They are challenging American technical dominance, as well as testing the political climate for signs of tariff difficulties.

Atsuyoshi Ouchi, who runs the semiconductor division for NEC, may have been talking for the Japanese semiconductor industry when he said, "We intend to be a major memory supplier in the U.S. We think our technology is at least as good as American technology, and we think our reliability is better. Japanese companies can supply 25% of the U.S. RAM market in two years."

There is little doubt that standard-product areas such as memories play to the Japanese ability to react quickly to a well-defined industry standard. Take dynamic RAMS: once it became clear 18 months ago that consensus was forming in the American market around Mostek's 4027 4-k and 4116 16-k RAMS, every major Japanese supplier began working on those parts. Within six months, Japan's leading semiconductor companies were able to export samples of 4027-type 4-k devices—and, within 12 months, 4116-type 16-k devices—beating to the marketplace many American suppliers who were still busy trying to qualify their own high-speed 4,096-bit and 16,384-bit dynamic designs

U.S. viewpoints

Since RCA Corp. is not a major supplier of n-channel MOS RAMS, Bernard Vonderschmitt, vice president and general manager of the Solid State division, can be objective in evaluating the Japanese threat to American mainframe memory suppliers. "I think the Japanese will gobble up U.S. suppliers in standard LSI areas where they can attack a well-established standard," he says. "The Japanese are effective at working together and cooperating on technical developments. Standard memory gives them a perfect opportunity to move in quickly with high-quality, extremely cost-competitive devices."

Gordon Moore, president of Intel Corp., a leading U.S. manufacturer of random-access memories, does not take lightly the Japanese ability to react quickly to industry standards. "We've been impressed with the Japanese rate of progress in digital technology, and we're watching them closely, especially in the VLSI area where they have government support and united goals. They seem to know where the semiconductor industry is

TABLE 2: JAPAN'S GOALS IN VERY-LARGE-SCALE-INTEGRATION

	Random-access memory		Microprocessor		Minimum line width (mils)
	Chip size (x 1,000 mil²)	Bit density (x 1,024 bit)	Chip size (x 1,000 mil²)	Word length (bits)	
1976	32	16	52	8 & 16	0.2
1979 – 1980	32	64	50	16	0.07
	50	256	60	32	0.04
1981 – 1983	45	256	55	32	0.03
	60	1,024	65	32	0.02

Source: Electronics

Electron beams. Japanese engineers are in agreement that electron-beam manufacturing systems are essential for making VLSI circuits. The government-sponsored VLSI lab is developing electron-beam equipment for mask and direct-wafer fabrication.

heading, and from what we can tell, they'll be there."

While American semiconductor manufacturers eye with trepidation the immediate Japanese threat to today's digital markets, many see an even greater danger in Japanese efforts to leapfrog the industry with powerful new VLSI circuits. Their fears may be well-founded, as illustrated by the projected march of ever more complex Japanese devices up the technology-development scale (Fig. 1). These curves, which represent the composite product goals of major Japanese manufacturers, show their determination to achieve a dominant position in semiconductor and computer technology by the 1980s. With the possible exception of Texas Instruments and Intel, no American manufacturer has displayed as ambitious a program.

Working within the government-sponsored VLSI project and independently in their own VLSI laboratories, Japanese semiconductor manufacturers plan to produce 65-k RAMs by 1979 and 262,144-bit RAMs by 1981. Such a timetable would put Japan's memory technology considerably beyond the reach of many American manufacturers. Moreover, the move into high-performance microcomputers is equally strong, with intentions announced to build 16-bit single-chip microcomputers by 1979 and full 32-bit microcomputer chips—the equivalent of the IBM 370—by 1983.

Although leading Japanese manufacturers will give no details on the exact nature of the technology they plan for this arsenal of VLSI components, it is certain they intend to stretch existing n-channel and bipolar technology. As in America, most Japanese manufacturers are working on modifying the double-level silicon-gate MOS process for 65-k RAMs. Squeezing circuit features down to 2 micrometers from about 5 micrometers will achieve the required 100,000-circuit-element complexity. The same process, equipped with depletion-load transistors, can then be applied to producing 16-bit microcomputers.

For 262-k RAMs and 50,000-gate microprocessors, Japanese designers are betting on a double-diffused (D-MOS) structure for a fourfold increase in complexity. By going to n-channel technology and by using fully ion-implanted structures, Japan's designers expect to fabricate D-MOS devices with submicrometer channel lengths—just what is needed for 262-k RAMs.

The D-MOS structures will scale down to provide power dissipations in the nanowatt range—keeping total chip power below 1 watt. Moreover, the process is amenable to dynamic logic designs, a circuit type that further reduces power requirements.

In the U. S., manufacturers apparently are only now beginning to develop a D-MOS capability. They are relying instead on shrinking silicon-gate designs (Intel) or on V-channel MOS designs (American Microsystems Inc.) for the move into VLSI.

Electron beams

More important for VLSI circuits than device types is fabrication—the ability to build 1-μm device patterns—a goal that everyone now agrees will require some form of electron-beam fabrication directly on wafers. (This is not to be confused with the technique of using electron beams to build masks, which are then exposed with conventional photolithographic methods—a process that stops at 2-μm geometries.)

Significantly, electron-beam wafer fabrication is where the Japanese have put a major portion of their development funds, both in the government VLSI lab and in their internal development labs.

A glimpse of the advanced nature of Japan's electron-

Watching the rising sun

A high regard for Japanese technical ability and an uneasy feeling about its effects characterize the reaction of computer and semiconductor manufacturers in the U. S. and other countries. Frank T. Cary, chairman of the board of International Business Machines Corp., puts it succinctly: "The Japanese manufacturers are extremely competent, especially NEC, Fujitsu, and Hitachi. We are not taking that competition lightly."

But Cary is quick to point out that IBM is not sitting idly by. While he will not say how much IBM is spending in VLSI computer development, others in the industry put the figure at just under $1 billion over the next three years—or at least as much as the total Japanese combined effort.

The No. 1 semiconductor executive has an equally high regard for Japan's recent digital efforts. "We have a healthy respect for the capabilities of the Japanese industry," says J. Fred Bucy Jr., president of Texas Instruments Inc. "They're backed by their government, and they can focus on selected targets, as they've well demonstrated in the heavy industries. And now they're moving into the high-technology area."

While watchful, Bucy does not feel unduly threatened by the Japanese VLSI effort. "They probably will establish a strong position from time to time in limited product segments," he says. "However, TI has outperformed them in such areas as calculators and digital watches, as well as semiconductors, and we are dedicated to maintaining our leadership in VLSI."

He admits that the Japanese firms are about on par with U. S. firms in MOS random-access memories, but "we are confident that TI is well ahead of the Japanese today in such important areas as electron-beam and dry processes, as well as CCDs, magnetic bubbles, microprocessors, standard bipolar ICs, and I^2L. But we always pay attention to any good competitor, and we consider the Japanese to be good competitors," he says.

More worried is Wilfred J. Corrigan, president of Fairchild Camera and Instrument Corp. "The basic problem is that we're not competing in the normal way here—we're competing with the Japanese government," he says. "We think the Japanese VLSI effort is enormous—something in the neighborhood of $500 million to $1.5 billion over a five-year period, spread out over many companies and in government-sponsored programs, but all focused on the same objective: advanced VLSI components and powerful computers. We regard it as a very serious issue."

Corrigan sees the Japanese united effort as the principal reason for the recent formation of the Semiconductor Industry Association, and Bernard T. Marren, its head, agrees. "Since we can't count on Government protection, our strategy is to counter the Japanese threat with a buy-American campaign among our computer makers," says Marren, who was president of American Microsystems Inc. "We'll remind them that component makers in Japan are computer manufacturers too, so buying Japanese components strengthens the competition."

Cooperation between U. S. components and computer manufacturers, says Charles E. Exley Jr., president of NCR Corp., is impractical "with or without Government support" to combat the Japanese offensive. "I think we individually must continue making substantial expenditures in engineering to keep ahead," he says.

In Europe, however, there appears to be sentiment in favor of forming cooperative efforts to combat the Japanese. Alfred Prommer, vice president of component sales at Siemens, thinks that his government should do its part in helping the industry attain a better competitive position *vis à vis* Japanese products. He opts for computer makers and semiconductor firms in Germany joining forces to develop an advanced LSI technology.

beam program comes from reports of the work at the government's VLSI lab, where several prototype electron-beam stations have been assembled, and at individual semiconductor plants. Details are skimpy, but it is known that the new machines are vector-scanned systems capable at the present time of fabricating a one-mask pass on a fully populated 4-inch wafer in 8 to 15 minutes. This throughput is not far from the 6-minute-per-mask throughput rate that American IC specialists feel is needed to make electron-beam wafer fabrication a production feasibility.

Indeed, the 8-minute 4-in.-wafer throughputs would make Japanese circuits fabricated with electron beams cheaper to build than American ones fabricated with photolithographic methods. By transferring 8-minute machines to production, the Japanese manufacturers could get an immediate two- to four-fold advantage in chip costs.

Another electron-beam cost-reducing factor on which the Japanese are counting is higher yields resulting from smaller chips. Figure 2 shows that an electron-beam-fabricated 65-k memory would be 32,000 square mils compared to 55,000 mil^2 for optically fabricated 16-k memories. Even if American manufacturers were able to fabricate 65-k chips with conventional methods, they would not be able to compete with the higher-yielding Japanese electron-beam RAMs. Moreover, a 262-k chip built with photolithography would require approximately 120,000 mil^2 of silicon, which is simply not producible in high volume.

Table 2 sums up the goals of the VLSI programs now under way in Japan. The milestones are awesome: 65-k RAMs on 32,000 mil^2 chips by 1979 and 16-bit microcomputer chips with 4 kilobytes of memory on 50,000-mil^2 slices. By 1980, memory chips would hold 262 kilobits and microcomputer chips would contain 32-bit instructions with 16,000 bytes of random-access memory. Finally, by 1983, 1-megabit memories would be in production, as would 32-bit microcomputer chips containing 32 kilobytes of memory. Computers built with such devices would indeed exceed the performance of today's IBM 370 computer by a factor of 100.

CHIP MAKERS PART OF GIANT FIRMS

Most Japanese semiconductor manufacturers have a clout that goes beyond their position on the cutting edge of industrial technology. They are divisions of corporations that rank among Japan's top twenty corporations. Conservatively managed, extremely well-financed, and highly integrated, these export-minded corporate giants are in sharp contrast to the volatile and fiercely independent American semiconductor manufacturers.

The biggest Japanese company with a stake in electronics is Hitachi Ltd. This $6.5 billion manufacturer makes semiconductors, computers, and communications equipment. Yet 25% of its sales are in heavy electrical machinery, such as turbines, and almost 20% are in heavy machinery, such as rolling mills.

Hitachi is no slouch in semiconductor production: its 1976 sales of $220 million would rank among the largest in the U. S. In-house consumption took semiconductor production, and 10% were exported, with 3% landing in the U. S.

Tokyo Shibaura Electric Ltd., often known as Toshiba, is a $3.5 billion industrial giant with equivalent emphasis on heavy electrical equipment. Its biggest product lines are home-entertainment equipment and consumer appliances, which accounted for almost half of last year's sales. Electronics and communications added another 27%. Toshiba sold $300 million worth of semiconductors last year and exported about 20%, with half of this total to manufacturers in the U. S.

Mitsubishi Electric Corp. is another electronics manufacturer that is also a major supplier of heavy electrical equipment, with almost half of last year's $2.5 billion sales going for such gear. Appliances and home-entertainment products accounted for 28%, while electronics products, including IC and discrete semiconductors, added another 28%.

The company is its semiconductor division's best customer, consuming about 30% of the output. Only about 5% is exported, mostly small-signal and power transistors and mostly to Asiatic and European markets.

Another group of Japan's IC makers are diversified electronics companies that can trace their origins to the field of communications. An interesting case is Nippon Electric Corp., which got its start as an overseas subsidiary of Western Electric in 1899. After passing under the control of ITT, it became an independent supplier. Telecommunications is still its biggest product line. More recently, however, NEC corporate managers have put increased emphasis on its semiconductor division, especially in the big growth areas of digital LSI. Success has been dramatic: the company is now the biggest Japanese supplier of memory and microprocessor chips in both domestic and export sales.

Last year's sales were $1.8 billion with 20% equipment and components for the NTT. Semiconductor sales were $357 million, of which 23% were used in house and 10% exported, one fifth to Asia and the rest evenly divided between America and Europe.

Like NEC, Fujitsu Ltd. started as a supplier of communications equipment. Unlike NEC, communications gear (telephone-exchange and wireless transmission equipment) now accounts for only a minor portion of its business. The company is primarily a manufacturer of computers and electronic data-processing equipment, which accounted for almost three-quarters of its $1.2

TECHNOLOGY LEADERS

Yoshiyuki Takeishi is typical of the leading semiconductor technologists borrowed from private industry for the government's VLSI Cooperative Laboratory. Developing the lab's electron-beam fabricating system is his assignment. He brings valuable experience from his last job at Toshiba, where he headed that firm's electron-beam efforts. Before that, Takeishi, as manager of Toshiba's LSI production technology, developed the 12-bit microprocessor that the company is supplying to Ford in the U. S. for engine controls. Another of Takeishi's achievements is his stacked-gate avalanche MOS structures, which may allow Japanese manufacturers to pass the Americans in reprogrammable read-only memories for computers. His background includes a brief stint at Bell Labs in 1962–63, where he was involved in basic work in silicon materials.

billion 1976 sales. Although the firm does manufacture sizable quantities of ICs—$112 million last year—80% were consumed in its own computer divisions. But Fujitsu executives see ICs, as well as computer and equipment components, as a major target for exports, especially to the big U. S. and European data-processing markets.

The final member of this group is Oki Electric Industry Ltd. with 1976 sales of $451 million. Unlike NEC and Fujitsu, it has stayed exclusively in the communications field, with participation in the computer industry only through its data-communications office equipment. (The company does sell high-end computers, made jointly with Univac, but they account for less than 5% of its billings.) Oki Electric's biggest product lines are office equipment, 38%, and electronic exchanges, 30%.

A third group of Japanese manufacturers is known mostly for consumer electronic products, although they manufacture sizeable quantities of semiconductors. Biggest of these is Matsushita Electric Industrial Ltd., Japan's largest electronics manufacturer with home-entertainment products (the National brand in Japan and Panasonic brand in the U. S.) accounting for 45% of its total 1976 sales of $6.1 billion. Matsushita's discrete and integrated circuit semiconductor production, which totaled $162 million for 1976, is a joint venture with Philips Gloeilampenfabrieken.

Prominent in this group are the two familiar names outside of Japan. Sony Corp., of course, is known around the world for its TVs, radios, tape recorders, and so on, and Sharp Corp. is known for calculators. While Sharp produces a large quantity of semiconductors for itself (16.2 million in 1976), Sony semiconductor production is concentrated on products that it feels it cannot buy elsewhere or that, if bought openly, will telegraph future product plans.

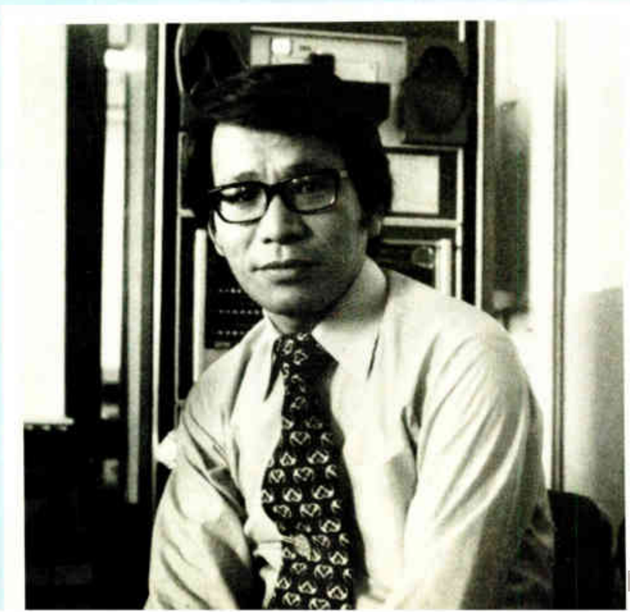
MAVERICK SEES OBSTACLES

Being under the wing of giant companies may hinder Japanese semiconductor development as much as it helps. The security provided by the corporate umbrella discourages talented engineers from striking out on their own. This, plus the financial community's reluctance to provide venture capital, may ultimately frustrate the ambitious semiconductor goals set by the government.

That is the lonely opinion of Jun-ichi Nishizawa, perhaps the only electronics entrepreneur in Japan. He runs a small laboratory called the Semiconductor Research Institute, in out-of-the-way Sendai in the northeastern part of the country. Adding to the picture of a maverick is the fact that Nishizawa, who also is a professor at Tohoku University, keeps SRI going on a shoestring to keep himself in the forefront of semiconductor research, not for personal gain.

Another inhibiting factor for semiconductor innovation will be finding suitable people, he says. "One reason is that Japanese education and social traits are not oriented towards speculation. While this may lead to the stability of the large companies, it prevents ventures such as ours from blossoming," he asserts.

The backing for his lab illustrates the reluctance of the big companies to invest in research, he says. The institute started in 1961 on a paltry $140,000, which consisted of royalties to Nishizawa and the professor with whom he studied, Yasushi Watanabe, for their



Takao Nakano, an engineer in Mitsubishi Electric Corp.'s IC research department, is at the hub of that company's VLSI plans. He is working on high-speed 4-k and 16-k MOS and bipolar memories and computer logic chips using double-diffused MOS technology. He is convinced that MOS processes, such as D-MOS, could eventually replace low-power Schottky TTL in high-performance LSI applications. Nakano is best known for his recent work in vertical injection logic, a technique that retains the low-power features of conventional I^2L and complementary-MOS approaches while increasing the density and speed characteristics. An example of his VIL technique is the LSI watch circuit that Mitsubishi is building on a chip half the size of C-MOS watches of equivalent performance.

Jun-ichi Nishizawa
Semiconductor Research Institute

work on pnp transistors, p-i-n diodes, and ion implantation.

The Japanese companies using these ideas were adverse to paying for them, but agreed to give the inventors contributions to set up a lab. The companies also agreed to pay a small annual membership fee of $17,000 to keep the lab going. Since then, the income has grown to around $400,000: $90,000 for annual membership fees, $250,000 for contract research, and $50,000 for license fees and know-how.

A large part of the lab's work centers on the static induction transistor (SIT), the only field-effect transistor with triode-like characteristics. Nishizawa and Watanabe had applied for a patent on the SIT in 1950. When Nishizawa returned to this work many years later to investigate what appeared to be errors in theory derived by Shockley, he discovered the device's useful triode features. This led to two new patents in Japan, with about 40 pending, and one in the United States, with about 20 pending. It has also led to many contracts.

The SIT's triode behavior is being exploited in stereo amplifiers by Nippon Gakki Ltd. (which makes Yamaha stereo equipment). Tohoku Metal Industries Ltd. is developing a kilowatt class of SIT power-transistors for ultrasonic equipment and another class operating at several hundred watts for use in broadcast frequency transmitters. Mitsubishi and Toshiba have received licenses for building SIT audio devices: Mitsubishi for ultrahigh-frequency gear (100 watts at 1 gigahertz and 20 W at 2 GHz), and Toshiba for devices that operate at frequencies above 3 GHz.

Nishizawa plans to use his static induction transistor in LSI logic configurations similar to integrated injection logic. His present designs, which operate at the incredibly low power-dissipation levels of 2 femtojoules, can be built into nonplanar configurations for microwave devices operating at speeds higher than 10 nanoseconds or in planar configurations for digital LSI applications. For example, Yamaha is working on SIT logic that will enable electronic musical instruments to perform with concert reality. Firms eyeing SIT logic devices include Seiko for watches, Toshiba for replacing complementary metal oxide semiconductors, and Sony for consumer ICs.

LAB CHIEF IS RESEARCH STAR

The strengths of the Japanese semiconductor industry are well embodied in Yasuo Tarui, head of the cooperative research laboratory in Japan's four-year VLSI project. His reputation should swell internationally when results start flowing from the lab to the computer-applications groups that will rely on the technology for next-generation computers and computer equipment.

Tarui has that combination of basic scientific curiosity and practical semiconductor knowledge so rare among

Atsuyoshi Ouchi (left), is key to Nippon Electric Corp.'s good fortunes. He was general manager of the IC division from the beginning. A circuit engineer turned manager, he credits the firm's LSI success to "harnessing markets to technology," something he says he has "learned from my American friends."

Toshio Abe (right), another veteran of the IC industry in Japan, now manages Toshiba's principal semiconductor plant (still quaintly called the Toshiba Transistor Works) where LSI production is done. As a technologist, he developed C-MOS LSI for watches and n-MOS for memories and microprocessors.

technical people. Even while working on narrow technology and complex design problems, he never loses sight of their bigger implications for semiconductor production. He sees the concept of very large-scale integration as a method of production as revolutionary as the invention of printing.

"The printing press gave the author a way of arranging the basic elements—characters representing the language—in low-cost mass-reproducible form, at once making his work available to millions," Tarui says. "Similarly, the mask-projection method of building ICs allows the electronics designer as much freedom arranging his elements as the author with his language."

From the very beginning, Tarui was shaping the course of Japanese semiconductor technology. Upon graduating from Waseda University, he joined the government's Electrotechnical Laboratory and spent four years on measurements of semiconductor materials. This was in the early 1960s when very little was known about conduction in materials such as germanium and silicon. From this basic work, he moved rapidly into fabricating germanium point-contact devices and then alloy-diffused transistors.

In 1965, seeing the full potential of semiconductor production, he was the first person in Japan to fabricate an IC—a germanium flip-flop with two transistors, four resistors, and two capacitors. He quickly turned to diffused silicon transistors and was ready to make a real contribution to the art.

For Tarui, 1969 was a vintage year. At the International Solid State Circuits Conference in Philadelphia, he gave a paper on Schottky transistor-transistor logic, the first in the world. Because of his paper, Texas Instruments wound up without a patent in Japan. During the same year his group developed a very fast n-channel MOS 144-bit memory, which was produced by Nippon Electric Co. for large computers. At the same time, his group developed an electron-beam exposure system for semiconductor applications. While this system was five or six years ahead of its time, it is what the industry is clamoring for now.

Yasuo Tarui
VLSI Cooperative Laboratory

It was in 1970 that Tarui pioneered D-MOS, also a world premier and in the forefront of today's VLSI techniques. In the same year, his group announced their results on preferential etching of gallium arsenide for the fabrication of FETs. Preferential etching was also later used in batch methods of fabricating lasers to replace cleaving, a process that radically reduced the cost of the devices.

Tarui has spent the last six years in n-channel memory and D-MOS and V-notch MOS work. He developed an analog memory and a nonvolatile stacked-gate digital memory that can be both programmed and erased electrically. Although development of the analog memory has been delayed by the press of other work, it could find important applications in display and information processing. It should also provide a very powerful method for studying the effects of time and ambient conditions on programmable memories.

Tarui spent a year in America studying at Stanford University in 1966. There he worked on analog memories and ferroelectric materials.

Takashi Tokuyama is one of that group of unsung semiconductor specialists whose work forms the underpinning of Japan's impressive process capability. Having spent all his working life (since 1953) in the Central Research Laboratory of Hitachi Ltd., he has to his credit a host of processes now used in the firm's products: low-temperature passivation for silicon transistors, multilayer passivations for integrated circuits, ion implantation for LSI device fabrication, annealing methods to increase IC reliability, and ion-beam deposition techniques for growing crystal lattices. Recently, Tokuyama has turned his talents to making solar cells. The first to propose deposition of polysilicon on aluminum oxide for low-cost devices, he has produced solar cells that achieve 3% efficiency on the first shot. These cells are now in intensive development aimed at increasing their efficiency.

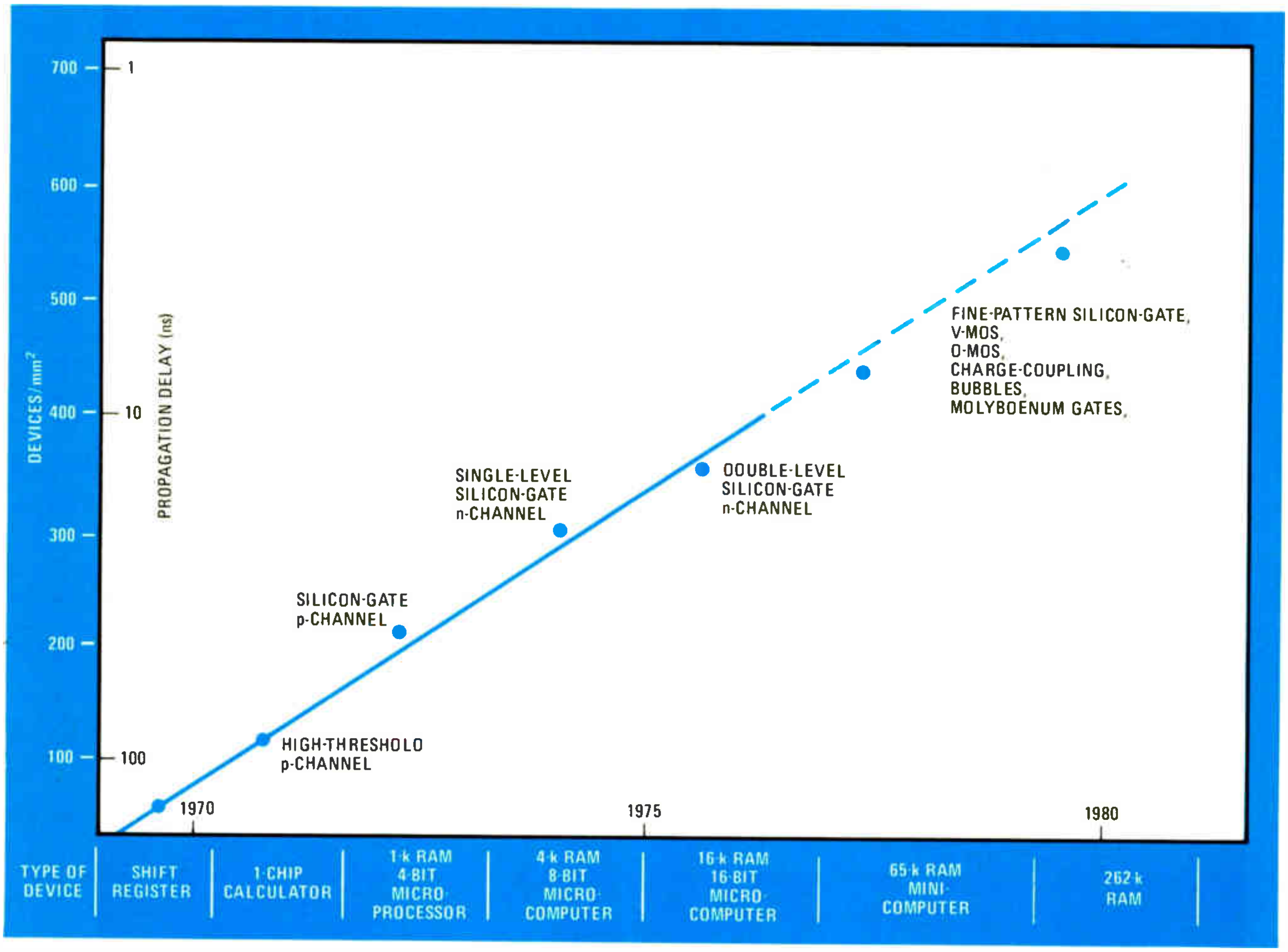
SPECIAL REPORT

JAPAN PRESSES INNOVATIONS TO REACH VLSI GOAL

Japanese semiconductor manufacturers have high hopes for very large-scale integration, and to realize them, they are developing an advanced and powerful semiconductor capability. For the first time, Japan's designers are not just copying but inventing integrated-circuit technology—a step they feel is absolutely essential if they are to overtake the Americans in digital design by 1980. No major technology escapes their attention. Standard and advanced metal-oxide-semiconductor and bipolar VLSI are yielding to attack, and a start is being made on charge-coupled devices and bubble memories—both virtually untapped areas in Japan till now.

The point at which Japan's designers stopped copying America and began innovating can be determined by examining the process techniques that Japanese manufacturers have used to implement the various LSI device types over the last 10 years (Fig. 1). In 1970, following the Americans, designers in Japan applied the simplest high-threshold p-channel MOS process to their first four-function LSI calculator circuits. In 1972, they moved to silicon-gate p-MOS for more complex 1,024-bit dynamic random-access memories and scientific calculators, and by 1974 and 1975 they were using single-level n-channel MOS processes for high-speed 4,096-bit RAMS and 4-bit microprocessors.

Meanwhile, still following the American lead, they began working on double-level variations of the basic n-channel silicon-gate process, until by the end of last



1. Breaking out. The last five years saw Japanese semiconductor manufacturers following the U. S. lead in digital-circuit techniques, but now they are developing proprietary processes based on D-MOS, V-MOS, molybdenum, and magnetic bubbles for memories and computers.

year they were already designing state-of-the-art 16,384-bit dynamic RAMs, 4,096-bit static RAMs, and 8- and 16-bit microprocessors—about the same time that U. S. firms were introducing these products on the market. With this double-level n-MOS capability, the Japanese had caught up with their U. S. rivals in dynamic RAMs.

However, the next level of VLSI product development—the 65,536-bit RAM and 16- and 32-bit microcomputers—demands innovation in both processing and circuit design, as the dotted portion of Fig. 1 shows. Table 1 shows Japan's current process capability. In the next three to five years, the Japanese hope to develop VLSI technology at a rate that equals, and in some cases exceeds, that of American efforts.

Table 2 shows the process types the Japanese plan to use for various stages of memory and microprocessor development through 1980. High on the list are double-diffused MOS, molybdenum-gate MOS with molybdenum bit lines, and integrated injection logic, with charge-coupled devices close behind. Already designers in Japan are far advanced in implementing double-diffused MOS structures for logic circuits and refractory metal structures for memories.

D-MOS coming at the double

Major Japanese manufacturers are working with the double-diffused MOS structures because they feel that these structures can achieve five times the speed and density at a third of the power consumption of today's single-diffused n-MOS structures. D-MOS does all this by in effect reducing the channel lengths in MOS field-effect-transistor structures to 1 micrometer or less without requiring micrometer-sized circuit dimensions.

A selective diffusion gradient under the gate is the key. The process, which is very similar to V-notch MOS (Fig. 2), adds a second lightly-doped p-diffusion, called a pi region, to a heavily doped p-region in the channel, so that its length during conduction appears very short, 1 micrometer and less. Two ion implantations maintain the proper diffusion profiles accurately.

TABLE 1: JAPAN'S PROCESS CAPABILITY

Technology	Propagation delay (ns)	Power-delay product (pJ)	Density (devices/mm^2)	Density (gates/mm^2)	Chip size (mm^2)
N-channel silicon gate	15	45	285	95	6 x 6
N-channel silicon gate depletion-load	12	38	320	107	6 x 6
N-channel double-polysilicon	10	35	525	175	6 x 6
Silicon-gate C-MOS	10	0.5	220	45	5.5 x 5.5
V-MOS, D-MOS	5	20	600	225	–
SOS/C-MOS	2 – 5	0.1	650	275	5 x 5
I^{2}L (double level)	5 – 50	0.01 – 1	500	150	5.5

Source: Electronics

Perhaps the best example of the D-MOS work in progress is the 4,096-bit high-speed dynamic D-MOS RAM built by engineers at Mitsubishi Electric Corp. with help from researchers at MITI's Electrotechnical Laboratory. This design, which has an access time of 60 nanoseconds, combines a basic D-MOS inverter with a depletion-load MOSFET output (Fig. 3). At the same time, an advanced arsenic doping process borrowed from bipolar design increases the stability and efficiency of conduction in the channel. Finally, a selective oxide-isolation process further increases packing density and simplifies fabrication by making it easier to oxidize surface steps. The result: the equivalent of a 0.4-μm channel-length and thresholds controlled within 1.2 $\pm$0.15 volts. Better yet, the structure's gain is five times that of conventional n-MOS structures.

Impressive as the 4,096-bit D-MOS dynamic RAM is, its developers see no profit in introducing the part into a maturing 4-k market. Rather, they see it as a forerunner of high-speed 16-k and 65-k RAMs. The 4-k design was built with standard 5-μm design rules that, when reduced to 3 μm, say, will yield circuitry two to four times denser with half the power dissipation. Thus, the same 4.33-by-4.9-square-millimeter 4-k chip could accommodate a 16-k RAM. If 2-μm rules were adopted, achieved either through electron-beam masks and photolithographic exposure or through electron-beam wafer fabrication, a 65-k D-MOS RAM would fit a chip only slightly larger than the 4-k design.

While a combination of D-MOS and fine-pattern geometry could eventually squeeze 65 kilobits of RAM onto a chip about the same size as today's 4-k devices, a simple extension of silicon-gate processing is already yielding a 65-k design that is larger but may still be manufacturable. It is a joint development of Nippon Telegraph and Telephone and three commercial suppliers (NEC, Hitachi, and Fujitsu). Such a 65-k RAM combines polysilicon gates in single-level cells with molybdenum bit lines that, thanks to the material's fine-grain structure, can be made into smaller line patterns. Then, to decrease cell size and power dissipation, the project's designers are using 2-μm line widths and oxides only 500 angstroms deep. The result is a 5.8-by-6.1-mm^2 chip dissipating 150 milliwatts, or less than today's 16-k RAMs. Access time is 200 nanoseconds, or about the same as that of most dynamic RAMs in production today.

While the 65-k RAM project is at full steam in four laboratories, the consensus is that a manufacturable device will not be available for about two years. By that time, Japanese technologists should have the lithographic means to fabricate 2-μm-wide lines in volume production.

Static memory looks lively

While dynamic-memory designers are utilizing Japan-developed D-MOS processing and molybdenum-gate structures for extra density and performance, static-

TABLE 2: A DECADE OF JAPANESE PROCESS CAPABILITIES						
	1975		1977		1980	
Memory type	1,024-bit static	4,046-bit dynamic	4 096-bit static	16,384-bit dynamic	16,384-bit static	65,536-bit dynamic
Speed	150 ns	250 ns	150 ns	200 ns	100 ns	200 ns
Process	n-channel C-MOS	n-channel single-level C-MOS I^2L		n-channel double-level	n-channel V-MOS D-MOS C-MOS I^2L	n-channel V-MOS D-MOS CCD
Microprocessor type	8- to 16-bit parallel	8- to 16-bit parallel			16-bit parallel (active RAM control)	16- to 32-bit parallel (active RAM control)
Cycle time	2 μs	1 μs			200 ns	100 ns
Process	n-channel C-MOS	I^2L			V-MOS D-MOS I^2L	

Source: Electronics

memory designers are modifying American-style n-channel processes for their next-level, 4-k static parts. Boasting the clocked peripheral circuits and resistive loads that lower power dissipation and pack more static cells onto a chip, these designs are similar to the commercially available Intel 4014 and Mostek 4004 4-k parts.

The Japanese are also adapting the oxide-isolation technique (called OXIM) used by Advanced Micro Devices for its static RAMs, a process that pushes access time below 100 ns. Thus the Japanese, as they did in the early stages of dynamic design, are taking the best of the American world to achieve very competent 4-k static devices for the American market.

While following the American lead in n-MOS static designs, the Japanese are making original contributions in low-power static designs that use complementary-MOS techniques. Their experience with C-MOS dates from their early use of it for calculator circuits, and they have now applied their considerable sophistication in C-MOS processing to memory.

The centerpiece of Japan's C-MOS effort is the work going on at Toshiba's Semiconductor division on clocked C-MOS (or C^{2}MOS). This technique differs from standard C-MOS in being static, in the sense that cell contents are retained statically, yet dynamic, in the sense that peripheral circuits are cycled during each transient time. (To do this, row decoders, sense circuits, and input/output controllers are designed with clocked gates and half-bit inverters.)

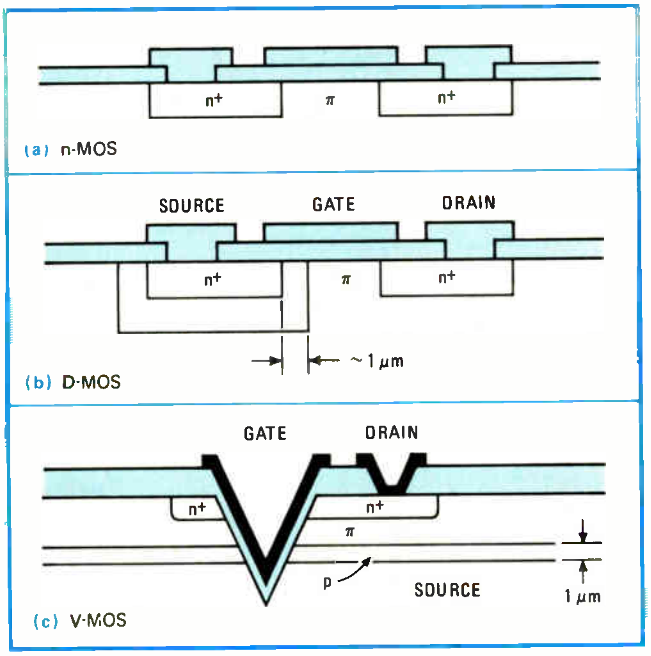
The technique yields a fully static 4-k RAM chip that, at only 4.7 square millimeters, is no larger than equivalent n-MOS 4-k RAMs yet dissipates one fifth the power. Moreover, since the standby current of 0.1 microampere is a fraction of that needed by n-MOS RAMs, the device will find immediate application in the American market wherever battery backup operation is desirable—in point-of-sale gear, calculators, cash registers, and so on.

This C^{2}MOS design is the most advanced in Japan and is a good measure of the ability of Japan designers to push C-MOS into the VLSI area. For very high densities, in fact, it appears quite attractive, since it offers extremely low power dissipation (nanowatts per cell) and high static performance (2- to 3-ns delays) in a compact configuration. For VLSI, Toshiba engineers estimate that by going from the standard 5-μm geometry, they can pack 8,192 bits onto the same size chip as holds the 4-k design. Then with 2- or 3-μm rules—the limit of photolithography—they believe they could get to the 16-k level with little increase in area or power dissipation. Those are the VLSI goals that Japanese designers are shooting for in static designs.

Dynamic logic starts up

Toshiba researchers are applying their clocked C-MOS process to microprocessors as well as and have already built a 16-bit C^{2}MOS parallel-processing chip with the performance of most minicomputer central processing units. What they do here is to use dynamic circuitry throughout—dynamic logic for computation and dynamic read-only memories for instruction decoders and control—a technique that, if successful, will usher in a new era in logic design.

To illustrate, the logic equivalent of a dynamic C^{2}MOS NAND gate is shown in Fig. 4. It should be noted that the circuit operates as a NAND gate when the waveform clock pulses are high, as shown, while maintaining the previous logic levels when those pulses are low. By going to fine-pattern geometry and reduced transistor scaling, the Toshiba C-MOS process could implement a full 32-bit parallel-processing configuration on a single chip. Apply C^{2}MOS RAM arrays on the same chip, and the device



2. Double is shorter. Japanese manufacturers are moving to double-diffused MOS processes for the next generation of large-scale-integrated circuits. Similar to V-MOS, D-MOS reduces the effective channel lengths of MOS transistors with gate diffusions.

becomes a stand-alone 16- or 32-bit microcomputer—another major goal of Japan's VLSI program.

Another promising path to VLSI is the back-gated-MOS or B-MOS structures. Hitachi engineers are currently developing them for use in 10,000-gate logic chips and 65-k RAMS. Clearly, if there is a limiting factor (apart from line width) in packing more digital circuitry onto a chip, power dissipation is it. Finer photolithography may be one way to achieve lower power (smaller devices run on smaller currents), but the Hitachi engineers think the B-MOS method of designing gates could accomplish the same thing without straining present lithographic limits.

Back-gated MOS for LSI

The technique is called B-MOS because a back- or grounded-gate MOSFET serves as the logic input device (Fig. 5). A back-gate transistor can operate with gain current modulation at input voltage levels as low as 0.1 V. That is well below the 1- or 2-V thresholds of the ordinary insulated-gate MOSFETs that make up the bulk of today's logic circuits. When the back-gate input device drives a normally biased MOS output transistor, logic elements can be built that operate stably yet dissipate mere microwatts.

The B-MOS inverter is constructed out of an n-channel B-MOS driver and a conventional p-MOS current source. In configuration, it resembles a C-MOS inverter, in which an n-channel element acts in conjunction with a p-channel element. But it is much more compact than conventional low-power C-MOS, where n and p transistors lie side by side. The p-type well of the back-gate input terminal slips into the n-type substrate needed for the output transistor (Fig. 5b). Just as in integrated injection logic, the B-MOS transistor pair merges into the space of a single transistor, keeping the level of power consumption low and the level of circuit integration high.

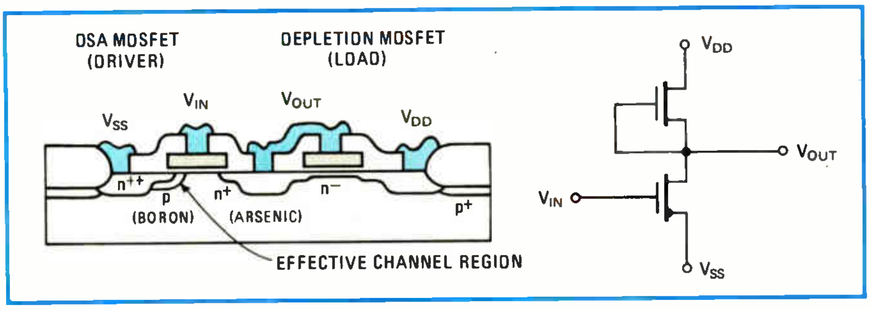
Hitachi workers in fact have demonstrated that a quad-gate B-MOS structure combines the low power and superior load characteristics of C-MOS equivalents with the high packing density of I^2L equivalents, while requiring no additional process steps (Table 3). The only drawbacks of B-MOS are its fairly low speed (50-ns gate delays) and its need for an extra power supply to bias the current-source gate.

Bipolar LSI is also on the program

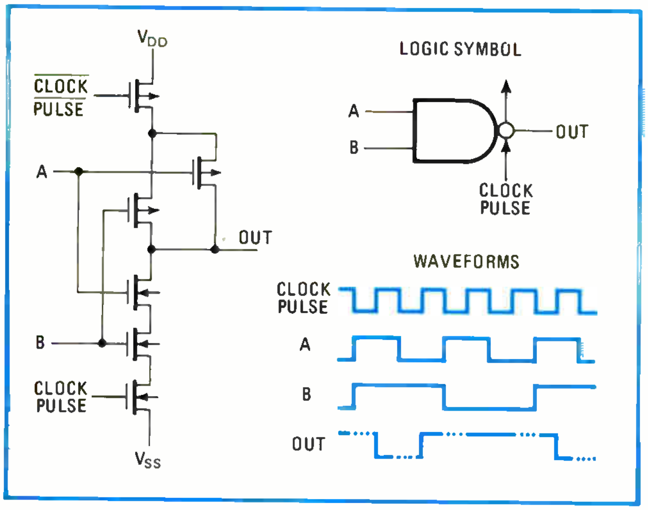
While Hitachi designers are developing MOS structures like B-MOS that rival the present-day performance of such bipolar LSI approaches as integrated injection logic, bipolar researchers are not sitting still. One approach to improving bipolar performance is vertical injection logic or VIL.

Using standard processing, Mitsubishi gets better I^2L performance by fabricating the pnp injector transistor vertically instead of laterally. This device, which merges with a multicollector npn transistor to form the basic I^2L gate, needs a narrow base for high gain. For conventional I^2L structures, this same narrow base also results in poor breakdown voltages, high leakage currents, and other degrading electrical characteristics. But when the transistor is stood on end, the now vertical base can be as narrow as need be, and electrical performance is not affected.

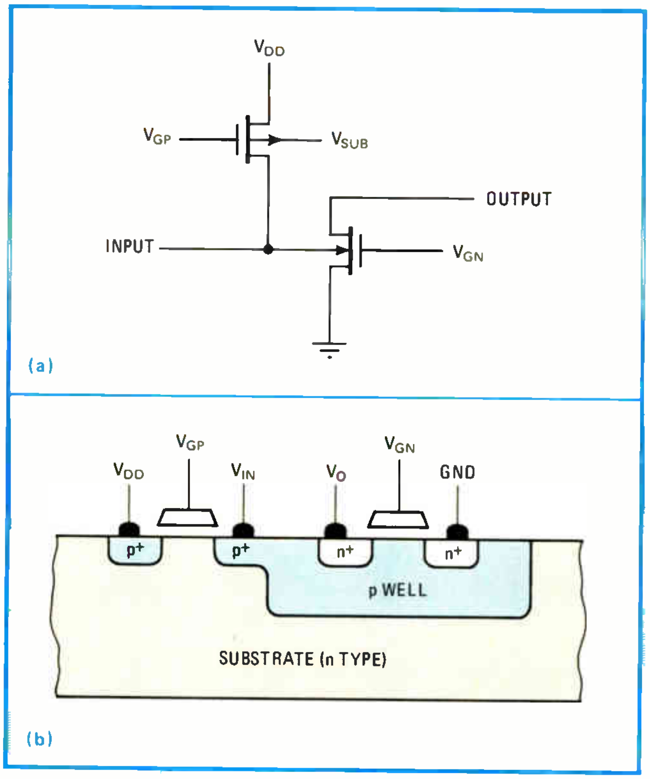
Compared with conventional I^2L, vertical injection logic has more than double the gain (0.9, as against 0.4),



3. D-MOS density. Engineers at various Japanese semiconductor manufacturers, as well as at the VLSI laboratory sponsored by the Japanese government, are working with D-MOS inverters and depletion-load outputs to achieve channel lengths of only 0.4 micrometer. This Mitsubishi technique could lead to 65-k dynamic RAMs and 16-bit microcomputer chips.



4. Modern C-MOS. Toshiba's clocked C-MOS technique boosts the performance of C-MOS circuits while increasing circuit density by a factor of 10. The circuit operates as a NAND gate when clock pulses are high and retains previous levels when the clock pulses are low.



5. Now B-MOS. Hitachi's back-gated MOS technique leads to microwatt power dissipations and low threshold voltages. B-MOS inputs drive a normally biased MOS transistor, in a configuration that resembles a C-MOS inverter but is considerably smaller.

four times the gate speed (8.8 ns per gate, as against an average 37 ns), and a much lower power dissipation (nanowatts per gate). Its power-delay product of 0.07 picojoule is the lowest reported to date for any I^2L structure.

As for the future, Mitsubishi engineers predict that VIL will prove capable of 1-ns gate delays and contend that this performance will give them an edge in memory and LSI logic. In fact, VIL versions of 4-k and 16-k RAMS and 8- and 16-bit microprocessors are already in development, along with watch chips and linear-to-digital and digital-to-linear interface circuits.

Another approach to bipolar LSI comes from Nippon Electric Co., where workers are employing a single heavy gold diffusion for integrated-circuit fabrication. The outcome is a new LSI family called gold transistor logic (GTL), that sports a packing density, and speed-power product as sensational as those of today's I^2L and in addition operates five times faster (Table 4). Moreover, GTL can be fabricated in a variety of configurations—TTL, diode-transistor logic, emitter-coupled logic and so on—and can therefore, unlike I^2L, interface on chip with other bipolar circuit forms. However, GTL does need six photoresist masking steps as opposed to four masking steps for basic I^2L.

In comparing the Japanese bipolar LSI efforts with American work, however, it is important to bear in mind that while the Japanese programs in I^2L and GTL have produced powerful high-performance LSI circuit elements, the Japanese manufacturers have neither moved the processes into production nor applied them to useful VLSI products. In fact, there is no VIL or GTL device on the market, either in Japan or abroad, and while prototype and developmental chips have been built, these new bipolar techniques remain largely untried in a high-volume commercial environment.

Exactly the opposite is true of the American work in bipolar LSI. Manufacturers like Texas Instruments and Fairchild Semiconductor have been introducing a variety of I^2L memories and microprocessor chips over the last two or three years. These devices, which use various generations of I^2L processing capability, have been steadily improved as process capability grew. TI is already on its third-generation I^2L process—one that achieves 5-ns propagation delay and 1-μW power dissipation—and plans to upgrade I^2L 16-bit microprocessors and its 4-k and 18-k static RAMS with the technique.

Fairchild Semiconductor, too, has been gathering extensive injection-logic production experience with fast 4-k dynamic RAMS and 16-bit minicomputer CPUs. Moreover, it has already developed a design strategy to achieve a 65-k RAM. Fairchild is using an I^2L circuit design in conjunction with its oxide-isolated fabricating process (I^3L) to achieve performance as good as Japan's VIL and GTL, as has TI with its advanced I^2L. Indeed, this production experience with high-performance LSI memory and microprocessor parts should give American manufacturers a major cost advantage over their Japanese rivals in the next generation of bipolar products.

Performance, on the other hand, is another story. Here Japanese manufacturers may be getting a leg up on their

TABLE 3: COMPARISON OF JAPANESE LOW-POWER VLSI TECHNOLOGIES

	B-MOS	C-MOS	I^2L
Cell area: inverter	0.58	1	0.31
Cell area: logic gate	0.35	1	0.14
Power (W/gate)	$\leqslant 10^{-6}$		$\leqslant 10^{-3}$
Delay time (ns/gate)	$\geqslant 50$	~10	$\geqslant 10$
Power-delay product (pJ)	0.01		0.3
Supply voltage (V)	0.15 – 0.5	$\geqslant 1$	$\geqslant 0.5$
Process masking steps	C-MOS-compatible 5 – 6	5 – 6	5 – 6
Drawbacks	multiple power supply	low packing density	limited fanouts

Source: Hitachi

TABLE 4: GOLD TRANSISTOR LOGIC COMPARED WITH INTEGRATED INJECTION LOGIC

Item	GTL	I^2L
Packing density (gates/mm^2)	100 ~ 200	120 ~ 200
Propagation delay time (ns/gate)	5 ~ 50	25 ~ 250
Speed-power product (pJ/gate)	0.5 ~ 20	0.5 ~ 10
Logic swing (V)	0.4 ~ 0.6	0.4 ~ 0.6
Supply voltage (V)	1.5 ~ 6.0	1.0 ~ 15
Photoresist steps	6	4
TTL compatibility	yes	no

Source: NEC

American rivals in high-speed memory and logic circuits by using more traditional emitter-coupled and current-mode logic. This they are doing mainly in cooperation with their own computer divisions, as well as with Nippon Telegraph and Telephone. A good example of the memory work is Fujitsu's 1,024-bit ECL RAM, which NTT will use in its next-generation switching equipment and Fujitsu will use for buffer memories in new high-speed computers.

With its typical access time of 7.5 ns, this part is the fastest 1,024-bit static RAM yet to be developed anywhere. It owes its speed to advances in both circuit design and processing technology. It is laid out with highly efficient washed emitters, Schottky-clamped flip-flop memory cells, and a 2-ns ECL sensing circuit to reduce peripheral delays. Fujitsu designers are also using V-groove isolation (tried and abandoned by American technologists) and a shallow-junction doping process that reduces junction losses and increases speed.

When it comes to speed

In high-speed bipolar logic, Hitachi, Fujitsu, NEC, and Oki Electric Industries have programs to supply 200-gate CML master slices to NTT for the company's upcoming generation of D-10 electronic exchanges. (The technology can of course go for commercial export.)

The 200-gate chips provide one of the fastest and densest logic configuration available for high-speed controllers. Gates operate with 2-ns propagation delays, twice to three times as fast as equivalent LSI chips in the ECL 10,000 series. Yet the power dissipation, at 3 milliwatts per gate, is about the same as the slower ECL versions.

NTT has designed a 4-bit arithmetic/logic unit using the master slice technology, with eight such chips making up the 32-bit central processing unit. Included in the design are CML peripheral interface chips as well. What is nice about it is that CML technology is compatible with standard ECL technology, working off the same −5.2-V supply, so that it is possible to mix CML and ECL chips on the same board without suffering interface and buffering penalties.

While the telephone company's influence on LSI component design is considerable, its cooperation with the private sector in VLSI fabricating is even more significant. The focus is, of course, on electron-beam fabrication for pattern definition of lines narrower than 2 μm.

NTT researchers, working with Hitachi, Fujitsu, and NEC engineers, are developing a high-speed electron-beam system for fabricating masks and actual wafers. If successful, it could catapult Japanese VLSI capability well above that of many independently working American and European manufacturers.

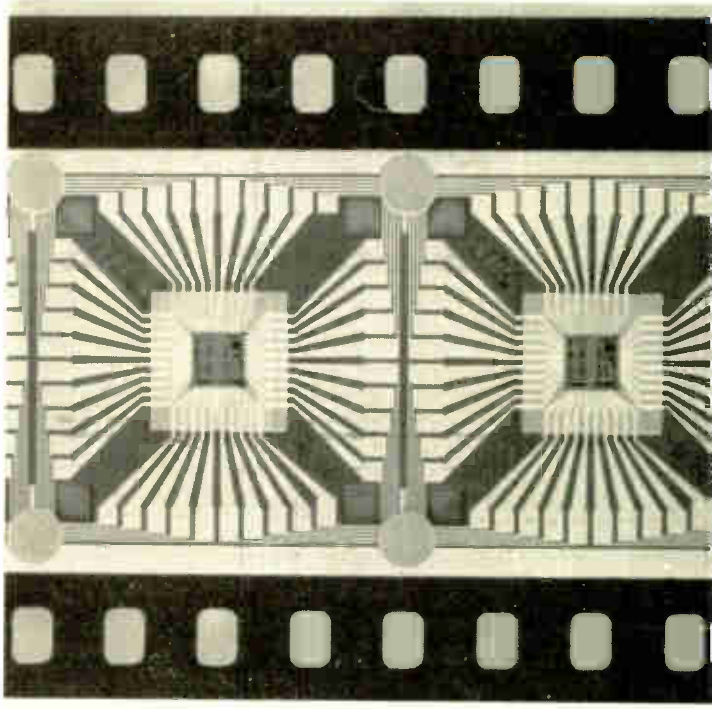
Three electron-beam systems now being installed in NTT's Musashino Electrical Communication Laboratory (the equivalent of Bell Laboratories in the U. S.) are vector-scan units purchased from Thompson CSF, Hitachi, and JEOL, a Japan-based production-equipment supplier, and each is being modified to perform system characteristics determined by conference between the partners and executed jointly.

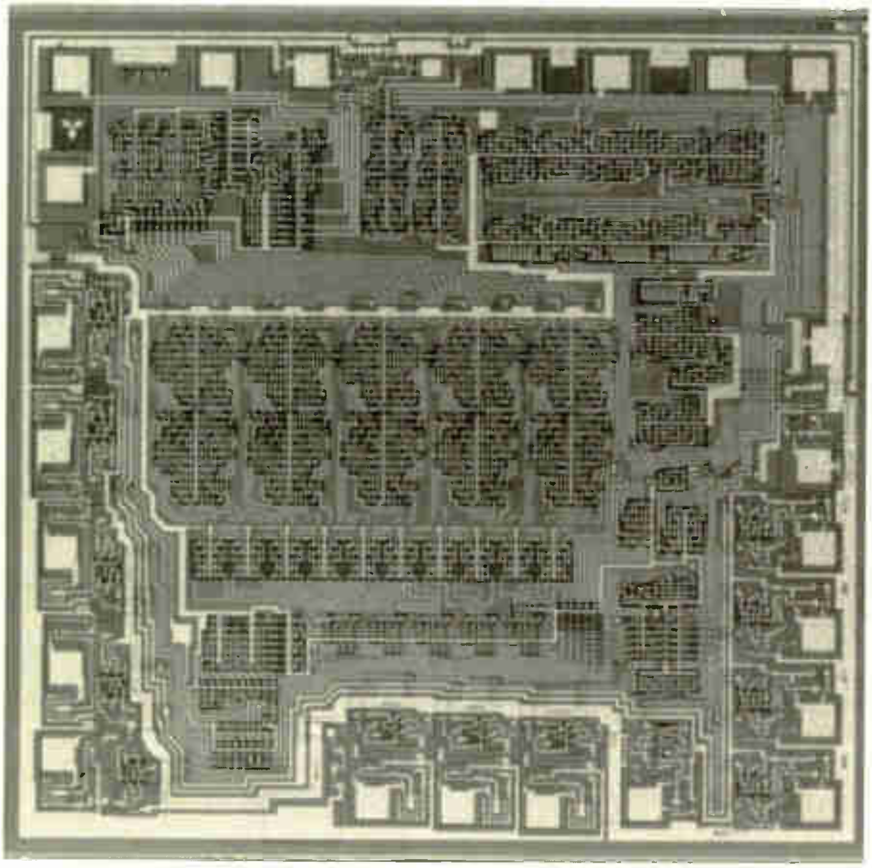
Modification in some cases is extensive. For example, the JEOL unit is being fitted with a high-speed arithmetic control unit built by NEC, a 16-bit digital-to-analog converter designed by NTT, and an output amplifier that can handle the JEOL scanning signals. The result is full 16-bit resolution in positioning in both the X and Y directions and coverage of 2-by-2-mm² field with a clock rate of 5 MHz. The beam spacing—from 0.3 to 0.97 μm—puts the unit well below submicrometer resolution capability.

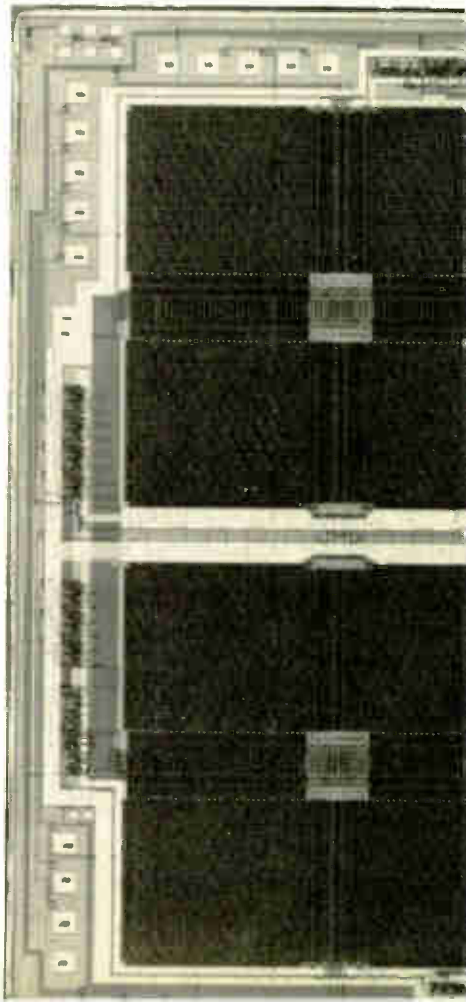
SPECIAL REPORT

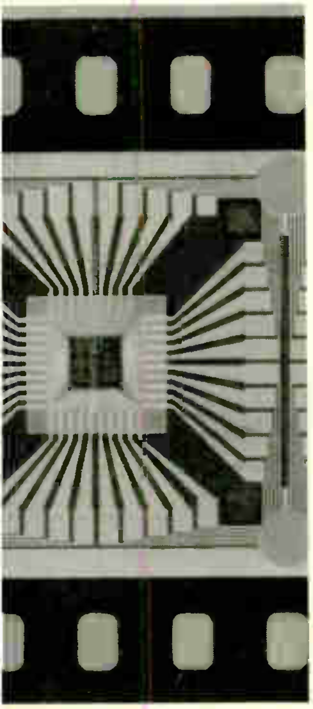
The advanced-technology payoff

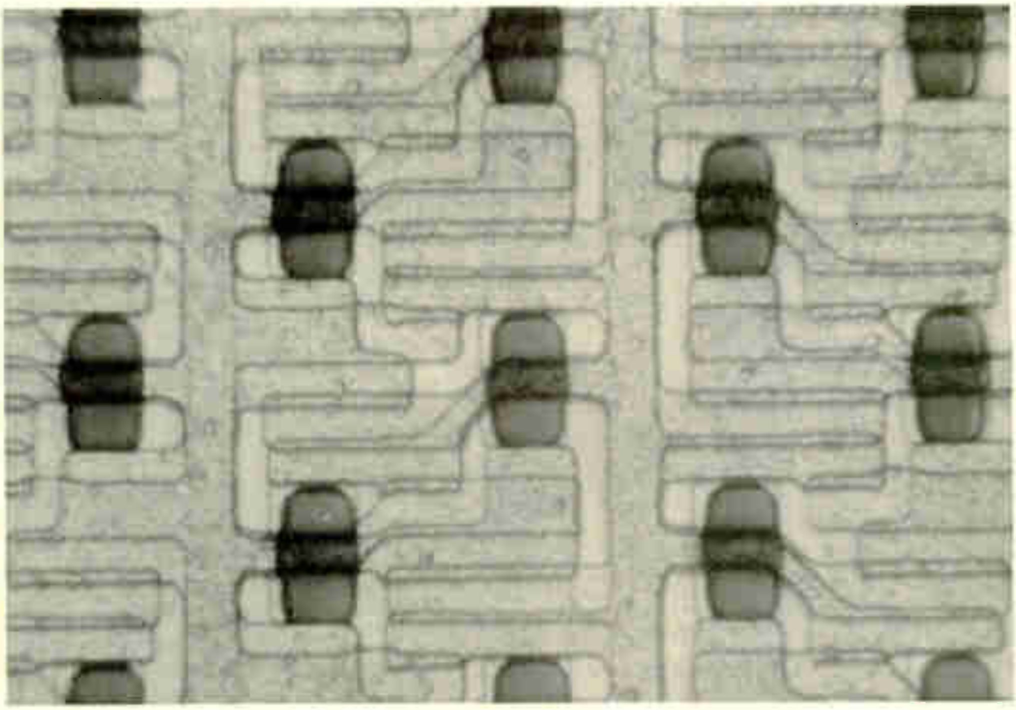
All these LSI chips have reached an advanced stage of development at Japanese semiconductor manufacturers. The near-right photograph shows a 200-element current-mode-logic gate array packaged in a low-cost film-carrier strip. A NEC product intended for a new line of big mainframe computers, the package illustrates one of Japan's major strengths: adopting low-cost assembly techniques for high-performance applications. At far right is a frame-transfer chip built by Sony with charge-coupled-device technology. Although Sony has introduced no CCD cameras, whereas Fairchild and RCA in the U.S. have camera products using CCD imagers, the big Japanese manufacturer of consumer products is well advanced in using the techniques for color-imaging devices. Far right at the bottom, is an n-channel MOS memory cell that is used in a NTT-funded 65-k dynamic-RAM project. The complete chip, which was fabricated by Fujitsu, is shown at bottom middle. The cell, a single-level silicon-gate structure, is connected to the sense amplifiers by low-capacitance molybdenum bit lines that can assume much finer patterns than polysilicon or metal lines on today's RAM products. Finally, shown directly below is a five-digit frequency counter using high-density integrated injection logic. The chip, built by Mitsubishi, also contains driver transistors on its periphery for seven-segment displays. The circuit has 845 gates that fit on a chip measuring only 3.43 by 3.2 mm².

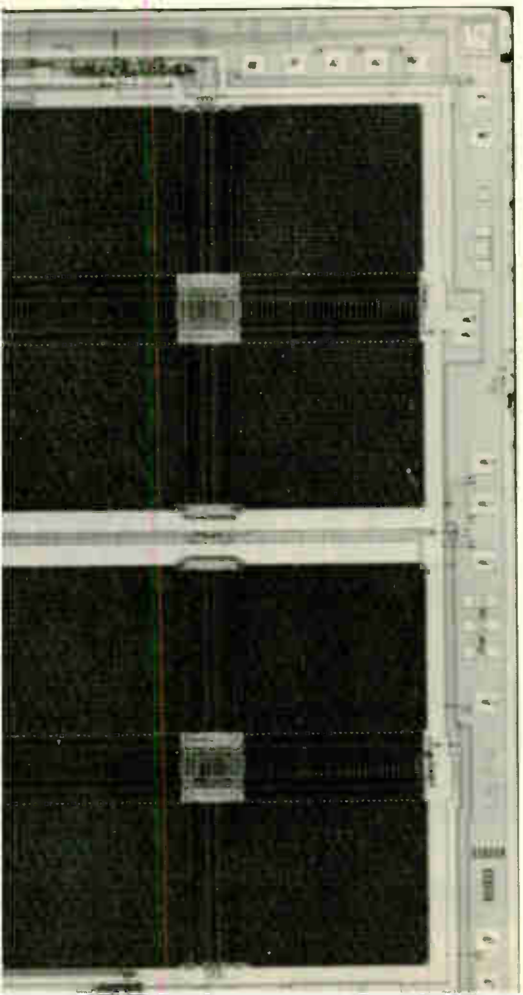


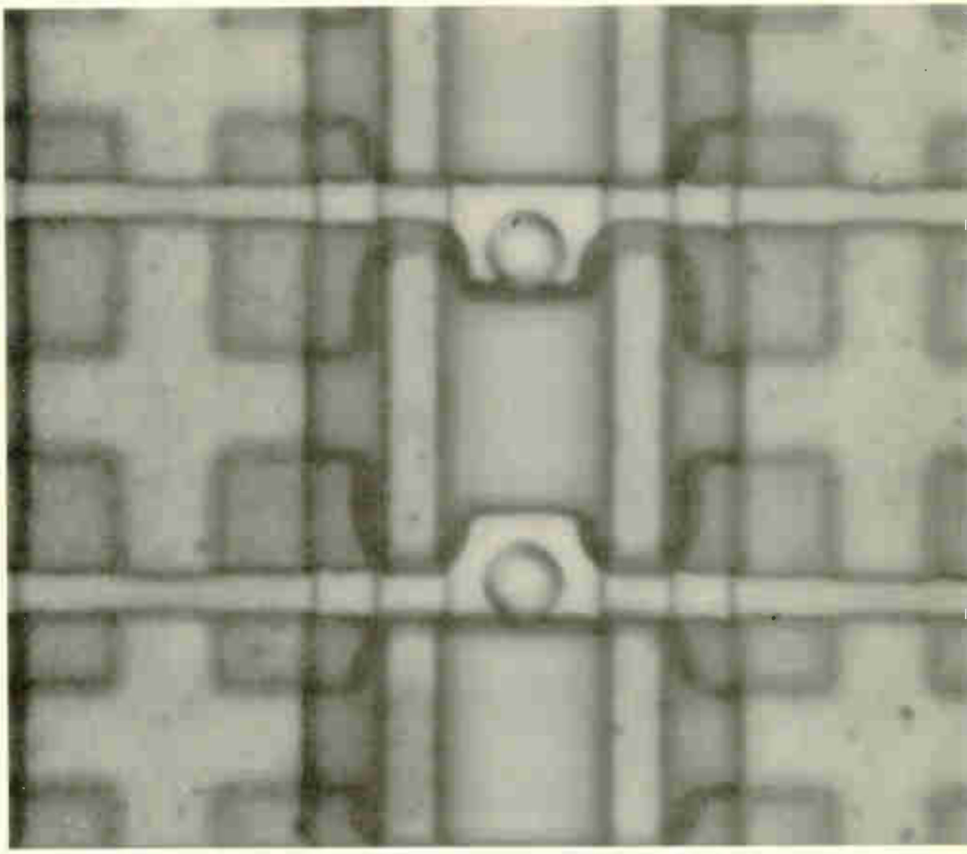












JAPAN PREPARES TO SELL THE WORLD ON MEMORY

With single- and double-level n-MOS technology in hand, the Japanese semiconductor makers are ready to storm the world's memory markets. Satisfied that they can meet their domestic computer and data-processing equipment requirements, they are planning major drives on the U. S. and European markets with 4-k and 16-k dynamic random-access memories, 1-k and 4-k static RAMs, and 8-k and 16-k read-only memories for use in both mainframe and peripheral microcomputer systems. Further off, but near enough, are the popular 2708 erasable programmable ROM, which the Japanese are now supplying at home and will soon be exporting as well, and the Intel 2716-type 16-k erasable PROM, which they are tooling up to make.

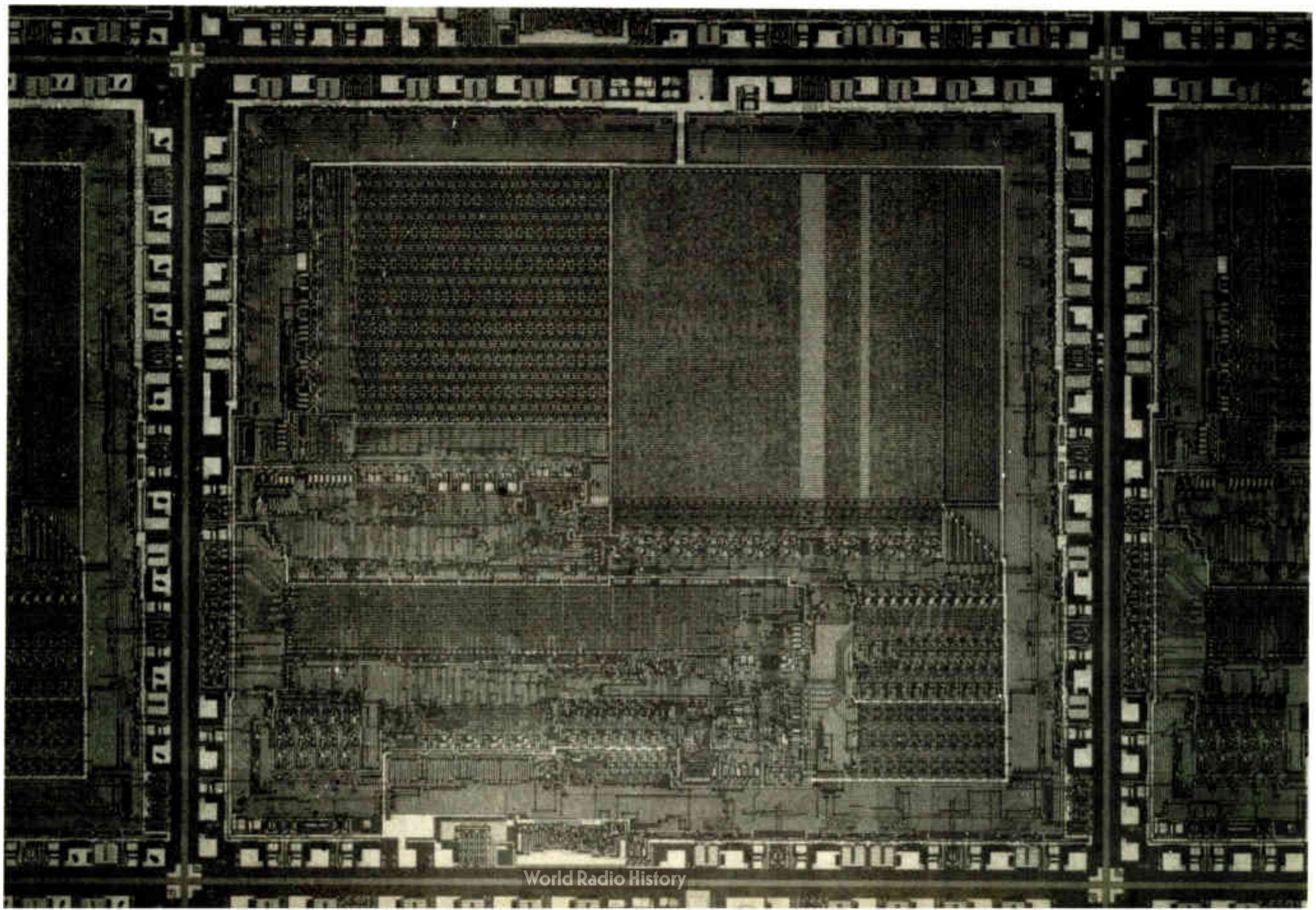
In charge-coupled memories, some Japanese memory makers are already hitting pay dirt, for they are introducing 65,536-bit CCD serial memories in Japan as replacements for small disks in microcomputer systems. New high-speed metal-oxide-semiconductor and integrated-injection-logic parts still appear to be 18 to 24 months away from serious product entry, although sample flyers will probably appear in Japan this year. Bubble memories are also under investigation in various laboratories.

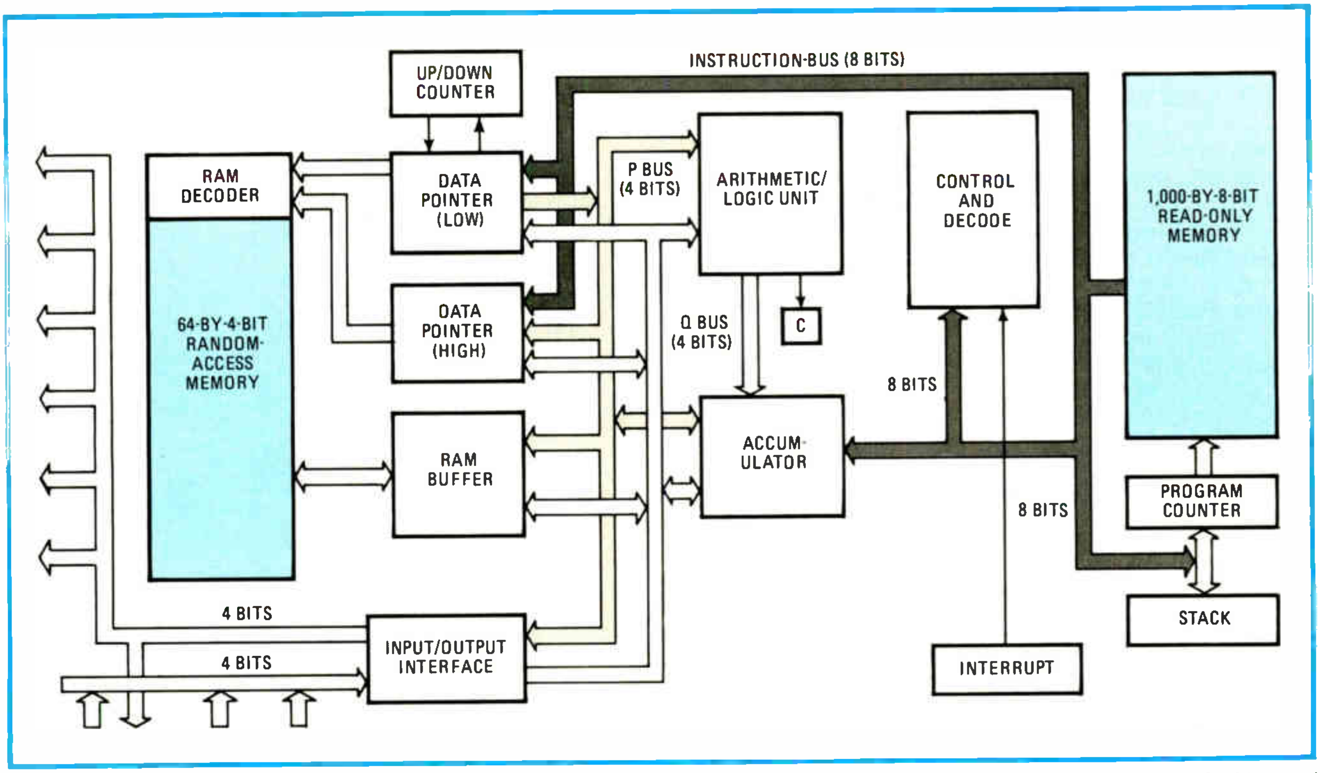
The dynamic picture

The big dynamic-RAM product in Japan is still the 4,096-bit copy of Intel's 2107B, which all the major Japanese computer manufacturers have adopted. The Japanese suppliers are NEC, Fujitsu, Hitachi, and Mitsubishi, all of whom either are or soon will be exporting to Europe and the U. S. In the lead both in Japan and abroad is NEC, which has been selling 22-pin 4-k devices in the U. S. for two years. But the extra influx should quicken the 2107B's price decline—it is already well below $4.

The situation is not all roses for Japanese suppliers, though, since major U.S. mainframe makers have already shifted the bulk of their designs to faster 16-pin parts, both to upgrade speeds and in order to anticipate

1. Getting tough in microcomputers. Japanese chip manufacturers are gearing up for a big push in 4- and 8-bit processor systems. This one-chip 4-bit microcomputer from NEC, part of a family covering controller applications, is representative of the trend.





2. One-chipper. NEC's 4-bit microcomputer is a self-contained controller for low-end consumer and industrial equipment. It has 8,192 bits of program ROM, 256 bits of data RAM, and a flexible arrangement of I/O ports for interfacing with the user's peripheral equipment.

the imminent arrival of the 16-pin 16,384-bit devices. In response, NEC, Fujitsu, and Hitachi will start churning out 16-pin 4-k types, copying Mostek or Intel. However, since their computer divisions are not switching to the smaller-package parts, they will be denied a big domestic market for getting production of the 16-pin devices up and their costs down.

If some Japanese memory makers, always excepting NEC, were caught flat-footed by the shifting 4-k market in America, they will not be beat in the rapidly developing 16,384-bit memory market. Neck and neck with American leaders Mostek, Intel, and TI are NEC, Hitachi, and Fujitsu, which are making industry standard 16-pin 4116s in speed ranges of 200 to 300 ns, and soon to arrive are Toshiba and Mitsubishi. NEC is even supplying the 150-ns version and probably will have Hitachi for company as exporters of the premium part this year.

Crowded market place

What will three and possibly five newly qualified contenders do to the already overcrowded U. S. memory market? Chasing the MOS RAM market has long been a strain on many American semiconductor manufacturers—indeed, TI and Intel are probably the only American companies consistently making money in mainframe memory. If these aggressive Japanese exporters arrive early with the right part, they could rapidly rid the U. S. ranks of all but the most powerful American firms competing in this heavily populated arena.

The Intel 2102 static types are being supplied by all Japanese RAM manufacturers but are exported apparently only by NEC, mainly to fill out its own 8080 microcomputer line. U. S. prices at $1.50 in volume are just too low to make the Japanese enthusiastic about exporting the 1,024-bit static RAMs.

In 4,096-bit statics, too, the Japanese may have trouble, this time because there is no U. S. industry standard for them to copy. NEC is leaning towards the Intel 2114 part, while other Japanese manufacturers are leaning toward the Mostek 4104 type. Making it worse, static memories are used mostly in small microprocessor systems or in peripheral equipment where volume is low, so that memories often are bought as part of the package that includes the microcomputer.

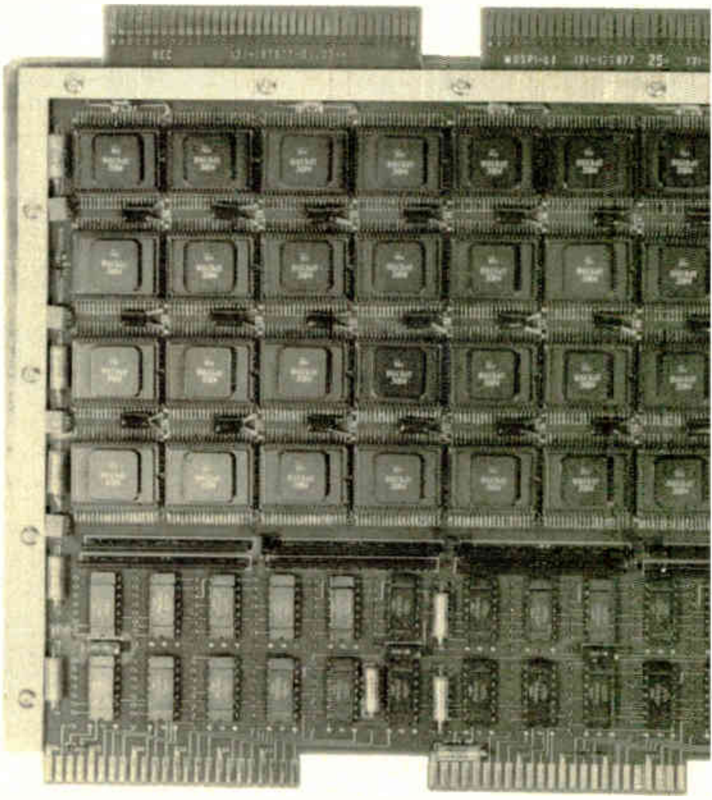
The Japanese may have better luck with C-MOS devices, especially Toshiba with its line of 1-k and 4-k static RAMs. Its participation in Japan's big electronic cash register industry gives Toshiba a leg up on its U. S. rivals in C-MOS RAMs—Intel, Intersil, and RCA.

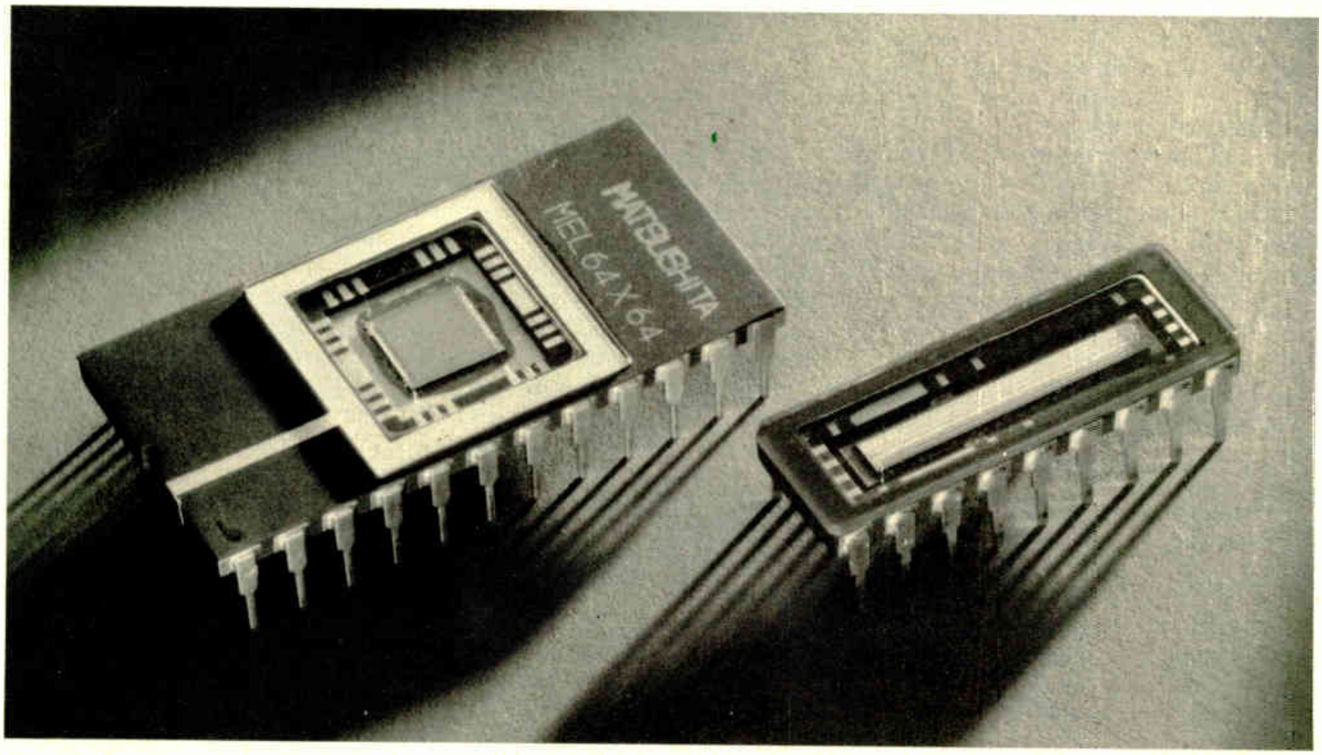
Microprocessors come last

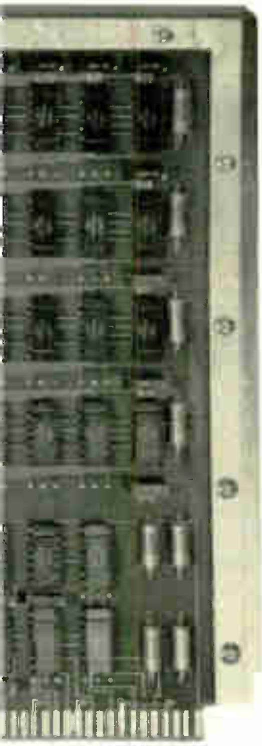
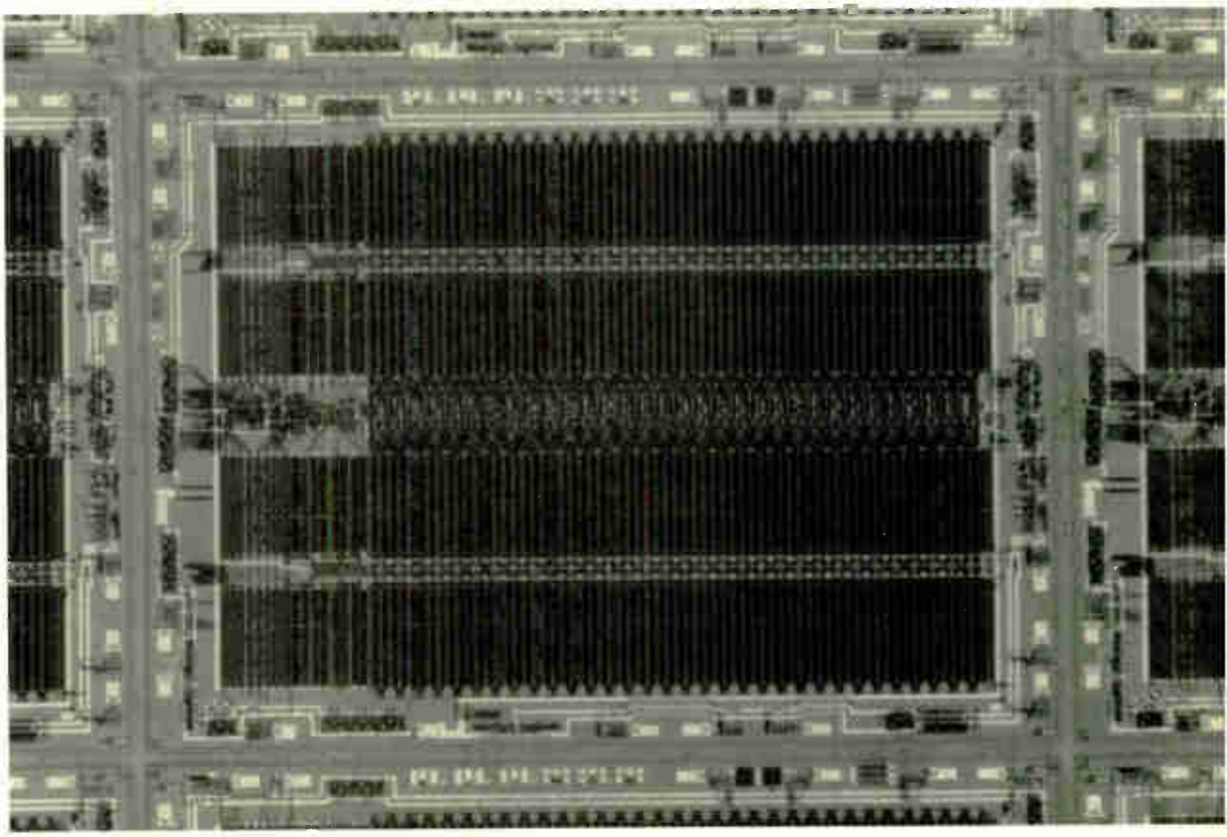
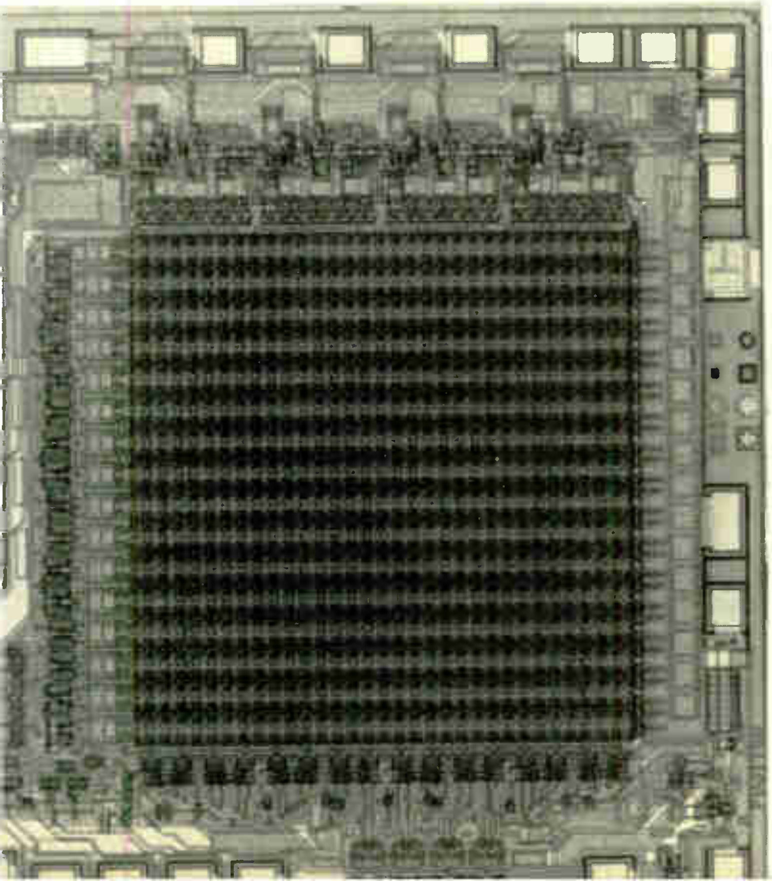
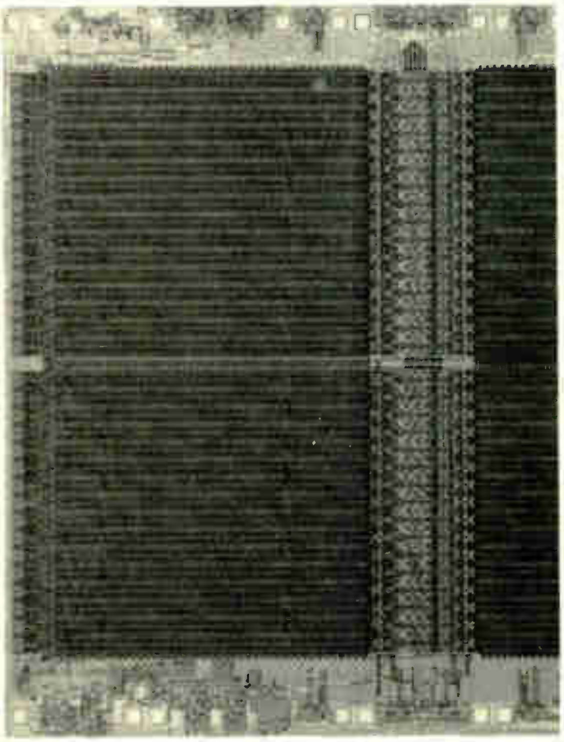
Japan lags behind the U. S. in microprocessors, even at home. Two giants split about 25% of the Japanese market between them—Nippon Electric and Intel. But though NEC makes 4- through 16-bit types, 70% of its sales are 4-bit systems, including one-chippers for elec-

Worthy competitors

Even as Japan is embarking on a VLSI program to produce integrated circuits for future computers and digital systems, the firms there are already using their considerable large-scale-integration capability to build a formidable array of products for today's markets. The memory card shown directly on the right is using NEC's new high-speed n-MOS dynamic random-access memories, which were designed for use in mainframe buffer systems. Hitachi's 16-k dynamic RAM shown on the far right is another example of production-ready state-of-the-art design. Using advanced IC techniques, such as double-level silicon gates, local-oxide isolation, and 5-micrometer photolithographic rules, it has an access time of 200 nanoseconds while dissipating only 500 milliwatts. Meanwhile, in charge-coupled-device memories, there is Toshiba's 65-k CCD serial chip (lower, far right) developed as a disk replacement in small microcomputer systems. Built with a double-level silicon-gate process similar to the one used in today's 16-k RAMs, it puts Japanese manufacturers on a par with U. S. CCD memory development. An example of a very-high-speed memory for buffer systems is Fujitsu's 7-ns, 1,024-bit random-access memory (lower middle) built with emitter-coupled logic. The part will be used in Fujitsu's upcoming big computers and will also be made available commercially both in Japan and abroad. Finally, Matsushita's linear MOS sensor arrays (directly below) are solid-state replacements for the low-resolution cathode-ray tubes used in industrial imaging applications. A 512-bit linear array is in volume production, and a 1,024-bit linear array and 64-by-64-bit area array are in pilot production.





4-BIT MICROCOMPUTERS IN THE MN1400 SERIES

		MN1400	MN1402	MN1498	MN1499
Dual in-line package		40-pin plastic	28-pin plastic	40-pin plastic	64-pin ceramic
Power supply (V)		+5	+5	+5	+5
Instruction cycle time (μs)		10	10	10	10
Instruction set (number of instructions)		75	57	68	75
Subroutine stack		2-level	2-level	2-level	2-level
Instruction memory	On-chip instruction ROM (bits)	1,024 x 8 (8,192)	768 x 8 (6,144)	–	–
	External instruction memory (bits)	–	–	1,024 x 8 (8,192)	2,048 x 8 (16,384)
Total data RAM (bits)		64 x 4 (256)	32 x 4 (128)	64 x 4 (256)	64 x 4 (256)
	directly addressable	4 words	4 words	4 words	4 words
Counter/timer (bits)		8	–	8	8
Power-on reset		yes	yes	yes	yes
Input	parallel	one 4-bit port	two 4-bit ports	one 4-bit port	two 4-bit ports
	sense	2	2	1	2
Output	discrete	one 12-bit port	one 5-bit port	one 9-bit port	one 12-bit port
	parallel	one 4-bit port	two 4-bit ports	one 4-bit port	one 4-bit port one 5-bit port
	PLA	one 8-bit port	–	–	–
Assembler support		yes	yes	yes	yes
On-chip clock generator (external control)		yes (yes)	yes (yes)	yes (yes)	yes (yes)

Source: Matsushita

tronic cash registers, vending machines, and consumer products. Its 4-bit types include both proprietary and general-purpose types, but none is compatible with American-made products.

Nevertheless, NEC soon plans to test the water here with 4-bit originals that cover the spectrum—from the μPD751 high-end three-chip set that is made with the n-channel process through a low-end single-chip p-channel device, μPD547 (Fig. 1). In between are several p-channel devices—the two-chip μPD541/μPD542 and the one-chip μPD548 for arithmetic operation, and the single-chip μPD546 for sequence control.

The block diagram of the μPD547C (Fig. 2) is typical of Japan's 4-bit one-chippers. The part contains all the necessary computer functional blocks—arithmetic/logic unit, ROM, RAM, and input/output functions to handle a host of low-end controller jobs. Included on the chip are a 4-bit parallel CPU and control logic, an 8,192-bit ROM for program memory, a 256-bit RAM for data memory, a stack memory, and input/output ports. The part can hook up directly with standard printers and seven-segment-digit displays, with no external parts needed.

Matsushita is another Japanese supplier of a 4-bit one-chip microcomputer family (see table). The parts range in size from 6,144 and 8,192 bits of program memory and 128 to 256 bits of data memory. Two chips in the family, the MN1498 and 1499, are expandable into more powerful systems by the addition of an external program ROM. Other firms in Japan with one-chippers are Sharp, which makes its own 4-bit unit as well as Rockwell's PPS-4 family, and Hitachi, Fujitsu, and Toshiba, which have one-chip parts on the way.

The word about 8 bits

In 8-bit microprocessors, NEC leads the Japanese semiconductor companies with its version of the 8080A, which it both sells at home and exports. (Others in Japan making the 8080 include Mitsubishi and Oki.) NEC is also well along in developing one-chip 8-bit versions of the one-chip Intel 8048 and 8748 and in addition produces proprietary 8-bit one-chippers, the μPD767 microcomputer and the μPD765 peripheral control microcomputer. For its 8-bit systems, NEC produces many LSI peripheral chips, including direct-memory-access, keyboard, and cathode-ray-tube controllers.

Hitachi's 6800, built under Motorola license, is just starting to have some success at home. Moreover, the firm has just developed three LSI peripheral chips for DMA, CRT, and cassette control, which in turn will be second-sourced by Motorola. Fujitsu makes a somewhat enhanced 6800, not under Motorola license, but uses it mostly for in-house designs. Sharp is making Rockwell PPS-8 devices and at year end will start turning out Zilog's Z-80 under license. □

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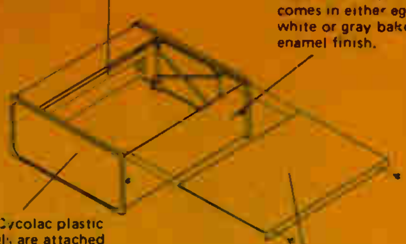

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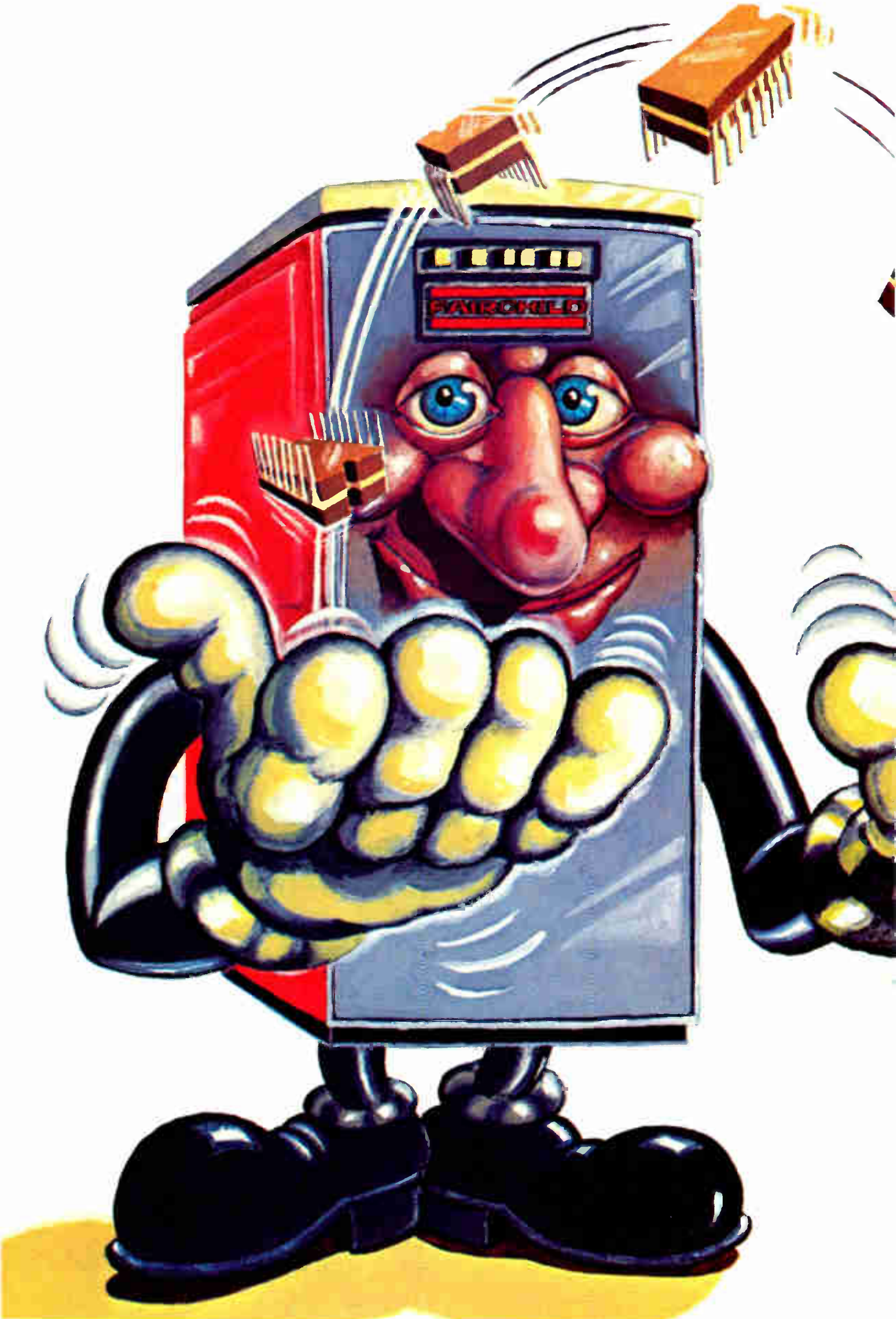
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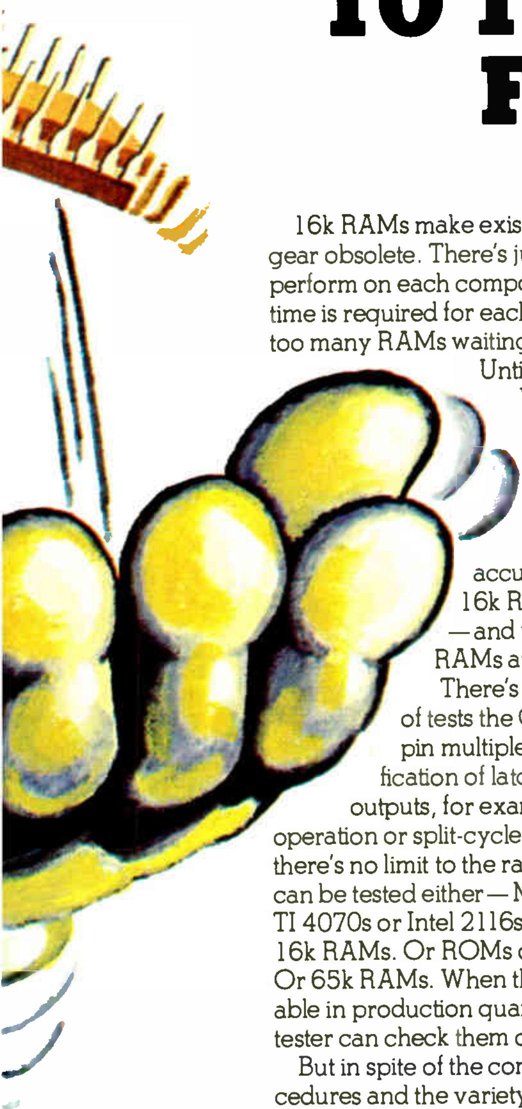

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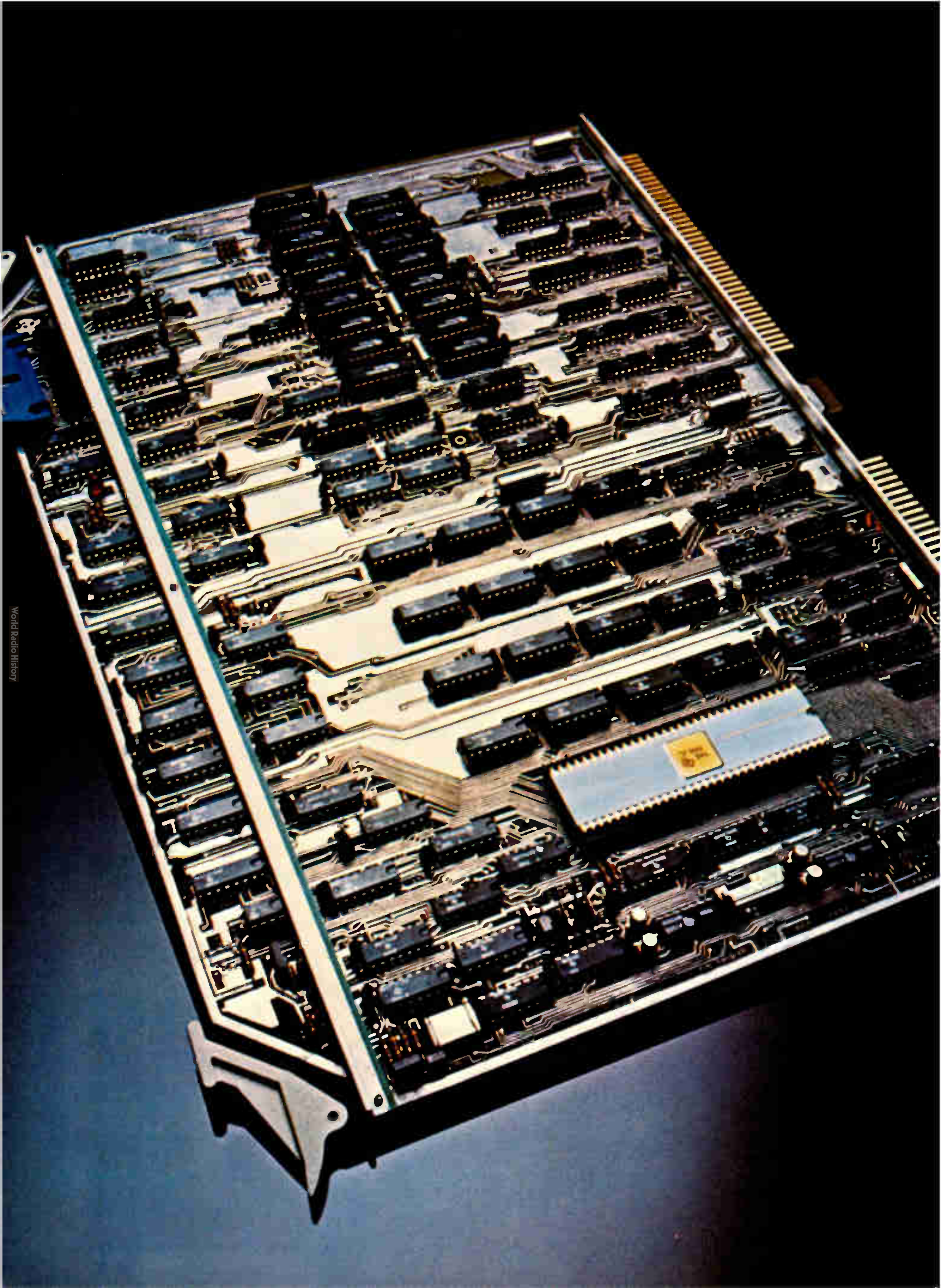

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Self-gating sample-and-hold controls oscillator frequency

by Peter Reintjes
Research and Design Ltd., Morehead City, N.C.

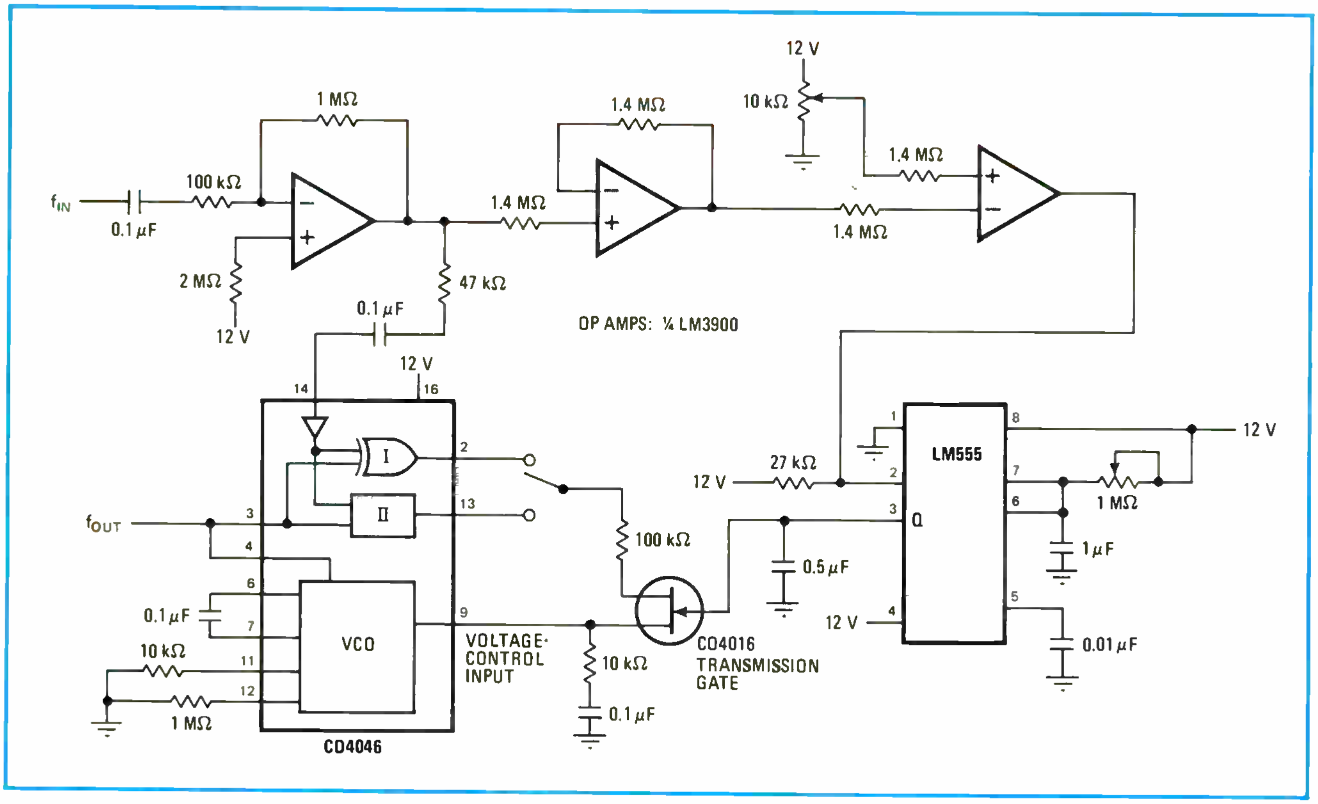
A phase-locked loop in conjunction with a transmission gate serving as a sample-and-hold device can remember the frequency of a short-duration signal by providing a constant feedback voltage to a voltage-controlled oscillator. The circuit is useful for electronic-music synthesis and tuning radio oscillators by remote push button, as well as other applications.

The circuit can sample and hold frequency bursts without the error introduced when the direct conversion of an input frequency to a voltage or digital quantity is attempted. As shown in the figure, a relatively high-level, short-duration alternating-current input signal is amplified, buffered and compared to a user-determined reference by the three operational amplifiers in the LM3900 device. The output of the last stage drives the 555 timer, which serves as a monostable multivibrator (one-shot). The input signal also drives the CD4046 phase-locked loop.

As the one-shot periodically fires in response to the input signal, the transmission gate conducts, completing the feedback loop in the PLL. This permits the output of a selected comparator in the PLL to feed the voltage-controlled oscillator at pin 9. The output of the comparator is a function of the difference between input and VCO output frequencies; the resulting current charges the RC network in the feedback loop consisting of the 10-kilohm resistor and the 0.1-microfarad capacitor. The final dc voltage, across pin 9, controls the VCO frequency and becomes constant when the input and VCO frequency match.

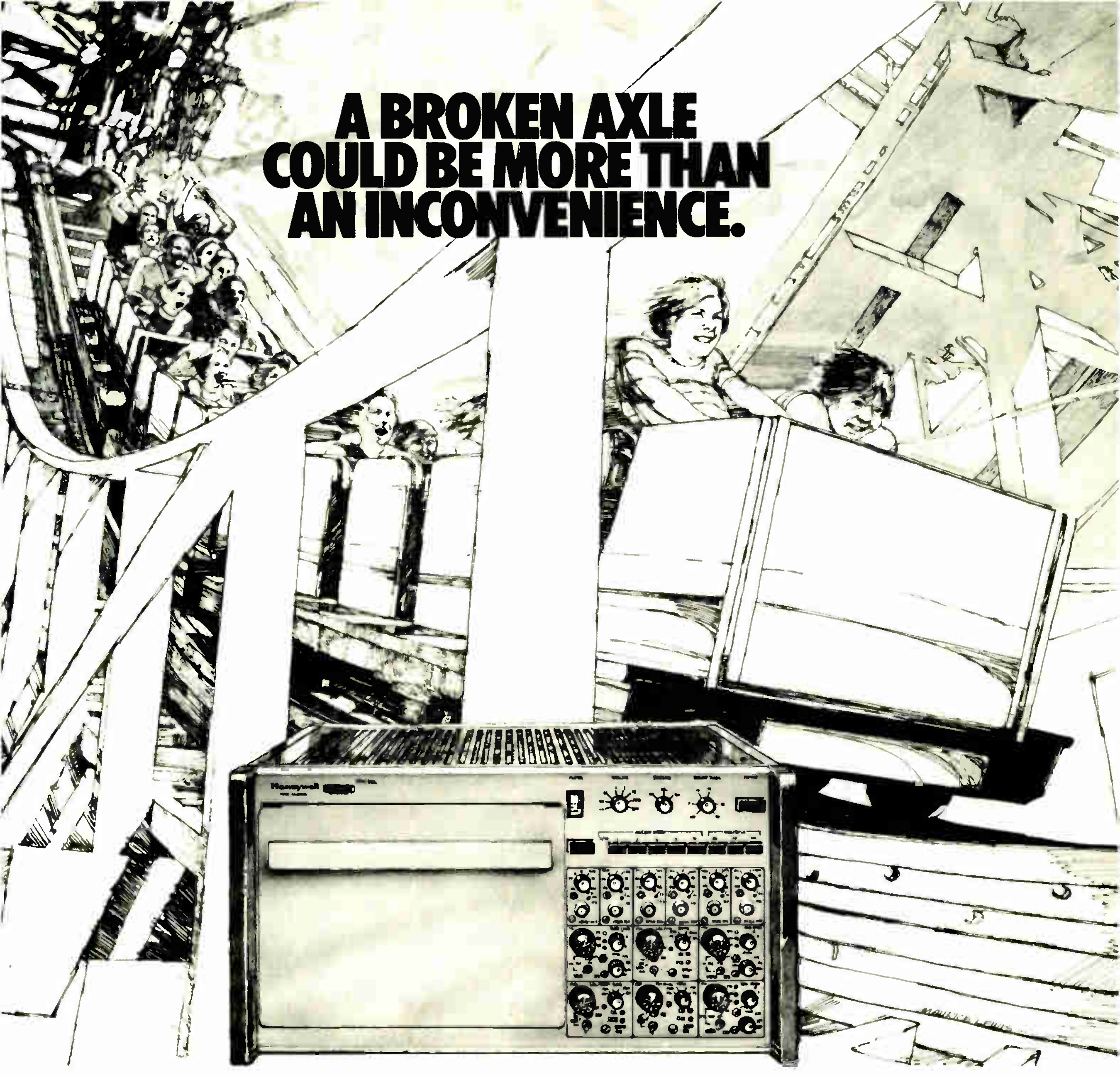
When the amplitude of the input signal fades, thus signalling the end of the burst, the feedback loop is opened because the 555 no longer fires. The voltage across pin 9 remains, however, because the high-input impedance of the VCO terminal prevents negligible leakage by the RC network. Therefore the VCO continues to oscillate at the same frequency indefinitely. The high input impedance provides a good "hold" characteristic.

Comparator 1 in the PLL, an exclusive-OR gate, should be used for high-noise input sources for optimum performance. Comparator 2 is an edge-detecting device and may be used for most other conditions. The LM555 sampling period is adjustable from 10 milliseconds to 1 second. The supply voltage on all devices may range from 5 to 15 volts. □



Self-gated sample-and-hold. Input-signal burst closes feedback loop in PLL, locks it to incoming frequency. Removal of input opens loop but causes no change in VCO frequency because of RC network, which stores unchanging voltage to drive oscillator.

Continued on page 134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Honeywell

Full adders simplify design of majority-vote logic

by Zhahai Stewart
Penfield Engineering, Boulder, Colo.

A majority-vote circuit—one with an output state determined by the logic states of the majority of its input variables—can be implemented by 4-bit binary full adders to yield lower chip counts or cost advantages than with standard designs using programmable read-only memories. The adders are easily combined to synthesize circuits used for decision-making or time-and-event-counter applications.

The circuits described use the 7483 full adder, but other adders that provide a similar logic function can be used. Each bit adder in the 7483 (Fig. 1a) has inputs A_i, B_i, and C_i; the outputs are S_i and C_{i+1}. Each adder is cascaded internally by connecting the C_i ports together.

The characteristics of the device are such that there will be a logic 1 output from the sum (S_i) terminal of each adder if one input is high or all three inputs are high. The carry output (C_{i+1}) of each stage will assume the high state if any two inputs or all inputs are high. This is the basic design tool used in the design of any n-bit majority gate.

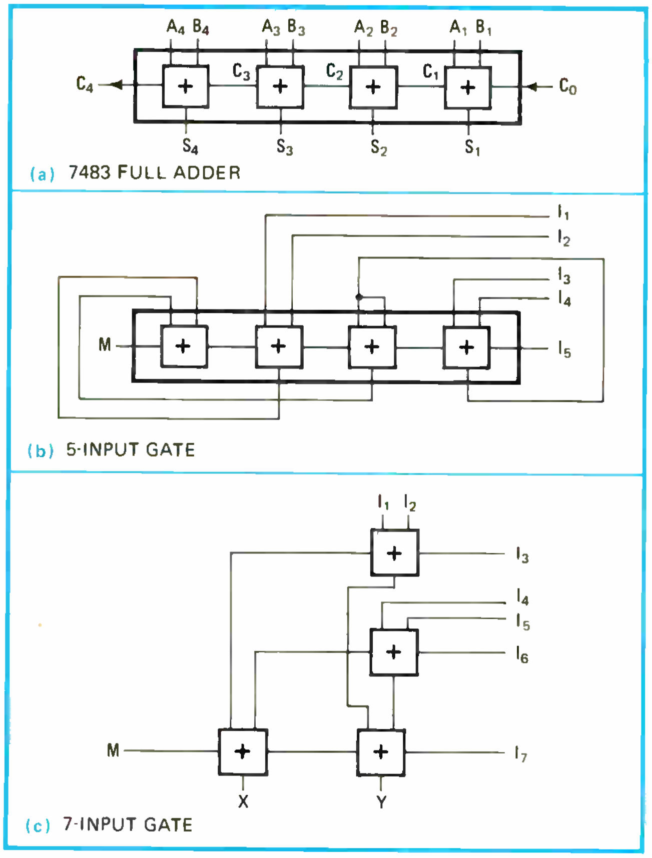
Only one adder is needed to form majority gates with as many as five inputs. For example, a three-input device can be built by introducing the input variables to A_3, A_4, and B_4 of the 7483, while tying all other inputs high to form the "trivial case" solution. In reality, only one quarter of the adder is used to full advantage. The output, taken from the carry-out port of the adder, will be high if any two of the three inputs are high.

Figure 1b shows an implementation of a more important case, the five-input gate. Output M is high if any three of the five inputs are high. The seven-input circuit (Fig. 1c) is a simple extension of the five-input case using the design rules outlined above, but it cannot be built using a single 7483 because its internal-carry connections are not accessible. While the adders cannot be directly cascaded, a majority gate of any size may be easily built as design experience is gained.

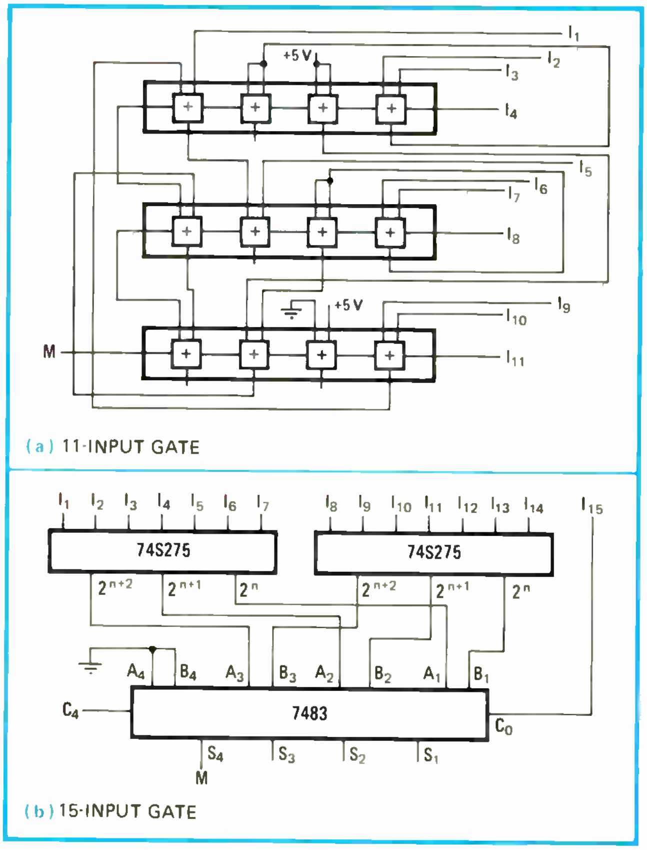
When the number of inputs is small, a PROM can generate the required gate function for slightly greater cost and design effort. However, when the number of input variables is greater than 10 or so, the use of adders will provide clear-cut advantages. An 11-input gate constructed from three adders is easier to design than with a PROM. (Fig. 2a).

When the number of inputs becomes very large, it is

1. Binary-adder majority gate. A single 7483 full adder (a) or similar device can be wired to produce up to a five-input majority-vote circuit. Five-input (b) and seven-input (c) gates are built using adders' truth table as the primary design tool.



2. No need for PROMs. Implementation with adders offer advantages over PROM designs when number of inputs exceed 10 (a). Tree networks can replace adders for additional ease in wiring when the number of input variables is higher (b).



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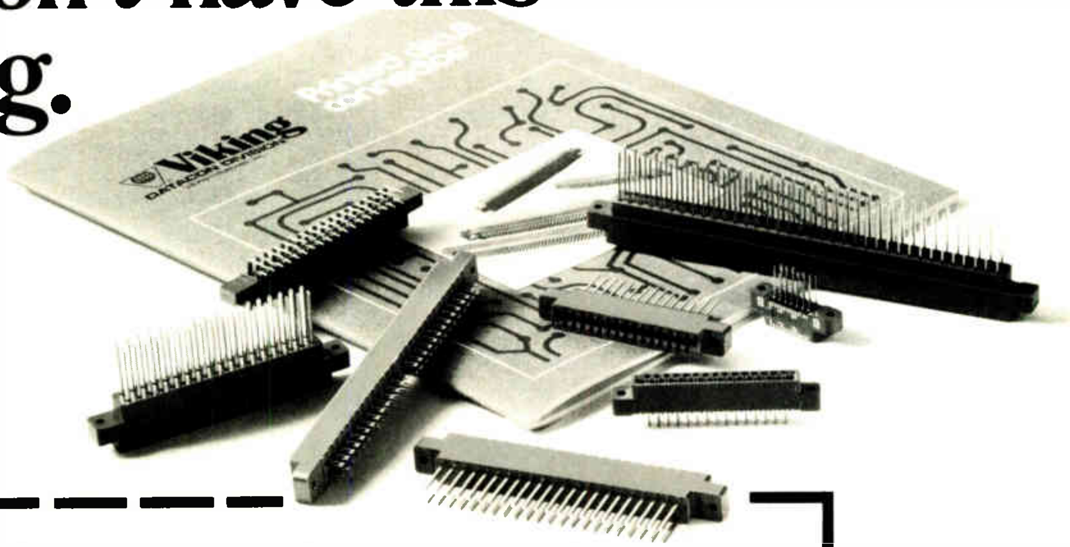

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advantageous to search for devices with characteristics similar to the adder and use them to reduce wiring and design headaches—and, in many cases, to minimize chip count. In Fig. 2b, a 15-input gate is implemented using two 74S275 "Wallace trees" and a full adder; the 74S275 provides the function of four adders without the external wiring. When connected to the external adder, space and cost are minimized.

If the carry bits of the Wallace tree are wired low, each tree output will yield the binary sum of the number of input variables that are high. Alternatively, the X, Y, and M outputs of two 7-bit devices (example in Fig. 1) may provide the binary sum to the external adder, where Y is the least significant bit. The output of both trees are then added directly by the 7483, with the result that M will be high if eight or more inputs are high. □

Glitchless TTL arbiter selects first of two inputs

by Yukihiro Mikami
Ottawa, Canada

Failure to differentiate between independently timed asynchronous signals only a few nanoseconds apart can cause glitches in standard transistor-transistor-logic circuits that spell disaster to system operation. Once the glitch is detected, it must be eliminated, so that an arbiter circuit like the one described here is essential in applications like dynamic memory controllers.

As shown in the figure, the 74S02 cross-coupled NOR latch will respond to a signal on request line A or B. The signal arriving first will appear on the corresponding output line. With simultaneous inputs, however, a single-pulse glitch, a sinusoidal oscillation, a metastable-state response (0.8-to-2.1-volt unassigned or guard-band region), or a combination of such responses may occur at each output for an indefinite period before the gate decides to switch into its desired state.

An RC network and Schmitt-trigger buffer eliminate these undesirable responses from the circuit outputs while minimizing the decision time. The amplitude of the glitch or oscillation is essentially filtered or damped, as the case may be, by the RC combination of the 330-ohm resistors and the 22-picofarad capacitor.

The resistors also combine with the 820-Ω resistor at the input of either Schmitt trigger to form a voltage divider. This divider effectively raises the positive-going switching threshold at this point by 0.6 to 2.1 v. Thus there is no spurious response, even for a 3-v glitch, a 1.5-v peak-to-peak oscillation, or a metastable-state response at the NOR gate output. The circuit responds with an output when the transient dies away, as the latch may then decide which signal came first. In the event of the arrival of two truly simultaneous signals, the gate would render an arbitrary decision.

Nonsimultaneous signals appearing at the appropriate output of the NOR gate will pass through the deglitching circuit relatively unaffected. Typical propagation delay of the arbiter is 20 nanoseconds for nonsimultaneous inputs and 25 ns for simultaneous input signals. □

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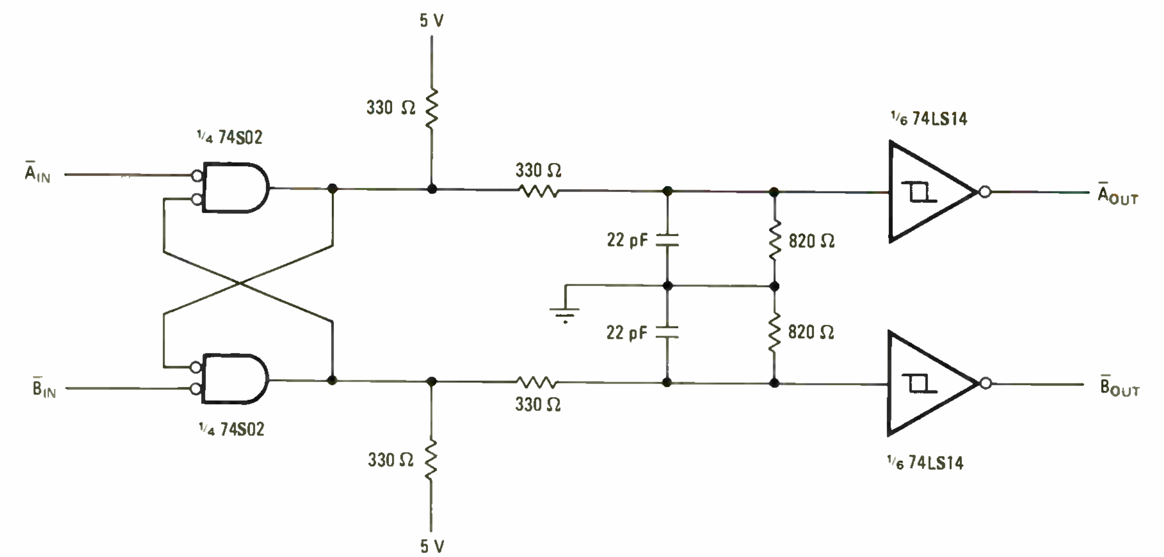
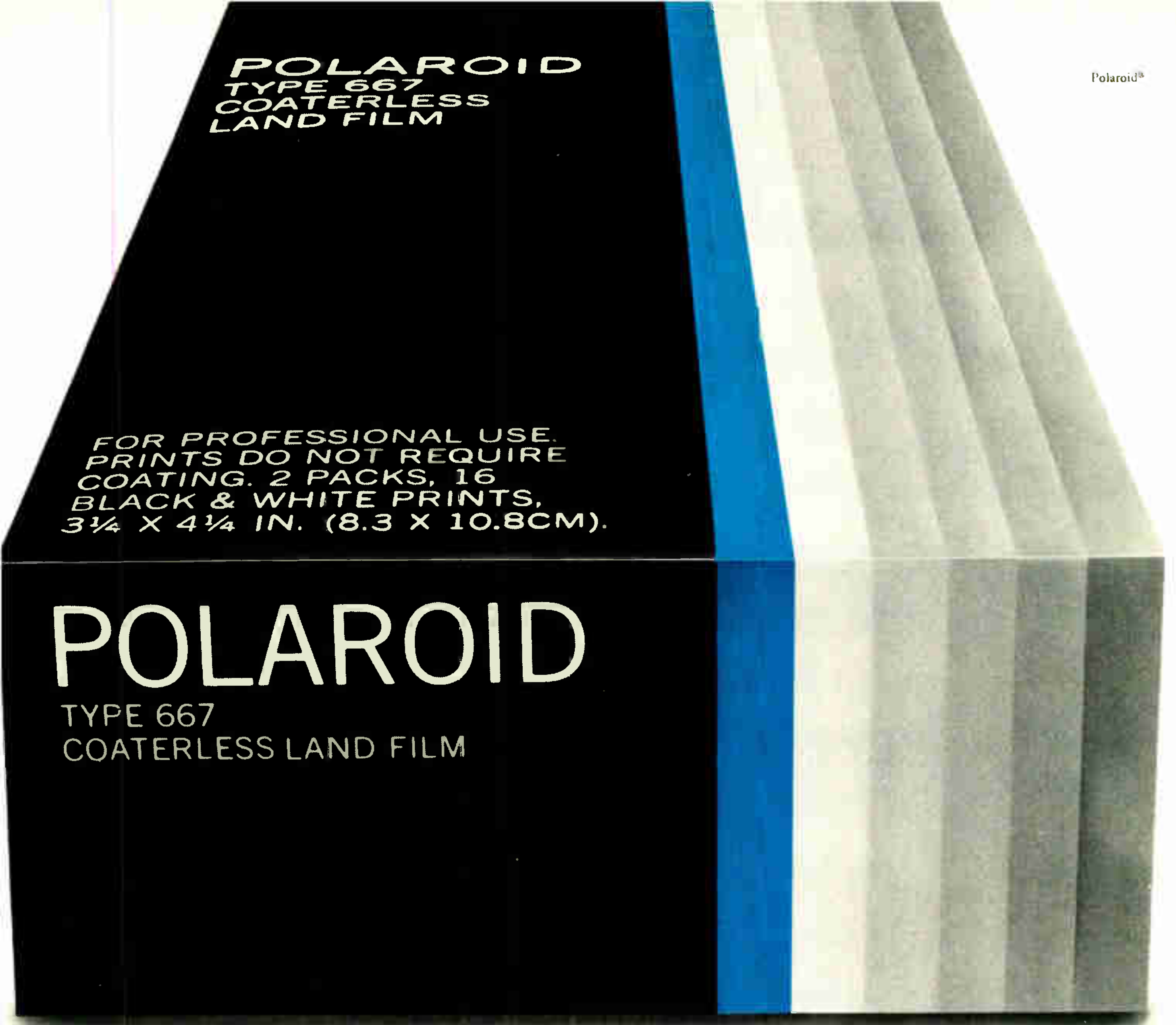


First come, first served. The input signal arriving first passes to an output, while simultaneously arriving signals produce an eventual output but no glitch. The resistor network raises the threshold of the Schmitt trigger, and the RC combination reduces glitch amplitude.



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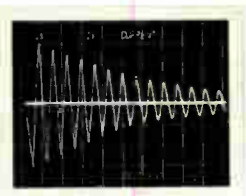

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Model	MM76	MM77	MM78	MM75	MM76C	MM76D	MM76E
Description	Basic 76	Basic 77	Jumbo 77	Economy 76	High speed counter*	12-bit A/D converter	Expand-ed 76
ROM (x8)	640	1344	2048	640	640	640	1024
RAM (x4)	48	96	128	48	48	48	48
Total I/O lines	31	31	31	22	39	37	31
Cond. Interrupt	2	2	2	1	2	2	2
Parallel Input	8	8	8	4	8	8	8
Bidirectional Parallel	8	8	8	8	8	8	8
Discrete	10	10	10	9	10	10	10
Serial	3	3	3	–	3	3	3
In-line package	42 pin quad	42 pin quad	42 pin quad	28 pin dual	52 pin quad	52 pin quad	42 pin quad
Availability	Now	Now	Now	2Q 77	2Q/77	3Q 77	16 wk ARO

Power supply is 15v except low voltage version of Basic 76 available 3Q 77.
Typical power dissipation is 70mw.
*Two 8-bit or one 16-bit presetable up/down counter with 8 control lines.

Rockwell design aids also help lower your system cost.

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*Available late summer 1977.

It also means that you don't have to relearn your software development system each time you use a different microprocessor chip. And that can save valuable time.

The 8002 offers several other time-saving features to ease the task of program creation: a text editor that simplifies software entry and revisions, an assembler with macro capability, and dynamic trace for software debugging.

Since microprocessor-based program creation and prototype design typically go hand in hand, the 8002 also offers three progressive option levels for program emulation and debugging, prototype emulation and debugging, and real-time prototype analysis.

The 8002 Program Emulation and Debugging System, which adds an emulator processor and software for a selected microprocessor, enables the developmental software to be run, tested, changed, traced, and debugged on the desired microprocessor. The

THE TEKTRONIX 8002 MICROPROCESSOR LAB

emulator microprocessor is identical to the microprocessor in the designer's prototype; if the software is to be executed on an 8080 in the prototype, for example, an 8080 microprocessor chip is used in the emulator processor.

The 8002 Interactive Prototype Emulation and Debugging System adds a Prototype Control Probe for a selected microprocessor. With the probe inserted into the prototype, developmental software and hardware may be tested, traced, and debugged together.

The 8002 Real-Time Prototype Analyzer System adds real-time trace and an 8-channel Analyzer Probe. At this level bus transactions and events external to the microprocessor may both be monitored.

One final advantage: the Tektronix name. Tektronix has always been responsive to the instrumentation needs of the design engineer . . . and the 8002 Microprocessor Lab is no exception. Its ability to deal with a number of different microprocessors, its many convenience features for software development, and its capabilities for software/hardware debugging, make it a unique design tool.

As a leading electronics instrument company, Tektronix offers you a full line of options and peripherals, from the three 8002 option levels . . . to PROM programming facilities for the 1702 or the 2704/2708 MOS PROMs . . . to a line printer and choice of system terminals.

Backed by years of experience, Tektronix also offers you a rare commodity in the field of microprocessor development tools: local Field Engineers and local service. A nation-wide network of Field Offices and Service Centers is ready to help you realize the full benefits of the 8002.

For more information or a demonstration of this new software development tool, write Tektronix, Inc., P.O. Box 500, Beaverton, Oregon 97077.

For availability outside the U.S., please contact the nearest Tektronix Field Office, Distributor, or Representative.

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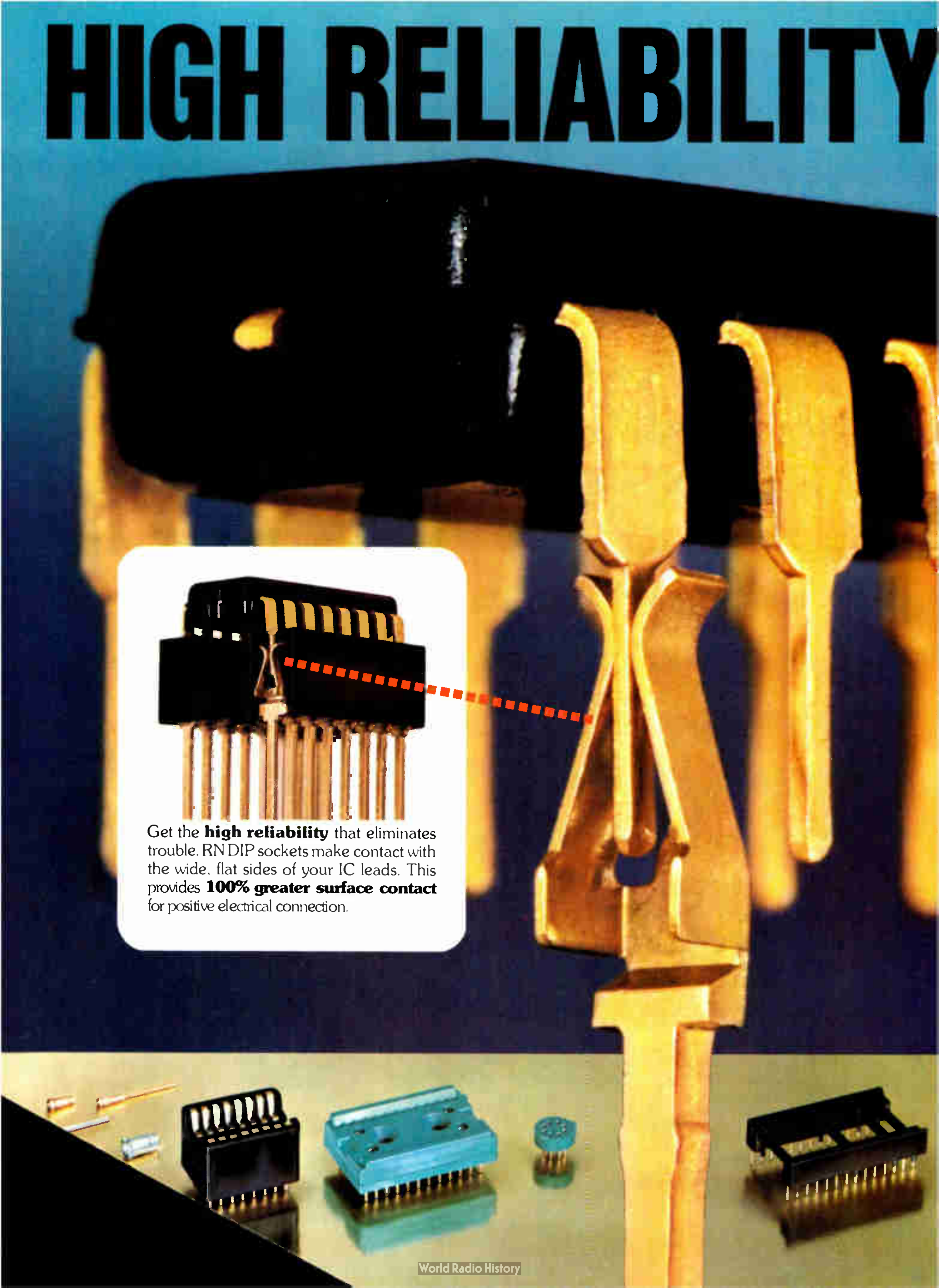
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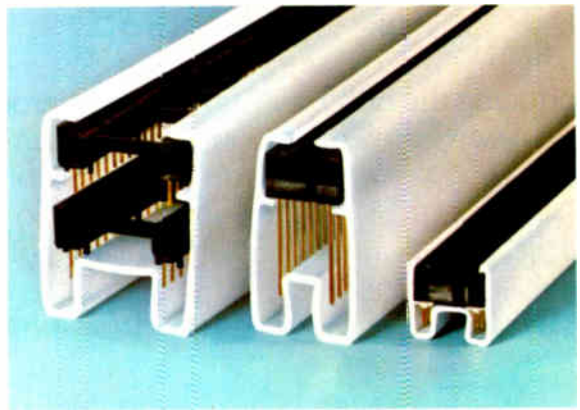

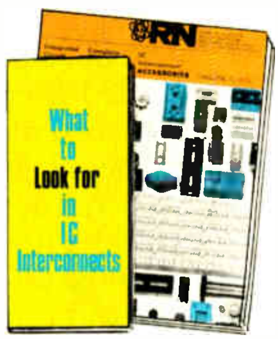

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IMP-16 helps small planes fly a straight course

by Steve Tsolis,
Advanced Electronics Development, Old Saybrook, Conn.

☐ By enabling business aircraft to fly directly to a distant destination, a microprocessor-based radio navigation system can cut up to 22% off their operating costs. At present, their pilots zigzag across country from one station in the very-high-frequency omnirange navigation network to the next, for lack of equipment powerful enough to compute a direct route in real time yet small enough to fit in their general-aviation airplanes.

The microprocessor used in the new R-Nav system is an IMP-16. Mainly because of it, the equipment costs less than \$10,000. The digital equipment built for commercial airliners costs \$48,000 and performs about the same, for all its bulk. Even conventional analog systems are \$12,000 to \$15,000 and also, of course, are much less precise.

To operate the IMP-16 system, the pilot taps out the end point of the flight on the keyboard, along with the bearings and frequencies of as many as 180 VOR stations along the route (see "The VOR network," p. 150). He may also enter other routing details, such as altitude required at a given point. In flight, the VOR receiver and distance-measuring equipment (DME) supply actual data for comparison with the planned flight path, and other inputs come from the rest of the aircraft's analog instrumentation. Using this data, the IMP-16 performs in real time all the calculations necessary for manual or automatic flight control—in particular the triangulation of the VOR distance and bearing data that makes it possible for the pilot to fly straight to his destination. The output data is shown and continuously updated on the airplane's various cockpit displays.

To derive complete flight control information in real time, with a high degree of accuracy, with minimal hardware, from such a variety of inputs, demands a powerful microprocessor. The National IMP-16/100 appeared suitable because of its 16-bit word size and its programming flexibility.

Advantages of the IMP-16

Included in the six-chip bit-slice processor are not one but two control read-only memory chips. The first contains a basic 43-word instruction set, supplemented by a 17-word extended instruction set on the second. This extended set includes such instructions as multiply, divide, double-precision add, and double-precision subtract, which are essential to much of the data manipulation needed for navigational computation.

To speed triangulation calculations, which form the basis of navigation, the IMP-16 uses trigonometric algorithms found in most pocket calculators. These functions are stored not in its control ROM but in the system's programmable read-only memory.

Also helping the IMP-16 to process data quickly is the fact that it has separate buses for input data, output data, and addresses, as well as 16 general-purpose flag

1. Cockpit console. Flight data is entered manually on the electroluminiscent keyboard, which consists of a Mylar layer sandwiched between a conductive polymer and copper contact grid. A seven-segment gas discharge panel displays the navigational data, updating it continuously.

outputs, two interrupts, and four jump-condition inputs. Some microprocessors can be multiplexed by using software subroutines to handle data inputs one at a time, but that would not provide the real-time inputs needed for high-speed jet aircraft.

An R-Nav system must combine high accuracy with speed. For example, directional information must be accurate to tenths of a degree, making 3,600 separate inputs necessary for data covering all 360°. This takes 2×10^{12} bits of information, and to input and process that much data quickly requires a 16-bit word. An 8-bit microprocessor could handle the larger word size, but it would take longer to process the data in that form. Moreover, the 16-bit word allows computation with a resolution of well over four significant digits without using the double-precision mathematics that an 8-bit microprocessor would require.

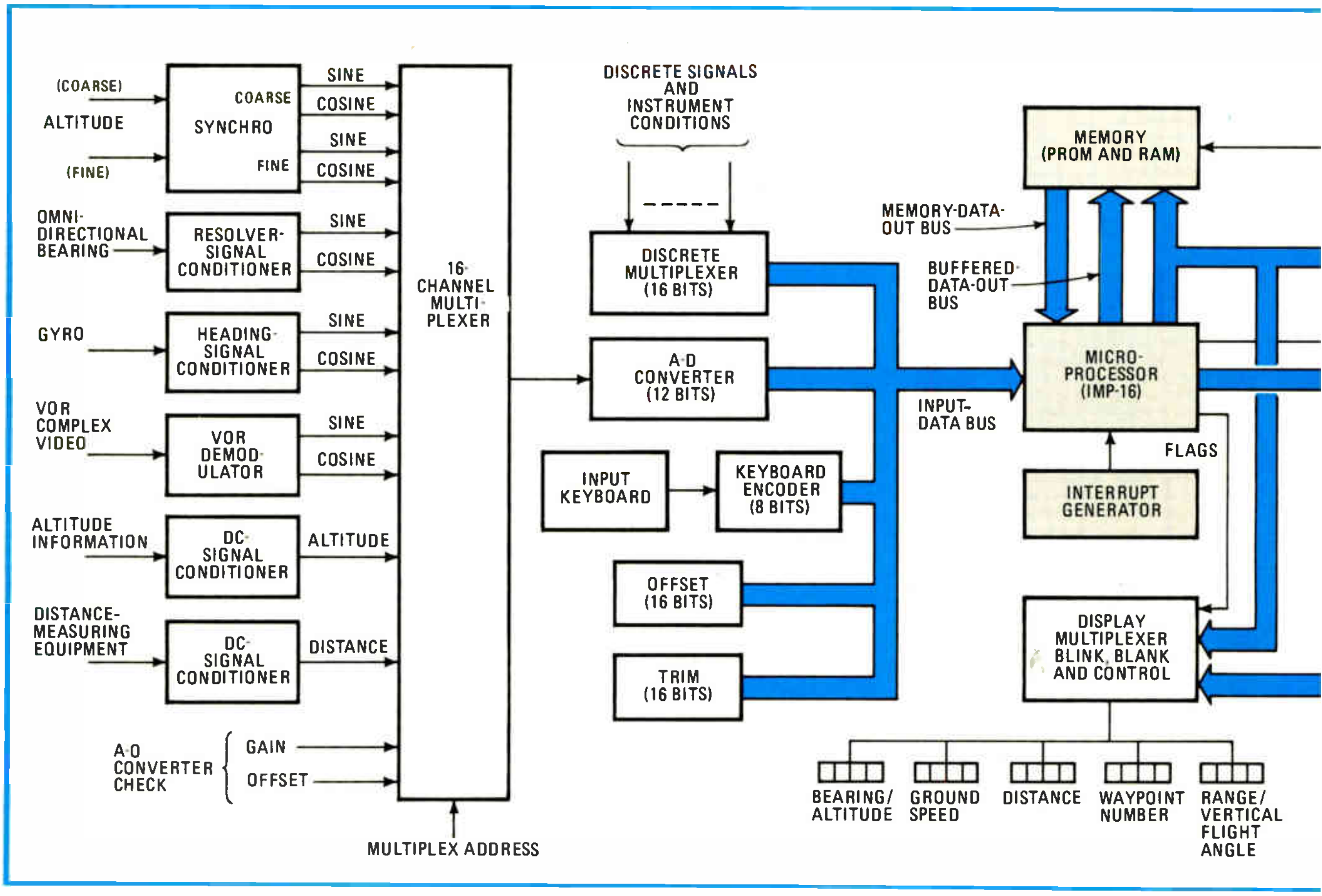
Between them, the IMP-16's 16-bit word length and powerful instruction set also reduce the overall amount of system memory needed—only 4,096 16-bit words of programmable read-only memory and 256 16-bit words of random-access memory are used. But as that alone did not shrink the hardware enough for the system to fit into the space allowed, several other space-saving features measures were adopted.

2. Space saver. In an analog system, synchro data must be resolved to a signal proportional to flight angle. But the microprocessor-based system calculates this angle from dc voltages representing sine and cosine information and needs less signal-processing circuitry.

The use of firmware

For instance, many of the functions that would normally require separate circuit modules were implemented in firmware to reduce the amount of interface circuitry. Also, an address-decoding and input/output-control circuit allows single-line control of many input and output devices. Finally, other peripheral devices are controlled with decoded addresses combined with one of the IMP-16's user-available flags, the result being that less PROM is needed. In other words, each bit of the 16-bit word can represent a peripheral decode instruction, so that the microprocessor can be wired directly to the peripheral, rather than requiring room in memory for decoding and encoding for peripheral addressing.

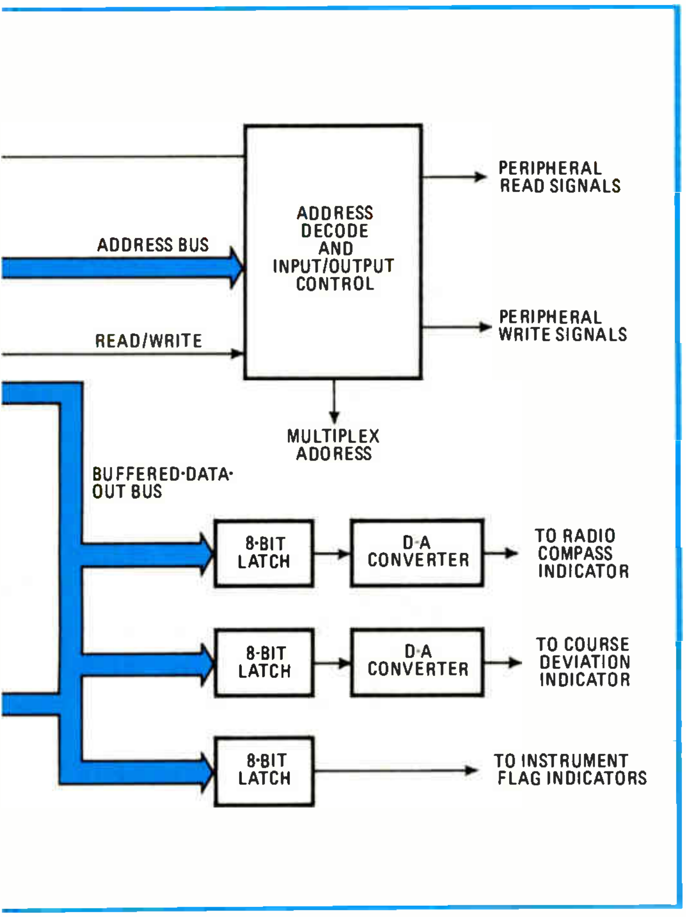
The R-Nav system comprises a navigational computation unit and a control display unit (Fig. 1). A block diagram of the complete system is shown in Fig. 2.



One of the computation unit's jobs is to condition the signal inputs, such as those representing coarse and fine altitude and omnidirectional bearing as well as VOR and DME information. Once conditioned, these analog signals are multiplexed and converted into digital format by a 12-bit analog-to-digital converter. This digital information, along with additional data from the keyboard, other signal inputs, and flags signaling instrument conditions, passes over the input-data bus to the IMP-16.

Two other buses link the microprocessor with memory, decode and control circuitry, and displays. The address bus connects the IMP-16 to the programmable read-only and the random-access memories, the address decode and input/output control circuitry, and the control display unit. The buffered-data-output bus links it with the 8-bit latches to provide data for the radio compass indicator, course-deviation indicator, and instrument flag indicators. That bus also carries data to the control display unit, where it is multiplexed to the various digital visual displays to provide information on bearing and altitude, range and flight angle, way point number, distance, and ground speed.

Since the R-Nav system must interconnect with existing aircraft instruments having slightly different



input/output signal requirements, it appears at first that a particularly large amount of I/O interface circuitry is needed. For example, to maintain altitude or provide controlled ascent or descent, the system must interface with a potentiometer or a two-speed signal from a synchro or a central air data computer, depending on the aircraft configuration. To satisfy all the possible interface conditions, normally accomplished in hardware, would have required many components. With microprocessor control, however, much hardware is replaced with firmware routines, which minimize the amount and complexity of the signal-conditioning circuitry needed. This approach not only keeps size to a minimum, but replaces recurrent manufacturing costs with a single, nonrecurring software development charge.

Simple signal conditioning

All input-signal-conditioning circuits are available in every R-Nav system even if they are not used. However, it only takes eight dual-operational amplifiers to provide complete conditioning. Variations in the connector-pin terminations and cables adapt the system to a specific aircraft equipment configuration. With this concept the R-Nav can accommodate all the different input/output requirements of the numerous aircraft instruments used in general aviation today.

Once the analog signals are conditioned to levels suitable for a microprocessor-based system, they are digitized at a 10-millisecond rate controlled by the interrupt generator and real-time clock. This makes the timing independent of program size and allows each input to be scanned eight times—a good compromise between stability and cost. Since most of the processor's time is used for computation, program control, and output driving, that scanning rate is fast enough to make the system stable enough for smooth autopilot operation.

During each 10-ms interrupt, several events occur. The analog-to-digital converter is read and then reset for the next conversion (better accuracy results when each conversion is made at a precise interval, because this eliminates any jitter that would be present if just software-controlled timing were used). Each interrupt is also used to increment a counter for accumulating time, which is essential in calculating ground speed and other navigational relationships. Also, the flight data entered by the pilot via a keyboard and stored in memory in the keyboard encoder chip is scanned and the resultant data multiplexed onto the input data bus for processing by the microprocessor during the 10-ms interrupts.

Note that the microprocessor-based system also lends itself to self-checking. This is done by multiplexing the analog ground and the reference voltage for the analog-to-digital converter. (Before being fed through the converter, this voltage is attenuated by approximately 90%.) With these two inputs, which represent the gain and offset of the a-d converter, the microprocessor can

The VOR navigation network

By broadcasting bearing information to aircraft, the very-high-frequency omnirange navigation network creates airways that must be used under instrument flight conditions and are usually used for cross-country navigation whenever a plane's on-board equipment cannot handle direct-flight computations in real time. The network consists of a series of transmitters operating in the 108.2-to-117.9-megahertz band and emitting nondirectional reference modulation as well as bearing information—a signal that varies in phase against a fixed reference through a 360° rotation in the horizontal plane. The VOR receiver in the aircraft picks up these signals and displays the relative bearings of the receiver and transmitter as well as nonambiguous indication of direction.

Most VOR stations are also equipped with Tacan equipment to provide distance information. Such stations are called Vortac. When an aircraft interrogates a Vortac station, the resultant distance information is displayed by its on-board distance-measuring equipment.

check the converter's calibration and to some extent compensate for parameter changes. If either the gain or offset of the a-d converter exceeds an established limit, an internal error signal is generated, and warning flags are set to alert the pilot to the existence of uncompensated errors.

Into the mill

The data is now ready for processing by the microprocessor. By this time, for example, input from synchro systems like the altimeter and compass system has been converted to dc voltages that represent the sine and cosines of the synchro angle and has then been digitized. The microprocessor takes both these values and uses software routines to calculate the arc tangent of the flight angle. This method, besides saving on hardware, provides more accurate and reliable results over an extended temperature range than could be obtained from an all-analog system.

In the same way, the microprocessor takes the conditioned VOR and DME inputs and from them calculates the distance and bearing between aircraft and way point (the point where the flight path intersects the VOR radial at 90°), time to way point, and distance and time to destination. Since it also computes ground speed accurately, regardless of the aircraft's heading, the pilot can fly around busy way points or bad weather and still receive valid ground speed information. The time and destination to way point are appropriately modified by the IMP-16 under these conditions.

The microprocessor determines the relative bearing between the aircraft heading and the VOR station being received, calculating deviation from desired flight path as well as VOR bearing.

Vertical flight paths are automatically determined by comparing the manually or automatically entered altitude at each way point with the aircraft altimeter input. The microprocessor calculates relative position and provides information to display whether the aircraft is below or above the prescribed altitude.

To conserve aircraft panel space, most system outputs drive existing aircraft instruments such as the flight director and the horizontal situation indicator. Computed data from the microprocessor is placed on the buffered-data-out bus to drive the 8-bit latches and then converted to analog format by digital-to-analog converters before being displayed on the appropriate aircraft instruments. Associated with these instruments are visual-instrument-flag indicators also controlled by the IMP-16. It receives information about the status of each instrument via the discrete multiplexer and actuates an 8-bit latch to indicate malfunction or lack of complete information.

Output data for the control display unit, however, stays digital. For instance, all way point data is stored in RAM located in the navigation computation unit and upon pilot command is transferred onto the output bus to latches in the display unit. These latches drive decoders for the seven-segment gas-discharge display elements and also, under microprocessor control, dim, blink, and blank them.

The display unit also has a self-check routine. When activated by a push button, it checks all associated equipment and flags. Should it detect a fault, the distance display shows all number eights.

Trading off hardware for firmware results in a very compact unit. The display portion, located in the aircraft panel, measures 4.5 inches high by 5.75 in. wide by 7.5 in. deep. The navigation computation unit, containing all analog interfaces, power supplies and the like, is located in the body of the plane, remote from the cockpit. It fits into an electronics rack measuring 7.5 in. high by 4.75 in. wide by 12.5 in. deep.

System flexibility

The IMP-16 R-Nav system is contained on five circuit boards with three blank slots for future expansion. With software control the system is easily adaptable to handle any additional features. One of these slots, for instance, could be used for a plug-in, hand-held calculator to determine range to destination and the fuel required as well as other flight factors that normally would have to be looked up in the aircraft flight manual.

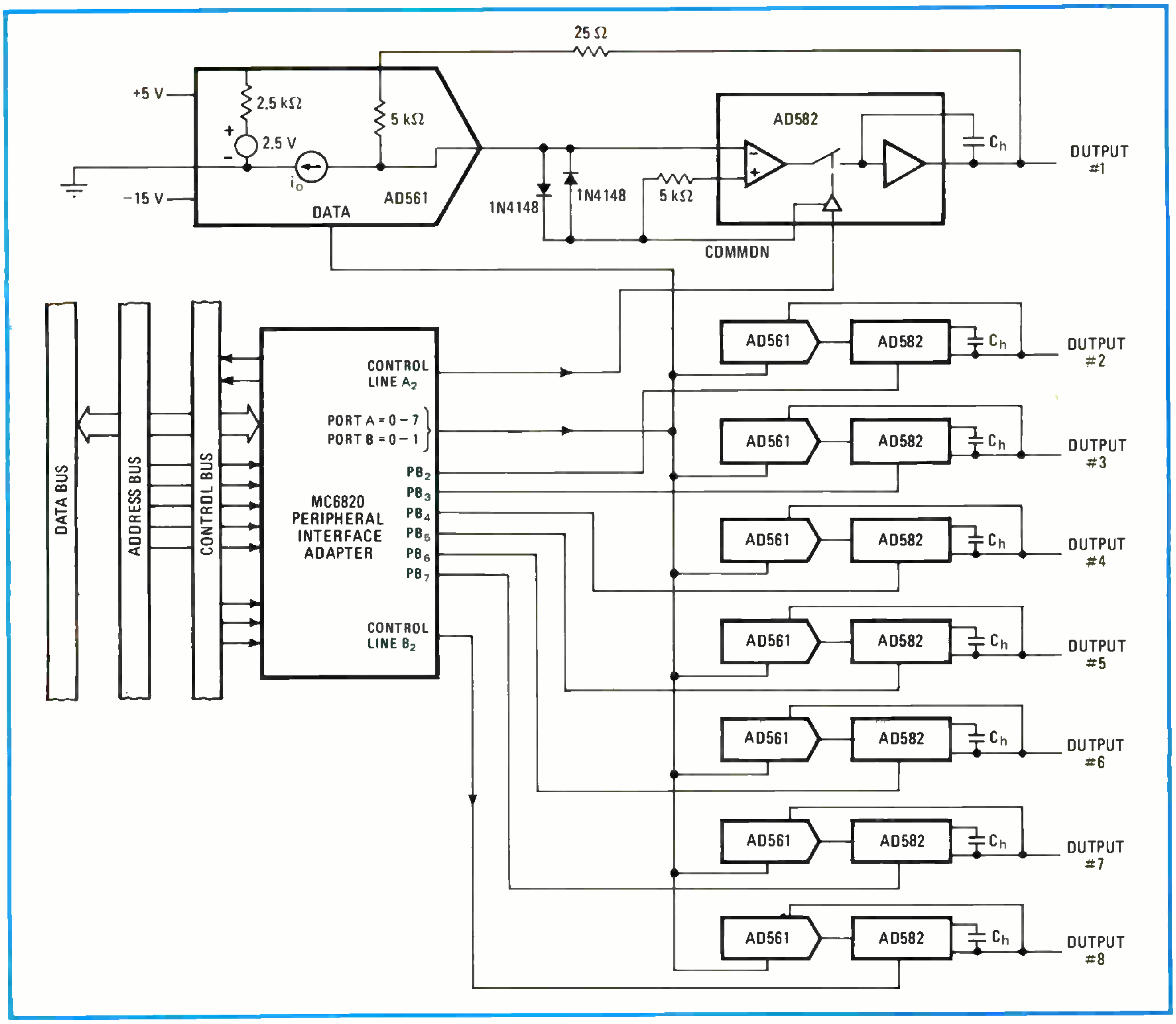
In the future, the system could include ground-proximity-warning capabilities and receive automatic flight-data programming from a remote location. Inertial platform, Loran C, Omega or other navigation inputs from satellites or ground stations could be interfaced easily by charging the software and adding a small amount of signal conditioning. □

Interface adapter multiplexes many d-a converters

by Paul Brokaw
Analog Devices, Wilmington, Mass.

Several digital-to-analog converters in a 6800-based data-acquisition system may be multiplexed with only one peripheral interface adapter if sample-and-hold amplifiers are placed at the output of each converter to select one of them. This eliminates latches and control circuits usually needed at the input of each converter to maintain the input data while the microprocessor is otherwise occupied. Chip count and cost are reduced because the same input data is processed by each converter.

The system in the figure uses the MC6820 PIA with its dual 8-bit ports to drive eight AD561 10-bit d-to-a current-mode converters and eight AD582 sample-and-hold devices. The AD582s function as operational amplifiers in the sample mode, permitting calibration of the converters when the sample-and-hold output is observed. Eight bits from the PIA's port A output are combined with 2 bits from the port B output to supply all 10 bits of



Sample-and-hold multiplexing. Output from the PIA supplies each AD561 with identical data; the AD582 gets the decoded channel number. Clamp diodes ensure that the converter output is zero when the AD582 is in the hold mode, preventing converter currents from degrading the circuit's operation. C_h should range from 100 pF to 0.015 μF, depending upon refresh interval.

data for each converter. The remaining six lines from port B and two additional control lines select the sample-and-hold units. By appropriate instructions from the microprocessor, the sample-and-hold devices pass the analog output of each converter in turn without requiring any additional gating logic.

Pretrimming each converter with an external 25-ohm resistor gives nominal accuracy, while more precise calibration is possible with a 50-Ω potentiometer. Each converter may be calibrated by generating a 10-volt dc signal from each 561, then adjusting the appropriate potentiometer for a 10-volt output at each 582. The error in calibration will be less than 1 least significant bit.

The AD582s, which are dynamically controlled charge-storage devices, must be refreshed periodically to restore lost charge on holding capacitors C_h. If the microprocessor is used in synchronous systems where the input data to the converter will not change during a sample period, one AD582 can be held in the sample mode until the program switches to the next converter. This permits a relatively long acquisition time, which allows for a long refresh period and larger hold capacitors. For example, a 0.01-microfarad capacitor will ensure a drift of less than ½ LSB when the refresh interval is 1 second. Most programs with polling routines will update the output more frequently than once per second, of course. □

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.

Calculator notes

SR-52 program simplifies universal number conversion

by John Bryant
Indianapolis, Ind.

If those persons sweating to manipulate numbers from one exotic base system to another will look up from their labors, they will find cause to rejoice. This program can easily convert a positive number in any system to any other system, from base 2 to 99. The 219-instruction program is a heavily modified version of the less versatile one found in the applications library for the SR-56.

The user has the option of converting numbers containing integers and fractions directly from base p to base q, or (for faster calculations when working directly with decimal quantities) from base 10 to base q, or base p to base 10. As shown in the simplified flow chart, once the option is determined, the number is entered into the display and pressing keys A, B, or C initiates the conversion to the desired base.

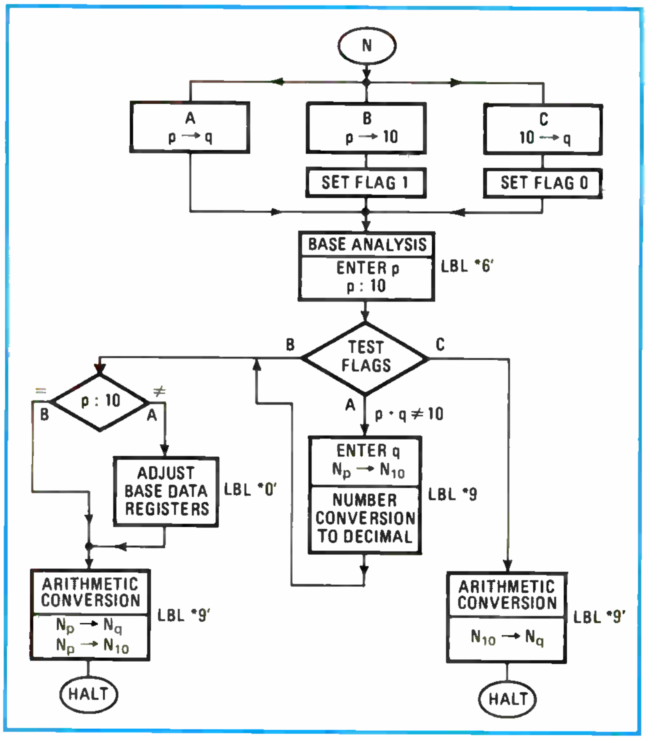
In each case, the program determines the p or q relationship to the decimal (base 10) system by executing its base-analysis routine. This routine is needed to express an integer using two decimal digits if p is greater than 10. For instance, numbers in base systems greater than 10 may be expressed in terms of letters. The letters must be converted to two digits using the numbers 0-9.

After the relationship is known, the system flags that enable the program to run the proper subroutine are tested, and number conversion to a decimal equivalent proceeds. If either the original or desired base is 10, a decimal-number conversion will be done once after the program transfers through paths B or C to the arithmetic-conversion subroutine. Otherwise, path A is followed with the user supplying the value of q to the program so that both bases are known before actual conversion begins. Conversions will be performed twice, p to decimal, then decimal to q.

If p and q are not equal to 10, it is necessary to adjust the base locations prior to the second conversion, so that the same conversion routine can be used to process a decimal number to a nondecimal base using decimal arithmetic. The arithmetic-conversion routine will approximate the input number to the new base through a series of iterations designed to eliminate rounding-off errors when working with integers and to approximate the fractional value within the limits of the calculator readout. Careful examination of the program will provide details of the operation.

When dealing with bases greater than 10, alphanumeric characters frequently represent the given or desired number. The calculator cannot display these characters because it is designed to work in the decimal system. However, it can represent the number with its available digits 0–9 in pairs.

For instance, when converting 26 in base 10 to base 14, the answer should be 1C. The calculator's output will be 1 12, however. Similarly, converting 38 from base 10



to base 14 yields 2A; the calculator's output is 2 10. Conversely, it is necessary to key in 1 12 for the base 14 number when desiring the base-10 equivalent of 26.

It cannot be emphasized too strongly that in any base system greater than 10, the alphanumeric characters must be expressed in digit pairs when any given column contains a number equal to or greater than 10. Then A = 10, B = 11, C = 12, etc. For example, the number 468 in base 10 equals 1 13 04 in base 16, or 1D4. With practice, this situation will become well understood. □

SR-52 UNIVERSAL-BASE NUMBER CONVERSION PROGRAM

LOCATION	CODES	KEYS	COMMENTS
000 – 003	46 12 50 01	'LBL B 'st flg 1	executive control flags
004 – 007	46 13 50 00	'LBL C 'st flg 0	
008 – 012	46 11 42 00 03	'LBL A STO 03	
013 – 016	01 00 75 81	10 – HLT	executive control and routing
017 – 020	51 79 60 01	SBR '6' 'if flg 1	
021 – 025	27 60 00 69 81	'INV' 'if flg 0 '9' HLT	
026 – 030	42 00 06 51 97	STO 06 SBR '0'	
031 – 035	51 69 42 00 03	SBR '9' STO 03	
036 – 041	01 00 75 43 00 06	10 – RCL 06	nondecimal conversion
042 – 045	51 79 41 69	SBR '6' GTO '9'	
046 – 049	46 27 51 97	'LBL 'INV' SBR '0'	
050 – 055	46 69 25 42 00 00	'LBL '9' CLR STO 00	
056 – 058	42 00 05	STO 05	
059 – 063	46 87 43 00 02	'LBL '1' RCL 02	
064 – 067	22 49 00 03	INV PROD 03	
068 – 072	43 00 03 75 01	RCL 03 – 1	build new N
073 – 076	44 00 00 95	SUM 00 =	
077 – 078	80 87	'if pos '1'	
079 – 083	46 88 43 00 02	'LBL '2' RCL 02	
084 – 089	49 00 03 43 00 03	'PROD 03 RCL 03	
090 – 093	52 22 52 75	EE INV EE –	clear display-register guard digits
094 – 100	46 68 53 42 75 01 54	'LBL '8' (STO – 1)	separate integer
101 – 105	80 68 75 01 95	'if pos '8' – 1 =	
106 – 109	22 44 00 03	INV SUM 03	fraction with guard digits in R_{03}
110 – 113	48 00 05 65	'EXC 05 X	
114 – 117	43 00 01 95	RCL 01 =	integer in R_{05}
118 – 121	44 00 05 01	SUM 05 1	
122 – 125	22 44 00 00	INV SUM 00	decrement R_{00}
126 – 131	43 00 05 75 01 02	RCL 05 – 12	
132 – 136	22 28 95 80 89	INV 'log = 'if pos '3'	
137 – 142	43 00 03 22 90 88	RCL 03 INV 'if zro '2'	
143 – 147	46 89 43 00 01	'LBL '3' RCL 01	
148 – 151	20 42 00 04	'1/x STO 04	
152 – 156	43 00 00 90 77	RCL 00 'if zro '4'	
157 – 162	94 80 78 43 00 01	+/– 'if pos '5' RCL 01	convert fractional portion of number
163 – 165	42 00 04	STO 04	
166 – 170	46 78 43 00 04	'LBL '5' RCL 04	
171 – 175	49 00 05 58 78	'PROD 05 'dsz 5'	
176 – 180	46 77 22 50 00	LBL '4' INV 'st flg 0	reset executive flags
181 – 187	22 50 01 43 00 05 56	INV 'st flg 1 RCL 05 'rtn	
188 – 192	46 97 43 00 01	'LBL '0' RCL 01	set up for decimal arithmetic
193 – 199	48 00 02 42 00 01 56	'EXC 02 STO 01 'rtn	
200 – 205	46 79 42 00 02 95	'LBL '6' STO 02 =	
206 – 210	80 67 01 00 65	'if pos '7' 10 X	digit separation constant
211 – 215	46 67 01 00 95	'LBL '7' 10 =	
216 – 219	42 00 01 56	STO 01 'rtn	

INSTRUCTIONS

- Key in program
- For conversion from base p to base q:
  Enter desired number (N). Press A. Display reads 10.
  Enter base of N (p), press RUN. Display reads 10 or 100.
  Enter desired base (q), press RUN.
- For conversion from base p to base 10:
  Enter desired number (N). Press B. Display reads 10.
  Enter base of N (p), press RUN.
- For conversion from base 10 to base q:
  Enter desired number (N). Press C. Display reads 10.
  Enter desired base (q), press RUN.

REGISTERS	
R_{00}	in use
R_{01}	base C
R_{02}	p
R_{03}	N
R_{04}	in use
R_{05}	N'
R_{06}	q

Engineer's newsletter

Lamp shakes in its socket yet shines steadily

When an incandescent indicator lamp must withstand vibration, many engineers prefer the more rugged subminiature 5-volt lamps to the common 28-v lamps, but often run into a problem with the solder spot contact on the bottom of the lamp. According to James Amis, chief engineer at Korry Manufacturing Co., Seattle, Wash., the lamp starts flickering after a few minutes of vibration and continues to do so even after the vibration stops. Cleaning the solder spot stops the flickering—but only until the vibration starts up again. Amis says the problem is "fretting corrosion." The relative motion of the two contacts constantly breaks old contact areas and establishes new ones, but as the old contact areas quickly oxidize and the motion is not sufficient to clear away the oxides, **eventually the whole surface becomes oxidized and the light goes out.** Oil at the interface will prevent exposure to air, but Amis says an even better solution is to use a special lamp with a nickel-plated brass disk instead of a solder spot, such as the CM 328-297 from Chicago Miniature Lamp Co.

The 555 gives you fingertip switching

If you need an inexpensive and reliable touch-controlled switch, try building one with the 555 integrated-circuit timer, suggests Howard Berlin, a technical consultant in Wilmington, Del. The basic switch is obtained by wiring the 555 in its standard one-shot mode, with the reset line (pin 4) tied to the supply, and then connecting a touchplate to the trigger input (pin 2). **This plate may be of copper or aluminum, and touching it momentarily with a finger** causes the timer's output to go high for a period of 1.1 times the RC time constant. If you hold your finger on the plate, the output will stay high. Usually a time constant of 1 second or so is enough. For latching operation, you remove the timing resistor altogether and connect a normally open push-button switch between the timer's reset pin and ground. Now by touching the plate you will latch the timer on indefinitely—until you push the reset button.

Or—to make a touch-controlled on/off switch, you just add a 7473-type J-K flip-flop at the output of the basic switch circuit. Wire the circuit's output to the flip-flop's clock input, tie both the J and K inputs to a 5-v supply line, and run the Q output to the load. Now, touching the plate once turns the load on, and touching it again turns it off. If you add a solid-state relay, **you can control household appliances.**

Read how to test sample-and-holds . . .

Here's a useful brochure that recently crossed our desk: **"Specifying and Testing Sample-Hold Amplifiers,"** from Teledyne Philbrick, Allied Drive at Route 128, Dedham, Mass. 02026. It's only five pages long, but it packs in a lot of information, including a glossary and extended discussions of parameter temperature coefficients and testing. (Although terminology tends to differ among manufacturers, at least you'll know Teledyne's.) Ask for Application Bulletin AN-30.

. . . and measure microwave gear

Hewlett-Packard, too, has another useful catalog and handbook available. This one's on microwave equipment, and it contains **a 20-page handbook section summarizing measurements of attenuation, impedance, power, frequency, and noise figure.** Write to the Inquiries Manager at HP, 1501 Page Mill Rd., Palo Alto, Calif. 94304.

Stephen E. Scrupski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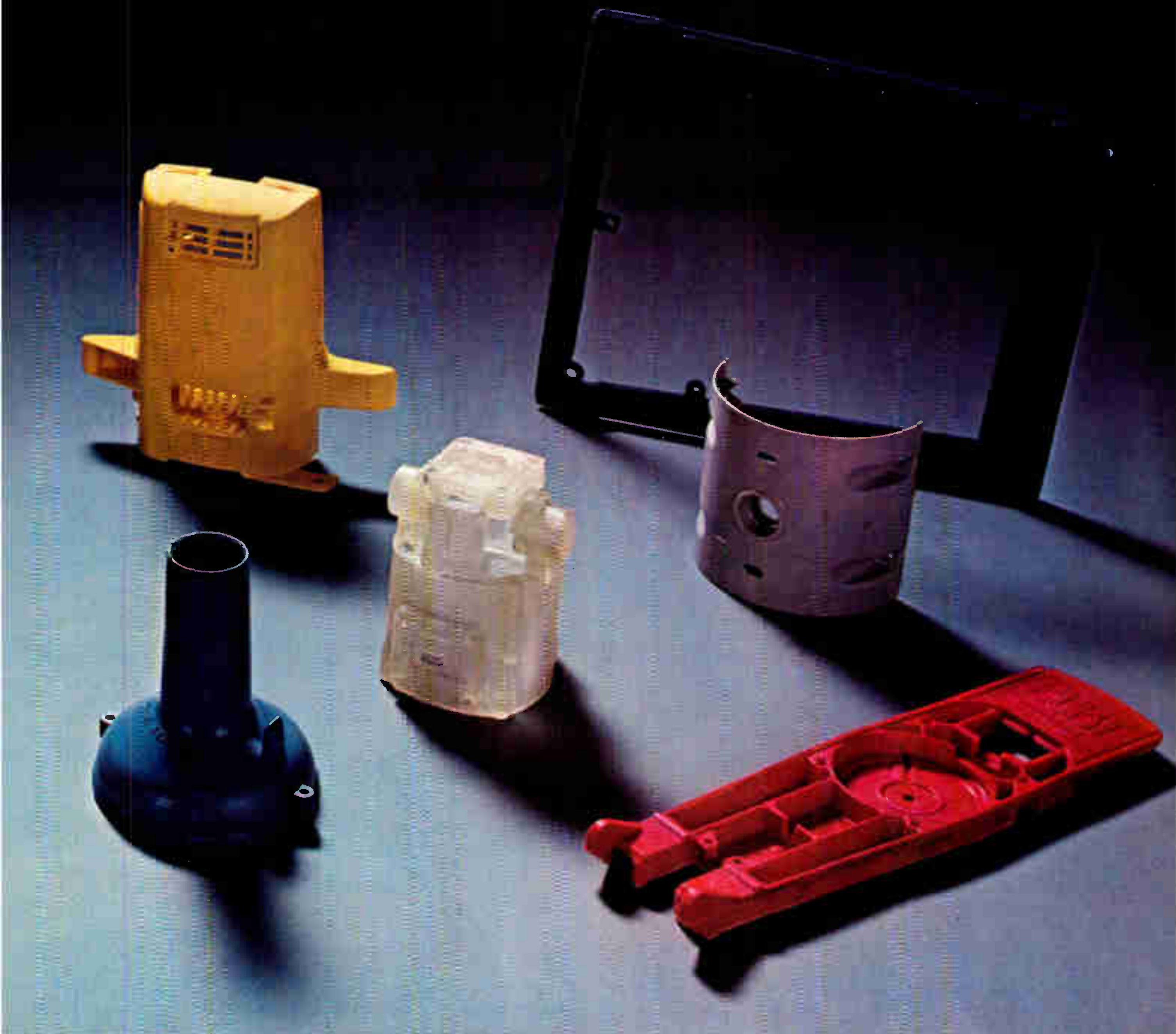

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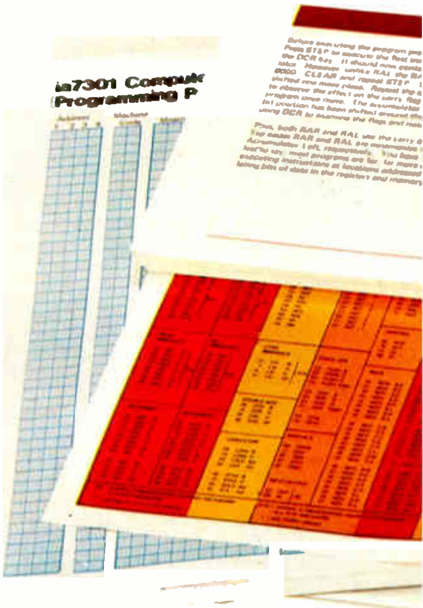

The Complete Microcomputer, $495.

There is no faster way to learn programming 8080A based systems than the ia7301 Computer-in-a-Book.™ In one, rugged binder you get a fully operational microcomputer and a comprehensive programming course that work together to make you an expert microcomputer programmer. Almost anyone with an engineering background can follow the "learn-by-doing" text, application by application. Programming exercises include programming switching, timing and counting functions, writing programmable controllers, setting up data search and file maintenance routines, and multibyte arithmetic programs. Then, you'll expand and apply your newly acquired knowledge by programming a digital clock, computerize your checkbook, and write a few games of skill like PONG™ and Mastermind.™

The ia7301 computer system comes to you entirely assembled and tested. All you need is a dual voltage power supply (+5V, +12V). As an option, Iasis offers a compact supply that fits in a briefcase.

The ia7301 microcomputer features 1K RAM, 1K PROM (containing the monitor program), sockets for an additional 1K PROM, 2 I/O ports, a neat cassette tape interface, a set of eight 7-segment LED digital displays and a handy 24 pad keyboard. Which is to say, the Computer-in-a-Book has the best combination of features and capability at a very affordable price.

And since this system has a special monitor program which allows you to look into all operating parts of the microcomputer, you'll never get bogged down in loading or debugging programs. The monitor can be used anytime through versatile mode keys to display and change data and instructions in memory or in all the 8080A registers. Likewise, programs can either be executed or stepped through, instruction by instruction, so that you can learn your way around the inner workings of the system. Complete is the best word for the Computer-in-a-Book.

The Computer-in-a-Book will also support a large, expensive microcomputer development system. The portable binder containing the ia7301 computer, programming pad and Hex conversion card offers a powerful tool to write and pretest program segments which can then be assembled in the development system. This is very efficient since it allows many engineers to program and debug in rapid succession.

Then, as your company brings microcomputer based products to market, the Computer-in-a-Book becomes an excellent training system and trouble-shooting tool for field service technicians. The on-board cassette interface can play a major role in helping management communicate program changes and new test procedures to field personnel for hardly the cost of commercial cassette tapes.

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The ia7600 Series Expansion Cube.

As you might expect, Iasis has combined a powerful hardware simulator and development system into one low cost package. The 7600 Series Expansion Cube has 12K RAM (expandable in 8K and 16K increments), 8K EROM, a CRT and keyboard interface, and much more.

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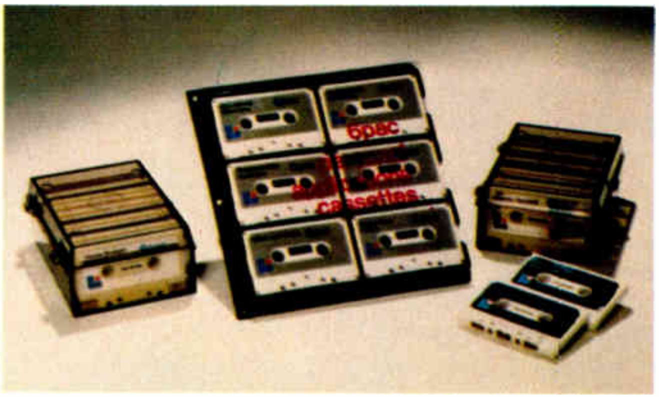
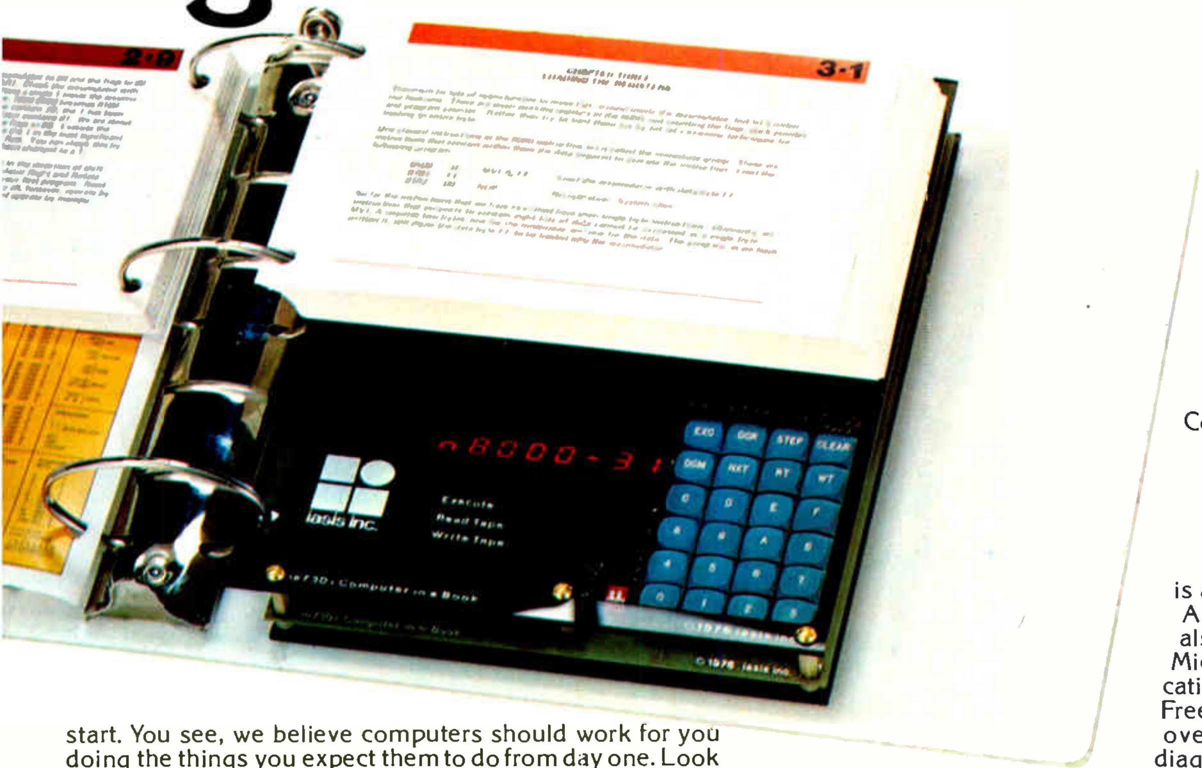


in-a-Book and a to go.



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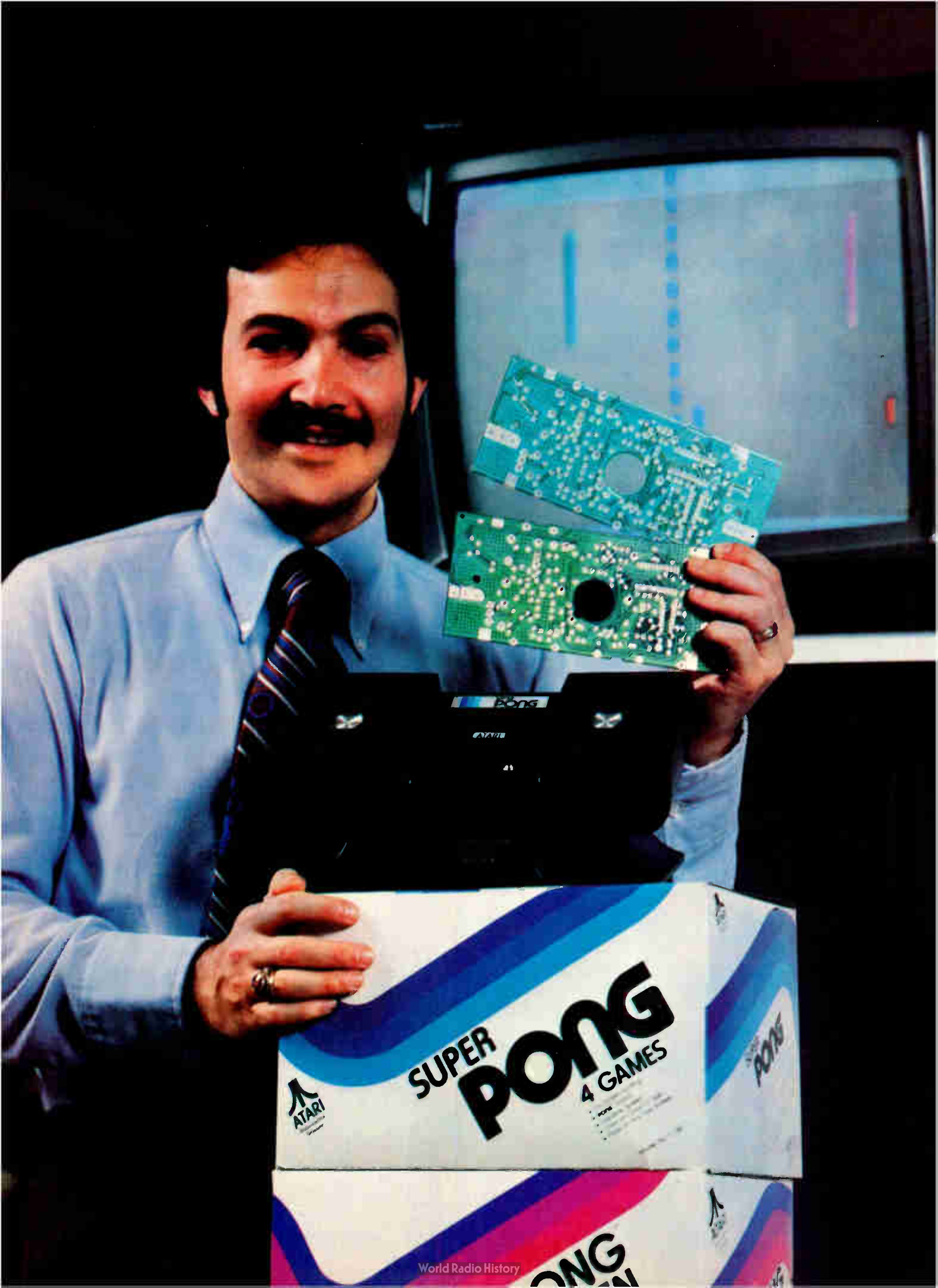
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Architecture and data bases are the hot topics at this year's NCC

Two fast-growing fields stressed at National Computer Conference

by Lawrence Curran, *Senior Editor*

☐ This year's National Computer Conference in Dallas, June 13–16, will be strong on the architecture and data-base management of computer systems that process all kinds of information. Since computer users are processing a wide variety of new information, as well as numerical data, today's computer is far more than a number cruncher, according to the conference program chairman, Robert Korfhage, professor of computer science at Southern Methodist University in Dallas. Moreover, microprocessor developments are increasingly influencing both the data-base setups and the architecture of such systems, he says.

Korfhage expects tomorrow's systems to be far more versatile than today's, and they will significantly enlarge the variety of information maintained in data bases. He envisions the day when pluggable, hand-held personal computers will have access to very large data bases and will tie into printers and other peripheral devices.

This year's conference confers legitimacy on the exploding field of personal computers [*Electronics*, March 31, p. 89] with a total of two days' worth of sessions, a personal-computing exposition, and a national congress of personal-computer clubs. The incorporation of this smaller show into the NCC is evidence, if any more were needed, of the pervasiveness of the microprocessor, which is the key building block in all of the personal-computer systems.

Conference officials say 317 exhibitors will cram their wares into 1,140 booths in the Dallas convention center. While this tops the 930 booths at last year's New York gathering, attendance probably will drop 5,000 to 10,000 from the 35,000 in 1976. A report on some of the products to be introduced begins on p. 171.

In addition to the regular program sessions, there will be seminars, covered by a separate registration fee, on topics ranging from distributed data-base systems through microprocessors and computer networks. Software design techniques will be covered in day-long courses conducted by authorities on the subject.

Because of the rapidly advancing microcomputer penetration into small systems, a session intended as a forecast of computer technology through 1985 has been focused down to assess the impact of microcomputers through 1980. Being organized by Charles Hornisher, a director of Iasis Inc., Sunnyvale, Calif., it will include an overview paper by Iasis president David Guzeman. He will examine the sociological impact of microcomputers as they mature rapidly from today's primarily commercial/industrial systems to true home computers used by owners who do not want to learn programming.

A forecast of the hardware such home machines will use will be offered by Donald Pezzolo, manager of product development at Cognition Inc., Mountain View, Calif. Pezzolo managed major development programs for automotive and consumer electronics at Fairchild Semiconductor. He will show that a variety of new data-gathering transducers will evolve by 1980. Bubble memories may be readily available to take on the entire storage task, he maintains. A software paper by Timothy Barry, a consultant from Mountain View, Calif., will elaborate on the overview's assumption that home-computer software will have to be greatly simplified and use a simple English language.

A multi-microprocessor system

A further illustration of the utility of today's microcomputer is its role in distributed and multiprocessing systems. A session will be offered that is dedicated entirely to a multi-microprocessor computer system developed at Carnegie-Mellon University in Pittsburgh. Samuel Fuller, associate professor of computer science and electrical engineering, will lead the session and is co-author of one of the three papers. His team is putting together a modular multiprocessor system called Cm*, which eventually could include as many as 100 microcomputers. The prototype system encompasses 10 Digital Equipment Corp. LSI-11 microcomputers.

Fuller says the system has been used to implement a simultaneous set of linear equations, a sorting problem, and an integer programming application. Initial performance results from these early applications will be presented at the conference.

The three papers cover the architecture and basic design of the system, its implementation in 1975/1976 technology with the LSI-11, and software systems. "I think the implementation paper will be of particular interest to other engineers who are attempting to integrate microcomputers into large computing systems," Fuller says. "The software paper is essential because it describes how useable the multi-microprocessor will be. It describes how we will manage the multiple central processors, allocate storage in main memory, and communicate between cooperating parallel processors."

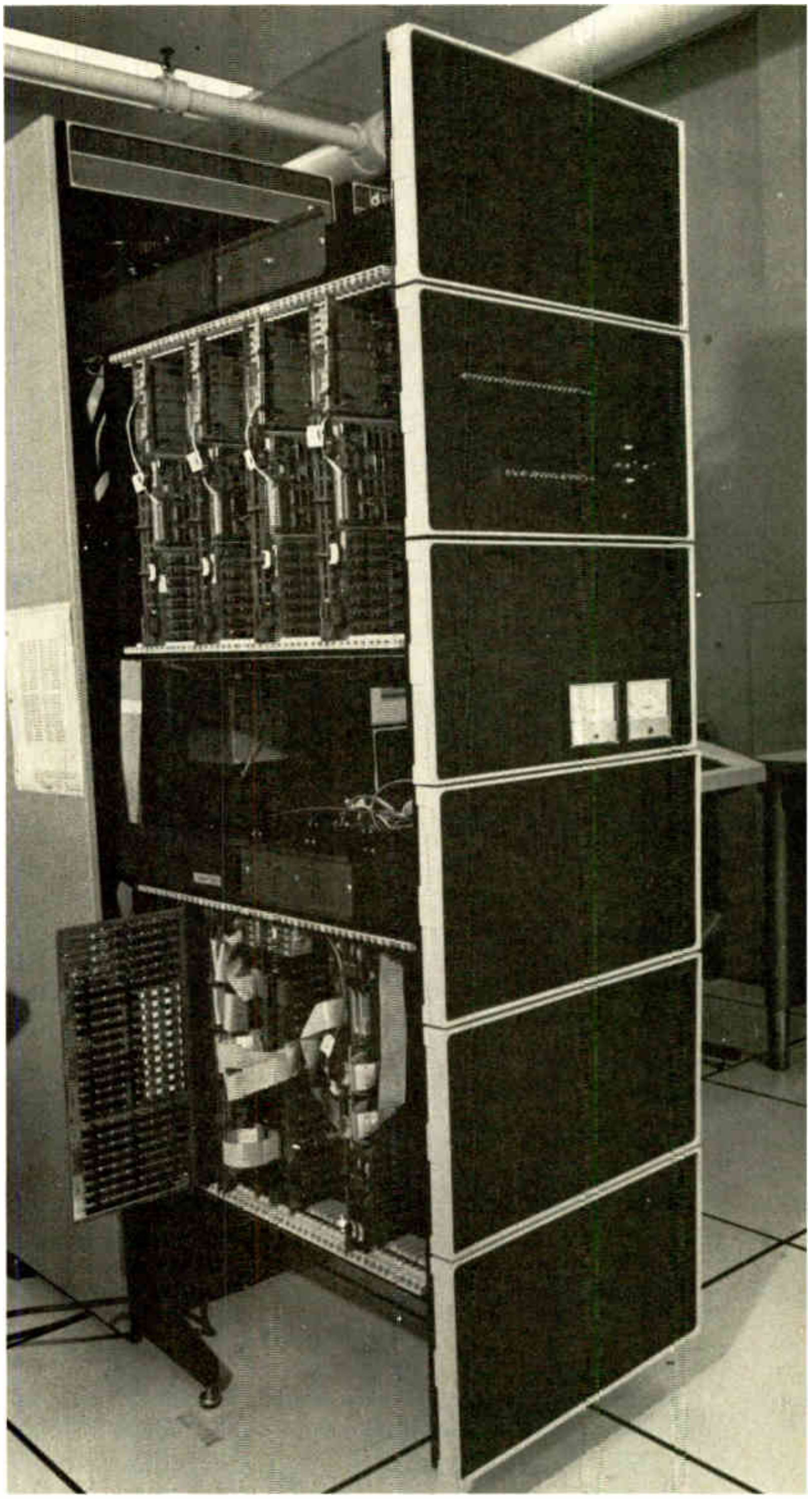
The Cm* project is funded by the Defense Department's Advanced Research Projects Agency, which pioneered the highly ambitious Arpanet linking dozens of dissimilar computers at sites called nodes throughout the U. S. Fuller does not think the Cm* concept will evolve into a smaller Arpanet, but he believes it could function as a node when fully implemented. He expects to build it into a system capable of speech recognition. Also, he wants to use it to implement an Algol 68 compiler/run-time system in order to show that multiprocessors using microcomputer technology can work with higher-level languages.

Architectural attitudes

A double session on microprocessor architecture runs the gamut from bit-slice, large-scale-integrated processor modules that have been put together in a multiprocessor configuration to a theoretical look at the use of light pipes—optical fibers—as interconnects between LSI circuits to help overcome the problem of pin limitations as circuits become extremely dense. The session chairman is Charles Vick, chief of the data-processing directorate in the Army's Ballistic Missile Defense Advanced Technology Center, which is located in Huntsville, Ala.

Mario Tokora, a member of the engineering facility at Keio University, Yokohama, Japan, will discuss the three-processor system he has implemented using the PM/II complementary-metal-oxide-semiconductor processor made by Matsushita Electric Industrial Ltd. The PM/II (for processor module in its second generation) is designed with multiprocessor-oriented architecture. Tokora's paper, given jointly with the Matsushita Research Institute, Tokyo, will validate multiprocessor design based on bit-slice building blocks. His aim is threefold: to provide maximum architecture flexibility with the smallest possible number of hardware modules; to construct a variety of computers of every size in which the total number of components is held to a minimum, and to demonstrate that the basic architecture need not vary, no matter what semiconductor processor is used.

His system consists of executor, sequence controller,



Multiprocessing. Sessions at NCC will assess new, increasingly complex uses of the microprocessor. This cluster of microcomputers is part of the Cm* multiprocessing system, developed at Carnegie-Mellon University, that will be covered in one such session.

and input/output controller. Word size ranges from 8 bits in the executor to 19 bits for some of the instructions. Tokoro claims a system performance slightly better than that of the bipolar bit-slice Intel 3000.

That same 3000 series is at the heart of a graphics-display controller to be discussed by Thomas Boardman, associate director of the computing center at the University of Colorado in Boulder. He contends that microprogrammed microprocessor-based architecture can replace huge quantities of random logic, substantially cutting the package count and circuit-board real estate from that needed if random logic were used.

Light-pipe interconnects

Another hardware paper looks at light pipes. That concept may be 5 to 10 years from widespread implementation, "but it's time to start thinking about it now because of the pin limitation inherent in ever-denser LSI devices," says G. Jack Lipovski, associate professor of electrical engineering and computer science at the University of Texas in Austin. A light beam traveling through fiber-optic cables can carry all the digital information between LSI devices. Lipovski's paper assumes the light pipes will eventually be cost-competitive with complex multilayer boards as an interconnect medium. He maintains that a carry/look-ahead circuit structure is general enough to accommodate "anything I've run into in interconnecting LSI devices."

He contends that the carry/look-ahead structure can be used for broadcast, collector, priority, and arithmetic/logic circuits, and that time multiplexing with a 1-gigahertz bus and light-pipe interconnection will permit processing performance similar to that of an Intel 8080 or Motorola 6800. The only wired connections between LSI devices in such an organization would be the power, ground, reset, and clock pins.

Probably one of the more stimulating panels during the conference will encompass both architecture and software, as its members address the topic "Toward the computer of tomorrow: a multifaceted challenge." Chairman and moderator Lowell Amdahl, a consulting engineer in computers, intends to guide the discussion along lines that will delineate the panelists' views on computer technology, architecture, applications, and new software languages—and their interrelationships.

Charles Vick, chairman of the architecture session, will serve as one of the panelists in this session. He will stress the interrelationship of software and distributed data processing as a solution to critical real-time problems. A new generation of software engineering will be required for such applications, he maintains, "or we'll have timing, control, communications, and data-base problems unlike any we've experienced in similar past undertakings." Gordon Moore, president of Intel Corp., can be expected to assess the impact of microprocessors and their increasing penetration of systems of all sizes. Albert Hoagland of International Business Machines Corp., San Jose, Calif., who has been working on storage technology for several years, will review the history and status of magnetic storage and project its evolution, while also looking at alternatives.

The user viewpoint will be represented by Herbert Grosch, a Sunnyvale, Calif., consultant and president of the Association of Computing Machinery. "He's excellent in debating, taking strong positions and championing them well," Amdahl says. "He'll be a good representative of the small user." The moderator describes panelist Harlan Mills of IBM in Gaithersburg, Md., as a leading proponent of software engineering who maintains that more sophisticated languages will concurrently program diverse sequential processors.

Finally, Gene Amdahl, chairman of Amdahl Corp., Sunnyvale, Calif., will offer his views on the constraints governing future computer development. He says they include existing customer investment, which must be preserved, the opportunities for functional enhancement arising from technological developments, major trends that modify market attitudes, and the direction of evolution chosen by the industry's standard setter—IBM.

Self-organizing data bases and software

With all the attention paid to data-base management, it is not surprising to find sessions devoted to self-organizing data bases and advanced concepts in data-base management. Gene Altshuler, organizer of both, says self-managing or adaptive data bases are a concept whose time has come. Altshuler, a senior management consultant in the Information Science Laboratory at Stanford Research Institute, Menlo Park, Calif., has long been concerned with the problem of easy data-base organization. He is convinced that hardware technology is proceeding toward a system that can store all the information a user might need—but, without similar advances in data organization and management, the user will not be able to get at it readily.

Altshuler says he has one of the seminal thinkers in self-organizing data bases in Peter Stocker, of the University of East Anglia, Norwich, England. Stocker will discuss storage utilization in such a data base. He first presented a paper on the topic in 1969, having earlier proposed the concept, established a model, and shown its feasibility. The model encompassed a data base of information nearly equivalent to what would be stored for the workings of a U. S. county government.

The self-organizing software system can present the user with a variety of options—along with the cost implications—if his request for data is in a form different from the way the data base is structured. The system can go as far as totally restructuring itself, but the software has been written so that the user will know the cost before he decides to ask for it. The system can also suggest holding a request for information that would cause a substantial restructuring until one or more similar requests were made of the system. In this manner, users would share the restructuring cost.

The session's second paper, dealing with self-adaptive automatic data-base design, will be presented by Michael Hammer of the Massachusetts Institute of Technology's laboratory for computer science. He will present the design principles for an automatic software system that can choose the physical design for a data base and adapt it to changing requirements for information. Hammer has applied a series of principles to a system that selects secondary indexes for an inverted file. For example, the primary index may be an employee's name in a personnel file. Secondary indexes could be such information as marital status, number of children, and whether the person is multilingual.

This system's self-adaptive feature allows users of the secondary indexes to retrieve information directly from any of them without intermediate steps. For example, the user may want to know all employees with three or more children. The adaptive data base allows direct access to that data without the need to request in sequence names, marital status, and number of children.

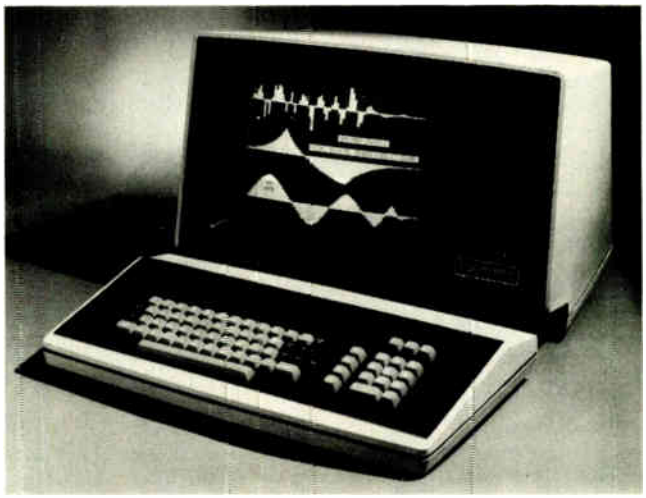
If enough requests are made of the data base to determine which employees are multilingual, for example, the adaptive system will recognize that information as being high-usage data and establish it as higher-priority data than some other categories. This allows quicker access to the information.

Better management

Advanced concepts in data-base management are needed for the ever-burgeoning field of nonnumerical information processing. In a session on such concepts, a paper on subjective decision making is described by its author, Peter C. W. Keen, as intended to promote discussion. Keen is assistant professor of decision sciences at Stanford University's graduate school of business. He is keenly interested in trying to make subjective decision making more scientific.

Keen contends that more decisions can be quantified. But to do it with computer technology, "we need to know how people use verbs (yes, verbs) in decision making and what technology can do to help," he says. Security analysts, for example, can reduce to computer analysis such commands or verbs as "give me a summary of price trends" on a given issue. That is quantifiable data that can be readily accommodated in a data base.

But a command such as "alert me if something happens," which might affect a company's stock, may be more important than quantifiable stock performance. Information in the "alert me" category could include a technological breakthrough by a company or a change in management. "We haven't begun to address that part of the decision-making process," Keen says. "We have a naive view of the user and need much more detail about how he uses verbs before we can find out if technology can help him."



Terminal growth. Among the wares exhibited at the conference will be a wide range of terminals—from dumb to exceedingly brilliant. Improved graphics, as in this color model from Ann Arbor Terminals Inc., will be found on both the video and printing varieties.

Somewhat less abstract will be a paper in the same session on advanced concepts of data-base management by Christine Montgomery, manager of the Information Science department at Operating Systems Inc., Woodland Hills, Calif. She will discuss a hardware technique that speeds up and cuts the cost of file searching. In line with Keen's thinking, she is convinced that nonnumeric data processing will be increasingly important.

Operating Systems Inc. has developed two prototypes of an 8,192-byte associative crosspoint processor that Montgomery describes as essentially an intelligent disk controller. It is aimed at text searching in very large files, with one of the prototypes working in the Pentagon in conjunction with a 180-million-byte disk.

The crosspoint processor is designed to perform a match operation when the file searcher uses a simple English-language command. For example, the user might want to search a newspaper library for any articles about Idi Amin or Uganda over a given time. Instead of using a software program to do the search, which could tie up an expensive mainframe computer for a lengthy period, the file search would use the associative crosspoint processor to do the word-matching function at disk readout speeds.

Montgomery believes the crosspoint processor is the first hardware solution to file processing. The company is certain that the processor can greatly speed the operation compared to software solutions. ☐

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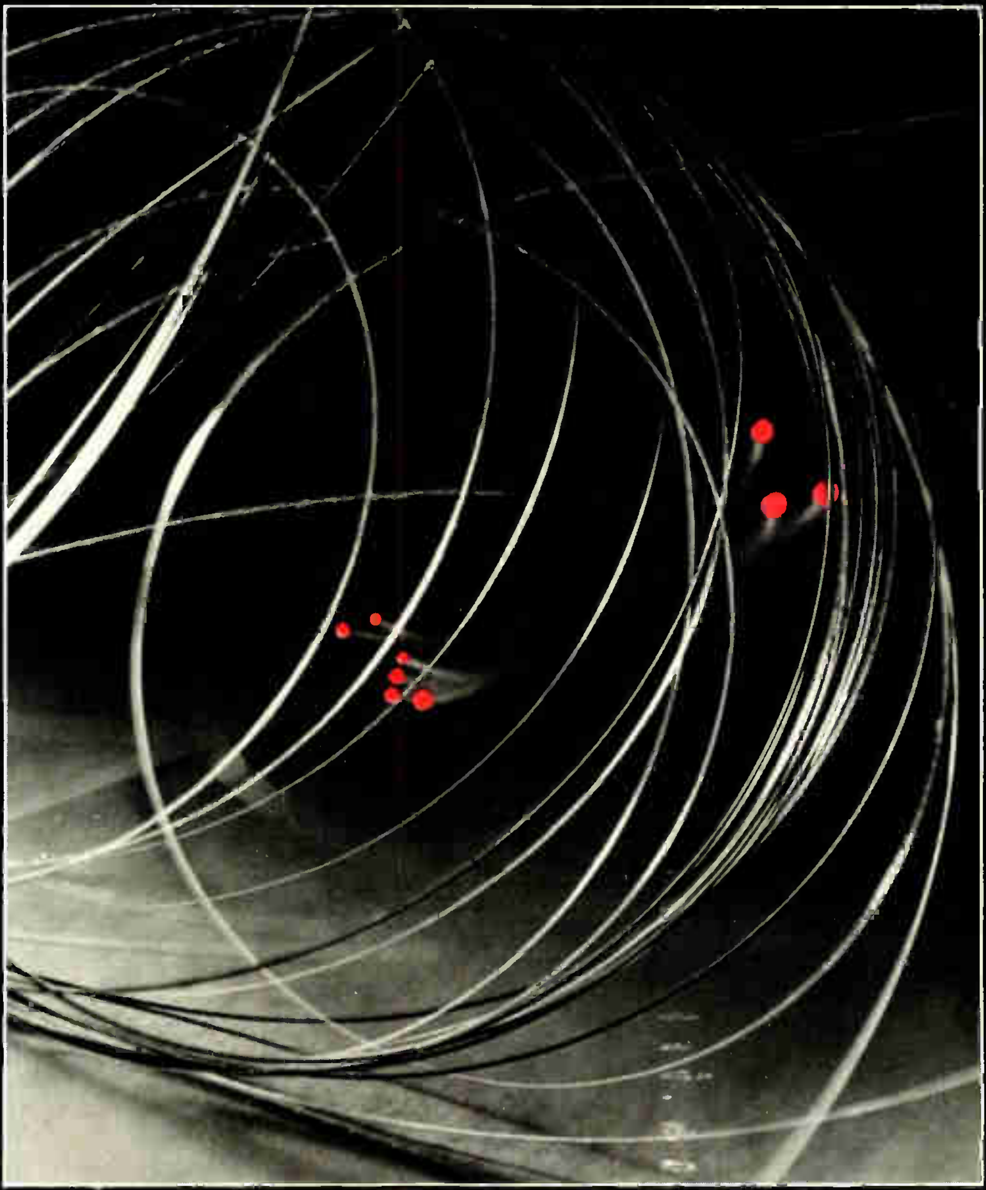

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Some significant new products make their debut at the show

Memories expand computer systems

Calling it the industry's largest minicomputer add-on memory, National Semiconductor Corp. is introducing the NS3-2 bulk-storage memory unit at the National Computer Conference. What's more, the company is also unveiling a "double density" add-in memory card, the NS11, to mesh with the PDP-11 minicomputer family.

According to Chuck Fleming, product marketing manager, the NS3-2 is a self-contained semiconductor random-access memory system with a maximum capacity of up to 512 kilobits by 22 bits—with error correction—or 1 megabyte. Also, while designed primarily as an add-on memory for all minicomputer systems, it adapts easily to a wide range of applications, he says.

The NS3-2 system is housed in a 5.25-inch-high cabinet with standard 19-in. racks and contains its own power supply and fans. The card cage/enclosure houses one timing-and-control card and up to four storage cards, with two additional card slots available for a combination of optional features including error check and correct (ECC), self test, 4-byte interface (44 bits), and custom features.

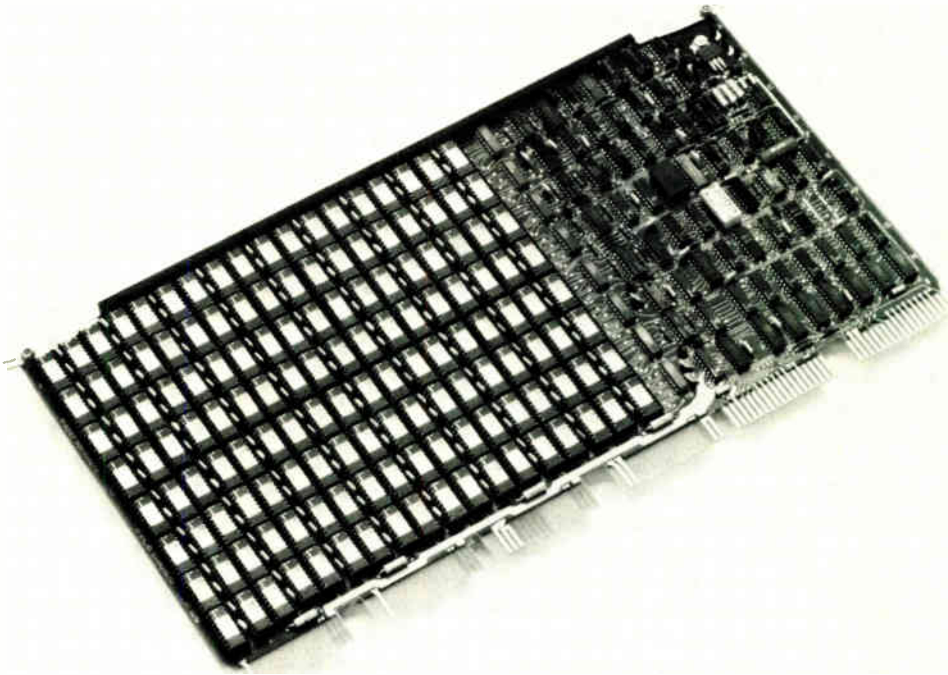
The memory is configured in four modular cards, each with a maximum of 128 kilobits by 22 bits. The basic system element, is a 16-kilobit dynamic RAM, which provides speed, reliability, and low cost. Memory flexibility is achieved by depopulating the board.

The timing and control card provides the interface between the host processor and the storage cards and contains address registers, card decode logic, data registers, refresh-related logic, and the timing-and-control circuitry.

A double-word (44-bit) latch card is required whenever the memory-word size exceeds 2 bytes. This card contains the input and output data registers and control logic required for 4-byte systems. The card, says Fleming, may be used with either unidirectional or bidirectional data interface.

The error check and correct control card contains the logic necessary to correct single-bit and detect double-bit errors for either 16- or 22-bit interfaces. Included on the card are data registers, error timing-and-control logic, bit-correct logic, and the parity circuitry necessary for generating the check bits to be stored in memory.

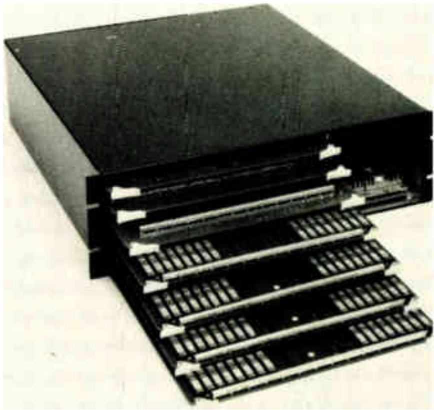
The NS11 "double density" card is a 32-kilobit-by-18-bit add-in memory card designed to be interchangeable with seven separate cards used in Digital Equipment Corp.'s PDP-11 minicomputer family. The card plugs directly into the



PDP 11/04, 05, 34, 40, 45, 55 minicomputers. According to William Leduc, product marketing manager, each NS11 card replaces two 16-kilobit DEC cards in the back-plane assembly with 50% savings in space, lower cost, and increased reliability.

Fully compatible with PDP-11 hardware, software, and standard peripherals, NS11 cards can be intermixed with DEC cards or configured as an all-NS11 memory with increments of 32 or, optionally, 16 kilobits. With either National or DEC management, up to four NS11 cards can replace eight DEC cards for a maximum capacity of 124 kilobits by 16 or 18 bits.

In 18-bit systems, the on-board parity circuits work in conjunction with the PDP-11 parity controller. To insure simple plug-in installation, the NS-11 includes on-board circuits for interfacing with the Unibus or modified Unibus, DIP-switch address block selection in 4-kilobit increments, and input power regulation.



It is dimensionally equivalent, says Leduc, to DEC memory cards and capable of operating from 0% to 90% relative humidity and 0-50°C. Compatible back-plane assemblies are provided, if required.

National Semiconductor Corp., 2900 Semiconductor Drive, Santa Clara, Calif. 95051 [351]

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8-bit operating system bows

Look for Intel Corp. to introduce a software operating system designed specifically for an 8-bit microcomputer at the National Computer Conference. Designated the RMX/80 real-time multitasking executive operating system, it is, says Ed O'Neil, software product manager at Intel, an easy-to-use but sophisticated tool that operates on Intel SBC single-board computers and System-80 packaged systems.

RMX/80 consists of a library from which required routines are configured with application tasks to form a full system. Users generate RMX/80 systems by selecting appropriate modules, relocating and linking them with user-generated tasks on an Intel microprocessor development system. According to O'Neil, the RMX system is organized in such a way that code, data, and stack can be placed in separate areas of memory. This means, he says, that peripheral devices are not necessary to load RMX.

Instead, programmable read-only memories containing nonvolatile code portions of an RMX system can be installed directly into SBC systems. In the case of power failure, program instructions resident in programmable read-only memory are not destroyed, and the system may be restarted when power is restored.

Requiring a minimum of 48 kilobytes of memory, RMX/80 contains all major real-time functions, including resource access based on task priority, inter-task communication, interrupt-driven control for standard devices, real-time clock control, interrupt handling, as well as other optional features. These functions, says O'Neil, eliminate the need to implement detailed real-time coordination for specific applications, greatly simplifying application development, particularly in areas of control, test and measurement, data communications, and specialized data-processing systems.

The nucleus of the RMX operating system, however, including task management, real-time control,

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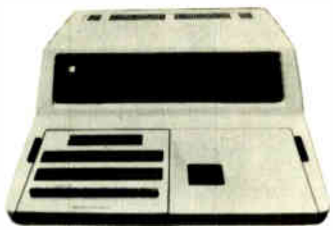

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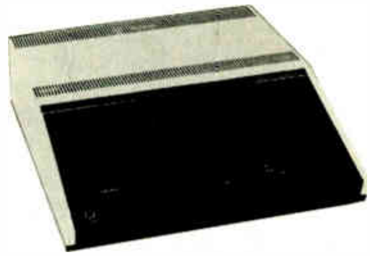
Model 1740



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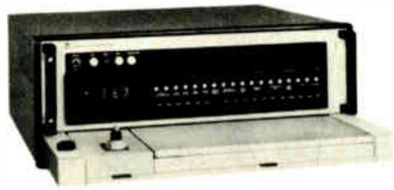

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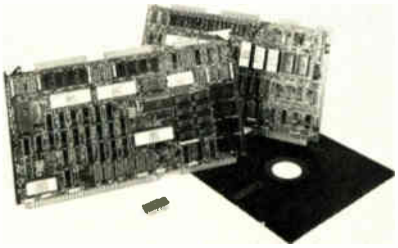

interrupt handling, and inter-task communication facilities, can be contained on 2 kilobytes of memory, such as on a 2716 nonvolatile ultraviolet-erasable ROM. Other features of the RMX/80 include customization based on system software requirements, full multitasking operation, priority access to system resources, full inter-task communication and synchronization—allowing tasks to send information to other tasks and to cause other tasks within the system to execute at proper times—and easy addition of special user I/O tasks.

Available in September, the RMX/80 executive operating system will be supplied to customers in the form of a diskette.

Intel Corp., 3065 Bowers Ave., Santa Clara, Calif., 95051 [352]

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Printer runs at 2,000 lpm

Aimed directly at original-equipment manufacturers, a high-speed line printer will be among the newest offerings shown by Documation Inc., Melbourne, Fla., at the National Computer Conference. Called the DOC 2000, it prints 2,000 single-spaced lines per minute, using a set of 48 characters and a fully buffered print line of 132 characters.

The printer evolved from the company's earlier DOC 2250. Though it prints 250 lines per minute less than does its predecessor, its circuitry has been greatly redesigned to cut production and materials costs to make it competitive in the OEM market. Gary Fisher, vice president for engineering, says it incorporates an Intel 8080 microcomputer to control the print hardware and communication with the host computer, as well as the decoding of all commands. The microcomputer also handles error detection and system status functions in the DOC 2000.

"There's no wire-wrapping in this unit," Fisher says of the electronics redesign. "We've recabled and reharnessed the whole system, using quick-connect pressed-on connectors." At the same time, however, the company retained the mechanical design of the 2250, which has been successful with end users.

The DOC 2000 is intended for top-of-the-line computer systems like the larger Digital Equipment Corp. models, which compete with IBM 370 mainframes. It can handle forms with as many as six parts, ranging from 3 to 24 inches long and 4 to 18¾ in. wide. Paper slew rate is up to 75 inches per second. Vertical line spacing may be either 6 or 8 lines per inch.

Other standard features include a powered forms stacker, an acoustically insulated cover, and interchangeable character arrays. A universal buffer allows any character set on the printer band to be used, and print bands can be changed in 2

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Documation Inc., P.O. Box 1240, Melbourne, Fla. 32901. Phone (305) 724-1111 [353]

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Computer has more memory

Datapoint Corp. is using this year's NCC to highlight its introduction of a powerful new business computer. The model 6600 Advanced Business Processor will offer users 2½ times the memory of the firm's model 5500, its current top-of-the-line product, and memory access and instruction execution times have been speeded up as well. Deliveries will begin next month.

Housed in a cabinet the same size as other Datapoint processors, the 6600 is one of the first computers on the market to take advantage of the 16,394-bit random-access memories now becoming available from semiconductor vendors. And Datapoint, which started stockpiling MK4116 RAMs from Mostek Corp. late last year in the absence of alternate sources, uses 18 RAMs on each of four boards to give its users 122,880 bytes of 8-bit storage with parity. The extra 8,192 bytes, along with a read-only-memory overlay on a fifth board, are assigned to system functions.

Memory cycle time has been reduced from the 5500's 800 nanoseconds to 600 ns, and the 6600's microprogrammed controller will execute a 16-bit instruction in 150 ns, pared from 200 ns on the earlier version. "In addition, we've speeded up some of the more complex instructions," says Jonathan E. Schmidt, vice president for advanced product development at the San Antonio, Texas, firm. "Some multibyte instructions, such as block transfers, were literally doubled in speed by the use of more efficient microcoding."

While Datapoint has enhanced its instruction set for the new machine, the 6600 is fully software-compatible with earlier processors. Both 8-bit and 16-bit instructions have been extended, and the firm has added integer multiply and divide as well as exotic doubly linked, list-handling instructions. "But new instructions are primarily utilized by the system," Schmidt says, "and in all cases the user's 5500 programs will run faster and better."

When configured as a host computer using Datapoint's Datashare business time-sharing system, the model 6600 will support up to 24 video display terminals, each of which can direct the execution of the same or different programs concurrently. The earlier 5500 processor is limited to 16 terminals.

The Schottky-TTL processor uses both 8- and 16-bit-wide internal architecture, with two sets of eight 8-bit program-accessible registers and a 16-bit pushdown stack. The 6600 includes dual cassette drives, a standard 55-key typewriter keyboard, an 11-key numeric pad, and a 7-by-3.5-inch video screen that will display up to 960 5-by-7 dot-matrix characters.

Purchase price for a typical system, consisting of the model 6600 processor with 5-megabyte disk drive, multiple-terminal controller,

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PROCESSOR	6/16	NOVA 3/4	PDP-11/04
Data Type Lengths (bits)	4,8,16	16	1,8,16
Instruction Word Length (bits)	16,32	16	16,32,48
General-Purpose Registers	16	4	8
Hardware Index Registers	15	2	8
Maximum Memory Available (KB)	64	64	56
Directly Addressable Memory(KB)	64	2	56
Automatic Interrupt Vectoring	Standard	N/A	Standard
Parity	Optional	Optional	N/A
Cycle Time (nanoseconds)	600	800	725

PRICE	6/16	NOVA 3/4	PDP-11/04
8KB Processor	$2200	$2600	N/A
16KB Processor	$2800	$3200	$3795
32KB Processor	$4000	$4400	$4995
Multipy/Divide Hardware	$ 950	$1400	$1820

Interdata's 6/16 wins the battle of the specs.

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What's more; all these hardware features enhance the nimble 6/16's performance. Its cycle time is only 600 nanoseconds, compared to 800 for the Nova and 725 for the 11/04.

Interdata's comprehensive software drives this powerful hardware full out. You get the field-proven OS/16 MT2, a real-time, multi-tasking operating system providing instantaneous response to events, while allowing the user to minimize memory by storing non-critical functions on disks. And the 6/16 can be programmed in your choice of FORTRAN, BASIC or MACRO CAL.

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and software/documentation package, is $32,500; the three-year lease price is $1,240 per month, including maintenance. The firm also has developed a new Cobol compiler that takes advantage of the 6600's full 123-kilobyte memory.

Datapoint Corp., 9725 Datapoint Drive, San Antonio, Texas 78284 [354]

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Board controls floppy disk

A single circuit board mounted inside the cabinet provides a built-in controller/formatter for a floppy-disk drive, doing away with separate hardware, cabling, and interfacing, according to Terry Zimmerman, general sales manager of ICOM division of Pertec Computer Corp.

Heart of the FD5200 board is a special floppy-disk controller chip designed by Western Digital Corp. to ICOM specifications. "The simple formatter circuit board performs an extensive amount of complicated logic needed to lay down a data pattern on a diskette in the IBM 3740 format," Zimmerman explains. The control section accomplishes track, seek, and verify without intervention of the host processor, he says, unlike other formatters. "This makes for simpler programming and more efficient operation." Other advantages are modular replacement of the board, when necessary, and fewer failures because of the reduced component number.

The FD5200 uses a simple 8-bit bidirectional bus that enables an original-equipment manufacturer to mount the drive directly. The drive has an 8-inch diskette and is based on Pertec's FD511 model. The ICOM floppy disk operates with any 8- or 16-bit microprocessor and can interface to a minicomputer. A diskette may be formatted by the unit.

Not only is the FD5200 suitable for stand-alone applications such as intelligent terminals, but it also offers multiprocessing capabilities in some systems, Zimmerman says. "The reduced cost of the FD5200, compared to an external formatter

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The Frequency Synthesizer and Level Generator model 2400 is particularly well suited for Telecommunication applications in the 300-Hz to 14-MHz band, covered in only one range with 1-Hz resolution.
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The output signal is delivered on a front-panel coaxial connector with 50 Ω or 75 Ω output impedance, depending on selected option. The output frequency is determined by eight rotary switches in Local mode, and programmed in parallel BCD code in Remote mode. The frequency resolution is 1 Hz in both cases, while the acquisition time in Remote mode varies from 1.2 ms to 3 ms depending on the increments affected by the frequency switching.
The output level ranges from + 19.9 dBm to – 79.9 dBm in Local mode, and from + 20 dBm to – 79.9 dBm in Remote mode. This level is determined by eight rotary switches in Local mode, and programmed in parallel BCD code in Remote mode. The level resolution is 0.1 dB in both cases, while the acquisition time in Remote mode is 100 ms.
The internal level regulation provides ± 0.05 dB output level flatness within the entire frequency range, and ± 0.01 dB level flatness can be reached with an external detector. Besides, the attenuator accuracy is better than ± 0.2 dB over the whole dynamic range.
Nonharmonic content lies below – 70 dB, harmonic signals are between – 40 dB and – 50 dB, and phase-noise in a 1-Hz bandwidth lies between – 110 dB and – 130 dB.
A low-impedance ($Z < 3\ \Omega$) auxiliary output, providing + 10 dBm to + 20 dBm output level, is also available on the rear-panel of the instrument.
Owing to the oven-controlled Master Oscillator, frequency stability is that of a Frequency Synthesizer, that is $\pm 5.10^{-9}$ per day. Besides, this Master Oscillator can be phase-locked to an external reference.

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for each unit, permits designers to consider using several drives rather than a single shared formatter." This makes possible performance improvements, including overlapping-head seeks, reads, and writes.

Single-unit price is less than $1,000 and is under $700 in small OEM quantities. Sample units will be available by midyear, with volume production in the fourth quarter.

ICOM Division of Pertec Computer Corp., 6741 Variel Ave., Canoga Park, Calif. 91303 (213) 348-1391. [355]

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1-board computer, simulator offered

Iasis Inc., a three-year-old company whose main business has been home-study courses in microcomputer programming using an 8080-based computer in a book, is moving into the mainstream of the microprocessor marketplace. The Sunnyvale, Calif., firm is introducing two new products aimed at what it perceives as two chinks in Intel Corp.'s marketing armor. One is a an 8080-based single-board computer—the SBC 80/80—that in both price and performance falls between Intel's two single-board computers, the SBC 80/20 and System 80/20 [*Electronics*, March 17, p. 121]. The other, says Iasis president David Guzeman, is the Iasimulator, a hardware simulator system for 8080 microcomputers that lowers the cost of development of a microcomputer system to one fourth of that required for more sophisticated systems, such as Intel's MDS.

Iasis' single-board units cost $650 each and contain 8 kilobytes of programmable read-only memory, 4 kilobytes of random-access memory, eight input/output ports and levels of interrupt, and a real-time clock. "We are aiming the SBC 80/80 at users who have stand-alone applications," says Guzeman, "but who require more memory, I/O, and interrupt capability than what's now available." Completely compatible with all of Intel's SBC 80 family of boards, the SBC 80/80 is also

compatible with teletypewriter outputs and the RS-232 protocol.

The SBC 80/80 is also an integral part of Iasis' other NCC-shown offering—the Iasimulator. At $1,895, Guzeman says it lowers considerably the entry-level cost of developing a microcomputer-based system and also the level of sophistication needed.

This new hardware-simulator system includes the 7600 expander cube, which contains an SBC 80 board, an 8-k RAM board, an interface board, and a PROM programmer. Completing the system is the 8080-based microcomputer in the 7301 computer in a book, which contains 1 kilobyte of RAM memory, 1 kilobyte of PROM memory, a power-monitor system, 8 seven-segment LED displays, 3 LED indicator lights, and a hexadecimal keyboard that features six special-mode keys.

Iasis Inc., 815 W. Maude Ave., Sunnyvale, Calif. 94086 [356]

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CRT terminal attains 19.2 kbauds

Quiet operation, fast transmission, and inherent reliability are among the reasons for the growing popularity of cathode-ray-tube terminals for the common-carrier communications lines. Two such terminals, the Regent 100 and 200 from Applied Digital Data Systems Inc., are teletypewriter-compatible and offer features that are unattainable with printing terminals.

Both the 100 and 200 have a full 128-character ASCII keyboard and separate 14-key numeric pad for data entry, and both provide a page display of 24 lines of 80 characters each. Communications can take place over a standard RS-232 interface or a 20-milliampere current loop, and the transmission rate is switch-selectable to up to 19,200 bauds.

The practical aspects of using a temporary display such as a CRT for common-carrier terminals become more apparent with an appreciation

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Circle 184 on reader service card

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of the display flexibility. Aside from upper- and lower-case letters, any part of the display can be highlighted by using reverse video, mixing half- and full-intensity brightness and blinking or underlining characters. This highlighting is especially effective if used with the forms-generating feature on the Regent 200, which allows the user to set up a format on the screen made up of combinations of protected fields for the questions and variable fields for the answers. The protected or variable data in the display can be highlighted for easy identification and retrieval.

The Regent 200 also boasts a buffered memory that permits three modes of data transmission. In the conversational mode, which is the only operating mode of the model 100, data is transmitted one character at a time to allow easy two-way communications and efficient question-and-answer operation.

When the terminal is in the message mode, the user transmits a line at a time, which is useful for message checking. Finally, in the page mode, the operator can transmit at once a full or partial screen of lines. The model 200 has as standard equipment eight user-programmable

function keys, which are an option on the model 100.

In addition, the 200 offers an editing option that allows the operator to clean up text rapidly for transmission or to delete characters or lines of data with simple keystrokes. At the bottom of the screen, both terminals have a status line that is distinct from the rest of the display. This line shows both the operating mode of the terminal and, when it is first turned on, the results of a self-diagnostic test of the memory and of the interface.

Applied Digital Data Systems Inc., 100 Marcus Blvd., Hauppauge, N.Y. 11787. Phone (516) 231-5400 [357]

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Intelligent printer offers firmware updating

A family of microcomputer-controlled medium-speed printing systems with both processing-power and output-printing capabilities is being unveiled at the National Computer Conference by Dataroyal Inc., of Nashua, N.H. Ronald O. Huch, president, says that the intelligent printers have a flexible configuration that will enable users to keep them up to date by making simple firmware changes.

The first of the systems, the model 7000, combines a 120-character-per-second parallel printer with an 8-bit microcomputer system that has 10,000 words of memory. Other members of the family offer serial interfacing and keyboard send/receive features.

"The new systems can be configured to meet a variety of commercial and industrial printing requirements," then reconfigured through changes in firmware as applications change or as new applications develop," Huch says. A variety of input and storage peripherals such as floppy disks or keyboards can be interfaced to the 7000, allowing the system to function either as a standalone printer or as a work station within a distributed network.

As much as 75% of the 7000's processing power can be dedicated to tasks other than the printing applications at hand. For example, report-or label-printing jobs that need 1,000 words of random-access memory and 2,000 words of programmable read-only memory leave up to 3,000 words of RAM and 4,000 words of programmable read-only memory for other applications.

Huch notes that the electronic sophistication in the back end is matched by mechanical simplicity in the front end that insures system reliability. The printing mechanism consists of a transport with only a lead screw and a servo motor, keeping parts to a minimum while permitting bidirectional printing.

Model 7000 includes a parallel interface as standard and produces an ASCII character set in either standard or extended widths. It is priced competitively with popular medium-speed printers at $2,871 in single units for end users and at $1,595 in tion including four key stations, 10 megabytes of disk storage, a tape drive, and a 600-line-per-minute printer will lease for approximately $1,950 per month, including maintenance. An entry-level system including two key stations and a 200-line-per-minute printer will lease for about $1,350 per month.

Inforex Inc., 21 North Avenue, Burlington, Mass. 01803. Phone (617) 272-6470 [359]

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Disks hold 70 megabytes

A line of moving-head disk drives that store up to 70 megabytes of data at rates of 1 megabyte per second is being introduced by Kennedy Co. The series 5300 drives have unformatted capacities ranging from 14 megabytes in the single-disk version up to 70 megabytes in three-disk model. Each surface has two 350-track-per-inch cylinders with a recording density of 600 bits per inch. Moreover, the line features a sealed enclosure, which permits operation in environments previously considered unsuitable for disk drives.

The drives use a dual-head carriage driven in an arc by a d'Arsonval-type actuator that positions the heads without lead screws or linear motors. Prerecorded servo-tracks on the bottom of one disk control the positioning.

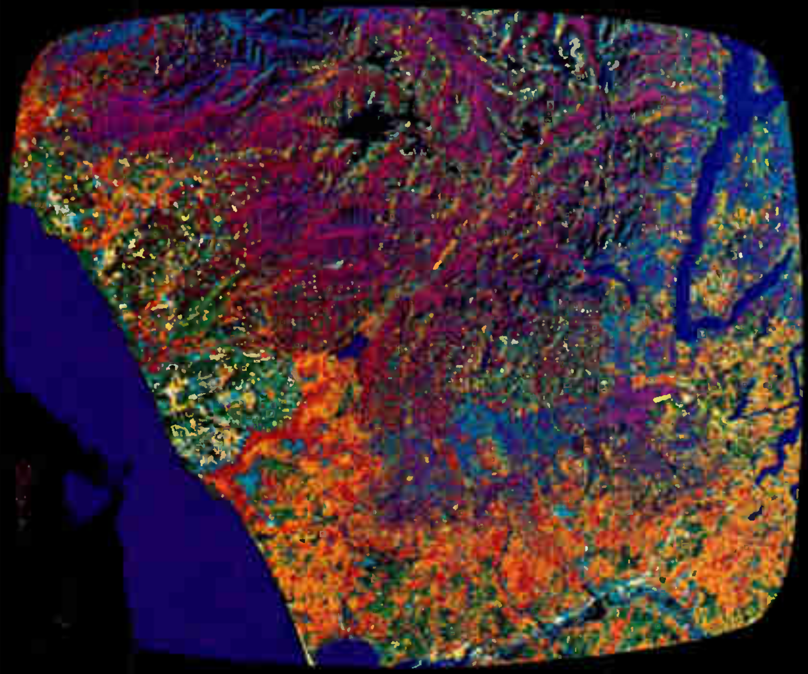
Recording heads fly at 20 microinches above the recording surface and land in clear spaces adjacent to tracks, to prevent head damage or lost data. Track-to-track head motion is 10 milliseconds, and average head movement time is 45 ms, with a worst-case maximum of 80 ms. Disk rotation of 3,000 rpm gives an average latency time of 10 ms.

Another feature, modified frequency modulation recording, is implemented with emitter-coupled logic, both for high-speed maximum frame definition and to eliminate data ambiguities caused by propagation delay.

The drives are 19 in. wide by 7 in. high by 22 in. deep. Weight is 45 pounds. Power supply and all electronics are included in a single assembly.

Drive prices range from $2,500 to $4,000, depending on data capacity and quantity.

Kennedy Co., 540 West Woodbury Road, Altadena, Calif. 91001. Phone (213) 798-0953 [360]



Semiconductors

Darlington finds TV niche

Power transistor, an npn silicon device, handles 8 A at 1,400 V

Inherent high-gain characteristics and the simplicity of Darlington transistors make them naturals for replacing discrete devices in such key jobs as switching in the horizontal-deflection output of color television sets. Here, most sets use combinations of 1,500-volt transistors and damper diodes. What has held back Darlingtons, however, is state-of-the-art voltage levels in the 500-V range, far lower than required.

To improve those levels, an engineering effort launched by Motorola Semiconductor's discrete division has paid off with a new high-gain Darlington device, already catching the eye of domestic TV manufacturers. The MJ10011 npn silicon power Darlington transistor, rated at 8 amperes and 1,400 V, attains nominal gain of 40 at 5 A.

"This order-of-magnitude gain increase was a major goal of the program," says Ralph Greenburg, planning manager for power products at the Phoenix division. Other objectives were "to combine the output transistor with the damper diode and equal the performance of discretes in all the critical parameters such as fall time, safe operating area, voltage saturation and thermal stability."

The Motorola design team not only succeeded in replacing the separate damper diode with the monolithic diode, Greenburg explains, but the high gain eliminates the conventional driver transformer because only a 200-milliampere base drive is needed. Other MJ10011 parameters are a forward voltage drop of 2 V maximum, saturation typically less than 2 V at 4 A, and an operating temperature range of −65 degrees Celsius to +150°C.

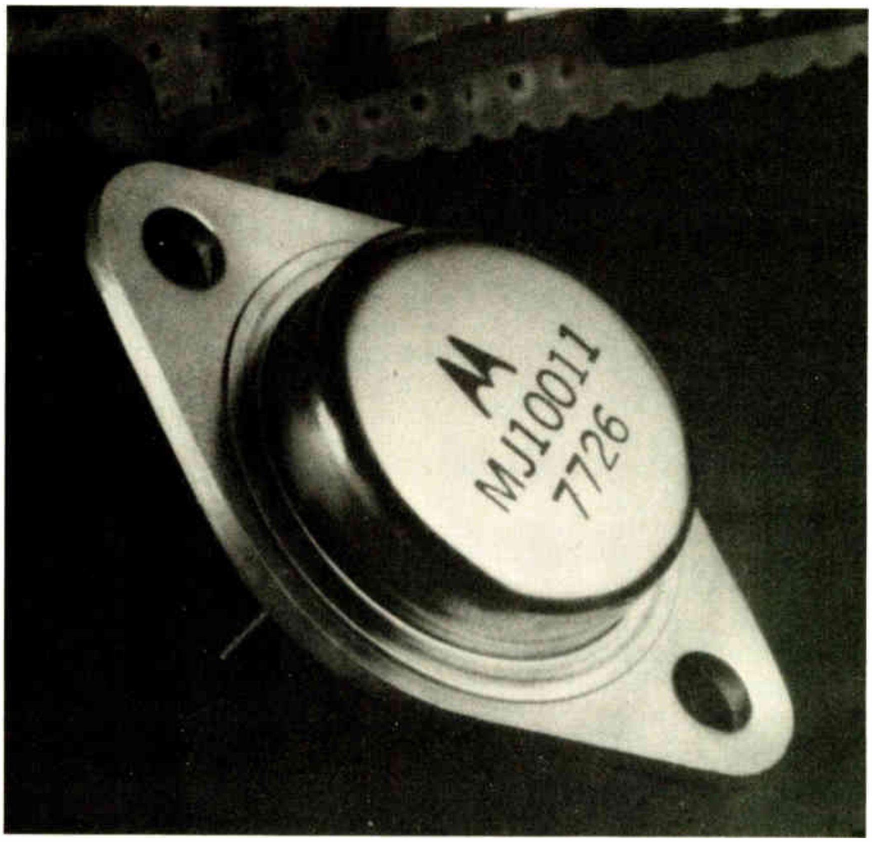
Motorola designers, employing integrated-circuit development technology, started with specially fabricated high-voltage discrete transistors and synthesized them into Darlington configurations. Various combinations of die geometries were coupled with base-to-emitter resistors and tested in a TV set until an optimum design prototype resulted. Finally, the synthesized version was converted into a single monolithic structure.

Another design goal, long-term electrical and thermal stability, required special glass-passivation techniques and a beefed-up TO-3 package to handle high voltage. Passivation of the collector-base junction is accomplished after mesa etching the Darlington's triple-diffused wafers. In this process, each die is isolated for electrical probing, with the cross sections showing a typical mesa outline, on slope of which the junction terminates. This entire slope is then covered with a proprietary Motorola photoglass, Greenburg points out.

The TO-3 package has a special construction to withstand high voltage, with glass insulators surrounding the base designed for maximum creepage path length, to resist arcing. Header thicknesses have a low thermal resistance, typically 0.6°C per watt, without sacrificing mechanical strength.

Eliminating the driver transformer, and its base inductor, also does away with the problems of matching inductance to device output of present switching systems, according to Greenburg. Here, variations in discrete-transistor performance from vendor to vendor require circuit designers to choose the correct base inductor to get optimum fall time, an expensive process.

Greenburg expects that the reduction of parts and the competitive pricing of the MJ10011 will provide significant cost reduction of the total horizontal-deflection system. Also, he says that fewer parts will enhance reliability and streamline the assembly. Major U. S. television manufacturers now have sample quantities of the Motorola device available for



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Price of the MJ10011 is $3.50 in 100−999 quantities, compared to $3.85 for Motorola's present discrete power transistor, which is among those used in the color TV function. Deliveries will start this summer.

Motorola Semiconductors, Discrete Division, Power Marketing, Box 20912, Phoenix, Ariz., 85036. Phone (602) 244-3912 [411]

Monolithic Darlingtons can switch 500 volts

A series of monolithic Darlington transistors, which have a power-dissipation rating of 96 watts, can switch up to 500 volts in 400 nanoseconds. The npn devices, designated the SVT6000 series, can withstand a continuous collector current of 15 amperes and a peak current of 20 A. The three transistors in the series have collector-emitter voltage ratings of 400 to 500 V dc and sustained voltage ratings of 300 to 400 V dc. At a collector current of 15 A, the $V_{ce(sat)}$ of the three units is 2.0 V. Key applications of the new transistors are expected to be in automotive ignition systems and in high-power switching regulators. The devices sell for $6.45 each in quantities of 500.

TRW Power Semiconductors, 14520 Aviation Blvd., Lawndale, Calif. 90260. Phone John Power at (213) 679-4561 [413]

Monolithic unit generates full ASCII character set

The TMS4710 is an 8,192-bit read-only memory programmed to function as a character generator of the full set of upper- and lower-case ASCII characters. The n-channel silicon-gate device is organized as 1,024 words of 8 bits each. Key operating features include a maximum access time of 450 nanoseconds, a minimum cycle time of 450 ns, a typical power dissipation of 310 milliwatts, and TTL-compatible inputs and outputs. The fully static ROM is housed in a 24-pin dual in-line package—

either plastic or ceramic. The former sells for $10.66 each in hundreds, while the latter goes for $12.66. The units are available now.

Texas Instruments Inc., Inquiry Answering Service, P.O. Box 1443, M/S 669 (Attn: TMS4710), Houston, Texas 77001. Phone David Sitrick at (713) 494-5115, ext. 2781 [414]

10-bit d-a converter works from −55°C to 125°C

The DAC-05 family of monolithic digital-to-analog converters includes units that are guaranteed monotonic over the full military temperature range from −55°C to 125°C. The sign-plus-magnitude devices are monolithic circuits that include a precision voltage reference, a logic-controlled polarity switch, and a high-speed (1.5-microsecond settling time) output operational amplifier. Units are available with ±5-volt outputs and ±10-V outputs. A total of 18 converters make up the family. Six of them operate from 0°C to 70°C, a second six operate from −55°C to 125°C, and the third six have the same temperature range as the second six, but are also processed to MIL-STD-883 Level B. Each group of six units consists of units that are monotonic to within 8, 9, and 10 bits in both the ±5 and ±10-V versions. Pricing extremes, for 100 to 999 pieces, are $15 each for the 8-bit 0°C to 70°C converters and $162 for the 10-bit devices that have been processed to the military standard.

Precision Monolithics Inc., 1500 Space Park Drive, Santa Clara, Calif. 95050. Phone Donn Soderquist at (408) 246-9222 [416]

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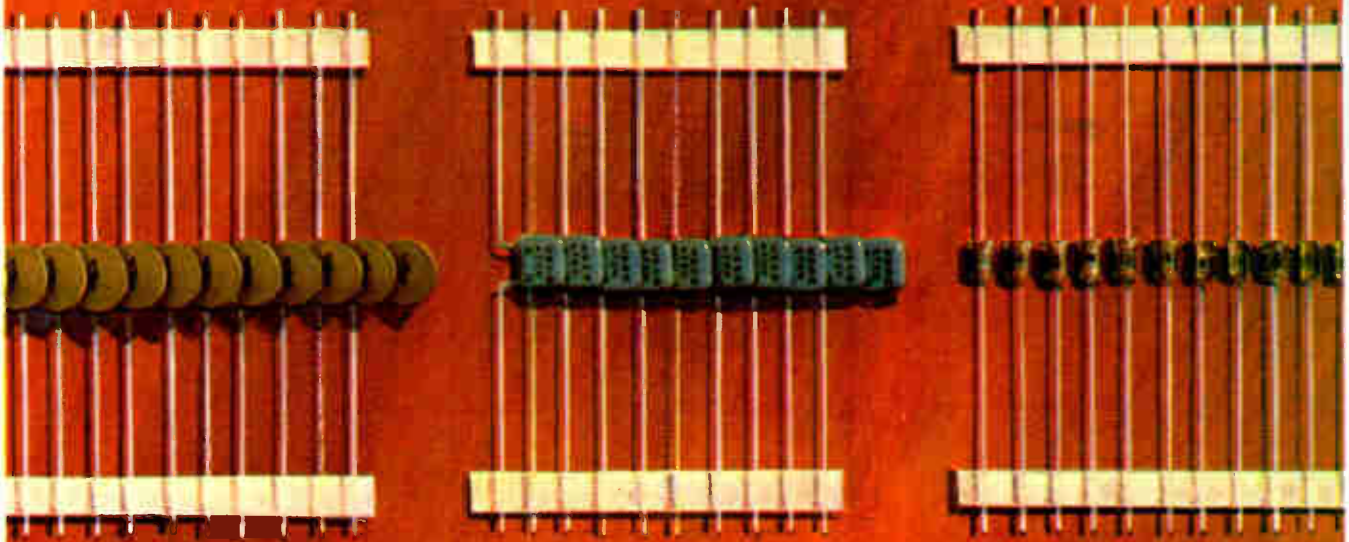

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Subassemblies

Amplifier has good stability

Instrumentation unit has input-offset drifts of 15 pA/°C and 0.25 µV/°C

For high-performance applications, an instrumentation amplifier should keep offset drifts low for both input voltage and current. Officials at Dynamic Measurements Corp., Winchester, Mass., believe they have the best combination of drift performances available in their new model 1312. The unit's maximum input-offset drifts are 15 picoamperes per degree Celsius for current and 0.25 microvolt/°C for voltage.

That performance is comparable with the closest competitive unit for the voltage specification and superior for current drift. The device is aimed at applications that include load cells in scales and handling signals from temperature and pressure transducers.

To get the good drift specs, says Stephen Connors, engineering manager, the company uses discrete components in the input stage, in combination with "the latest op amps on the output to keep good temperature tracking on the front end." The front end combines field-effect transistors and super-beta transistors in what Connors calls a novel kind of bootstrapping circuit that reduces input bias current to 15 nanoamperes maximum. It also provides a high common-mode rejection ratio of 114 decibels, specified at 120 hertz.

Other important features of the model 1312 are a maximum output settling time of 50 microseconds, independent of gain, for a 20-volt step; a gain range from 1 to 1,000; a minimum bandwidth of 75 kilohertz with a voltage gain of 2 to 1,000, and shielding against electromagnetic interference on five sides by a metal can.

Connors points out further that internal trimming on the output yields a maximum offset voltage of ±200 millivolts, adjustable to 0. The unit has a power supply range of ±5 v to ±18 v.

A companion unit, the model 1313, with certain specs slightly relaxed, sells for $69. The 1312 is priced at $79 in quantities of 1 to 24. Delivery is from stock.

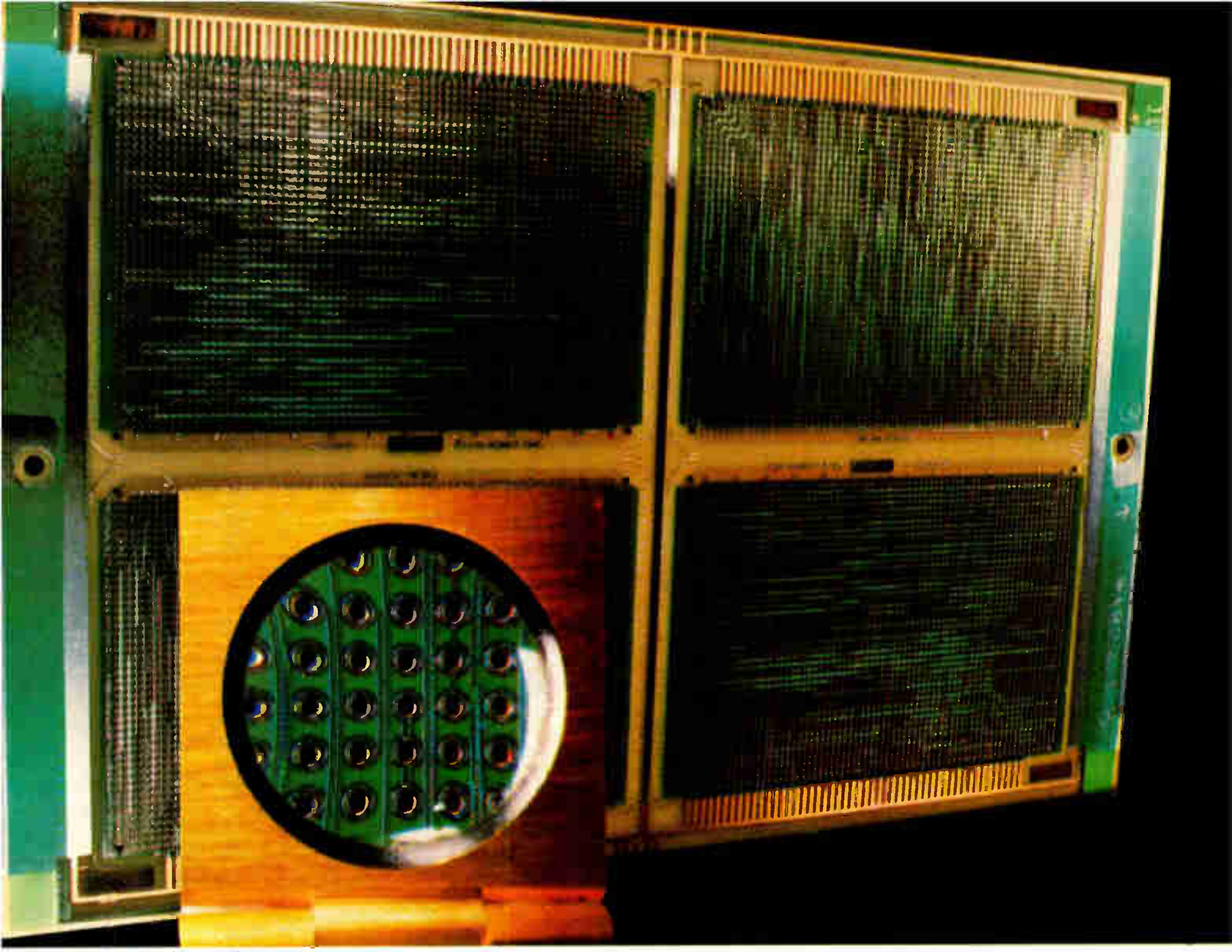
Dynamic Measurements Corp., 6 Lowell Ave., Winchester, Mass. 01890. Phone Stephen Connors at (617) 729-7870 [381]

V-f converters combine low drift with low price

Two voltage-to-frequency converters, the VFC12LD and the VFC15LD, offer designers low drift specifications that are exceeded only by converters costing twice as much. Both units are guaranteed to drift less than 10 ppm/°C, although 8 ppm/°C is regarded as typical. The converters are both linear to within better than 0.005% of full scale.

The devices differ in their input-voltage and output-frequency ranges. The VFC12LD handles inputs from 0 to 10 volts and produces frequencies from dc to 10 kilohertz. The VFC15LD handles 0 to 20 v and produces 0 to 20 kHz.

Both of the new converters are of modular design, measuring 1.5 by 1.5 by 0.4 inches. They are self-contained and require only ±15-v power supplies. In hundreds, the VFC12LD sells for $46, while the VFS15LD is priced at $47. The unit



Printed circuit board courtesy of Memorex Corporation

More than a fine line separates RISTON* Dry Film Solder Mask from other masks.

We know fine lines are important to you. That's just one of the reasons why we developed RISTON* Dry Film Solder Mask. Photo-imaging gives precise resolution, even on dense circuitry boards and around critical pad areas. Because there is no bleed-out or solder bridging, inspection is fast, with minimum rework and few rejects. With RISTON Dry Film Solder Mask, application and processing are easy, without specially skilled operators or screen setups and attendant delays.

Reliability? You can count on it! The uniform thickness of RISTON Dry Film Solder Mask permits handling of the highest density circuitry and offers high impedance integrity with outstanding electrical insulation. Long or short runs are a natural, and boards can be produced up to 21" x 24", one after the other, without multiple recoats or skips.

All of these features of the dry film process with RISTON Solder Mask add up to wide flexibility for the designer. What's more, it comes in a variety of film types which enable masked boards to pass UL flame-retardant standards. RISTON Dry Film Solder Mask adheres to all common metals and performs consistently under a variety of soldering conditions as well as solder flux cleaning. The result for you is a tough, permanent, well-designed board.

Find out how the benefits of RISTON Dry Film Solder Mask fit your needs. Call your Du Pont RISTON Technical Representative, or write Du Pont Company, Room 35619, Wilmington, DE 19898.

*Registered U.S. Pat. & Tm. Off. for Du Pont's processable dry film photoresist system

RISTON Division

DU PONT

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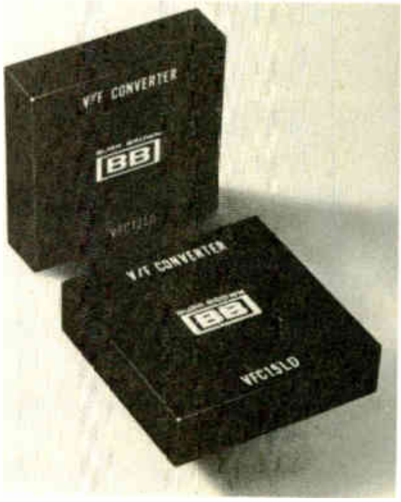
Electronics

Circle 197 on reader service card



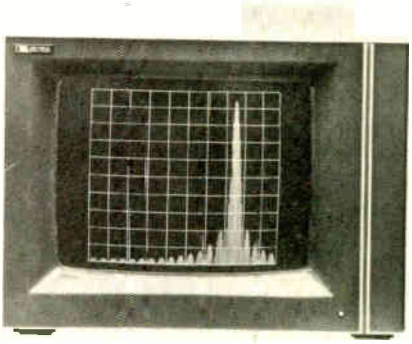
prices are $57 and $59 respectively.

Burr-Brown Research Corp., P.O. Box 11400, Tucson, Ariz. 85734. Phone (602) 294-1431 [383]

Large-screen CRT display provides 0.5-mm spot

The high-resolution model 1304A cathode-ray-tube display combines a screen area of 20 by 25 centimeters with a spot diameter of only 0.5 millimeter. The unit, which can display 2,000 alphanumeric characters in normal room lighting, uses electrostatic deflection for fast response and low power consumption. It has a writing speed in excess of 25 cm per microsecond and a power consumption of only 60 watts. Dynamic focus keeps the spot sharp at all intensity levels.

Applications for the 1304A include calculator and computer graphics, spectrum analysis, and physiological monitoring. For this last application, a $50 option can be



PUSH to initiate automatic in-circuit testing of all of your analog, hybrid and digital boards.

Test *all* of your printed circuit boards and, in many cases, completely eliminate costly functional testing. Faultfinders FF101C and FF303 in-circuit test systems give you the flexibility you need with a broad range of CPU/peripheral compatibility. And you can get full time utilization of the system computer with foreground/background programming to execute automatic program generation, text editing, data analysis or file maintenance *even while you're testing boards.*

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Latham, Tom Coleman, (518) 783-7786;
Irvine, Chuck Hults, (714) 549-4901;
Chicago, Al Roraus, (312) 696-0335;
San Francisco, Bruce Douglas, (408) 432-9020;
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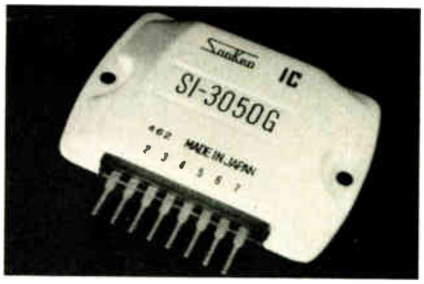
specified to meet the requirements of UL listing 544 for medical and dental electronic equipment. A variety of other options are also available. The basic unit sells for $2,400. Delivery time varies from about 8 to 12 weeks, depending upon options.

Inquiries Manager, Hewlett-Packard Co., 1501 Page Mill Road, Palo Alto, Calif. 94304 [384]

Hybrid rectifier/regulator puts out 2 A at 5 V

The SI3050G hybrid power rectifier and voltage regulator is a compact unit that can put out up to 5 amperes at-5 volts dc. The device, which



includes circuitry for overload and short-circuit protection, requires few external components and no adjustments. Priced at $8.50 each in singles, dropping to $6.10 in hundreds, the unit is available from stock.

Energy Electronic Products Corp., 6060 Manchester Ave., Los Angeles, Calif. 90045. Phone (213) 670-7880 [385]

Power-supply modules deliver up to ± 180 V dc

A new series of dual high-voltage modular power supplies is particularly well-suited for use with such high-voltage equipment as large-swing operational amplifiers and deflection amplifiers. The three supplies in the series offer outputs of ±120 volts at 25 millamperes (model BPM-120/25), ±150 V at 20 mA (BPM-150/20), and ±180 V at 16 mA (BPM-180/16). All three devices offer line regulation to within

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0.05%, load regulation to within 0.1%, and output ripple of 10 millivolts rms, maximum. Temperature coefficient is no more than 0.02% per degree Celsius.

The supplies feature a minimum isolation resistance of 100 megohms, output current limiting, and an operating temperature range of −25°C to 71°C.

Datel Systems Inc., 1020 Turnpike St., Canton, Mass. 02021. Phone Eugene L. Zuch at (617) 828-8000 [386]

450-cubic-inch power supply puts out 1,000 watts

Operating at 70% to 80% efficiency, a line of high-power switching power supplies puts out 25% more power than did previous models in the same package sizes. The units deliver up to 1,000 watts from a package that measures 5 by 8 by 11 inches and weighs less than 14 pounds.

Available voltages range from 2 to 28 volts dc with currents up to 150 amperes. All units feature dual wide-range inputs of 85 to 132 v ac and 170 to 264 v ac at 47 to 63 hertz. They will maintain regulation down to 78 v ac and 156 v ac for up to 10 minutes, providing brown-out protection. Output regulation is maintained for a minimum of 30 milliseconds after loss of input power—useful in computer systems in which it is important to preserve data integrity. Regulation for both line and load variations is within 0.1% with less than 25 millivolts of peak-to-peak ripple. Prices on the new supplies start at $750.

Power/Mate Corp., 514 S. River St., Hackensack, N.J. 07601. Phone Joe Geronimo at (201) 343-6294 [387]

Need ROM retention and RAM alterability?

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Our Metal Nitride Oxide Silicon NVM are fully reprogrammable in-circuit.
They offer long-duration storage security without battery backup or "power-on" auxiliaries.

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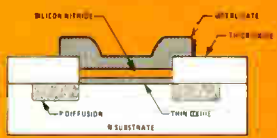
Data is secure for a minimum of 10 000 hours and can be read 10^{10} times between refresh cycles.

PROGRAM VERSATILITY
Nitron NVMs offer entire memory or word alterability. And it can all be done in-circuit a minimum of 10^5 times. Millisecond write times are ideal for applications in the human-response range.

SYSTEM COMPATIBILITY
We built in on-chip decoding, and TTL and CMOS compatibility. Plus, Nitron NVMs can be reprogrammed without additional power supplies or power supply switching.

PRODUCT AVAILABILITY
Nitron NVMs are available off-the-shelf for parallel data applications in 64x4 and 256x4 configurations; and for serial data applications in 16x16, 16x18 and 1024x1 configurations. If you don't see what you need, tell us about it. We custom design NVMs, too.

Unique Nitron process puts silicon nitride and silicon dioxide layers between MOS gate and substrate. When voltage is applied, trapped charge offsets threshold voltage. Charge remains after voltage is removed.



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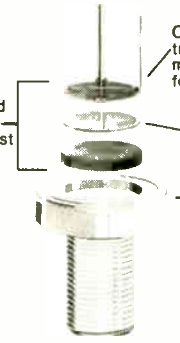
Circle 203 on reader service card

Inherently rugged, these triple-diffused devices permit circuit operation directly from rectified 117V or 220V line—eliminating transformers. Ideally suited for inverters, convertors, switching regulators, motor controls and wherever there's hi-rel applications. The exploded view demonstrates our single chip design and packaging concept which makes high-voltage, high-current transistors off-the-shelf availability possible. Pre-rating and pre-testing techniques of chip allows choice of solid copper packages. For further information and application assistance, call Sales Engineering, PowerTech, Inc., 0-02 Fair Lawn Ave., Fair Lawn, N.J. 07410; Tel. (201) 791-5050.

TYPE #	(pk.) I_C	V_{CE}	h_{FE} @ I_C	Switching Speed (Typ.)
PT-3512	70A	325	10 @ 30A	$t_r = .5\ \mu s$
PT-3513	70A	400	10 @ 30A	$t_s = 1.2\ \mu s$
PT-3522	90A	325	10 @ 50A	$t_f = .5\ \mu s$
PT-3523	90A	400	10 @ 50A	
350 Watt Power Rating			Guaranteed SOAR	



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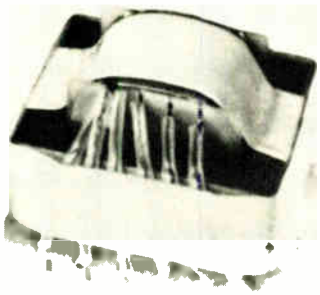
NPN Silicon Power Transistor Switch—Highest KVA at lower cost, weight & space.

Components

Transformer aims at medical uses

Intended to shield patients from shock, unit is designed to operate at 20 kHz



Switching power supplies, which are beginning to supplant series supplies in new computer installations, may be about to move into medical electronics applications where the patient must be protected from electric shocks. The isolation transformers needed for medical gear have been large, heavy 60-hertz devices. But Stevens-Arnold, a long-established transformer house, has come up with a new 20-kilohertz design that meets the stringent requirements of Underwriters Laboratories UL544 standard for medical and dental equipment. Although it is intended to operate from a 20-kHz square-wave generator, the unit still holds interwinding leakage current to a low 20 microamperes at the standard line frequency of 60 Hz.

Furthermore, the model IT-3573 incorporates thermal protection for each of its secondary windings. Thermal fuses, which are inserted in series with the windings, trip when the transformer overheats to temperatures of 125°C to 150°C. The unit is also available with input protection—fusing against a fault current in the primary protects all the secondaries.

The primary, which is centertapped, can handle voltages of up to 100 volts nominal. The secondary is available with single or multiple windings. Single secondaries provide 200 watts of output power at voltages of 40 to 100 v. Multiple secondaries can have voltages ranging from 20 to 100 v, with an output power of about 150 w for double windings and around 125 w for triple windings.

Designed for mounting on printed-circuit boards and weighing a mere 4 ounces, the transformer measures 1.81 inches long by 1.56 in. wide by 1.375 in. high (when seated). Its power-transfer efficiency is a high 98%, and breakdown voltage between the primary and the secondary is 2,500 v root mean square.

In addition to medical electronics, the unit is suitable for use in industrial process control and scientific instrumentation. Also, it is available with an optional electrostatic shield between the primary and secondary to reduce capacitive coupling and minimize switching transients in critical applications.

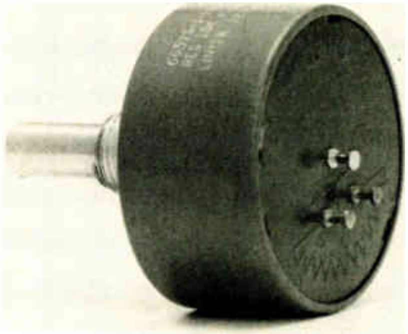
In lots of 100, the transformer sells for $14.50 each. Delivery is within four weeks.

Stevens-Arnold Inc., 7 Elkins St., South Boston, Mass. 02127. Phone (617) 268-1170 [341]

Nonlinear precision pots sell for about $6

The model 6657 single-turn potentiometer is a low-cost precision unit that is offered with a full line of nonlinear functions. Selling for about $6 each in production quantities, the potentiometers have a standard independent linearity of 1%. Among the standard nonlinear functions that are available are sine, cosine, sine-cosine, and logarithmic.

Measuring 1 5/16 inches in diameter, the pots have a bushing mount and a conductive-plastic element. Molded-in terminals add to reliability. Other specifications include a resistance range of 1 kilohm to 100

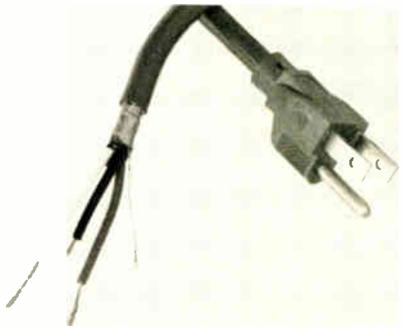


kΩ, a power rating of 1.5 watts at 70°C, and a rotational life of 10 million revolutions.

Trimpot Products Division, Bourns Inc., 1200 Columbia Ave., Riverside, Calif. 92507. Phone (714) 781-5200 [343]

Shielded power cords reduce interference

Two versions of UL-listed shielded power cords and cord sets are designed to minimize electronic interference in the power supplies of business machines and test equipment. They are expected to greatly reduce the need for filtering devices in sensitive test gear and computers. Two types of shielding are available: Beldfoil with a drain wire, and



copper-serve shielding. The Beldfoil shielding consists of an aluminum/polyester film wrapped around the conductors. A foldback design ensures continuous metal-to-metal contact and 100% shield coverage.

The copper-serve shielding is formed by spiralling copper wire around the conductors. It provides nearly 100% coverage and acts as a ground wire when terminated. The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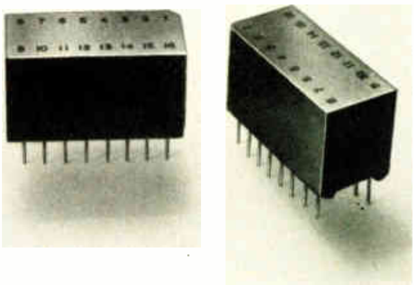
Circle 207 on reader service card

cords are SJT-type, 14 to 18 gage, with three-strand copper conductors.
Belden Corp., 2000 S. Batavia Ave., Geneva, Ill. 60134 [344]

Solid-state relays offer high noise immunity

A series of miniature solid-state relays with high noise immunity is intended to convert high-voltage ac and dc signals to TTL levels. The low-cost devices in the HL series accept inputs from 5 to 48 v dc or 6.3 to 120 v ac. Using photoisolation, they provide an output capable of switching 5- or 12-volt logic levels at currents up to 25 milliamperes. All HL relays are packed in a 16-pin dual in-line package about 0.5-inch high. Pricing is $4.50 each in thousands with a delivery time of three to four weeks for small quantities.



Theta-J Relays Inc., 1 DeAngelo Drive, Bedford, Mass. 01730. Phone (617) 275-2575 [345]

Compact cathode-ray tube has 100-MHz bandwidth

An all-electrostatic cathode-ray tube for instrumentation applications features a 9-inch-diagonal screen, a vertical sensitivity of 6 volts per centimeter, and a bandwidth of 100 megahertz. Designated the DC5106, the tube is only 15.55 inches long and has maximum bulb dimensions of 8.43 by 6.50 inches. Applications for the DC5106, which has a mesh-lens, post-deflection scan-expansion

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Circle 209 on reader service card

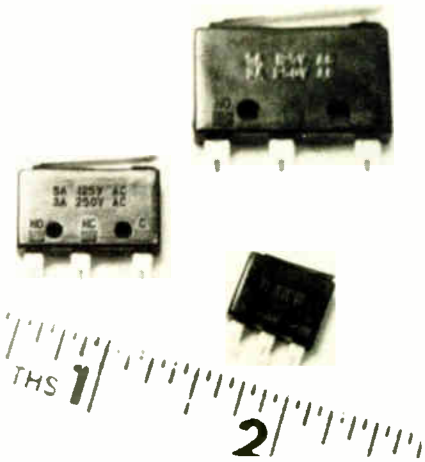
New products

system, include real-time signal analysis, medical equipment, and computer terminals.

DuMont Electronics Corp., 750 Bloomfield Ave., Clifton, N. J. 07015. Phone (201) 773-2000 [346]

Microswitches are highly reliable, extremely thin

Three new snap-action microswitches have been designed for applications in which size, weight, and reliability are critical factors. The precision single-pole/double-throw switches have a mechanical life of 1 million operations and an electrical life of 100,000 operations.



The switches are rated at 5 amperes at 125 V ac or 3 A at 250 V ac. Maximum operating force is 120 grams. Release force is 20 g. Differential travel is only 0.02 millimeter. The smallest of the three switches

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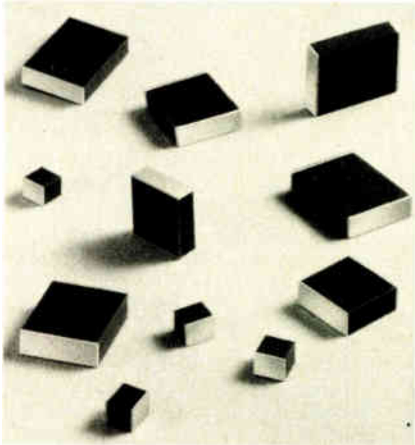
Circle 211 on reader service card

measures 0.5 by 0.41 by 0.21 inch. The units are available from stock.
Control Temp Inc., 10930 Grand Ave., Temple City, Calif. 91780 [348]

Ceramic-chip capacitors operate up to 4,000 V dc

High-voltage ceramic-chip capacitors designed for operation at working voltages up to 4,000 v dc are available with NPO/COG and BX/X7R dielectrics. Capable of providing high capacitance values at high



voltages, the units are intended for use in high-voltage power supplies and meter multiplier circuits. Capacitance values range up to 0.82 μF.
Johanson/Monolithic Dielectrics Division, Box 6456, Burbank, Calif. 91505 [347]

TOPICS

Components

Mag-Con Inc., St. Paul, Minn., announces the start-up of a new design and production capability for supplying custom-designed transformers for microprocessing equipment. . . .**Grayhill Inc., La Grange, Ill.,** has produced a printed-circuit-board-mountable version of its 16-position rotary switch that measures only 0.562 inch in diameter and extends less than 0.6 in. behind the panel. . . .**C.P. Clare & Co., Chicago, Ill.,** reduced the prices of its LA/LB relays by almost 30%.

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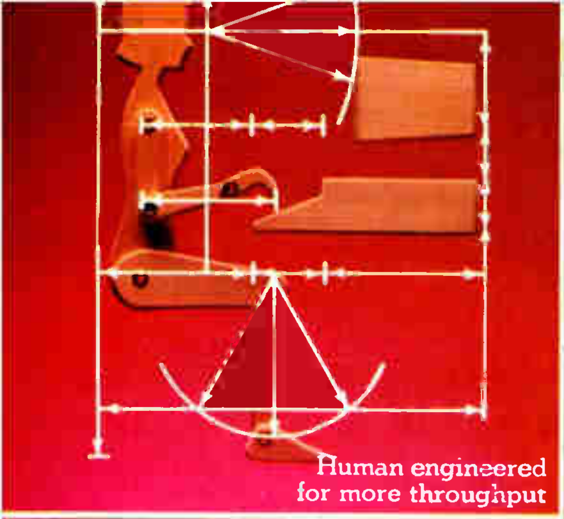

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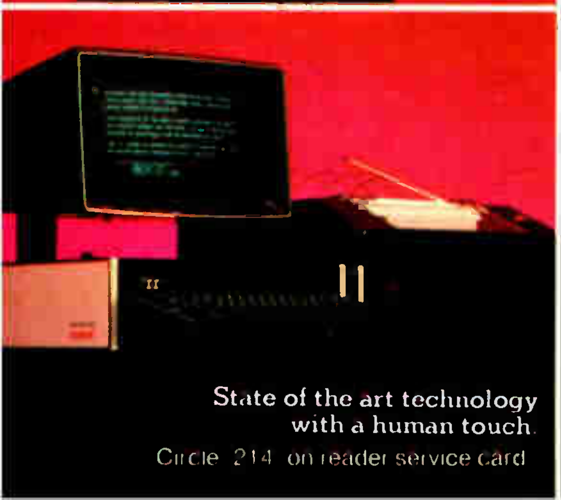

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Circle 214 on reader service card

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Industrial

S-d converter uses 0.25 watt

Low-profile module uses C-MOS circuitry, sells for $345 in small quantities

As more and more angular-positioning systems come into the realm of computer control, the demand for synchro-to-digital and resolver-to-digital converters continues to increase. But designers do not simply want more converters, they want converters that take up less space, consume less power (so they can be packed tightly without overheating), and, of course, cost less money. Enter the ILC Data Device Corp. model SDC-632.

This is a 12-bit tracking converter that can be configured to handle either resolver or synchro inputs. It uses complementary-MOS circuitry to keep total power consumption down to 225 milliwatts and is housed in a 4-ounce module that measures 3.125 by 2.625 by 0.42 inches.

The SDC-632 is actually a series of 12 products. There is a choice of synchro or resolver input. There are two operating temperature ranges: 0°C to 70°C and −55°C to 105°C; and there are three input voltages: 11.8, 26, and 90 volts. The reference input can vary from 20 to 130 v and from 360 to 1,000 hertz.

The converter will maintain its full 8.5-minute accuracy for input rates that do not exceed five revolutions per second. It exhibits no lag error for inputs that meet this criterion. For a 179° step change, the unit will settle to within one least significant bit within 120 milliseconds (typical) and will settle to a final value within 160 ms (typical) and 240 ms (maximum). At an acceleration of 3,000°/s^{-2}, the converter will lag by one LSB.

Two power supplies are required: 15 v dc and 4.5 v dc. The lower voltage sees a resistance of at least 10 kilohms, so essentially all of the power is supplied by the 15-v input. Typical current demand is 10 milliamperes, with 15 mA specified as maximum.

A key feature of the SDC-632 is full isolation of the synchro or resolver input and the reference input. Transformer isolation and high input impedances on both reference and signal inputs eliminate loading errors. And a ratiometric conversion technique makes the unit insensitive to voltage and frequency variations. The device has a fanout capability of four TTL loads. For quantities of one to nine pieces, the 0°C to 70°C converters sell for $345 each, while the extended-range units go for $395. Delivery is from stock to four weeks.

ILC Data Device Corp., Airport International Plaza, Bohemia, N.Y. 11716. Phone (516) 567-5600 [371]

Thermocouple compensator powers itself for 200 days

A built-in battery allows thermocouple reference-junction compensators in the NC420 series to operate continuously for up to 5,000 hours (more than 200 days) or up to three years with intermittent use. The encapsulated solid-state units replace ice baths and ovens. Standard reference temperature setting is 0°C, but other temperatures are available. The units are typically accurate to within 0.25°C at 25°C and to within 0.75°C over the range from 0°C to 50°C. The standard model has an output impedance of less than 250 ohms. The compensator is cylindrical in shape, with a length of 3 inches and a diameter of 0.625 in. It sells for $69 each in lots of 1 to 24

cable both supplies the device with the power required by its impedance converter and carries away the low-impedance output signal.

Endevco D. I. D., 30700 Rancho Viejo Road, San Juan Capistrano, Calif. 92675. Phone (714) 493-8181 [376]

Enclosed linear transducer is accurate within 100 μin.

The model SST linear transducer is a fully enclosed device that is accurate to within better than 100 microinches. Available with either a 2- or a 4-inch stroke, the SST is designed for use in production environments as either a feedback element or as a primary measurement tool. Its outputs are compatible with transistor-transistor-logic levels for easy control interfacing.

Dynamics Research Corp., 60 Concord St., Wilmington, Mass. 01887. Phone (617) 438-3900 [373]

Thermistors measure from 500°C to 1,000°C

A line of ionic conduction thermistors is designed for measurement and control applications in the temperature range from 500°C to 1,000°C. The standard device has a nominal dc resistance of 10 kilohms at 750°C and a temperature coefficient of about −1%/°C. Other units, with 750°C resistances from 3 kΩ to 12 kΩ, are also available.

Because the high-temperature thermistors are ionic devices, their

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For further information, write to Oxy Metal Industries Corporation, 21441 Hoover Rd., Warren, MI 48089.

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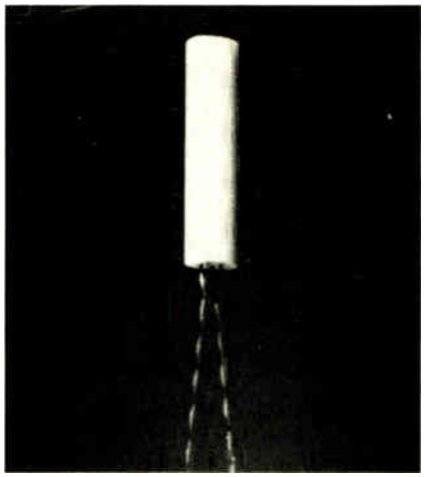
Circle 219 on reader service card



ac behavior is different from their behavior at dc. When operated at 60 hertz, for example, a 10-kΩ unit will exhibit an impedance of 6.3 kΩ. Intended for such demanding applications as measuring automobile exhaust-gas temperatures, the rugged Hi-Temp devices are bead thermistors spot-welded to twisted nickel-chrome leads and encapsulated in alumina. They are available with body lengths from 0.25 to 2 inches.

Fenwal Electronics, 63 Fountain St., Framingham, Mass. 01701. Phone (617) 872-8841 [377]

Pyroelectric IR detector includes signal conditioning

Despite its low 100-piece price of $29 each, the model 406 pyroelectric infrared detector includes a sensing element and an impedance-converting source follower/voltage amplifier. The detector has a sensing area 2 millimeters in diameter, a 10-hertz voltage responsivity of 275 volts per watt, an optical pass band that extends from 2 micrometers to 15 μm, and a specific detectivity (D*) of 1.8×10^8 cm-$\mathrm{Hz}^{1/2}$/W.

The model 406 uses a lithium tantalate wafer as a sensing element. A special germanium window with an antireflection coating can be supplied at no extra cost. The model 406 is available from stock.

Eltec Instruments Inc., P. O. Box 9610, Daytona Beach, Fla. 32020. Phone Fred H. Oettel at (904) 252-0411 [378]

Announcing the first major advance in magnetic shielding in 50 years.

The time is right for a revolutionary concept in magnetic shielding.

Increased sales of electronic equipment, a trend toward miniaturization, and intensified regulatory considerations have put increased emphasis on electromagnetic compatibility.

Consequently, electronics manufacturers need cost-effective magnetic shielding not plagued by fabrication problems and use limitations associated with conventional nickel alloys.

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To find out how METSHIELD fabric can help solve your shielding problems, phone John Dismukes at 201-455-4031 or Jack Thorp at 201-455-3306. Or send in the coupon.

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Mail to Metglas Products, Allied Chemical Corporation
7 Vreeland Road, Florham Park, NJ 07932

Allied Chemical
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New products/materials

High-stability thick-film resistors, which have been very difficult to produce, have now become a routine matter with duPont's Birox 1700 series of resistor inks. Besides providing temperature coefficients of less than 50 parts per million per degree Celsius, these thick-film compositions give high yields of close-tolerance resistors that change less than 0.1% in value after laser trimming. They are intended for use in such demanding applications as military, aerospace, telecommunications, and medical electronics.

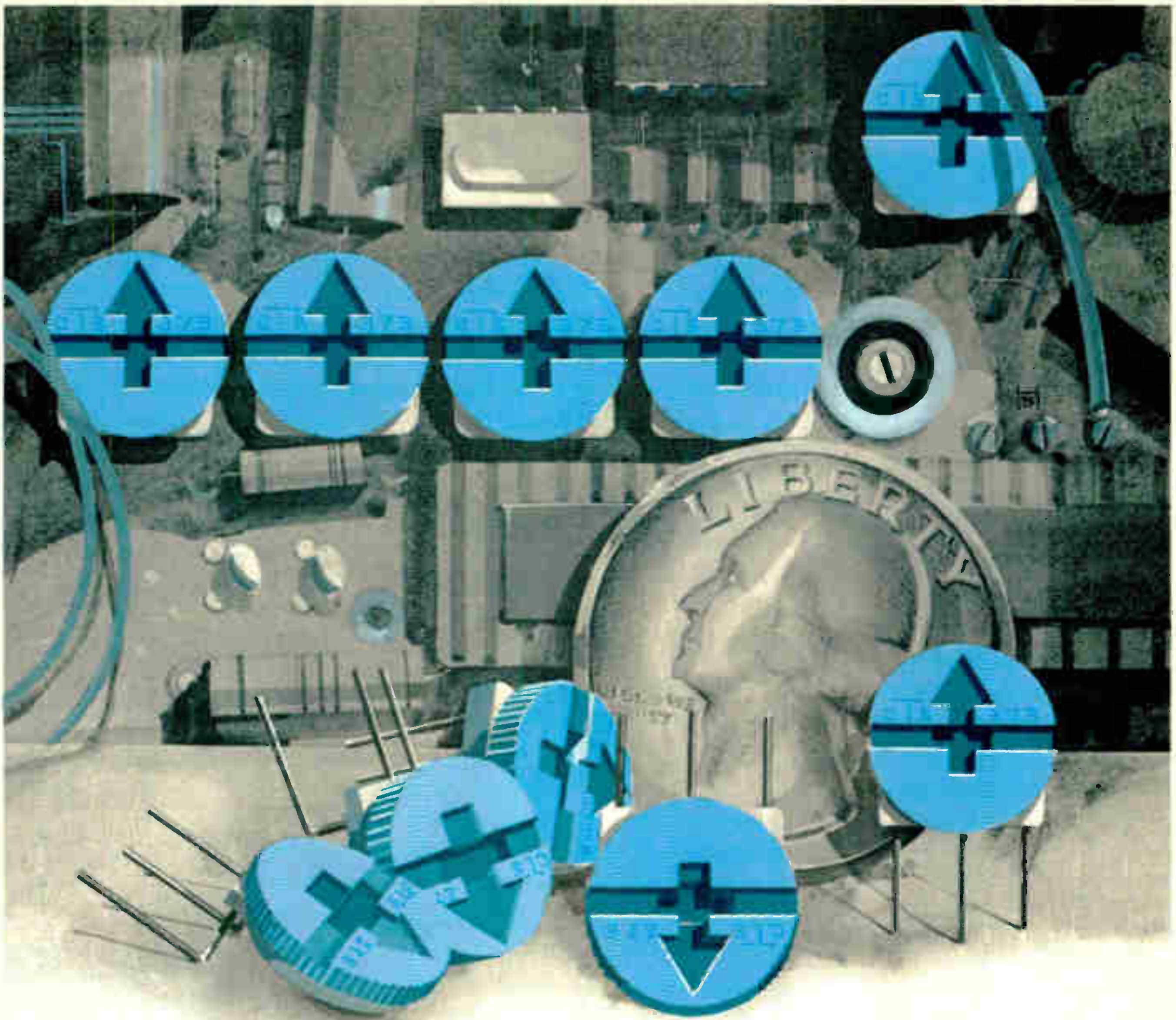
Additionally, the inks offer processing flexibility—they may be fired in cycles of only 30 to 60 minutes at a peak temperature of 850°C. A wide range of sheet resistivities is available, including values from 100 to 100,000 ohms per square. The compositions, which are designed for termination with silver-bearing conductors, exhibit minimal sensitivity to resistor geometry, as well as to modest variations in printing and firing conditions.

E. I. du Pont de Nemours & Co., Photo Products Department, Electronic Materials Division, Wilmington, Del. 19898 [476]

A nonmetallic conductive coating, Merix Anti-Static #79 is designed to prevent the build-up of static charges on all kinds of electronic circuit boards and components. After being diluted with its own volume of deionized water, the coating material is wiped onto the surface to be treated. On plastics it provides a surface resistivity of 20 to 100 megohms per square, while on glass it provides more than 100 megohms per square. The nonflammable material sells for $21.60 per gallon in lots of 60 gallons.

Merix Chemical Co., 2234 East 75th St., Chicago, Ill. 60649. Phone (312) 221-8242 [478]

Gallium-arsenide ingots up to 6 inches in diameter are now commercially available. The circular-cross-section Czochralski-grown boules are expected to provide substantial savings in wafer fabrication, labor, and yield-per-unit area because of lower edge losses. The material can



CTS mini cermet trimmers... low in price, high in performance.

Fantastic! Small ⅜" dia. (10mm), great performance and CTS reliability are only three reasons you should use our NEW series 375 single turn cermet trimmers. The low 25¢ price tag is still another.

CTS 375's, in six popular terminal styles, feature a low ± 100 ppm/°C standard temperature coefficient—throughout the resistance range. Power rating, 1 watt at 40°C; ½ watt at 70°C. CRV of 2%. Settability of .03%.

And the serrated adjustment knob doubles as a dust cover to protect the element from dirt, oil and other contaminants. It's a lot for so little. But you expect that from a company that's put millions into electronics for industry. For complete information, write **CTS OF WEST LIBERTY, INC.**, 6800 County Road 189, West Liberty, Ohio 43357 or phone (513) 465-3030.

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A world leader in cermet and variable resistor technology.

New products/materials

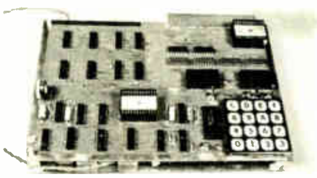
be supplied as ingots, as sliced wafers, or as wafers polished to Epidyne or customer specifications.
Epidyne Inc., 12525 Chadron Ave., Hawthorne, Calif. 90250. Phone (213) 772-4545 [477]

Ceramic adhesives that can be used at temperatures in excess of 2,800°F are offered in convenient kit form. Kit 970 includes four materials: one-component adhesive 918, which can be used up to 2,500°F; high-resistance model 919, for use up to 2,800°F; fast-setting number 940, which has a service temperature of

2,200°F; and high-strength adhesive 944 for use up to 2,000°F. The kit sells for $24.95. In small quantities, the individual adhesives sell for $25 per quart; for quantities of 5 to 12 quarts, the price is $20 a quart.
Cotronics Corp., 3379 Shore Parkway, Brooklyn, N.Y. 11235. Phone (212) 646-7996 [479]

A copper-base adhesive for use at elevated temperatures is intended to compete with silver- and palladium-base adhesives in hybrid-circuit fabrication. Usable up to 2,000°F, Aremco-Coat 543 can be cured at

1702A MANUAL EPROM PROGRAMMER



Features hex keypad, two digit hex address and two digit hex data display. Controls include load, clear, go! (step), key/copy, data in/data out, and counter up/down. Profile card includes high voltage pulse regulator, timing, 8 bit address and 8 bit data drivers/receivers. Two 6½" x 9" stacked cards with spacers. Allows programming in 20 minutes — copying in 5 minutes. Requires +5, −9, and +80 volts.

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Circle 100 on reader service card

16 POSITIONS

INTERSWITCH now offers two new 16-position thumbwheel switches – the Type H front mounting switch and the Type P rear mounting switch.

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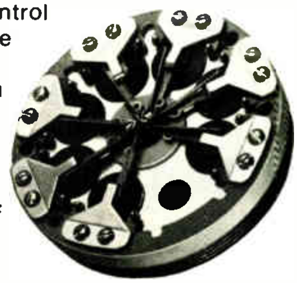
Circle 36 on reader service card

Name one other printer this small that prints multiple copies using standard paper

Don't even bother trying; only our DMPT-3 Miniature Alphanumeric Printer puts it all together like this. Granted, our 20-column workhorse is the industry's smallest alphanumeric impact printer. Granted, it packs the versatility of both "first line up" text and "first line down" print formats. Even so, that's just the beginning for the DMPT-3.

The truth is, you not only get multiple-copy capabilities, but you can use ordinary adding machine rolls instead of the special paper thermal printers require. You not only get a full alphanumeric capability, but enhanced characters and high 120 cps speeds as well. You'll graduate from messy ribbons to a drop-in ink platen with a 75,000-line life. And you can move up to microprocessor compatibility by putting our programmable control option between the DMPT-3 and the outside world. You get it all, but only in the DMPT-3.



For more details, call or write today.

PRACTICAL AUTOMATION, INC.
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Tel.: (203) 929-5381

Circle 225 on reader service card

New products/materials

temperatures as low as 250°F. It is supplied as a viscous paste that can be thinned for spraying; it can also be screen-printed or brushed on. The material has already been used to

attach alumina substrates to gold-plated Kovar packages. The minimum order of Aremco-Coat 543 is a half pint; it sells for $30.

Aremco Products Inc., P. O. Box 429, Ossining, N. Y. 10562. Phone Herbert Schwartz at (914) 762-0685 [480]

A glass-sealing material developed specifically for joining the two glass surfaces in liquid-crystal displays has the same coefficient of expansion as the soda-lime silicate glass used in LCDs. Called AVX 8800, the material has a proprietary vehicle system that burns out completely during glazing, resulting in a bond that is free of vehicle-related bubbles. The material's glazing and sealing profiles are identical, meaning that the same oven can be used for both processes.

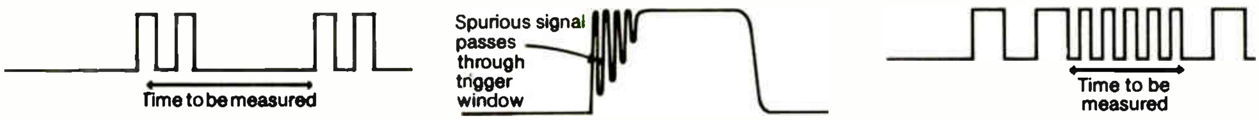
AVX Ceramics Corp., Materials Division, 10441 Roselle St., San Diego, Calif. 92121 [475]

A gold stripper formulated to strip gold from copper, steel, brass, or nickel without using any electric current is especially recommended for printed-circuit boards and other electronics applications where protection of the base metal is important. Supplied as a dust-free, free-flowing, highly soluble powder, Oxytron 620 is capable of removing 0.5 to 1.0 mil of gold per hour without attacking the underlying metal substrate.

Sel-Rex Division, Oxy Metal Industries Corp., 75 River Road, Nutley, N. J. 07110 [474]

The extras make the difference

Extras like variable trigger hold-off (with displayed hold-off time) and external reset/start allow spurious signals to be ignored, multiple pulse period measurement and even measurements on sections picked out of a pulse train.



The extras add up to a very versatile 9-digit timer/counter that can make many lab measurements easier--and some even possible for a single instrument setup.

High stability timebases, BCD and analog outputs, IEEE buss, internal battery and rack mounting are some of the options available.

Philips PM6620 series timer/counters from 80 to 1000 MHz; starting at $965.

Want more information or a demonstration? Call our toll-free Hotline number: 800 631-7172 (New Jersey residents: call collect), or contact: Philips Test & Measuring Instruments, Inc.:

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Circle 227 on reader service card

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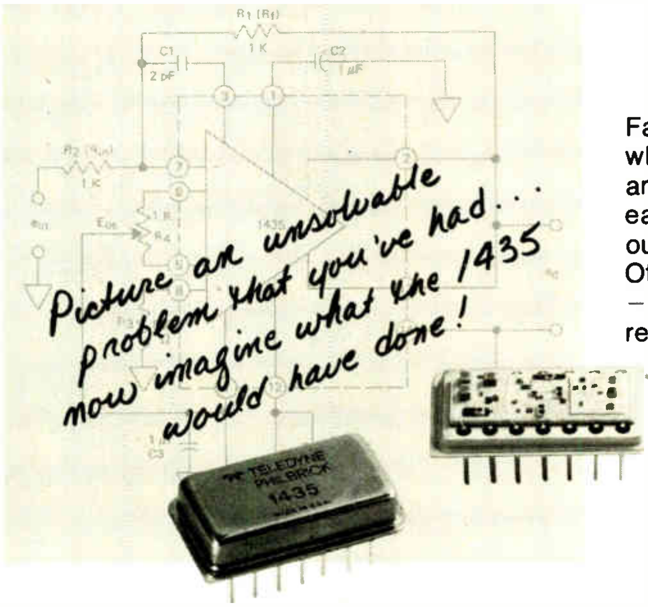

Far more people than you would have imagined! People who require the performance of a true differential input op amp at frequencies from DC to beyond 100 MHz, with the ease of using a 741 at 100 kHz. Those who want a ±5 volt output to reach an accuracy of 0.01% in 70 nanoseconds. Others who require this state-of-the-art performance from −55°C to +125°C, and many more who require the high reliability provided by MIL STD 883 processing.

Your application may not need the full temperature range or the hermetically sealed DIP, but for many industrial applications these and other features of the new Video Op Amp offer you vital reliability.

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Circle 40 on reader service card

New literature

Simulator-based logic testing. Application note AN 210-1 is a tutorial text designed to help the digital-circuit designer and test engineer understand the technology of modeling and simulation. Included in this 48-page booklet are the fundamentals of digital testing and logic circuit simulation. Inquiries Manager, Hewlett-Packard Co., 1501 Page Mill Road, Palo Alto, Calif. 94304. Circle reader service number 421.

UL specs. Questions most frequently asked concerning the specifying of products are answered in a new brochure, "How to Specify Products That Meet UL Safety Requirements." It is intended to aid architects, specification writers, insurance underwriters, consultants, and others. Underwriters Laboratories Inc., Public Information Office, 207 E. Ohio St., Chicago, Ill. 60611 [422]

Ion implantation. In a series of technical reports, practical information is provided on the semiconductor production process. Included in the series are the basics of ion-implantation equipment selection (VR-123) and features of high- and medium-current ion-implantation machines (VR-122). Varian, 611 Hansen Way, Palo Alto, Calif. 94303 [423]

Vacuum gauges. A wide variety of gauges are described in this new 23-page catalog. Featured is the new Penthervac GPT-450 continuous reading Penning-Thermistor gauge, which automatically switches pressure scales through 11 decades. Pressure ranges from 1 atmosphere through 10^{-10} torr are covered by various sensing elements and matching controllers. CVC Products, Inc., 525 Lee Road, P.O. Box 1886, Rochester, N.Y. 14603 [424]

Photomultiplier tubes. Besides providing up-to-date information on photomultiplier tubes, a new catalog contains complete information on related sockets, magnetic shields, and power supplies. Specifications for 118 types of photomultipliers and related equipment are included. RCA

THE FASTEST, MOST DEPENDABLE, MOST VERSATILE STRIP CHART RECORDER ANYWHERE.

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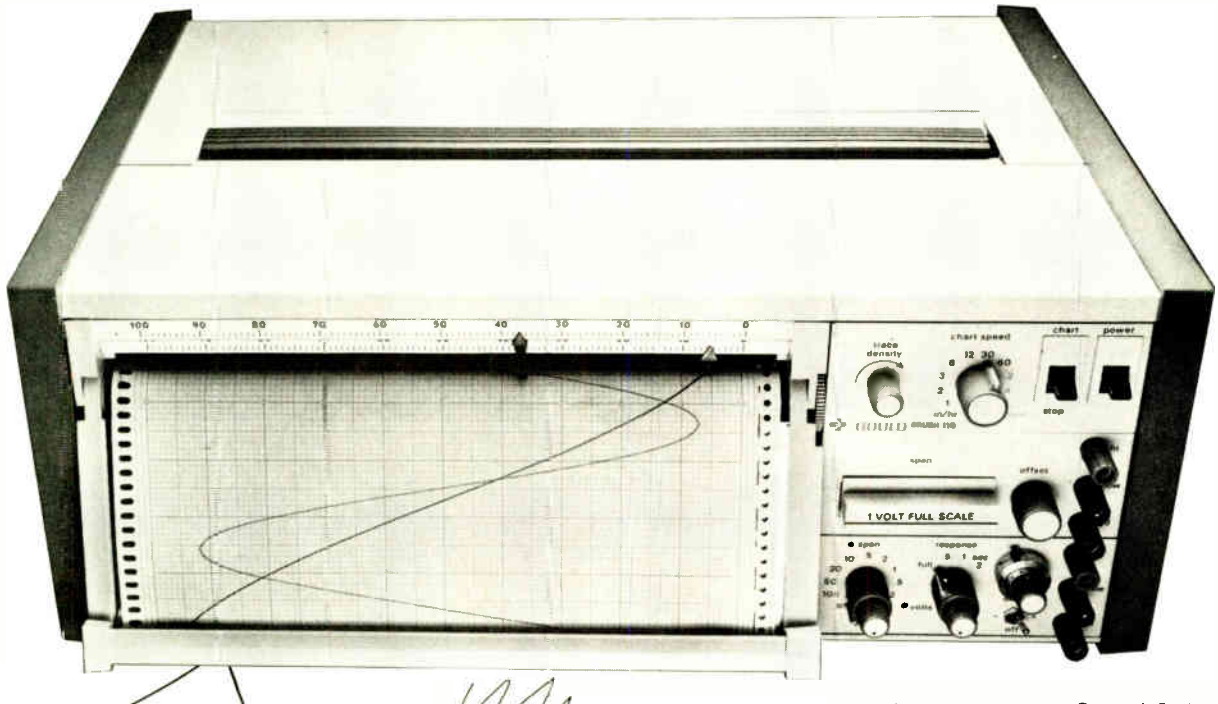
The pen tip warms up in just milliseconds. So it can produce accurate traces even during a series of short movements. And response time is exceptional. Full-scale response time is 250 milliseconds, which enables it to record fast-changing signals more faithfully than most other strip charts.

When it comes to reliability, we back up our promise with a lifetime pen guarantee. One reason we can make such a strong guarantee is that the special ceramic pen tip is virtually wear-free. No frequent, costly pen replacements. And although other pens are sometimes damaged by excessive off-scale input signals, ours is not because we use hard-electronic limiters and soft mechanical stops.

Then take versatility. The 110 has features that let you tailor it to your exact application. For example, you can choose from ten chart speeds. A selection of plug-in signal conditioners accommodate a wide range of input signals. Charts may be pulse-driven by an external device. And an optional solid state electronic chart integrator follows positive and negative signals up to 4 times full scale on the analog channel.

We don't believe there's another strip chart recorder in the market that is as fast, dependable and versatile. But don't take our word for it. We'll be happy to give you a demonstration anytime, anywhere. Once you see it, we think you'll believe it too.



For brochure call toll free at (800) 325-6400 Extension 77
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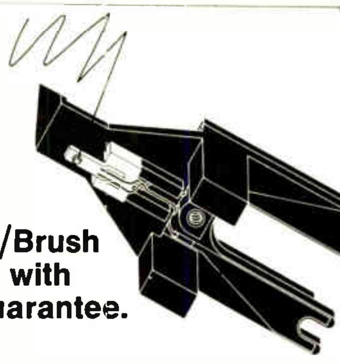

The GOULD/Brush thermal pen with a lifetime guarantee.

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GOULD

Distributor and Special Products Division, 200 Clements Bridge Road, Deptford, N. J. 08096. Attn: Sales Promotion Services [425]

C-MOS products. All available C-MOS standard products are listed in a new catalog. Specifications and functional and pinout information on 98 different SCL4000B-series devices

and other items are offered. A description of the new Solid Plus low-cost/high-reliability screening program as an option for the logic and memory products is included. Al Genchi, Solid State Scientific Inc., Montgomeryville, Pa. 18936 [426]

Components. A components catalog for industry and military use contains technical and ordering information for circuit-protection devices, relays, switches, buzzers, and flashers. Time-current characteristics are also included. Littlefuse Inc., 800 E. Northwest Highway, Des Plaines, Ill. [428]

IC cross-reference guide. Now you can easily find the correct direct replacement of one IC for another. A cross-reference guide lists linear ICs that can replace those of five other manufacturers. It is based on electrical and mechanical characteristics as shown in current published data. Control and interface circuits are included. Interchangeability in particular applications is not guaranteed. Texas Instruments Inc., Inqui-

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We put it together to demonstrate Cutler-Hammer's unique capability to produce custom—and even proprietary—switch "specials" to satisfy virtually any end-product requirement.

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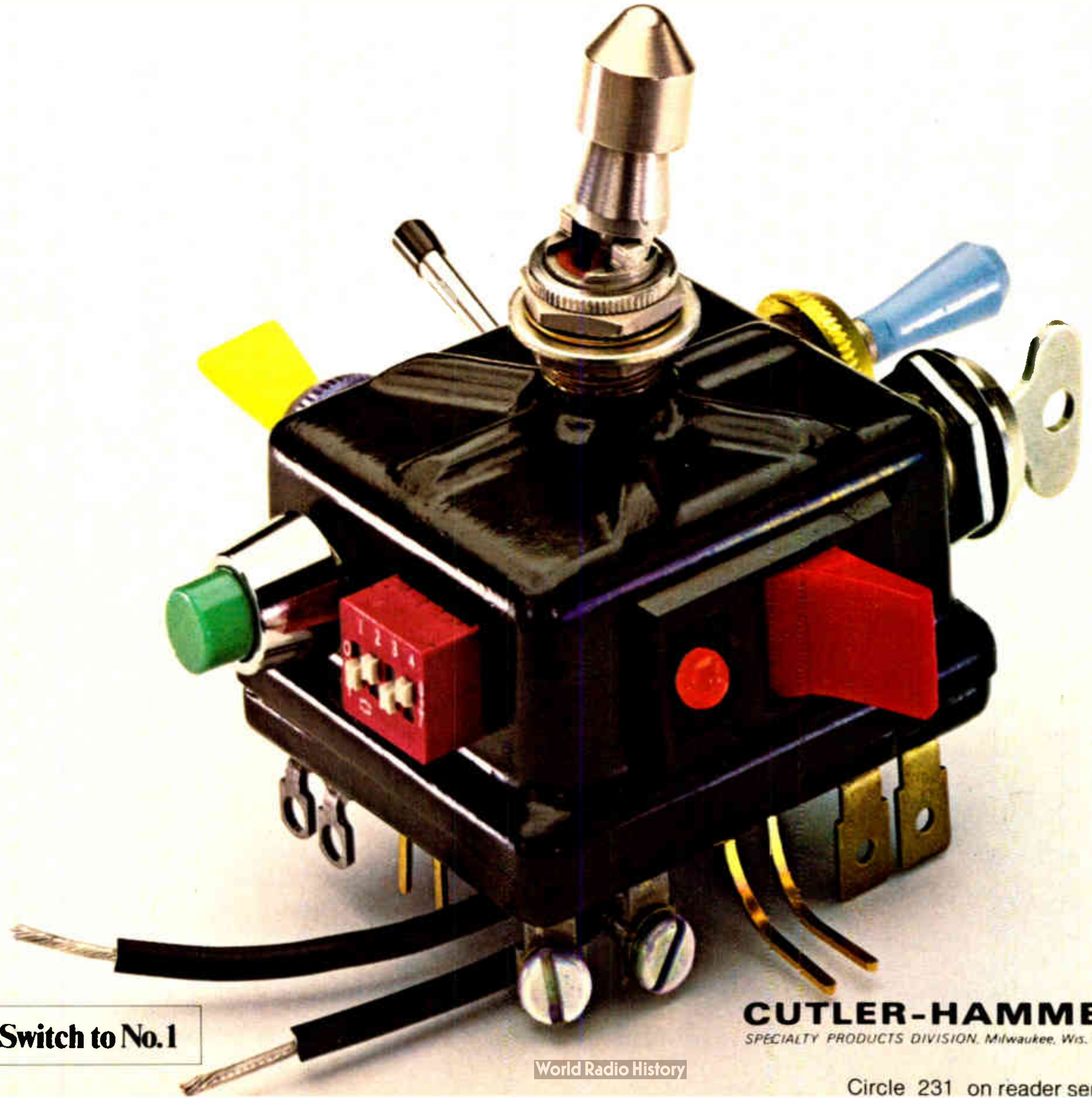

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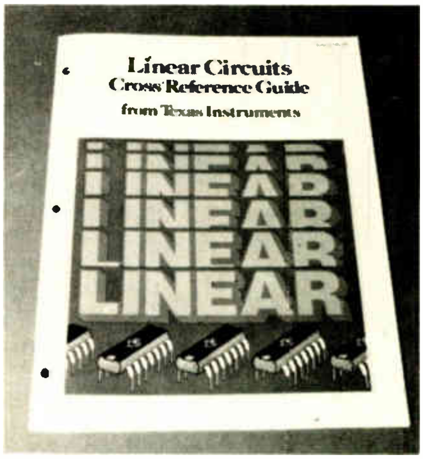
SPECIALTY PRODUCTS DIVISION, Milwaukee, Wis. 53201

Circle 231 on reader service card

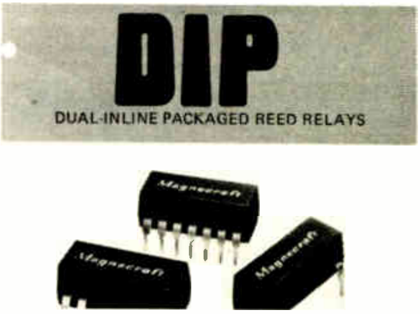
New literature



ry Answering Service, P. O. Box 5012, M/S 51 (Attn: Bulletin CB-245), Dallas, Texas 75222 [429]

Readout displays. Catalog SG744 provides detailed descriptions and specifications for incandescent, neon and light-emitting-diode readout displays. Its 54 pages cover a product line of four different character heights in discrete character modules, integrated-module and decoder-driver packages, and groups of characters in complete displays including bezel assemblies or panel brackets. A glossary of terms is included. Dialight, a North American Philips Co., 203 Harrison Place, Brooklyn, N. Y. 11237 [430]

DIP relays. Characteristics of the Magnecraft relay line in dual in-line packages are listed in a new 16-page booklet. There is also a section of application data, which provides



potential users with applications information. The line of relays includes 1 Form A, 2 Form A, 1 Form B, 1 Form C and 2 Form C. High-reliability, mercury, and position-free mercury types are also

B&K-PRECISION's new 3½ digit DMM

For over two years, our competition has been trying to figure out how B&K-PRECISION could sell a full-feature 3-digit DMM for only $99.95. They've dissected it, analyzed it, and some even asked us how we did it. Well, they can start all over because we did it again!

B&K-PRECISION's new Model 2800 portable DMM features 3-1/2 digit display, auto-zeroing and 100% overrange reading for only $99.95. Basic DC accuracy is 1%. Twenty-two ranges read up to 1000 volts DC or AC, 1000mA and 10 megohms.

All ranges are well protected against overloads. Even if you should accidentally apply +1000VDC to the 2800 while switched to an ohms range, no instrument damage will result. All DC and AC voltage ranges are protected up to ±1000 volts DC or AC. The current ranges receive the double protection of diodes and a series fuse.

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Strain gauges. A new brochure, #100-1, is available for users of strain gauges in stress analysis. A strain-gauge selector chart is included. BLH Electronics, 42 Fourth Ave., Waltham, Mass. 02154 [431]

IC sockets. A 72-page catalog of high-reliability integrated-circuit sockets, socketboard systems, and IC interconnect accessories includes a special test-data section. This section gives details on operating temperatures, insertion and withdrawal forces, contact resistance, and similar parameters. Copies of the catalog are offered by Robinson-Nugent Inc., 800 East Eighth St., New Albany, Ind. 47150 [432]

Bell 301/303 Current Interface. A convenient wallet card that contains the Current Interface chart for Bell 301/303 modems is available from International Data Sciences Inc., 100 Nashua St., Providence, R.I. 02904. The chart gives the pin assignment, common mnemonic name, direction of signal flow, and the function of each signal in the Current Interface. [433]

Paralleling semiconductors. Tech Tips 5-6, entitled "A Graphical Approach to Paralleling Semiconductors," helps design engineers determine how many devices must be connected in parallel to satisfy the demands of a high-current system. An important point stressed in the note is the necessity for matching the forward voltage drops of the semiconductors at or near the ultimate operating current. For a copy, write to Semiconductor Division, Westinghouse Electric Corp., Youngwood, Pa. 15697. [434]

Using a levelmeter. An application note that tells how a frequency-selective level meter can be used to perform five different types of tests is offered by Cushman Electronics Inc., 830 Stewart Drive, Sunnyvale, Calif. 94086. Ask for Product Application No. 7. [435]

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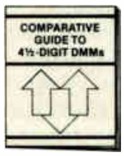

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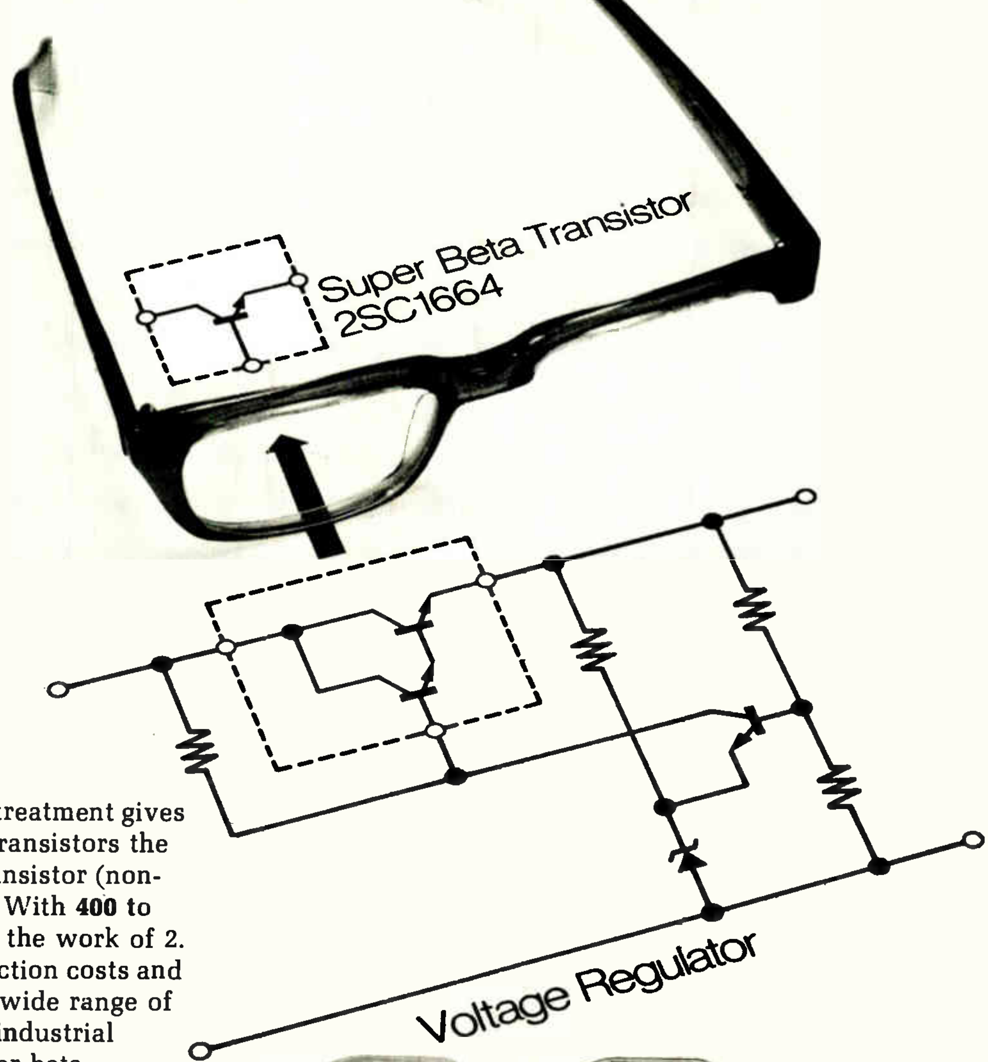

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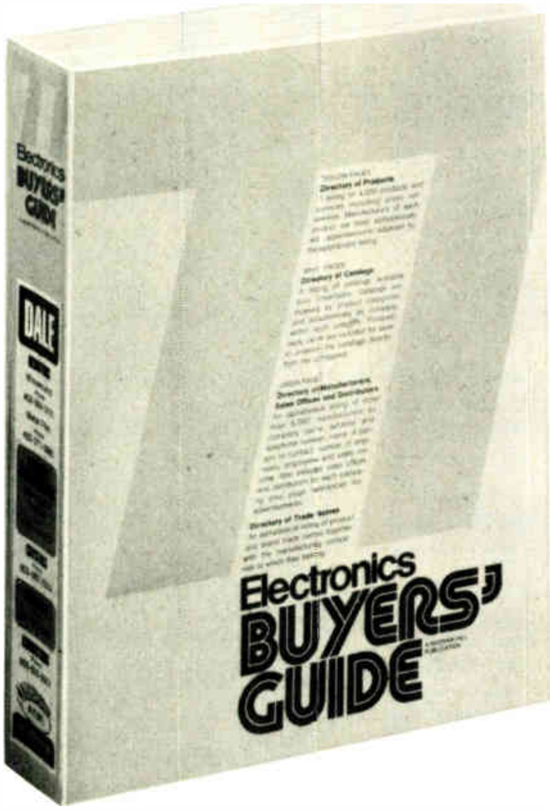

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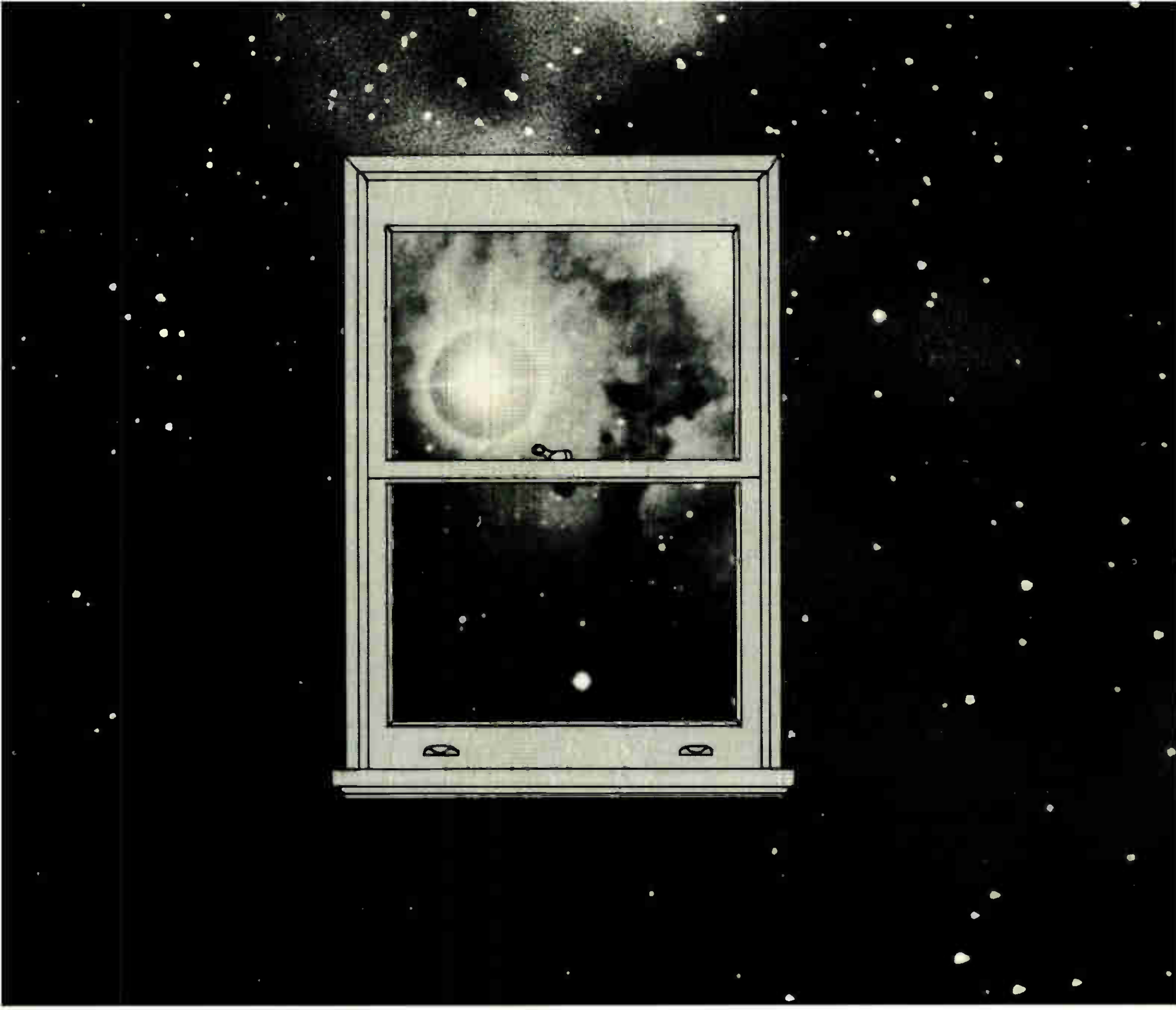

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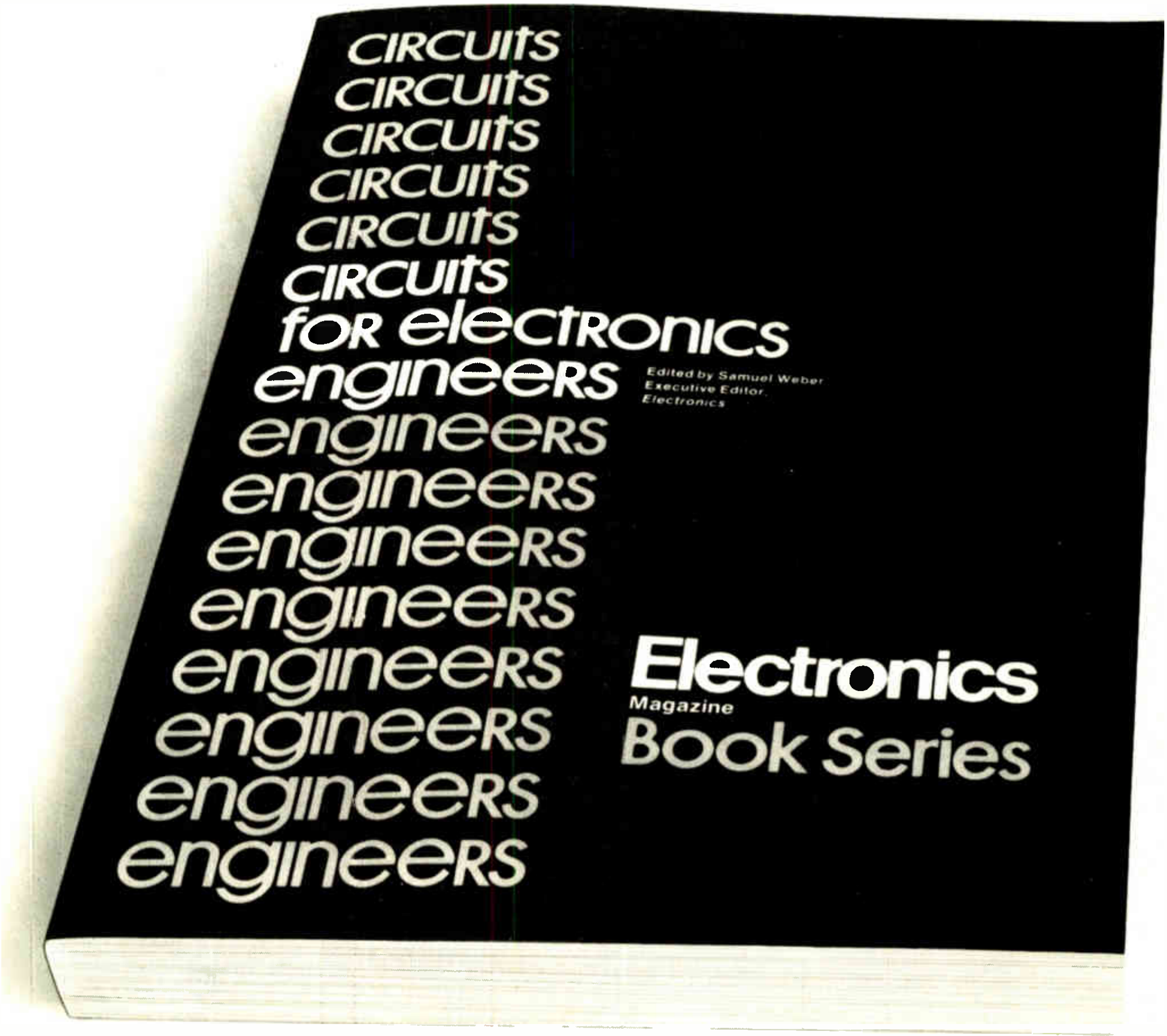

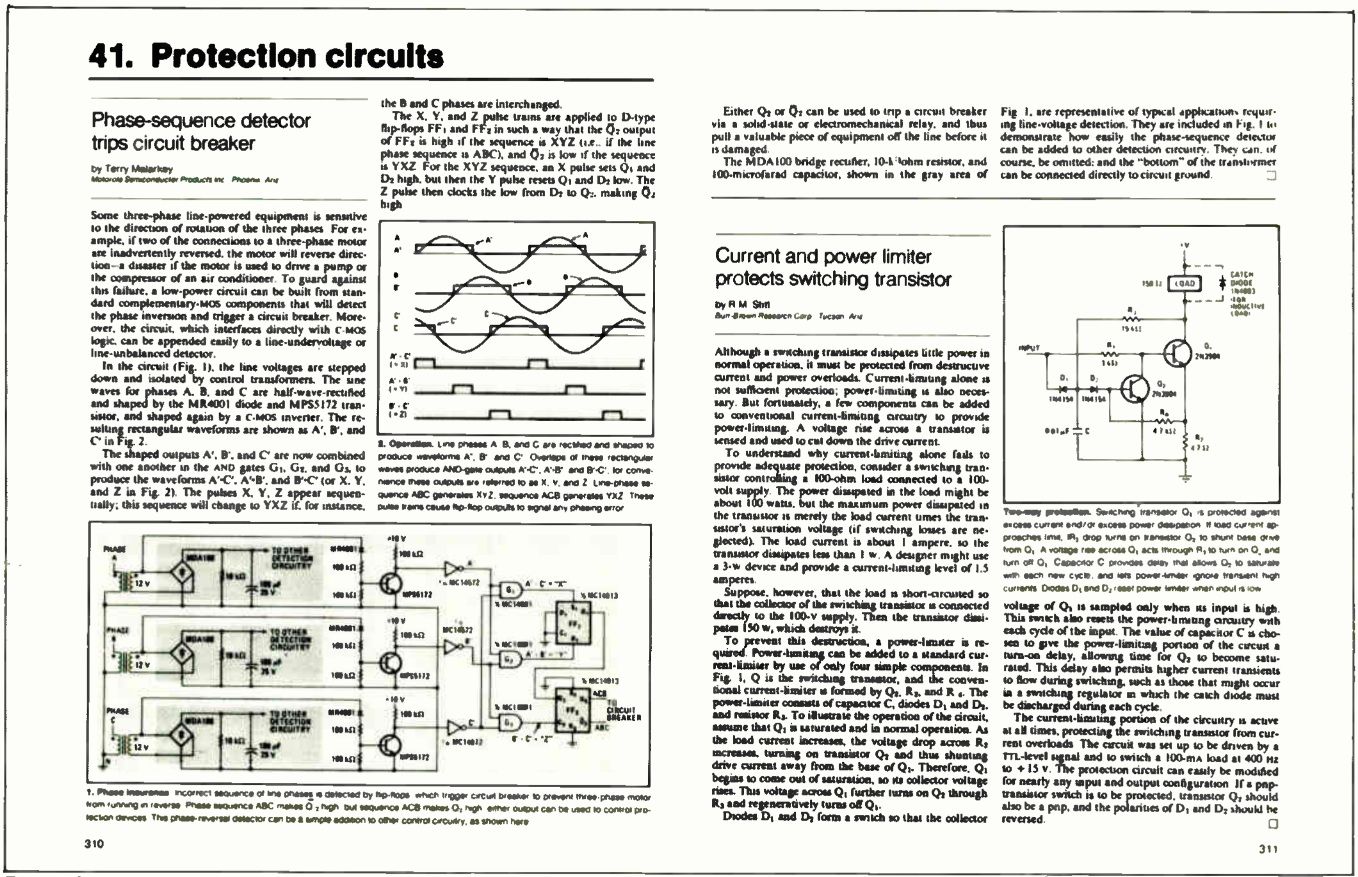

41. Protection circuits

Phase-sequence detector trips circuit breaker

by Terry Malarkey
Motorola Semiconductor Products Inc Phoenix Ariz

Some three-phase line-powered equipment is sensitive to the direction of rotation of the three phases. For example, if two of the connections to a three-phase motor are inadvertently reversed, the motor will reverse direction—a disaster if the motor is used to drive a pump or the compressor of an air conditioner. To guard against this failure, a low-power circuit can be built from standard complementary-MOS components that will detect the phase inversion and trigger a circuit breaker. Moreover, the circuit, which interfaces directly with C-MOS logic, can be appended easily to a line-undervoltage or line-unbalanced detector.

In the circuit (Fig. 1), the line voltages are stepped down and isolated by control transformers. The sine waves for phases A, B, and C are half-wave-rectified and shaped by the MR4001 diode and MPS5172 transistor, and shaped again by a C-MOS inverter. The resulting rectangular waveforms are shown as A′, B′, and C′ in Fig. 2.

The shaped outputs A′, B′, and C′ are now combined with one another in the AND gates G_1, G_2, and G_3, to produce the waveforms A′·C′, A′·B′, and B′·C′ (or X, Y, and Z in Fig. 2). The pulses X, Y, Z appear sequentially; this sequence will change to YXZ if, for instance, the B and C phases are interchanged.

The X, Y, and Z pulse trains are applied to D-type flip-flops FF_1 and FF_2 in such a way that the $\bar{Q}_2$ output of FF_2 is high if the sequence is XYZ (i.e., if the line phase sequence is ABC), and $\bar{Q}_2$ is low if the sequence is YXZ. For the XYZ sequence, an X pulse sets Q_1 and D_2 high, but then the Y pulse resets Q_1 and D_2 low. The Z pulse then clocks the low from D_2 to Q_2, making $\bar{Q}_2$ high.

2. Operation. Line phases A, B, and C are rectified and shaped to produce waveforms A′, B′ and C′. Overlaps of these rectangular waves produce AND-gate outputs A′·C′, A′·B′ and B′·C′; for convenience these outputs are referred to as X, Y, and Z. Line-phase sequence ABC generates XYZ, sequence ACB generates YXZ. These pulse trains cause flip-flop outputs to signal any phasing error.

1. Phase insurance. Incorrect sequence of line phases is detected by flip-flops, which trigger circuit breaker to prevent three-phase motor from running in reverse. Phase sequence ABC makes $\bar{Q}_2$ high, but sequence ACB makes Q_2 high; either output can be used to control protection devices. This phase-reversal detector can be a simple addition to other control circuitry, as shown here.

310

Either Q_2 or $\bar{Q}_2$ can be used to trip a circuit breaker via a solid-state or electromechanical relay, and thus pull a valuable piece of equipment off the line before it is damaged.

The MDA100 bridge rectifier, 10-kilohm resistor, and 100-microfarad capacitor, shown in the gray area of Fig. 1, are representative of typical applications requiring line-voltage detection. They are included in Fig. 1 to demonstrate how easily the phase-sequence detector can be added to other detection circuitry. They can, of course, be omitted; and the "bottom" of the transformer can be connected directly to circuit ground.

Current and power limiter protects switching transistor

by R M Stitt
Burr-Brown Research Corp Tucson Ariz

Although a switching transistor dissipates little power in normal operation, it must be protected from destructive current and power overloads. Current-limiting alone is not sufficient protection; power-limiting is also necessary. But fortunately, a few components can be added to conventional current-limiting circuitry to provide power-limiting. A voltage rise across a transistor is sensed and used to cut down the drive current.

To understand why current-limiting alone fails to provide adequate protection, consider a switching transistor controlling a 100-ohm load connected to a 100-volt supply. The power dissipated in the load might be about 100 watts, but the maximum power dissipated in the transistor is merely the load current times the transistor's saturation voltage (if switching losses are neglected). The load current is about 1 ampere, so the transistor dissipates less than 1 w. A designer might use a 3-w device and provide a current-limiting level of 1.5 amperes.

Suppose, however, that the load is short-circuited so that the collector of the switching transistor is connected directly to the 100-v supply. Then the transistor dissipates 150 w, which destroys it.

To prevent this destruction, a power-limiter is required. Power-limiting can be added to a standard current-limiter by use of only four simple components. In Fig. 1, Q is the switching transistor, and the conventional current-limiter is formed by Q_2, R_3, and R_4. The power-limiter consists of capacitor C, diodes D_1 and D_2, and resistor R_3. To illustrate the operation of the circuit, assume that Q_1 is saturated and in normal operation. As the load current increases, the voltage drop across R_2 increases, turning on transistor Q_2 and thus shunting drive current away from the base of Q_1. Therefore, Q_1 begins to come out of saturation, so its collector voltage rises. This voltage across Q_1 further turns on Q_2 through R_3 and regeneratively turns off Q_1.

Diodes D_1 and D_2 form a switch so that the collector voltage of Q_1 is sampled only when its input is high. This switch also resets the power-limiting circuitry with each cycle of the input. The value of capacitor C is chosen to give the power-limiting portion of the circuit a turn-on delay, allowing time for Q_2 to become saturated. This delay also permits higher current transients to flow during switching, such as those that might occur in a switching regulator in which the catch diode must be discharged during each cycle.

Two-way protection. Switching transistor Q_1 is protected against excess current and/or excess power dissipation. If load current approaches limit, IR_2 drop turns on transistor Q_2 to shunt base drive from Q_1. A voltage rise across Q_1 acts through R_3 to turn on Q_2 and turn off Q_1. Capacitor C provides delay that allows Q_2 to saturate with each new cycle, and lets power-limiter ignore transient high currents. Diodes D_1 and D_2 reset power limiter when input is low.

The current-limiting portion of the circuitry is active at all times, protecting the switching transistor from current overloads. The circuit was set up to be driven by a TTL-level signal and to switch a 100-mA load at 400 Hz to +15 v. The protection circuit can easily be modified for nearly any input and output configuration. If a pnp-transistor switch is to be protected, transistor Q_2 should also be a pnp, and the polarities of D_1 and D_2 should be reversed.

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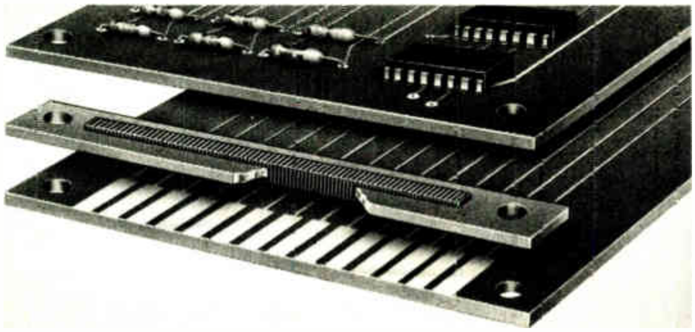

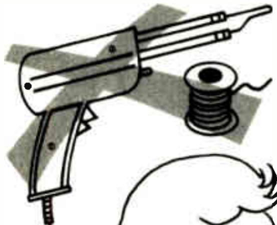

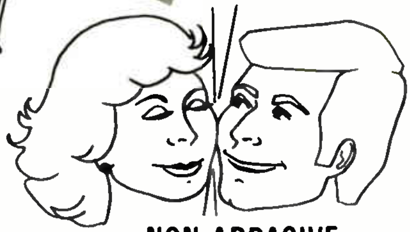

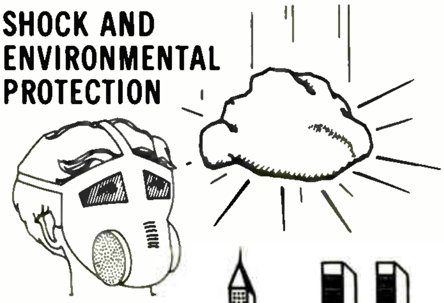

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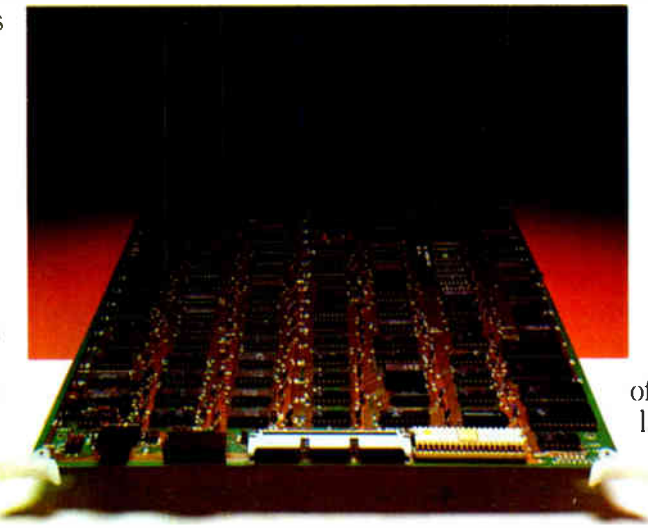

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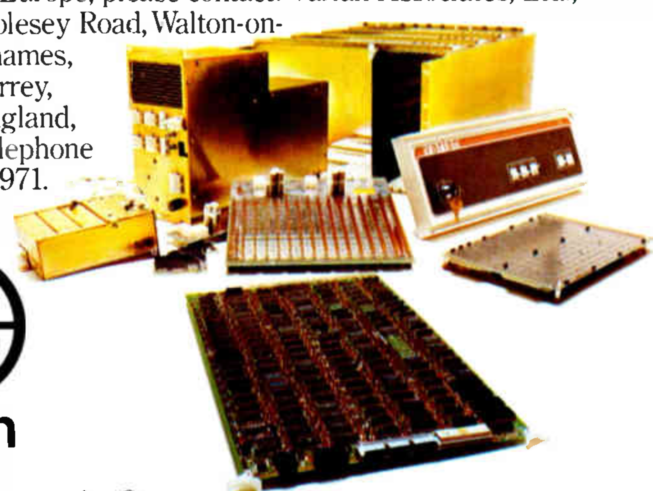

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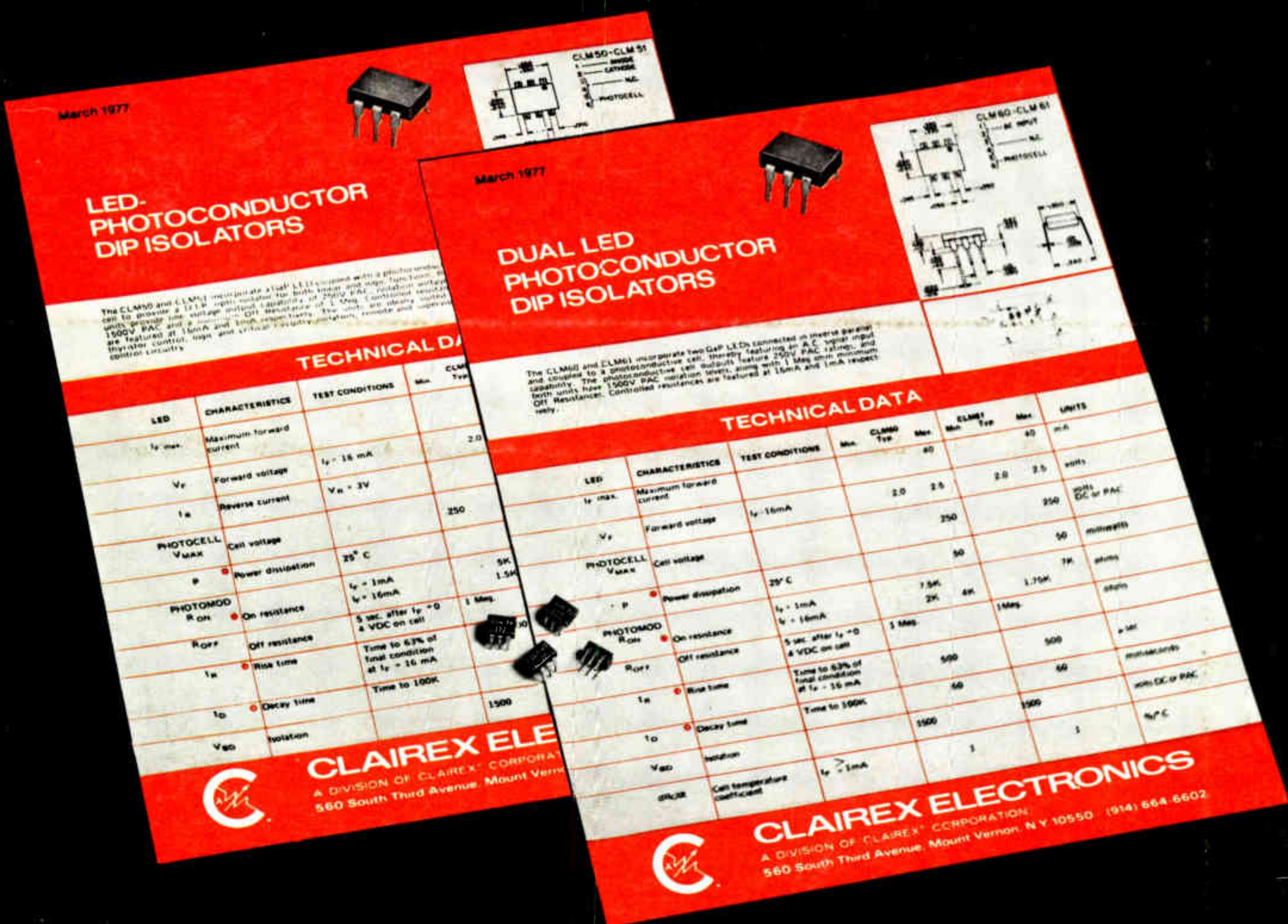

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