MAY 8, 1980

NCC REPORT: COMPUTER MAKERS BRACE FOR SOFTWARE CRUNCH/142

What's behind the sudden computer price rise/96

Shifting to gigahertz designs with magnetostatic-wave devices/123

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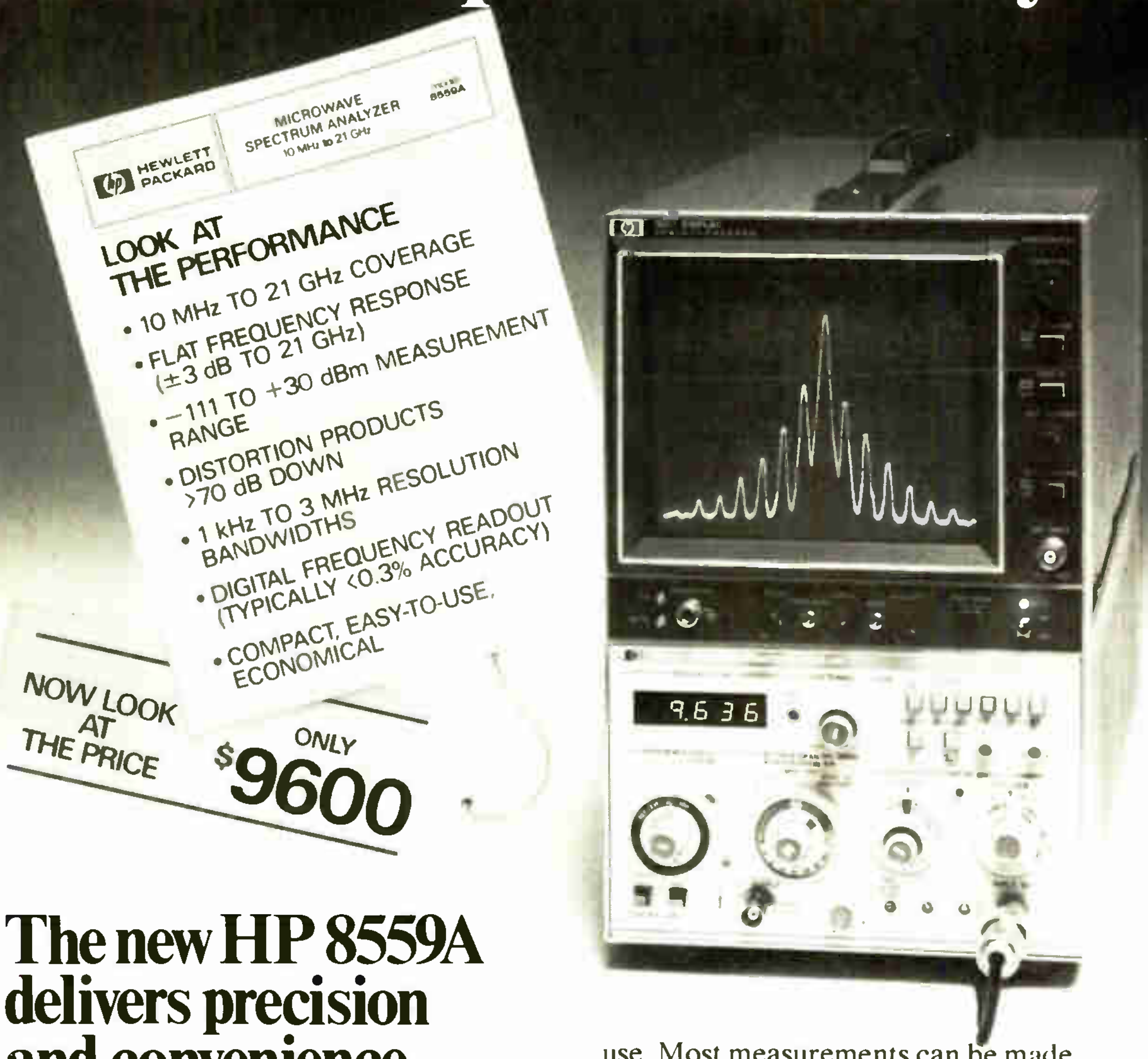

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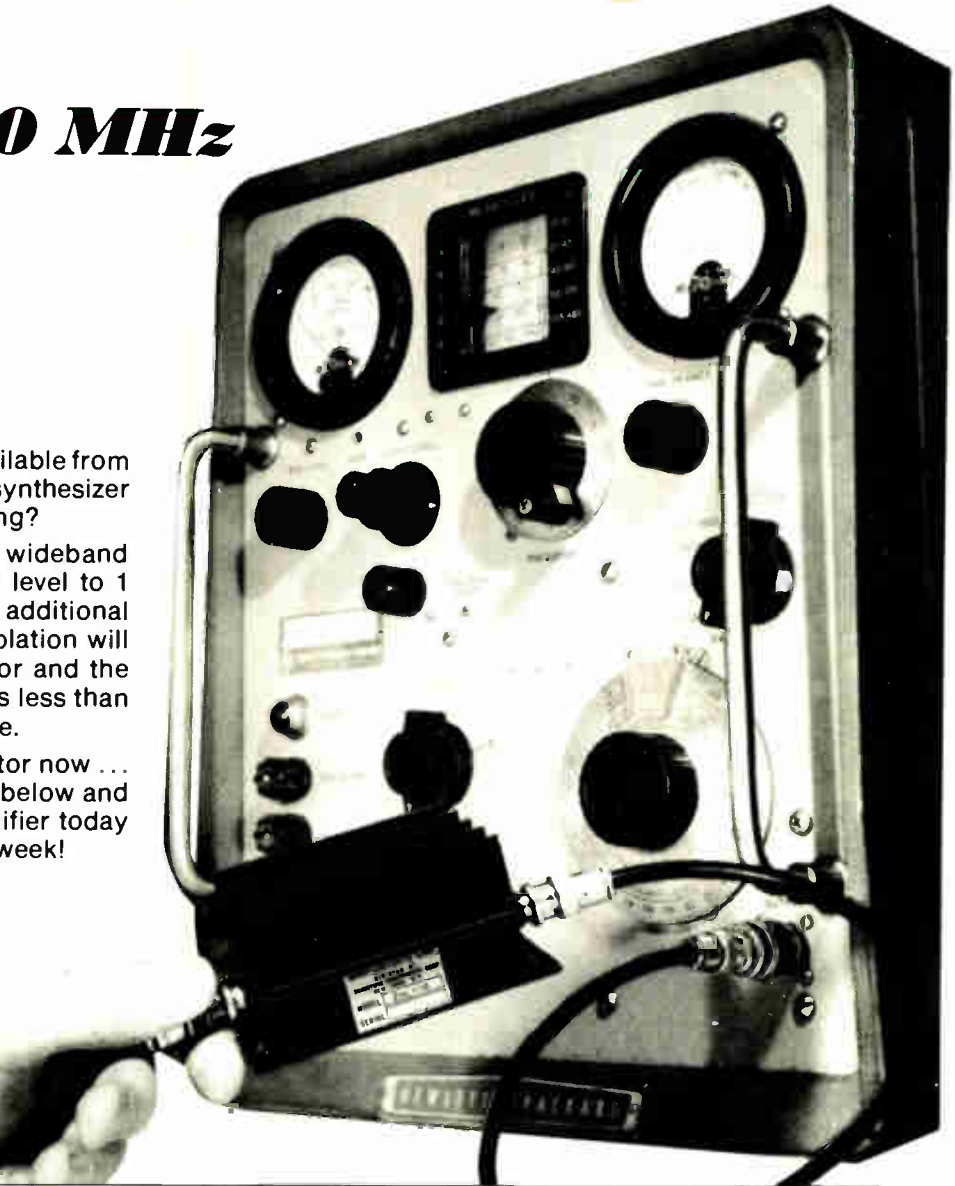

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Electronics
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Highlights

Cover: 8087 handles math for microprocessors, 114

The new number cruncher in the 8086 family fully implements the proposed IEEE standard for floating-point numerics—and offers a few extensions as well. It has high immunity to overflow, underflow, and errors, thanks to a "temporary real" data format that allows rounding of intermediate results. The high-performance MOS math-processing chip typically boosts the 8086's calculation rate by a factor of 100.

Cover is by Art Director Fred Sklenar.

Motorola reveals strategies for 16-bit microcomputer battle, 89

With thousands of 68000 microprocessors coming off the line each month, doubts expressed in some industry quarters that Motorola Inc. will soon have peripherals ready to support them are countered by an announced schedule of nearly a dozen peripheral chips. Supporting the firm's intention to sell boxed 32-bit systems, planned silicon includes a memory management unit. Positions of other industry competitors begin to solidify in light of this and recent word from Intel Corp.

Magnetostatic-wave prototypes operate in microwave region, 123

Thin yttrium-iron-garnet films grown epitaxially—with techniques developed for magnetic-bubble memories—support magnetostatic waves that can be used in filters and delay lines. Prototypes now being used in signal enhancers and other devices operate at 1 to 20 GHz.

Tight hardware control makes C code shine on small computers, 129

Code written in C, a structured, high-level programming language, can manipulate computer hardware in the direct manner assembly code does, making it especially useful for programming small computers. At the same time, C offers portability and productivity advantages.

NCC special report: computer makers brace for software crunch, 142

Surveyed on the eve of the National Computer Conference, engineering managers and research directors from a number of hardware makers have software very much on their minds. Customers demanding complete solutions to specific problems are in effect asking them to do more software work in the face of a programmer shortage.

. . . and in the next issue

Special report on the latest dynamic random-access memories . . . a flexible computerized processing facility for large- and very large-scale integrated circuits . . . developments in power MOS FETs . . . a new 32-bit mainframe with large virtual memory . . . breadboard-stage estimation of light power coupled into butted optical fiber.

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Publisher's letter

What better time to take a close look at technology trends in computers than the arrival of the annual National Computer Conference? That's exactly what computers and peripherals editor Tony Durniak has done (p. 142) as part of our package of articles and news stories tied to the NCC, which this year will be held in Anaheim, Calif.

As has been expected for some years, the thrust of computer technology has now shifted to domination by software. "I see this concentration on software as a portent of fundamental changes in the structure of the industry and in the way the industry does business," Tony observes. "Companies have begun to set up special software divisions and we may even see 'software factories'," he adds.

Computer companies have been talking about the growing importance of software for almost a decade. Now it's no longer a trend to talk about—it's here. "Software design cannot be ignored," Tony comments, "nor will the anticipation of so-called software in silicon come close to altering the situation. Design, distribution, and sale of software will engage the industry's closest attention for some time."

Turning to the hardware, Tony points out two major themes in state-of-the-art technology. First is what he calls the "continuum of computer power"—that is, the arrival of single very large-scale integrated chips with the capabilities of minicomputers or even mainframes. Second, as a result of the first trend, computer designers are probing deeper into semiconductor technology.

Besides this look at computer technical trends, the NCC package includes a review of the conference sessions (p. 150) and a special section devoted to exclusive new products to be introduced at the show (p. 185). Once again the number of exhibitors has increased, with over 400 companies occupying booths.

Those who attended the last NCC in Anaheim will no doubt remember the use of a parking garage—euphemistically called the West Hall—for some of the exhibits. This year there will again be a West Hall, but the sponsors have made assurances that the ambience will be improved. Some $250,000 was spent on air-conditioning equipment. In addition, over 100 companies will have booths in the Disneyland Hotel's lower exhibit hall. This new hall, by the way, used to be a parking garage, which may be another NCC trend as the industry keeps growing.

Starting on page 93 is a story written by WB2EZG, which is the call sign of circuits editor and ham radio operator Vince Biancomano. The hitherto unsung saga of Doug DeMaw's and Wes Hayward's efforts to upgrade the quality of ham radio receivers and to establish standards of measurement is close to Vince's heart.

He, too, has experienced the receiver problems of the amateur radio operator that DeMaw and Hayward have tried to solve. And in the 17 years since he got his license, Vince has seen improvements in this hardware.

In the case of transmitters, the pendulum is swinging to equipment one-upmanship. "Nowadays, it seems the idea is to be the loudest," Vince complains. "With kilowatt amplifiers out there, receivers sometimes can't handle the signal strengths at the antenna and break into oscillation from overloading," he explains.

A devoted operator, Vince tries to make an annual trek to Monte Carlo, Monaco, carrying his radio gear along in order to broadcast from one of Europe's rare ham locations. The objective is to be a "DX," one of the foreign contacts prized by ham operators around the world. This year Vince has another dream, which should be more difficult to realize.

"Young Prince Albert of Monaco is a ham operator, call sign 3A1A. Maybe I can use my radio connections to get an invitation to tea with Princess Grace," he jokes.

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Readers' comments

Doubts about Japan

To the Editor: Having chaired some five sessions over the past eight years at the annual IEEE Reliability Physics Symposium and as the author of several technical publications in the field, I believe that I can speak with some authority about "How Japanese manufacturers achieve high IC reliability" [March 13, p. 140].

The authors point out that "defect density has an adverse affect on device yield" and that "aluminum corrodes easily in reaction to moisture"; that "handling precautions are needed to protect devices from static electricity"; that "ionic contamination has also been a major cause of failure in semiconductor devices"; that "crack-free passivation layers must be placed atop the metalization"; and so on. The failure mechanisms that they cite are very old, very well researched, and very well characterized, and they have been under control for years now by all of us.

The authors state, "In Japan, quality-control activities are companywide. . . . This is in sharp contrast to the approach to quality control taken in the U.S." This is certainly not true in the semiconductor companies that I have worked for in my 19-year career, including Texas Instruments and National Semiconductor.

They also say that "a language barrier works in favor of Japanese industry. Most Japanese engineers can read and understand the many papers and publications on quality control and reliability written in English." It is true that they do have a lot to read. The literature of IC quality and reliability is and has been totally dominated by U.S. workers. I would like to challenge the authors to name just one significant failure mechanism that was studied and first reported by a Japanese worker. All of the mechanisms described in this paper were discovered and originally reported in this country.

Mr. Goto and Mr. Manabe write, "Last year, when soft errors in dynamic RAM's were big topics, NEC had a rush of orders from all over the world because it had no soft-error problems in its 16-K RAMs. A soft error is the transient upset of memory caused by an alpha particle." NEC, however, was completely unaware of this mechanism until Intel's Murray Woods published his classic studies in April 1978. And if NEC parts did have any special resistance to alpha particles during the production year 1979, it was by blind luck rather than via some intentional special processing.

Regarding clean-room conditions in the U.S. versus Japan, laminar-flow clean benches were invented in this country by Sandia. Also, a properly designed clean room will not transport particles from the floor to the work areas because of the highly directional nature of the filtered air flow. And typical U.S. worker clean-room attire is not substantially different from that of the Japanese in any case. We will admit that we don't care what our people wear at home.

When they say, "This seems to have promoted a passive attitude toward reliability assurance on the part of the [U.S.] manufacturers. They do not work on things for themselves but follow the military's lead," they are patently wrong. The reliability and quality effort of my employer, National Semiconductor, which I believe is representative, is a major, top-priority effort that operates across all of the levels of the organization.

The general flow of technical innovation in solid-state electronics has been and continues to be a one-way street from the West to the East. I know of no significant innovation, from the germanium junction transistor, through the first planar TTL circuits, to today's ion implanted, arsenic-diffused n-channel MOS microprocessor chip, that came from Japan.

Japanese solid-state components are not more reliable than U.S. products. They never have been. In my opinion, they most likely never will be.

James A. Cunningham
Santa Clara, Calif.

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News update

■ Techniques to detect moisture in sealed integrated-circuit packages as they go down production lines are becoming available, prompted by the need for cheaper, faster methods of moisture analysis. Two companies now offering moisture-sensing chips are Harris Corp.'s Semiconductor Group and Panametrics Inc.

Both report that their chips make possible measurements correlating favorably enough with mass spectrometry to meet the U. S. military's evaluation requirements. Spectrometry has been the test method of choice, but it is expensive—and it usually cannot be done in house, so results take one to six weeks. However, with ever more complex and expensive ICs coming, users are insisting on reliability tests such as the moisture analysis.

Production. Unlike the recently disclosed Massachusetts Institute of Technology moisture sensor [*Electronics*, Feb. 14, p. 50], the Harris and Panametrics chips are intended primarily for production-line checks, not automatic field monitoring. Both firms' chips will withstand IC processing temperatures of 500°C.

Intended for insertion in a few IC packages as part of a production run, they cost less than $8 each in lots of 1,000. They yield measurements in less than a half hour.

Unlike mass spectrometry, both of the new techniques are nondestructive, so tests are repeatable. Harris reports that repeatability of results using this method is within ±2°C.

The Harris HIO-55001-6 chip is the heart of a testing scheme that heats and cools the package so that any moisture condenses onto the chip. The more moisture that condenses, the greater the increase in the circuitry's conductivity. A lot of associated equipment for heating and measuring is needed.

Panametrics' Mini-Mod-HT is an aluminum oxide parallel-plate capacitor and reacts to the presence of water-vapor molecules with varying impedance levels measurable by the Waltham, Mass., firm's model 771 hygrometer. Unlike the Harris chip, it does not require heating and cooling of the package. **-Linda Lowe**

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Circle 13 on reader service card

People

To statistician Godfrey, his new post figures

Price watcher. Sperry Univac's Godfrey says, "Cost-effectiveness is the objective."

The new director of research for Sperry Univac is a statistician with a pronounced bent toward software. And Michael D. Godfrey, 43, thinks that this background is going to help future efforts at the Blue Bell, Pa., computer operation.

"Statisticians are interested in everything. They're interested in data as empirical evidence and in making sense of it," he says. "Trying to understand data from computer systems and what it's telling us is a statistical problem."

"We have to know more about software," he continues. "The scarcity of such software sources makes us want to be better at it, and being better at software development will be a good thing."

Godfrey received his bachelor of science degree in engineering in 1959 from the California Institute of Technology, where he studied solid-state physics and logic design. He has since received a Ph.D. in mathematical economics from the University of London and has been with Sperry Univac's product strategy and requirements group since 1977.

Because of his training as an economist, Godfrey is very conscious of the rising cost of computers, caused in a large part by increasing software content. "We have to produce cost-effective products. Cost-effectiveness is the real objective."

Godfrey has three immediate answers to this problem. The first is represented in the trend toward software modularity and portability: "The software contribution to systems architecture is much greater than it was. This allows software packages to be developed for a line of products," he says.

The second involves a closer interaction between hardware and software designers: "By explaining to a software designer how the hardware is organized, the end result is that the system works better. From the research side, hardware people are not always as skilled at using tools derived from a software standpoint. Typically, the nearest software tools [for the hardware designer] are not always the best tools. We have to look at improving that technology."

The third is easing the program itself: "In microcode, the idea of realizing a program language is a useful notion," Godfrey says. "Programming bit by bit by hand is a symbolic manipulation representing an established concept. We're going to need a high-level language for microcoding," he concludes.

Bass says packets are key to office of the future

He is a jogger and a racquetball player, but when Charlie Bass talks about robustness he is usually referring to packet-switching communications networks. "The key to distributed processing is how robust its communications technology is," he asserts. "It is its efficiency, its reliability, its ability to perform certain transformations, and its ability to find resources and allocate them to the user."

Bass, who left his post as general manager of Zilog Inc.'s Systems division last July to cofound Ungermann-Bass Inc. of Santa Clara, Calif., believes that for office equipment from a variety of vendors, a packet-switched local network best fulfills his definition of robustness (see p. 41). His opinion comes from

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People

Getting across. Charlie Bass finds he has to bridge equipment communications gap.

long experience with the technology. It began when he took part in the first radio broadcast of packet information, the Aloha Project, at the University of Hawaii in 1968–72. It continued through professorial stints at the Universities of California at Berkeley and at Santa Cruz, as well as at Stanford University, before he went to fledging Zilog in 1975 as director of software.

To implement an effective packet-switching network for a multivendor environment, Bass has been faced with the need to bridge the communications gap between pieces of equipment that were not designed to exchange information. "The free enterprise system is responsible for the incompatibilities between various pieces of automated office equipment," he notes, "but it is also responsible for the rapid advancement of the equipment."

To overcome these incompatibilities, Bass has written numerous software drivers that interface different types of office equipment with the Ungermann-Bass network. "What we are doing is solving the base-level incompatibilities between equipment so that information can be exchanged," Bass observes. "The next step that people will have to contend with is interpretation. They will have to order the sense of what they wish to communicate. In using local networks to implement electronic mail, for instance, they will need to establish criteria to review that mail." □

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- **Fast 4 MHz operation—150 nanosecond access time**
- **Fast hard-disk transfer rate of 5.6 megabits/second**
- **Low cost**

And that's not all you get. Not nearly.

BROAD SOFTWARE SUPPORT

You also get Cromemco software support—the broadest software support in the microcomputer field. Software that Cromemco is known for. Like this:

- **Structured BASIC**
- **FORTRAN IV**
- **RATFOR (RATional FORtran)**
- **COBOL**
- **Z-80 Macro Assembler**
- **Word Processing System**
- **Data Base Management**

And more all the time.

FIELD PROVEN

The Z-2H is clearly in a class by itself. We introduced it last summer. It's field proven. It's reliable.

And it's rugged. Housed in a sturdy, all-metal cabinet.

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As always with Cromemco, you get expandability. The fast 64K RAM in this Model Z-2H can be expanded to 512 kilobytes. That amount of RAM combined with 11 megabytes of hard-disk storage gives you enormous computer power—the equal or even beyond what much larger computers sometimes offer.

What's more, this computer gives you a 12-slot card cage. That's to plug in your special circuits as well as additional RAM and interface cards.

This expandability is supported by still more Cromemco value — the Z-2H's heavy-duty power supply that gives you 30A at 8V and 15A at ±18V to support plug-ins.

LOW COST — SEE IT NOW

The Z-2H is real. It's been in the field for many months. It's proven itself.

You should see the Z-2H now. Contact a Cromemco representative and arrange for a demo. Learn that Cromemco is a survey-winner for reliability.

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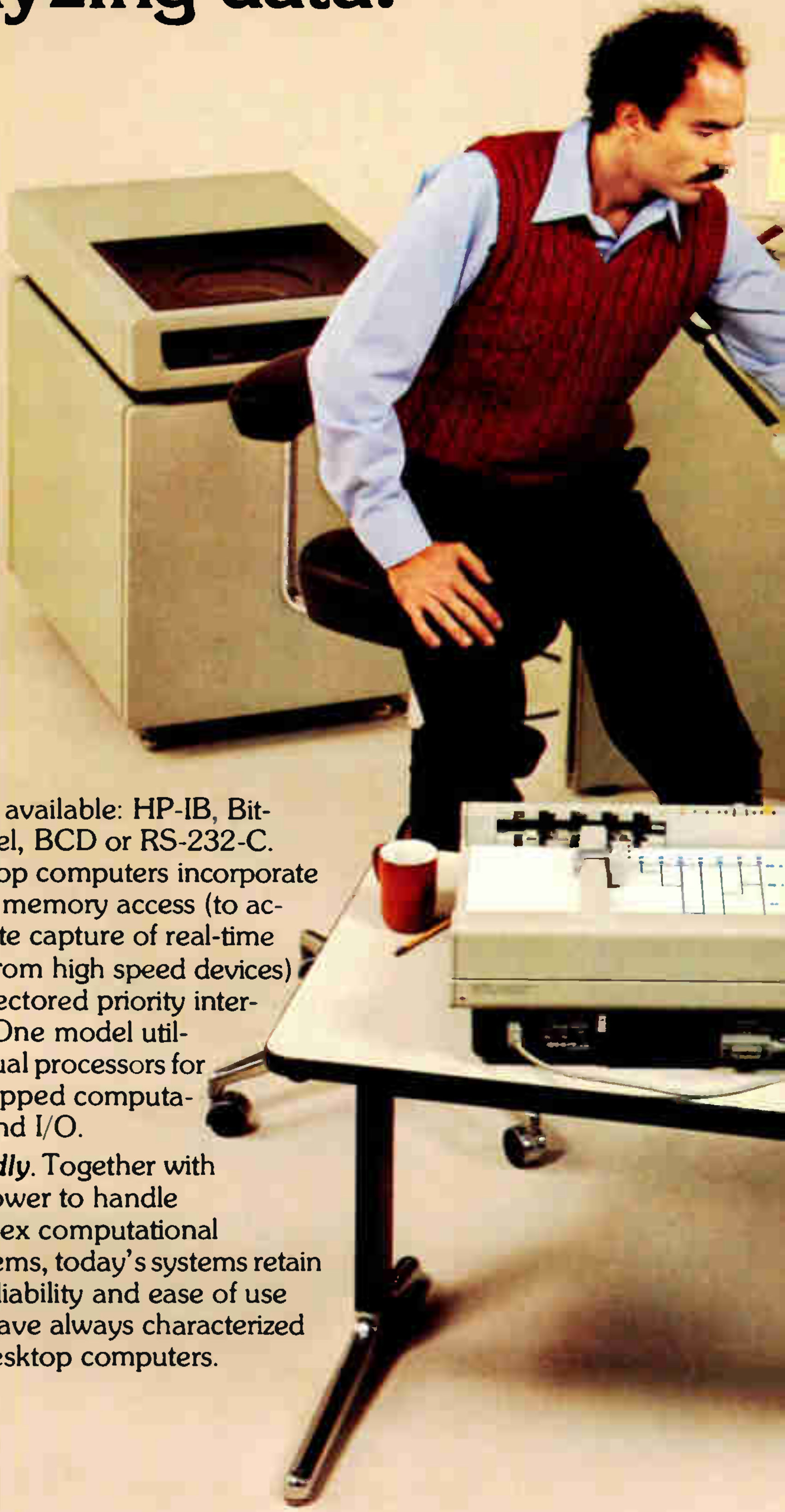

Computation Power. Today's Hewlett-Packard desktop systems put big computer power under your personal control. You solve problems with up to 449K bytes of user-addressable read/write memory, all available for your programs and data. Built-in operating systems incorporate HP Enhanced BASIC, a powerful super-set of ANSI Standard BASIC. Coupled with optional assembly language, HP Enhanced BASIC gives you optimum performance for time-critical operations. Extensive libraries of HP software help turn weeks of setup and development time into days.

Powerfully Integrated. Each system is a functionally integrated work station, from the keyboard and CRT display to the built-in processors and quiet printer. It provides everything you need to manipulate data, check interim results, perform side computations, explore variations and produce alphanumeric and graphic hard copies of your solutions.

Systems Capability. Your system can be augmented with a broad range of HP peripherals or front-end measurement instruments. Interconnection is as easy as selecting interfacing cards and cables from one of four protocols available: HP-IB, Bit-Parallel, BCD or RS-232-C. Desktop computers incorporate direct memory access (to accelerate capture of real-time data from high speed devices) and vectored priority interrupt. One model utilizes dual processors for overlapped computation and I/O.

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Controller at our seminar - and find out how.

you take control of its powerful BASIC software. You determine what an operator sees and how it's presented. It's like sitting at the operator's elbow guiding him through each test procedure.

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- Three memory devices — 60K byte main memory, 175K byte floppy disk and two optional 128K byte high-speed electronic disks (E-Disk™)
- Enhanced BASIC language with IEEE commands — for easy systems programming
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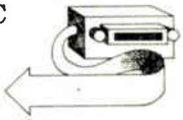

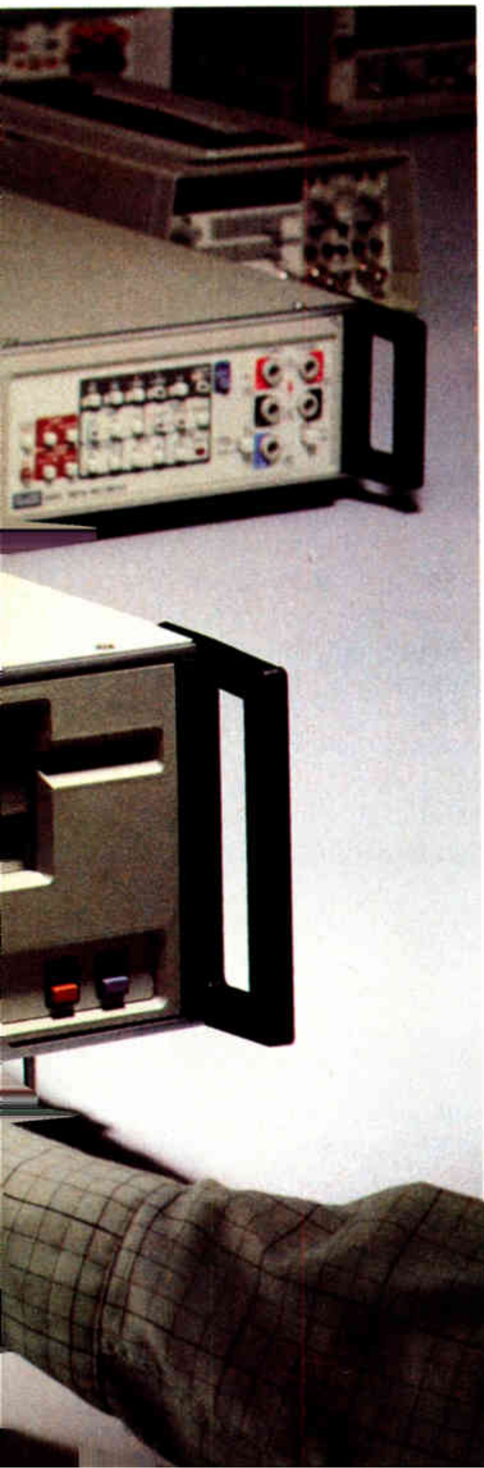

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For Technical Data Circle No. 21

EI 5/80

Editorial

Don't get mad, get better

The news that some semiconductor products sold by Japanese companies into the U. S. market have been superior in reliability and quality to similar products made by U. S. vendors has stimulated an interesting variety of defensive reactions. Admittedly, the achievements of the U. S. semiconductor industry that have propelled it to world leadership are a justifiable source of pride. But pride doesn't sell memories—it takes price, performance, delivery, and consistent quality. For more than three years now, reports from users have been circulating that some U. S. high-technology products have not measured up to the incoming quality level or field failure rates exhibited by Japanese devices. Coupled with the current undercapacity and high demand faced by the semiconductor industry, the reliability factor has enabled the Japanese to make important inroads into U. S. markets.

In the face of this, rationalizations to the effect that the Japanese carefully select devices to be shipped to potentially big American customers or that they buy into the market with lower prices just won't do. The fact is that the Japanese prices are competitive, not necessarily lower [*Electronics*, April 10, p. 81] and that the volume of business they are doing with U. S. mainframe companies would seem to preclude such preselection.

If U. S semiconductor reliability is less than it should be, then the problem must be confronted and dealt with. The Japanese approach may never be suitable to the American culture and methodology, but Americans certainly ought to learn something from their philosophy and be able to invest what it takes to solve the problem.

When the present climate of shortage and demand has passed and there are more devices than sockets, customers will be more selective. And they'll remember which vendors served them with reliable, high-quality products.

The Government says it's here

The Government has officially declared that the recession of 1980 is under way, and not a moment too soon: we're beginning to hear mutterings from some electronics people whose businesses are good economic indicators.

Distributors, for instance, are generally the first to go into a slump and the first to climb out of it. And some of them are saying their inventories are starting to build up even as their book-to-bill ratios begin to fall. Taken together, those are signs that difficult days may be coming. Then, some instrument makers are complaining about accounts-receivable problems, as well as some contraction in sales (though the latter may be due to customers' difficulties in getting hold of the necessary cash).

Even some computer experts are fretting because the industry has raised prices for the first time, which may not position it too well for sales to recession-hit manufacturers that want to automate.

The questions remaining about the 1980 recession is how bad and how long. At this point, it appears that the thing to do is pick one's favorite economic observer and go with his or her view—if you can find one who didn't predict a recession for 1978.

Meetings

Microwave Power Tube Conference, Advisory Group on Electron Devices the Electron Devices Society of the IEEE, Naval Postgraduate School, Monterey, Calif., May 12–15.

Electro/80, IEEE, Hynes Memorial Auditorium, Boston, May 13–15.

Metrology of Modern Electronic Instrumentation, National Bureau of Standards (Barry A. Bull, B-162 Metrology Building, NBS, Washington, D. C. 20234), NBS, Gaithersburg, Md., May 13–15.

Tech-Transfer '80, Royal Netherlands Industries Fair (P. O. Box 8500, 3503 RM Utrecht, Holland), Utrecht, Holland, May 13–16.

Microcomputer Show '80, Japan Electric Industrial Development Association (3-5-8 Shiba Koen, Minato-ku, Tokyo 105, Japan), Tokyo Ryutsu Center, May 14–17.

Second Annual Conference on Electro-Optical Systems and Technology, American Institute of Aeronautics and Astronautics (Dept. EOS, Box 91295, Los Angeles, Calif. 90009) *et al.*, Pacifica Hotel, Los Angeles, May 15–16; and Hilton Inn, Sunnyvale, Calif., June 5–6.

SRE–80 Reliability Symposium, TIE—Transportation, Information and Energy, Society of Reliability Engineers (Suite 1, 732 Wilson Ave., Downsview, Ont., Canada M3K 1E2), Holiday Inn Downtown, Toronto, May 15–16.

29th Annual Convention, The National Cable Television Association (Washington, D. C. 20006), Dallas, May 18–21.

Custom Integrated Circuits Conference, IEEE, Americana Hotel, Rochester, N. Y., May 19–21.

National Computer Conference, American Federation of Information Processing Societies Inc. (1815 North Lynn St., Arlington, Va. 22209), Anaheim Convention Center, Anaheim, Calif., May 19–22.

Naecon '80, IEEE Dayton Section, Dayton Convention Center, Dayton, Ohio, May 20–22.

Semicon/West '80, Semiconductor Equipment and Materials Institute Inc. (625 Ellis St., Suite 212, Mountain View, Calif. 94043), San Mateo County Fairgrounds, San Mateo, Calif., May 20–22.

First International Hybrid Microelectronics Conference, IMC Organization Committee (Box 3, Niiza Saitama 352-91, Japan), Keio Plaza Hotel, Tokyo, May 28–30.

34th Annual Frequency Control Symposium, U. S. Army Electronics Technology and Devices Laboratory (Fort Monmouth, N. J. 07703), Marriott Hotel, Philadelphia, May 28–30.

IEEE Computer Conference, NBS and IEEE (Frances Nielsen, B-212 Technology Building, National Bureau of Standards, Washington, D. C. 20234), NBS, Gaithersburg, Md., May 29.

North American Radio Science Meeting and Antenna International Symposium, IEEE *et al.* (1980 URSI/AP-S Meeting, Department of Electrical Engineering, Laval University, Quebec City, Quebec, Canada G1K 7P4), Laval University, June 2–6.

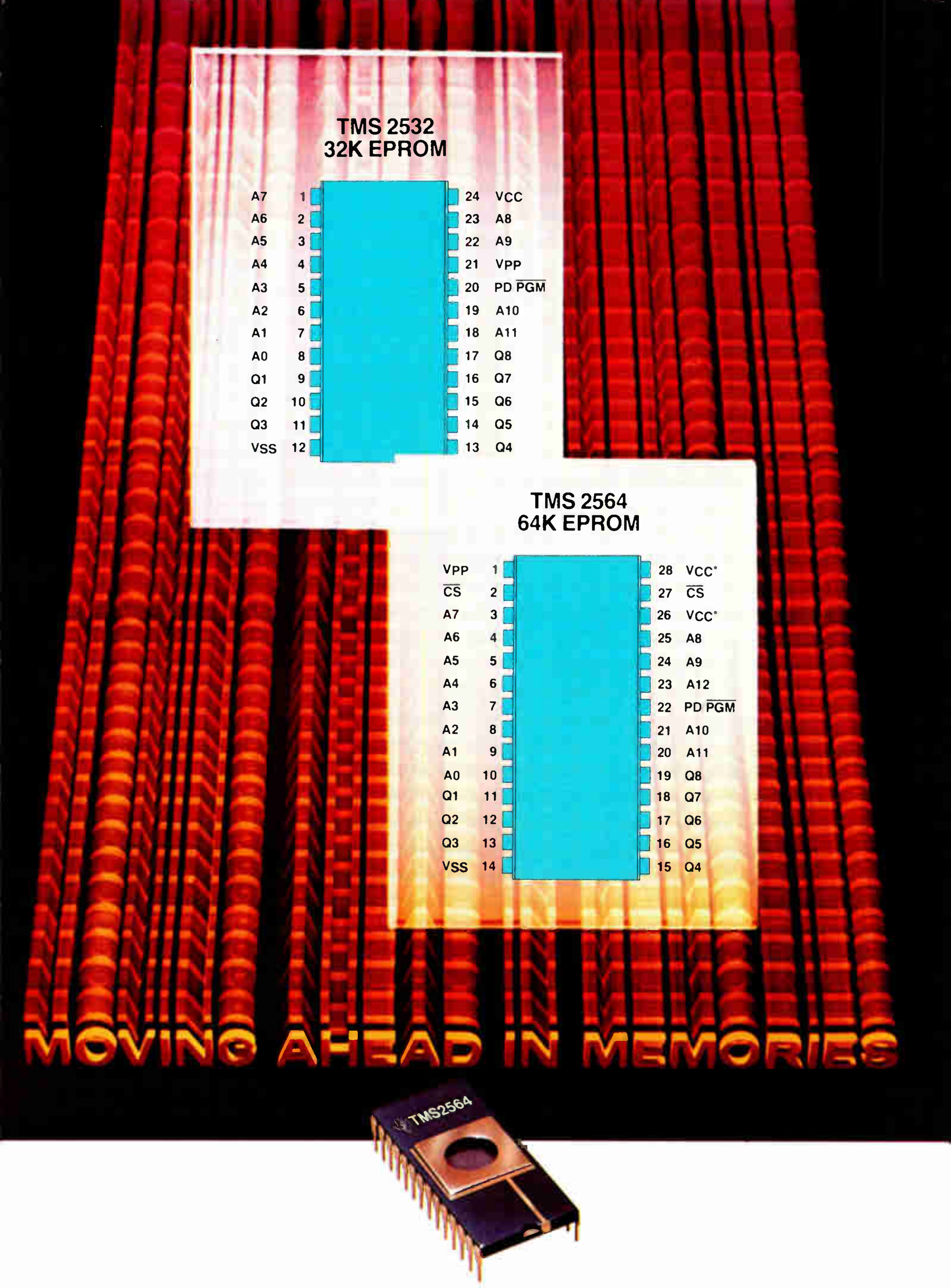
14th Pulse Power Modulator Symposium, IEEE *et al.* (Palisades Institute for Research Services, 201 Varick St., New York, N. Y. 10014), Orlando Marriott Inn, Orlando, Fla., June 3–5.

Eradcom Hybrid Microcircuit Symposium, U. S. Army Electronics Research and Development Command (Fort Monmouth, N. J. 07703), Fort Monmouth, June 4–6.

29th Power Sources Conference, U. S. Army Electronics Research and Development Command (Fort Monmouth, N. J. 07703) *et al.*, Deauville Hotel, Atlantic City, N. J., June 9–12.

HP announces a way to accelerate microcomputer development...

HP—When you depend on logic


TMS 2532
32K EPROM
A7 1 24 VCC
A6 2 23 A8
A5 3 22 A9
A4 4 21 VPP
A3 5 20 PD PGM
A2 6 19 A10
A1 7 18 A11
A0 8 17 Q8
Q1 9 16 Q7
Q2 10 15 Q6
Q3 11 14 Q5
VSS 12 13 Q4
TMS 2564
64K EPROM
VPP 1 28 VCC*
CS 2 27 CS
A7 3 26 VCC*
A6 4 25 A8
A5 5 24 A9
A4 6 23 A12
A3 7 22 PD PGM
A2 8 21 A10
A1 9 20 A11
A0 10 19 Q8
Q1 11 18 Q7
Q2 12 17 Q6
Q3 13 16 Q5
VSS 14 15 Q4
MOVING AHEAD IN MEMORIES
TMS2564

8Ks, 16Ks, 32Ks, and now...

The first 64K EPROM. From Texas Instruments. Naturally.

Introducing the TMS2564. The industry's first 64K EPROM. The densest yet. With all the high-performance features of TI's 5-V EPROM family. Features like 8-bit word configuration, fully static operation, automatic chip-select/power down, and low-power.

Pin compatibility

TMS2564 is offered in a 600-mil, 28-pin dual-in-line package. But, it's compatible with industry standard 24-pin 64K ROMs, as well as less dense EPROMS.

This is because pins 3 through 26 of the TMS2564 are compatible with pins 1 through 24 of the 24-pin devices. Compatibility is enhanced by reserving both pins 26 and 28 for the 5-V supply. So, with a supply trace to pin 26, both 24 and 28-pin devices can be used, with no jumpering.

Fully static

Like all TI EPROMS, the TMS2564 maintains the fully static tradition that makes designing easier.

No timing signals. No clocks. No strobes. No refresh. No problems. Simply, cycle time equals access time.

Lowest power ever

Operating at an access time of 450 ns with a power dissipation of only 840 mW maximum or less than 13 μW per bit, it's the lowest power per bit ever achieved in EPROMS.

Easy programming

The TMS2564 is designed to facilitate rapid program changes in high density, fixed memory applications.

All that's needed for simple, in-system programming, is a single TTL level pulse.

You can program in any order. Individually. In blocks. At random. So, programming time is reduced to a minimum. And, you can use existing 5-V PROM programmers.

Erasing? Simple ultraviolet. Just like any other EPROM.

Widest choice

By adding the new TMS2564 to our fast-growing EPROM family, we offer the designer a product breadth unmatched by any other supplier.

All TI EPROMS are available in 600-mil packages with JEDEC compatible pin-outs.

And they all share the reliable N-channel process technology.

TI's growing EPROM family. For all your present and future memory requirements.

For more information about the first 64K EPROM, or any other family member, call your nearest field sales office or authorized distributor. Or write to Texas Instruments, P.O. Box 1443, M/S 6955, Houston, Texas 77001.

Fifty Years of Innovation

TI'S GROWING EPROM FAMILY

Device	Description	Power Supply	Max Power (0°C) Operating	Standby	Access Time
TMS2564	64K	5 V	840 mW	131 mW	450 ns
TMS25L32	32K	5 V	500 mW	131 mW	450 ns
TMS2532	32K	5 V	840 mW	131 mW	450 ns
TMS2516-35	16K	5 V	525 mW	131 mW	350 ns
TMS2516	16K	5 V	525 mW	131 mW	450 ns
TMS2508-25	8K	5 V	446 mW	131 mW	250 ns
TMS2508-30	8K	5 V	446 mW	131 mW	300 ns
TMS2716	16K	+12, ±5 V	720 mW	—	450 ns
TMS27L08	8K	+12, ±5 V	580 mW	—	450 ns
TMS2708	8K	+12, ±5 V	800 mW*	—	450 ns
TMS2708-35	8K	+12, ±5 V	800 mW*	—	350 ns

*T_A = 70°C

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Circle 32 on reader service card

Electronics newsletter

GaP scrutinized for semiconductors working up to 600°C

Gallium phosphide may be the next semiconductor material for making devices that operate at very high temperatures. Sandia Laboratories in Albuquerque, N. M., in conjunction with Texas A&M University in College Station, is investigating the material used for Schottky diodes that can operate at up to 500°C. GaP's large energy bandgap compared with that of silicon makes it more useful at temperatures theoretically as high as 600°C. **Various metalization schemes are under investigation by Sandia and Texas A&M, including the use of chrome, platinum, and nickel.**

TI organizes separate group for speech chips

Following its recently announced plan to sell synthetic-speech chips to outside customers [*Electronics*, April 24, p. 42], Texas Instruments Inc. has underscored its commitment to the technology by establishing a new organization within the company devoted primarily to speech. Bernard H. List, formerly vice president for U. S. MOS operations in Houston, will head **the new organization based in Midland, Texas, where the firm is establishing a Speech Technology Center.** The West Texas city is already the site of a TI plant, where two new p-channel MOS wafer-fabrication lines will be added for speech component production. A third new p-MOS production line in Dallas will additionally be devoted to the new organization, which will also have responsibility for the p-MOS TMS 1000 family of 4-bit single-chip microcomputers.

Plasma drivers made with Bidfet hot sellers, says TI

Texas Instruments Inc. reports that demand for its new SN75501 and SN75500 512-line plasma-panel driver chips has been so great that the stock is diminishing rapidly; lead times for very large orders could stretch out to as much as 18 weeks. TI is now in full production on both parts, which use TI's proprietary high-voltage Bidfet process and is trying to increase its inventory. The firm is also known to be working on **monolithic chips that can drive even more than the present 512-line limit.** At the same time, TI is believed ready to use its Bidfet process for high-voltage telecommunications parts such as SLIC—subscriber-loop interface circuit—devices.

256-bit EE-PROM emerges from Motorola in Austin

Motorola Inc.'s MOS division in Austin, Texas, has begun shipping samples of a 256-bit electrically erasable programmable read-only memory. The part, organized as 16 by 16 bits, is fabricated in a dual-level–polysilicon floating-gate technology similar to the Flotox process used by Intel Corp. Known as the MCM 2801, **the device requires a single 5-V power supply** for operation in the read mode and is said by Motorola officials to be capable of more than 10,000 write/erase cycles. Program and erase functions require 25 V. The MCM2801 is aimed at consumer, telecommunications, and industrial applications and is planned as a forerunner to other EE-PROM parts organized by 8 bits.

Flat-screen color display uses shutter array

A patent application has been filed on an innovative and radically different type of flat-screen display system believed to be suitable as a replacement for the cathode-ray tube in real-time color television and other consumer applications. It could be used as well in industrial and commercial applications such as computer terminals and graphics displays. The color display system is based principally on the **combination of an electro-optical**

shutter matrix array and an optical modulation system. The developer, James R. Perry III of Perry Engineering in Concord, Calif., is currently seeking financing for prototype development of the system.

Color displays for PDP-11, VAX-11/780 coming from DEC

Digital Equipment Corp., Maynard, Mass., is about to announce its first color display terminals. The 19-in. VS11 and VSV11 displays will resolve spots as small as 0.7 mm in arrays 512 dots on a side. Designed for direct memory access with DEC's PDP-11 series and VAX-11/780 computers, the family of displays is built around a large memory and a 2901-type bit-slice processor to speed display operations and minimize central-processor overhead. **The processor can execute 64-bit microinstructions at 160 ns per instruction.** Up to 256 colors are available under software control, and 16 levels of gray scale in monochrome models. Prices will run from $8,000 to $15,000. Also **among seven new software packages for its VAX-11/780 computer,** DEC plans an operating system that will handle electronic mail, high-speed interfacing, and networking.

U. S. semiconductor market to grow 26%, TI predicts

Led by computer and industrial users, the semiconductor market in the U. S. should reach $5.8 billion this year, a growth of 26%, according to the latest estimates from Texas Instruments Inc. Although the computer segment should jump by almost a third, **TI expects softening in this market by the end of the year,** especially among small and medium-sized manufacturers. The industrial market, up 23%, will be paced by a 30% to 35% gain in telecommunications, says the company.

National pushes 2147 line to 55-ns region

Using its proprietary XMOS n-channel silicon-gate process, National Semiconductor Corp. of Santa Clara, Calif., has extended its 2147 family of 4-K static random-access memories to include a version with 55-ns cycle times. The high-speed device, designated the MM2147-3, is organized as 4,096 words by 1 bit and **requires no clocks or refreshing.** Housed in a standard 18-pin dual in-line package, the MM2147-3 is available in production volumes and is priced at $29 each in lots of 100.

Addenda

Onyx Systems Corp. of San Jose, Calif., will show its C8002 microcomputer system at the National Computer Conference in Anaheim, Calif., May 19–22. Onyx says that the C8002 is the **first microcomputer system to be based on the Zilog Z8000 processor** and is also the first to contain its own 8-in. Winchester disk. The system will be available with 256 kilobytes to 2 megabytes of random-access memory. . . . Fairchild Camera and Instrument Corp. of Mountain View, Calif., has licensed Western Electric Co. **to manufacture its fast low-power Schottky TTL integrated circuits for internal use.** Under the terms of the cross-licensing accord, Fairchild, a Schlumberger Ltd. subsidiary, will transfer to Western Electric certain technology related to the digital logic line, including circuit design, exclusively for use in products made by Western, the manufacturing arm of the American Telephone & Telegraph Corp. . . . Monsanto Co. says that **polished silicon wafer sales are growing at a 20% annual rate** and that its sales, which approached $100 million in 1979, are expected to reach $500 million in the future.

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Trace it all, and fast . . .

If you're switching from 8 to 16 bit microprocessors, make sure your logic analyzer can support the move. An adequate number of input channels is the prime prerequisite for 16-bit-uP testing.

Dolch's LAM 4850 is not only the record holder with 48 input channels, it offers you even more of the world's first features such as 3 level simultaneous clocking to untangle multiplexed bus signals or "trigger tracing" that lets you examine nested program execution in real time.

It's features include:

- 1024 bits recording and reference memory per channel
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Now that our microcomputers have more memory options, so do you.

DEVICE	RAM	ROM	I/O
F3870	64 x 8	2K x 8	32
F3872	128 x 8	4K x 8	32
F3876	128 x 8	2K x 8	32
F3878	64 x 8	4K x 8	32

We've just expanded our industry-standard F3870 line by adding three new microcomputers with increased on-chip memory options. Each is a complete 8-bit microcomputer on a single MOS chip and is 3870 pin-compatible.

Bigger ROM memories.

The series begins with the multi-source 3870 that gives you up to 2K bytes of ROM. With our three increased-memory versions, you can now get more features, a more sophisticated controller and more design flexibility.

Starting with the F3876 which offers 2K ROM, and the F3872 and F3878 which offer 4K ROM. These give the designer the size versatility he needs for almost every application, as well as allowing him to make smarter controllers.

POWER DOWN	POWER SUPPLY
NO	5V
YES	5V
YES	5V
NO	5V

More RAM with power-down protection.

The F3872 and F3876 offer 128 bytes of RAM, with 64 bytes available for power-down protection. That means that if your system shuts down, there's no memory loss, because the RAM remains powered and protected, with low current demand.

A microcomputer for all reasons.

No matter what your application needs, the F3870 series can meet them. It's an excellent choice for a wide variety of control applications, including terminals, communications, automotive and instruments. It's the perfect family of low-cost microcomputer circuits for the high-volume, cost-sensitive controller market.

So now, there isn't a more complete family of devices available that will let you build a new system, or upgrade an existing one. For more information, call or write F3870 Series, Fairchild Microcomputer, P.O. Box 880A, Mountain View, California 94042. Telephone: (408) 224-7000.

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Circle 37 on reader service card

Circuits conference features Japan's 512-K ROM

by John G. Posa, Solid State Editor

Also on tap are C-MOS chip using piezoelectric effect, implantable neural stimulator, ultrafast SOS processor

A half-million-bit read-only memory to store Chinese ideograph characters; a complementary-MOS integrated circuit powered solely by the piezoelectric effect; an implantable neural stimulator of four ICs; a C-MOS-on-sapphire central processing unit that can crank through 32-bit additions in 100 nanoseconds—these are just a few of the advanced developments to be described at the May 19–21 Custom Integrated Circuits Conference.

Sponsored by the Institute of Electrical and Electronics Engineers, the gathering at the Americana Hotel in Rochester, N. Y., is a forum for designers of ICs so special that the mass-production learning curve cannot be exploited in full. Nonetheless, the chips' density and speed requirements are likely to push leading-edge technology to new achievements—after all, the microprocessor began as a custom design.

Trends. Three aspects of custom fabrication stand out from the conference's program (see table). One is the use of electron-beam lithography to meet the requirements of quick turnaround and ultrahigh density. Another is the increasing reliance on the low power of C-MOS. The third is computer-aided design more capable than ever of symbolic chip layout and verification.

Japan's Nippon Electric Co. found that direct writing with an electron beam was the most suitable method of producing its 512-K ROM. Four times larger than state-of-the-art devices, it is the biggest ROM ever produced without resorting to full-wafer integration.

Direct writing needs no masks, and, in this case, 1-micrometer features were achieved. Cell size and chip size are 44 square μm and 91,000 mil^2, respectively; access time and power dissipation are 400 nano-

HIGHLIGHTS OF THE 1980 CUSTOM INTEGRATED CIRCUITS CONFERENCE

Session	Paper	Organization
Monday, May 19		
SESSION A: Model characterization	Three-dimensional VLSI MOS FET models	University of Waterloo
	Custom solid-state imaging arrays	Eastman Kodak
SESSION B: Hybrids	Multichip hybrid technology	Honeywell
	Computer-aided hybrid design	Tektronix
SESSION C: Custom and high-voltage circuits	GaAs ICs made with electron beams	Hughes Research Labs
	Thin-film transistors for display circuits	Xerox
	ICs for implantable neural stimulator	Stanford University
	High-voltage MOS driver arrays	Xerox
	60-V ac power MOS FET	Honeywell
	60-V custom driver chip	IBM
	Vacuum-fluorescent-display driver	AMI
Tuesday, May 20		
SESSION D: Custom applications	MOS circuit simulation	R.C. Foss Mosaid
	Single-chip CRT controller	Perkin-Elmer
	8-bit-slice C-MOS CPU	Rockwell
	1,000-gate I^{2}L gate array	Northrup Research
	Custom analog processor	Silicon Systems
	Piezo-powered IC transmitter	National Semiconductor
SESSION E: Circuit design techniques	Fast-turnaround custom VLSI	Bell Labs
	Systematic VLSI design	Bell Labs
	Custom silicon-gate C-MOS circuits	Harris
	C-MOS analog and digital circuits	RCA
	Composite-cell logic	Signetics
Wednesday, May 21		
SESSION F: Fabrication technology	Polysilicon gates for CCD imagers	Eastman Kodak
	A new silicon-gate MOS technology	Sony
	Refractory metal IC technology	General Electric
	I^{2}L vs integrated Schottky logic	Harris
	Custom bipolar linear LSI	Sony
	512-K read-only memory	NEC
SESSION G: Computer-aided design	Automatic custom MOS LSI layout	Bell Labs
	Symbolic layout and design	DMT Corp.

seconds and 800 milliwatts.

In another paper, Hughes Research Laboratories in Malibu, Calif., reports on the use of electron-beam lithography for gallium-arsenide ICs. Its submicrometer transistors exhibit power-delay products as low as 0.46 picojoule.

When it comes to low power use, C-MOS is the best. Taking advantage of this fact, National Semiconductor Corp. has developed for Gould Inc. a chip for detecting tire profiles that generates its own power supply from the mechanical stimulation of a piezoelectric crystal.

Inside. The crystal and chip sit inside the tire, and when air pressure drops low enough, the tire's wall excites the crystal. The IC rectifies and limits this signal to obtain its power and then transmits a tire identification code to the driver of the vehicle.

Interestingly, this ID number uses the Santa Clara, Calif., company's Tricode encoding scheme [*Electronics*, Sept. 27, 1979, p. 38]. The chip works at up to 25 volts at less than 10 microamperes.

Another project that puts C-MOS chips in tight places is an implantable neural stimulator developed at Stanford University. It is designed as an auditory prosthesis, stimulating the inner ear.

Consisting of four ICs (one is bipolar), the circuit receives dc power over a radio-frequency input and stimulus information in the form of digital ultrasonic pulses. Custom design here keeps power consumption down to 30 mW.

SOS. Rockwell International Corp. modified its 8-bit-slice Schottky bipolar central processing unit intended for use in military communications. The device's power consumption was reduced by 95%, yet as before, four of them can execute up to 5 million 32-bit microinstructions per second. C-MOS on sapphire got the job done.

Throughput is so high that critical portions of the architecture are implemented with programmable logic arrays. These PLAS use SOS diodes to parallel-process functions of up to 28 inputs within the span of a single 25-ns clock subcycle.

The chip, from Rockwell's Anaheim, Calif., operation, relies heavily on the use of computer-aided design, as did many of the conference's custom ICs. To be discussed are computer programs for modeling bipolar and short- and long-channel MOS field-effect transistors, designing custom hybrid and very-large-scale integrated circuits, and automatic layout and verification of MOS chips.

Data communications

Network to mediate exchange of data among incompatible office equipment

A budding Californian company headed by two well-known figures in the semiconductor industry has come up with a local-network concept that it says will allow the often incompatible pieces of automated office equipment to communicate. Net/One, from Ungermann-Bass Inc., is a packet-switched network carried by coaxial cable and with all the hardware and software necessary for a fully operational net.

Interest is blossoming in such concepts, with a push under way on a standards effort [*Electronics*, March 27, p. 40]. Net/One joins such other schemes as Datapoint Corp.'s ARC network, Zilog Corp.'s Z-Net (see "Z-Net allows easy add-ons"), and Xerox Corp.'s Ethernet.

Wide use. However, the Ungermann-Bass equipment is designed solely for networking tasks instead of being an enhancement of word processors or computers as in the other approaches. Also, it can link a wide variety of office equipment whereas the ARC and Z-Net systems can han-

Z-Net allows easy add-ons

By incorporating a packet-switched local networking scheme into the operating system of its recently announced MCZ-2 series of office systems, Zilog Corp. will be letting users add computing power in small increments with no obsolescence of existing equipment. The broadcastlike operation of the net eliminates the need for a central controller, which in turn could become a system bottleneck.

Dubbed Z-Net by the Cupertino, Calif., firm, this local network transmits information packets along a coaxial cable at rates up to 800 kilobits a second. The packets are 8 bits wide by up to 512 bytes deep; header information is additional.

The network is designed to facilitate the transmission of intrafacility electronic mail, as well as to link local computing stations and shared high-speed peripherals. A 600-line-per-minute printer, for example, can be attached to an MCZ-2 work station and be used by the other MCZ-2 members of the network.

Z-Net can also be used to communicate with other networks through the RS-232-C ports available on the MCZ-2. An important example of this is the work station's ability to emulate an IBM 2780 or 3780 intelligent terminal, which in turn allows it to access Zilog's earlier MCZ-1 series.

Zilog's local-net scheme works solely with the MCZ-2 computer [*Electronics*, April 10, p. 34], which ranges in price from the bare-bones $5,990 2/20 to the $12,175 2/50 that includes software, 2.4 megabytes of floppy-diskette storage, and a display. Each unit can handle five RS-232-C ports and a parallel interface port.

When Z-Net becomes available in the third quarter, the MCZ-2 will be offering 10 to 40 megabytes of cartridge disks that will serve as network nodes. The network scheme can link as many as 255 single-processor stations, and it will also link the four-processor package that will become available in the fourth quarter. **-M M.**

dle only their makers' gear. Ethernet initially will be maker-specific, with the Xerox 860 word processor incorporating it expected to be offered late this year.

Transport level. Net/One is the first product from the Santa Clara, Calif., firm started by Ralph Ungermann, cofounder of Zilog, and Charlie Bass, a former general manager of Zilog's Systems division. It operates at the transport level of network protocols, one of seven levels [*Electronics*, Dec. 7, 1978, p. 120].

The transport control level is necessary to implement a practical local networking system. It provides for network-independent data-flow control; it guarantees the correct delivery of an information packet; and it reconstructs the packeted information into a form native to each network member.

The Ungermann-Bass network goes even further to offer a choice of virtual circuit or datagram protocols. The datagram protocol does not require the establishment of a virtual circuit in order to send packets, although a virtual circuit protocol does perform packet sequencing.

Operating at the transport level also requires a complete network-control protocol, which takes care of the functional and procedural means of exchanging data, as well as channel selection and routing. It also requires a complete link control, which includes polling, error control, and high-level synchronous data-communications protocols.

Interfacing. In Net/One, the office equipment does not serve as network nodes. The individual units connect to RS-232-C or parallel ports in network interface units that store the data packets in buffers before putting them onto the 4-megabit/second net on a contention basis.

The system offers two types of interface units: the NIU-1 with four RS-232-C and two parallel ports and the NIU-2 with 16 RS-232-C and eight parallel ports. The NIU-1 will cost about $4,000 dollars, and the NIU-2 will be about double that for half the cost per work station if all 16 of the RS-232-C links are in use.

The NIU modules provide the algorithms for network use. They pull the data packets into the buffers, perform cyclical redundancy checks, detect collisions, and send interrupts to the bus.

They are also connected by an 8-megabyte/s data bus, which will allow for rapid transfers from disks. This high-speed bus will also provide access to high-speed computer buses like the PDP-11 Uni-Bus.

Drivers. Although Net/One operates at a higher level than previous packet-switched networking schemes, it is not a panacea for incompatibility. Software drivers, for example, must be written to complete the interface with a piece of equipment.

Most of these drivers are available from Ungermann-Bass and are included in the network price. Others can be generated by the user, typically with 500 to 750 lines of code. To aid the user in this, an optional network development system will be available when Net/One goes on sale in June. **-Martin Marshall**

Communications

Hybrid SLIC meets REA specs

For International Telephone and Telegraph Corp.'s MicroSystems division, happiness is a subscriber-line interface circuit that combines elements of large-scale integration and thick-film technologies. The Deerfield Beach, Fla., company is including functions left off proposed or actual SLIC chips, including its own 3081/3082 parts.

"It still is a hybrid SLIC," says Wilber L. Riner, director of marketing and business development. "But it incorporates a lot more functions than are available in monolithic SLICs, which need a Christmas tree of parts on a printed-circuit board before they work. And the price is really going to surprise people."

Riner does not say what the price will be, since the part is still in the breadboard stage. However, ITT MicroSystems expects samples to be ready in the 1981's first quarter, with production quantities following by the middle of the year.

Added. Among the functions added to the bipolar part is protection against lightning strikes designed to meet specifications of the U. S. Rural Electrification Administration. Meeting the requirement is necessary to sell the part to independent U. S. telephone companies funded by the REA.

The part also aims at meeting the REA specification for fighting cross currents induced by power lines that touch or come near to telephone lines. The new SLIC will therefore be marketable in Europe where such specifications are stringent.

The MicroSystems division sees such features making integrated SLICs palatable to manufacturers of equipment for central offices and private branch exchanges. Though the 3081/82 parts have been designed into products, equipment makers in general have been leary about newer monolithic SLICs, some of which have not made it out of the design stage.

In the ITT approach, most of the circuitry is incorporated in a medium-scale integrated array. Critical resistors and large voltage-handling devices are on a hybrid substrate. Thus the resistors can be trimmed precisely by laser, and large amounts of power can be handled without damaging the reliability of the bipolar array. External adjustments also are easier.

"The device replaces a board of parts and allows a 4 to 1 space reduction," says Ringer. "This allows for reduced labor and board-assembly costs, as well as savings in reliability and space."

Minus. With all these pluses, there still is one minus. Riner admits that the new SLIC will not provide certain test functions found in standard telephone equipment. "No one else does it either," he says. "There is not enough commonality among SLIC users for us to provide it."

"In any case," he is quick to add, "it allows us to use the same chip in European products where they do a wide variety of tests. And the same SLIC can be used in a 24-volt branch exchange or a −50-V central office." -Harvey J. Hindin

Business

Foreign investment in U. S. firms zooms

Foreign investment resulting in 10% or more ownership of individual U. S. electronics and electrical equipment makers is mushrooming. Of the 34 transactions completed in 1979's first half, the value of 21 is known to be $613 million, whereas the known value in all of 1978 was only $109 million, the U. S. Department of Commerce says.

Moreover, the department's International Trade Administration expects even bigger increases in the second half's data, which is collected for many business activities, including electronics and 16 other manufacturing industries. In all, ITA counted 379 deals completed in the first half and was able to place a $4.4 billion value on 207. Preliminary figures for the entire year are 1,070 transactions with a known value of $12.5 billion.

Interests. Who is investing in what U. S. electronics? An ITA international economist, Evelyn G. Brown, notes that Japanese electronics companies are buying, although they tend to build their own U. S. plants. For easier market access, both Japanese and Korean interests are investing in U. S. electronics wholesale and distribution operations, she notes. Brown's list includes 22 buys into wholesale areas in addition to the 34 manufacturing investments shown in the table.

European interests, on the other hand, are moving to acquire U. S. technology—"particularly in integrated circuits," Brown says—by investing in established American manufacturers. Last year's acquisition of Fairchild Camera and Instrument Corp. by Schlumberger Ltd. is the most obvious example of that, Brown points out.

More. Other French purchases on her list include Schlumberger's investment in Unitrode Corp.; that in Proprietary Software Systems Inc. by Compagnie Internationale de Service/Information (CISI, a software house owned by the French atomic energy agency); Thomson-Brandt's investment in Solid-State Scientific Inc.; and a joint venture by units of Général d'Electricité CIE-CGE with Sensor Technology Corp.

Also, CGE's CIT-Alcatel invested in Telecommunications Switching Systems Inc. and Friden Mailing Equipment Corp. Although the last does not fall precisely into the electronic and electrical equipment category, officials note it is closely related, as an electronics end-user.

West Germany's eight U. S. deals were dominated by the six of Siemens AG. They included investments in Litronix Inc., Microwave Semiconductor Corp., Orbis Systems Inc., a wholesaler known as Circle A W Products, and increased holding in two affiliates, Siemens-Allis Inc. and the separate Siemens-Allis Inc. Switch-Gear division. Siemens is still shopping, as the recent investment in Threshold Technology Inc. shows [*Electronics*, April 24, p. 56].

Others. Topping the government list of British and Canadian investments were the UK National Enterprise Board's deal with Inmos Corp. and Bell Canada's investment in Intersil Inc., plus increases in the Canadian telephone company's investment in Northern Telecom Inc. The financial holding companies characteristic of Swiss and Dutch businesses make it difficult to trace their investments. The ITA says identifiable funds from Switzerland are confined to U. S. wholesalers and distributors, and a Dutch chemical-making group, AKZO NV, bought into General Circuits Inc. and Garry Manufacturing Co. -Ray Connolly

FOREIGN INVESTMENT IN U.S. ELECTRONICS AND ELECTRICAL EQUIPMENT MAKERS, JAN. 1 – JUNE 30, 1979

	Total cases	Cases with value known	Known value ($ millions)
Canada	3	1	5.0
France	4	2	375.4*
Japan	8	5	32.3
The Netherlands	2	2	29.2
Switzerland	4	1	50.0
United Kingdom	5	5	68.3
West Germany	8	5	53.1
Total	34	21	613.3

*$363 million is Schlumberger Ltd.'s acquisition of Fairchild Camera and Instrument Corp.

Fiber optics

Bell's 2½-mile link speeds data

A 44-megabit-per-second fiber-optic system is speeding computer communications in a 2½-mile link in an American Telephone & Telegraph Inc. test. The New York City test uses AT&T-designed interfaces and fiber-optic cable to link standard mainframe computers in real time.

Implications. The test may break new technological ground. Equally important is the usefulness of such equipment to a Bell venture into data communications, considered likely now that the Federal Communications Commission has given the go ahead to the phone company [*Electronics*, April 24, p. 104].

New York Telephone has installed the fiber-optic cable and related interface equipment and will be overseeing the test. The system runs between two phone company buildings in Manhattan's downtown financial district and will eventually carry voice transmission, as well as data information.

The system connects three main-

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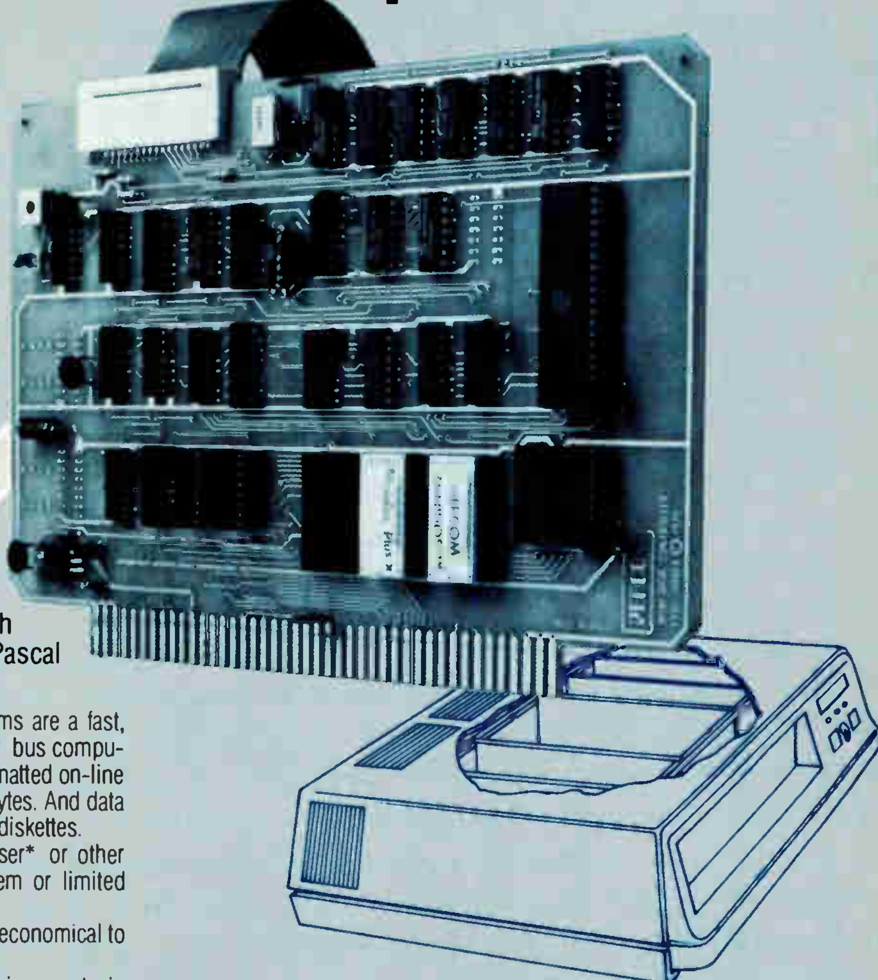

- Compatible with EXORciser* and other 6800/6809 computers based on EXORciser* bus concept.
- 40- or 77-track drives in one-, two- and three-drive configurations add 102K bytes to 591K bytes of random access data on-line.
- 40-track LFD-400EX™ drives store data on both surfaces of mini-diskettes — almost 205K bytes per disk.
- EXORciser* bus compatible controller includes 1K of RAM, provision for 3K of PROM. Mature design features explicit clock-data separator, drive motor inactivity time-out function, and more.
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Low cost Percom LFD-400/800EX mini-disk data storage systems are a fast, dependable alternative to tape storage for 6800/6809 EXORciser* bus computers. A single 40-track LFD-400EX™ drive adds 102K bytes of formatted on-line storage; a single 77-track LFD-800EX™ drive adds almost 200K bytes. And data may be stored and read from either surface of LFD-400EX™ minidiskettes.

Fast mini-disk data storage makes your Motorola EXORciser* or other EXORciser* bus computer more than just a development system or limited evaluation system.

For example, at the low LFD-400/800EX prices it becomes economical to use your development system as the final working system.

Data capture/retrieval in research, test and production environments is another application where versatile, random-access LFD-400/800EX storage can provide efficient operation.

Equipment control is yet another area where the speed and facility of mini-disk storage greatly expands application possibilities. Even if you use a mini-disk only to load and control programs you'll save simply by taking a lot less time than with slow, inconvenient tape storage. Moreover, by storing programs on fast-loading, low cost minidiskettes you eliminate the overhead of burning PROMs — an expense that quickly adds up to far more than the price of an inexpensive Percom mini-disk system.

The bottom line? An EXORciser* or Micromodule*, with percom LFD-400/800EX mini-disk data storage, is a remarkably adaptable microcomputer — a system that meets the quality and dependability demands of industry yet is competitively priced with personal computing systems.

PRICES

Model	1-drive system	2-drive system	3-drive system
LFD-400EX™	$649.95	$1049.95	$1449.95
LFD-800EX™	$945.95	$1599.95	$2245.95

MPX Disk Operating System (2-chip ROM set)
Standard versions for most popular monitors $69.95
LFD-400/800EX Users Instruction Manual:
Includes driver utility listings, controller schematic $15.00

The system prices are single-quantity prices. A system includes (1) the drives, power supplies and enclosure, (2) the EXORciser* bus compatible controller PC card with 1K RAM and provision for three 2708 EPROMs, (3) an interconnecting cable, (4) an 80-page users instruction manual, and (5) a system minidiskette. The Percom Software Services Group will customize the MPX DOS for a nominal charge if one of the standard versions is not suitable for your monitor. LFD-400EX™ systems use 40-track drives; store 102K bytes of formatted data per minidiskette side. LFD-800EX™ systems use 77-track drives; store almost 200K bytes on one side of minidiskette.

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Meeting data-transfer demands

Communication at multimegabit-per-second rates—the natural output speed of computers—has long been the dream of systems engineers. Though this has been achieved without fiber-optic technology, the glass cables do offer some pluses for computer-to-computer communication.

To begin with, glass fiber is smaller and lighter than equivalent copper cables. Even more important, it is impervious to induced electrical fields. This immunity means that lightning, electrical machines, or radio transmitters cannot affect bit-error rates.

Moreover, light-carrying fibers do not interfere with one another or with sensitive electrical circuits, so computer data is secure from external interference or tapping. Finally, the fibers cause no sparks, tolerate mechanical abuse, and function in water.

So the New York Telephone Company has good reason to investigate the feasibility of linking existing computer gear and using existing protocols with fiber-optic cable. Another strong candidate for long-distance high-speed data communications is a satellite link, like the U. S.-to-France-and-Germany test last year by Comsat, IBM, and French and German government communications agencies. That four-node experiment sent 1- and 2-megabit/s data over a time-domain multiple-access link. **-Harvey J. Hindin**

frame computers at one location with three other mainframes at the second. "The two sets of computers are approximately 13,000 feet apart," notes Howard W. Bruhnke, southern Manhattan district manager for distribution engineering.

"That can't be compared to computers set up 100 or 200 feet apart, where the fiber-optic cable is simply an integral part of the data bus," he says. The data transmission over the long link needs no optical repeater, although harsh environmental conditions may cause greater signal attenuation over time, Bruhnke says.

Equipment. Bell Laboratories designed the fiber-optic data interfaces to convert the digital signals to light pulses. Western Electric supplied the fiber-optic cable, connectors, and the light-emitting diodes.

The 3/8-in. cable consists of three ribbons, each containing eight fibers. The fibers have a 50-micrometer core, with a 125-μm outer diameter. Bruhnke notes that the cable has the capacity to carry 60 fibers should future systems need it.

In the initial testing of the system, the error rate was measurably improved over copper cable, despite a steamy and hot environment. The transmission accuracy was reportedly 10 billion times greater than the average rate of one error for every 10,000 bits sent over wire cable, according to Bruhnke.

"The system has run for three days with only one data transmission error. That hasn't been the history with copper," notes Carl A. Larson, supervising engineer for outside plant lightwave installations.

The test equipment has the potential for transmitting data at speeds of up to 274 megabits/s, although Bruhnke is not ready to speculate on when that may be put to use. Nor is he willing to estimate the cost of an eventual production system.

"The final system will ultimately be cheaper than the test. This initial test system is only a front-end for an entire system," he says. "The total system would be comparable with copper, but time cycles, durability, and other parameters have to be looked at first."

Slower, nearer. In a related announcement scheduled for May 6, Honeywell Inc., International Telephone and Telegraph Corp., and Du Pont Co. were expected to introduce components that will facilitate fiber-optic links operating at the other end of the performance spectrum—short distance and medium speed.

According to industry reports, Du Pont will provide a fiber for the short-distance links, while an ITT division is to unveil a new easy-to-use connector family, and a Honeywell operation will introduce the necessary emitters and receivers.

Planned to operate at rates under 30 megabits/s, the links are intended primarily for computer applications to tie central processing units to peripherals. The new ITT connectors are expected to cut fiber termination time by 90%.

The Honeywell, ITT, and Du Pont group will join a number of companies in offering short-haul fiber-optic links. Hewlett-Packard, for instance, already offers a family of components that operate at rates up to 10 megabits/s over distances up to 1,000 meters. **-Pamela Hamilton and Anthony Durniak**

Packaging

14-layer pc board sprouts many ICs

Faced with the problem of packing thousands of hot-running large-scale integrated circuits into a small space, Hughes Aircraft Co.'s Radar Systems Group came up with a module of two 14-layer printed-circuit boards with a heat exchanger bonded between them. The module can hold 252 ICs and 98 decoupling capacitors. With 20 modules, Hughes can fit its programmable radar signal processor into 1 cubic foot on the F-18 fighter.

Feat. "Getting that many parts into that small a volume and cooling it is something," says Donald E. Manser Jr., head of the programmable processor section in the Physical Design department of the El Segundo, Calif., group. "To develop 14-layer pc boards with 10-mil lines and 10-mi spaces in production is not exactly an industry standard."

Going to pc boards with 14 layers is necessary, despite the tricky manufacturing processes, to interconnect the almost 5,000 closely packed ICs and almost 2,000 capacitors. The processor is implemented in high-speed Schottky TTL and emitter-coupled logic—housed in flatpacks, rather than dual in-line packages, to save space.

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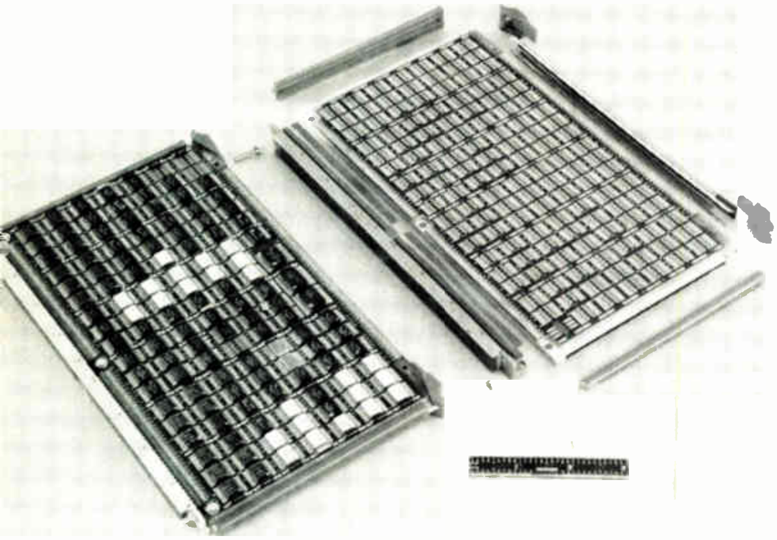


Packed boards. By developing a 14-layer pc board, Hughes Aircraft is able to fit 5,000 ICs and 2,000 capacitors into 1 ft^3.

so tough are the 21 complex processing steps needed for each of the 14 layers. Moreover, each operation depends on a correct previous step, so any mishap at any point in the production process can force rejection of the entire board.

Commercial versions usually have two or four layers—seldom above eight. "When you get to 10 and up, the handling gets difficult, with keeping layer-to-layer registration the toughest part," Manser says. To get it, tolerances for interconnection openings must be much tighter than with fewer layers.

Hughes has developed special tooling to drill the 30-mil holes, holding tolerances to 7 to 10 mils. The drilling is demanding, because the thickness and complexity of the boards means they cannot be stacked for single-pass drilling.

Laminations. The boards are 6-by-9-inch copper-clad panels laminated together. They use seven panels with copper sheets on each side, laminated with sheets of insulating bonding material.

To test, Hughes follows an IC technique of including a special section on each fabricated panel, which itself cannot be checked after lamination because such testing is destructive. If it shows defects, the panel is rejected. "This is the only way, since the typical board has 2,000 holes and no way can they be checked by hand," says Manser.

Heat. Cooling the modules is no simple matter, he says, since most dissipate 60 to 80 watts typically, and the ECL-heavy boards push 100 W. Because most aircraft provide only 3 pounds of cooling air per minute per kilowatt, "we have to distribute it as finely as possible to each module," he says.

To cool each type of module, Hughes developed a family of eight slots to regulate air flow. The slots in the molded plastic grillwork shown in the photograph above vary to provide 10-W cooling increments. "That way, we can see that the hottest boards get the most air," Manser says.

-Larry Waller

Industrial

Simple system charts factory work flow

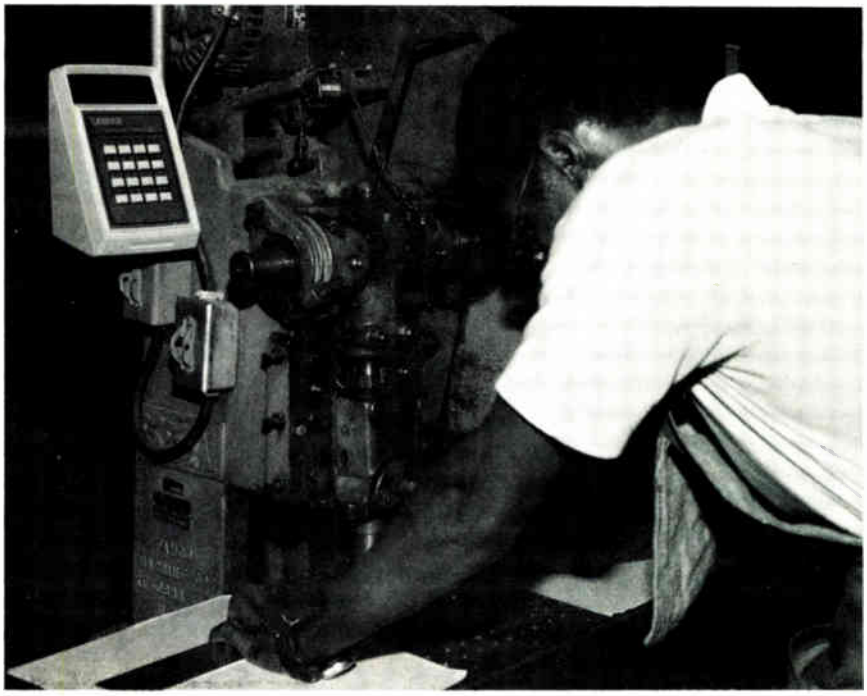
Venturing into a new arena, Lanier Business Products Inc. is introducing a low-priced system for monitoring work flow and production in a factory. Called Alert, it keeps track of work in progress and of where every job is in the production cycle.

It also charts equipment downtime and the time spent by each worker on a job. This raw data is then processed into a format the plant management can use to reveal how well the plant is being run.

Attractions. Lanier feels it has made Alert inexpensive enough, at \$150,000 for a 250-terminal system, to be attractive to efficiency-minded plant owners and simple enough to use so that workers accept it, says George O'Leary, vice president of the recently formed Computer division of Lanier, an Atlanta-based manufacturer of dictation and word-processing equipment.

A 16-key touchpad terminal, with a five-digit light-emitting-diode display to echo keyed-in numbers, is placed at each machine of the manufacturing process (see photograph),

Punch in. Production-line workers use simple, low-cost terminals to enter work-flow and production information in Lanier's new Alert factory work-monitoring system.



IMMEDIATE DELIVERY

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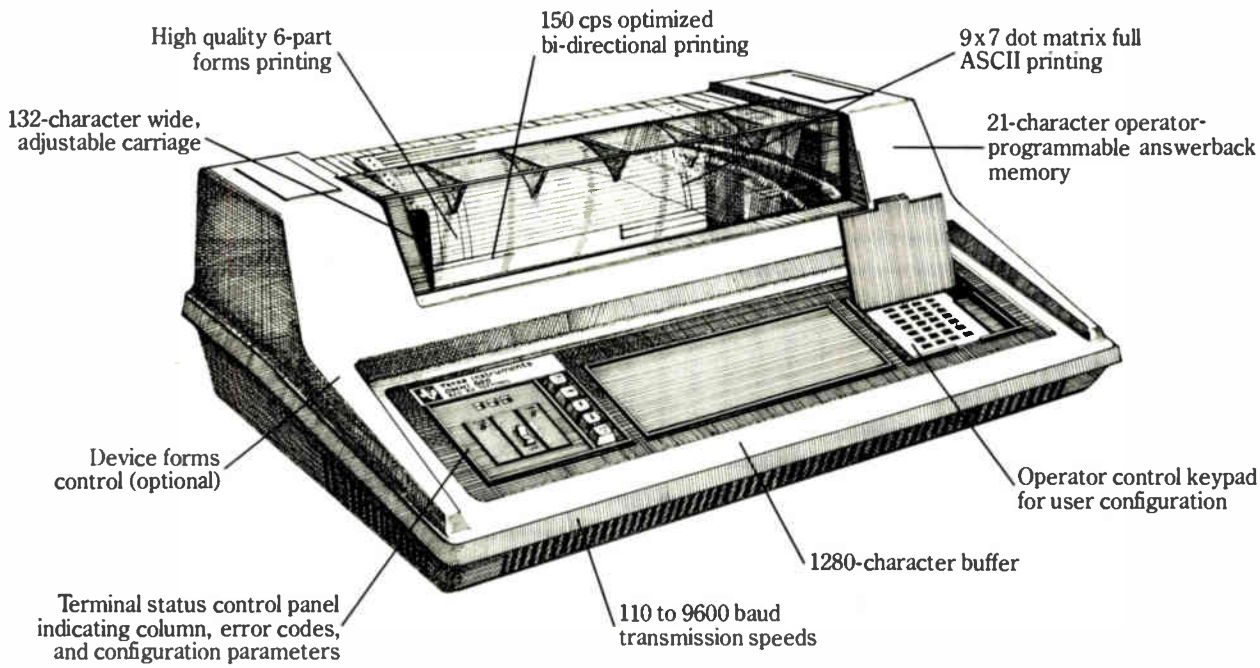

The OMNI 800* Model 820 RO Printer has the same designed reliability as its associate, the 810 RO. With more standard features and options like expanded and compressed printing, the 820 RO offers greater flexibility for additional applications. And, should application needs change, the 820 RO is easily upgraded to a KSR model for a modest cost. The productive 820 RO Printer has all the quality and performance you associate with the OMNI 800 Family.

TI is dedicated to producing quality, innovative products like the Model 820 Receive-Only Printer. TI's hundreds of thousands of data terminals shipped worldwide are backed by the technology and reliability that come from 50 years of experience, and are supported by our worldwide organization of factory-trained sales and service representatives.

For more information on the 820 RO, contact the TI sales office nearest you or write Texas Instruments Incorporated, P.O. Box 1444, M/S 7784, Houston, Texas 77001, or phone (713) 937-2016.

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rather than at a central site as with other factory data-collection systems. Sixteen terminals are strung along a party line using twisted-pair wires, and 16 such party lines are multiplexed to a Computer Automation 430 minicomputer that is the heart of the Alert system.

In operation. Workers key in their own identification numbers, a job number, and then a start command when they begin work. Stop work and machine breakdowns are also entered. The Alert system is thus able to compile the data needed to give a supervisor the big picture on the plant floor, revealing trouble spots before they become serious production bottlenecks.

What makes Lanier think Alert can compete successfully in a field that hosts such heavyweights as IBM, Honeywell, and NCR? Price, for one, is a factor. Whereas $4,000 buys a single terminal in the more elaborate systems, Alert averages $600 per terminal over the whole system price. The company also has some 300 sales and service offices already in place around the U. S. and can offer service on its new system on a 24-hour basis, says O'Leary.

Also, Lanier has equipped Alert with software, built around the Computer Automation operating system, specifically designed for transaction processing. Ordinarily, a manufacturer might add a production-control program to the computer that handles the accounting and inventory control. But these are batch- rather than transaction-oriented—or real-time—tasks.

Single entry. "Trying to handle production control in a typical batch system means one entry will often require 10 disk accesses before all files are updated," O'Leary says. "With one entry we access the disk once and update all 10 files."

What will come next from the division? O'Leary is mum. But Alert was under way well before he arrived—from Computer Automation, where he was marketing vice president for the Naked Mini division. Designs for other products, he indicates, are on the drawing board.

-Gil Bassak

Solid state

Motorola whips up big 8-bit batch

With a capacity to address only 64 kilobytes of memory, Motorola Inc.'s high-performance 8-bit MC6809 microprocessor has been likened to a 500-horsepower engine with a 3-gallon gas tank. The forthcoming MC6829 memory-mapping unit that will expand the address space to 2 megabytes should offer a lot more mileage to designers of 6809-based systems.

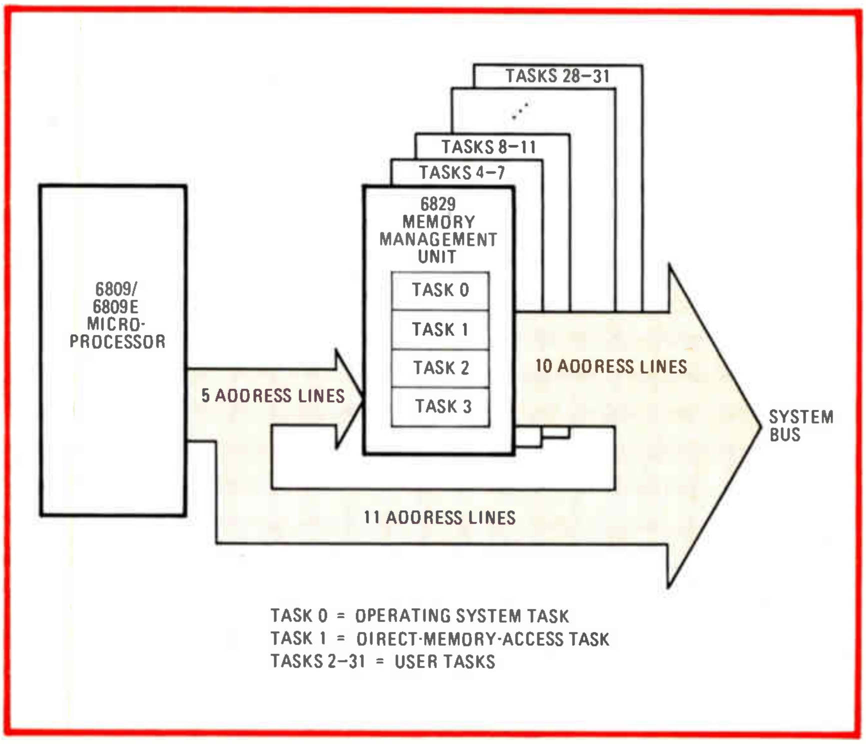
On a small die of about 20,000 square mils, the new chip is partitioned to handle four concurrent tasks of 64 kilobytes each, so it is a cost-effective solution for small systems. But because as many as eight chips can be hooked up in parallel for a cascaded 32-task capability, the 6829 also will fit into large 6809 systems.

The chip isolates its tasks and provides write protection so that no one task can be written over another. It also allows sharing of code and resources and provides automatic switching to the operating-system task, which allows the programmer to set up user/supervisor modes.

Officials at Motorola's Austin, Texas, MOS Integrated Circuit division are counting on the memory mapper to help the 6809 family against the 8088, which is Intel Corp.'s 8-bit version of its 16-bit 8086. Motorola is also introducing other chips in the family and other microprocessor ICs at next week's Electro/80 show in Boston.

21 lines. The 6829 memory mapper expands memory space by applying five upper address lines from the processor and the contents of a 5-bit task unit to an internal high-speed mapping random-access memory. The resulting 10 output address lines, combined with the processor's lower 11 address lines, produce 21 lines (see figure) that can address 2 megabytes. The 8088 supports 20 lines and a 1-megabyte address capability.

As well as introducing new 8-bit parts, Motorola will be using Electro



Increased range. The MC6829 memory-mapping unit draws on five MC6809 address lines to expand the CPU's maximum addressable memory from 64 kilobytes to 2 megabytes.

NO. 11

NATIONAL ANTHEM

SEMICONDUCTOR NEWS FROM THE PRACTICAL WIZARDS OF SILICON VALLEY.

Data acquisition rethought.

BLC-8715 INTELLIGENT ANALOG INTERFACE SMOOTHS OUT PROCESS CONTROL.

The ultimate CRT controller

National and Widlar do it again

ew IC pressure transducers

Introducing STARPLEX™ with ISE™

Checking out the National Archives

Data Acquisition Logic Transistors Hybrids Linear Interface Bubble Memory
RAMs/ROMs/PROMs Transducers Displays Custom Circuits Optoelectronics
Memory Boards Microprocessors Development Systems Microcomputers Modules

National's new BLC-8715–
a more intelligent approach to data acquisition.

High-speed intelligent I/O board offloads analog pre-processing functions from the data acquisition system CPU.

National announces a bright new addition to its family of Series 80 Board Level Computers: the BLC-8715 Intelligent Analog Input Board.

The BLC-8715 was specifically designed for industrial data acquisition and process control systems. This new microprocessor-based interface offloads all of the analog data pre-processing functions normally performed by the host CPU.

And in doing so, the CPU may then devote more of its valuable resources to the rest of the control system.

Faster than a speeding digit. Besides freeing up host system resources for more demanding tasks, there are many reasons why the rugged BLC-8715 smooths out process control.

One of the most dramatic is its A/D conversion speed. Based on National's proven BIFET™ technology, the 8-bit BLC-8715 Analog Input Board performs the A-to-D conversion in a scant 8μsec.

More versatility than ever before. The BLC-8175 performs "front end" measurement and control functions for 16 analog processes. But that's not all.

It also features 22 digital (TTL-compatible) lines for controlling simple on/off equipment functions, digital read-outs, and even keyboard manual override systems.

And to further increase the board's versatility, the Practical Wizards at National designed it so that it may be configured in either of two ways.

By using its standard RS232C interface, the BLC-8715 becomes a remote "slave" to the CPU host.

However, the intelligent I/O board can also interface directly with the host system bus. One of the many benefits of this approach is the BLC-8715's Mailbox memory: 256 bytes of RAM that are directly addressable by any intelligent device on the bus.

It certainly comes as no surprise that National should be the first to take a more intelligent approach to data acquisition and process control.

After all, that's what Practical Wizardry is all about.

BIFET is a trademark of National Semiconductor Corporation

The LM11. A dramatic advance in op amps.

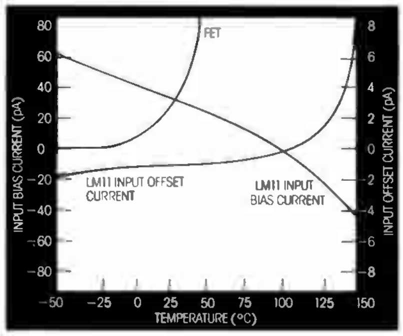
This new op amp represents the largest single advance in bipolar op amp design in over a decade.

National again drives home its leadership in linear with the new LM11 precision DC amplifier.

Designed by Bob Widlar, the LM11 incorporates the best features of existing bipolar designs – and then some:

50pA input bias current (max)
10pA input offset (max)
300μV offset voltage (max)
3μV/°C drift (max)

As shown in the graph, the LM11's input bias current is not only very low, it also remains well behaved over the entire mil-temperature range.



Leakage current only affects input current of the LM11 above +125°C.

An order of magnitude better than FETs. Overall, the new LM11 reduces DC error terms to such an extent that the op amp is no longer the limiting factor in many practical designs. Especially over the mil-temp range.

Further, its offset voltage, drift and long-term stability are an order of magnitude better than FETs.

Although internally compensated with provision for offset balance, the new LM11 is pin-compatible with, and quite similar to, the well-known LM108A amplifier.

STARPLEX™ aids μP system development.

STARPLEX with ISE,™ the fully developed development system.

Using the STARPLEX development system with National's 8048 Emulator Package, designers of 8048 Family systems get the kind of sophisticated tool needed for efficient microcomputer development.

And with 8048 ISE (In-System Emulator), they get capabilities that up to now simply haven't been available in this type of instrument.

What is ISE? National's ISE is a separate STARPLEX module housing 32K bytes of real-time map memory, plus all the necessary logic for breakpoints, tracing, and memory mapping.

ROM display and disassembling. The 8048 emulator package has its own 4K of RAM dedicated to the real-time emulation of the processor's program ROM. So the designer has complete access to this memory throughout emulation.

He may examine and disassemble existing ROM contents, make changes, and execute the altered code. This gives him considerable flexibility in a new product design, as well as in debugging existing systems containing a previously masked 8048.

STARPLEX can not only develop and debug software for the 8048 Family, but also for 8080 and Z-80* microprocessors plus BLC/SBC Series 80 boards. NSC800, 8070 and other ISE packages will of course become available as these new processors are introduced.

When you get right down to it, National's STARPLEX with ISE offers features not available in any other development system on the market today. Yet it costs substantially less to own and operate than any system currently being sold.

Practical Wizardry strikes again.

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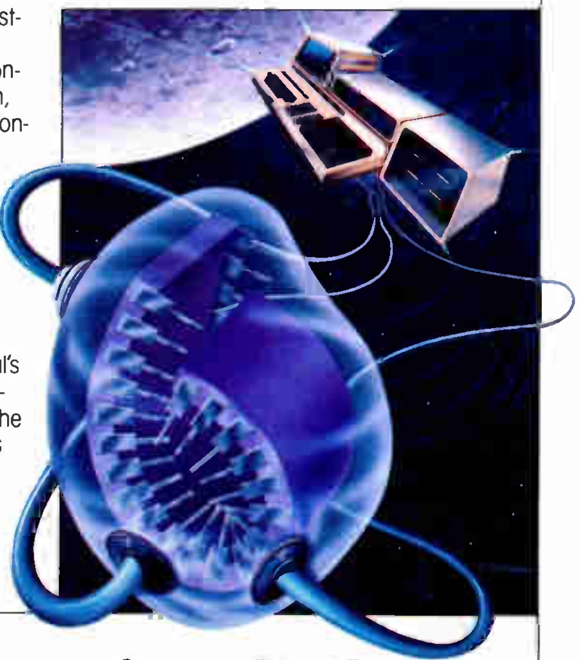

Economical IC pressure transducers from National.

Ever since National introduced the first hybrid IC pressure transducer in 1973, engineers have "robotized" a wide variety of electromechanical applications.

Today National offers the broadest line of IC pressure transducers on the market. Their line encompasses not only hybrids, but a full range of monolithic devices as well. All of which offer pressure systems engineers much greater design flexibility than ever before. At much lower design costs than ever before.

These IC pressure transducers are compact and easily interfaced with other integrated circuits. And because National processes silicon in large volume, they can offer these products at very low costs.

In fact, their LX05XX and LX06XX monolithics are the lowest cost IC pressure sensors available. They offer high accuracy and ±5 to ±100 psi pressure ranges. Their compact TO5 and ceramic packages allow easy PC board installation which cuts costs of OEM pressure systems even further.

Of course, the LX16XX hybrid is also available in a ceramic package. This fully signal-conditioned pressure transducer features built-in temperature compensation, high-level output and full voltage regulation.

The LX16XX, in a nylon or diecast zinc housing with NPT fittings and a snap-on connector, becomes an LX18XX. The LX18XX is ideal for plug-in operation with pressure ranges from ±5 to 300 psi.

For high pressure applications – 100 to 5000 psia – National offers the LX14XX hybrid series. Housed in rugged cylindrical brass or stainless steel, the LX14XX is available with flying leads and an optional fluid isolator. This device is perfectly suited for submersion or tough industrial environments.

For additional information, check the coupon for the Pressure Transducer Data Packet – including the handbook, data sheets and application notes. Everything you need to get in on the "robotic" revolution from the Practical Wizards of Silicon Valley.

What's new from the National archives?

- 006 ☐ Special Functions Data Book ($6.00)
- 024 ☐ DP8350 Series Data Sheet and Application Notes
- 034 ☐ LM11 Data Sheet and Application Note
- 035 ☐ Additional Series/80 Information
- 036 ☐ Optoelectronics Handbook ($3.00)
- 037 ☐ Additional STARPLEX and ISE Information
- 039 ☐ BLC-8715 Data Sheet
- 040 ☐ Pressure Transducer Handbook ($3.00)
- 041 ☐ Additional Pressure Transducer Information

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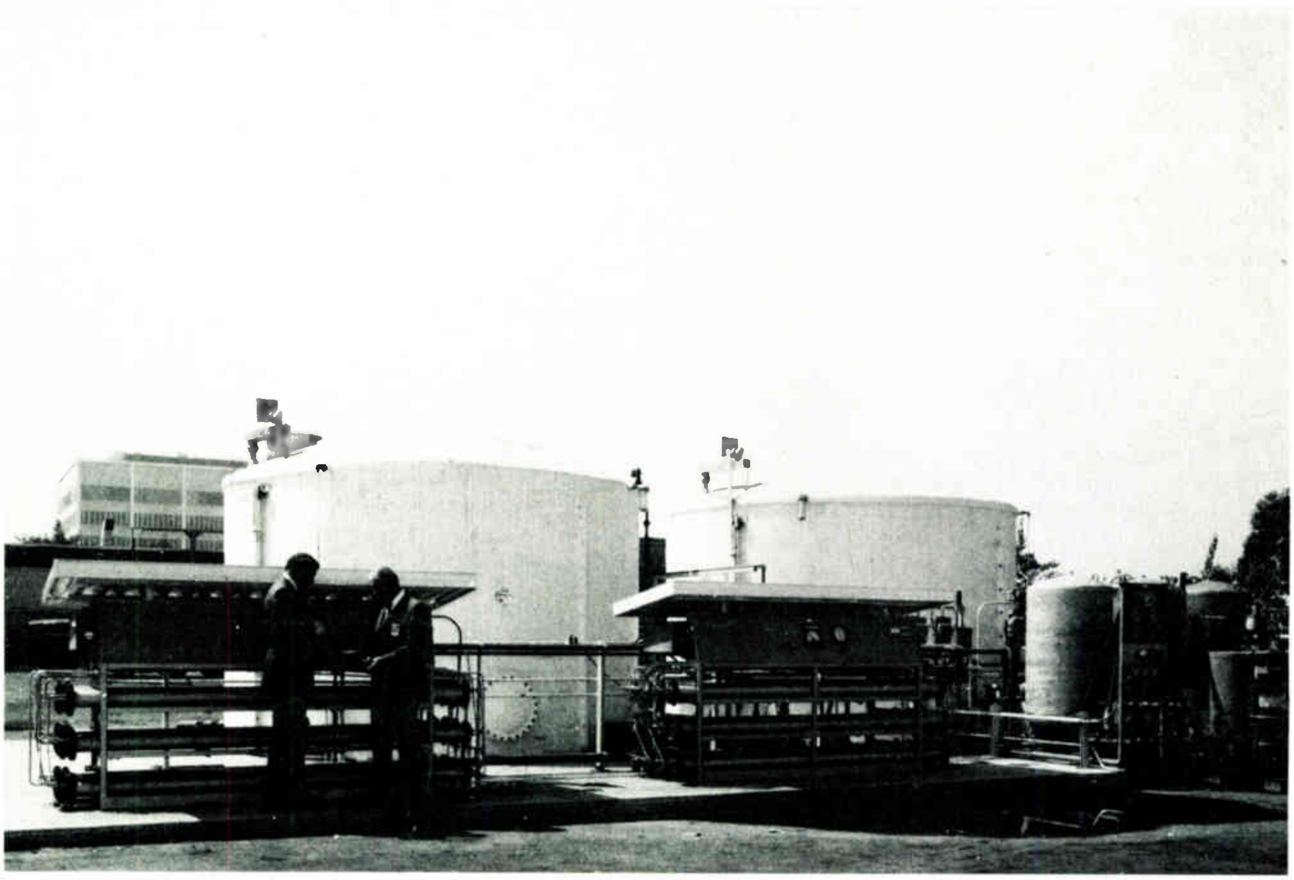

Can Culligan water treatment help a major MOS/LSI manufacturer increase production cost efficiency? Ask North American Rockwell Microelectronics.

Volume manufacturing of MOS/LSI's, with electronic densities of about 400,000 circuit elements per square inch, requires rinsing water as pure as the production tolerances are critical. North American Rockwell Microelectronics, a circuits industry leader, tried to meet the need with bulk quantity distilled water, but production engineers weren't satisfied. Variances in purity increased unit spoilage, and the high cost of trucking in huge quantities of distilled water reduced profits. NRMEC needed a better answer.

Culligan delivered the solution—A Reverse Osmosis/Deionization water treatment system was installed at NRMEC's Anaheim MOS/LSI manufacturing plant. Using city water, the Culligan RO/DI system yields product water virtually free of particulate matter, total dissolved solids and bacteria. This results in a process water with a resistivity of 18 megohms. That's about five times as pure as commercial distilled water. And for NRMEC, far more cost effective.

Your Inquiry is Welcome—Culligan RO/DI water treatment systems are finding increasingly wide applications in the electronics industry. To find out how Culligan can improve your manufacturing cost efficiency, call your local authorized Culligan dealer. Or contact Greg Montgomery at Culligan USA. Phone 312/498-2000. Or mail the coupon.

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Circle 53 on reader service card

to unveil several coming additions to its 16-bit 68000 family (see p. 89). Besides the 6829 memory mapper, other new 6809 8-bit family members include the MC68B09, a 2-megahertz version of the original 1-MHz machine; the MC6809E with an external clock; the MC6839 floating-point read-only memory; and the MC6842 serial direct-memory-access processor.

On-chip E-PROM. The company also plans to introduce the MC68701, a version of its 6801 single-chip microcomputer with an erasable programmable ROM added. Also, four new versions of the MC6805 central processing unit will be discussed, including the 6805R2 with on-board 8-bit analog-to-digital converter. All the new 8-bit chips are planned for availability before the year is out.

In itself, the third-quarter availability of an E-PROM version of the 6801 is not very significant. Intel has offered single-chip microcomputers with on-board E-PROMs for some time, and other firms like Texas Instruments Inc. have offered similar chips more recently.

The 68701, however, is unusual in that programming of its 2 kilobytes of E-PROM may be done by the chip's CPU with the aid of a 2-K-by-8-bit ROM monitor package known as Probug. Thus no expensive PROM programmer is needed—all that is required are four additional chips, and Motorola is offering them on the MCX6801EVM board that is designed for evaluation of the 68701 computer. **-Wesley R. Iversen**

News briefs

Memorex signs up another overseas partner

A second overseas manufacturer has entered into a technology licensing agreement on computer disk drives with Memorex Corp. Fujitsu Ltd. of Japan, like Olivetti Corp of Italy, will immediately begin manufacturing Memorex's 11.7-million-character 8-inch disk drives and will provide technical support for future 8-in. drives from the Santa Clara, Calif., maker of computers and peripherals.

Memorex also is endorsing the combination of fixed and removable backup media for the 8-in. drive. Its model 201 disk drive to be shown at the National Computer Conference has 25 megabytes of backup, half of them fixed and half removable. To compete with Control Data Corp.'s 16-megabyte Lark disk drive (see p. 188), the Memorex unit has an average access time of 30 milliseconds and transfer rate of 1.2 megabytes per second.

Fledgling IC maker set to try wings

Applied Micro Circuits Corp., founded by former American Microsystems Inc. chief executive officer and cofounder Howard S. Bobb, and former AMI marketing manager Joseph A. Mingione, has completed the financing package with which it plans to establish an integrated-circuit manufacturing plant in the San Diego area. AMCC will shortly introduce two families of uncommitted gate arrays. One is a combined emitter-coupled-logic and TTL array said to mesh the high speed of ECL core circuitry with a TTL input/output section. The other family, using standard complementary-MOS processing, will include both complex linear and high-density digital structures. The firm also is involved in the design of dedicated custom ICs and in C-MOS microcomputer designs and says it plans to introduce its first low-end C-MOS microcomputer shortly.

Raytheon has big plans for intelligent terminals

An ambitious microprocessor-based family of intelligent terminals is starting to roll out the door at Raytheon Data Systems Inc. The Norwood, Mass., company's PTS-2000 has a controller that can support eight terminals with binary synchronous communications. By the end of the year it will be handling synchronous communications and larger clusters, and in 1981 it will be expanded to handle multistation shared-resource word processing, the company says. These units are compatible with IBM Corp.'s popular 3270 family of cathode-ray-tube terminals, and a larger family member due in 1982 will support local processing and distributed processing and will compete with IBM's model 8100 system. A typical PTS-2000 configuration with four terminals, one controller, and a printer costs $22,170.

Testing

RAM tester weds accuracy to speed

A strong contender in the race to a high-speed accurate random-access-memory tester is emerging from Teradyne Inc.'s Semiconductor Test division. The J389 relies on a 125-MHz crystal oscillator and precision-delay circuitry plus a novel compensation for edge-timing errors to provide a tester to exercise the new RAM generation.

The new model has a programming resolution of 0.5 nanosecond and a positional accuracy of 250 picoseconds, half the figures for the present J387A. Such accuracy "is needed by RAM producers who classify their devices principally in terms of cycle and access times," says Edward Rogas Jr., product manager of the memory products group at the Woodland Hills, Calif., division.

"With a highly accurate memory system, narrow guard bands can be used to classify devices precisely and determine their performance," he says. With static RAMs approaching cycle times of 20 ns, memory-tester technology needs to sprint to get ahead of the parts.

Speed. The operating speed is 20 MHz with no restrictions, as is true of the J387A. However, all clock edges can be recycled at 30-ns intervals, the equivalent of 33 MHz.

With a base price of $215,000, the J389 will be available within nine months. On Wednesday, May 21, it will be the subject of an "Advances in Semiconductor Device Testing" technical session of the Semicon/West conference in San Mateo,

A whole new world of µsoftware development.

Introducing the MDT 1000 Series.

It's affordable. It's expandable. It's a whole new world of microsoftware development for everyone using the powerful 6500 microprocessor family—the MDT 1000 Series from Synertek Systems.

This is a Micro Development Tool that has it all—complete with CRT display, keyboard, system software, three Micromodule boards, EPROM programmer and power supply plus optional CAS-1 recorders. For software development. Hardware prototyping. Testing. Consulting. Or just learning about microprocessors. And, because the MDT 1000 is Motorola EXORcisor™ bus compatible, it expands in a snap to meet growing system requirements.

Programming the MDT 1000 saves time. That's programming as it should be. The MDT 1000, with optional BAS-1, offers over 20,000 bytes of ROM-based operating software. This software availability is made possible by the over 12.000 SYM-1 single board computers already in use today. Standard features include a powerful 8K ROM resident assembler/editor, RAE.

The best thing about the MDT 1000 is that it's available right now—in 4K, 8K and 16K RAM versions at prices you would expect to pay for a CRT terminal or EPROM programmer alone. Starting at $1,495. For complete technical information on the MDT 1000 Series, contact your nearest Synertek Systems distributor. Or call at (408) 988-5682 or 988-5689.

Synertek Systems manufactures a growing line of evaluation microcomputers and keyboard modules, OEM modules, and development systems for both standard and custom applications.

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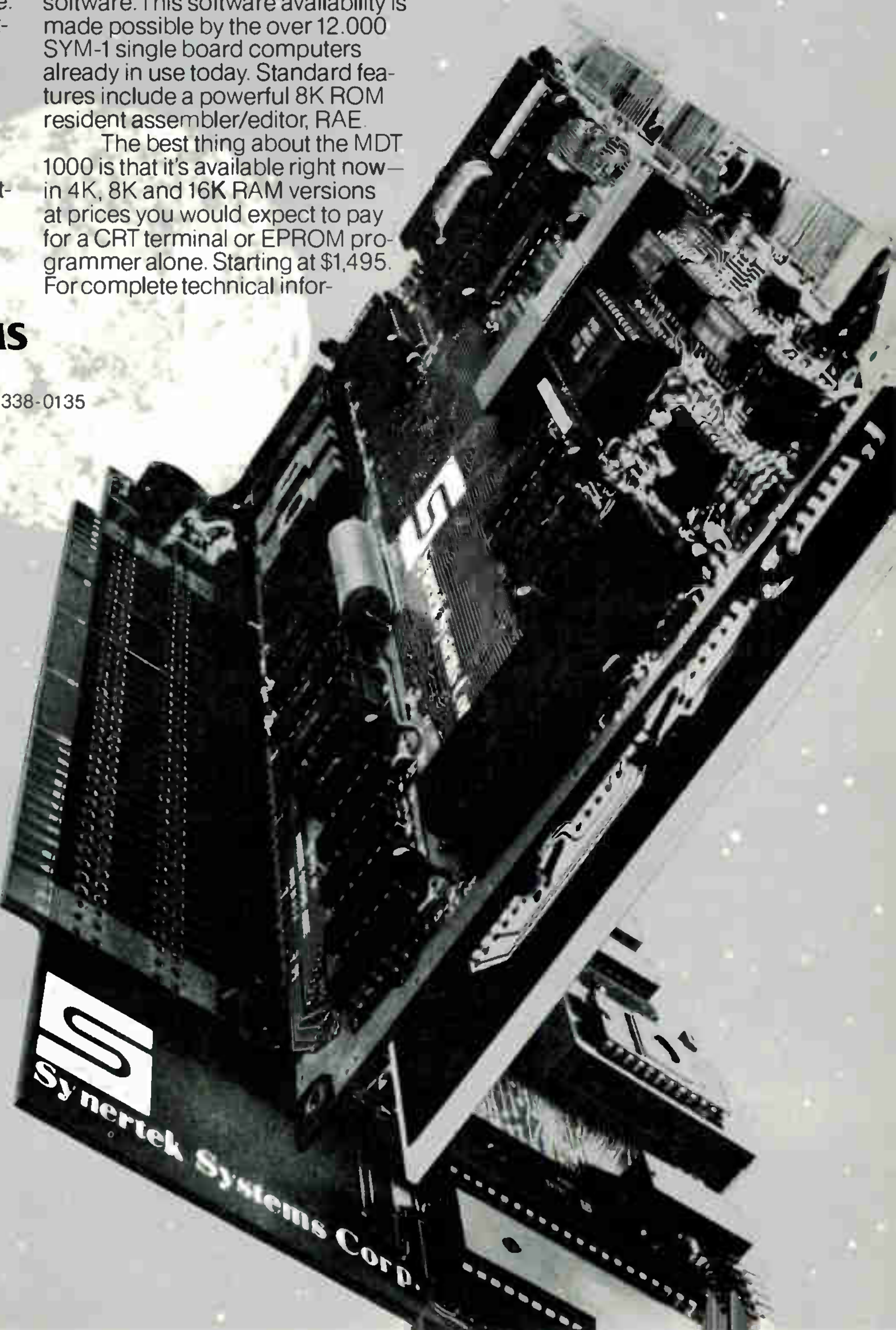


Circle 55 on reader service card

Calif. Sessions on Tuesday and Thursday will deal with advances in fine-line lithography and in silicon wafer processing, respectively.

Timing. The J389 [*Electronics*, April 24, p. 34] derives its timing from the 125-MHz crystal oscillator whose 8-ns period is divided by the precision delay lines into 0.5-ns intervals. Cycle times and edge delays are obtained by counting these intervals, and 16 cycle-time values can be programmed and stored in RAM before each test, then selected under microprogram control for each cycle of a functional test.

Similarly, each of 150 edge-delay circuits contains a RAM that stores 16 different values from 31 independently timed edges that determine when waveform transitions occur. These values are selected on a cycle-by-cycle basis under microprogram control, as are 16 programmed format sets that define the waveform transitions at each timed edge.

"By programming 16 cycle times, 16 edge-timing sets, and 16 format sets, over 4,000 waveforms can be selected for each cycle," Rogas notes, with a different set of waveforms available for each test in a program. "This provides more than enough cycle-to-cycle flexibility to satisfy complex device waveform and timing requirements."

Edge checking. Other memory test systems like the J387A attempt to minimize timing errors by looking at a representative edge and then tweaking the other edges. The J389 achieves and maintains its accuracy under a proprietary computer-controlled method called automatic edge lock (AEL). This method independently maneuvers each edge so that it meets the appropriate timing by using time-domain reflectometry with 30-ps resolution to align edge timing at the pins of the memory under test.

According to Rogas, AEL calibration occurs automatically. Unlike earlier memory testers, the J389 needs no special calibration fixtures nor an operator to judge when calibration is required.

Yet another key feature of the J389 tester is its adoption of a new high-level programming language. Called Pascal-T because it consists of Teradyne-derived testing statements written in Pascal format, the language simplifies test-program preparation such that "a typical Pascal-T program listing is less than one tenth the length of the equivalent program written in older languages," Rogas states. "It will minimize program generation time by as much as 50%." **-Bruce LeBoss**

Industrial

Robots to gain eyes for seam welding

A Japanese and American development team is building a vision system with which a robot can see well enough in an optically noisy environment to guide arc-welding machines laying down seams at speeds as high as 30 inches per minute. The Kawasaki-Unimation team has devised a system that determines the deviation from the correct seam line by comparing a correct template image with the actual image.

"Our system is special-purpose—for arc welding only—and so we don't need the complexity of [outline] pattern recognition," says Ichiro Masaki, the manager of the team. The robot need recognize only a line (the seam), not objects. But, he points out, the intense glare and spattering from the arc constitute optical noise sources that can confuse many vision systems.

Setup. The Unika 79A, as the team calls its vision system, uses a solid-state television camera to pick up the seam image, obtained through illumination by a laser beam projected through a slit. Every 0.1 second, the system's processor compares a learned template image with the actual image to develop an error signal. Optical noise is no problem, because its correlation with the template is zero.

To teach the robot the template pattern, the system's processor digitizes and stores the image as a 50-by-50-element matrix. When the

welding pass starts, the image from the seam is digitized as a 100-by-100-element matrix, larger because the seam may not be in the center of the field of vision.

The template pattern is shifted electronically left and right, up and down, 25 times in each direction. For each shift the processor computes the cross correlation between the two matrixes—that is, it computes it in 2,601 positions (51 by 51). The shift value that produces the highest correlation represents the off-seam error of the welding head.

Hardware. Masaki says that the team first tested the concept by computer simulation using a Data General Nova minicomputer. But, he notes, a minicomputer would be too slow and too expensive for this kind of job.

"The simulation takes several minutes," he reports. "Although it could be speeded up, the mini could not give the correlation every tenth of a second that we need."

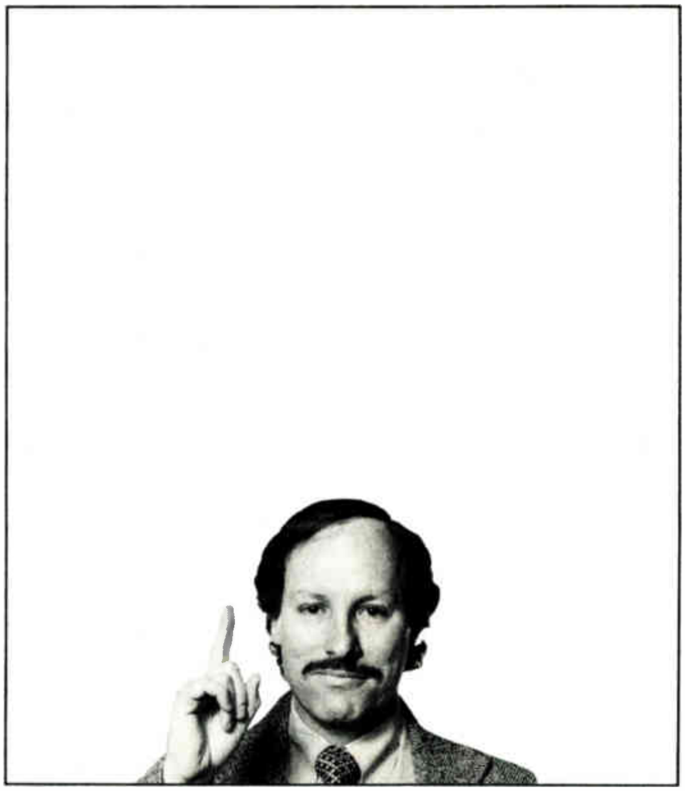
So, an experimental version of the Unika 79A was implemented as a hardwired processor based on standard medium-scale integrated TTL with parallel paths to provide the required high speed at low cost. Unimation will not disclose exactly how many parallel paths are used.

The present timetable calls for completion of a prototype system during the second half of this year, again using TTL. Maurice Dunne, chief engineer, expects that the Danbury, Conn., company will be able to announce specifications and prices during the second half of 1981 and to start deliveries during the first half of 1982. To be competitive, he says, the vision system should add less than $10,000 to the price of the robot on which it is used.

Team. Masaki was sent by Kawasaki Heavy Industries in Kobe, Japan, to Unimation, where he works with development engineer Robert Gorman and a software team. "We've had a technology-exchange agreement with Kawasaki for 11 years," says Dunne. "We are doing this development here because they have bilingual engineers and we don't." **-Charles Cohen**

"A computer system for analog measurement must be built from the ground up."

Fred Molinari, President



When analog capability is merely tacked onto a laboratory computer system, performance is predictably poor.

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As a result, LAB-DATAX is the highest performance microcomputer data acquisition system available today.

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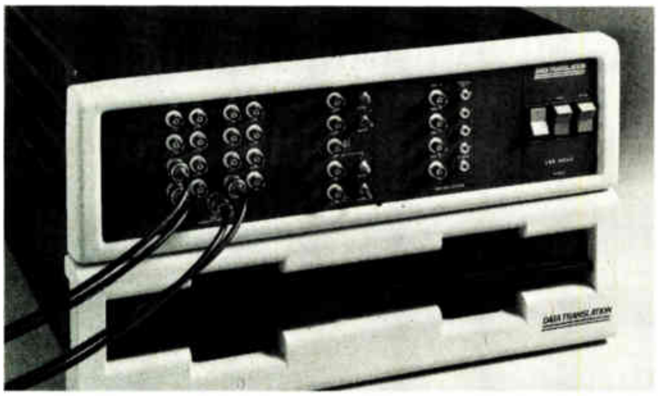

Every model of LAB-DATAX includes an LSI 11/2™ CPU with 64KB RAM memory. A fixed and floating point instruction set. A synchronous serial interface. A bootstrap loader. A dual-drive double-density Floppy Disk. DTLIB-FORTRAN callable subroutines. And 16 slot dual-height capacity.

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Washington newsletter

AT&T beats FCC applications cutoff with domsat proposal

In a swift move that beat a new Federal Communications Commission cutoff date for applications, the American Telephone & Telegraph Co. has filed to launch and operate its first three domestic communications satellites. AT&T says it is still negotiating with two manufacturers for the 4-to-6-GHz satellites proposed for launching between 1978 and 1986 to replace three Comstar satellites leased by the company from Comsat General Corp. since they were put in orbit between 1974 and 1978. The AT&T estimate of the project cost is $230 million, according to the FCC filing, which says **the new digital satellites will each have a capacity of 21,600 simultaneous voice conversations or 24 TV channels**—a 20% increase from the Comstar series. The new series will operate with the same eight earth stations now in use.

Commerce settles TV dumping claims for $75 million . . .

Despite strong protests from domestic manufacturers and Capitol Hill, the Department of Commerce has negotiated settlements of dumping duties on television receiver imports from Japan for the nine years prior to April 1, 1979. If all 110 companies sign the agreement—and 22 already have—the department's general counsel, Homer Moyer, says the U. S. will get between $75 million and $77 million—**about 50 cents on each dollar of what Moyer calls the $138.7 million "maximum defensible claim"** of the U. S. About $66 million of the settlement will come from the agreements, under which no party admits to dumping, and Moyer says another $9 million to $11 million will come from settlement of 10 pending civil suits by the Bureau of Customs charging dumping. U. S. affiliates of nine Japanese TV makers that have already signed include General (Technika), Hitachi, U. S. JVC Corp., Matsushita, Mitsubishi, Nippon Electric, Sanyo, Sharp, and Toshiba. Among the major U. S. importers that signed are J. C. Penney, Montgomery Ward, and Sears, Roebuck.

. . . as opposition by industry, Congress is called futile

Government and industry officials say privately that they expect the settlement to hold despite threats of legal action by Compact—the industry-labor Committee to Preserve American Color Television—and strong protests by Rep. Charles A. Vanik (D., Ohio), chairman of the House Ways and Means international trade subcommittee. **Compact says $700 million is outstanding in dumping duties on the $2 billion worth of Japanese TV imports over the nine years.**

Carter to wait despite IEEE push for engineering study

The White House is expected to wait until July—when it gets its requested evaluation of engineering and science education from the National Science Foundation and the Department of Education—before deciding what, if any, action to take on forming a blue-ribbon commission to study U. S. engineering. That is the initial reaction of White House technology staff members to the call at the end of April for just such a panel by Leo Young, president of the Institute of Electrical and Electronics Engineers. Young made his personal proposal at the IEEE technological policy conference in Washington, D. C., urging support for the plan by the IEEE and the American Association of Engineering Societies. Strong government and societal commitments in Japan and Western Europe to using technology for increased productivity impressed on Young **the need for a comparable U. S. program to establish a national technological policy**—including the formation of a National Engineering Foundation.

Washington commentary

Competition is coming for Comsat and the internationals

Now it's Comsat's turn to be restructured. Within two weeks of the Federal Communications Commission's ruling to deregulate telecommunications terminals over two years and let American Telephone & Telegraph Co. compete with everyone else, the commission is proposing to do much the same to international satellite communications and Communications Satellite Corp. Comsat has yet to respond officially to the FCC proposals, but insiders say the company, like AT&T, is not altogether unhappy with the plan laid out in three separate actions designed to stimulate U. S. competition.

First, the FCC recommends that Comsat form an arm's-length subsidiary for all unregulated communications business, including research and development, to preclude the threat of cross-subsidization of new ventures by regulated communications revenues. Second, Comsat would be permitted to sell its international satellite services directly to U. S. users, removing the restriction that it serve only other carriers. Finally, Comsat and other U. S. International carriers would be permitted to sell services for resale and shared use—with or without added service innovations.

Reaction at Comsat

Comsat likes the last two ideas, of course, but is troubled by the proposal to make the company split its businesses, as AT&T is being ordered to do [*Electronics*, April 24, p. 104]. Nevertheless, the FCC recommendation to Congress, which created Comsat in 1962, is not all that rigid. Interlocking directors would be permitted for both companies, for example, although officers, books, and facilities would be separate, and industry observers note that Comsat already has an effective, operating subsidiary in Comsat General Corp., its domestic satellite company, that could be reshaped to meet the new rules. The parent company would then operate only in the International Telecommunications Satellite Organization, known as Intelsat, and its maritime counterpart, Inmarsat.

Since the creation of Comsat during President John F. Kennedy's administration was politically designed to prevent AT&T from expanding its earthbound monopoly into space, some congressional staffers see a distinct irony in the FCC's recommendation. It calls for "specific controls to minimize Comsat's opportunity to evade rate regulation through misallocation of costs and to discourage it from using its unique Intelsat/Inmarsat roles to maintain exclusive access to and use of technology and information in order to improve its position in competitive markets." To one senior House Republican, that can be oversimplified to mean, "Comsat has gone wrong by becoming a success and must now pay a price for its innovation."

But there are few other tears being shed for Comsat. It already owns a large share of Satellite Business Systems Inc., in partnership with International Business Machines Corp. and Aetna Life & Casualty Co., both of whom promise to be big users of the new domestic digital system when it becomes operational next year. Moreover, Comsat stands to enrich its coffers substantially if the FCC proposal for it to offer its services directly holds up. That judgment came in response to petitions by Aeronautical Radio Inc., the carrier for the nation's airlines, and the Department of Defense on behalf of all Federal executive agencies.

The Comsat business potential from those two segments alone is huge. And for that reason, opposition to the new rule making from AT&T and the international record carriers is sure to be intense. The issue is likely to wind up in court, say carrier officials, if it cannot be blocked within the FCC. Considering that the IRCs include such corporate heavyweights as ITT World Communications, RCA Global Communications, Western Union International, and TRT Telecommunications Corp., the fight could be a long one.

Where the money lies

But the proposal to permit resale and shared use of U. S. international services holds the most moneymaking potential in the shorter term. Telecommunications equipment makers at home and abroad are eyeing it with pleasure as they envision new service innovations that will broaden the relatively sluggish international equipment market. Analysts of those markets are already beginning new studies of where and when the new business will come, and a better picture of market potentials should emerge as the FCC rulemaking advances through the hearings and study process this year.

More steps remain to be taken, of course, before the FCC recommendations become final, some of them in Congress regarding the structure of Comsat. But now the commission finally seems to have rid itself of the confusion and built-in conflicts that marked its prior moves toward an open, competitive market. And that is a welcome accomplishment. **-Ray Connolly**

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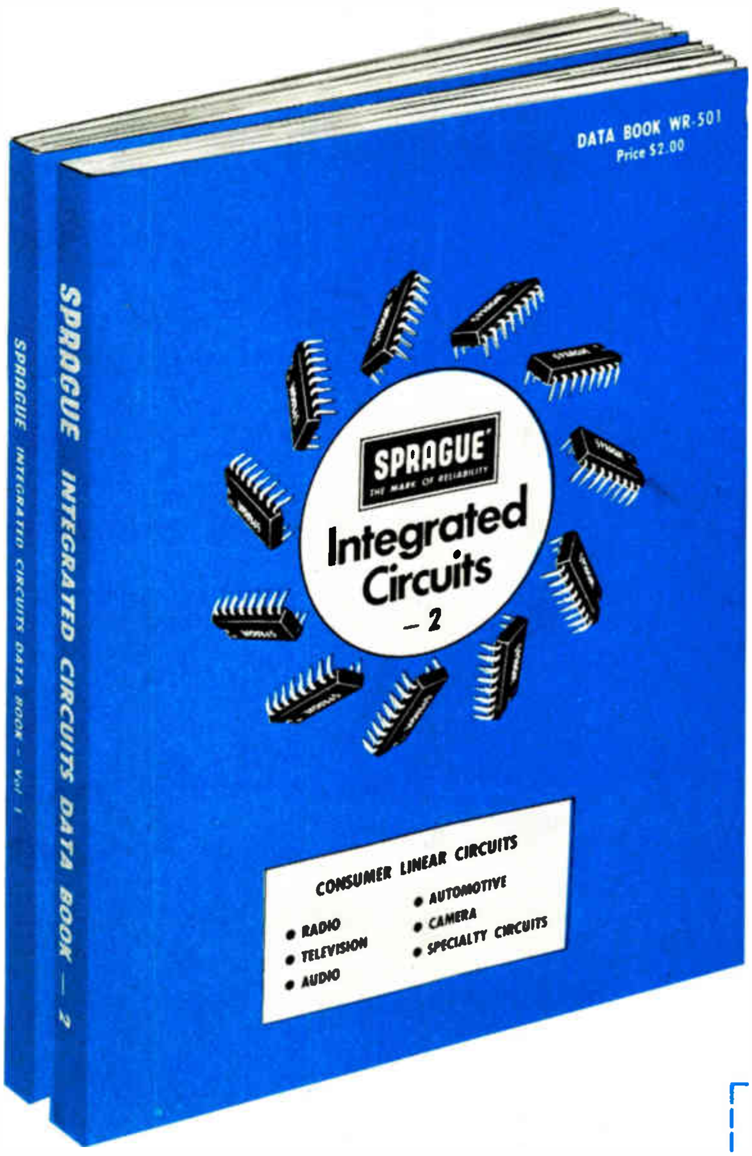

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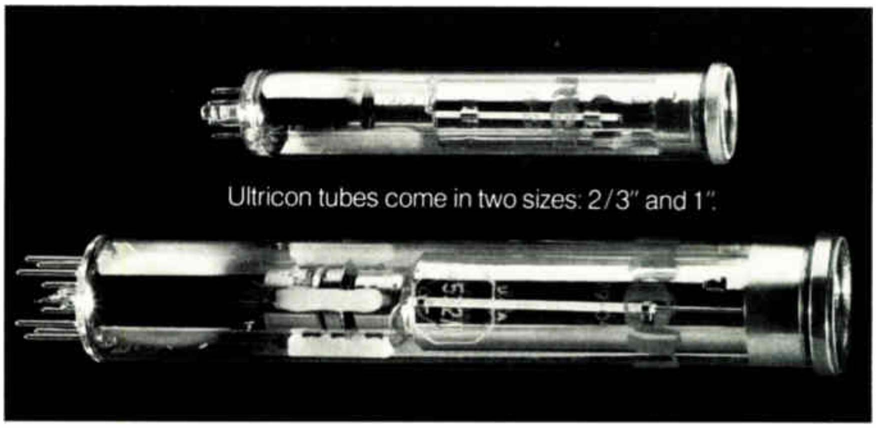
Ultricon tubes come in two sizes: 2/3" and 1".

RCA's new Ultricon™ camera tubes are a major advance in silicon-target technology.

Designed for superior performance in CCTV cameras, the Ultricon tube offers significant improvements over standard silicon target vidicons and heterojunction types.

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The Ultricon offers all the advantages you expect from a silicon target vidicon: low lag and extremely high resistance to image burn-in.

Plus, we have made further advances to reduce highlight blooming. Which means bright spots and reflections in a scene have minimal effect on the picture.

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Fits most CCTV cameras.

RCA Ultricon tubes are interchangeable with many existing silicon target, heterojunction, and other type tubes.

Which means you can get more out of your new designs. Or you can upgrade an existing camera simply by replacing your present silicon target, heterojunction, and other type tubes with Ultricon tubes, making only the same simple camera adjustments needed whenever a new tube is installed.

The Ultricon tube comes in 2/3" or 1" sizes with magnetic focus. Or 2/3" with electrostatic focus.

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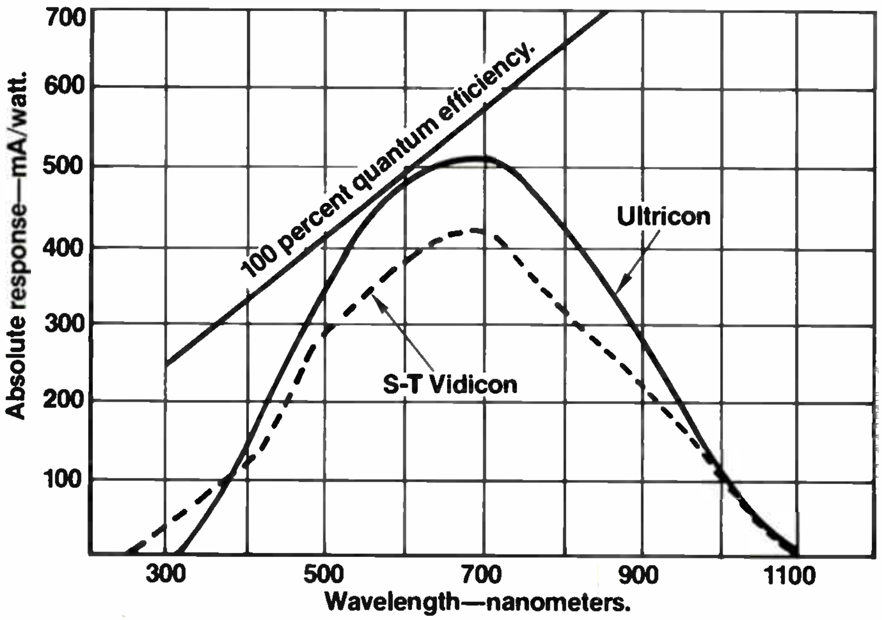

Intermetall readies one-chip C-MOS filter and codec

Intermetall GmbH, the Freiburg, West Germany–based headquarters company of the ITT Semiconductors Group, is currently developing a filter-codec **claimed to be the first one-chip version using complementary-MOS technology.** Intended for one channel in pulse-code-modulation telephone systems, the very large-scale integrated circuit will come in two designs, one for Europe and the other for the U. S., to accommodate the different approximation methods in those two regions. No date has been set, however, for when the devices will be available. The chip's two converters work on the charge-redistribution principle, and the two low-pass filters are switched-capacitor types, providing a minimal signal-delay time. **Frequency response, delay distortion, idle-channel noise, signal distortion, crosstalk, and gain variations exceed CCITT recommendations,** Intermetall says. The devices, to come in a 24-pin dual in-line plastic package, operate off +5 and −5 V and consume less than 150 mW.

Olivetti continues computer moves with buy into IPL

C. Ing. Olivetti & Cie. has bought 33% of IPL Systems Inc., the second largest maker of IBM-compatible mainframes in the U. S. **A later purchase of shares, according to the deal, would boost Olivetti's interest in the privately held Waltham, Mass., firm to 40%.** This agreement follows a recent Olivetti contract with IPL, as well as with Hitachi, to lease IBM-compatible hardware and St.-Gobain's purchase of 20% of Olivetti last month [*Electronics*, April 24, p. 67]. Additionally, Olivetti has set up a joint venture with Memorex Corp. to produce and market 8-in. mini-Winchester fixed-disk drives; production of the 101 drive is expected to begin in Ivrea, near Turin, around the end of the year. Olivetti will own some 60% of the joint venture.

Xerox and Thomson to continue cooperation on electronic office

The recent agreement between Xerox Corp. and Thomson-CSF to develop jointly an inexpensive optical disk reader-recorder may be just the first in a series of accords between the two. In a joint statement, the two companies say they are "investigating other prospects . . . for the development of data-processing and office information systems." Sources at Paris-based Thomson say **negotiations are under way for cooperation in word-processing and digital facsimile equipment.** Marketing agreements between the two are also a distinct possibility, they add. Although Thomson has already signed a distribution agreement with 3M for its low-cost digital facsimile machine [*Electronics*, Aug. 30, 1979, p. 70], Thomson officials point out that the accord is nonexclusive and covers only distribution. The major French electronics and data-processing equipment makers, including Thomson, CIT-Alcatel, and CII-Honeywell Bull, are counting on substantial government aid as part of a national effort to develop the electronic office equipment industry in France.

Phone boxes using credit cards slated for UK trial

Public telephones that accept prepaid credit cards instead of cash are to go on trial at 400 sites in the United Kingdom later this year if negotiations under way between the British Post Office and two potential suppliers are successful. The cards would be purchased over post office counters and thrown away after their credit is exhausted. **When the card is inserted into a slot, its value, displayed on the phone's digital readout, is automatically reduced** as the call progresses. The system eliminates the need for exact change, reduces vandalism, and requires less maintenance, but poses operational problems, at least initially. The BPO is to evaluate two systems, one from Emidata, in Slough, the other from a Swiss company, Sodeco-Saia AG, represented in the UK by Landis & Gyr Ltd. In the Emidata system, credit is stored on a magnetic stripe, whereas the Sodeco card—also on trial in Brussels—stores credit data by means of a holographic technique. The technology contrasts with bank and credit cards being developed in France [*Electronics*, Jan. 17, p. 68] and Italy that incorporate active semiconductor devices.

Grundig looking to U. S. market for dictating machines

Grundig AG, West Germany's largest entertainment equipment producer, with strong activities in other consumer electronics sectors, intends to expand its dictating machine business in North America. The Nuremberg-based company wants **to strengthen its position in that market either by some sort of cooperative deal or by licensing production to another firm,** rather than by setting up its own manufacturing facility in North America. One of Western Europe's top producers in the field and with a nearly 50% share of the West German dictating equipment market, it figures that about 1.23 million pocket and office dictating machines were sold world-wide last year, representing a value of almost $400 million, up from $360 million the previous year. **Grundig thinks the market will grow by at least 4% annually through 1985,** with the three major market areas being North America, West Germany, and the United Kingdom.

British company makes low-cost fuel consumption meter

Following the example of watches and calculators, microprocessor-based automotive systems are already tumbling in price. Out now from the British car accessory manufacturer, Mobelec Ltd. in Oxted, Surrey, is a fuel consumption meter that **sells for $98 and can be retrofitted to any car.** Based on a PIC 1655 from General Instruments' Microelectronics division, the Maximiser displays instantaneous fuel consumption or total gallons consumed on a journey on a three-digit light-emitting-diode display. An impeller inserted in the fuel line provides a direct indication of fuel consumed, and the speed can be derived from a pickup at the back of the speedometer. No matter what the pickup point, the meter can be calibrated for any car to which it is fitted merely by driving at a preset speed and then pressing the calibration buttons. Triangle Digital Services developed the microprocessor hardware.

Addenda

Now that the Medical Systems division of General Electric Co. has agreed to pay Britain's Thorn EMI Ltd. $37.5 million for the purchase of the bulk of its interests in X-ray tomography and for the settlement of any outstanding patent litigation against the U. S. company, **the two firms are exploring the possibility of Thorn EMI's continuing the development of imaging products for GE using the expertise of its central research laboratories.** Such products could include nuclear magnetic resonance imaging systems, already in advanced development, that clearly display soft tissues. . . . West German postal authorities have **let a contract to two firms for a new car-radiotelephone network that is to increase the country's capacity from about 18,000 subscribers now to a total of 100,000** within a few years. Philips affiliate Felten & Guilleaume Carlswerk AG, Cologne, and Siemens AG, Munich, are to install the network, valued at about $22 million.

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Intel's new 8272 controller for double density floppy disks lets you command shorter design times.

Why have second thoughts about designing a double density floppy disk drive into your system, when Intel's 8272 is available now. With a powerful command set, microprocessor compatibility, Intel's HMOS* technology and the ability to reduce CPU overhead, our controller for IBM compatible single or double density floppy disks is the logical choice for system designers.

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Freedom for the CPU.

Our new 8272 double density floppy and mini-floppy disk controller is the right solution for systems designers. It saves time, reduces power dissipation and slices the high cost of burdening an 8-bit or a 16-bit CPU with floppy disk control functions. A powerful instruction set built into Intel's new 8272 controller will reduce your programming efforts up to 50%. Less code is required, so you spend less time and use less memory.

Intel's 8272 solution also tackles the problem of CPU overhead and software intervention. Our double density floppy disk controller has the capability of scanning a single sector or an entire track's worth of data fields. Data on the floppy disk gets compared byte-by-byte with data in your system memory. And, since a single command locates and compares the data, no additional software is necessary.

Faster data access.

Our new 8272 controller does more than drive up to four floppy disks simultaneously. It handles parallel seek on up to four disks for faster data access.

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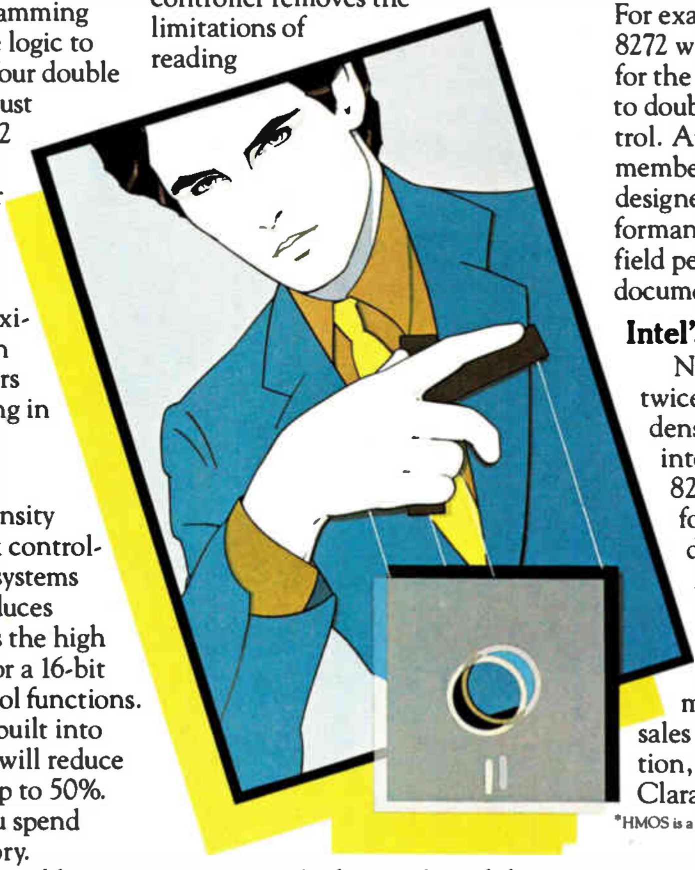

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Circle 69 on reader service card

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How STC speeds production testing by a factor of five to one . . .

Storage Technology Corporation's revolutionary 8650 Winchester disc subsystem for big, mainframe computers utilizes double-density recording to pack twice the normal amount of data in the same space as a conventional, single-density disc.

Critical to the success of this technology are complex, high-speed, analog read/write and servo boards. In fact, STC's read/write board contains more than 350 separate active and passive components.

When conventional methods were used, it took approximately 15 minutes to test each board. As this testing time became more and more unacceptable, the decision was made by STC to switch to automatic testing.

Paul Zieschang, Manager of Hardware Development, recommended that the company assemble its own system using 12 HP-IB compatible insruments, an HP 9835A Desktop Computer as system controller and a 9885 Disc. Zieschang reports that the 9835A was chosen because its large CRT display made it easy for an operator to interface with the system, and because of its programming ease. What's more, STC incorporated diagnostics into the system which help STC technicians better understand the testing procedure. This software even helps technicians locate — via a flashing cursor and a graphic display of the board's topology — the position of any component on the board. Finally, the 9835A also delivers a print-out of the component's value and STC part number.

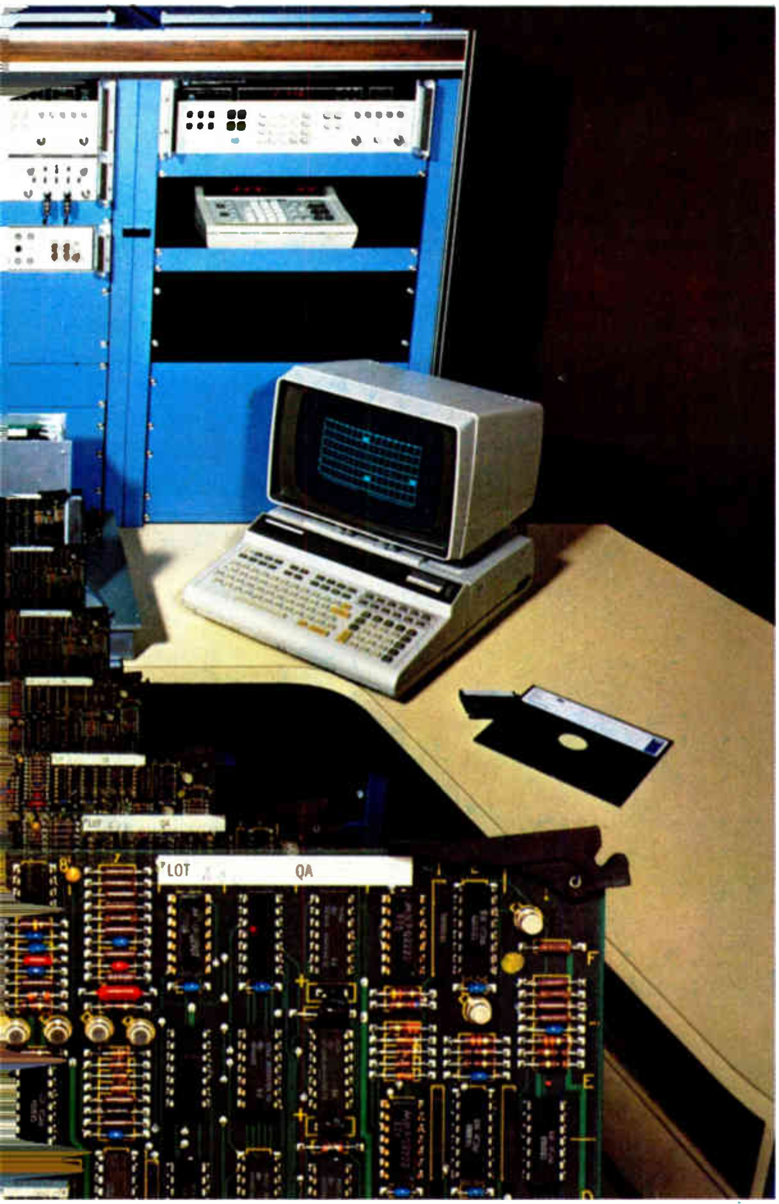
Documentation simplifies system configuration.

According to Zieschang, some of the many application notes supplied by Hewlett-Packard were helpful both in deciding the first configuration and speeding assembly of STC's first HP-IB system.

Flexibility that reduces the chance for obsolescence and speeds assembly.

Twelve HP-IB compatible instruments were chosen for this system, according to Zieschang, because HP's bus architecture and programming ease permit the flexiblity necessary to make changes within the system as STC's requirements change and, thus substantially reduce the possibility of system obsolescence.

HP instruments also provide STC with speed of assembly. The company assembled and programmed its first automatic



using HP-IB "designed for systems" instruments and computers.

test system faster than other comparable ways of solving its system test needs. Zieschang believes they will be able to assemble and program future systems even faster.

The bottom line.

Just as important, Zieschang says the STC HP-IB compatible system will reduce testing time from 15 minutes per board to approximately three minutes. A factor of five to one. The system is also expected to reduce the time required to debug faulty boards from 45 to 20 minutes. In short, STC's HP-IB system will help the company turn out more boards per day.

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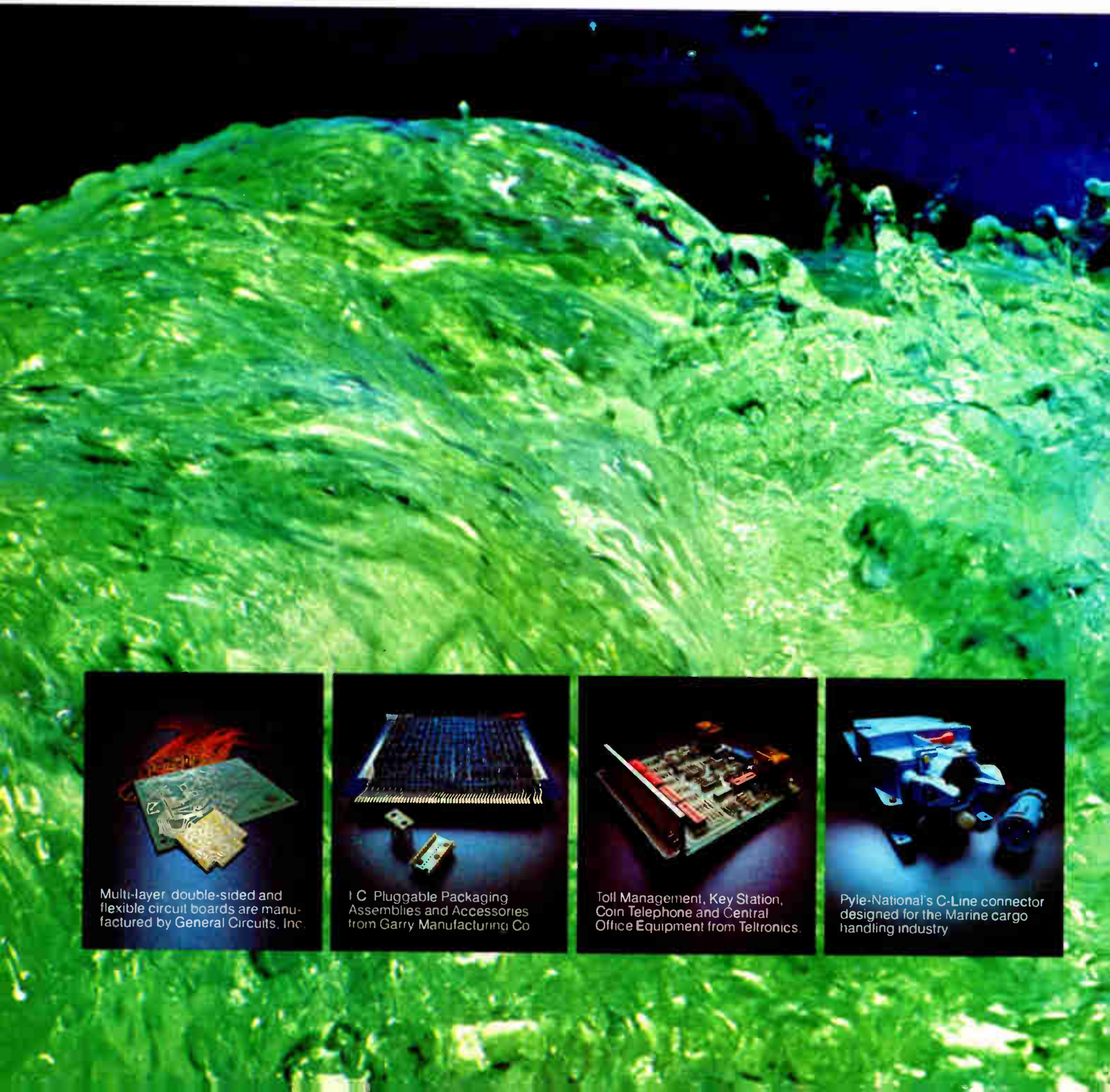
Electronic & Industrial Cable Division, Willimantic, Connecticut. Wire and cable for the business machine, utility, military, and industrial process industries. Also, extruded electrical insulating materials. Additional plants are located in Manchester, Connecticut and Glenrothes, Fife, Scotland (Brand-Rex Ltd.).

Garry Manufacturing Company,

SOME RIDE THE WAVES OF



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Pyle-National's C-Line connector designed for the Marine cargo handling industry

New Brunswick, New Jersey. Manufactures a variety of electronic interconnection devices, including integrated circuit logic panels, sockets and related accessories. Also operates a plant in Pennsylvania and at two locations in Switzerland.
General Circuits, Inc., Rochester, New York. Manufactures multi-layered, double-sided and flexible printed circuits for the computer and telecommunications markets.
Nonotuck Manufacturing Company, South Hadley, Massachusetts. Fabricates uninsulated copper and copper alloy wire.
Pyle National Company, Chicago, Illinois. Specializes in commercial and military connectors for aircraft, missile, industrial, railroad and general purpose applications. Has subsidiaries in Mississauga, Ontario, Canada, and Nottingham, England.
Telecommunications Cable Division, Willimantic, Connecticut. Producers of a broad line of telephone wire and cable products, including fiber optic cables, at plants located in Asheville, North Carolina, and Siloam Springs, Arkansas.
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PROGRESS. OTHERS MAKE THEM.

System transmits color photos at monochrome speed

by John Gosch, Frankfurt bureau manager

University-developed method uses wire, radio phone links; color photos can also be received in black and white

An engineering team at the Technical University of Braunschweig, West Germany, has developed a transmission system that allows color photos to be sent over wire or radio telephone channels at the same rate as black-and-white pictures. The photos can be received either in their original color or, in coded form, as monochrome versions.

In conventional color photo transmission methods, the red, green, and blue components of the original are sent one after the other, but that takes three times longer than transmitting a monochrome picture. "That's why topical press photos slated to go into print as fast as possible are sent almost exclusively as black-and-white pictures," points out Hubert Niemeier, a member of the development team at the university's Institute for Communications Engineering.

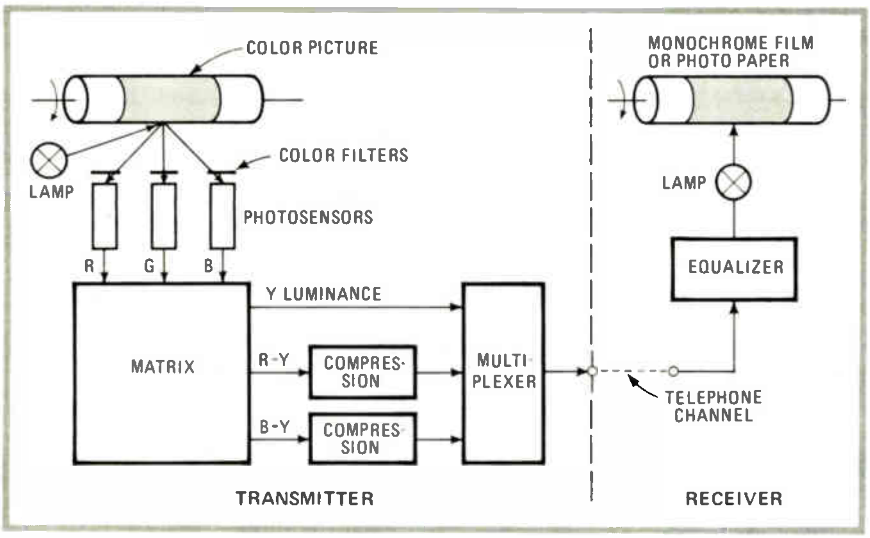
With the new system—its development was funded by the German Research Society, a government-financed organization—the coded color components are transmitted simultaneously and in compressed form together with the black-and-white component of the original color photo. The signal compression and the simultaneous transmission account for the threefold time reduction compared with ordinary color transmission schemes using phone circuits. It takes about four minutes to send a 9-by-12-centimeter (3.5-by-4.7-inch) color photo with the new method.

The institute is currently negotiating with an unidentified electronics firm about the commercial exploitation of its system. Niemeier sees press agencies, magazine publishers, newspaper editorial offices, and television broadcasting studios as the prime customers. Studios could use it for blending topical color shots into news programs, for example.

Signals. At the transmitting end, the original color photo is helically scanned, with three color filters in the scanning head serving to divide the modulated light information into the red, green, and blue components (see figure). From the latter, three photosensors generate the R, G, and B chrominance signals, which are subsequently matrixed to produce the Y luminance signal and the $R-Y$ and $B-Y$ color-difference signals. The luminance information is identical to the black-and-white component of the original color picture, and the two difference signals contain the color information.

Both color-difference signals are compressed with respect to time and applied together with the luminance signal to a multiplexer. While a line is being scanned, the multiplexer sequentially feeds the $R-Y$, then the Y, and then the $B-Y$ signal to the telephone channel. Because of signal compression, the bandwidth needed—300 to 3,400 hertz—is no larger than that required for black-and-white picture transmission.

For recording in color, a special color picture receiver is needed. But a conventional monochrome photo receiver can be used to record a black-and-white picture, because of the luminance information in the signal combination. After going through an equalizer, which com-



Speedy. System sends color photos as fast as black-and-white. A special color receiver is needed, but for black-and-white versions a conventional monochrome receiver suffices.

pensates for nonlinearities in the modulating lamp and the film, the signals are used to control the exposure of film or photographic paper. The picture can be developed by conventional means and then used by, say, a newspaper to determine if a color version is wanted.

If a color photo is wanted, the received black-and-white picture, which has the color-difference information at the start and end of each line, is scanned using a normal monochrome television camera. Its output is fed to a demultiplexer to separate the composite signal into the luminance signal and the compressed color-difference signals. Next, the latter two are expanded in a "decompression" circuit. Its output is then fed together with the luminance signal to a dematrixing stage that produces the red, green, and blue chrominance signals.

France

Wafer stepper aligns chips fast

Researchers at Thomson-CSF's Central Research Laboratory believe they have taken a giant step toward a quicker and more accurate chip alignment system by refusing to repeat what their predecessors have done. The wafer stepper for large-scale integrated circuits, to be produced by Thomson's Cameca subsidiary in 1982 [*Electronics*, April 24, p. 68], will be able to produce 50 4-inch wafers per hour with automatic chip-by-chip alignment precise to within ±0.2 micrometer. The minimum line width will vary from 1.4 to 0.5 μm, depending on the optics chosen by the user.

Thanks to what Thomson calls real on-axis alignment, the machine will be faster and more accurate than steppers employing video image analysis, says Jacques Trotel, manager of the firm's microlithography laboratory at Orsay, near Paris. The latter has been adopted by, for one, GCA Corp.'s Burlington division.

The alignment system is similar to that of the PAS 2000 stepper being developed by Philips—formerly called the SIRE 3 [*Electronics*, April 12, 1979, p. 110]. It is based on diffraction grating. The difference, according to Trotel, is that Thomson's alignment pattern will be positioned directly adjacent to each circuit on the wafer; in contrast, the PAS 2000 calls for an alignment pattern distant from each circuit, which Trotel describes as "pseudo-on-axis alignment." With real on-axis alignment, he explains, there is no need to move the wafer into place after it has been aligned.

Broken up. The alignment pattern on the reticle consists of a series of parallel, equidistant lines. During the first masking step, a similar pattern is placed on the wafer. The on-wafer pattern differs from the reticle pattern in that the lines are broken up into a series of points; that is, the on-wafer alignment pattern is a matrix of dots.

To align the two patterns, a coherent light beam, from a small laser, is projected through the reticle alignment pattern onto the wafer. By measuring the light diffracted back up to the projection lens, the degree of alignment can be determined, because of the diffraction characteristics of coherent light waves.

The orders of diffracted coherent waves behave in a specific manner, and since the on-wafer pattern consists of a series of points, the presence or absence of diffracted images of those points on the projection lens indicates the quality of the alignment between the two patterns. For example, if only the first-order diffracted waves show up on the lens, the two patterns are not very well aligned, whereas the presence of the second- and third-order diffraction indicates a high degree of alignment.

Totaled up. As a result, by measuring the total amount of diffracted light on the projection lens, maximum alignment can be obtained. Measurement is accomplished through the use of a single photosensitive cell, which reacts to both amplitude and phase variations.

Trotel says the process takes only 60 milliseconds. Chip alignment can thus be done much more quickly than with video image analysis, which requires point-by-point scanning. Another advantage of the technique, he says, is that video image analysis in some cases fails to detect very slight contrast variations, whereas it is relatively easy to pick up even very slight changes in coherent diffracted light waves thanks to phase variations. -**Kenneth Dreyfack**

Great Britain

Phone links to carry teleconferences

Picture-phones linking offices and homes via cheap wideband fiber-optic links have been widely hailed as an effective alternative to business travel in an increasingly energy-conscious world. But low-cost light links still seem a long way off, so in the interim the British Post Office plans to offer, starting in late 1981 or early 1982, an experimental visual services network that does the job largely through the existing telephone network using narrowband trunk lines. Expensive fiber-optic links will come into play only for short hops between customers' premises and the local exchange.

Piped in. The upcoming network will pipe conferencing facilities right into customers' offices and factories, most likely on a wideband optic link, though post office engineers have also shown how a narrowband video signal can be squeezed down to go over a conventional telephone pair. The hardware the BPO has in mind will show three conferees in close-up or six on a split screen. It will also provide document transmission and telewriting services.

Actually, the BPO has had Confravision, a video conference service linking large cities, since 1971. But to use it, the conferees have to travel to a special studio, an obvious drawback. What's more, the service uses expensive wideband microwave links to carry the video.

To hold down bandwidth, the engineers sacrifice picture quality. The

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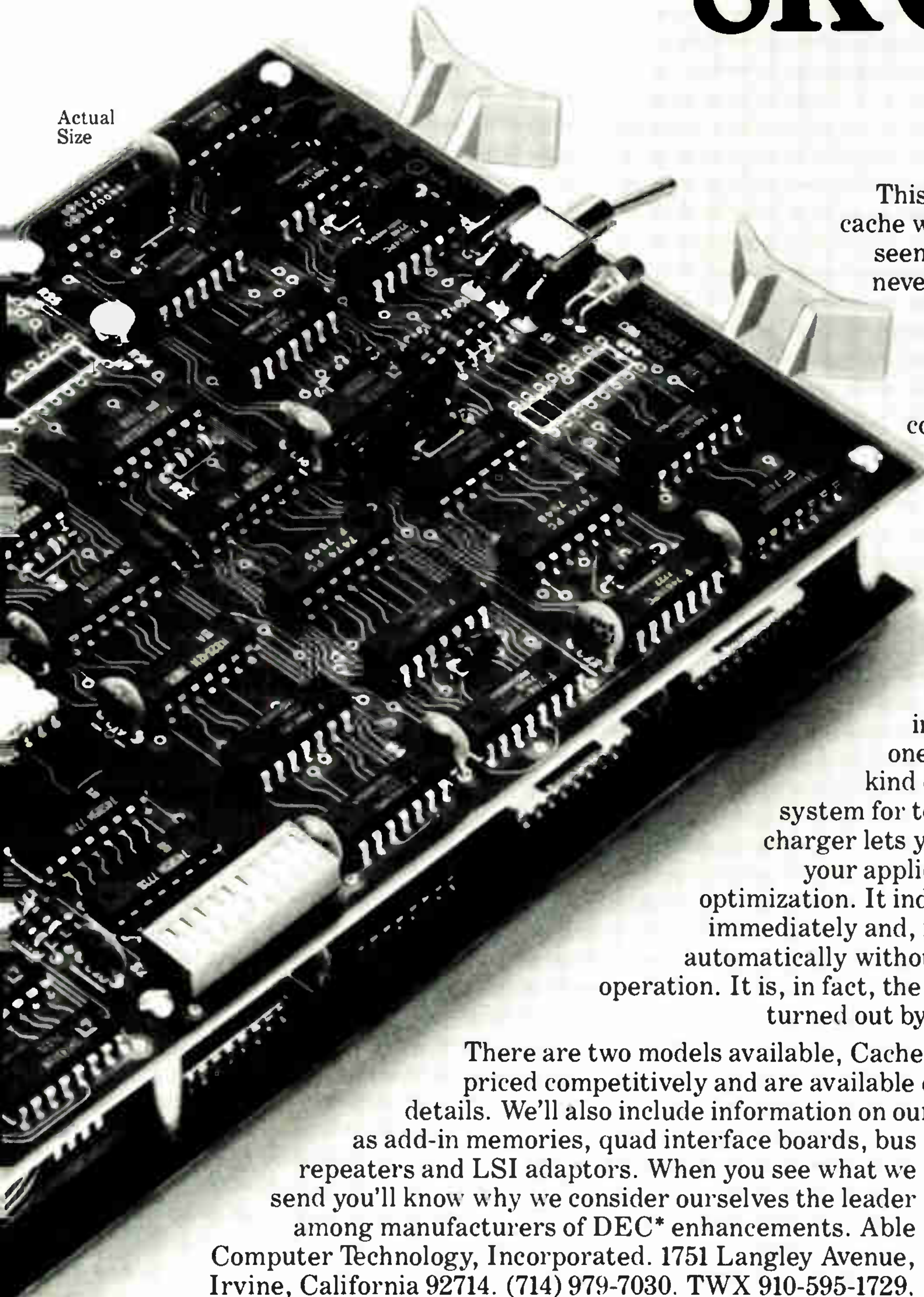

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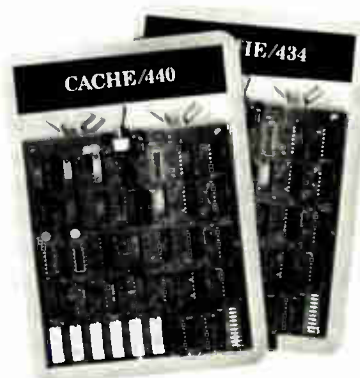

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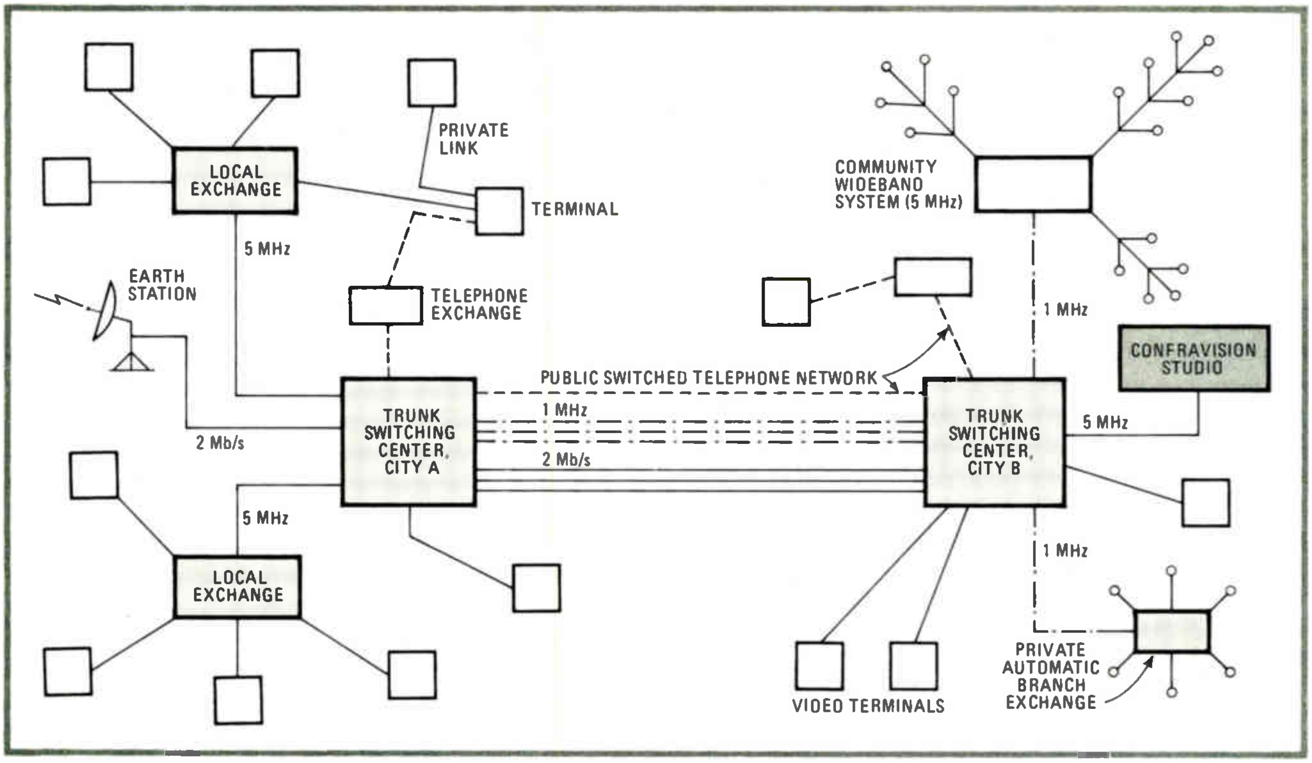

On screen. The BPO has proposed an experimental teleconferencing system that will initially use the public switched telephone network. To do so, the standard TV bandwidth will be compressed from 5 to 1 MHz and only every other TV line will be transmitted.

television equipment will be standard 625-line television hardware, but for trunk transmission the normal 5-megahertz video signal is filtered to 1 MHz. This reduces the horizontal but not the vertical resolution, so only every other line is transmitted. The bandwidth compression equipment at the local exchange will be shared by the users, most likely cutting trunk transmission costs 80%.

Eventually, lower-cost 2-megabit/second data links will be used to carry the 1-MHz, 313-line TV images. The post office, in fact, is collaborating with other European telecommunications agencies to develop a codec for this purpose.

Because the hardware is standard, say the engineers working out the system at the BPO's Martlesham, Ipswich, research center, moving up to full 625-line transmission when low-cost wideband links become available will be simple. Meanwhile, they point out, because of better use of the picture frame, faces will be as clear, even with the reduced line definition, as with Confravision.

However, for document scanning higher definition is needed, and to achieve it the engineers trade in some speed using a newly developed digital slow-scan television terminal. It writes a complete digitally encoded field of the wanted picture into a store and then reads it out at whatever bit rate is available up to a maximum of 128 kilobits/second. (This equipment will also be available to users of the BPO's Orator audio conferencing service now being field-tested and will be offered separately as well for traffic surveillance and other applications.)

The system employs a simple 4-bit differential pulse-code-modulation scheme and sends only every other line, with 256 points per line. Over a 4.8-kb/s line, the transmission time is 50 seconds; over a 64-kb/s System X digital link, the time is less than 4 seconds. The system is also compatible with viewdata, the interactive service that ties terminals to data banks through the public switched telephone network.

First customers for the new service almost surely will be big companies who can afford to set up small TV studios for teleconferencing. The terminal equipment will be tied into a service unit linked to a local video services exchange via incoming and outgoing 5-MHz channels and an ordinary telephone pair. The broadband paths will carry audio, data, and control signals multiplexed with the line-synchronization pulses of the video signal. They will handle facsimile and telewriter services as well. The telephone pair will be used for nonvideo calls and for slow services such as viewdata, for which a decoder is included. **-Kevin Smith**

West Germany

Molecular probe does little damage

Combining their expertise in low-temperature physics and electron optics, researchers at Siemens AG have developed a technique that probes almost nondestructively into the molecular structure of organic

Resolved. At 4 K, Siemens researchers have been able to represent sample's molecular structure without damage and with a resolution of 1.6 Å (left). At room temperature and roughly one third the dose and accelerating voltage, the structure is largely destroyed (right).

materials and achieves a point resolution as high as 1.6 angstroms. As far as they know, that value has not previously been reported.

The technique, implemented with a superconducting electron micro-

Around the world

Sharp enters facsimile competition

Sharp Corp. will join the facsimile race in September with a long-range goal of capturing a 10% share of the world market. Last week, it unveiled its Hayax machine, which transmits a standard-sized page in 3 minutes in conformance with the CCITT Group 2 specifications. The desktop unit, to cost about $2,400, allows the operator to monitor the copy being wired simultaneously with the transmission. Sharp uses a specially developed charge-coupled-device sensor to produce clear copy and an ink-jet printer that enables plain paper to be used. Versions that can copy in 20 or 40 seconds were also demonstrated. The initial production schedule calls for 300 units per month, for the domestic market.

SGS to second-source two Mostek telecomm chips

SGS-ATES Componenti Elettronici SA has signed an agreement with Mostek Corp., Carrollton, Texas, to make two Mostek products for the European telecommunications market as a second source. The products are the MK 5156 codec and the MK 5912 switch capacitor filter. The company, based in Agrate, outside of Milan, says that the idea is to bring its completely interchangeable parts to the market within a year or so. It will sell through subsidiaries throughout the Continent.

Home alarm systems ring the bell with West Germans

The West German craving for security is giving the market for electronic and electrical fire- and theft-alarm systems a big boost. According to the Frankfurt-based Central Association for the Eletrotechnical Industry, last year nearly half a million such systems were sold domestically, estimated at roughly $250 million in value. The 1979 market growth—about 11%—far exceeded that for the electronics and electrical industries as a whole. For this year, the association expects the growth to continue unabated.

Fuji to up video cassette tape production 400%

Fuji Photo Film Co. will expand its home video cassette tape capacity fourfold to 4 million units a month by May 1981. The company will spend some $20 million—one fourth of its total capital spending during the current fiscal year—to build a new 2.5-million-cassette/month plant. In addition, it will increase the capacity of its existing plant from 1 million units a month to 1.5 million. Fuji's investment plan is based on its estimate that the present capacity will be fully utilized by the summer of 1981. The company estimates its share of the domestic market in home video cassette tapes at 25% to 30%, about the same as that of TDK Electronics Co. Both produce tapes for VHS and Betamax video tape recorders.

scope, has important implications in biological research. One prime example is in investigating the nature of cancer cells.

It is also important in electrical engineering, for gaining a more profound knowledge of organic substances of the kind used in making insulating materials, points out Isolde Dietrich, the head of the Munich research department at which the technique was developed. It is in fact for that purpose that the method is initially intended.

Frozen. The key to the technique is getting the temperature of the apparatus and the sample to be investigated down as low as possible. Using liquid helium, the Siemens team has lowered the temperature to 4 K. That, plus the ability to keep the system stable at that temperature, virtually freezes the molecular structure into place, allowing a high-resolution, high-contrast picture to be made.

To represent a molecular structure, the sample must be bombarded with a certain dosage of electrons. The dosage, Dietrich explains, must be big enough to ensure that the signal-to-noise ratio still permits a reasonably good picture. At room temperature, however, the result is a highly damaged structure: the impinging electrons simply carbonize it, leaving a residue with little information content.

Virtually no movement. But cool the sample to near absolute zero and the structure freezes. The electrons still break up the bondings between the molecules, but the molecule fragments remain intact. They cannot diffuse, as they would at room temperature, because there is virtually no thermal energy or movement at near absolute zero.

In implementing the technique, Dietrich's team uses a superconducting lens system into which the sample is placed. The system is thermally decoupled—that is, isolated—from the outside world. With both the system and the sample at the same low temperature, the whole apparatus is thermally highly stable; temperature gradients that could otherwise cause a lateral drift of the sample are all but eliminated. The material's low expansion coefficient—less than 0.001 of the value at room temperature—also contributes to a stable system environment.

As the left-hand photo shows, at 4 K and with a dose of 170 electrons per square nanometer and a beam accelerating voltage of 220 kilovolts the molecular structure is almost completely intact.

The sample involved consists of the organic substance L-valine, a component part of protein. The white dots represent diffraction reflections. From them, it is possible to determine the atomic structure of the substance. **-J. G.**

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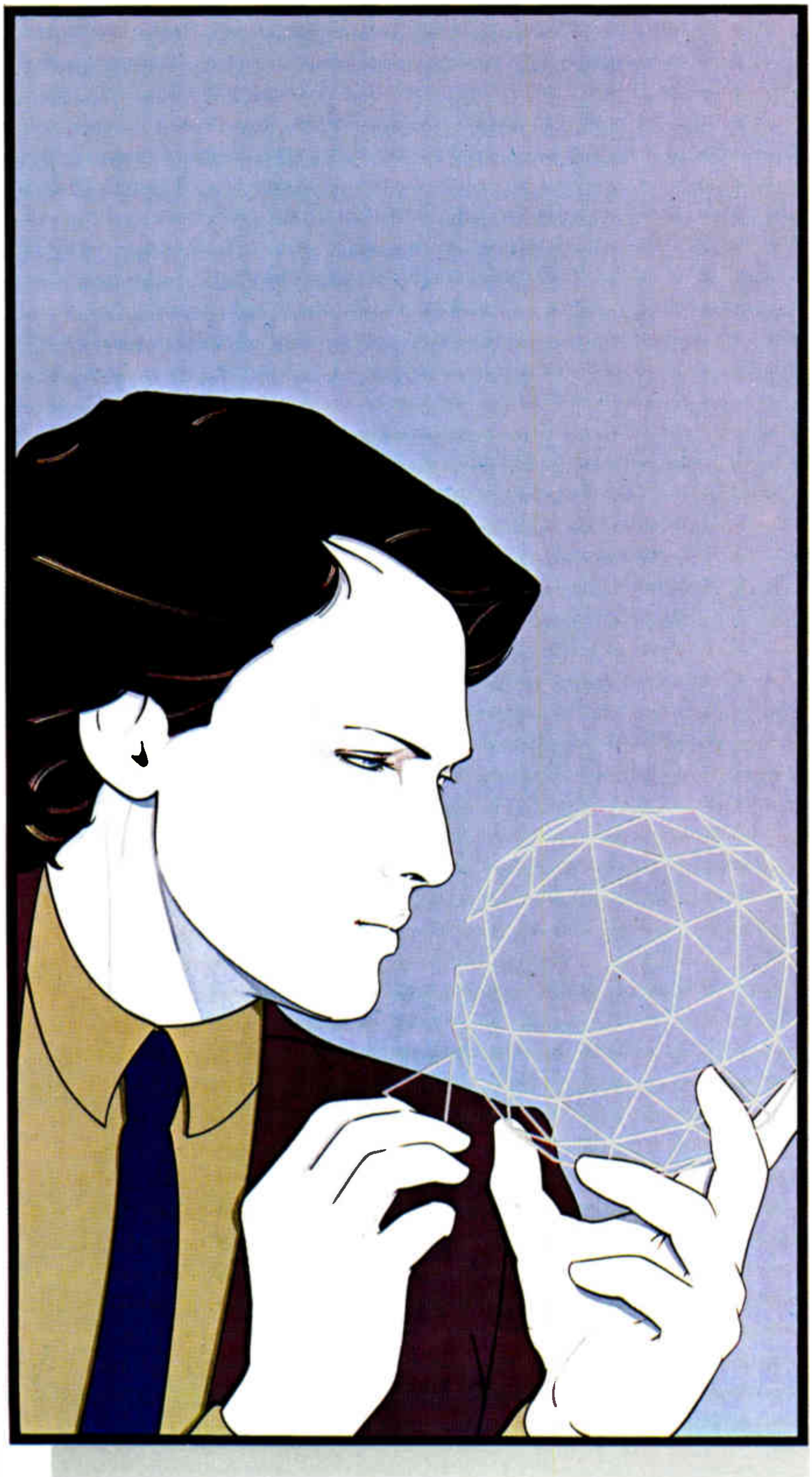

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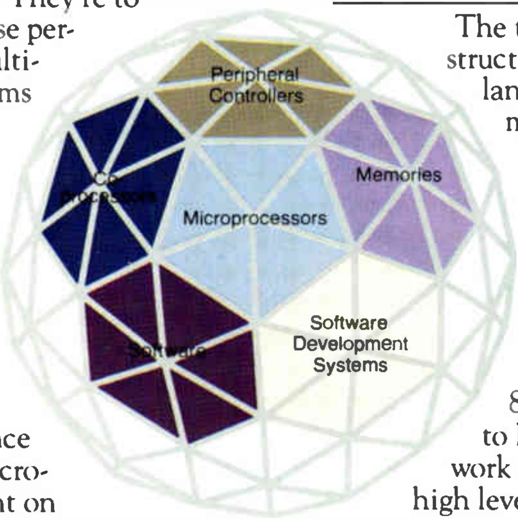

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16-bit makers solidify positions

Motorola's announcement of raft of peripherals for its 68000 CPU gives shape to competitors' strategies

by Raymond P. Capece, Technical Managing Editor, and John G. Posa, Solid State Editor

The stakes have never been higher in the contest for 16-bit microprocessor market share, as one by one the manufacturers are showing their hands. The latest is Motorola Inc., which, while making little noise since first going to silicon on its flagship 16-bit processor—the 68000—has been busily chipping away at support blocks like peripheral circuits and software to put flesh on the bones of its offering. As a result, the microprocessor operation, based in Austin, Texas, together with the microsystems operation, in Phoenix, Ariz., is ready to announce a variety of peripheral chips, software packages, and development products at next week's Electro/80 in Boston.

"But we're not selling futures," declares Murray A. Goldman, operations manager for the n-channel MOS microcomputer group in Austin. He is referring to details given by Intel Corp. of forthcoming product lines to succeed the 8086 family [*Electronics*, Feb. 28, p. 89]. "Intel has suddenly moved the battleground out from 1981 to 1985, and we'd like to keep the focus on today." He adds that with significant volumes of 68000 chips coming off the line—production has blossomed into thousands of parts per month—the company has fended off allegations that the large (70,000-square-mil), complex (68,000-device) chips cannot be built. Another allegation—that Motorola will not have the peripherals to support the 68000—will be eliminated with the announcement of nearly a dozen chips.

Déjà vu. Goldman likens the competition's release of product plans to "a position we were in five years ago with the 6800, when we needed to preannounce to gain market share." But he adds that Motorola's microcomputer effort has come a long way since then, when its move from Phoenix to Austin proved crippling [*Electronics*, Nov. 24, 1977, p. 75].

But once the Austin facility was in place, Motorola began building its microcomputer portfolio aggressively. By 1977, it had four major programs under way: three 8-bit families, including the 6805 low-end single-chip microcomputers; the 6801 mid-range single-chip family; the 6809 high-end microprocessor family, and its advanced 16-bit design, the 68000. The first three all are to receive new members (see p. 48).

"No other company has introduced that many parts of that kind of complexity in as little time," boasts Jim Fiebiger, vice president and general manager of Motorola's MOS Integrated Circuit division, which has had a compound annual growth rate of some 86%. "In all, we expect to average one part per month over the next few years out of microcessor operations," Fiebiger adds.

Churning 'em out. Jim Fiebiger says Motorola's microprocessor operation will average a new part each month over next few years.

Support roles. Through the end of next year, eight different chips will be rolling off Motorola's lines in support of the 68000. Those due out by year-end include:

- The 68120 intelligent peripheral controller, a programmable device based on the 6801 single-chip microcomputer that will allow users to hook devices such as printers asynchronously to the 68000 bus.
- The 68122 cluster terminal controller, which unburdens the 68000 of coordinating the communications among several terminals.
- The 68540 error-detection and -correction chip, which fixes single-bit and detects double-bit errors in 16-bit systems and can be cascaded to 32 bits for future systems.

Next year, Motorola will debut:

- The 68451 memory management unit, providing address translation and protection (and supporting virtual memory) for the 68000's 16-megabyte address space.
- The 68450 direct-memory-access controller, a complex device with the 68000's microprogrammed control unit at its core for 4-megabyte/second transfer of data in words or blocks between systems (to be wrought in silicon by Hitachi Ltd. of Japan, a licensed second source of the 68000 family.
- The 68230 parallel interface and timer, a general-purpose housekeeping device to handle input/output, interrupt, and timing needs.
- The 68561 multiple-protocol communications controller, a sophisticated data-communications periph-

eral that will handle SDLC, HDLC, Bisync, and X.25 protocols.

- The 68341 floating-point ROM, a packaged software routine programmed with position-independent re-entrant 68000 code that carries out floating-point arithmetic.

Further down the line, Motorola is planning a dual-port random-access memory, a bubble memory controller (to be executed by Motorola's domestic second source, Rockwell International Corp.), and a serial DMA processor aimed at distributed-processing applications.

With Motorola's 16-bit microprocessor plans bared, competing strategies become all the more apparent. In particular, support devices for the 68000, Intel's 8086, Zilog Inc.'s Z8000, and National Semiconductor Corp.'s NSC16000 have evolved in a manner quite unlike that of the peripheral chips of their 8-bit predecessors. These older microprocessors were surrounded with peripheral controllers and support chips as an afterthought, usually in response to customer feedback.

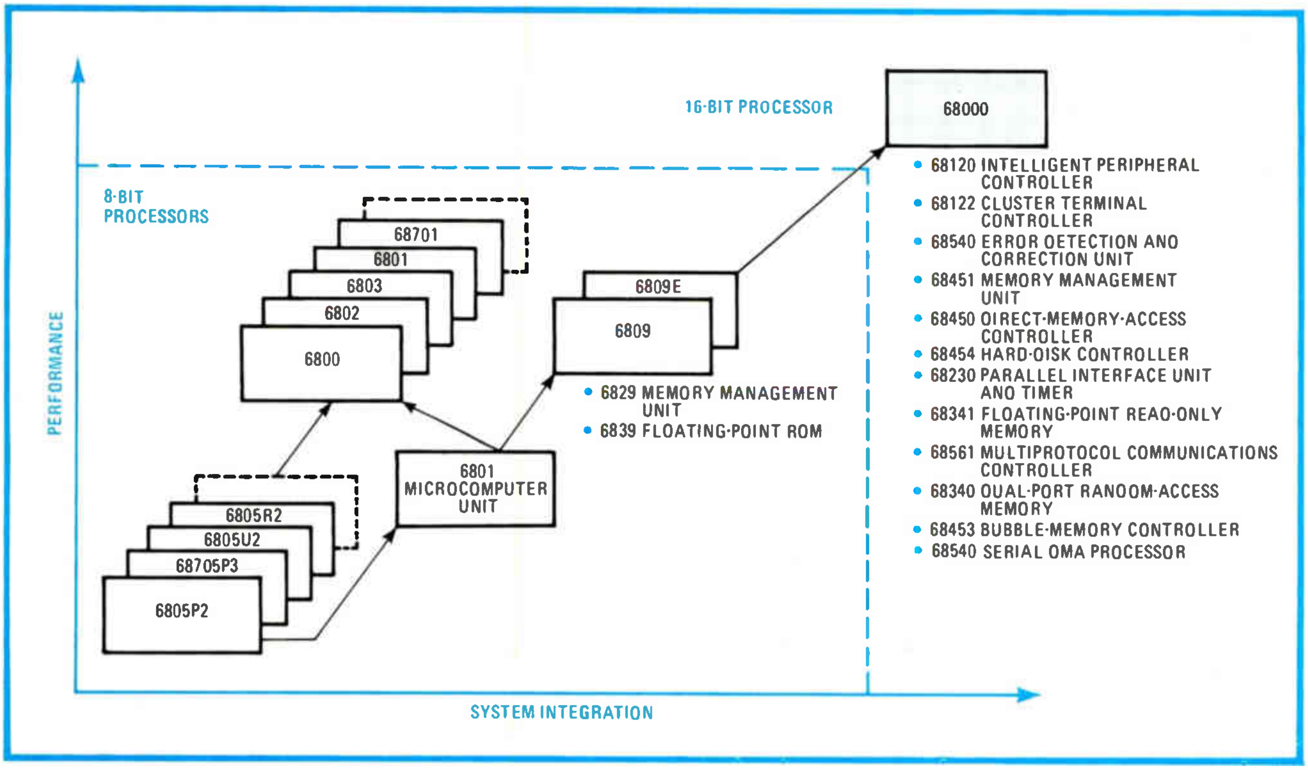
In contrast, the latest machines and their companion products result from partitioning a grander architecture, envisioned by the chip makers in advance. As such, these subsystems can be recombined on silicon as large-scale integration allows.

This explains the genesis of Motorola's and Intel's coprocessors; Zilog's extended processing units, or EPUs; and National's slave processors: so powerful are the computers promised by these companies that the CPU itself had to be diced up. In effect, then, today's high-performance 16-bit units are really multichip solutions awaiting H-MOS II and III. Still, a look at each manufacturer's system architecture unveils the philosophy of each.

Texas Instruments Inc., which plans two high-performance additions to its 9900 family within a year, is sticking with its memory-to-memory architecture. The approach has been criticized for its disproportionate number of references to external memory, but the solution seems obvious: "We will bring the workspace on chip," hints John Hughes, manager of microprocessor system engineering at TI.

Intel has forgone a separate memory management unit, choosing first to offer an input/output processor, the 8089, and a high-class mathematics coprocessor designated the 8087 (see p. 114). The other chip makers have near-immediate plans to manage memory with an external device; with Motorola and National, this slave makes available 16 megabytes of virtual storage.

It seems that end-user systems are not yet in Intel's game plan; the other manufacturers are aiming straight for that market, however. Motorola recently revealed plans for boxing its 68000-based boards into full 32-bit systems built around the Versabus [*Electronics*, Jan. 31, p. 81], which it is pushing to be accepted as an industry standard. National, as well, sees itself strong in systems, especially since its acquisition of Itel Corp. Zilog, for its part, has always considered itself oriented toward small-business systems. As for TI, the more advanced of its new 9900 offerings must, of course, preserve the installed 990 minicomputer system base. And Intel's aversion to the systems business will be put to the test with its next offering, due out later this year. It will likely compare favorably with the National, Zilog, and Motorola families. □



The Austin portfolio. Motorola's Austin operation is involved in raising, and adding to, four separate microprocessor families. The 8-bit members are based on the 6801, 6805, and 6809 CPUs. At the high end is the 68000, which does not suffer from lack of support.

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Circle 92 on reader service card

Communications

Two hams capture manufacturers' ears

DeMaw and Hayward's years of work to improve receivers force industry to react to their suggestions and design innovations

by Vincent J. Biancomano, Circuit Design Editor

Nestled quietly among the 34 technical sessions scheduled for the upcoming Electro/80 conference is No. 5, "Recent Developments in Communications Receiver Design." Its presence on the program must be considered to be as much a tribute to two men as to the timeliness of its subject.

The two are M. F. "Doug" DeMaw, who organized the session, and Wesley Hayward. DeMaw is in Hartford, Conn., as technical department manager at the American Radio Relay League Inc. and Hayward is in Beaverton, Ore., as an engineer at Tektronix Inc. But together, by hard work and persistence, they have persuaded rf engineers to reexamine the design philosophy and circuits needed to build high-quality radio receivers for amateurs, spurring commercial producers to turn out equipment with high dynamic range and selectivity and a high noise floor for a reasonable price. It also took years of persistence for these two "nonprofessionals" to be admitted to Electro.

And the industry has generally been appreciative. "The technology in the high-frequency semiconductor area and the like was becoming readily available, and so I viewed this type of progress as inevitable," says Chip Margelli, assistant vice president of the U. S. operation of Japan's Yaesu-Musen Ltd., a major maker of amateur gear. "But Wes and Doug did lead in attempting to define the language, posing questions as to the type of measurements that should be standardized in order to gauge the performance of receivers in a real-life environment."

Others such as Bill Sabin, an engineer at Rockwell International Corp.'s Electronics Operations, Collins Radio division, Cedar Rapids, Iowa, acknowledge the Hayward-DeMaw contribution in educational terms. "Their book on solid-state design is recommended reading for our junior engineers. And even though receiver requirements for commercial/military applications, our major business, are altogether different from those of the radio amateur, we have on occasion picked up some ideas from their collaboration," he says.

Pioneering. Few will deny that many of the first circuits embodying the design philosophies required to achieve superior performance first reached the general engineering community through the pages of a journal for amateurs, the league's QST. And many of these papers were written by the two men, who were not professionally engaged in the business of designing communications receivers.

Unquestionably, their "Solid State Design for the Radio Amateur" must be considered a landmark text for those interested in actually building high-performance equipment. In addition to discussing receiver-design basics and advanced receiver concepts and other contemporary transmitter topics, carefully and at a level that all can understand, it contains practical information that will not be found in any other of the standard sources available to the professional or nonprofessional.

Strong relationship. Dynamic range and its relation to receiver

MIXERS: INHERENT TRADEOFFS

Device	Advantages or apparent advantages	Disadvantages or apparent drawbacks
Bipolar transistor	• low noise figure that provides high gain	• easily overloaded • intermodulation distortion (IMD) performance poor
JFET	• low noise figure that provides conversion gain • good IMD, blocking, cross-modulation performance • not easily overloaded	• high local oscillator power required • operates as square-law detector for large-input a-m signals
Dual-gate MOS FET	• good IMD, blocking, crossmod performance • provides conversion gain • not easily overloaded	• higher noise figure • operates as square-law detector for large input a-m signals
Diode	• low noise figure that provides excellent dynamic range • excellent overload characteristics	• high local oscillator drive required • needs proper termination to source-load • conversion loss

noise figure, minimum discernible signal level, input and output intercept, gain compression, and so on in a superheterodyne receiver (and other types as well) have become important over the years because of the signal levels encountered in certain portions of the spectrum. Distortion created anywhere in the receiver can lead to blocking, intermodulation products, and cross modulation. But more often than not, overload created at the front end, or input stage, of the receiver creates those conditions.

Thus, much of the work to linearize the receiver's response over the years has been concentrated at its front end. With the introduction of low-noise devices such as junction field-effect transistors, used in single-ended mixers around 1970, the need for an rf input amplifier in a solid-state receiver virtually disappeared, and one of the major causes of overload, or saturation, in the receiver's i-f stages became less of a concern. The best JFET mixers still continue to provide a superior noise figure (4 decibels) and output intercept (25 dB or more).

The introduction of the dual-gate MOS FET soon after with its definitive square-law characteristic permitted construction of single-ended mixers with excellent immunity to blocking and intermodulation. With adequate rf filtering at the input and development of local oscillators of high spectral purity, it was possible to achieve a noise figure of 8 to 10 dB, a two-tone dynamic range of 85 to 90 dB, and a noise floor of −120 dB at communication-channel bandwidths of 500 hertz with third-order output intercept points (intermodulation distortion—or IMD—indication) approaching 12 to 15 dB. Singled-ended diode mixers performed similarly except for a bit lower noise floor.

Hamming it up. Wesley Hayward, a Tektronix engineer, helped influence design.

Recent arrivals. Double-balanced FET mixers for suppressing the local and signal frequencies from the output, and thereby providing improved IMD and cross-modulation performance, came into vogue during the mid 1970s, with quiet diode-ring mixers arriving later on. Diode rings proved to be among the best types of mixer available. Despite their conversion loss of 5 or 6 dB or so, some provided dynamic ranges approaching 100 dB, good output intercepts (up to 23 dBm), and wideband performance, although they were prone to odd-order harmonic mixing and, in addition, required the proper termination.

Now, designers are beginning to eye the power FET as a high-level mixer, but the minimum supply requirements of these low-noise devices, 24 to 28 volts, is at present a stumbling block, for devices having these specified supply values are not convenient for the standard 12-V mobile circuitry now in wide use. A low-voltage FET will be developed soon, however.

Along with the upsurge of interest in optimizing the ability of receivers to handle large signals has been some reexamination of the tried-and-true double-conversion superheterodyne method.

Best route. "In 1970, I believed that use of the single-conversion method in hf receivers was the best one to follow, considering the technology then available, for optimizing the parameters under consideration—cost, simplicity, image rejection, blocking, IMD, generation of birdies, etc.," says DeMaw, who started his work to demonstrate "that I could build a better receiver than I could buy." "Despite all that has happened since then, I'm still not convinced that any other scheme offers the overall excellence of the single-conversion method, especially with regard to achieving good dynamic range easily, even for some vhf receivers."

Long range. Doug DeMaw of the ARRL collaborated across country with Hayward.

If anything, improvements in the technology that have made possible low-cost, low-noise, high-frequency transistor and MOS FET amplifiers and selective high-frequency filters may indeed lead some to doubt the rationale for pursuing the superhet principle (which was developed to translate high-frequency signals to some lower frequency so they could be amplified by conventional vacuum tubes and achieve selectivity at the same time). In fact, high-quality, low-cost receivers of the homodyne or direct-conversion type (that is, translating the signal frequency down to baseband) have been resurrected and virtually perfected over the past decade. But these simple units are beset by inherent problems of their own, too. Examples are oscillator radiation and the inability to null the audio image, thereby decreasing the signal-to-noise ratio because of an unavoidable doubling of the receiver's bandwidth.

High i-f. Conversely, the technology that has made the dc receiver possible is also making plausible a superheterodyne receiver having extremely high intermediate frequency. High-frequency i-f filters having sharp cutoff and excellent stability now make possible so-called up-converters. These are increasingly being used to translate the incoming radio signals to an intermediate frequency ranging anywhere from 30 to over 100 MHz in order to achieve values of image rejection previously unattainable. □

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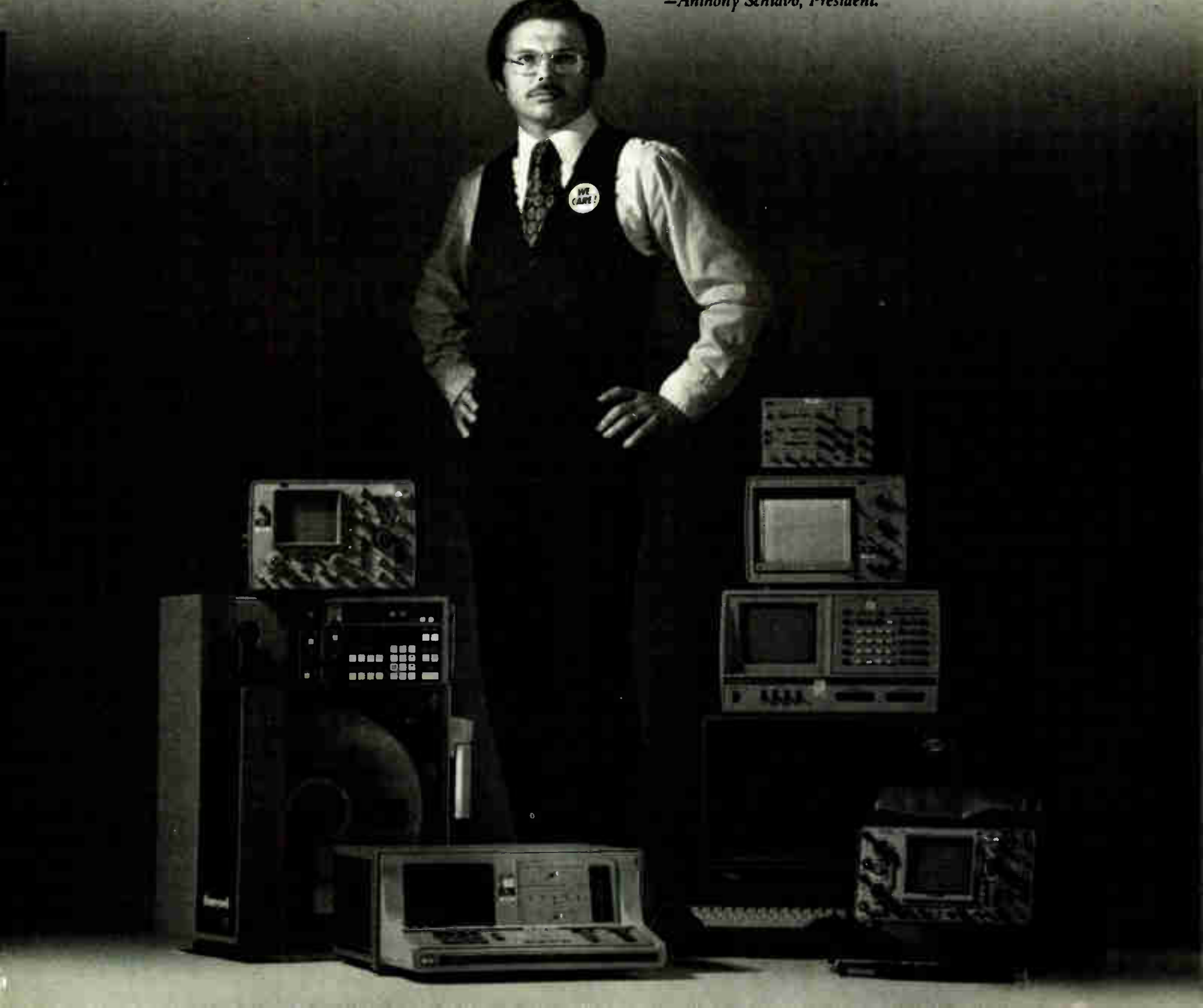


Computers

Technology can't outrun inflation

Computer makers find that soaring cost of materials, labor, and money is forcing them to raise equipment prices

by Anthony Durniak, Computers & Peripherals Editor

Although they continue to use new technology to shrink the physical size of their products, computer manufacturers are finding it increasingly difficult to shrink the price tags. The resulting price increases that have swept the industry in the first quarter of this year may be just the first signs that the industry is not as recession-proof as it had always believed itself to be.

The round of price increases started in earnest after IBM Corp. raised its rental and lease prices at the end of December by an average of 7% and its purchase prices some 5% on a broad range of products. During January and February, a number of other mainframe and peripheral vendors, including Honeywell Information Systems, Amdahl, Memorex, Storage Technology, and Sperry Univac, followed suit with price increases ranging from 5% to 15%.

March saw the minicomputer companies and other firms join the trend as Digital Equipment, Data General, Datapoint, and Raytheon Data Systems, among others, raised their prices.

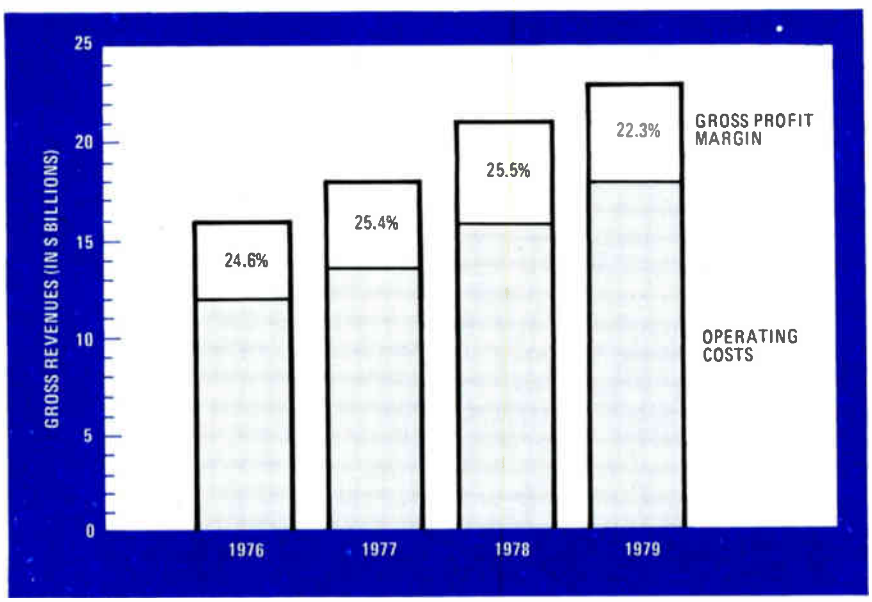
Opening the gates. Obviously, the IBM raise gave the industry "a psychological encouragement to raise prices," notes industry analyst Gideon Gartner, president of the Gartner Group, Greenwich, Conn. But companies point to significant increases in their operating costs that they say would have forced them to increase prices despite IBM's actions.

"Under stable conditions, technology improvements rarely result in price increases, and users have been realizing improved price-performance ratios," says Richard V. Palermo, executive vice president of operations at Datapoint Inc., San Antonio, Texas, which aims its small systems at the office-of-the-future market. "But with the underlying materials, labor, and money costs rising faster than the technology offsets, we must eventually make some adjustment in prices to users," he says.

Dan Crawford, director of engineering at Raytheon Data Systems Co., Norwood, Mass., specifically notes that "for the first time the small integrated circuits cost more than they did last year." Costs of some leading-edge devices, especially memory chips, did come down, but "in aggregate, the price-performance ratio hasn't dropped as fast," he says. In addition to semiconductors, Crawford points to increases in the costs of petroleum-based plastics widely used in system cabinetry and skyrocketing prices for precious metals. Prices have been describing a steady upward line, even for less-precious copper.

In agreement. William G. Moore, corporate vice president and general manager of computer operations for Perkin-Elmer Corp.'s Data Systems group, Oceanport, N. J., agrees that "the decline in component prices has stopped, at least temporarily." He notes that, despite previously negotiated contracts, "in some cases the vendor said they couldn't deliver at that price and we had to renogotiate."

Jeffrey Kalb, engineering vice president at Data General, Westboro, Mass., feels that devices whose prices are yield-dependent, such as memories, still have enough steam to



The squeeze is on. Typical of the computer industry, IBM is finding its gross profit margins being squeezed as costs increase as a percentage of the company's revenues.

catch up with inflation. The bigger problem, as he sees it, "is to amortize the development costs of LSI devices." If the whole system is on a limited number of chips, or even a single chip, "you have to sell a whole lot to recoup your development costs."

Russell E. Planitzer, vice president of market development at Prime Computer Inc., Wellesley Hills, Mass., is confident the technology is not losing its capability to bring prices down—the problem is that the price tag on everything else is increasing so fast.

"You look at the profit-and-loss statement of any vendor and you'll see that the biggest component is people costs." The current shortage of engineers and programmers is not helping matters either, because it is pushing salaries of those on the market upward, he adds.

Furthermore, the cost of money, with the prime lending rate bouncing around near a staggering 19%, is constricting many of the firms, especially since most of the smaller companies must pay more than the prime rate that banks charge their best customers.

Profit margins cut. What's more, the price increases are not covering all the added costs, so that the bottom line will be affected. As William T. Altman, marketing vice president at Raytheon, notes, "We didn't pass through the whole cost increase." As a result, profit margins will be squeezed.

Perhaps the severity of the problem is best illustrated by the problems being experienced by industry-giant IBM (see chart). For 1979, revenues grew only 8.5% to $22.86 billion, whereas its operating costs grew 13.2% to $17.76 billion, resulting in a 5.2% decline in operating income to $5.1 billion. Last month, the company reported that for the first quarter of this year the trend has continued, with revenues of $5.75 billion again an 8.5% increase compared with the same quarter last year. At the same time, its costs increased to $4.65 billion, or 11.8% more than last year. As a result, IBM's operating income was $1.1 billion, a decline of 3.3% from the same period last year.

Similarly, Honeywell chairman Ed Spencer last month blamed its 22% decline in first quarter earnings on "lower profit margins caused by inflationary cost pressures." NCR Corp.'s first quarter income was also down 15%, even though revenues increased 11%.

Cracks in the shield. In addition to being susceptible to inflationary pressure, there is that naggingly recurrent suspicion that the industry may be less immune to a recession than it once thought. With the cost of money increasing so dramatically, some customers will postpone orders, and others will choose to lease rather than finance a capital investment.

IBM chairman Frank Cary comments that the corporation's results reflect the fact that "purchases of data-processing equipment increased at a much lower rate than total gross income." Perkin-Elmer's Moore also notes that "our commercial OEM customers are having trouble financing inventory and selling systems at levels they were a year ago."

Data General's president, Edson D. de Castro, commenting on the seeming immunity to recession of the computer industry, says that he feels it is not so much recession-proof as recession-resistant. "There will be some impact on our industry," he says, "but the general advantage of computers is increased productivity. In times of inflation, people are motivated to improve their productivity, so they will try to do that by buying computers."

In any event, the industry may have to change the way it does business. "The bigger profit margins are on software," Moore says, and therefore "a lot of OEMs are going to piggyback software value-added onto systems." The upshot is that as a hardware supplier, he says, Perkin-Elmer is also making more software available.

Finally, Moore points out, "the only way to get to the bottom line is to get the tax rate down." Consequently, his company is looking at overseas manufacturing because of the reduction in taxes and duties such a move would mean to the company's foreign shipments—now half of its revenues. □

Electronics abroad

Taiwan pushes high technology

Efforts in computers and semiconductors, including C-MOS deal with RCA, are calculated to keep GNP growing apace

by Robert Neff, McGraw-Hill World News

No longer content with electronics industries best known for cheap televisions and semiconductor assembly work, Taiwan is moving deliberately but boldly to develop its own integrated-circuit and computer technologies. The effort is part of an emerging grand strategy to shift the nation's robust labor-intensive economy toward high-technology, "value-added" products that will keep the gross national product growing at its current 8% annual clip.

"Having had a solid foundation, the electronics industries, ranging from computer to TVs, will be more and more important in our present development program," says K. S. Chang, Minister of Economic Affairs for the Republic of China.

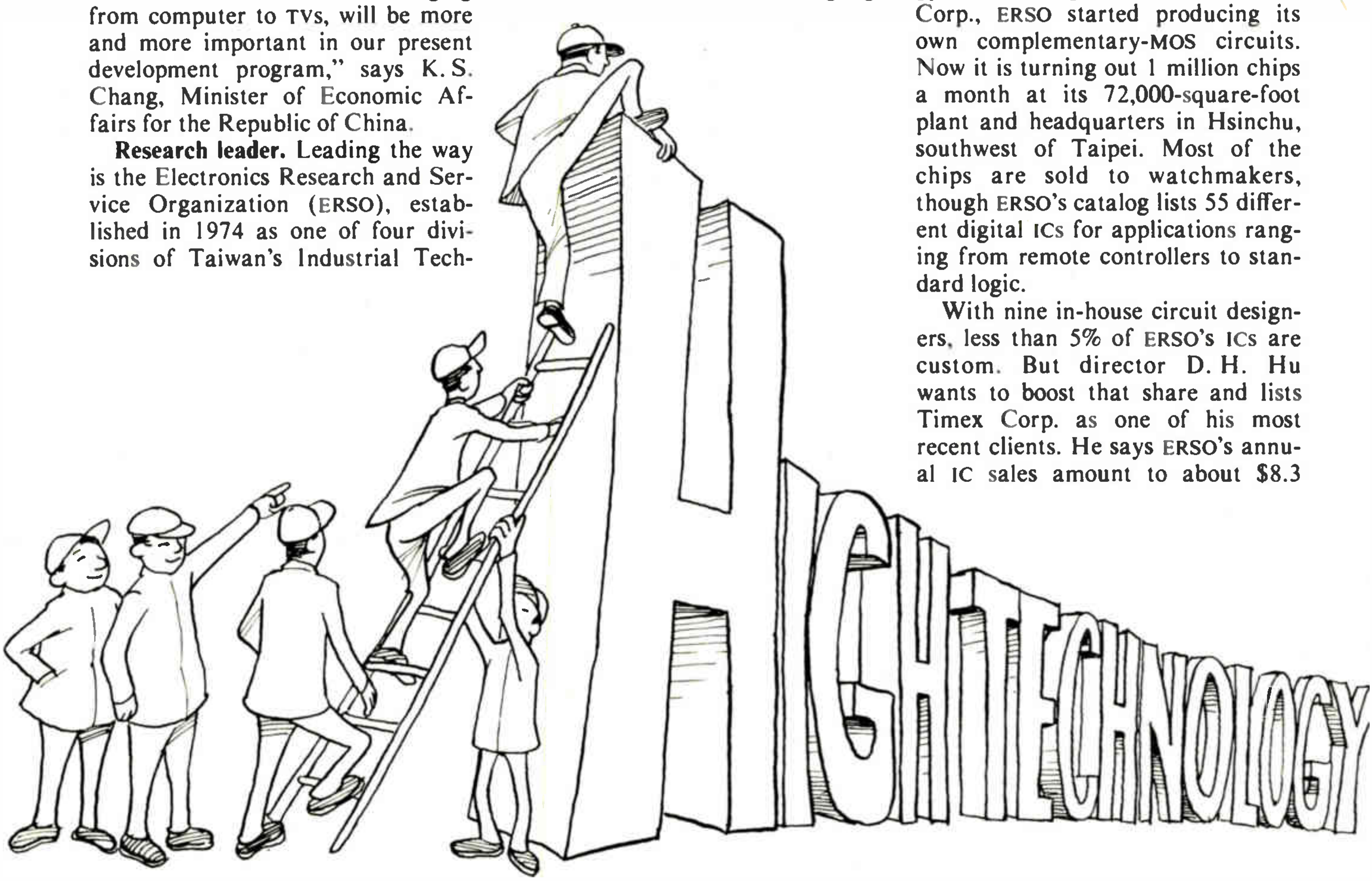
Research leader. Leading the way is the Electronics Research and Service Organization (ERSO), established in 1974 as one of four divisions of Taiwan's Industrial Technology Research Institute (ITRI). Government-established but autonomous, the institute's mission is to provide research and technical services that will speed technological development by industry.

ERSO's current annual revenues total about $16.7 million, of which about 42% comes from government contracts. Besides government-mandated quality control of Taiwan's electronic products, ERSO is making computer-based industrial controllers for local industry, is developing the nation's first Chinese-language computers, and is the only local designer and supplier of ICs.

But more than providing sophisticated products, ERSO wants to spin off its technology to private enterprise. Already, several staff members have left ERSO to launch their own semiconductor company, United Microelectronic Corp., which will be Taiwan's first.

Transfer. The most substantial progress has been with ICs. In March 1978, less than two years after signing a three-year technology-transfer agreement with RCA Corp., ERSO started producing its own complementary-MOS circuits. Now it is turning out 1 million chips a month at its 72,000-square-foot plant and headquarters in Hsinchu, southwest of Taipei. Most of the chips are sold to watchmakers, though ERSO's catalog lists 55 different digital ICs for applications ranging from remote controllers to standard logic.

With nine in-house circuit designers, less than 5% of ERSO's ICs are custom. But director D. H. Hu wants to boost that share and lists Timex Corp. as one of his most recent clients. He says ERSO's annual IC sales amount to about $8.3



million, going to 30 to 40 local manufacturers at a little higher than prevailing world prices.

ERSO is developing computerized industrial controllers to help the local electronics and other industries improve their productivity. It has already sold six microcomputer-based sequential process controllers and plans to expand its controller line into a family of products.

More ambitious is its effort to develop a computer with Chinese-character input/output employing a completely different technique from Japan's kanji processors, which use one pattern per character. Faced with 48,000 characters versus Japan's 5,000 or so, Hu's staff came up with about 500 radicals—or character elements—from which all characters can be formed. Those radicals are stored in read-only memory and formed into characters by a microprocessor. The major obstacle now is building a character generator. ERSO has already developed a Chinese-language I/O terminal, but Hu figures a commercial minicomputer is about two years away. It will start transferring its technology to local makers before then.

Others. However, ERSO is not the only source of electronics research and development in Taiwan. Such relative giants as Tatung Co.—best known for its electrical appliances—are busy working on their own computer and IC technologies.

"We're making and testing prototypes of all kinds of computers, peripherals, and word processors," says Tatung's chairman, T. S. Lin. His laboratories also are making "simple" ICs, he says, but producing them on an industrial scale will take more time.

Tatung already is building its own minicomputers for in-house use. Lin admits that the effort has been aided by Tatung's marketing agreement with Japan's Fujitsu Ltd. to sell Facom computers. He adds that he can start selling Chinese- and English-language minis soon and that Tatung will probably be the first Taiwanese firm to do so. With relations with the People's Republic of China improving slowly but steadily, Taiwan's computer makers might one day find themselves with a leg up on other vendors there. □

Circle 101 on reader service card

Distribution

Precious-metal adders irk distributors

Cost and volume of paperwork to handle surcharge mount as customers grow angry and adamant suppliers squeeze them

by Larry Waller, Los Angeles bureau manager

Distributors, those key middlemen who handle nearly 30% of the components business in this country, are caught in a crossfire over precious-metal surcharges, called adders. Between bullying from suppliers that are imposing adders and abuse from obdurate customers that dislike the surcharges, the distributors' lot has become an increasingly unhappy one. What's more, an avalanche of paperwork is burying them, causing mounting errors and threatening to crush record-keeping systems.

"It's a pain in the neck, a customer nightmare for us administratively," moans Donald Sweet, assistant to the president at Hamilton/Avnet Electronics. The opinion was echoed throughout the distribution industry. With its $512 million 1979 sales, Hamilton/Avnet, Culver City, Calif., has the problems of dealing with adders on a broad spectrum of parts. The 45 or so people it has assigned to handle adder red tape is representative of the personnel increases required in the industry: roughly one person for each $10 million to $11 million in sales.

In such a fluid situation, with raised voices common, one fact stands out: distributors, usually slow to criticize, believe they have been done in. "There aren't going to be any windfall profits due to precious metals," predicts Joel H. Girsky, secretary-treasurer of Jaco Electronics Inc., Hauppage, N. Y. "In fact, I hope we won't have lost money when it's all over." In El Segundo, Calif., Sidney L. Spiegel, president of the Wyle Distribution Group, concurs. "The issue is not making more money, but avoiding losing money on the gold adder. When all of this is done, it will cost us." In Wyle's case, where an on-line computerized inventory and billing system keeps track of daily operations, exact results are not yet clear, because of delays and bottlenecks in processing invoices and payments.

Nearly to a man, top distribution officials throughout the country agree where the trouble started (other than metal price jumps themselves). "The decision to go with adders was done in an ivory tower," charges Seymour Schweber, president of Schweber Electronics, Westbury, N. Y. Instead of conferring in advance with distributors, most suppliers put together adders without considering the difficulties, say the critics. "The vendor told us, 'The price is going up and your problem with your customers is your problem,' " says Don Cassidy, president of the Moltronics division of Cetec Corp., South Gate, Calif. "We really should have had a 60-day notice to get the mechanics in place, but we got nothing," adds Spiegel.

Finding themselves flooded with adder formulas, distributors' staffs could not cope with the burden of calculating, invoicing, and tracking payment. Even with computers the changes generate such a mountain of paperwork that normal routines are disrupted. "It started like a necessary nuisance and went from that to a situation that's bleeding the distributors," says Schweber. "It can become a hemorrhage."

Fear customers. What concerns most officials, besides the still-unreckoned costs, is relationships with key customers. Many are understanding, since they experience price escalation, but others are irate,

Recession warning light is bright

If potential damage by adders on profits isn't enough worry, a basic indicator of the distributor business also is blinking a warning signal. Incoming orders are tapering off noticeably, according to a sampling of executives. Concern is understandable, since this sign often occurs in early stages of a recession, and the Government says that one has started.

Says Wyle Distribution Group president Sydney L. Spiegel: "Changes of some kind started in March. I suspect a recession." Clouding an immediate judgment, however, is the behavior of order and backlog figures during a transition period. "They jump around so much they cannot be read clearly," he adds. But in the 1974–75 bloodbath, he notes, distributors felt recession's cutting edge six months before manufacturers because of the shorter-term nature of their sales agreements. Adds Donald Cassidy, president of Cetec Corp.'s Moltronics division, South Gate, Calif., "We're looking for a 20% to 25% reduction for the second quarter, because that's what suppliers see." Early results bear him out, with book-to-shipment ratios falling.

At Hamilton/Avnet, where optimism is the rule, William C. Cacciatore, vice president for worldwide operations, says incoming orders have dipped slightly, "but nothing dramatic." Although bullish for the year, he does not expect 1979's 30% growth rate to continue—"That's insanity." For adders alone, Cacciatore acknowledges a ballooning of expenses in their wake.

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Data Precision Corporation, A Division of Analogic Corporation, Electronics Avenue, Danvers, MA 01923, (617) 246-1600, TELEX (0650) 921819 especially when they get a much higher bill, with no warning, due to mistakes or oversights. "When they don't get the change notice, they won't pay," says H/A's Sweet.

Byron Kirkwood, president of Dallas-based KA Electronic Sales, who is having few such problems himself, says he hears talk in the trade, particularly involving military connectors. "A customer would let you quote it [the adder], buy it, and then just not pay."

At Hall-Mark Electronics Corp. in Dallas, Joseph Summer, director of semiconductor business development, notes that the customers who are in the worst position are those with government contacts. Such contracts were frequently negotiated at fixed prices a year or more ago and the contractor has no way of passing on the surcharge.

A good part of distributors' anger at suppliers comes from not seeing adders coming soon enough. Particularly troubling is their effect on back orders, where a customer already has a fixed price. "Customers won't accept paying more" is the nub of this problem. The only solution in many cases is for the distributor itself to foot the difference, if it wants to keep the business, say many officials. The adder works best with customers when the distributor had forewarning and data from the vendor to fully explain it, says Moltronics' Cassidy. "The more authoritative we can be, the better."

By far the touchiest item deals with "pass-throughs." This is a concept, says one distributor, that suppliers are trying to impose on everybody. It defines the adder as a cost that the distributor is to pass to the customer without taking any additional charges for handling.

"Everybody will have to charge," flatly states Cassidy, who admits his firm already is tacking it on. Kirkwood of KA, who passes the surcharge along to customers without charging, goes along with him somewhat. The adders cost 1% to 2% to process, and "if the product is sold on credit, there can be an additional 2% to 4%," he says.

Glimmer of hope. But some rays of hope are breaking through the gloom, coming mainly from suppliers moving toward a simple price change and away from the adder. Support for simple price changes rather than adders is a subject distributors across the board can agree on. Schweber terms price changes "better for all concerned" and Norman Hurwitz of Apollo Electronics, Cambridge, Mass., calls them "best of all." The preferred way is for manufacturers to "amortize the metal costs into the product, take an average figure and integrate it as a flat price increase," says Hurwitz. "We've said that from the beginning," notes Wyle's Spiegel.

But before price changes can be implemented extensively, metal prices have to stabilize enough to establish a benchmark. When will stabilization occur? Views run the gamut from Schweber's "over soon" to Sweet's "maybe a year" to Spiegel's "who knows?" □

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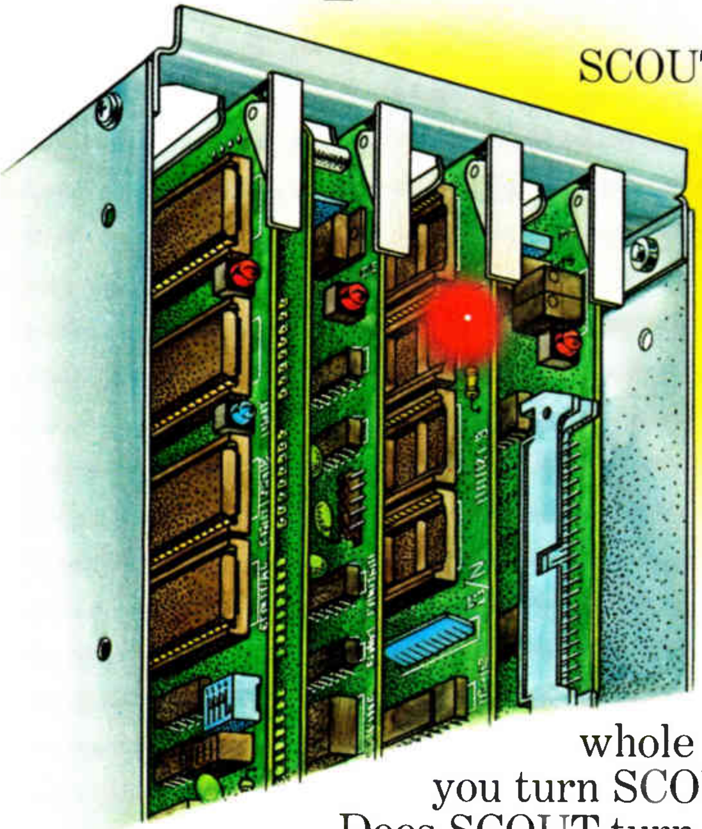

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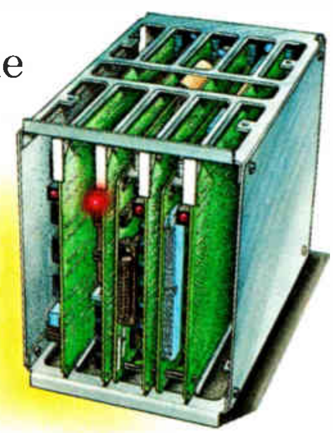

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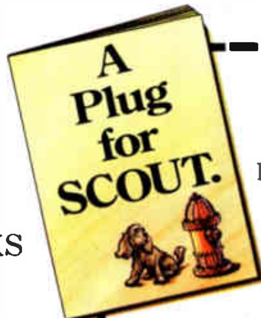

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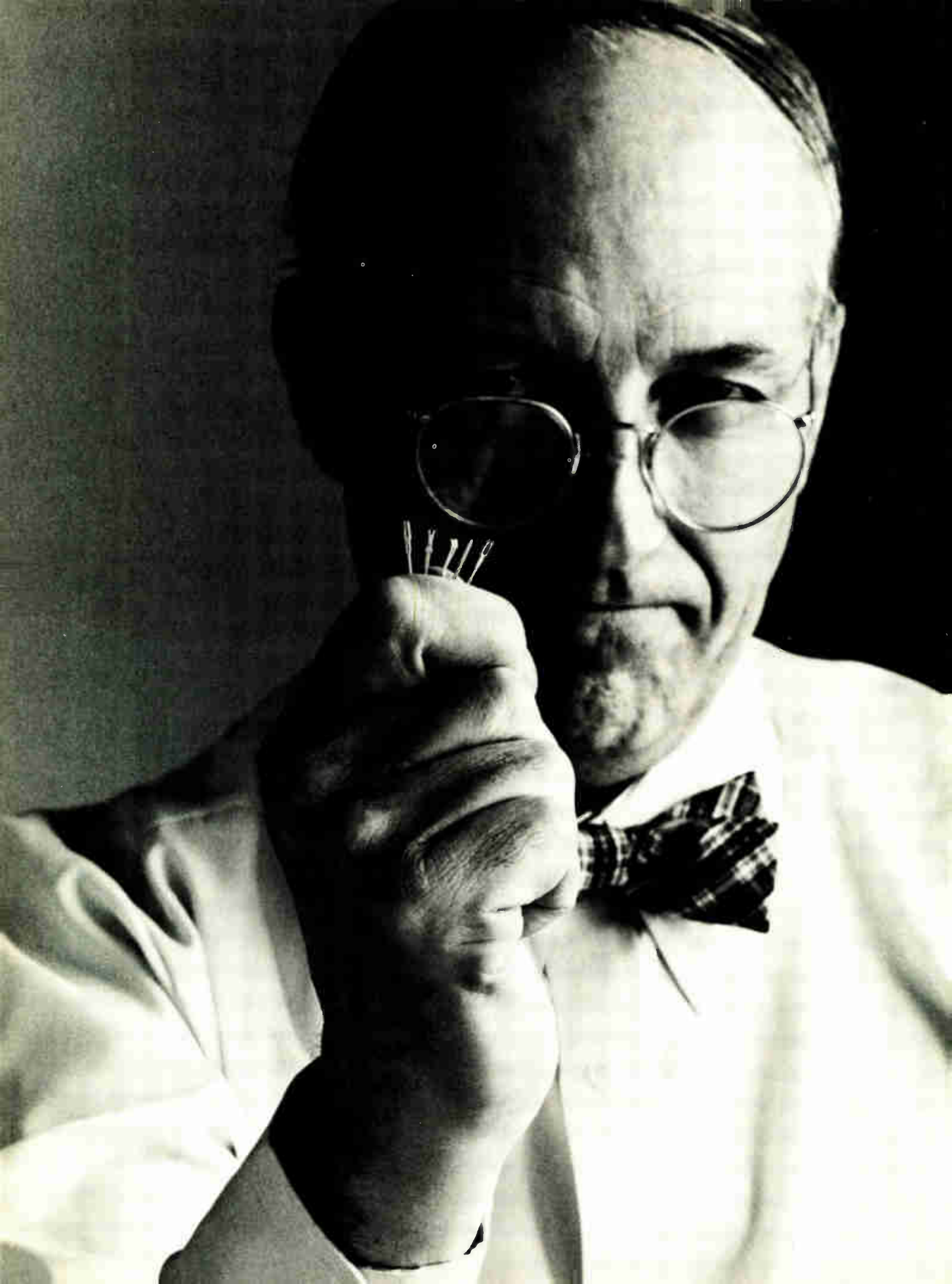

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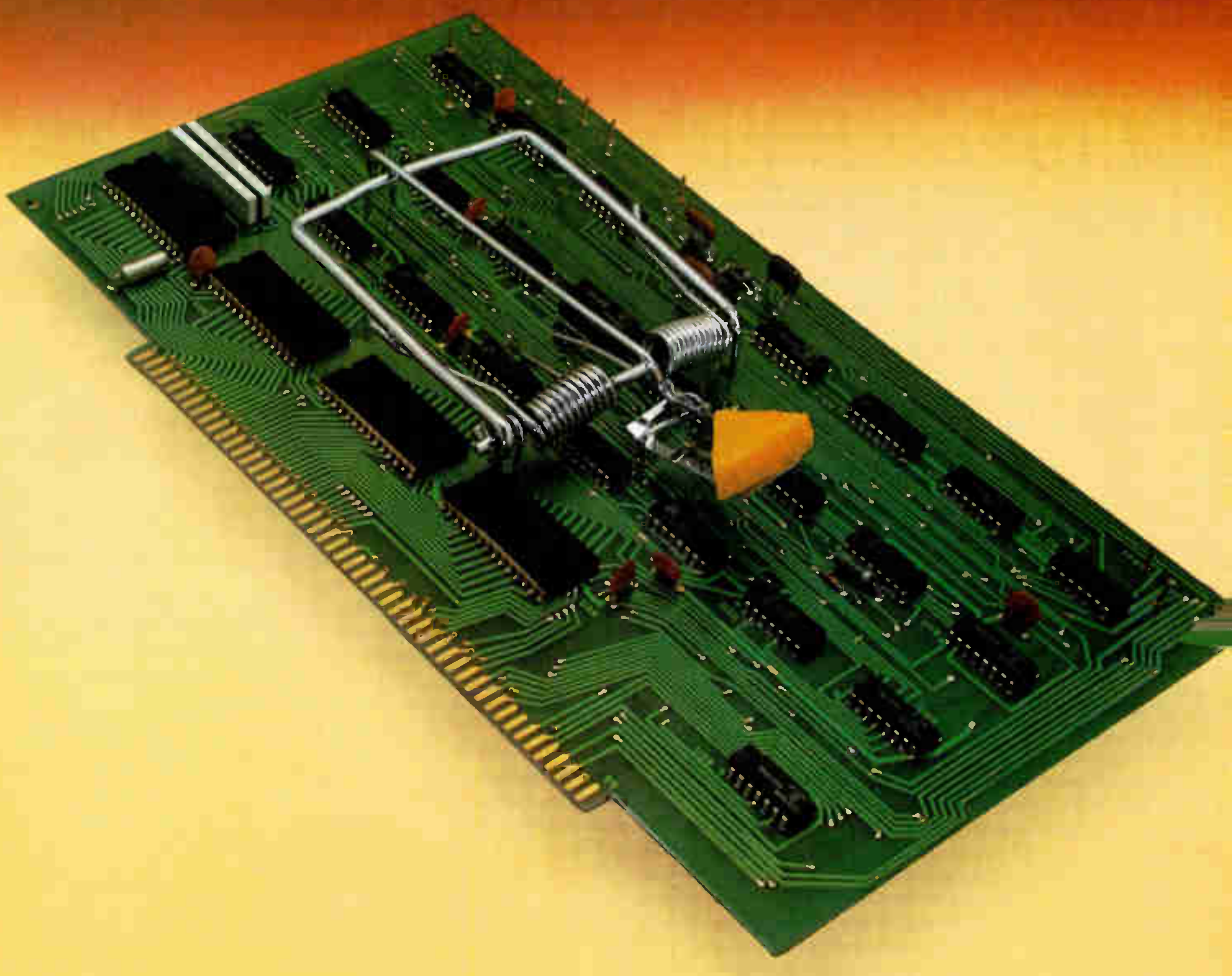

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And, of course, the 1615A, with 24 channels, lets you analyze relationships between activity on synchronous buses such as combinations of address, data and I/O.

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For more information

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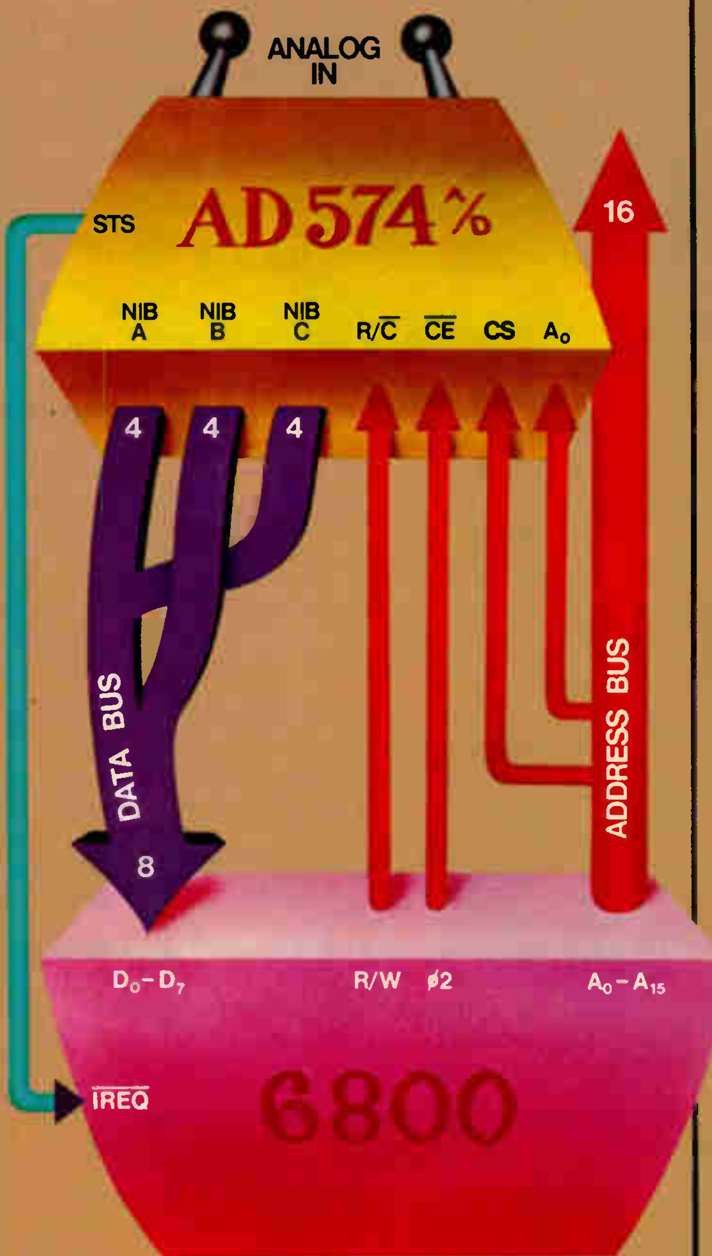

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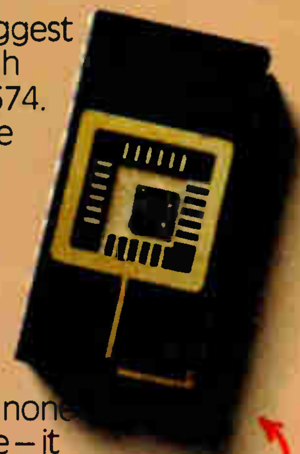

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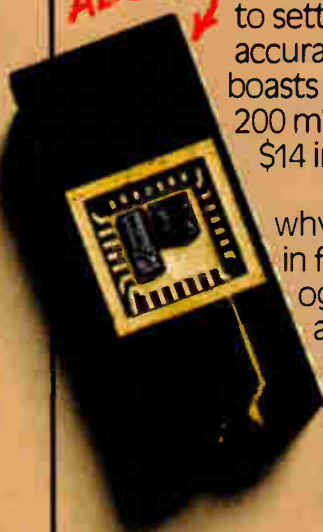

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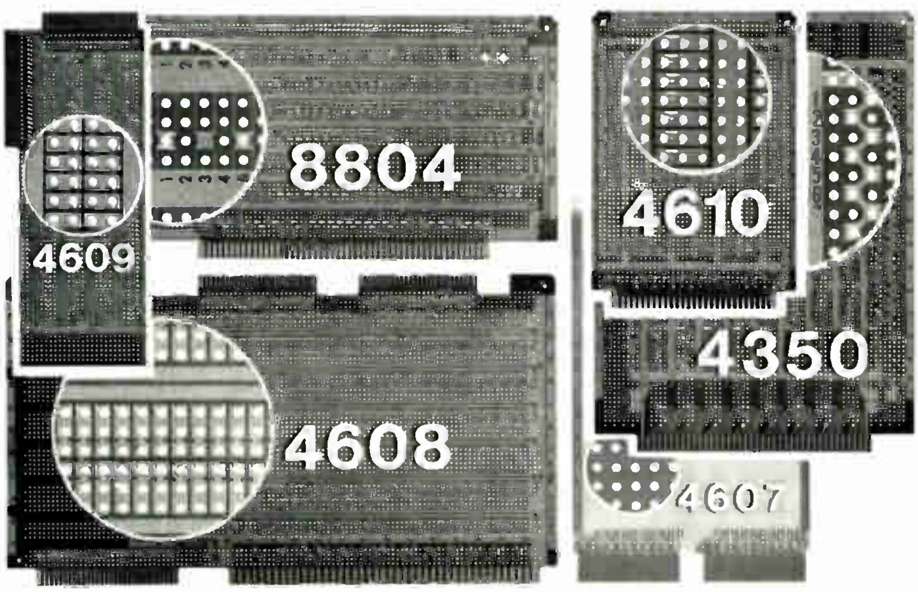

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Making mainframe mathematics

by John Palmer, Rafi Nave, Charles Wymore, Robert Koehler, and Charles McMinn, *Intel Corp., Santa Clara, Calif.*

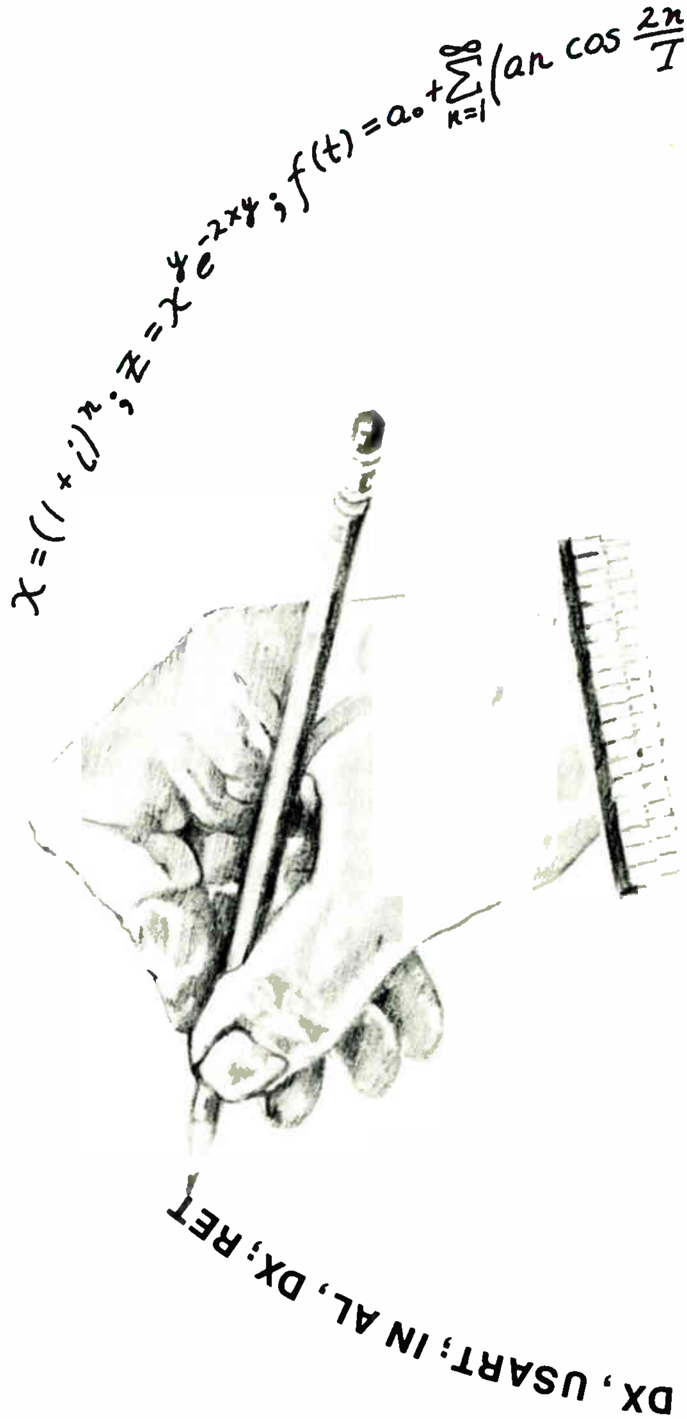
☐ Ongoing advances in very large-scale integrated-circuit processing now permit a complete floating-point mathematics subsystem on a single silicon substrate. The 8087 numeric data processor is designed to function as a tightly coupled coprocessor to a general-purpose 8086 or 8088 microprocessor. Its specialized architecture is derived from experience gained in fitting much larger machines with similar mathematical capabilities.

As with mainframe computers, dedicated data types, instructions, and registers are fully integrated to enhance the performance of the hardware and untangle the design of software. The evolution of numeric-processing support for mainframes and minicomputers is spotted with gradual and often haphazard extensions imposed upon otherwise general-purpose hardware; the 8087, in contrast, represents one of the few attempts to rigorously analyze in advance the hardware and software needs for numeric processing.

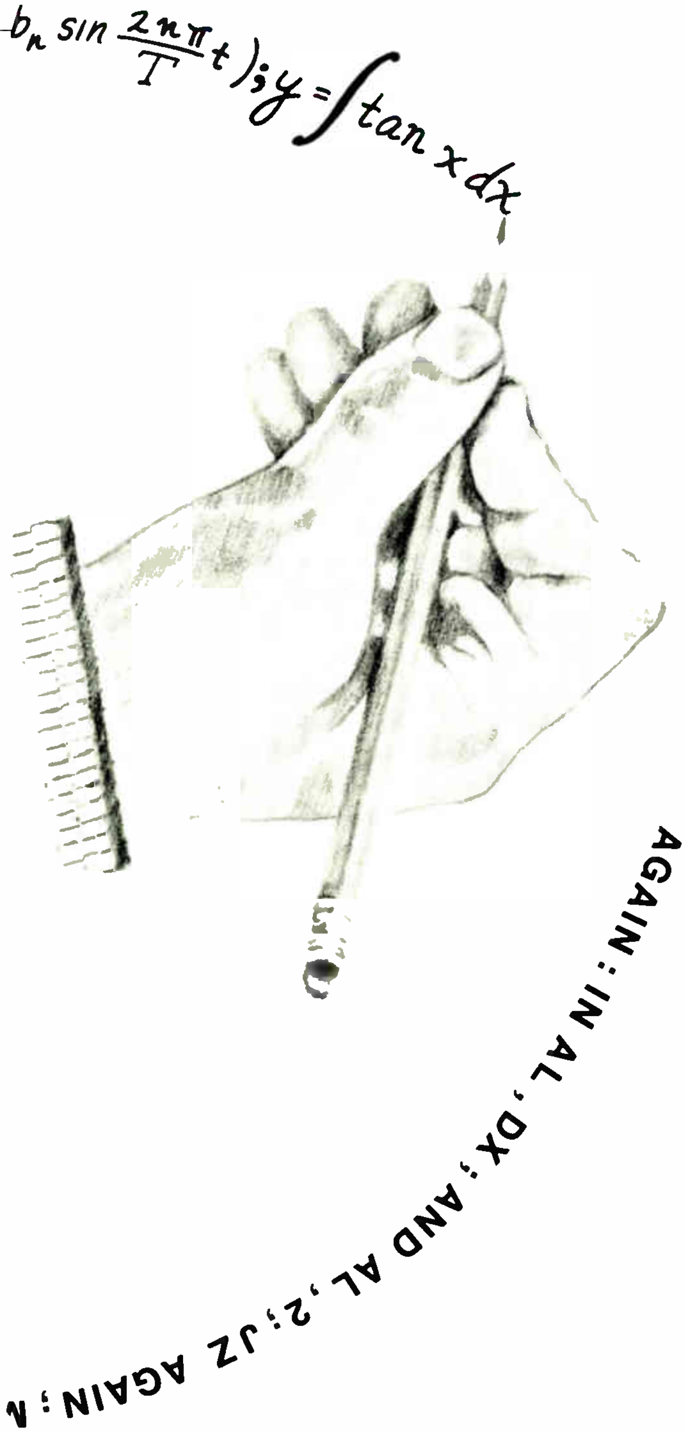
This planning was expedited by the work of the Institute of Electrical and Electronics Engineers, which has proposed a standard for floating-point arithmetic [*Electronics*, May 24, 1979, p. 98]. Therefore, unlike most prior implementations, the 8087 conforms to a detailed specification for numeric operations (see "The 8087's roots," p. 117).

The 8087 typically offers a hundredfold improvement in throughput over calculations done entirely in software subroutines executed by the 8086 or 8088. The new chip also offers enhanced precision through a 64-bit internal data path, an 80-bit register stack, and a 68-bit arithmetic and logic unit.

In many ways, though, raw speed and more bits are easily arrived at—scaling down devices can account for both, in fact. Even the 8087's single instruction for calculating trigonometric functions and logarithms, raising numbers to powers (exponentiation), and finding square roots do not warrant the careful attention that must be given, especially with number crunching, to possibly undesirable exceptions that are bound to crop up in the course of the computations. Here the 8087 really shines, with its high degree of immunity against overflow, underflow, and errors due to the rounding of intermediate results. This degree of immunity makes the 8087 applicable in the most demanding kinds of application—for instance, accounting, which requires exact



accessible to microcomputers



results with no rounding over a wide range (as large as 18 decimal digits).

The 8087 is the result of high-performance silicon-gate MOS technology (HMOS), which packs the die with scaled-down 4-micrometer transistors. On-chip substrate biasing yields faster and more reliable operation. With HMOS, the entire mathematics processor is about 109,000 square mils, containing the equivalent of over 65,000 devices (Fig. 1). This includes the internal register stack, comprising more than 700 bits of random-access memory, and a microprogram section that contains over 30,000 bits of microcode. The 8087 operates from a single 5-volt supply and is housed in a standard 40-pin ceramic package.

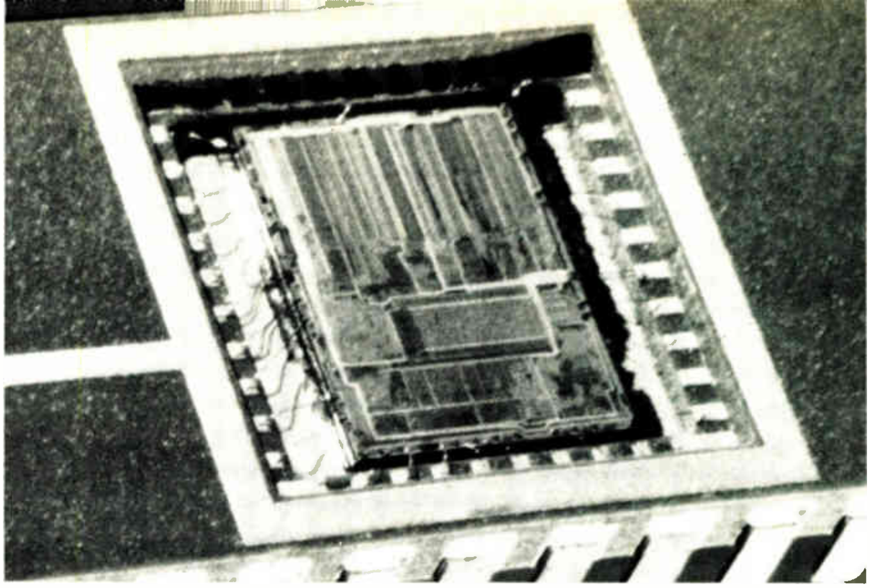
The coprocessor concept

As noted, the 8087 is specifically designed to operate as a coprocessor with the 16-bit 8086 (or 8088) microprocessor. A coprocessor extends the capabilities of the central processing unit to which it is attached; specifically, coprocessing is a special case of multiprocessing, one in which both processors execute from a single instruction stream. Figure 2 shows a typical configuration.

In the 8087-8086 combination, both processors operate in unison. They monitor the same instruction stream and execute selected instructions from it. For example, while the 8086 deals with memory segmentation, calculating the addresses of operands in memory, the 8087 can go off and perform complex arithmetic and logic operations that would otherwise have to be computed by the 8086 with software subroutines.

The 8087 can weed out its own instructions as they appear on the local bus that it shares with the 8086. When one of a particular set of escape instructions appears, the 8087 automatically recognizes it as its own. The 8086 calculates the memory address for the initial operand, if any, and puts that on the bus. The 8087 latches this address, reads the operand, and begins to execute the required numerical operation, leaving the microprocessor free to process nonnumeric commands. The 8087 takes control of the bus only when necessary, to load and store operands.

The 8087 and microprocessor communicate over the control lines shown in Fig. 2. The request/grant line is used by the 8087 to obtain control of the local bus for



1. Made for math. High-performance MOS technology puts the 8087's 65,000 devices on a single chip measuring 330 mils on a side. The device's register stack comprises the equivalent of 40 16-bit registers, and a microcode section stores over 30,000 bits.

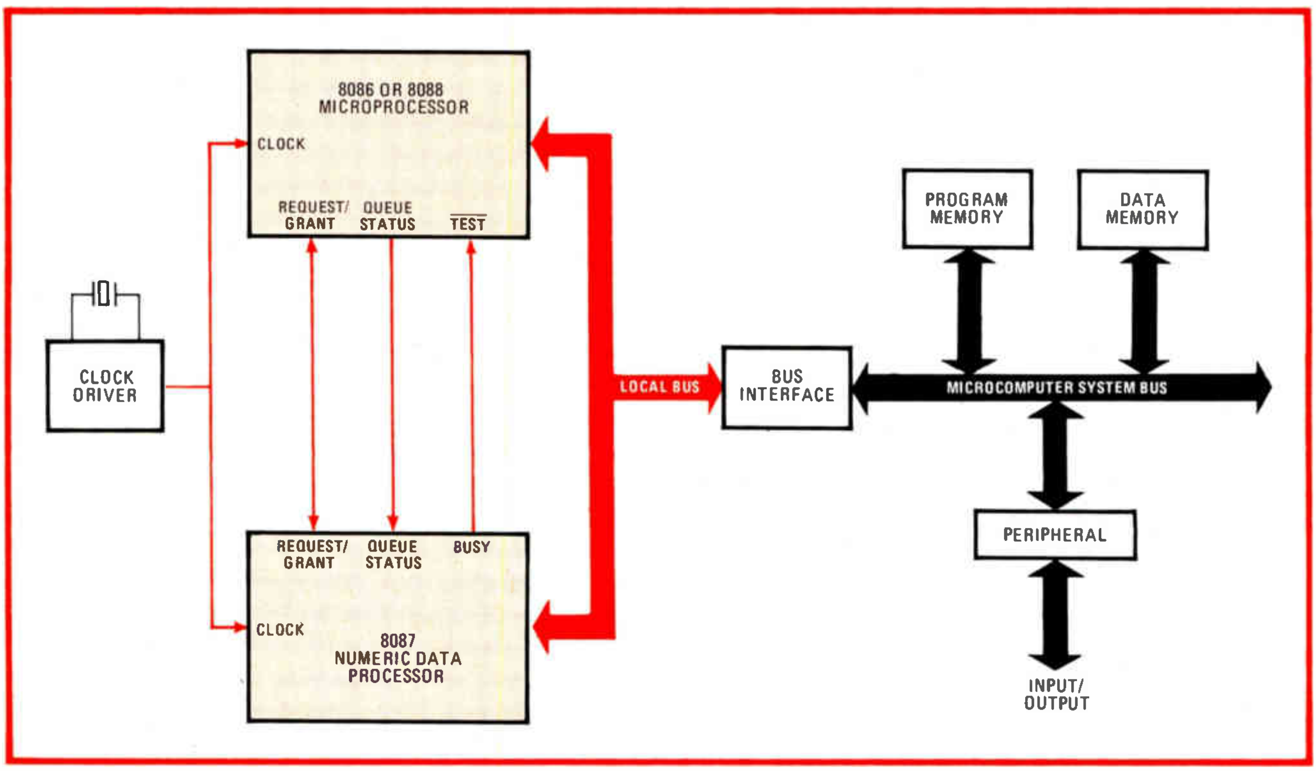
data transfers. The queue-status lines synchronize the fetching and decoding of instructions by the two devices. The 8087's busy signal informs the 8086 or 8088 that it is executing an instruction, and the latter's wait instruction tests this signal to find out when the 8087 is ready to execute subsequent instructions. Finally, the 8087 can interrupt the 8086 or 8088 if it detects an unmasked exception. Typically, the interrupt request is routed via an 8259A programmable interrupt controller.

This type of coprocessing increases system throughput because no overhead is incurred in setting up the 8087 for a computation and because the 8086 does not have to wait for results from the 8087. Indeed, the 8087 can be viewed as an architectural extension of an 8086 or 8088—it in effect extends the register resources and instruction set of the CPU. Figure 3 shows the register pool of the 8086-8087 combination.

Programming the 8086-8087 combination is identical to programming a lone 8086. From the programmer's standpoint, the 8087 simply provides 68 new instructions and data types (seven in all) on top of those provided by the 8086.

Coprocessor programming

Table 1 lists the various instruction classes the 8087 can execute. Each instruction has one or two operands that are loaded onto the top of the stack from an inner stack element or directly from the local bus lines if the operand is in memory. To bolster performance and simplify software, the common, or core, instructions (add, subtract, multiply, divide, and compare) can directly manipulate both memory- and register-based operands.



2. Coprocessing. The 8087 works with an 8086 or 8088 microprocessor through a tightly coupled form of multiprocessing called coprocessing. Both general-purpose and specialized processor eye the same data stream and perform the functions they do best.

The 8087's roots

In the mid-1970s, Intel embarked on expanding the computational capabilities of microprocessors from simple addition and subtraction of integers to an array of widely useful operations on real numbers. In 1977, the company adopted a standard for representing real numbers in a floating-point format. The floating-point arithmetic library (FPAL), the first product to use this standard format, is a set of subroutines for the 8080 and 8085 microprocessors. These routines perform limited standard functions on 32-bit single-precision real numbers; an FPAL multiplication takes about 1.5 milliseconds. The next product, the iSBC 310 high-speed math unit, implements the FPAL in hardware on a single card and reduces the single-precision multiplication time to about 100 microseconds.

The 8232 is single-chip arithmetic processor for the 8080/8085 family. The 8232 can operate with 64-bit double-precision real numbers; 32- and 64-bit multiplications take about 100 and 875 µs, respectively.

In 1979, a working committee of the Institute for Electric and Electronics Engineers solicited proposals for a standard for minicomputer and microcomputer floating-point arithmetic. The standard used by FPAL, the iSBC 310, and the 8232 was presented to the committee and subsequently expanded upon. This standard is designed to meet, among other things, the requirement that programs be portable, that is, that algorithms can be run on any machine complying with the standard and numerically identical results will be obtained. The standard also sets forth requirements designed to provide a high degree of safety and reliability for numeric computation. Standard data formats are established, and rules for rounding and precision control are specified. Most important is the requirement that devices satisfying this standard monitor their own activity and, in a prescribed manner, notify the program when numerical results are in error. This process has become known as exception handling.

The 8087 extends Intel's standard for numerics. It implements on a single chip the proposed IEEE standard, including all its options for single- and double-precision calculations. In addition, the 8087 provides many functional extensions to the proposed standard. It is compatible with previous Intel numeric products, and programs written for the 8087 will be transportable to future products that conform to the proposed standard. As the figure indicates, the 8087 provides over 10 times the speed of the 8232 and a hundredfold improvement over the FPAL; it performs 32- and 64-bit multiplications in about 18 and 27 µs, respectively.

Programs are written in ASM-86, an assembly language common to the 8086, 8088, and 8087. ASM-86 provides directives for defining all 8087 data types, plus additional mnemonics for all new 8087 instructions. The fact that some instructions in a program are executed by the 8087 and others by the 8086 is usually of no concern to the programmer.

PL/M-86, Intel's high-level language for the 8086 and 8088, can be used to program the 8087, too. PL/M-86 provides access to many 8087 facilities—again, without requiring that the programmer understand the details of the 8086-8087 combination. All 8086 and 8088 addressing modes may be used to access 8087 operands, thereby enabling convenient processing of numeric arrays and other structures in memory.

Figure 4 is a block diagram of the 8087. Data arrives via the local bus lines on the left. Operands for computations come in on the 16 address and data lines marked AD_0–AD_{15} and are held in the operand queue. The operands are converted into an intermediate format called temporary real as they are loaded into this register stack. This format affords more accurate results even when using double-precision operands.

Register resources

The 8087's substantial register bank comprises eight 80-bit registers, equivalent to 40 16-bit registers. These registers may be used as an ordinary push-down stack, but they can also be addressed explicitly by the program; that is, references can be made to any of the eight registers at any time, not simply to the top one or two. This feature makes programming more flexible because intermediate results can be tucked away in unused portions of the stack—and retrieved later—without additional memory references.

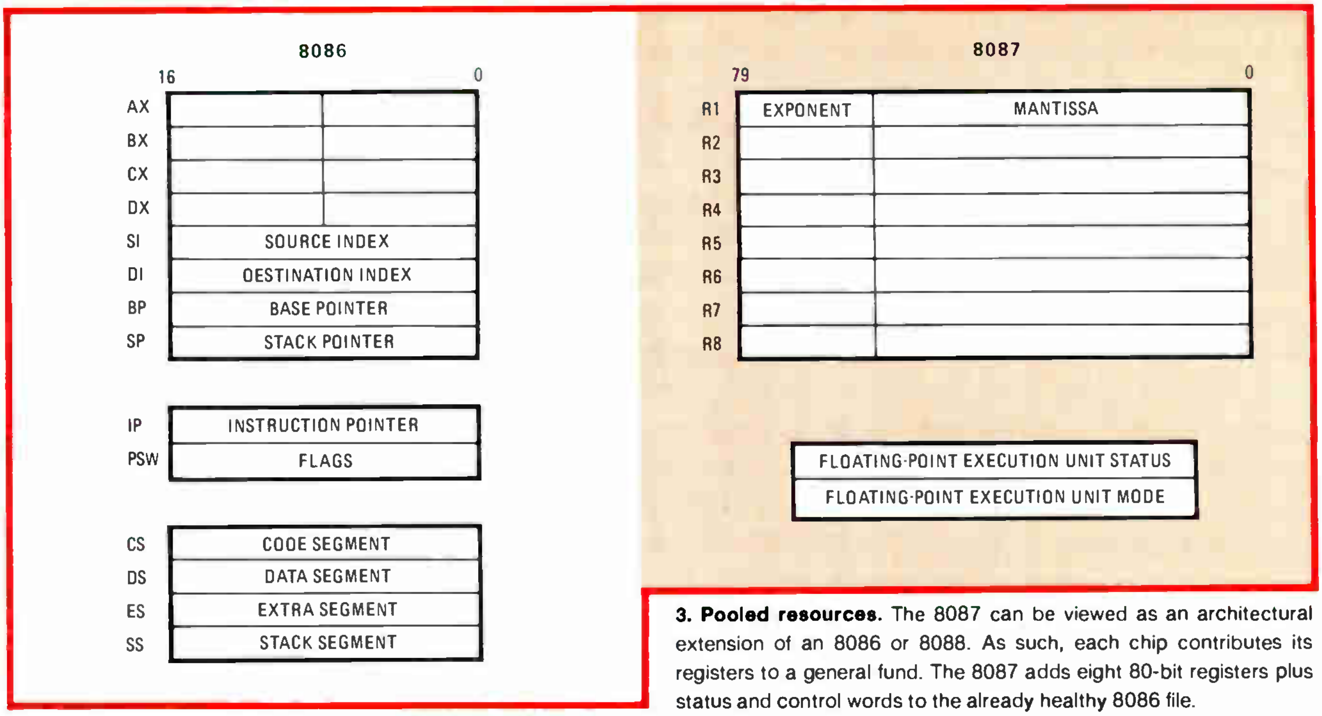
The stack may also be used for passing parameters to and from subroutines. Various routines can call the same subroutine without having to observe a convention for passing numeric parameters held in dedicated registers. As long as the stack is not full, each routine simply loads the parameters onto the stack and calls the subroutine.

Associated with the stack is a 3-bit pointer called top, and with each stack element a 2-bit tag field (Fig. 5). The stack elements are numbered relative to the pointer; ST(i) is the i^{th} element from the top of the stack. The tag field is used to detect uninitialized stack elements and to designate special values (like zero) for exception-handling routines written by the programmer and for internal microcode optimization. The values represented in this stack are in the temporary-real format. They have 64 bits of fractional precision and a range of over $10^{\pm 4900}$ (15-bit exponent).

The lower block in Fig. 5 consists of a status word, a control word, a word containing the eight tags for the stack elements, the instruction address pointer, and the data address pointer. The status word stores the busy flag (which drives the busy signal), some condition codes, the top pointer, and the following exception flags:

I	invalid operation
D	denormalized operand
Q	division of nonzero by zero
O	overflow
U	underflow
P	inexact

The 8087 provides ample mechanisms for dealing with these exceptions that might arise during computation. The sophisticated programmer can write specific exception-handling routines and thus control the detailed behavior of the machine. In this case, the user would unmask exceptions and perform interrupts to exception-



3. Pooled resources. The 8087 can be viewed as an architectural extension of an 8086 or 8088. As such, each chip contributes its registers to a general fund. The 8087 adds eight 80-bit registers plus status and control words to the already healthy 8086 file.

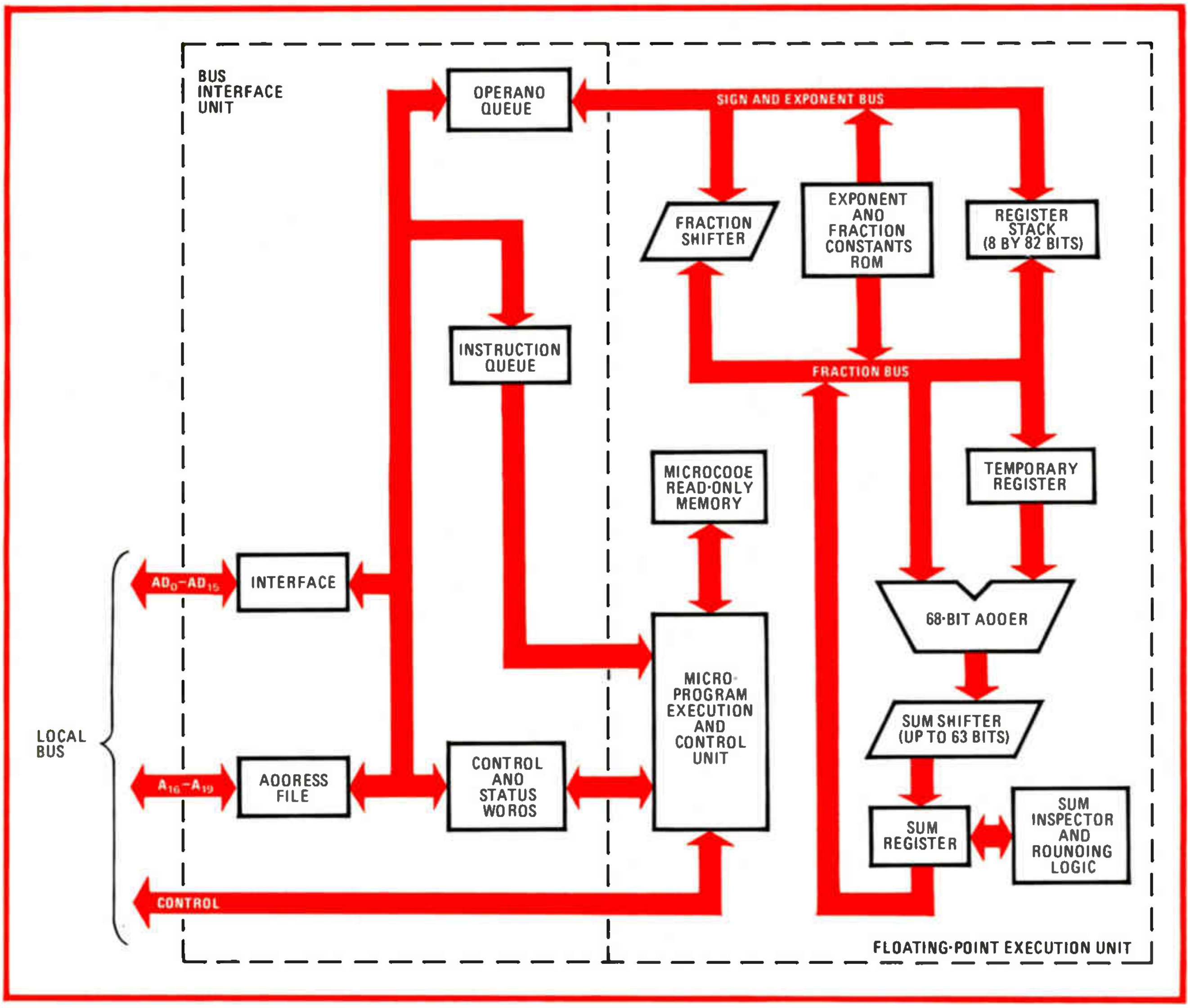
TABLE 1: PRINCIPAL INSTRUCTIONS OF THE 8087

Class	Instruction types
Data transfer	load and store (for all data types), exchange, free
Arithmetic	add, subtract, multiply, divide, subtract reversed, divide reversed, calculate square root, scale, increment, decrement, use remainder, round, to integer, change sign, absolute value, extract mantissa or exponent
Logical	compare, examine, test
Transcendental*	calculate tangent, arctangent, $2^X - 1$, $Y \cdot \log_2 X$, $Y \cdot (\log_2 X + 1)$
Constants*	0, 1, π, $\log_{10} 2$, $\log_e 2$, $\log_2 10$, $\log_2 e$
Processor control	load control word, store control word, store status word, load environment, store environment, save, restore, set interrupt-enable, clear interrupt-enable, clear errors, initialize

* Combining these instructions in very simple routines provides all the common trigonometric, inverse trigonometric, hyperbolic, inverse hyperbolic, logarithmic, and power functions.

handling routines. Alternatively, the 8087 will automatically handle exceptions on chip, relieving the programmer of the need to write and debug such routines. Thus, general applications programmers benefit from the 8087's precision and safety, whereas traditional machines would require familiarity with numerical analysis techniques and exceptions.

The control word in Fig. 5 consists of exception masks and control bits. For the seven exceptions having flags there is also a mask that, if reset, allows an interrupt to be generated. But if the mask is set, it suppresses the interrupt and causes the 8087 to execute an on-chip exception-handling routine. These default procedures are designed to handle a vast majority of situations that



4. Sectioned off. Like the 8086, the 8087 is split into a bus interface unit and an execution unit. Data from a 16-bit local bus is converted into a temporary real format and processed by a 68-bit arithmetic and logic unit. Results are then converted back into the original data type.

come up. It is recommended that most users mask for all exceptions except invalid operation.

The control bits in the control word specify the level of precision as well as the actions to be taken for rounding and for infinite results. Precision control regulates the rounding process to one of three ranges: real (24 bits), long real (53 bits), and temporary real (64 bits). Control of precision is particularly useful when the programmer wishes to simulate other machines that might have less internal precision available than the 8087. Infinity control chooses between affine and projective infinity.

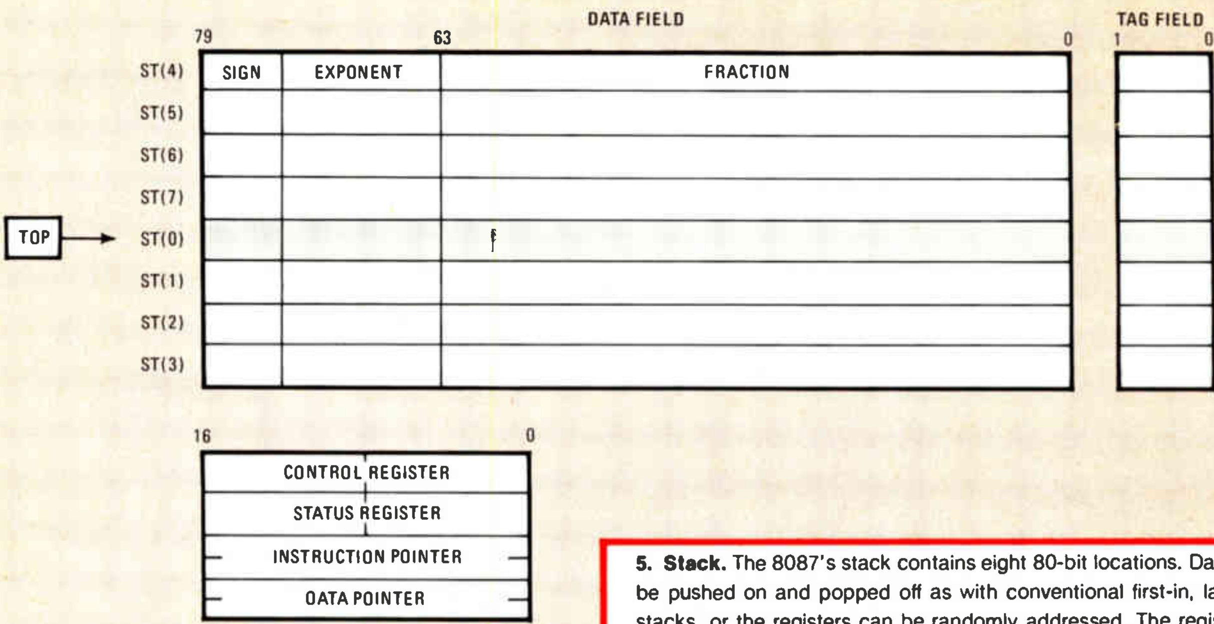
Rounding control selects one of four approaches: unbiased round to the nearest representable number, round up, round down, and round toward zero. The P (inexact) exception is especially important, since it notifies the programmer whenever the results of a computation are being rounded. Therefore, results that must be exact can be guaranteed as such.

Rounding control is also useful for interval arithmetic. Calculations can be carried out, for example, by always rounding up, then rounding down. Two sets of results are obtained, with the true result in between. Thus, even when some rounding is inevitable, the 8087 can still make guaranteed statements by specifying bounds, or intervals, within which the exact result exists. Interval arithmetic has other applications, too, in which the user analyzes the effects of various types of uncertainties, errors, and other variations in the input data.

Completing the description of Fig. 5, the instruction and data pointers hold the address of an instruction and the data it refers to, if any, respectively. In the event that an exception generates an interrupt, this information is available to the programmer for use in the exception-handling routine.

Temporary-real format

The 8087's architecture includes an extended intermediate format called temporary real that affords the user significant advantages. As mentioned, the chip manipulates both single-precision 32-bit real and double-precision 64-bit operands, and as a result of temporary real, the commonly supplied system functions are accurate to



5. Stack. The 8087's stack contains eight 80-bit locations. Data can be pushed on and popped off as with conventional first-in, last-out stacks, or the registers can be randomly addressed. The register at the top of the stack is singled out by the top pointer.

double precision. That is, if x is a long-real value, then e^x, ln x (the natural logarithm of x), and the tangent of x, and so on, will all be accurate to within less than one unit in the last place of long-real precision. In fact, because of their delicate hardware implementations, these functions will be more accurate—to within a few units in the last place of temporary-real precision.

The true test of temporary real comes, however, in calculating the most demanding function in the 8087's repertoire, x^y. In performing this function, as many fraction bits are lost to rounding as there are bits in the exponent of y; for instance, if x and y are in the double-precision format, then $z = x^y$ will lose about 11 bits. This loss would introduce significant error in a function that is crucial for many commerical calculations, including those for interest rates. However, with the 8087's temporary-real format and logarithmic functions, x^y (with x and y both temporary real) is accurate to about one unit in the last place of long-real precision. Besides ensuring accurate calculations of rates of return, the 8087 with temporary real guarantees that integral values of the arguments of x^y yield exact results: 2^3 equals 8, not 8.00 . . . 01.

Finally, the temporary-real format provides the means to construct accurate mathematical, statistical, and commercial libraries of functions. The user of these libraries supplies data in real or long-real formats and receives results with identical precision. The library uses temporary-real variables to perform the calculations and thus protects not only against roundoff errors, but also against intermediate overflows and underflows. (Most overflows and underflows occur on intermediate calculations, since the input and output variables are usually within reasonably narrow ranges.)

Performance claims for most libraries are "in the absence of overflow and underflow." But by judiciously using temporary-real variables, either overflows and underflows will be of no consequence or the user will be provided with a necessary and helpful warning.

The 8087 can operate on integer, binary-coded-decimal, and binary floating-point numbers, for a total of seven data types (Table 2). Regardless of data type, operands are converted without rounding into the temporary-real format as they are fetched from memory. All internal computations are done in the temporary-real format. Only when the result is about to be returned to memory is the data converted back into the format of the data type desired by the program. The conversions to and from temporary real are entirely transparent to the programmer. This automatic conversion also allows mixed-mode arithmetic, in which operands and results need not be of the same data type.

Easily emulated

One major advantage of the 8087's being so closely coupled with the 8086 is that a software emulator can be built easily. In fact, Intel provides such an emulator of 8087 hardware that runs on an 8086 or 8088. It generates trap routines that are substituted for the 8087's escape instructions. The use of these routines allows 8087 software to be written and executed while prototype hardware is still being developed. Then, when prototype hardware is ready, these same programs will run 100 times faster than the emulator. Table 3 gives an idea of the 8087's performance. Execution times for several 8087 operations are compared with those for equivalent operations executed in software on a 5-megahertz 8086. The software equivalents are the assembly language procedures for the 8087 emulator.

The hardware preparation required to add an 8087 to an existing 8086- or 8088-based system is an easy one, too. The 8087 uses the same clock generator and system bus interface components (bus controller, latches, transceivers, and bus arbiter) as the processor it supplements. Thus the 8087 itself is the only additional chip required for extensive high-performance numeric-processing ca-

TABLE 2: DATA FORMATS OF THE 8087

	Range	Precision	Format (Most significant byte; bits 7 … 0 per byte)
Word integer	10^4	16 bits	I_{15} … I_0 2's complement
Short integer	10^9	32 bits	I_{31} … I_0 2's complement
Long integer	10^{19}	64 bits	I_{63} … I_0 2's complement
Packed binary-coded decimal	10^{18}	18 digits	S — D_{17} D_{16} … D_1 D_0
Short real	$10^{\pm 38}$	24 bits	S E_7 … E_0 F_1 … F_{23} F_0 implicit
Long real	$10^{\pm 308}$	53 bits	S E_{10} … E_0 F_1 … F_{52} F_0 implicit
Temporary real	$10^{\pm 4,932}$	64 bits	S E_{14} … E_0 F_0 … F_{63}

Integer: I
Packed BCD: $(-1)^S(D_{17} \ldots D_0)$

Real: $(-1)^S(2^{E-\text{bias}})(F_0 . F_1 \ldots)$
Bias = 127 for short real, 1,023 for long real, 16,383 for temporary real

TABLE 3: EXECUTION TIME FOR ACTUAL AND EMULATED 8087 INSTRUCTIONS

Instruction	Approximate execution time (μs)	
	8087 (5-MHz clock)	8086 emulation
Add or subtract magnitude	14/18	1,600
Multiply (single precision)	18	1,600
Multiply (double precision)	27	2,100
Divide	39	3,200
Compare	10	1,300
Load (single precision)	9	1,700
Store (single precision)	17	1,200
Calculate square root	36	19,600
Calculate tangent	110	13,000
Raise to the appropriate power	130	17,100

pabilities in such a system.

The transparent software and simple hardware interface of the 8087 make it extremely easy to add numeric support to existing products like board-level computers. Intel is following this simple course in adding numeric support to existing 8086-based iSBC 86/12 single-board computers. As an option, a plug-in module will be provided. The user simply unplugs the 8086, plugs in the module (which has the 8087 on it), and then plugs the 8086 into the module.

A wide range of applications will benefit from the 8087's combination of high performance and software support. For instance, small, accurate, and reliable inertial navigation systems can put the 8087 to work. Its built-in trigonometric functions speed up and simplify the derivation of positional information, such as bearing and acceleration data.

The 8087's ability to accept decimal operands and produce exact decimal results up to 18 digits long greatly simplifies the programming of business data-processing applications. Financial calculations that rely on power functions, like $(1+i)^n$ for compound interest, will take advantage of the 8087's exponentiation instructions. Business-oriented languages like Cobol also benefit from the 8087's accuracy and rounding.

In real-time process control situations, the 8087's extended precision and speed enable it to handle a wide dynamic range without loss of precision. Finally, the direct numeric support for the 8087 available in all 8086 high-level languages makes software cost-effective. □

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Magnetostatic-wave devices move microwave design into gigahertz realm

Garnet films fashioned into components like delay lines and filters do the job of SAW devices operating at much lower frequencies

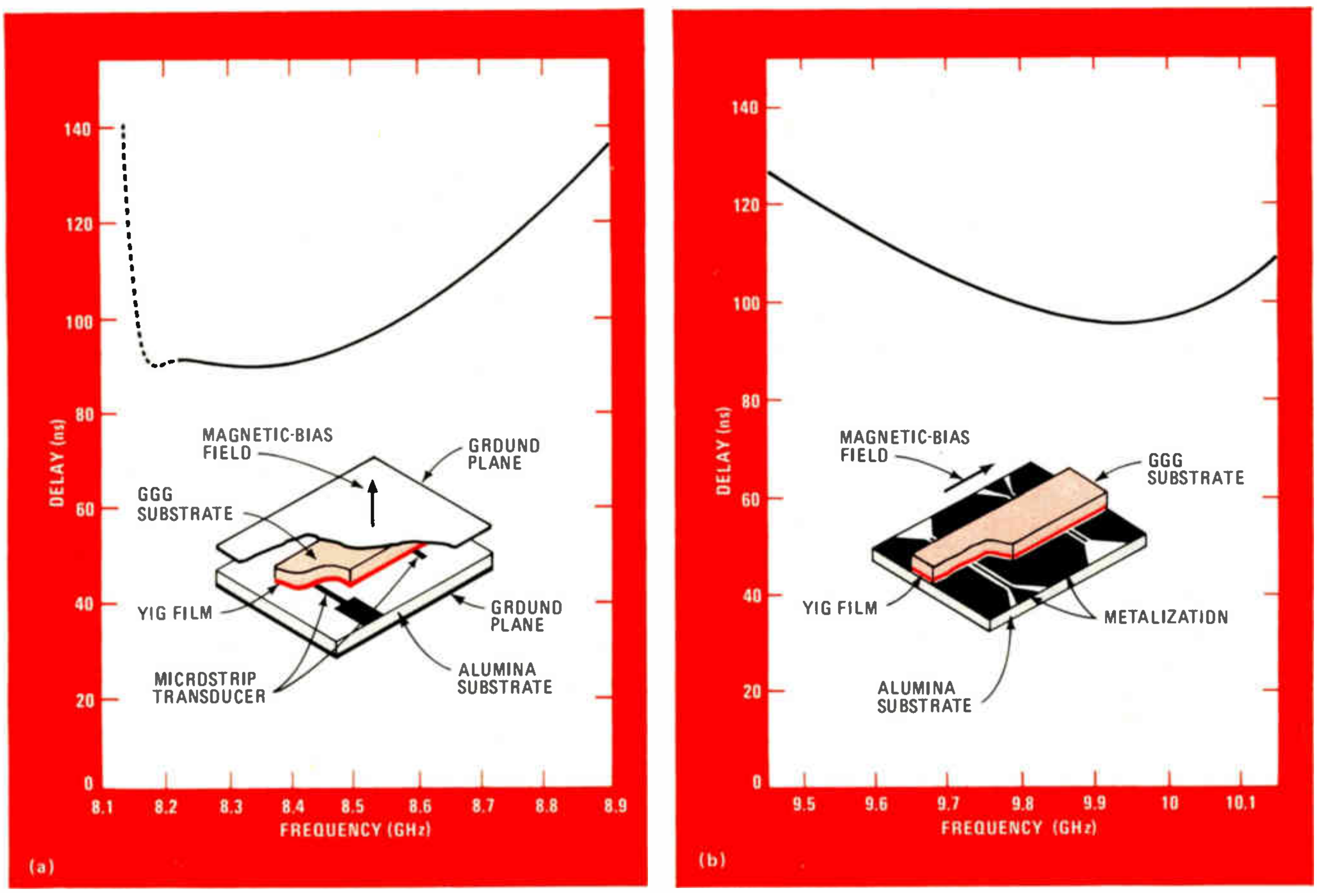
by J. D. Adam, M. R. Daniel, and D. K. Schroder, *Westinghouse Electric Corp., Research and Development Center, Pittsburgh, Pa.*

☐ Microwave-frequency information has traditionally been processed at lower, intermediate frequencies because it is difficult to make the needed microwave delay lines, transversal filters, and signal-to-noise enhancers. So a design engineer with a radar or communication set in the 1-to-20-gigahertz range must use a mixer to convert the incoming signal to the hundreds-of-megahertz frequency band where surface-acoustic-wave (SAW) devices are available to manipulate the received intelligence.

Now, however, magnetostatic-wave (MSW) devices are becoming available to perform the functions of the acoustic-wave devices. And they operate directly at microwave frequencies of 1 to 20 GHz with bandwidths of 0.5 to 1 GHz.

Compared with SAW technology, MSW technology offers lower propagating losses, simple transducers not needing narrow-line-width photolithography (the line widths required are typically 50 micrometers), and broad frequency tunability by means of an externally applied magnetic field.

Perhaps most important, when signals are processed at microwave frequencies, the radar or communication-system user has a faster decision-making capability since the information the signal carries is handled in close to real time. And, as a bonus, the distortion caused by the



1. Delay line. A 20-micrometer YIG film with ground planes 0.55 millimeter above it and 0.15 mm below it (a) supports a forward volume magnetostatic wave. The same YIG film spaced about 15 μm above a coplanar waveguide (b) supports a backward magnetostatic wave.

Magnetostatic-wave devices: some background

Early experiments on magnetostatic waves in bulk yttrium-iron-garnet (YIG) were begun in the late 1950s, and microwave delay lines were demonstrated at that time. But materials problems made it difficult to achieve the desired device characteristics, and reproducibility was poor. This led to a drastically reduced effort in the field.

With the advent of magnetic-bubble memory devices, the liquid-phase epitaxial (LPE) growth of thin-film YIG layers made great strides in the early 1970s. This caused a renewed interest in MSW devices, since the LPE technique used for bubble films lends itself to MSW films, even though the films themselves are not quite the same. MSW devices use pure YIG with as high a saturation magnetization as possible, whereas bubble films are doped to reduce this magnetization. Furthermore, the thin-film geometry lends itself to integrated circuit techniques, and radar and electronic countermeasures (ECM) have advanced to the stage where they can benefit from the microwave capabilities of MSW devices.

Work is currently going on at a number of industrial research laboratories and universities in the U. S., Europe, and Japan. Westinghouse is evaluating four types of devices to be delivered to the Air Force later this year. They are a wideband (1-gigahertz) linearly dispersive delay line, a stabilized oscillator, a 10-channel multiplexed filter bank, and a programmable tapped delay line. Each of these devices operates at a 9-GHz center frequency.

On a different Air Force contract, a signal/noise enhancer covering the 2.5- to 5.2-GHz ECM band has been built and successfully operated. Earlier, Rockwell International Corp. delivered a dispersive delay line to the Air Force. At its Aerospace division, Westinghouse is putting together a spectrum analyzer using an MSW dispersive delay line operating at 3 GHz with an 800-MHz bandwidth. These are among the first epitaxial YIG devices delivered, indicating that prototype devices are available to the system engineer now. Production devices will be available in a few years.

mixer, which introduces errors into the receiving system, is eliminated.

Under development by the Westinghouse Research and Development Center and elsewhere, the devices are not yet ready for general use, and mixer and intermediate-frequency device manufacturers need not worry about the competition (see "Magnetostatic-wave devices: some background," above). On the other hand, practical devices have been made, and though they are not generally available, those involved in signal processing should be aware of their performance.

The devices built to date include constant delay lines, linear dispersive delay lines, transversal filters—such as reflective arrays and periodic transducers—bandpass filters, resonators, and signal-to-noise enhancers. They are based on the properties of a form of energy propagation called dispersive spin waves (see "MSW devices: how they work," opposite page).

An important device is the constant delay line, in which all frequencies experience the same delay. It can be configured so that the time delay is adjustable as required, for example, for phased-array radars.

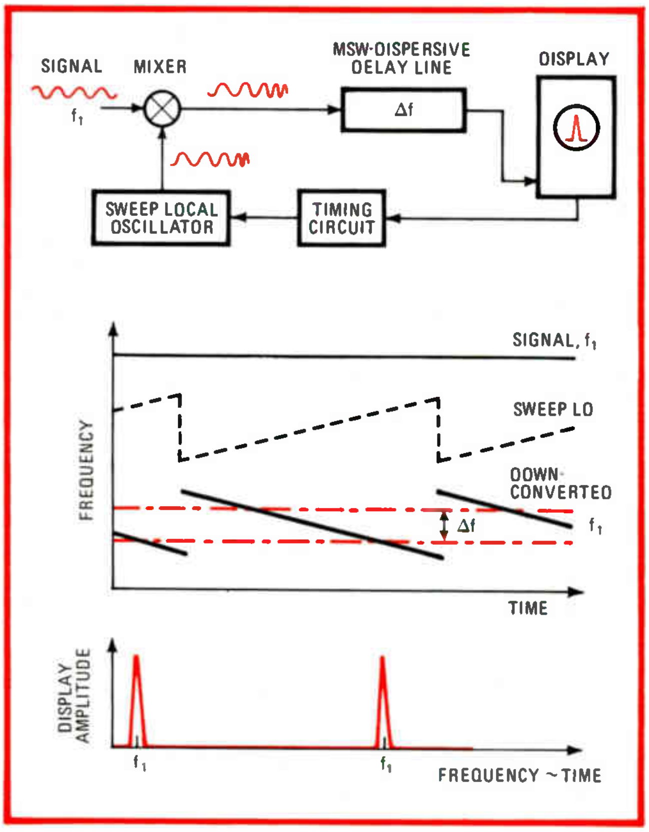
For their part, dispersive delay lines are needed in compressive receivers, and signal-to-noise enhancers are employed in frequency memory loops. Although delay-line design depends on spin-wave phenomena, their operation is easily explained.

What causes the delay?

The basic magnetostatic-wave device is a constant delay line, which delays a signal applied at an input port a fixed amount of time before it arrives at an output port. Because magnetostatic waves do not usually have a linear relationship between frequency and wavelength, their travel time between input and output ports in a delay line varies with frequency. Normally, this would mean delay is not constant with frequency—an unacceptable situation.

Fortunately, certain device parameters can be made to compensate for this nonlinearity. Thus a delay line is possible that exhibits a constant delay to within ±5% over approximately 400 MHz of bandwidth at 10 GHz.

One way to make such a delay line is to apply a steady magnetic field normal to an yttrium-iron-garnet film, so that forward volume waves propagate. Then, by positioning two ground planes, one above and one below the YIG film and at appropriate distances from it, the char-



2. Microscan. The input signal is mixed with an up-chirp and then passed through a down-chirp delay line. The output shows the input frequency as time-axis spikes, where the time is proportional to the frequency SAW lines can also provide this delay.

MSW devices: how they work

Magnetostatic-wave devices depend on the propagation of slow, dispersive spin waves at microwave frequencies in low-loss ferromagnetic materials. Typically this material is an epitaxially grown yttrium-iron-garnet (YIG) layer on a gadolinium-gallium-garnet (GGG) substrate.

The spins are aligned along the field direction by a steady applied magnetic field (a). A local perturbation, caused, for example, by a current in a conductor close to the magnetic material, creates a disturbance that propagates through the YIG film (b), in much the same way as plucking a stretched guitar string causes the vibration to move along the wire.

The inverse conversion of the magnetic disturbance into a current in a second conductor placed some distance from the first completes a simple delay line. This conversion is made with an MSW-to-microwave transducer.

The analogy to the guitar string can be stretched a little further by comparing higher vibrational string frequencies (due to increased tension) with higher frequencies in an MSW device caused by a higher magnetic field. This increased field aligns the spins more rigidly.

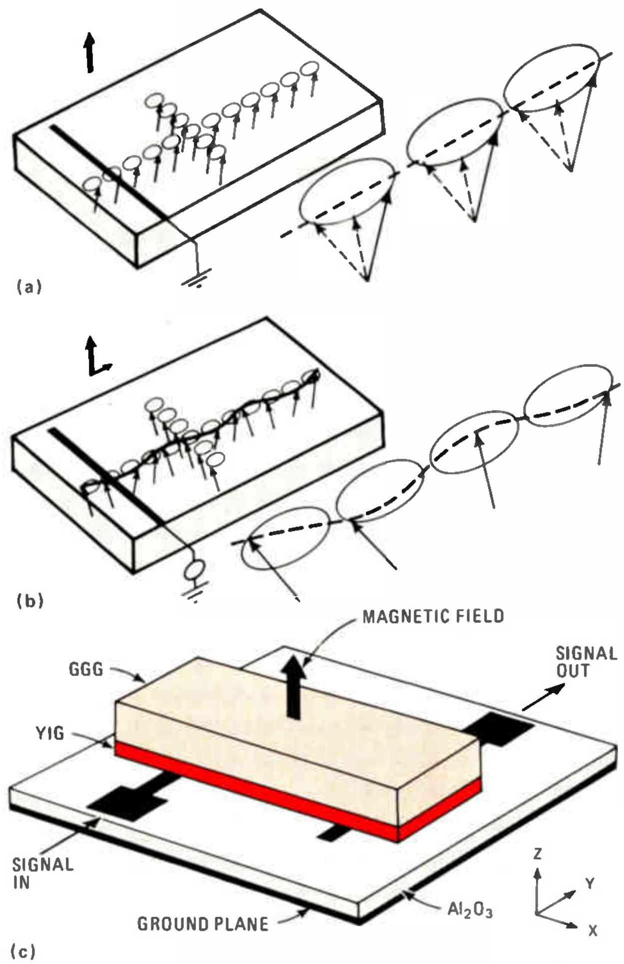
With this approach, tuning is relatively easy. For example, the center frequency from 3- to 10-GHz is changed by merely doubling the applied magnetic field. No physical changes (the dimensions of the device or transducers) are required. This allows for the implementation of electrically variable delay lines. This effect is very difficult to achieve in acoustic-wave devices although it is routinely done in charge-coupled devices. The CCDs operate at much lower frequencies (1–10 MHz), however.

In a basic MSW device (c), the electromagnetic signal is coupled into the YIG film by a simple microstrip transducer. The film is separated from a ground plane by an alumina insulator.

Forward volume waves—one of three possible types of waves—propagate when a magnetic field is applied vertically in the Z direction. They travel within the YIG layer and have normal dispersive characteristics where the delay increases with frequency.

If the magnetic field is applied along the X direction, backward volume waves are generated with an inverse delay-frequency behavior. A third field direction, across the film in the Y direction, generates surface waves confined to the YIG surface, like surface acoustic waves.

In addition to the magnitude and direction of the applied magnetic field, a third design parameter is the location of the ground plane. The spacing of the ground plane from the YIG surface can be exploited to achieve various device functions. Combinations of these externally controlled parameters yield a wide variety of device characteristics.



acteristics of the wave can be modified to produce a constant delay over a useful frequency range (Fig. 1a).

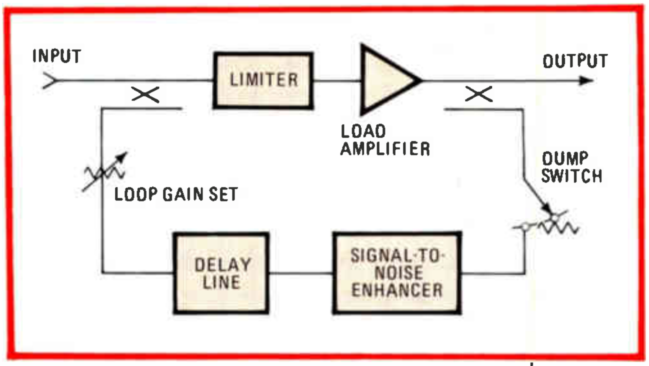
A constant delay can also be achieved with the simpler arrangement of just one ground plane. But, with this approach, the working bandwidth is reduced to about 85% of that of the two-ground-plane example. By adjusting a steady magnetic field in the plane of the YIG film, rather than normal to it, backward volume waves are generated. These propagate parallel to the field direction. A single ground plane placed very close to the YIG film again gives constant delay behavior (within ±5%) over about the same 400-MHz bandwidth at the same frequency.

A convenient way to implement a close ground plane spacing (a distance of less than or equal to the YIG film thickness of 20 micrometers) is to use a coplanar waveguide structure rather than a microstrip structure. The coplanar waveguide's ground plane is in the same plane as the center conductor and resembles coaxial cable. The results of Fig. 1b were achieved using one layer of a 12-μm-thick insulating spacer between the YIG film and the coplanar waveguide ground plane. For backward volume waves, a second ground plane does not significantly improve the constant delay bandwidth.

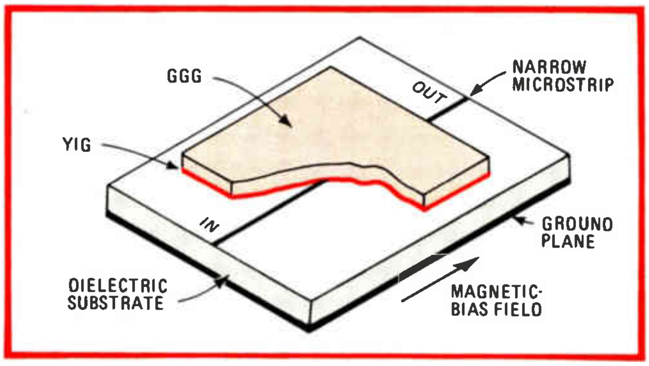
Typical values

A constant delay of 100 ns is typical for magnetostatic volume waves. However, the YIG film thickness and ground plane spacings all affect the delay. By selecting these particular parameters, delays may range from 10 ns to 500 ns.

The location of a ground plane in relation to the YIG surface is a design parameter for the constant delay line. This parameter has also been successfully used to pro-



3. Frequency memory loop. Loop gain is low for noise-level signals because of high loss in the enhancer. But a strong signal causes the enhancer loss to decrease, raising loop gain above unity. Opening the dump switch erases the memory and restarts the process.



4. Enhancer. The signal-to-noise enhancer consists of an epitaxial YIG film in contact with a narrow microstrip line. When a suitable magnetic bias film is applied, magnetostatic surface waves are launched in the YIG film by a microwave signal in the microstrip line.

duce an MSW delay line with a linear delay-versus-frequency characteristic. This device functions readily at either 10 GHz or 3 GHz—both commonly used radar frequencies. It also finds application in a microscanning receiver (Fig. 2).

One delay line with linear delay versus frequency was made from a YIG film 20 μm thick placed about 20 μm from a ground plane. For this device, changing the steady magnetic bias field from 2,400 gauss to 4,800 gauss shifts the operational frequency of the device from 3 to 10 GHz. The insertion loss of this delay line—without either input or output impedance matching—did not exceed 45 dB over the linear delay region at either 3 or 10 GHz. Furthermore, a reduction in the insertion loss to less than 20 dB is expected as YIG crystal growth techniques mature.

Though this device propagates forward waves, useful linear delay characteristics can also be obtained from backward volume waves with the magnetic field in the plane of the film and parallel to the MSW propagation direction.

Now delay varies linearly with frequency when the YIG film is placed a distance equal to about 10 times its thickness away from the ground plane. However, the factor of 10 is not critical.

But unlike the first situation, where delay increased with increasing frequency, the linear delay of this device decreases with increasing frequency. The backward volume waves have the characteristic of decreasing delay time with frequency.

Up-chirp and down-chirp

As with the forward volume waves, the backward waves are readily tunable by varying the magnetic bias field. In the language of signal processing, the delay line for forward waves has an up-chirp response and that for backward waves has a down-chirp response.

When a signal applied to the delay line covers the same bandwidth but is of opposite time-versus-frequency form—a down-chirp—the output is a sharp spike. The incoming signal, say, at X band, is then compressed by a pulse-compression factor of about 220. This signal-processing function cannot be directly accomplished by any other currently available technique at 10 GHz and is in fact a unique capability.

Frequency-selective signal-to-noise enhancers or power expanders can be realized with magnetostatic waves. These devices are used in frequency memory loops, as seen in Fig. 3.

In contrast to the microwave limiter, which shows low loss for small signals and high loss for large signals, the expander shows high loss for small signals and low loss for large signals. This characteristic is achieved over a 1-GHz instantaneous bandwidth by using the expander as a saturable absorber of power from a microwave transmission line.

In this device, the dump switch is normally closed and the delay time is shorter than the input pulse length. Thus, an input microwave signal whose amplitude is above a preset value experiences a net loop gain and circulates around the loop so as to form a continuous wave signal.

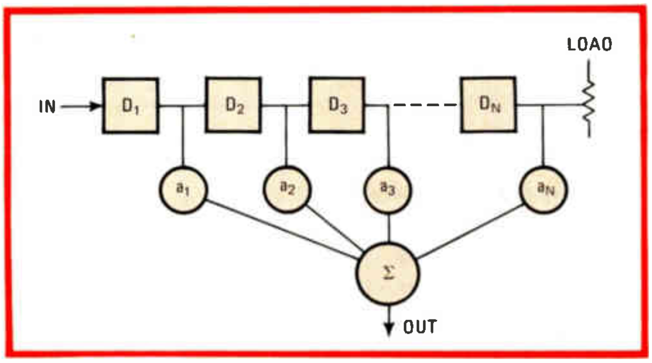
For proper enhancer operation, the stored frequency is quantized to the nearest mode of operation of the loop. This means that the total phase shift around the loop must be an integral multiple of 2π.

The limiter in the circuit determines the maximum amplitude of the stored signal in the loop. If the signal-to-noise enhancer is operating properly, inputs with amplitudes below the preset value (noise) experience a net loop gain of less than 1 and are not stored.

Conventional frequency memory loops that do not include a signal-to-noise enhancer are closed only when a signal is detected by another circuit. These conventional approaches are more costly and do not work as well. And typical storage times, even using components with ultra-flat amplitude responses, are limited by noise buildup to fewer than 100 loop circulations.

With the signal-to-noise enhancer, however, the loop can be normally closed and infinite storage times obtained. Amplitude response specifications of components can also be relaxed so that acoustic- or magnetostatic-wave delay lines may be used in the loop. In addition, because of the frequency-selective characteristics of both the enhancer and the limiter, multiple frequencies can be stored.

In one approach to implementing a signal-to-noise enhancer (Fig. 4), a straight-through microstrip transmission line connects the input to the output port. A thin film of single-crystal YIG (grown on a gadolinium-



5. Taps. Transversal filters using magnetostatic or surface-acoustic-wave action have the same basic structure. The signals picked up at the taps are weighted and delayed portions of the original. These are summed as desired to shape the filter bandpass.

gallium-garnet substrate) is placed above the microstrip in direct contact with it. The film is biased by an external static magnetic field in the plane of the film, oriented parallel to the microstrip.

At low radio-frequency current levels, the excitation of magnetostatic surface waves (MSSW) is linear. The MSSWs propagate at right angles away from the microstrip, in this way carrying energy away from it. This results in high loss.

Above some critical magnetic-field strength, the spin-wave amplitudes become saturated, and the coupling between the microstrip and the MSSWs decreases. A smaller proportion of the energy in the line is carried away, resulting in much lower insertion loss.

If MSSWs reaching the edge of the film are allowed to reflect back to the line, radio-frequency energy will be coupled into the microstrip, with some time delay. The effect will be strong interference-fringe–type ripple in the below-threshold frequency-response curve. To prevent this, the edges of the film are ground at a shallow angle (typically 1°) to act as an MSSW absorber.

An important characteristic of the expander is its frequency selectivity. Measurements show that the attenuation of a small (below-threshold) signal is not significantly decreased by an adjacent large signal so long as the signals are separated by more than 10 MHz. Thus the expander can readily reject even interference that is close by.

In common with other magnetostatic-wave devices, the center frequency of the power expander can be adjusted by the magnetic bias field. The low frequency limit of approximately 1 GHz is determined by the finite bias field required to magnetically saturate the YIG film. The upper limit for uniform low threshold power levels is about 4.2 GHz. At higher frequencies the threshold increases to more than +20 dBm.

Operation at frequencies of up to 6 GHz has also been demonstrated with a YIG film having a coplanar waveguide structure. In addition, enhancement using lithium ferrite instead of YIG has been successfully demonstrated in the 4- to 8-GHz band.

The magnetostatic wave devices described so far have been based on simple transducers and have relied on changes in the device boundary conditions to modify the intrinsic dispersion of the YIG film. This approach can be carried a step further in complexity and versatility to multiple YIG films. A few geometries comprising two coupled YIG films have been investigated and some promising configurations identified.

But an alternative approach to the synthesis of any desired device characteristic is to consider the delay line as a transversal filter. Generally the required response of a transversal filter (Fig. 5) is obtained by summing and weighting the outputs of a series of lightly coupled, nonreflecting taps, which sample a signal propagating in a delay line. This can be accomplished with MSSWs, since the wave is accessible at the surface of the YIG film and thus is easily tapped at arbitrary points along its propagation path.

Transducers

As in the now-sophisticated SAW technology, tapping can be done using single-finger transducers that are electronically summed. Narrowband periodic transducers are available (Fig. 6) that use meander-line, parallel, and interdigital transducers. The typical response of these transducers is sin (x)/x.

Of these, the parallel-bar transducer approach produces output at long wavelengths and twice as many harmonic responses as the meander line or interdigital transducers. Useful filters require further suppression of these sidelobes. In principle this can be achieved by amplitude-weighting each element in the transducer. A few of the parameters available for element weighting are finger width, length, and distance from the YIG. This weighting is under study at Westinghouse.

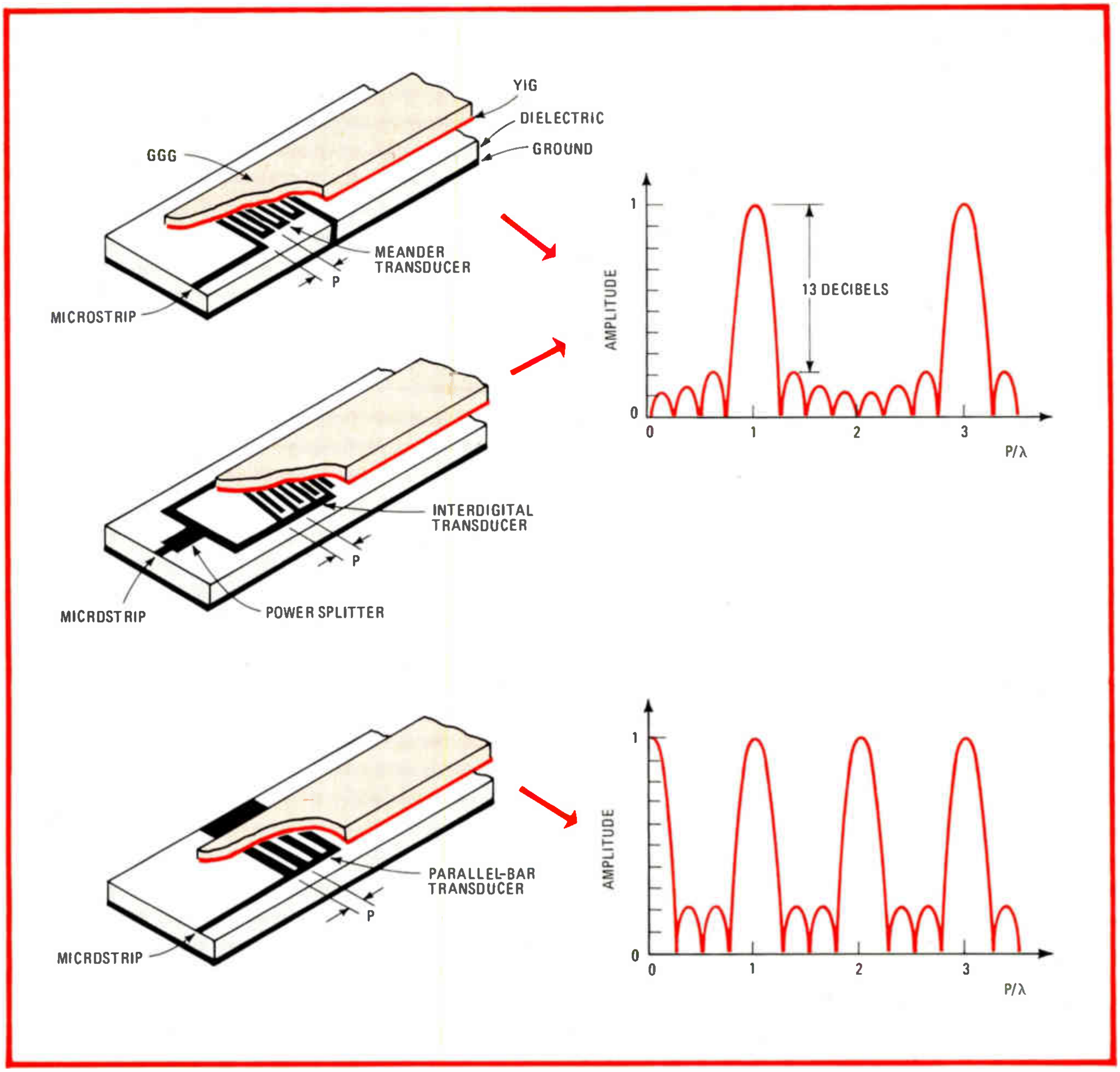
A second tapping technique uses reflecting metal strips or etched grooves in the YIG film. In this case the sampled portions of the wave are summed at the common output transducer. Here, a uniform periodic array reflects magnetostatic waves over a narrow wavelength range. This range depends on the number of, and spacing between, the elements of the array. This effect has been demonstrated for waves incident at both normal and oblique angles on the array.

If the array lacks a uniform period, then different parts of the array reflect at different wavelengths. Using this effect the engineer can design a wavelength-dependent path length for the magnetostatic waves.

Such a device is analogous to the SAW reflective array compressor. But, in the magnetostatic wave case, the spacing between the reflecting elements is adjustable, which compensates for the nonlinear dispersion of the magnetostatic waves. This yields constant delay lines as well as delays that increase or decrease linearly with frequency.

Experiments on these devices have highlighted problems arising mainly from the strong coupling of the MSW to the conducting strips. Solutions to these problems require a better understanding of the reflectivity of metal strips and grooves and the development of a model for multiple-finger transducers, which includes the effects of reflection and other finger interactions.

It is important to develop this model because the ability to synthesize desirable filter and delay line characteristics via magnetostatic wave transversal filters promises tunable, resonators and oscillators with a high



6. Transducers. Each narrowband periodic magnetostatic-wave transducer has a characteristic frequency response. The basic types are the meander-line, the interdigital, and the parallel-bar. Each has a specific purpose for the device designer.

quality factor, as well as low-loss bandpass filters with low spurious response and improved selectivity compared with characteristics of current spherical-YIG devices. In addition, constant or dispersive delay lines with bandwidths of greater than 1 GHz and delays in the 50-to-500-ns range will become available for microwave signal processing.

Keep it stable

The final important factor in the design and application of MSW devices is the variation of the device center frequency or delay with temperature. The center frequency change of a narrowband filter as a function of temperature in a constant-bias field is approximately linear with temperature at the rate of +9 MHz/°C. It is possible to improve this center frequency stability through the choice of permanent-bias magnetic materials with a suitable temperature coefficient.

In one design, a permanent-bias magnet used commercially available samarium cobalt and Rarenet-B. When this new magnet was used, the change in center frequency with temperature was reduced to approximately 6 parts per million/°C. This kind of magnet is applicable to all narrowband devices.

But because the group delay of a magnetostatic wave depends on the saturation magnetization of the YIG film, other ways are required to keep time delay constant with temperature. One is to maintain the device temperature outside the expected temperature excursion with an oven. More satisfactory is altering the composition of the YIG film so the magnetization factor is about constant with temperature. This is under study. □

C language's grip on hardware makes sense for small computers

Versatile structured syntax also permits adjustment of program portability, length, and speed of execution

by M. S. Krieger and P. J. Plauger
Whitesmiths Ltd., New York, N. Y.

☐ Minicomputer and microcomputer programmers often start out short on memory space and machine speed, and so take it as axiomatic that assembly language must be used to program their small machines. But there are obvious productivity gains to be had from structured high-level languages, gains that are at least as important in microprocessor work as they are in mainframe work. And high-level languages offer the possibility that machine-independent code can be written, leaving the software investment less at the mercy of any one hardware vendor.

How can the benefits of a high-level language be realized without paying penalties in code space and execution time? One solution is to pick the right language and use it on several different computers, while paying careful attention to both efficiency and portability. Whitesmiths Ltd. chose the language C, developed at Bell Laboratories and used widely throughout the Bell System, as the best tool for writing large quantities of software for small computers.

In the past year, two to three programmers have delivered over 30,000 lines of documented code that supports C programming on microprocessors and minicomputers. Compilers are currently available for Digital Equipment Corp.'s LSI-11, PDP 11/04, 11/34, and 11/70, and VAX-11/780; Intel Corp.'s 8080 and 8085; and Zilog Inc.'s Z80. Intel's 8086 and 8088 microprocessors are also supported, but as emulations of their simpler precursors, and are not yet used to full advantage. Support for Motorola Inc.'s MC68000 is currently being readied as well.

All PDP 11–based code makes use of the extended instruction set and the floating-point processor whenever possible, but versions of the code are also available that use neither or only one of these hardware options. This assortment represents a broad range of hardware capable of supporting identically the same program.

Along with the C compiler comes an extensive library of portable routines, including functions for performing formatted and random input/output on a variety of operating systems, including RT-11/RSTS CP/M, CDOS, RSX-11M/IAS, ISIS-II, VMS, and UNIX/Idris.

The C language

C was developed by Dennis Ritchie at Bell Laboratories, Murray Hill, N. J., about 10 years ago; compilers for C on the PDP 11 have been operational since the early 1970s. C is not machine-dependent, so programs can be freely transported from machine to machine with the not unreasonable expectation that they will run correctly without modification. Furthermore, there are no committees meeting to determine a standard C; rather, Appendix A of "The C Programming Language," by B. W. Kernighan and D. M. Ritchie (Prentice-Hall, 1978), serves to define C.

The language mirrors the abilities of many different processor architectures and produces particularly efficient code as a result. The need to break into assembly language for efficiency's sake is exceedingly rare. For example, the UNIX operating system, which served as initial host and testbed for C, has been rewritten almost completely in C over the past several years. UNIX is not

Pointer arithmetic in C

One of the C programming language's unique advantages is that it permits extensive manipulation of pointers—variables that can be used as machine addresses. Languages such as Fortran implicitly pass pointers on subroutine calls (on a call-by-reference basis), so that changes are made to the original variable and not just to a temporary copy. Pascal permits only pointer assignment and copying; modification must take the form of subscripting, as in the Fortran array references.

In C, the statement:

```
int a [10], i, *p;
```

declares an array of 10 integers called a, an integer i, and a pointer to integer p. Thereafter, the following statements can be written:

```
p = &i; /* p now points at i */
*p = 3; /* i is assigned 3 */
```

More importantly, consider the traditional loop for clearing 10 elements of the array a in Fortran:

```
    do 100 i = 1,10
    a(i) = 0
100 continue
```

This can be written in C as:

```
for (i = 0; i< 10; ++i)
  a[i] = 0;
```

or, using pointers:

```
for (p = a; p<&a[10]; ++p)
  *p = 0;
```

Note that ++i adds 1 to the integer i, but ++p adds 2 to p on a computer with 2-byte integers. Pointers are adjusted by multiples of the size of the objects pointed to.

Pointer arithmetic frequently leads to more efficient programs—an important consideration in operating systems and microcomputer applications. In the program above, the inner loop using pointers, *p = 0, is much more efficient than a [i] = 0, which requires a multiplication and an addition before the assignment can be made. The standard method in C, for instance, of copying a null-terminated string is to use source and destination pointers and to write:

```
cpystr(s, d)
  register char *s, *d;
  {
  while ((*d++ = *s++) != '\0');
  }
```

On an LSI-11, the move loop in this function body takes only 4 bytes of code; on VAX it takes 5 bytes.

The danger in using pointers is that program errors cause wild storage overwrites that are very hard to debug. It is also easier to write programs that are hard to read, as the last example suggests. C, however, seems to provide just enough checking of pointer usage to catch the worst offenses, but not enough to interfere with flexible use.

only a well-designed and reliable system, but is at least as efficient as systems operating on comparable hardware.

UNIX has been transported to at least three other computers, and Whitesmiths Ltd. has developed a smaller operating system, called Idris, with most of the external characteristics of UNIX, also written mostly in a highly portable version of C. Idris currently supports several simultaneous users on an LSI-11, with reasonable response.

C provides the usual control-flow statements (if-then-else, while, for, and case) found in most modern structured programming languages. It provides both simple and complex data types, and new types may be created through a definition facility called typedef.

Extensive data types

Among C's simple data types are bit fields, characters, short and long integers, pointers, and short and long floating-point quantities. Complex objects are built from the simple types, or from other complex objects, by repetition (array of), sequencing (struct), and alternation (union). The words in parenthesis are the names of the associated types.

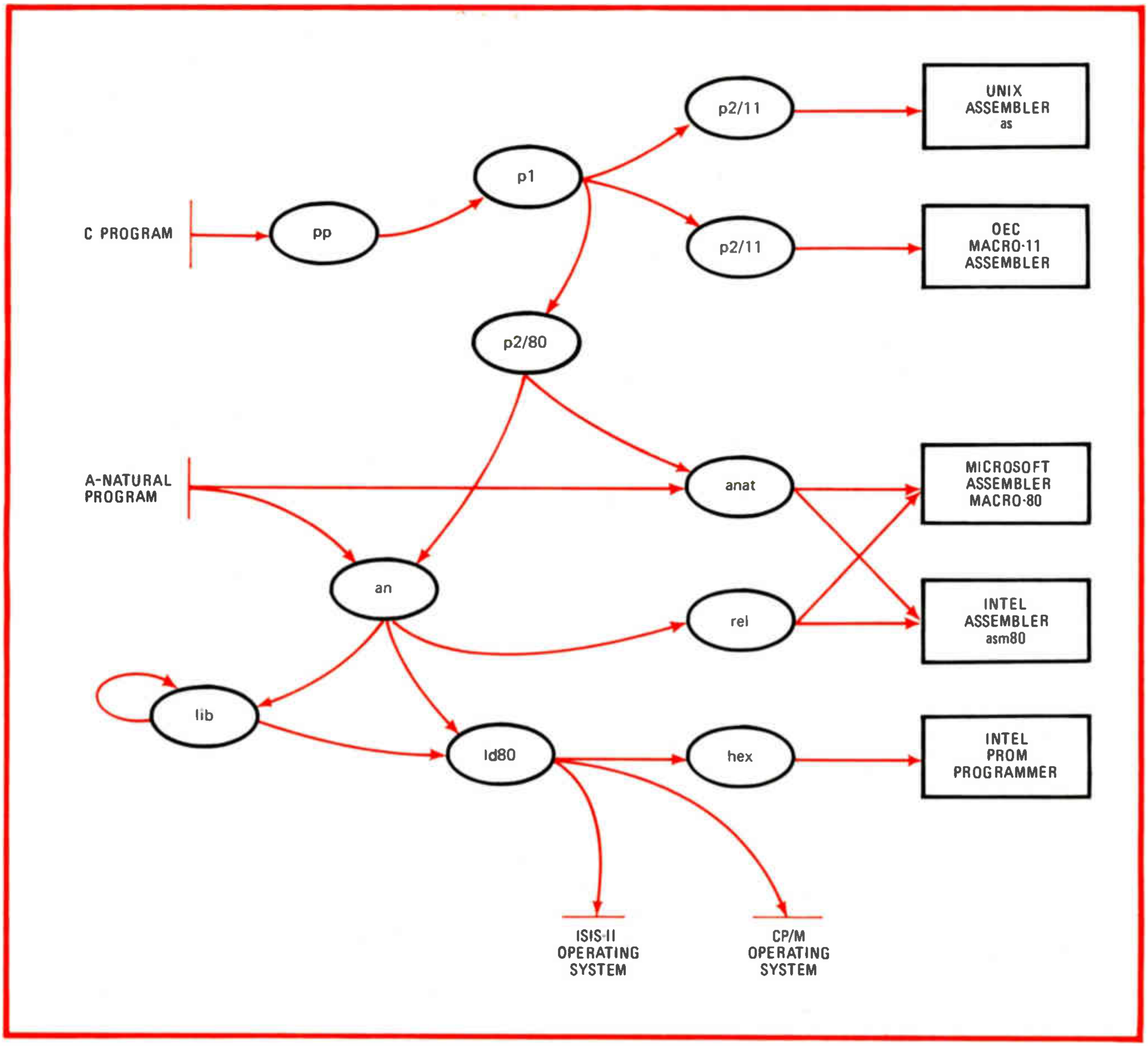
The major advantage of this full set of data types is that any construct that arises in system programming, including hardware control registers, can be represented in C. Furthermore, if the hardware can be addressed in memory, as on the PDP 11 Unibus, then it can be directly manipulated from within a C program. It is significant that all input and output drivers provided with the UNIX system are written exclusively in C.

C functions are called by value. Simple data objects passed to functions have their values passed rather than their addresses, making it impossible to accidentally overwrite the original. Since the value of a pointer may be passed, calls by reference are also provided.

All C functions are recursive; it is an easy matter to automatically declare variables local to a function, so that a fresh set of them is allocated on the stack for each call. If a local variable is known to be heavily used, the programmer can request that it be held in a register, and, up to the limit of machine resources, the compiler will accommodate the request. Judicious use of registers can dramatically reduce the size and execution time of a program.

C programs are generally represented as sequences of data objects and function bodies within multiple files. Data objects may be global to all program files, local to a specific program file, or local to a specific range of code within a function. Static data, even complex structures, may be initialized at compiling time. The language itself does not provide a controlled storage class, but that is provided by the library functions alloc and free, which administer a run-time heap. The language also has no input/output statements; once again, ample facilities are provided by the portable library.

C has a richer-than-usual set of arithmetic operators, but confines its operands to scalars (integers, floating-point numbers, and pointers), so that code explosion is minimized. For example, a whole array will never be implicitly copied by what looks like a simple assignment.



1. Translation. Each bubble represents a separate program that does part of the translation of an application program in C or A-Natural into a number of different forms. Output can be fed directly to standard operating systems or assemblers used with PDP 11s and 8080s.

One method of improving object-code efficiency is to use one of the many assigning operators of C. The value of variable y is added to the doubly dimensioned array a (represented as a [i] [j] in C) by:

```
a [i] [j] + = y;
```

This is the same as a [i] [j] = a [i] [j] + y except that the elaborate expression on the left side of the first expression need be evaluated only once, effecting a much tighter code sequence.

Mixed-mode expressions are widely permitted in C, since all meaningful type conversions are defined. The following are all valid C statements:

```
double d;
char c;
int i;
int *p; /* p is a pointer */
p = i; /* pointer gets integer */
c = d; /* character gets double floating */
i = d; /* integer gets double floating */
d = c; /* double floating gets character */
```

A pointer may not be multiplied by seven, however (an operation not likely to be useful); but the programmer is explicitly permitted to assign an absolute machine address—which looks like an integer—to a pointer, a very useful license for low-level handlers. (See "Pointer arithmetic in C," p. 130.)

By judiciously relaxing its type checking in certain places such as this, C permits code that must normally be written in assembly language to be intermixed with normal data manipulations. That way, maintaining mixed code in two different languages can often be avoided, and the data manipulations at least can be kept readable.

It is difficult to say precisely how efficient the code produced by the C compiler is. The best indicator is that the output of the compiler can typically be pared down by 15%, with relatively little effort, in the hands of an experienced assembler programmer. With considerable rethinking and rearrangement, that same programmer can often gain an additional 15% saving in memory requirements. The same savings apply to execution time, as a general rule.

Note that this is not the same as saying that an assembler programmer will always beat the C compiler by 30%. Even ignoring the tremendous savings in coding time gained from writing in a higher-level language, the much higher error rate that comes with assembly language programming must also be considered. Compilers are not as inventive as humans, but they do not get tired.

Whatever the true cost of using C, Whitesmiths has found that it is more than repaid in lower programming costs. And since software costs are large and growing, while read-only memory and microprocessor costs are small and shrinking, the benefits can only increase.

Portability

It is important to write machine-dependent code only with malice aforethought, keeping trickery isolated to a minimum number of program files. This takes planning, standards, and discipline—three things that many people have tried in vain to legislate through compilers with stringent checking. C does not really attempt to perform this testing because no matter how persnickety a compiler is, programmers can still write bad programs unless they adopt a style and standards not easily enforced by the machine. Since this added discipline is unavoidable, it may as well be used to supplement a simpler and more flexible language. (The only real justification for this approach, however, is that it works.)

Those 30,000 lines of code mentioned earlier break down into 3,000 lines of assembler support for two machines, 4,000 lines of system-dependent C for five systems, 11,000 lines of machine-targeted C, and 13,000 lines of highly portable C. Machine-targeted C refers to programs such as code generators and assemblers; code that can run on any computer that supports C but whose output is eventually useful only on one machine—an 8080 cross compiler based on PDP 11, for instance.

Note that three quarters of this code is portable in the usual sense of being able to run unchanged on multiple systems, and that nearly half is truly indifferent to its environment. Applications programs should fit almost exclusively into this last, most portable category.

Machine-independent C is written with no knowledge of the hardware or operating system on which it will run; it calls on the portable C library for all input and output. In addition, certain known pitfalls are avoided, such as assuming that integers are a given size, or that bytes within an integer occur in a given order. This style is not hard to master, but does require constant attention to avoid lapses.

System-dependent C is used by systems programmers to write operating systems or interfaces to operating systems. The RSX-11M library, for instance, includes a function called emt, which permits an arbitrary system call to be generated via the standard emulator-trap hardware mechanism on the PDP 11. Needless to say, any code that uses emt is necessarily tied to RSX-11M or one of its ilk. But writing in C makes the code easier to write and to maintain. Other functions permit synchronous or asynchronous system traps and Fortran IV function calls.

Machine-dependent C is used by systems programmers to write those parts of an operating system that talk directly to the hardware. In addition to the numerous PDP 11 examples that benefit from Unibus addressing, there are the 8080 functions, like in(port) and out(port, data), that permit arbitrary input and output from a C function. Hence, even on the 8080, I/O drivers can often be written purely in C.

The point is that by rigorously factoring code into these three categories, one can keep a remarkable quantity of the software for any application highly portable, to reduce the amount of code that must be written when moving to a new machine. The implementer can thus obtain the cross product of applications programs and machines.

A simple example of this cross-product effect is Whitesmiths' e program, a text editor used to enter and edit programs and ordinary text (including this article). Written in machine-independent C, e relies on the system-dependent interface to talk to any of a variety of operating systems. It consists of approximately 2,000 lines of C code, and was originally implemented on a PDP 11 under the Idris operating system.

By simply cross-compiling the C code for the 8080, e was moved to an 8080 running CP/M. By recompiling e on the PDP 11 running under RSX-11M or RT-11, the editor was made available for those systems as well. The very same tool is thus present on a variety of systems. The user avoids having to learn new editors often and the editor can be made available to diverse users. The result is a very popular utility that runs on several operating systems, and it can be made to run on many more.

C translation

A C program can be processed in many ways, depending upon the output desired. Each of the bubbles in Fig. 1 is a separate Whitesmiths program that does part of the translation process; the square boxes represent the standard assemblers and operating systems used with PDP 11s and 8080s. A C program is first preprocessed (by pp) to include parameter files and to define manifest constants. For instance, if the file x.c contained:

```
#include "file.h"
#define EOF -1
. . .
```

then file.h would be included in the input stream, and any subsequent occurrences of the manifest constant EOF (end of file) would result in its value being taken as −1. The resulting stream of data is fed to passl (pl) which performs all remaining semantic checking and produces a flow graph with imbedded expressions for subsequent code generation.

For the PDP 11, a code generator (p2) produces either UNIX assembler code or MACRO-11 for the various operating systems of Digital Equipment Corp.; a similar

A natural assembly language

The output of Whitesmiths Ltd.'s 8080 code generator is A-Natural, a narrative assembly language that is easier to read and write than conventional assembler code. It features uniform register names and simple operator notation, plus a precedence-free left-to-right translation:

```
a = *bc + *hl —> *hl
```

is A-Natural for the 8080 instructions:

```
LDAX  B
ADD   M
MOV   M,A
```

Note that the leftmost operand in the A-Natural expression is used repeatedly across the line, making it easy to express multiple operations on an accumulator. The above example could have been written:

```
a = *bc
a + *hl / answer in a
a —> *hl / move answer into *hl
```

The following two sample functions are the only ones in A-Natural needed in the portable ISIS-II interface, reflecting the two places where C code is not sufficient. The first is ihdr.8:

```
  /  ihdr.8
  / copyright © 1979 by Whitesmiths Ltd.
  / startup code for C under ISIS
  public start
  public isis.
start:
  sp = &stack / put the address of stack (in iend)
              into sp register
  call _main / call the main C function
  sp <— bc / put the completion code onto the stack
  call exit. / exit from C environment
isis.:     / isis interface packed with ihdr
  c = *(hl = 2 + sp) / system code from stack
  de —> sp = ^ (hl + 1 + 1) / cb address from stack
                            / first save de
  call isis / address of isis found in iend.8 (40)
  sp —> de / restore de
  bc = (hl = 4 + sp) / get return code
  ret
```

The second function is iend.8:

```
  /  iend.8
  / copyright © 1979 by Whitesmiths Ltd.
  / system parameters for C
  public isis
  public _memory
  public stack
isis: = 0x40 / isis system is found at hex 40
stack: = 0xf600 / isis default stack at hex f600
_memory.: / iend should be loaded last and _memory.
          will point to the beginning of usable memory
```

When loading or binding a C program to run under ISIS, ihdr.8 is placed first and iend.8 is placed last. Thus, ihdr will be entered at the start of a program; it will call the user's C main program, and exit. The isis interface is packed with ihdr. It too must be written in A-Natural assembler language, since the ISIS calling sequence is not compatible with that used with C. The iend.8 function includes only those constants that must be known to ihdr or other C functions. In particular, '_memory.', a constant known to the C interface, must be loaded statically as the last data location.

pair of generators talks to either VAX/VMS or VAX/UNIX. The output of the 8080 code generator is always A-Natural, a narrative assembly language developed by Whitesmiths (see "A natural assembly language," above).

A-Natural code is either translated (anat) into an existing assembler language or assembled (an) into relocatable binary code for use with the Whitesmiths librarian (lib) and loader (ld80). The output can then be executed on an existing 8080 system, or used to program read-only memories for free-standing applications.

Thus, a C program can be compiled and tested on a PDP 11 under, say, RT-11, then transported to an 8080 for final checkout. Even free-standing code can be largely checked out in a more hospitable environment, with suitable machine-level stubs, before being unleashed.

Popularity contest

The widespread adoption of UNIX among universities has bred a generation of C enthusiasts that are only now coming into the labor force in real numbers. And since C has become a *de facto* standard programming language in the Bell System, now in use on upwards of 1,000 small and large computers, it is probably going to be around for a while.

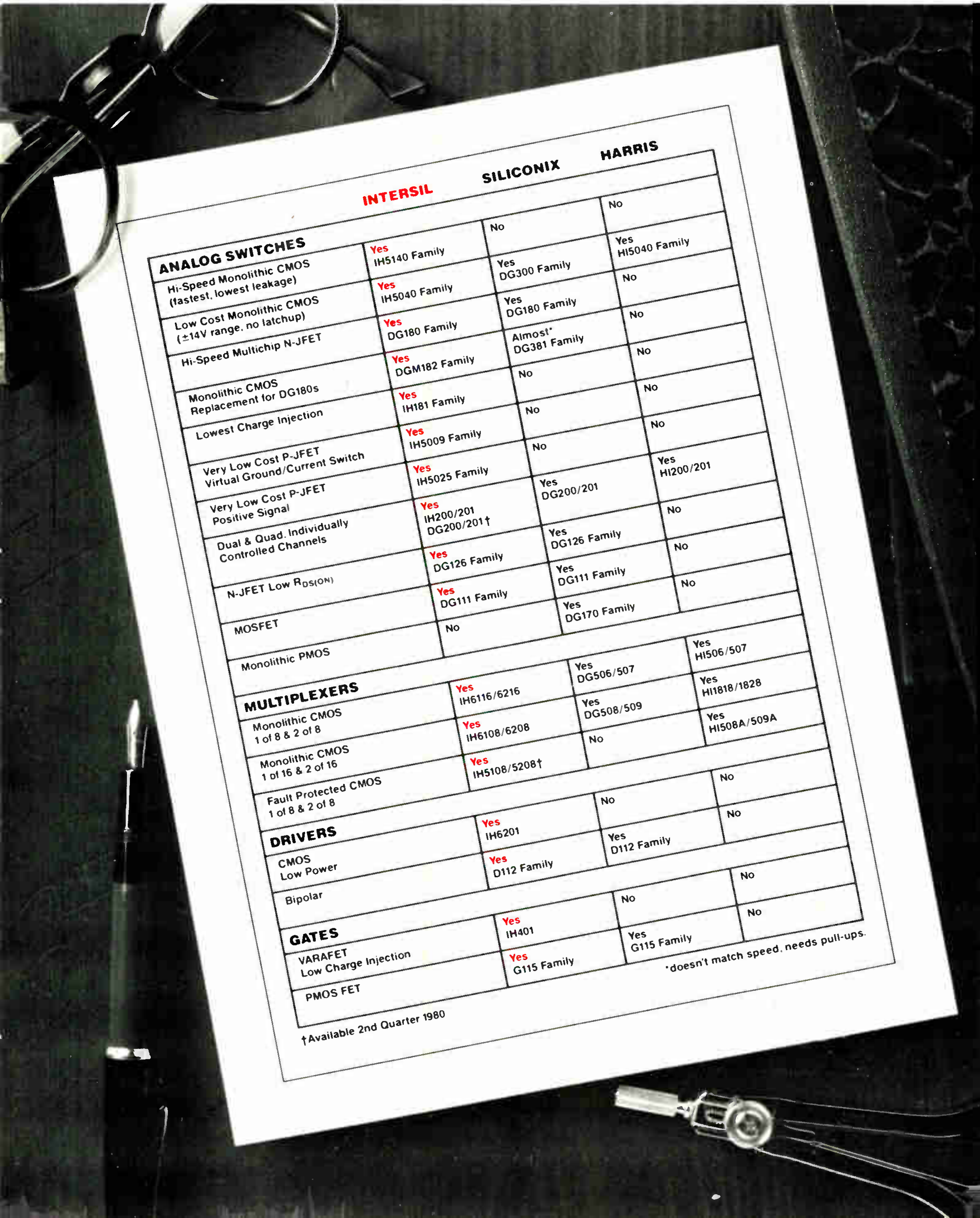
This is a safe bet even given the popularity of Pascal and the strong government backing of Ada. The former is a much smaller language than C that must inevitably be extended to be useful outside its original sphere of discourse: expressing student programs in a teaching environment. Pascal implementations tend to be either nonstandard or nonportable.

Ada, on the other hand, is a much larger language than C and requires many services that are usually considered part of the operating system. Since no operating system currently exists that can support Ada without change, it will be some time before anywhere near the full language is available. And even the simplest use of Ada may well call for more run-time baggage than most small computers can support.

Regardless of the eventual success of these competing languages, C is here now and growing fast. Implementations are springing up on the newer microprocessors and minicomputers, and ever greater quantities of C code are appearing in the marketplace. C compilers have been announced for the Motorola 6800, the Zilog Z8000, and the Intel 8086, among other popular machines. Whitesmiths plans at least two—possibly three—new code generators in the next year.

It is ironic that the ability to write very machine-dependent code with C has encouraged its portability. By filling the gap between assembly language and traditional high-level languages, C has succeeded in wooing numerous converts from both camps. □

AN OPEN-BOOK QUIZ: WHO'S



	INTERSIL	SILICONIX	HARRIS
ANALOG SWITCHES			
Hi-Speed Monolithic CMOS (fastest, lowest leakage)	Yes IH5140 Family	No	No
Low Cost Monolithic CMOS (±14V range, no latchup)	Yes IH5040 Family	Yes DG300 Family	Yes HI5040 Family
Hi-Speed Multichip N-JFET	Yes DG180 Family	Yes DG180 Family	No
Monolithic CMOS Replacement for DG180s	Yes DGM182 Family	Almost* DG381 Family	No
Lowest Charge Injection	Yes IH181 Family	No	No
Very Low Cost P-JFET Virtual Ground/Current Switch	Yes IH5009 Family	No	No
Very Low Cost P-JFET Positive Signal	Yes IH5025 Family	No	No
Dual & Quad, Individually Controlled Channels	Yes IH200/201 DG200/201†	Yes DG200/201	Yes HI200/201
N-JFET Low $R_{DS(ON)}$	Yes DG126 Family	Yes DG126 Family	No
MOSFET	Yes DG111 Family	Yes DG111 Family	No
Monolithic PMOS	No	Yes DG170 Family	No
MULTIPLEXERS			
Monolithic CMOS 1 of 8 & 2 of 8	Yes IH6116/6216	Yes DG506/507	Yes HI506/507
Monolithic CMOS 1 of 16 & 2 of 16	Yes IH6108/6208	Yes DG508/509	Yes HI1818/1828
Fault Protected CMOS 1 of 8 & 2 of 8	Yes IH5108/5208†	No	Yes HI508A/509A
DRIVERS			
CMOS Low Power	Yes IH6201	No	No
Bipolar	Yes D112 Family	Yes D112 Family	No
GATES			
VARAFET Low Charge Injection	Yes IH401	No	No
PMOS FET	Yes G115 Family	Yes G115 Family	No

*doesn't match speed, needs pull-ups.

†Available 2nd Quarter 1980

Foldback limiter has minimal parts count

by Michael G. Lyngsie
MG-EL Consultants, Copenhagen, Denmark

Providing virtually the same function as the foldback limiter proposed by Kularatna,[1] but using a minimum of parts, this circuit delivers a well-regulated 24 volts at a maximum of 4 amperes. The circuit is extremely rugged and will meet all but the most demanding industrial requirements.

In operation, transistor Q_1 operates as a differential amplifier to detect changes in output voltage and at the same time to keep track of the reference voltage, V_Z, which is constant as long as $I_E R_6 < V_o - 6.8$. The power-Darlington stage Q_2–Q_3 that follows serves as the series-pass transistor and its associated driver.

If there is a short circuit at the output or the load requires excessive current, I_E will also increase because Q_2 and Q_3 must be driven harder. This action causes Q_1 to draw off a corresponding current that is normally delivered to the zener. Thus the zener voltage must fall, and foldback limiting is initiated. The quiescent current that will flow during foldback ($V_o \approx 0$) is solely dependent on R_1, which re-initializes the supply upon removal of the overload condition. R_1 can be made as large as desired, with the only limitation being that I_{R1} must be greater than the sum of the leakage current (I_{leak}) through capacitor C_5, and I_{DC}.

Placing the series-pass transistor, Q_3, in the negative rail offers two distinct advantages. First, the device can be operated in the common-emitter configuration, enabling Q_3 to provide voltage gain and current gain. This enhances the dynamic range of the circuit. Secondly, most industrial equipment utilizes a negative ground, and so the power transistor can be directly mounted anywhere on the chassis for efficient cooling and the problem of electrical isolation can be eliminated. Furthermore, regulation is extremely fast because the only capacitors in the circuit are associated with the input filter (C_1) and output bypass networks. Foldback action is not very fast, though, because of the large value of C_2. This capacitor can be made an order of magnitude smaller without sacrificing stability.

The output voltage will be held constant to 100 millivolts with this arrangement. Other voltages can be selected by altering the voltage-divider chain R_3–R_4–R_5. The maximum output current is approximately:

$$I_{max} = (V_o - 6.8) h_{fe\ Q2} h_{fe\ Q3} / R_6$$

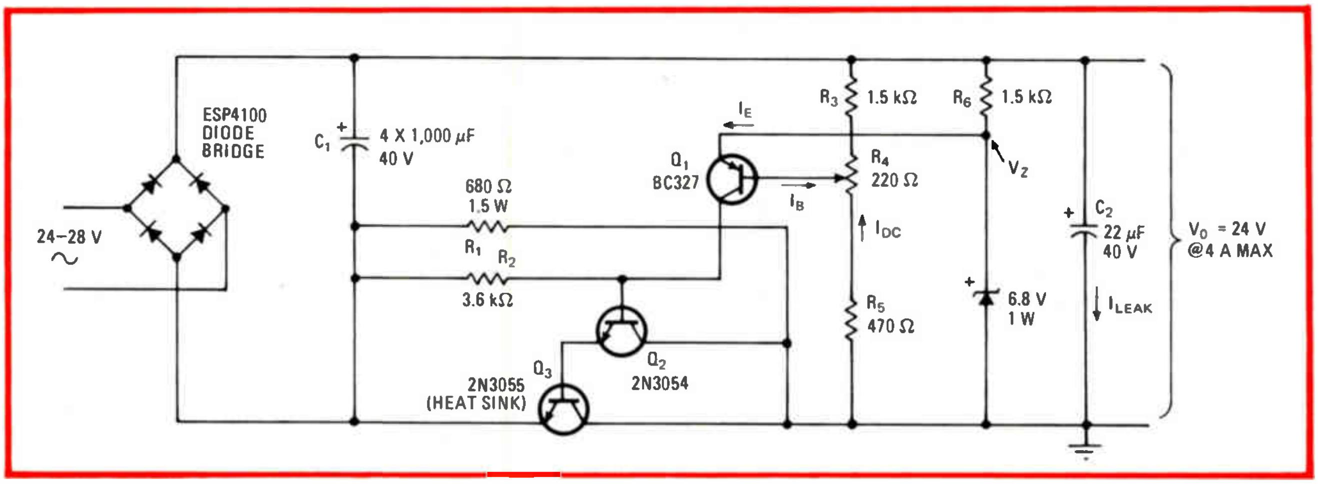
neglecting I_B and the current flowing in R_2.

The circuit develops a slight positive temperature offset of 0.4 V after warmup, due to the positive temperature coefficient of the zener diode. If this offset proves to be annoying or unwanted, a forward-biased 1N4001 can be placed in series with the zener to eliminate the problem.

It is recommended that four 1,000-μF capacitors be used for C_1, instead of a single 4,000-μF device because of the high ripple currents (and heat generation) that will be encountered. Output ripple is only 20 mV peak to peak at 3.5 A. If desired, the ripple may be more than halved by the addition of another 1,000-μF capacitor at the input. □

References
1. A. D. V. N. Kularatna, "Foldback limiter protects high-current regulators," *Electronics*, Jan. 31, 1980, p. 98.

Designer's casebook is a regular feature in *Electronics*. We invite readers to submit original and unpublished circuit ideas and solutions to design problems. Explain briefly but thoroughly the circuit's operating principle and purpose. We'll pay $50 for each item published.



Rudimentary. Simple but rugged and reliable foldback limiter delivers 24 V ± 100 mV at a maximum of 4 amperes. Output ripple is only 20 mV at 3.5 A and may be reduced further simply by placing additional capacitors at input. Placing series pass element, Q_3, in ground lead gives circuit good dynamic range and simplifies solution of classic mounting-vs-isolation problem in dealing with cooling of the power transistor.

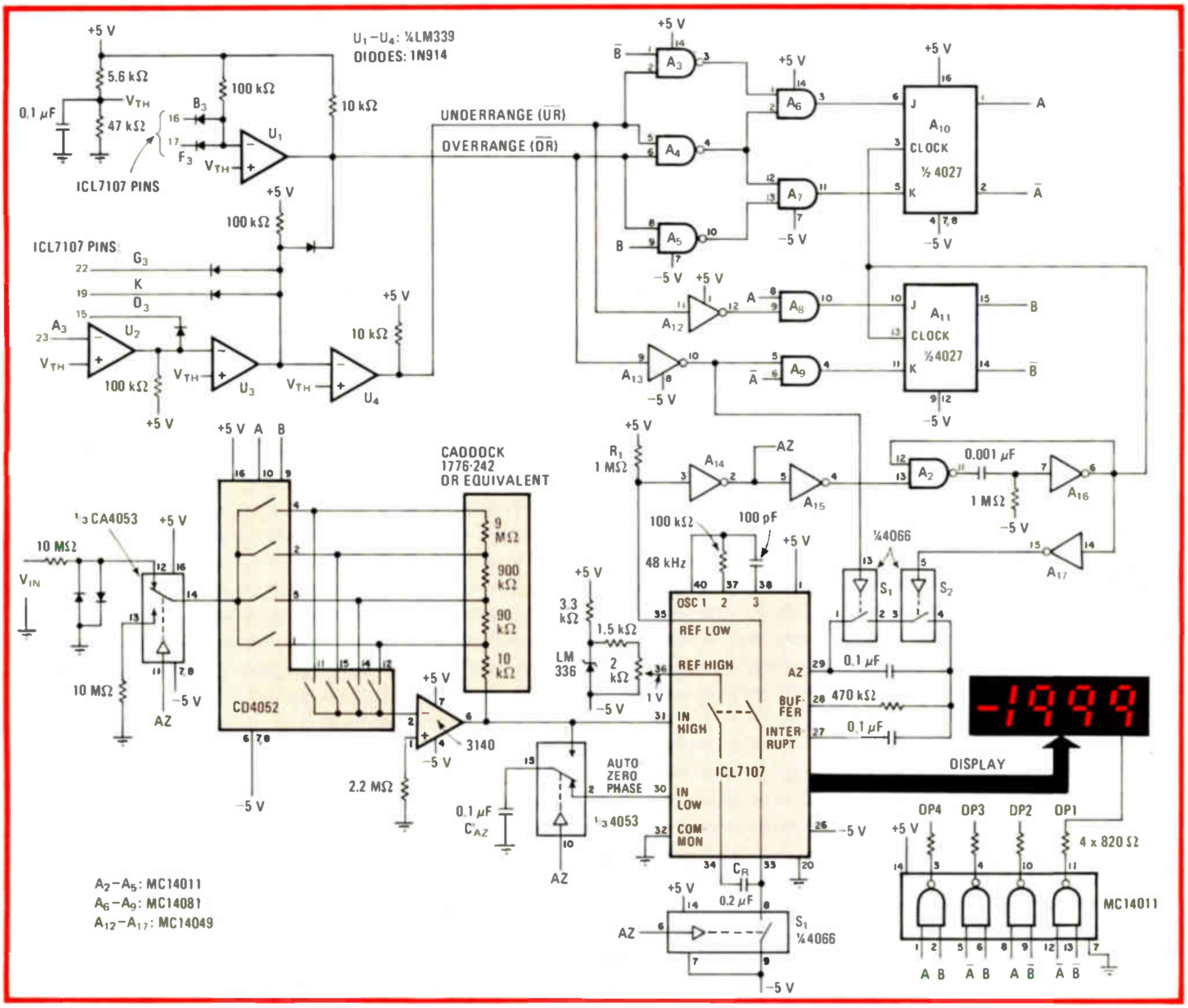
Low-cost autoranger scales DVM over four decades

by L. Y. Hung
Boston, Mass.

Autoranging capability can be added to a digital voltmeter with this circuit, which costs less than $25. Built around a dual-slope integrating analog-to-digital converter to ensure greatest measurement accuracy, the unit scales a 3½-digit voltmeter over a range of four decades (±1 to ±1,000 volts dc) without the need for complex feedback circuitry.

In operation (see figure), signals to the input are applied to the ICL7107 a-d converter through the range switch formed by the 4052 multiplexer and the attenuator that includes the CA3140 comparator and its accompanying decade resistor network. During each 333-millisecond measurement cycle, the converter proceeds to eliminate the error caused by the comparator's offset (autozero phase), stores the input voltage (integrating phase), and displays the difference, in terms of a voltage, between the integration time and the time required to discharge a reference potential from capacitor C_R (display phase). The autorange circuit (A_3–A_{13}) that follows tracks both underrange and overrange conditions with the aid of a suitable detection circuit. It generates the appropriate signals for controlling the range switch and thus the gain of the attenuation network.

The autorange circuit determines underflow or overflow at the initial portion of the autozero phase. During this time, the voltage on pin 35 of the converter drops momentarily. The drop switches gate A_{14} and thereby closes switch S_1, an action that brings pin 35 to logic 0 and completes the charging cycle for C_R. The rising edge of the AZ signal that clocks the range switch is delayed about 1 millisecond by A_2 and A_{16}, providing sufficient time to stabilize the display and to check for the underrange and overrange conditions.



Searching. DVM autorange circuit uses A_3–A_{14} to detect underflow and overflow conditions by examining the output state of ICL7107 a-d converter, then sets gain of input attenuator network over four decades through 4052 range switch. Circuit cost is under $25.

The range switch is an up-down counter. It will count down one state if an overrange signal is present and up one state if an underrange condition exists, over the binary range 00 to 11. The discharge path provided by switches S_2–S_3 reduces the residual charge on C_{AZ} during the de-integrating phase; otherwise continuous rocking between two adjacent scales may occur.

As for underrange and overrange detection, only one quad comparator need be connected to the ICL7107, as shown at the upper left. Both signals are derived from the converter's seven-segment outputs. Underranging occurs if the displayed number is less than 200; for overrange, the number must be greater than 1,999.

A blank display on digit 3 indicates the overrange condition. A blank output on digit 4 and either a 1 or a 0 on digit 3 signifies underrange. In equation form:

$$\overline{UR} = \overline{\overline{OV} \cdot G_3 \cdot \overline{K} \cdot (\overline{A}_3 + D_3)}$$

where A_3, D_3, and G_3 are the display segments of digit 3 and K is the converter's thousands multiplier. □

Improved burglar alarm discourages auto thieves

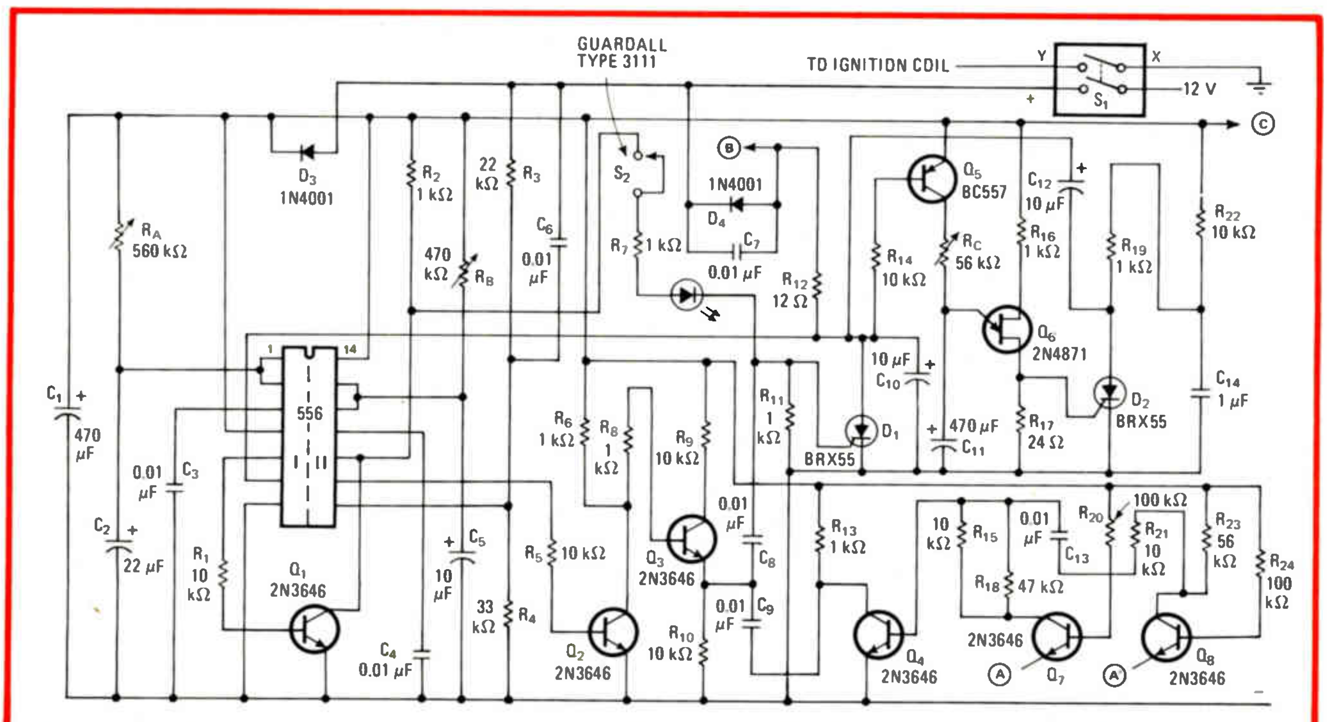
by Jose S. Correa de Quieros
Engineering Faculty, University of Oporto, Portugal

Inexpensively detecting an increase in battery current—like that caused by the car's courtesy light—this automobile burglar alarm competes on a cost-vs-performance basis with any of the commercial all-electronic devices now available. The alarm also senses and responds to severe mechanical shocks of the kind caused by breaking glass. Standby current is only a few milliamperes.

Closing switch S_1 arms the alarm through device I of the 556 dual timer after a time determined by R_A and C_2, enabling the driver to exit from the auto without triggering a false alarm. This switch also grounds the ignition coil so that it is impossible to start the engine.

Device II of the timer serves as the battery-discharge sensor. Voltage divider R_3–R_4 detects the small drop in the nominally set voltage at pin 8 (trigger input) of the 556 due to any current flow exceeding a few milliamperes. Q_2 and Q_3 then turn on (or D_1 and Q_4, if lamps, radios, tape players, or other loads connected to point A or A′ are disconnected by the thief), firing D_1 and Q_5 after a time determined by R_B and C_5. The horn relay at point B is then energized and timer Q_6 initialized. R_B and C_5 should be set to provide a delay of 5 seconds or so to enable the owner of the vehicle to enter and disarm the alarm. After a time set by R_c and C_{11} (maximum is 20 seconds), D_2 fires, resetting D_1 and the horn relay.

Capacitor C_1 and diode D_3 develop a dc average of the pulse train that is required to power the auto's clock via point C, effectively preventing the pulses from generating a false alarm. Severe mechanical shocks are detected by switch S_2, which is set with the aid of a screwdriver and a light-emitting diode that turns on when the switch elements make contact. When S_1 closes in actual operation, D_1 fires immediately to set off the alarm. □



On guard. Auto alarm detects small increases in battery current such as that caused by courtesy light activated by burglars, setting off horn relay after specified delay. Switch S_2 senses mechanical shocks of the kind caused by breaking glass and sounds alarm immediately.

This Bridgeport CNC Vertical Milling Machine, controlled by Digital's powerful LSI-11/2 microcomputer, is cutting production times for customers by up to 85%.

In 16-bit micros, great hardware doesn't guarantee great performance.

You need high-powered software too.

And only Digital gives you both. Because while everyone else is just getting started in high-performance micros, we've been shipping them for years.

So we give you all the software tools you need to make the most of great hardware.

We start where the others leave off.

Digital's LSI-11/23 micros offer the only double-precision floating point processor in the industry. Built right into the hardware so it doesn't cost you memory overhead.

You also get a memory management unit so efficient, you can run several real-time programs at once.

And you get the basic instruction set of our PDP-11 minicomputer family. It can do in one memory cycle what others would take four to accomplish.

But like we said, hardware is only half the story.

The industry's only high-performance micro software.

Digital's software systems are literally years ahead of the competition.

The RSX-11M operating system, for example, is the industry-standard real-time software for superminis.

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And for your run-time software you can use RSX-11S, a streamlined version of 11M that takes up an incredibly small amount of memory.

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Digital's programming tools are easily the most advanced in the business. So you can concentrate on refining your application software, instead of struggling with it.

For example, you get an interactive debugger that's built right into the processor. With English diagnostics for the linkage editor, FORTRAN, and even MACRO, so you can catch bugs before your programs ever run.

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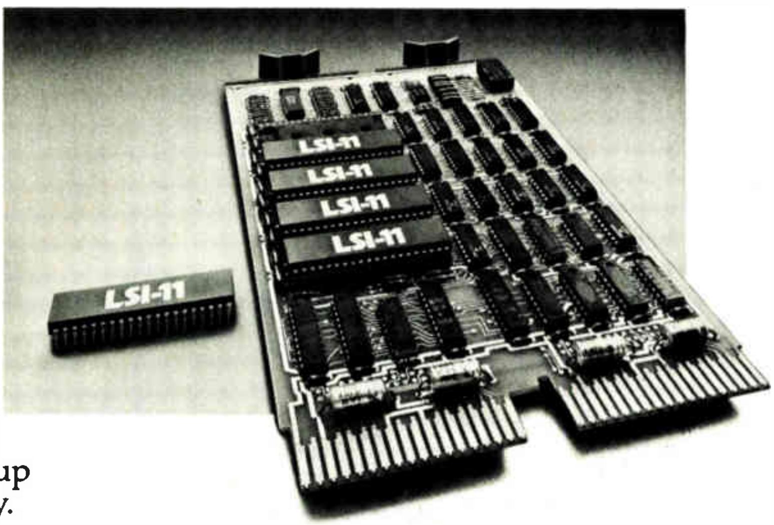


It took the minicomputer company to make micros this easy.

digital

Computer technology shifts emphasis to software: a special report

Surveyed on the eve of the National Computer Conference, industry managers are also digging into semiconductor development

by the *Electronics* staff

☐ The computer industry is being swept by an unprecedented shift in emphasis to software. That is the consensus of engineering managers and research and development directors at a variety of computer manufacturers sampled on the eve of this year's National Computer Conference—traditionally a time for reflection on the state of the art and its practitioners.

Their comments point to fundamental changes for the industry in the decade ahead. Fueled by user demands for complete solutions to problems rather than just computing tools, the vendors are turning their attention to more sophisticated systems software. At the same time, the explosion of new applications for computing power is creating a demand for programmers that is outstripping the supply. Minicomputer and even microcomputer manufacturers, which traditionally emphasized the hardware features of their machines, are now stressing the software support behind their products.

"Where we sold hammers, lumber, and nails before, now we have to go into the prefab house business," says Steven J. Gaal, vice president for software development at Data General Corp., Westboro, Mass. "It's because of the shortage of systems programming people in all [applications] sectors."

And the manufacturers realize that after more than a decade of talking, something must now be done to improve both the software and the productivity of the people producing it.

"Fast-growing companies like Prime will stop dead in their tracks unless they can increase the throughput of their technical [programming] staffs," says Joseph F. Cashen, vice president of engineering at Prime Computer Inc., Wellesley Hills, Mass. "We just can't hire enough new people to keep going otherwise."

The growing interest on the part of these computer technology managers in software is clearly reflected in this year's NCC technical program (see program preview, p. 150). Software-intensive applications such as office automation are highlighted. Programmer productivity improvements will be studied in sessions on software engineering and high-level languages.

Of course these computer technologists continue to follow the hardware trends as well. New hardware organizations that link multiple processors are being examined, and research into computer architecture stresses support for existing software.

Very large-scale integration, now on the verge of practicality, is distorting what used to be the clear-cut boundary between the computers and the chips used to build them. This is forcing computer specialists to turn their attention to semiconductor technology and the techniques used to design and package chips. No longer willing to leave their hardware future to the semiconductor makers, many computer manufacturers are researching new device technologies ranging from gallium arsenide to Josephson junctions. Some are looking to work with traditional semiconductor vendors on the design of gate arrays or similar semicustom approaches, while others are developing in-house custom LSI capabilities.

Furthermore, the individual semiconductor chips are becoming so powerful that they are overlapping with traditional computers, creating a continuum of computing power. It becomes difficult, for instance, to differentiate a 16-bit microprocessor that can address 16 megabytes of main memory from a mainframe.

But now, as never before, software is sharing the spotlight with hardware. "The complexity and capabilities of hardware are underutilized currently because the industry just doesn't have enough applications programs to take full advantage of them," says Ian R. G. Edmonds, vice president development programs and planning at Prime. "Price/performance of hardware has improved by leaps and bounds, but there's been zero improvement in programmer productivity (see table)."

The successful computer firms of the future, he says, will be those offering programmers better and easier means of developing applications programs. These means include hardware that stresses ease and simplicity of use, but just as important—probably more so—will be software tools like very high-level languages, packages which allow users to access a data base without applications programs, and what are being called "program generators." These packages lead a programmer by simple steps through the creation of a routine, querying him about what needs to be achieved in each step and then converting his instructions into software steps. These techniques need lots of work, but have tremendous potential for speeding a programmer's job, he says.

Gordon Bell, vice president of engineering at Digital Equipment Corp., Maynard, Mass., agrees that the personnel shortage is going to be a difficult problem to solve. "We may be hit harder in software than in hardware [engineering]," he warns. "The long-term solution is to look at the disciplines using data processing and to induce these disciplines to help solve the software problem in their areas—physics, for instance, or business. I see computer science shaking out as a basic science, much as chemistry or biology is today, with a stress on areas like information and data bases, perhaps. Then it could be adapted to the needs of the specialities."

The microcomputer demand

In addition to the shortage of minicomputer and mainframe programmers, there is an even larger problem being caused at the other end of the computer industry by the tremendous sales volumes in the microprocessor and microcomputer business. Andrew Grove, president of Intel Corp., Santa Clara, Calif., predicts that unless new techniques and software structures are used, some 1 million software engineers will be required by 1990 just to service this low end of the computer continuum.

On the other hand, John Hanne, manager of product development for Texas Instruments Inc.'s Computer Systems division in Austin, Texas, feels that although there probably will be some temporary shortages of programmers, "the economic system will take care of it in the long term. That is, more folks will become programmers because it will become a more rewarding career paying bigger salaries."

The increasing importance of software to the total computer system will result in fundamental changes in the structures of the computer industry. "I see the establishment of multiple divisions at HP that are dedicated to the development of software," says E. David Crockett, the computer strategy manager for the computer groups of Hewlett-Packard Co., Palo Alto, Calif. "It's quite a departure from our traditional concept of a division, one in which people manufacture a product, put it in boxes, and ship it out the door."

This article was written by Computers & Peripherals Editor Anthony Durniak on the basis of reporting by James B. Brinton and Linda Lowe, Boston; Wesley R. Iversen, Dallas; Larry Waller, Los Angeles; Martin Marshall, Palo Alto; Pamela Hamilton, New York; and Managing Editor Alfred Rosenblatt.

DATA-PROCESSING INDUSTRY GROWTH TRENDS

	1955	1965	1975	1985
Industry	1	20	80	320
Machine performance	1	10^2	10^4	10^6
Programmer productivity	1	2.4	5.6	13.3
System reliability	1	5	24	120

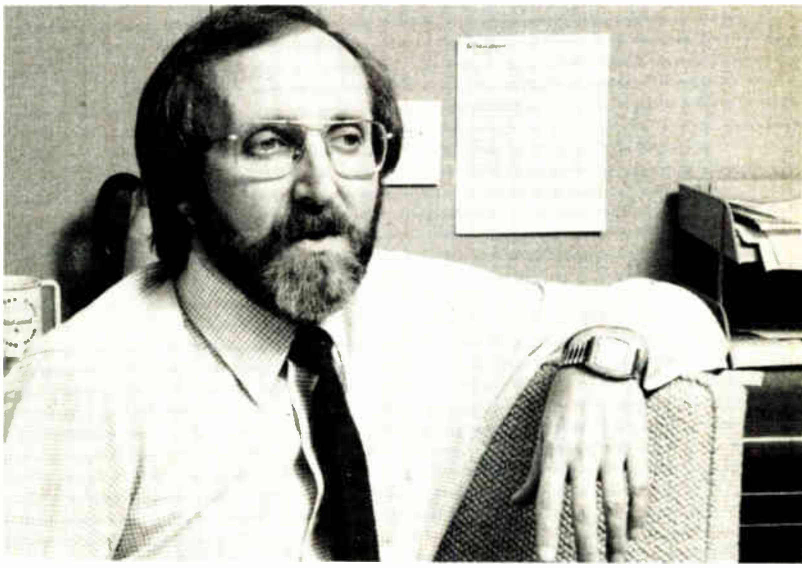
SOURCE: ART BENJAMIN ASSOCIATES LTD.

Specific plans for the allocation of those divisions have not yet been formulated at HP, but Crockett cites the growing number of programmers at the company to support his projection. "We started in 1966 with a handful of programmers. Now, 60% of the research people in the computer groups [which include calculators and peripherals] are programmers. If we just talk about people working on the central processing units, that figure is 75%—and it is growing," he notes.

This growing staff also represents the major portion of all computer companies' research and development budgets—typically over 55%.

The Sperry Univac division of Sperry Corp., Blue Bell, Pa., recently coordinated all its software research projects under a director of software technology—a move that had been taken in hardware many years ago. Probably the most important thrust for Richard Wexelblat, its director of software technology, is the human-machine

1. More complete solutions. Computer makers are supplying more than just software development tools these days, says Steven J. Gaal, vice president for software development at mini maker Data General; extensive prefabricated solutions are wanted.



interface as an on-line tool for computers. "We want to see practical natural language-acquisition rules applied directly to actual systems and data bases," he says. Univac is doing research to develop "a real English-language interface which can be typed in to support inquiries from occasional users." But, he adds, "we don't want to talk English to a full-time data user, either," who prefers the cryptic but time-saving codes now used.

Wexelblat points out that he wants the machine to respond a third of the time with the right response, to ask the user to rephrase the question a third of the time, and to say it didn't understand the question a third of the time. "In other words, I don't want the machine to ever come back with the wrong answer or incorrect data," he emphasizes.

Better human interfaces

HP's Crockett says his company is also working on improved human interfaces and sees the evolution of "natural" languages stemming from the artificial intelligence research now under way at a number of universities: "We're going to see increasingly friendly systems, so much so that the end user, rather than a professional programmer, will be able to program the system for his needs. Such things as menu-driven programming will help this along. Then, in conjunction with the 'natural' languages, we will see speech recognition appear."

This so-called user-friendly software will be especially important in applications in the office, where a larger number of inexperienced users will depend on computer systems. "In the future we're going to have more and more software that doesn't require any programming effort on the part of the user," agrees Vic Poor, senior vice president for research and development at Datapoint Corp., San Antonio, Texas. "In order to expand our market, we've got to go into areas where the customer doesn't forever have to bring in more and more programmers to do more and more coding before he can get anything to run."

But "the price of programs will rise, if only because of the programmer shortage," Data General's Steven J. Gaal says. As a result, business practices will change radically. "We will see a marked increase in software unbundling, and higher explicit prices for software, especially more use and service charges."

At Data General, Gaal says, they "are trying for higher programming productivity by using structured high-level programming. Thus we are developing modular programs which can perform on different systems with only different headers," for example.

At the Perkin-Elmer Computer Group's Computer Systems division, Sal Alini, director of software development, sees two primary directions: "Higher-level languages and a more transportable set of primitives—we need machine-independent code," he says, "and the way to do that is through machine-dependent software kernels." The rest of the software can be written in machine-independent, high-level language.

Alini also cautions, however, that software reliability and maintainability will be more important. "Whether at the system or the user level, software must be easily maintained," he says, because it is impossible to detect all errors before it is shipped to the customer. "You can't test all end permutations that may be found when the software is used. You have to optimize the ways to react to bugs as they come up."

Over the last four years Control Data Corp. has also been phasing in a high-level programming language for all its systems program development. A derivative of Pascal, the Cyber Implementation Language, or Cybil as it is known around the Minneapolis, Minn., firm, is used with a two-part compiler, according to Russ Petersen, a section manager at CDC's Arden Hills (Minn.) Programming division. A common front end of the compiler begins the translation process, while the back end, customized for the particular computer being programmed, generates the actual object code.

But perhaps more crucial to improving programmer productivity are the computer-aided design and simulation tools Control Data is developing. The computer-aided design system for software, or CADS for short, has interactive debugging aids, maintains data dictionaries, and performs other housekeeping chores that aid communications between programmers on a development team. And the simulation tools let software development proceed before the hardware is finished.

Software engineering, the 10-year-old concept of applying engineering discipline to the programming art, influences the way CDC programmers work, Petersen says. "For example, the concept of code reviews is readily accepted today," and structured programming techniques are widely used.

Ultimately, CDC would like to reach a point where the software would resemble hardware and "components would be taken off the shelf and put together," adds H. Nix Fraser, vice president of systems operations, adding, "The hardware people have done a better job in specifying and maintaining interfaces between components than we have."

Software paraprofessionals

CDC is also experimenting with new employee training and work practices. To begin with, the Control Data Institute, an educational subsidiary, is training what Fraser calls "software paraprofessionals, or software technicians," junior programmers without college training who concentrate on coding. "We're trying to break down the development process to use more of these technicians," Fraser says. "We're trying to do the same thing in software that hardware people did." After all, he notes, "a senior hardware designer doesn't solder his prototypes—a technician does that."

Similarly, Honeywell Corp. is encouraging all its divisions to use structured software design methodology it dubs "Wellmade." Wellmade was developed at the Corporate Computer Sciences Center in Bloomington, Minn. Robert Kelley, a senior principal research scientist there, says a formal language is first used to describe the operation to be performed and the structure of the data to be manipulated, and then the algorithm, or procedure to be followed, is designed. One of the beau-

R&D at IBM

The problem for International Business Machines Corp. when it comes to discussing technological trends in the computer industry appears to be an embarrassment of riches.

It is hard to single out just one research project from among the hundreds the company funds with its $1.3 billion research and development budget—and that figure excludes product programming and all R&D for Federal government projects.

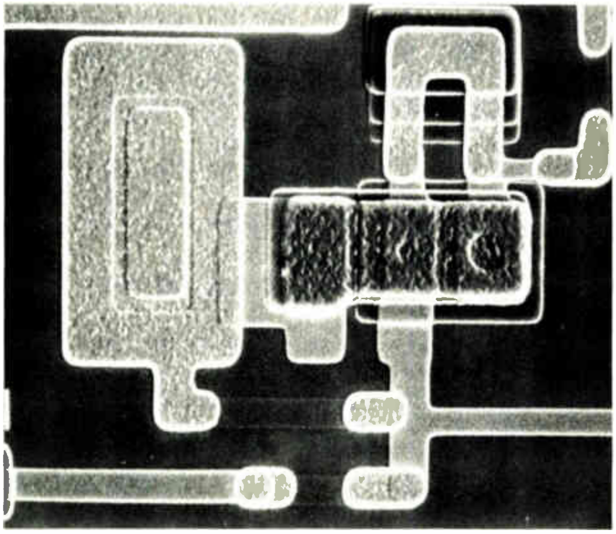
But Lewis M. Branscomb, vice president and chief scientist for the corporation, says a primary thrust is to examine logical extensions to current technology. "We look at how far the laws of physics and chemistry allow us to go on purely technical grounds. Then we look at what the most attractive choice there will be to what there is now," he says. Examples he cites include semiconductors versus superconducting material and megnetic versus optical data storage.

One logical alternative to current technology is apparently Josephson junction semiconductors, the subject of the entire March, 1980 issue of the IBM Journal of Research and Development.

Under study at IBM's Thomas J. Watson Research Laboratory in Yorktown Heights, N. Y., since 1967, the program has since been expanded to include the IBM research center at Zurich, Switzerland, and the Data Systems division's laboratory at East Fishkill, N. Y.—the home of the logic chips for most IBM computers. In addition to its exploration of the superconductivity and tunneling phenomena basic to the Josephson effect and developing Josephson devices themselves, the company has demonstrated LSI-type circuits with 13-picosecond switching speeds [*Electronics*, June 21, 1979, p. 46] and developed the novel packaging techniques needed for them.

In an article in the IBM Research Journal, Wilhelm Anacker, manager of the exploratory cryogenic technology department at Yorktown Heights and head of the Josephson technology project, explains the attraction. With such devices he feels it could be possible to build a computer with cycle times of 500 to 5,000 ps, which, "combined with current computer architecture, could provide mainframes with 10- to 100-fold higher computing rates than that of an IBM 3033 mainframe system."

Of course such a computer is still a way off since many design and packaging problems remain to be overcome.



ties of the Wellmade method, Kelley notes, is that "it leaves the door open for further theoretical work" in software engineering.

A vivid example of the new attention being paid to software is the joint effort between the Japanese government and its leading computer manufacturers [*Electronics*, Jan. 18, 1979, p. 63 and Aug. 16, 1979, p. 76]. The five-year program has budgeted ¥56.4 billion ($235 million at ¥240 to the dollar) to research operating-system kernels, network and data-base management, virtual machine techniques, and very high-level language processors. The ultimate objective is to facilitate Japanese language processing, according to executive director Masato Nebashi.

Cost balance changing

In addition to being international, the problems of software development are becoming pervasive throughout the continuum of computing power. "The problems in the microprocessor area are exactly the same as in the mainframe area," points out Bruce Russell, the director of special systems who heads up the research and development effort in software at Megadata Corp., the Bohemia, N. Y., maker of microprocessor-based intelligent cathode-ray-tube terminals. "Software costs are going to swamp everything else. This means you must design software not, as in the past, primarily to take up as little memory as possible out of the CPU. Designers will soon be concerned mostly with the cost of software because the cost of the CPU and memory has gone so low."

To cut costs, the software will have to be reusable. "We want software that can be used in more than one application—and this means software that is modular," Russell says. "We also want to be able to use higher-level languages to make the initial coding easier and to design the modules to be easy to maintain."

According to Russell, the standard interface between software modules must be maintained religiously. It may also be necessary, for example, to go through a procedure call and return, instead of directly accessing the data: "This takes more run time, but it could be worth it in terms of the cost of building and maintaining the software." Russell is direct in his advice concerning this extra time. "Spend the cycles!" he declares. "We already have the power in the 16-bit microprocessors, and we will have even more in the 32-bit processors to come. "We've got performance to burn. Spend some of it to ease the software problem."

Of course still of major interest to the computer manufacturers are ways to provide this hardware performance.

Jeffrey C. Kalb, vice president of engineering at Data General, sees the ability to place more and more gates onto a single silicon chip as the forcing factor. "We'll have 32-bit microprocessors by 1985," he predicts, "and other sophisticated chips will be available."

Reflecting growing computer industry concerns, however, Kalb is looking to ways to preserve his architectural and design flexibility in the face of this growing circuit integration. "Lots of bigger computer systems are not yet amenable to the small geometries of MOS—they need speed and drive capabilities that MOS can't deliver," he notes. These demands become especially evident on 32-bit computers. But, Kalb says, no one computer maker "has to support a design-from-scratch effort. Therefore, I think the time of the gate array has come." In fact, he says, "Data General is looking at gate arrays seriously for the first time as a major component of computer design."

The costs of semiconductors also concern him. "The industry is nearing some limits especially in the materials costs of packaging, silicon, petrochemicals, etc." Furthermore, "the industry is now becoming labor- and capital-intensive. This bodes ill for rock-bottom prices."

As for the type of computers to be built with these chips, Data General will stay with bus-oriented architectures, Kalb says. "They are flexible and expandible." A perfect example of this, he notes, is the new single-chip Eclipse microprocessor that combines custom LSI techniques with a bus-oriented design [*Electronics*, Feb. 14, 1980, p. 119].

How best to use the latest semiconductor technology is also the primary question on the mind of David I. Caplan, the new vice president and director of development at Perkin-Elmer Corp.'s Computer Operations, Oceanport, N. J.

"You can get big chip makers to optimize chips for your own use. When we look at those standard chips on the market today, we become convinced we have to go more and more toward individual chips to build new architectures," he says. Perkin-Elmer recently bought a company to develop its custom LSI designs. It does no manufacturing, but it does supply the entire company, including the instruments and optical groups, with LSI designs. "Ultimately we will be creating our own masks and designing the chips around our architecture. Our LSI people are using a cell approach in this designing," Caplan says.

The only standard chips Caplan is especially interested in are "MOS memories. The 16-K chip is now standard and the 64-K chip starting to become available." But using these parts will require new memory system designs. "We've done a lot of prototype work in error-correction code techniques because the soft-error rate is a lot higher with the higher densities," he says.

Although Hewlett-Packard is known for its custom C-MOS-on-sapphire work, it is keeping its technological options open. It has 11 IC facilities working with nine different semiconductor technologies, according to Crockett. The C-MOS on sapphire goes into the new model 1000L, 300, and 3000 series (Fig. 3). But the model 250 and desktops are all in n-channel MOS. "We believe it is healthy to have internal competition between n-MOS and C-MOS-on-sapphire technologies," he asserts.

Hardware development at Prime Computer also is being directed with an eye toward keeping open such technological options as fully customized LSI and VLSI chips, partially customized devices like gate arrays and programmable array logic, standard microprocessors, and even good old medium-scale integrated circuits.

Prime will be looking to use these chips to develop products offering more capabilities within the traditional price range of its equipment. Much attention will given to developing the high end of its product line, but Prime will also be working at extending its low end to machines that act as nodes in networks, which Cashen sees as one of the major directions for the industry in the 1980s.

Reliability stressed

Another consideration in designing and building systems will be ease of use and error correction. "Dropping hardware prices are bringing equipment within the reach of less sophisticated users, and simplicity, maintainability, and reliability of machines will be a big advantage in that market," Cashen believes. Incorporating more self-diagnostic capability into machines will also be a way to conserve scarce technical people. "It's cheaper to throw a lot of silicon into error correction because it saves you manpower that would otherwise be all tied up in extensive testing, diagnostics, and maintenance," he says.

Naturally not every company in the business is looking to leading-edge LSI technology. "We're not technology pioneers, but manufacturers," states Angus McLagan, director, hardware engineering at Computer Automation Inc., Irvine, Calif. Such an approach, therefore, eschews

If you want to go . . .

It's already too late to register by mail for the NCC being held Monday, May 19, through Thursday, May 22, at the Anaheim Convention Center opposite Disneyland on Katella Avenue in Anaheim, Calif., but on-site registration is available. Attendance at all four days of the conference, exhibit, and personal computing festival is $75, including the price of a copy of the proceedings. Students can get in for $10 but without the proceedings.

Those wanting to go just to the exhibits can do so for $25 for four days, or $10 for only one day. A single day at the program and exhibits is $25. The personal computing festival by itself is $9 for the four days, $15 with the personal computing proceedings, or $5 for one day without proceedings.

In addition to the main conference itself, there are separately priced professional development seminars that cost $50 each.

Staffers will be on hand to register you—and explain this price list—starting at 4 p.m. Sunday, providing an opportunity to beat the crowds that are sure to materialize when registration opens at 7:30 a.m. on Monday. Registration the rest of the week also starts at 7:30 a.m.

not only radical new computer architectures, but also first use of new semiconductor devices. Instead, it puts a premium on innovative methods of implementing present machine organizations, or microarchitectures, with available, proven chips, according to McLagan. Examples at Computer Automation are two new central processors under development to upgrade present machines and, above all, preserve existing software. These are new versions of the LSI-2/20 and the Naked Mini-4.

Mainframe concerns

On the other hand, the big mainframe makers are perhaps the most concerned with future semiconductor technologies. Sperry Univac, Control Data, Honeywell, NCR, and Burroughs all have in-house semiconductor production facilities and are researching a variety of new fabrication techniques and design procedures. Naturally, IBM is leading the way with research in semiconductor technologies, including studies of the underlying chemistry and physics (see "R&D at IBM," p. 145, and Fig. 4).

There are three concurrent efforts going on between Univac's Blue Bell, Pa., headquarters and Sperry's Corporate Research Center in Sudbury, Mass., says Joseph B. Tomei, director of device research. The first deals with silicon-based components using semicustom or quasicustom design techniques. The second is in gallium arsenide, which will be the next in line for implementation. Sudbury has been doing materials research in gallium arsenide for over two years, and at Blue Bell, work has been going on since the summer of 1978. Another important area of concern for Univac is in Josephson junction technology, which Tomei feels is up to 15 years away as far as an actual product goes.

"We try to cover technology so that it is there on a timely basis for development efforts," Tomei observes.

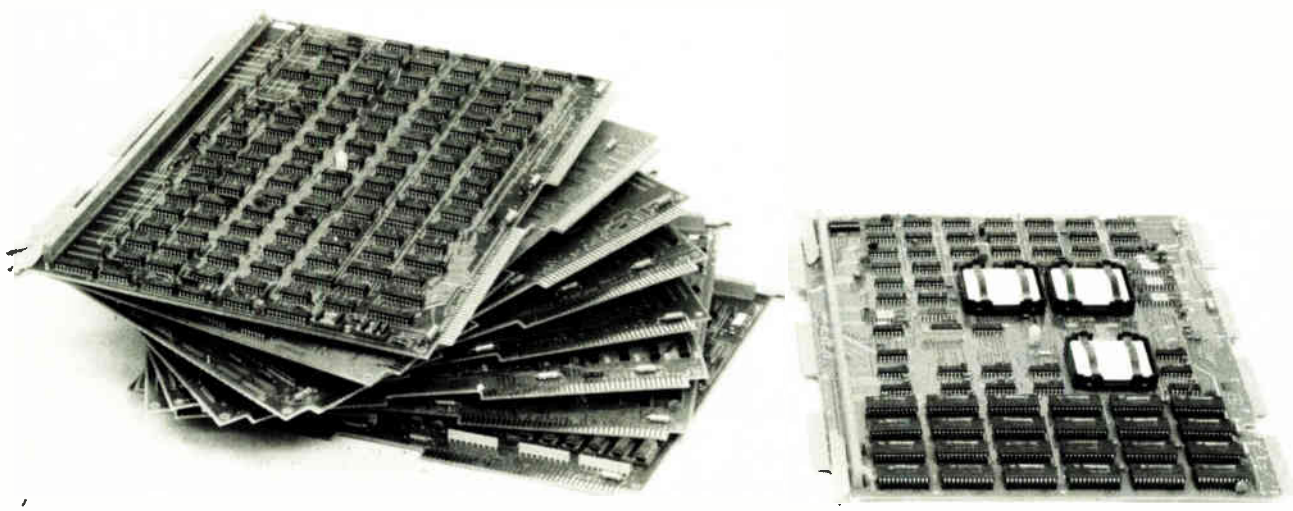
But no matter what device technology is applied, "using LSI and VLSI with 200,000 or 300,000 gates per chip causes a partitioning problem," he notes. "How do you do implementations that work?" He sees the need for custom chips, but notes that the semiconductor makers are not "interested in custom or specialized circuits. Even a semicustom gate-array structure isn't something that you see too many of."

2. Programmer shortage. The scarcity of software personnel is beginning to worry the industry, according to Gordon Bell, engineering vice president at Digital Equipment Corp. He thinks this problem may be harder to solve than it has been in hardware design.

Univac is counting heavily on a computer-aided design group that does layout, sets packing density requirements, and establishes wiring algorithms. A lot of the work is done in conjunction with several universities, according to Tomei.

Developing and/or acquiring software to help design these gate arrays is one of the biggest problems facing Univac, says Tomei. Only with the smaller arrays can some of the layout be done by hand. Tomei believes that a software package will be in place within the next six months to automatically generate these gate arrays.

As for the device technologies, Tomei notes that "gal-



3. Customization. Computer designers are finding that large-scale integration makes it difficult to distinguish the computer from the chips. Hewlett-Packard Co., for instance, managed to fit 90% of its seven-board 3000 series central processing unit onto three custom chips.

lium arsenide is five or six times better than silicon. The power levels required are a factor of 40 to 100 times less than with silicon technologies," he says. He doesn't see the companies leading the gallium arsenide development effort—Rockwell, Hewlett-Packard, and McDonnell Douglas—as parts vendors. So Univac is doing its own development in that area. "We want to make sure we have gallium arsenide covered."

"In the layout studies, we're looking at how to attack the design problem of meshing memory with logic," Tomei says. "But the minute you put logic on a memory chip, you're leaving the realm of the standard chip—which isn't good unless you want to make all your own semiconductors."

"But there will be a blurring of memory," he says, especially with faster device technologies—because when memory is on a separate board as little as a foot away, "it is by definition slow," according to Tomei.

Computing near 0 K

At Blue Bell, the research into Josephson junctions with its potential for ultrafast computing is a three-month effort so far—most of the work until now has been done at Sudbury. Blue Bell will be looking at lead-based junctions (similar to those IBM has pioneered), while Sudbury explores neodymium-based junctions. Some of the immediate problems Tomei sees include how to test the devices and connecting to the liquid helium environment the devices require.

Lloyd Thorndyke, CDC's senior vice president for research, cautions that the "center of mass is not in the [semiconductor] foundry, but in how to cope with the technology once you've got it." To that end CDC has developed an extensive set of design tools and testing techniques to help design its Cyber 200 supercomputer [*Electronics*, Feb. 1, 1979, p. 42]. These are used to design its LSI 168 emitter-coupled-logic gate arrays, developed with Fairchild Camera and Instrument Corp.'s semiconductor operations and equivalent to Fairchild's F200K chips. These tools—essentially computer-aided design software—first simulate a chip's operation to ensure that it will perform as expected, then facilitate the layout of the chip, verify that the design is accurate, and finally produce the masks for the metalization layers that interconnect the gates arrayed on the chip.

4. Helping hands. The increasing complexity of software and hardware design makes use of computer-aided design imperative, industry managers say. An engineer at IBM's East Fishkill, N. Y., facility is shown using its automated design system for gate-array layout work.

Thorndyke points out that as the hardware becomes more complex, such computer-aided design techniques will become more critical. "If one's going to build larger, more complex machines, the only way to do it is through simulation."

Of course this implies spending a fair amount of money on computers that help build computers. Thorndyke says this will pay for itself by improving the productivity of the hardware designers.

Still, research and development money is not limitless, and Thornydke says that since the industry is faced with an increasing capital requirement, it must change the way it does business. In particular, he advocates closer cooperation between the semiconductor and computer houses. "We can leverage our development dollar by working with someone else who does what they do best."

To encourage this cooperation, of course, the computer companies have to be convinced that the semiconductor companies are still interested in the business, which will be relatively low in volume compared with the demands of new chip applications in the consumer and automobile area. But Thornydke is convinced that semiconductor companies will continue to woo computer companies' high-technology business because "the low-technology, high-volume products have low margins." And if they don't fulfill his plan, then "foreign suppliers will supply the high-technology parts."

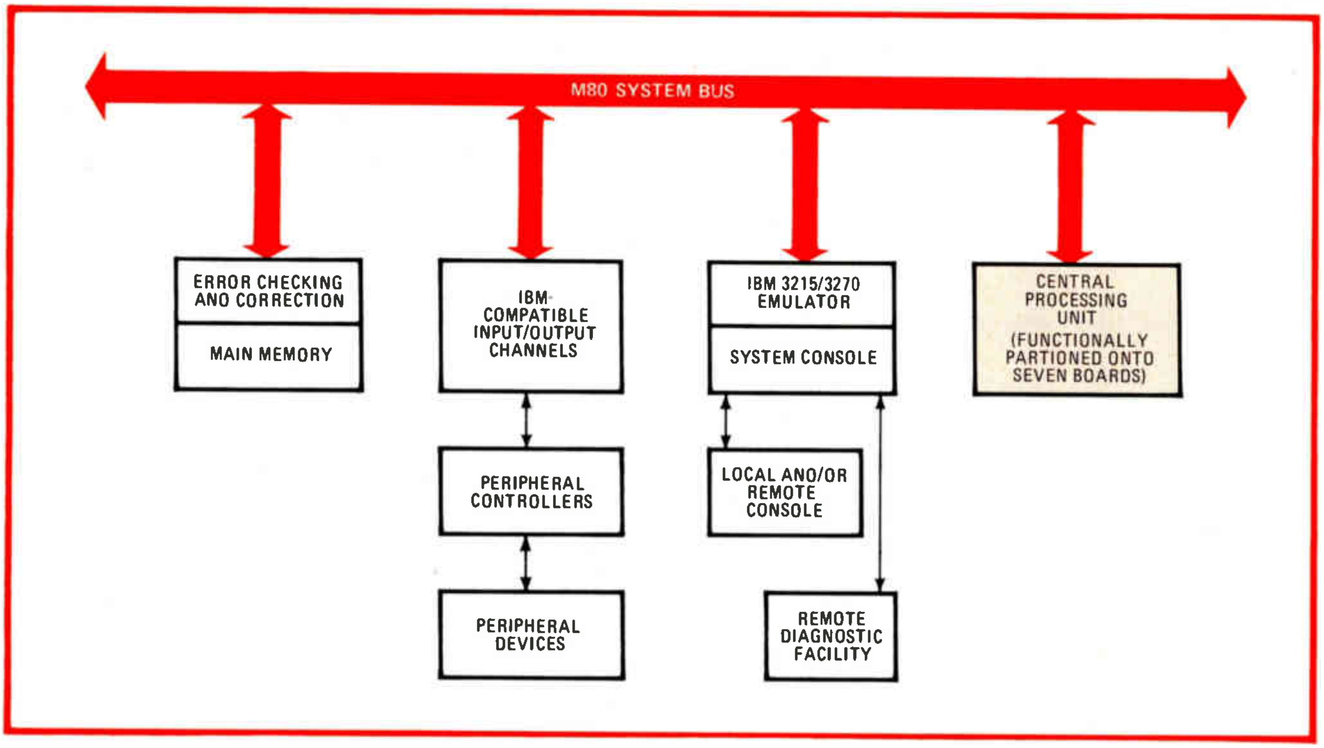
Nonetheless, CDC is keeping its fingers in the device research pie. It is following Josephson junction work, although it has no research of its own, and is also examining gallium arsenide. Furthermore, the company has developed and fabricated its own 256-K bubble memory chip, that it says involved advanced mask-making techniques.

Power for terminals

The availability of cheap memory chips and complex custom circuitry has a company like Datapoint thinking about putting a full business processor in every terminal in a distributed processing system. "And we can do that because they're going to be so cheap that you don't think anything about wasting them," Vic Poor says.

Poor notes that Datapoint's bus-oriented Attached Resource Computing system is perfect for tying their powerful terminals together. "ARC is our fundamental architecture. We see our product strategy over the next five years capitalizing entirely on the approach," Poor says. And that means a good portion of Datapoint effort will be aimed at improving ARC software.

ARC encompasses multiple processors or computers running independent "partitions" tied together by a



5. Functional partitioning. No longer depending on new semiconductors to differentiate their products, some computer makers are doing more design innovation. Magnuson Computer Systems functionally partitions its CPU and then hangs it on a flexible bus-oriented system.

high-speed bus. As Poor puts it, "the software that supports an ARC system today is pretty primitive compared to what it could be. . . . The bandwidth—the amount of data you can pass between processors—is enormous. And in a typical ARC application out there today, those buses are just loafing."

At present, Datapoint refers to file processors and applications processors separately, with peripherals attachable to the applications processors on a local basis. But over the next five years, the distinction between a file processor and an applications processor will disappear, says Poor, and peripherals will be attachable in any manner, no matter where they are physically located.

Network architectures

Gordon Bell of DEC is also concentrating on the architectures of networks rather than those of processors.

"We continue to think about bus orientation; it is a major issue and computer designers are far from exhausting the capabilities of buses," he says. "But the bus itself is moving upward into a more global context—networks. Our ultimate goal is total transparency, whereby all machines within an organization could be coupled together so that the user would simply see more capability at his terminal and deal with architecture far less than today."

Bell foresees the black boxes of 1985 containing a number of buses; three-level bus structures would not surprise him, nor would the addition of a number of specialized buses, perhaps with specialized processors hung from them—communications and fast-Fourier-transform types are just two of those he mentioned. "Such specialized processors already are available today, but at high cost; by 1985, signal processing, say, will either cost far less to begin with or be available cheaply through networked resource sharing. There will be a lot of signal-processing hardware available below $100,000."

"But I'm less concerned with what's in black boxes than how to hook them up—to the degree that networking and interfacing with other machines conditions unit architecture, I'm watching it closely."

At Magnuson Computer Systems Inc., technical director Carl Amdahl (son of IBM-compatible market pioneer Gene Amdahl) adds that "circuit technology is available to everyone within a relatively short time." Thus, he says, "it is only through architectural advantages that a computer manufacturer can exploit and maintain a marketing and performance advantage." The Santa Clara, Calif., company uses a "function-slice" architecture in its IBM-compatible M80 series mainframes, rather than to organize its design around bit-slice processors.

This functional slice approach employs three 32-bit-wide buses within the mainframe. The first of these is the system bus between main storage and the CPU. The second two are within the CPU: a CPU data bus and a control bus. The cards in the mainframe sit on these buses and can pick off specialized processor functions, such as arithmetic processing and local storage functions (Fig. 5).

"The bit-slice approach creates cards that perform all functions upon a small window or slice of data," notes Amdahl. "With our functional slice approach, each card performs only certain functions but on the entirety of the data. This allows us to add functions to the bus, with each function being implemented as a separate processor or as a piece of a single processor." The ability to upgrade that results helps prevent obsolescence. □

Technical agenda reflects state of computer art

☐ Although often bypassed by attendees in favor of the razzle-dazzle of the exhibit floor, the technical program of the American Federation of Information Processing Societies' National Computer Conference continues to provide the broadest view of computer technology.

This year's view will also be more clearly focused and easier to handle, says program chairman Don B. Medley. Instead of the 156 sessions that overwhelmed attendees at last year's NCC in New York, this year's program features a more manageable 95 sessions. "We cut back tremendously to reduce the number of parallel sessions."

Hewlett-Packard Co. chairman David Packard will kick off the conference with his keynote address on Monday at 9:30. The technical sessions themselves start that afternoon. They are grouped into eight broad categories covering basic computer technologies themselves and their applications (see chart).

Reflecting the increasing emphasis on software in the

	MONDAY		
	MORNING	1:30 – 3:00	3:15 – 4:45
Computer Architecture		Data-base translation or distributed data-base architecture	Survival systems
Applications of Computer Technologies		Change management	
Data-Base Management and Communications		Data-base design practicum	
			Architecture of the next generation of data-base management systems
Office Automation	KEYNOTE ADDRESS	Developing technologies in office automation systems	Management of information technologies in the 80s
Simulation Technologies		Solar-energy computer-simulation modeling	Advances in process control
Software Engineering Technologies		ADA – where it stands now	
Social Dynamics and Special Topics		Privacy protection in transborder data flow Venture capital	Early experiences in complying with foreign restrictions in privacy laws The social dynamics of computing use in organizations
Image Processing and Computers in Medicine		Medical imaging	Medical education

	TUESDAY			
	8 – 9:30	9:45 – 11:15	1:30 – 3:00	3:15 – 4:45
Computer Architecture	Network architecture		Intelligent memory	Supersystems 80s: problems of designing and programming
Applications of Computer Technologies	Computers in amusements and sporting events	Computers and the performing arts Application development methods and systems Personal computing Improving performance of computer personnel	Computer support behind the scenes in movie and TV production Tools for growth	Computer use for special effects and movies and television Planning for information systems
Data-Base Management and Communications	Concurrency, consistency, and reliability in data-base management		Distributed minicomputer networks	Telecommunications from the minicomputer user's viewpoint
Office Automation	Office automation and the executive suite			
Simulation Technologies	Numerical methods for the 80s			TRAC: an architecturally flexible multiprocessor multimemory system
Software Engineering Technologies	MUMPS: the David and Goliath story in software engineering	Pascal in the real world	Software engineering education High-level languages for microprocessors	Economics of software
	Implementing a software management discipline			
Social Dynamics and Special Topics		User requirements and software specifications	Microcomputers and privacy	In-house information systems Libraries of the future
Image Processing and Computers in Medicine				

industry, some 20% of the sessions pertain to software engineering. These will examine the tools and techniques for systematic software development and ensuring program correctness and reliability. Of special interest will be a look at Ada, the Department of Defense's high-level programming language, on what session leader Hal Hart of TRW Inc. calls its first birthday.

Office automation, the hottest business application of this technology these days, will be explored in several sessions that range in content from how to analyze the office procedures to be automated to what is available in electronic mail systems.

Data-base processors seem to dominate the sessions devoted to computer architecture. The impact of very large-scale integrated circuits will be examined as well.

Roughly half of these sessions will have published papers—a total of about 145. The other half will feature panels of experts who will deliver oral remarks. Medley says the mixture is perfect for covering the computer industry. "This is particularly important in fast-moving technical areas," he observes.

Also, he notes that many busy experts in the field are neither able nor willing to write papers these days. "But we still want published papers because these provide a record of the state of the art at this point in time."

The popular professional development seminars, instead of lasting an entire day as in the past, now come in half-day versions as well, Medley notes. "This enables a person to attend a seminar in the morning and then go to related technical sessions in the afternoon that can expand upon or enhance the material presented in the seminar."

This year's NCC promises a full schedule. Bring comfortable shoes—getting to sessions around the mammoth Anaheim convention center will entail a great deal of walking.

WEDNESDAY

8 – 9:30	9:45 – 11:15	1:30 – 3:00	3:15 – 4:45
Issues of data base machine design			
Computers in home entertainment Decision support systems Education in information systems		Computers in animation Control and audit	How to recruit, develop, and retain top data-processing talent Distributed systems
Keys to distributed processing	Data-base technology	The many voices of data-base management	
Applications of office automation	Modeling of office procedures	Electronic mail	
	DSS gives credibility to management information systems and data processing	Simulation – a planning tool	
Software reliability	Trends in software reliability	Tools for verification and validation	The program development environment
	Software requirements engineering		
			Changing technologies of recording data Auditing-systems security
	Image understanding	Modern trends in facsimile data compression	Real-time image processing

THURSDAY

8 – 9:30	9:45 – 11:45	1:30 – 3:00	3:15 – 4:45
	Data-base processors	CONLAN-A formal construction method for hardware description	Impact of very large-scale integration
	Microprocessing: facilities, training and applications	Techniques for improving data-processing staff performance	Management: new concerns and opportunities
Implementing a data-management plan and query approaches	Tightly coupled distributed architecture design		Practical natural language access to data base Distributed processing systems concepts
The developing information infrastructure			
			Software models Simulation in small business
Software engineering technology transfer Software quality assurance		Quantitative measures of the quality of programs and systems	Computer software standards Software testing
Mass market computers Green thumb concept of data dissemination Communication protection	Energy considerations in computer installations System concept development Social impact of personal computing	Social service delivery systems Trusted computer system developments Computerized production and the worker Privacy protection in the U.S.	
		Voice communications with computers	

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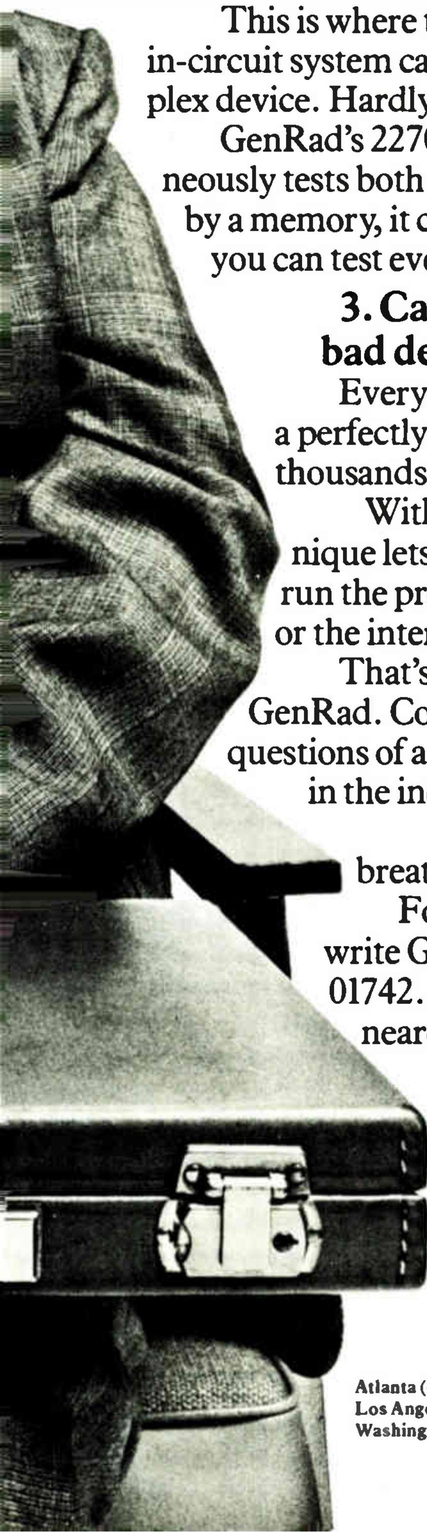

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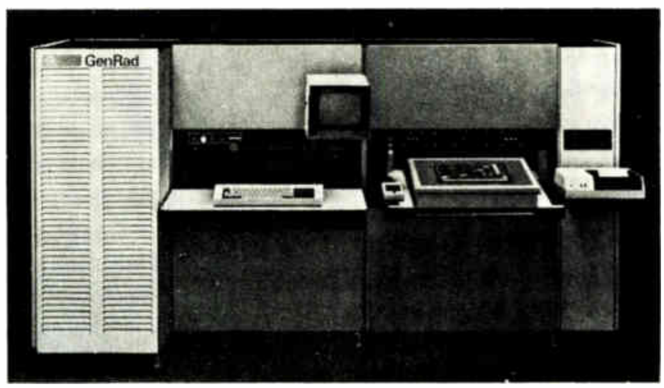

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Circle 153 on reader service card

Recovering analog signals economically from BCD outputs

A monolithic digital-to-analog converter makes it simple to add analog meters to an instrument or create feedback to its analog inputs

by Gary Grandbois, *Precision Monolithics Inc., Santa Clara, Calif.*

☐ Low-cost digital meters, with their highly accurate readouts, now adorn most instruments and control systems. Nevertheless, the input and control signals of this equipment remain analog, and they cannot easily or inexpensively be made to benefit from the accuracy of its binary-coded decimal output.

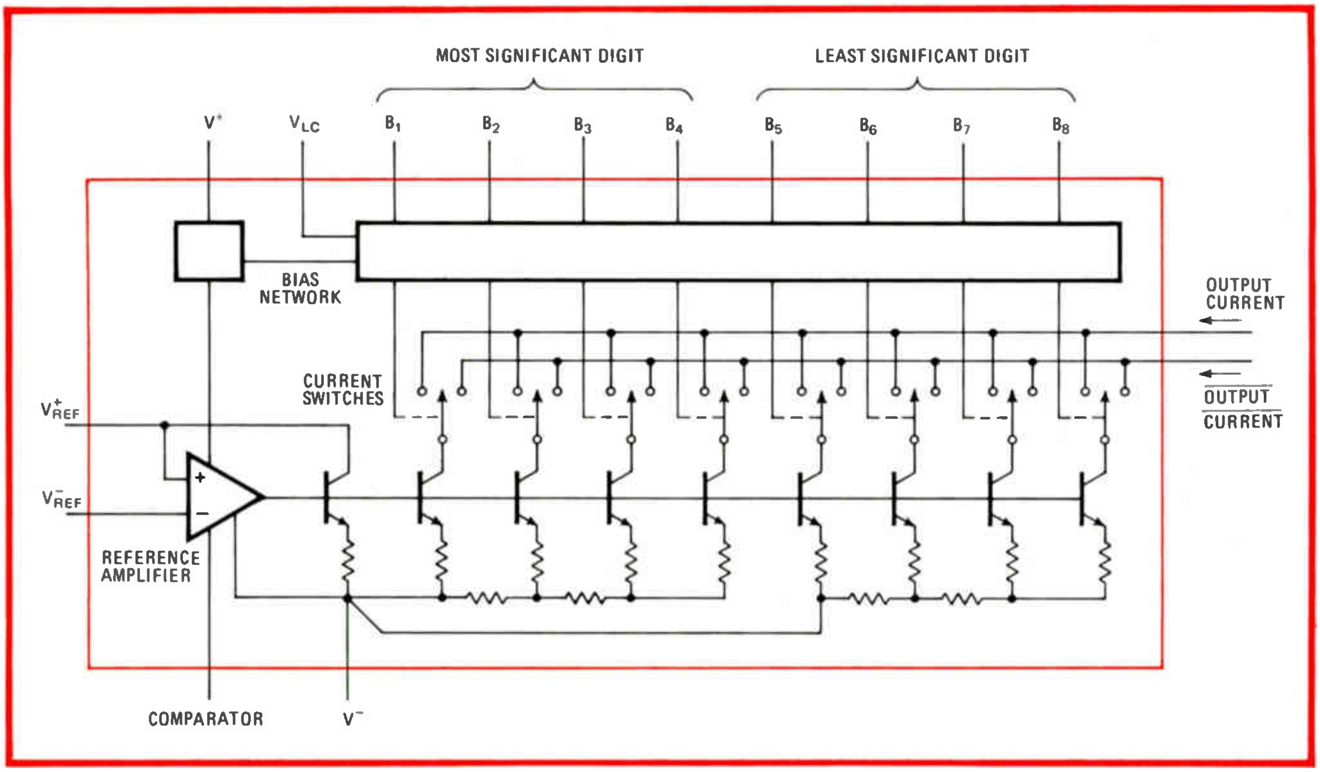
A low-cost monolithic BCD digital-to-analog converter (Fig. 1) is intended to remedy this situation. Designated the DAC-20, it produces an output current as a function of its input BCD number and reference current.

The two-digit DAC-20 is the first of a new breed of low-cost BCD interface converters. A bipolar multiplying d-a converter with complementary current outputs, it can be used with either positive true or negative true (complementary) logic. The DAC-20's output features wide voltage compliance of -10 to $+18$ volts, making possible direct current-to-voltage conversion through a resistor to ground or another voltage source.

Nor does it matter what kind of BCD output an instrument has, be it bit-parallel digit-serial (multiplexed BCD) in format or fully parallel (for printers). A BCD d-a converter such as the DAC-20 can be readily interfaced to an instrument with any of these BCD outputs through direct connections or via opto-isolators for high common-mode-voltage protection.

Analog indications still in demand

Despite the fact that much of the output of instruments and controls is digital numeric data, analog output displays are still in demand. A BCD d-a converter can be used in an instrument to drive an analog meter or strip-chart recorder, for example. This allows the instrument user to grasp output information with relative ease. An analog hard-copy output of an instrument enables



1. Analog output. This monolithic BCD d-a converter allows instruments and controls with BCD outputs to drive analog displays inexpensively. The output current from the device's analog switches can be converted into a voltage through a resistor termination.

the user to focus on a graph's or curve's particular segment and spot trends that would normally be obscured by digital readouts.

Analog output meters for instruments are ideal for indicating the degree and direction of trends and for revealing rates of change. On the other hand, digital displays provide precise readings without the analog display's ambiguity and vulnerability to the subjectivity of the viewer's interpretation. Thus the ideal display is one that combines a digital and analog readout. Not surprisingly, a recent trend is to supply analog readout options for digital multimeters in the form of analog meters or bar graphs.

Process control is another application. The output of a digital instrument monitoring a process can be fed into the DAC-20. The DAC-20's output is then fed back to the monitored-process input to complete a loop. As in the analog meter application, the only additional component required is a precision voltage reference input for the DAC-20. A thermocouple monitor, for example, can be turned into an oven controller.

A particularly useful application of a BCD d-a converter is adding more functional capability and intelligence to any instrument that uses a seven-segment-type numeric display. The input analog-to-digital converter or front-panel thumbwheel switches employed in such an instrument make use of a BCD coding format.

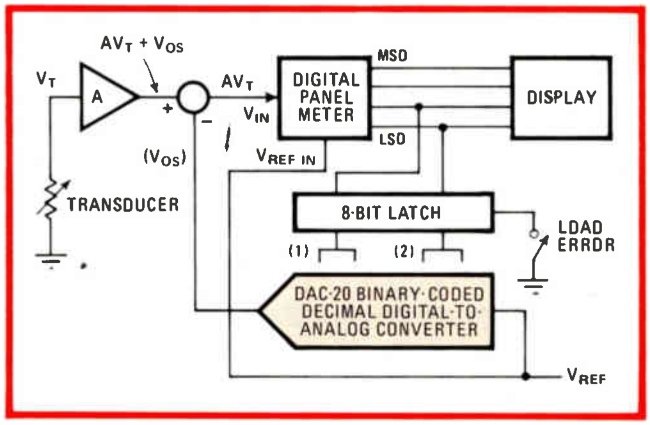
Parallel BCD formats are usually found in older instruments and ones not designed with large-scale integrated circuits. This output format allows easy interfacing to the DAC-20's input. Bit-parallel digit-serial (multiplexed) BCD formats are usually available in 4-bit arrangements, where successive 4-bit digits are multiplexed on a 4-bit bus and identified by additional signal lines known as digit strobes (or digit-select lines). These multiplexed lines must be demultiplexed into a fully parallel format, however, before a DAC-20 BCD d-a converter can be used. A latch IC can perform this function ahead of the DAC-20. It can be used for systems with inter-digit blanking (where dead time is available between digit select lines) and active-low digit strobes. Each time the digit-select line goes low, the 4 bits of BCD data are loaded into the 4-bit latch.

In scale

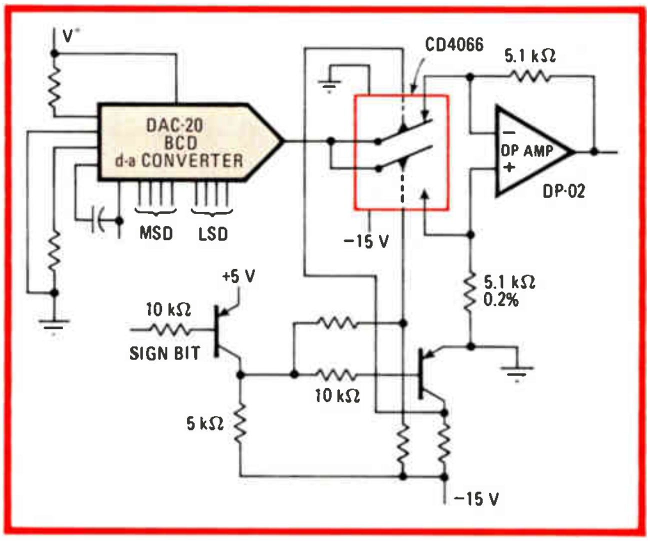
The combination of latch and BCD d-a converter can be applied to a variety of systems, including those that, like modern weighing scales, use digital panel meters.

In auto-null and auto-tare weighing-scale applications, the DPM serves as the a-d converter, producing a multiplexed BCD output. Besides activating a digital display, the DPM's output can be fed into a BCD d-a converter through an 8-bit latch. Figure 2 shows a weighing-system circuit in which a BCD d-a converter is used along with zero-offsetting negative feedback. When the transducer and DPM combination reads a number other than zero (for those cases in which a zero reading is in order), the number is loaded into the 8-bit latch, causing the BCD d-a converter to supply a difference voltage to the DPM over a return loop. This voltage acts to return the weighing system rapidly to a zero input reading.

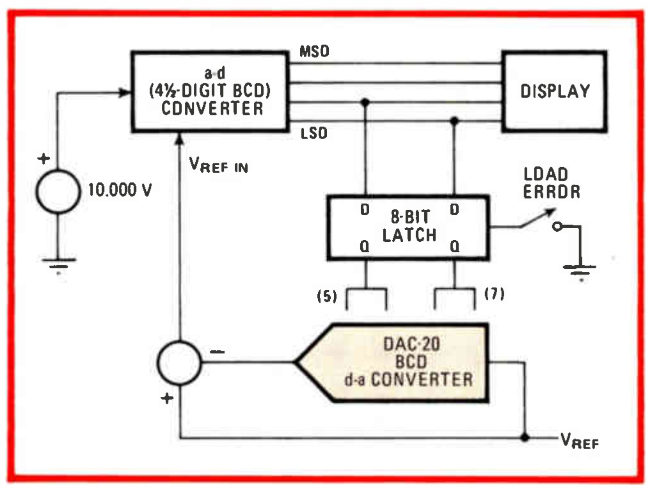
Use of the DAC-20 BCD d-a converter in the circuit of



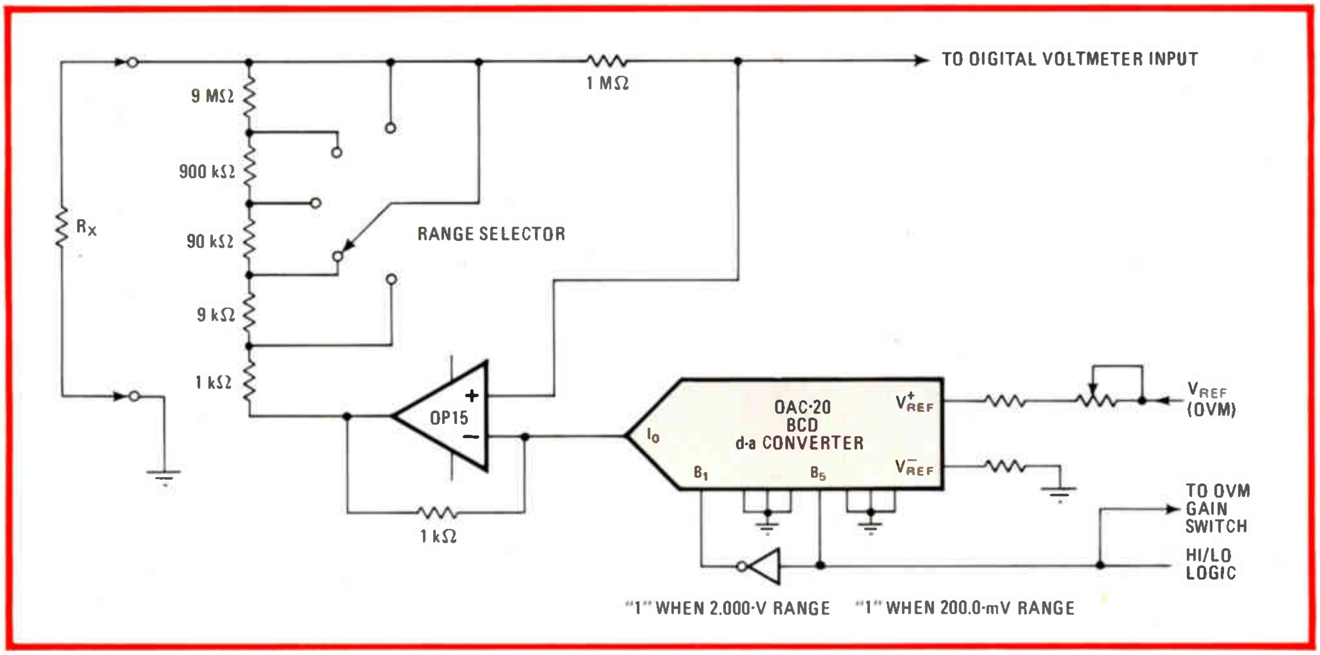
2. Automatic zeroing. A BCD d-a converter can be used for zero-offsetting applications. The digital panel meter and transducer combination displays a nonzero value, which causes the d-a converter to generate a negative error-correction feedback signal.



3. Bipolar nulling. For bipolar automatic nulling applications, additional components such as an analog switch (CD4066) and a differential amplifier (OP-02) are needed. This allows the BCD d-a converter to function as a sign and magnitude circuit.



4. Self-calibration. A digital voltmeter (the 4½-digit a-d converter) can have self-calibration with the use of a BCD d-a converter. The instrument's error code is loaded into the 8-bit latch, causing the BCD d-a converter to supply the proper correction voltage.



5. Resistance. A BCD d-a converter can provide a digital voltmeter with high and low resistance measurement capability. A programmable current source provides the resistance-to-voltage conversion in the resistor ladder network, for input to the digital voltmeter.

Fig. 2 permits the nulling of 4½-, 5½-, and 6½-digit panel meters. The applications are many and varied. They range from auto-tare digital scales, where the tare button is pushed to subtract the weight of the empty container (the tare weight) from subsequent weighings, to push-button zeroing, to cancel non-ideal transducer and signal-conditioning offset voltages.

Nulling voltmeters automatically

The approach illustrated in Fig. 2 can also be used for automatic nulling of digital voltmeters. Through the use of a 4-bit latch at the digital voltmeter's output, a DAC-20's output can be fed back into the voltmeter's differential input for analog subtraction. The DAC-20 essentially adds null correction to the last two least significant digits of the voltmeter's a-d converter input. The 4-bit latch stores the null word and loads it into the DAC-20 upon a null command from a push button. The DAC-20's nulling output is subtracted at the voltmeter's input until either the latch is cleared or a new null is entered. No potentiometer adjustments are needed since the entire operation is automatic.

In weighing applications, of course, there are no negative weights and this nulling circuit is in fact useful only for unipolar operations. For bipolar nulling applications, therefore, a sign-and-magnitude BCD d-a converter is needed (Fig. 3). Adding a complementary-MOS IC switch, a bit-level shifter, and a differential amplifier to the DAC-20 BCD d-a converter provides the necessary sign-drive and output-polarity reversal.

Thus equipped, the DAC-20 can be used to drive an analog meter where only the magnitude and the sign of a digital instrument's output are observed. The most significant digits of a digital voltmeter's output are latched into the 4-bit latch IC, which supplies a continuous digital input to the DAC-20. The converter's output is manifested as a continuous analog display on the meter.

Self-calibration of instruments is another useful application of the DAC-20 BCD d-a converter. This can be achieved in conjunction with a laboratory standard for voltage, current, resistance or temperature.

Figure 4 illustrates one such application in which the two-digit BCD d-a converter is used in conjunction with a nonvolatile memory that stores the system's digital error.

Regardless of the number of BCD d-a converter digits, the device's drift as well as that of the reference voltage are assumed to be less than two least significant digits—stable enough in terms of this circuit. Thus when a laboratory calibration standard with an output of 10^n (where n is the number of digits) is applied to the instrument's input, the error code is loaded into the dual-digit 8-bit C-MOS latch. This latch then supplies the proper correction voltage, through the BCD d-a converter, at the push of an activating calibration button.

Although the error-correction technique in Fig. 4 is nonlinear, the error is less than 1 LSB over the instrument's full 100-count range. This can be seen from:

$$\Delta V_R = (\%\ \text{error} \times V_R) - (\%\ \text{error} \times \Delta V_R)$$

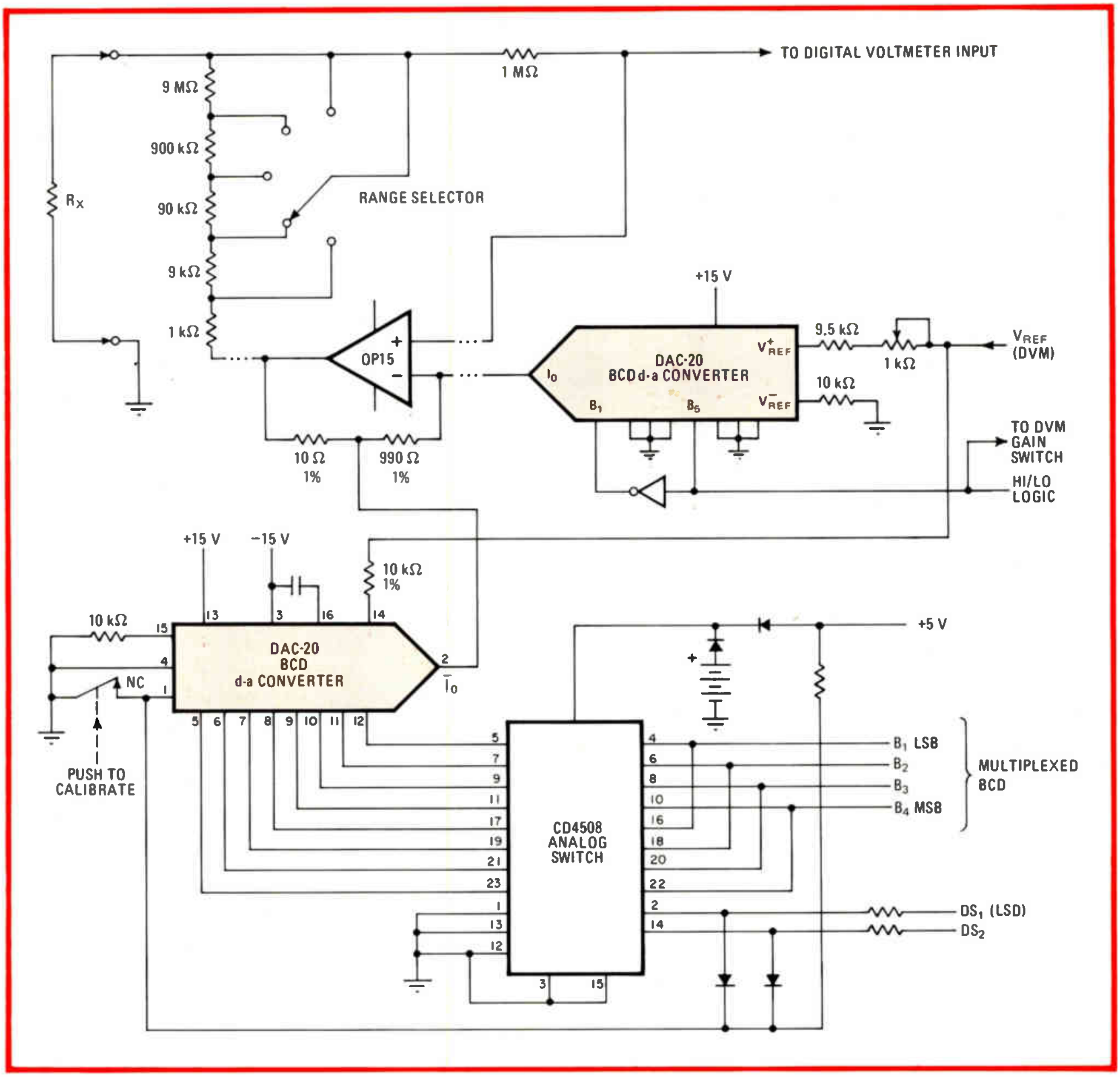
where V_R is the reference voltage.

Assuming that both the error and the V_R corrections are small (on the order of 1% each), the equation reduces to:

$$\Delta V_R = \%\ \text{error} \times V_R$$

and the BCD d-a converter adds the stored error term to the a-d unit's reference voltage for a correct display.

Since the BCD d-a converter's correction voltage applies to only the last two digits, its inherent drift is reduced by the ratio of the d-a and a-d converter codes—that is, 100/10,000 or 1/100 for a 4½-digit instrument, and 1/10 for a 3½-digit one. Even the use of the lowest-grade BCD d-a converter like the DAC-20Q is possible in the circuit of Fig. 4. Such a converter contrib-



6. Auto-calibration. Automatic calibration of a digital multimeter's resistance measurements is possible with the use of a BCD d-a converter. This circuit functions in the same manner as the one in Fig. 4 except for a reversal in the sense of correction.

utes only a maximum temperature coefficient of 0.8 parts per million/°C to a 4½-digit instrument.

The application of the DAC-20 BCD d-a converter is also useful in resistance measurements. The converter's wide output compliance of −10 to +18 V and its low temperature coefficient of 50 ppm/°C make it ideal for such applications.

An important feature permitted by the DAC-20 is that its input current can be reduced by a factor of 10 under logic control. This makes it possible to measure high and low resistance by gain-switching a multimeter's a-d input converter to compensate for the current change. Thus pn-junction resistances can be measured with and without forward biasing, for high- and low-resistance measurements, respectively.

A resistance-measurement circuit (Fig. 5) involving resistance-to-voltage conversion via a programmable current source can make use of the DAC-20. The input resistor network of a multimeter can be used to program the output current.

A further refinement of the circuit in Fig. 5 makes possible the automatic calibration of multimeter resistance measurements. All that is needed is the addition of a self-calibrating circuit with a BCD d-a converter (Fig. 6). This circuit functions in the same manner as the one in Fig. 4, except that the sense of correction is reversed—that is, I_o is used instead of $\bar{I}_o$. An increase in the voltage causes a decrease in the instrument's reading, and vice versa. This circuit also requires the use of a calibration standard resistor of a power of 10 (here, 1 kilohm), so that the stored correction term or error is a decimally related value. □

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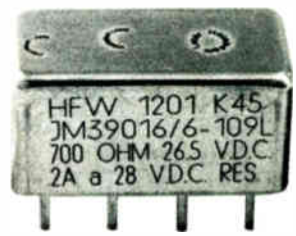

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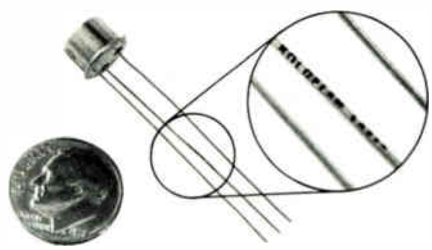

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100-MHz oscilloscope displays innovations in digital storage

Overcoming some of the drawbacks of earlier digital storage oscilloscopes, unit samples at rates closer to theoretical maximum and coins new specification

by Thomas P. Dagostino and Michael R. Turner, *Tektronix Inc., Beaverton, Ore.*

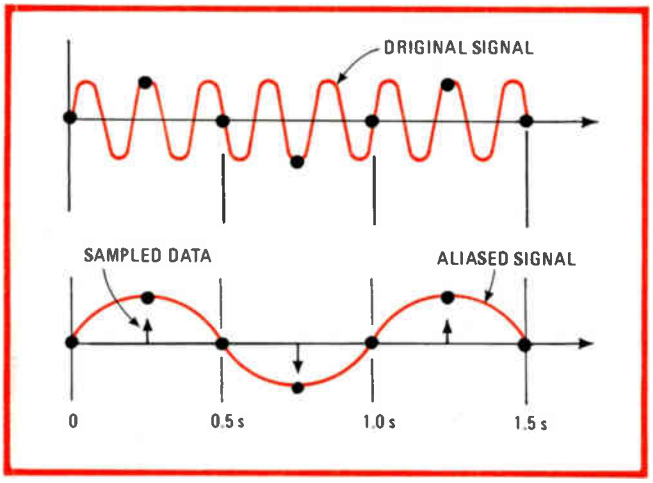
☐ Digital storage oscilloscopes are finding quick acceptance among those who understand their advantages. And recent innovations incorporated in the model 468 portable oscilloscope have overcome some of the problems of earlier digital scopes, such as jitter and envelope error, while at the same time boosting the useful storage bandwidth of the instruments.

An important advantage of the digital storage scope is ease of operation. Waveform storage is usually controlled by a single switch or push button, a system much easier to use than, for example, variable-persistence storage with a cathode-ray tube, where several interactive potentiometers control the storage of a signal.

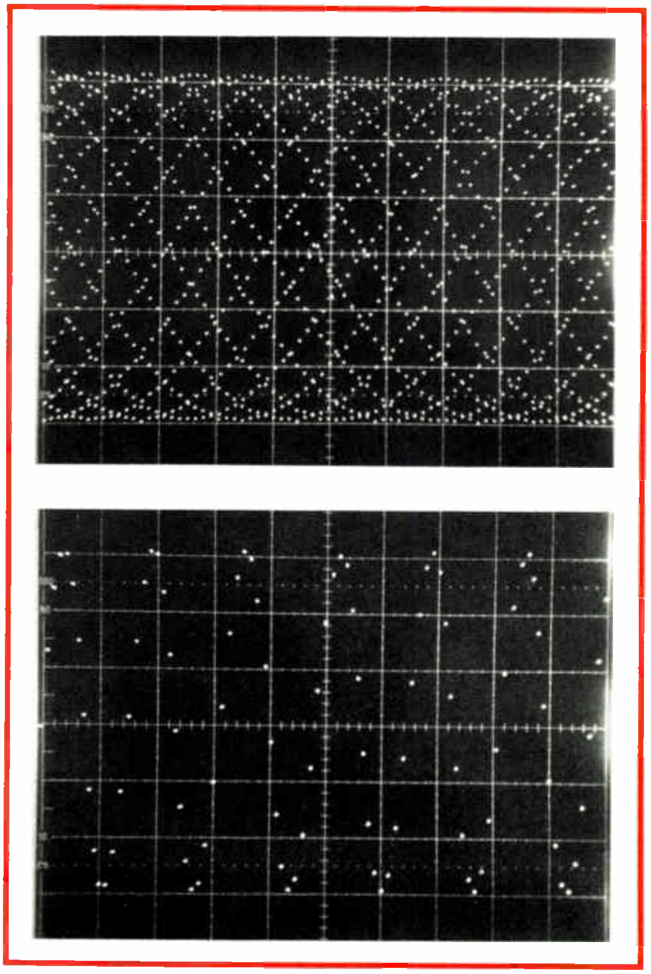
Another advantage is evident after a waveform has been acquired. Digital storage scopes have bright, crisp displays with better contrast than CRT storage scopes. The information in memory can be displayed on the screen using a constant refresh rate. Thus the display quality can be as good as that offered in nonstorage modes. Storage time is essentially unlimited and no fading or blooming will occur, no matter how long the waveform is stored or displayed.

With their ability to store multiple waveforms, digital storage scopes can be used like split-screen bistable storage scopes. What's more, some of them allow captured waveforms to be expanded and repositioned. Thus two waveforms can be overlaid for comparison, with fine enough trace quality to make this feature quite useful.

Additionally, internal or external waveform processing is possible with digital scopes. Features such as signal averaging to remove random noise or cursors for digitally controlled time and voltage measurements are available. If more extensive processing is needed, data can be



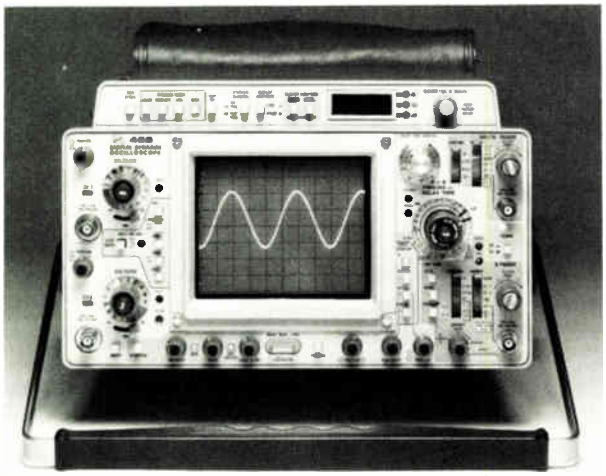
1. Aliasing electronically. The 5-MHz signal shown above was sampled at a rate of once per cycle, far above the Nyquist limit. Connecting the sample points with only the knowledge that the original signal was a sine wave gives the aliased 1-MHz signal below.



2. Aliasing by eye. Even though samples were taken at a rate well below the Nyquist limit, the display above looks like many untriggered sine waves because the eye tends to join points closest in space. The expanded display below shows the signal's true shape.

King Kong in a digital world

Building on the strength of its 100-MHz 465 oscilloscope, often referred to as the "King Kong of oscilloscopes" because of its towering market position, Tektronix has raised the 468 digital storage oscilloscope. At first glance the new scope even looks identical to the 465B44, the 465B oscilloscope introduced at NCC last spring [*Electronics*, May 24, 1979, p. 281] with the optional DM44 digital multimeter "penthouse" added.



In nonstorage mode, the 468 is the functional equivalent of the 465B; it displays dual traces up to 100 MHz at 5 mV per division, has a 2-ns-per-division sweep rate with X10 sweep magnifier, and provides trigger viewing, a variety of triggering modes, and an alternate sweep mode. In adding storage capabilities, Tektronix designers revised operation of the DMM, making it a digital storage pod.

The 468's pod is autoranging, so the range-selection push buttons of the DM44 have been replaced with keys to select store or nonstore operation, storage mode, and reference storage. The resistance, temperature, and period (1/time) functions of the earlier penthouse have also been eliminated to make room for buttons, which select pre- or post-trigger view and sine or pulse interpolators.

With the pod, bright-spot cursors select time- or voltage-measurement points. The cursors are placed on the waveform using the cursor position knob on the pod. The knob also selects the number of sweeps to be averaged if that storage mode is selected. With all these changes, the user can call into play the 468's full storage/display capabilities. **-Richard W. Comerford**

transmitted over interfaces such as GPIB or RS-232.

Digital scopes have also had their limitations. Perhaps the major one is the limit on storage bandwidth that has resulted from the relatively low speed and high cost of analog-to-digital converters and memory. Whereas a-d technology is advancing continually, digital storage scopes have a long way to go before competing with the fastest CRT storage scopes. Whereas the latter instruments can hold nonrepeating signals with frequencies of up to 400 megahertz (2,500-centimeter/microsecond beam writing speeds) with variable-persistence storage and 100 MHz (350 cm/μs) with bistable storage, digital storage had been limited to nonrepeating waveforms of about 1 MHz before the 468.

The storage bandwidth limitations of digital storage scopes have their roots in both sampling theory and display technique. Disregard for these limits results in different forms of aliasing—the signal displayed does not provide a good representation of the actual signal acquired. Aliasing can occur either because of the way in which the signal is sampled or because of the way the human eye perceives it.

Recovering signals

Sampling theory states that to be recovered completely a signal must be sampled more than twice per cycle. Another way to describe the limitation is by the so-called Nyquist frequency, which is equal to one half the digitizing rate. No signal at or above the Nyquist frequency can be recovered. Note that the Nyquist frequency rate is an asymptotic limit—exactly two samples per cycle will not do.

If a signal is sampled two or fewer times per cycle, a phenomenon called aliasing can occur, in which the reconstructed signal turns out to be a lower-frequency version, or alias, of the actual signal. Figure 1 shows a 5-MHz signal digitized at 4 MHz and the resulting display, an aliased image that appears to be a 1-MHz sine wave. Aliasing can only be prevented one way—by sampling a signal more than two times per cycle of the highest frequency it contains.

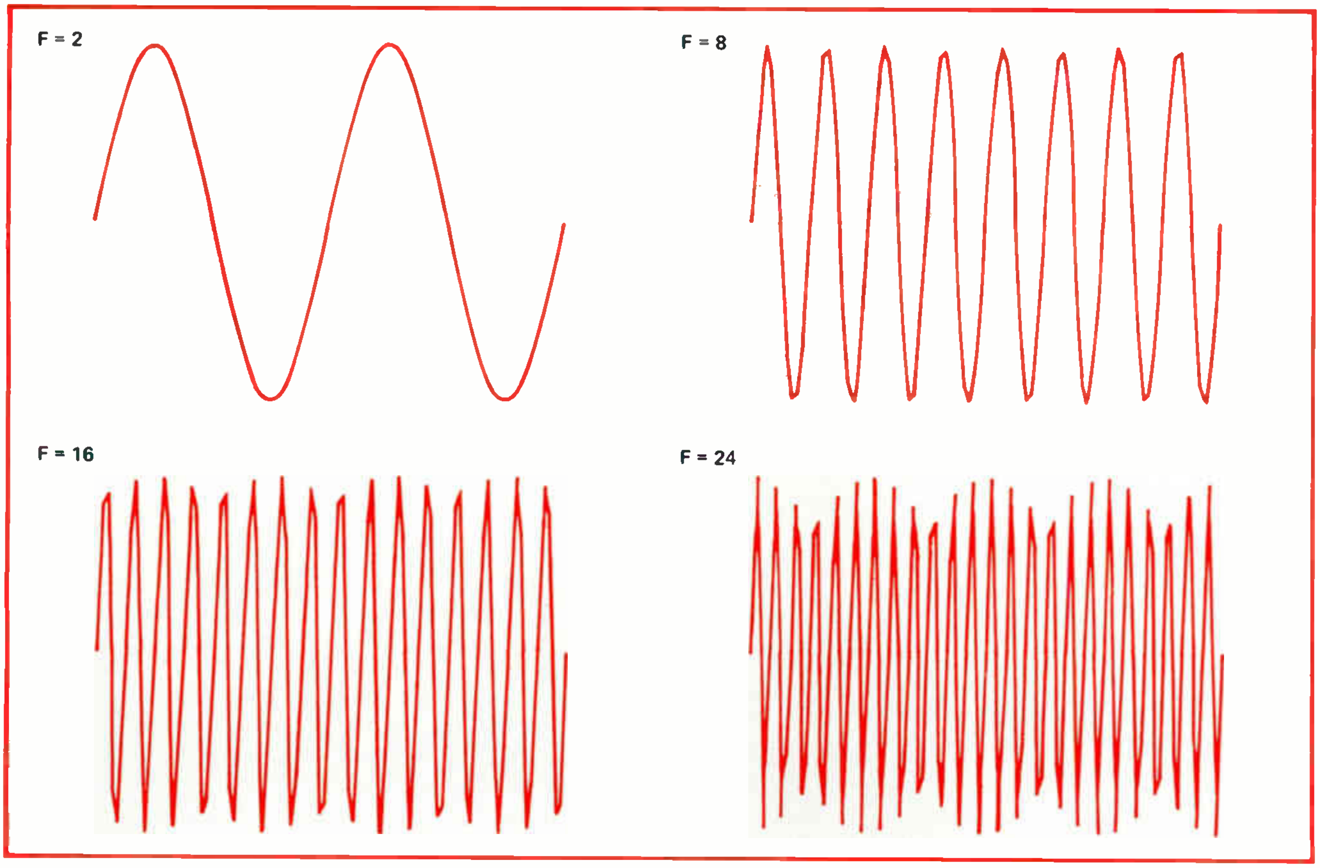
The storage bandwidth limitations of digital storage scopes are also determined by the way a stored signal is displayed. With the dot display used in some digital storage scopes, another type of aliasing—perceptual aliasing—can take place with signals that are well below the Nyquist frequency. Perceptual aliasing—seeing the wrong signal despite theoretically adequate sampling—is a result of the eye's tendency to join the closest points in space to make an image, although these may not be the closest points in time. Figure 2 illustrates this. Joining the sample points eliminates perceptual aliasing, a solution incorporated in several digital storage scopes.

Phantom carrier

Whether the dots are joined or not, another type of perceptual error can occur in which the displayed signal seems to be amplitude-modulated—that is, it appears as a carrier wave inside an envelope. This envelope error is a function of the number of samples per period, or sample density—when the digitizing rate is too low, samples will not always be taken at, or very close to, the peaks of the waveform. Figure 3 shows the envelope error increasing as the number of samples per cycle, or sample density, decreases with a fixed digitizing rate.

A third type of problem that is display-related and greatly annoys users is horizontal jitter.

With digital storage, the trigger point is a reference for stopping signal sampling. Since that point occurs asynchronously with respect to the sampling clock there



3. Pseudomodulation. A perceived envelope, seen most noticeably at bottom right of figure, results even when a vector interpolator is used to correct sample points because those points do not occur frequently enough to capture values at or near the signal's maxima or minima. For each of the above displays (showing 2, 8, 16, and 24 cycles), 64 samples are taken regardless of the number of cycles.

is a ±½ sample interval uncertainty each time a waveform is acquired. When the same waveform is acquired many times, the resultant display can look much the same as a jittery analog display. Jitter becomes very noticeable in expanded waveforms or waveforms with low sample density, where ±½ sample interval can be a significant fraction of the screen or a waveform cycle.

Recognizing these disadvantages that have plagued other digital storage scopes as well as the advantages digital storage offers in a general-purpose oscilloscope, Tektronix developed its 468, which combines 10-MHz useful digital storage with all the nonstorage capabilities of the industry-standard, 100-MHz 465B (see "King Kong in a digital world," opposite page). Key to overcoming the disadvantages was the development of a very fast digitizer in combination with stored-signal–processing capabilities that permit the user to select a display scheme that is appropriate to the particular measurements he is making.

The heart of the 468 acquisition system is a 25-megasample-per-second a-d converter. Inside this very high-speed converter are 255 strobed comparators with decoding logic to convert the outputs of the comparators into an 8-bit data word. The digitizing rate varies from 10 samples per second at a 5-second-per-division sweep speed to a maximum of 25 million samples per second at sweep speeds of 2 microseconds per division and faster. Until now, this maximum digitizing rate has been specified by digital storage scope manufacturers to suggest the storage bandwidth of digital storage oscilloscopes.

Although this specification indicates the Nyquist frequency, it does little to allow a potential user to compare them with CRT storage scopes. This is because the fastest signal that can usefully be digitized and displayed depends not only on the digitizing rate but also on the display technique. This combination is embodied in the concept of useful storage bandwidth (USB) (see "About the new scope specs," p. 164).

Reducing samples

For sine waves, approximately 25 samples per cycle are necessary for a dot display to give an accurate representation of the signal. Were it to provide such a display, the 468's useful storage bandwidth with this type of display would be 1 MHz. Joining the dots with vectors improves this ratio to only 10 samples per cycle, so the USB is therefore 2.5 MHz. But by internally processing a stored signal using its sine interpolator, the 468 requires only 2.5 samples per cycle to display sinusoidal signals accurately and thus achieves a useful storage bandwidth of 10 MHz.

The use of this proprietary sine interpolator prevents envelope errors from occurring during sine-wave measurement; it looks at the relative location of each sampled point before interpolating intermediate points between the last two sample points. Several factors in the

About the new scope spec

Sampling theory states that more than two samples per cycle of a sine wave are needed to characterize the signal. But despite this mathematical acceptability, ergonomically speaking, a signal shown with little more than two dots per cycle is impossible to understand. Increasing the number of samples per cycle begins to show the shape of a sine wave, and at approximately 25 samples per cycle the display is unmistakably that.

When vectors are used to connect the slightly more than two samples per cycle of a sine wave, the display is again meaningless. As the number of samples increases, however, the sine-wave image starts to appear. Now approximately 10 samples per cycle alone are needed to define it.

Since mathematically the signal can be defined with little more than two samples per cycles, it should be possible to represent the signal to a user with fewer than 10 samples per cycle. If the digitized information is passed through an interpolator—in this case, a digital low-pass filter—the original signal can be recreated from fewer samples.

With the sine interpolator in the 468, only 2.5 samples per cycle of a digitized sine wave are needed to display that waveform. This is a sample reduction factor of 10 over a simple dot display and a factor of 4 over a simple vectored display. The accompanying screen photos demonstrate the result of digital interpolation.

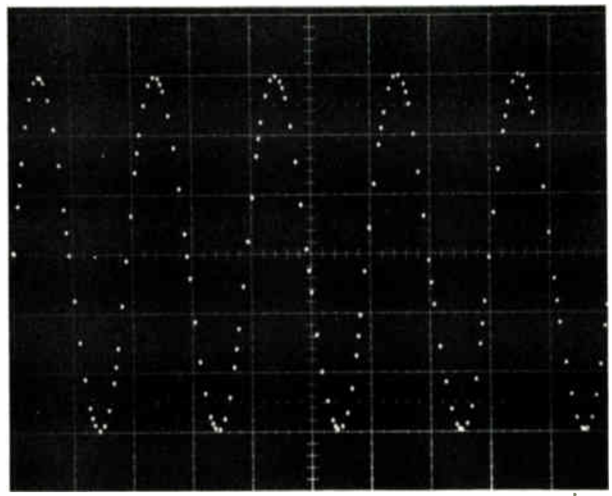
With this background, the useful storage bandwidth of digital storage oscilloscope can now be defined with the following equation:

$$USB_{(MHz)} = \text{digitizing rate}_{(MHz)}/K$$

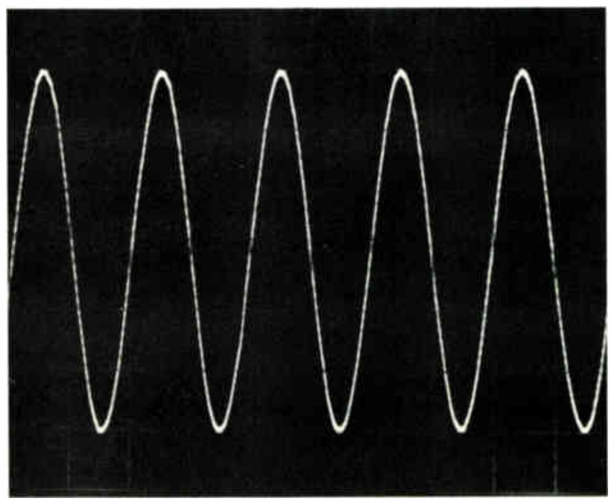
where K is 25 for dot displays, 10 for vector displays, and 2.5 for a sine interpolator like that used in the 468.

1 MHz

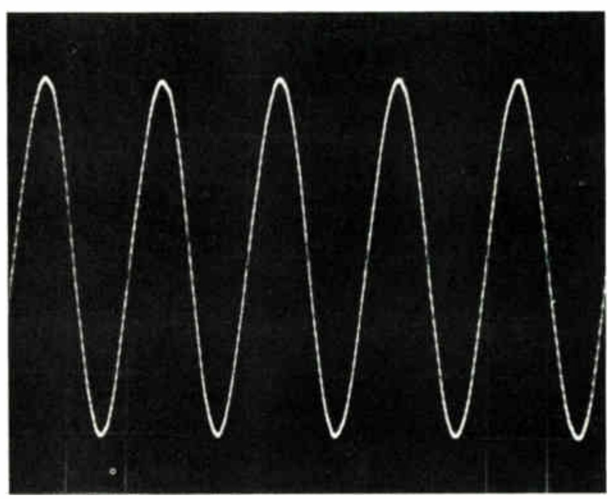
DOT INTERPOLATION



VECTOR INTERPOLATION



SINE INTERPOLATION



design of the interpolator are balanced against each other, the most important being processing time, amplitude response as the signal approaches cutoff frequency, and impulse response. Basically, the sine interpolator can be considered an approximation of an ideal brick-wall filter, which drops all frequency components above the usable storage bandwidth.

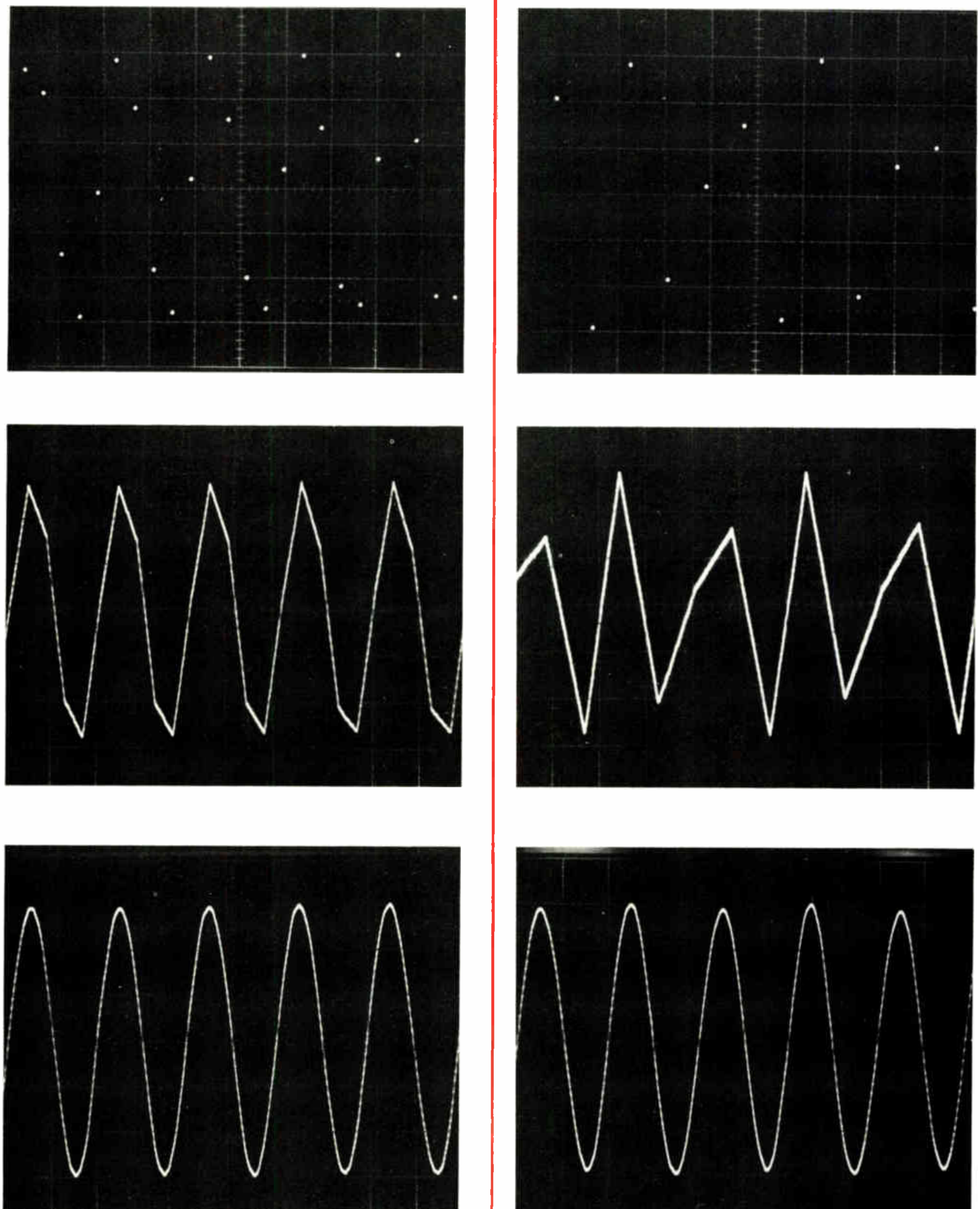
As such, the interpolator works wonders with sinusoidal signal samples, but its manipulation of pulses would be less than ideal. This is why a pulse interpolator like that in other digital scopes is also provided.

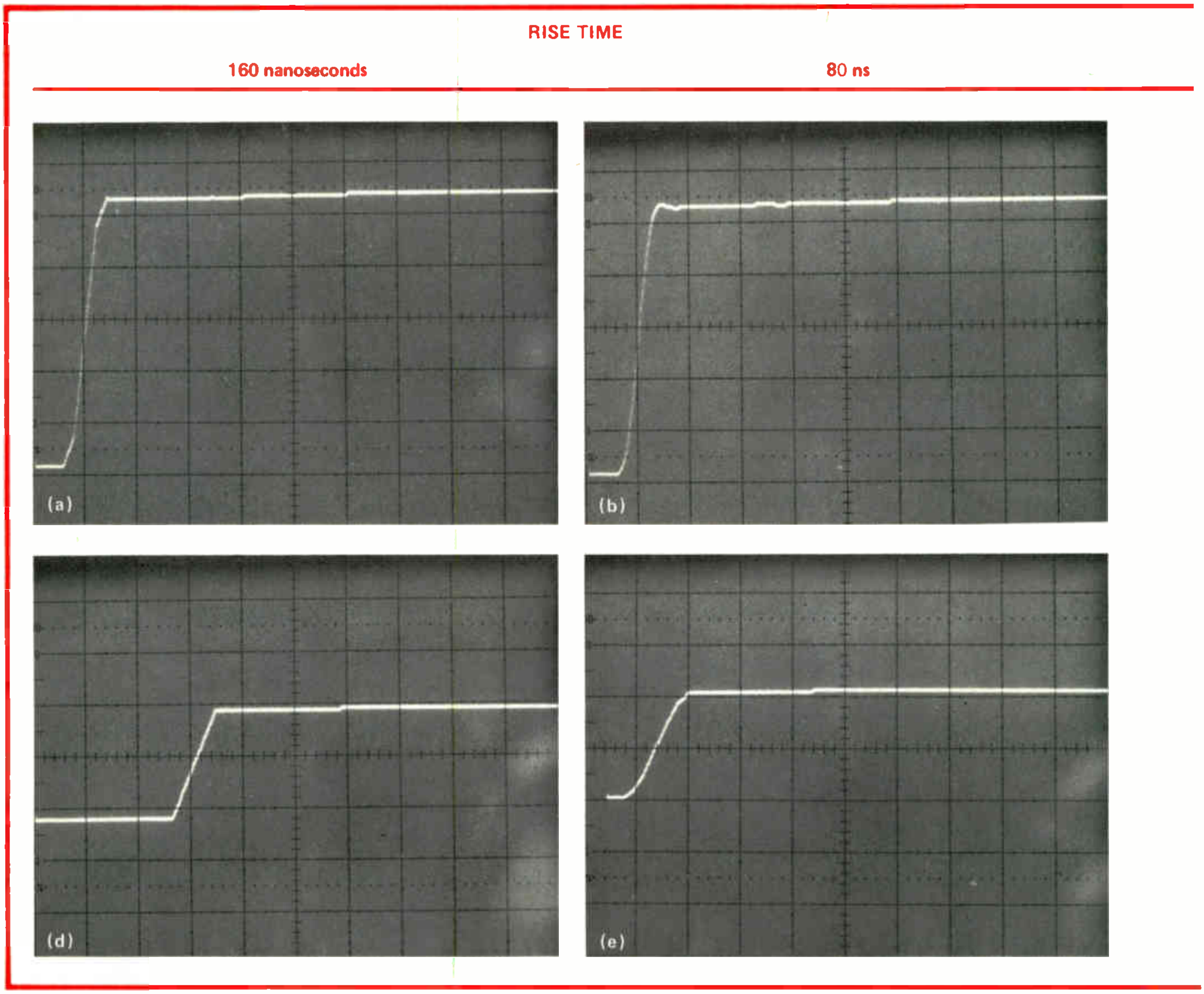
Fourier analysis shows that a step consists of many harmonics all summed together. As the step time decreases, a system with a greater bandwidth is required to pass the signal without degrading its rise time. If a step that contains significant energy beyond the cutoff frequency is put into the sine interpolator, it will emerge with preshoot and overshoot. This preshoot and overshoot on a square wave are similar in appearance to the Gibbs phenomenon.

If the signal presented to the 468 sine interpolator has many samples on the rise time, the convolution of the impulse response of the filter and the input waveform will not produce any distortion. When there are less than three samples, the preshoot and overshoot will begin to manifest themselves.

When there is only one sample on the rise, the convo-

5 MHz	10 MHz





4. A matter of interpolation. Signals with rise times of 160, 80, and 6 ns are reconstructed using a sine interpolator (a, b, and c, respectively) and a pulse interpolator (d, e, and f). When fewer than three samples are taken during rise time as in c, the sine interpolator produces overshoot and undershoot in the reconstruction. For this reason, both interpolators are included in the 468.

lution of the input step and the impulse response of the filer yields the integral of the impulse response. This integration can be plainly seen in Fig. 4. As the number of samples on the rise decreases (Figs. 4b and 4c) the amount of preshoot and overshoot increases. Figures 4d, 4e, and 4f show the input waveforms processed by the pulse interpolator of the 468.

To provide the greatest possible measurement accuracy with all possible input signals, it was decided that the 468's users should be able to select the form of interpolation, hence the inclusion of the pulse interpolator.

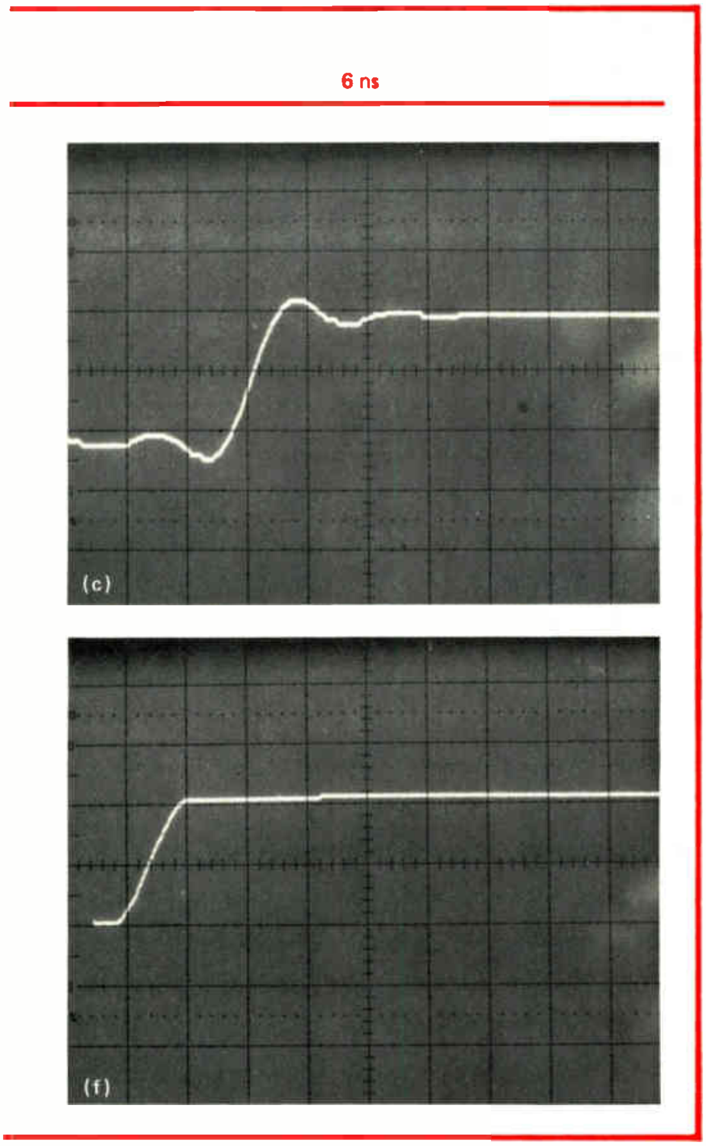
Judicious use of the 468's high sampling rate permits it to address other shortcomings digital storage scopes have had. The time resolution of digital scopes is not as great as that of CRT storage scopes: digital sampling is a discrete process, whereas CRT storage is continuous, making CRT-stored signals infinitely divisible. This has made certain measurements more difficult, if not impossible, with digital storage scopes.

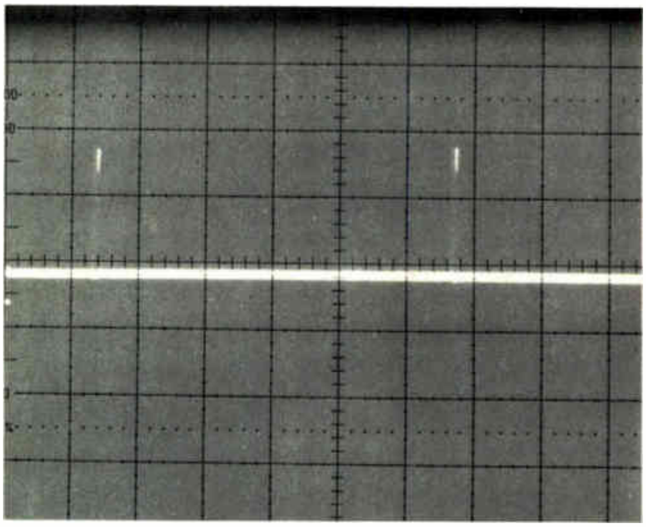
For example, suppose the one-time occurrence of the time difference between two 10-μs pulses about 7 seconds apart were to be measured. Using CRT storage, the time base could be set to one division/s and the scope triggered by the first pulse. The time between pulses could then be read from the screen-stored signal as the length of time from the start of the trace to the displayed second pulse.

Resolving the differences

Making this measurement with most digital storage scopes would be more difficult. First, a sample rate fast enough to guarantee capturing the pulses—say 5 microseconds per sample—would be needed, as well as a record length long enough to capture over 7 s of information. Assuming a 10-s record length and 5 μs per sample, 2 megabytes of memory would be needed in order to acquire the signal.

The 468 allows this type of measurement with its





5. Judicious capture. To display two 10-μs pulses the scope must sample at 25 megasamples/s. Since retaining all samples for the 10-s interval shown would require massive memory, only the maximum and minimum of each 50 samples are stored in envelope mode.

envelope mode, which effectively uses two sampling rates to capture the pulses and the time difference.

The overall sample rate is controlled by the time/division setting. Each horizontal division represents 50 samples; dividing the time/div setting by 50 gives the sample rate. For instance, if the time/div setting is 1 s/div, the sample interval is 1 s/50 samples, or 20 milliseconds/sample.

But the 468's high-speed a-d converter can go much faster. In this situation, it is beneficial to use the converter's full sampling capability to determine during which two 20-ms sample intervals the two 10-μs pulses occurred. The envelope mode runs the converter at a fast rate (in this case 200 nanoseconds/sample) and looks for the minimum and maximum values that occur in the window between sample storages. These values are recorded in memory, and the 468 display (Fig. 5) shows a 10-s record with the two 10-μs pulses easily and clearly displayed.

The envelope mode is also useful for catching glitches or indicating occasional dropped or extra pulses in a pulse train, when multiple sweeps are acquired and displayed. In this mode, the firmware routine that transfers information from the acquisition memory to the display memory also performs another minimum and maximum comparison. The new data is compared with that already in the display system, and only the minimum and maximum values for each sample window are retained. This enables the user to see how an input waveform is changing over a user-selectable number of sweeps—from 1 to 256, as well as continuously.

The 468's unique envelope mode is also useful as an aliasing indicator. If aliasing is not occurring, the envelope mode display will look like the normal storage acquisition display. If a signal is being undersampled and aliasing is occurring, the envelope mode will indicate this with a solid band across the oscilloscope's CRT display.

The 468's display also incorporates jitter correction, solving a problem that has plagued all other commercial digital storage scopes. The jitter-correction circuit corrects for the ±½ the sample interval shifting of a waveform caused by the asynchronous relationship between trigger point and sample clock.

First, during acquisition the time between the trigger and the next sample clock is measured. A horizontal offset is then computed and the offset summed with the ramp displaying the digitized waveform. This results in a stable waveform on the CRT display, even when the waveform has been expanded. Though the technology needed to correct jitter is not too difficult to implement, other scope manufacturers seem not to have felt the need to include it.

These innovations address three shortcomings present in previous digital storage oscilloscopes. Display interpolation improves the useful storage bandwidth possible with a particular sample rate. The envelope mode detects aliasing and also catches glitches and other fast pulses. Jitter correction helps make the displays useful, even at low sample density. Such advances let digital oscillography achieve its full potential. □

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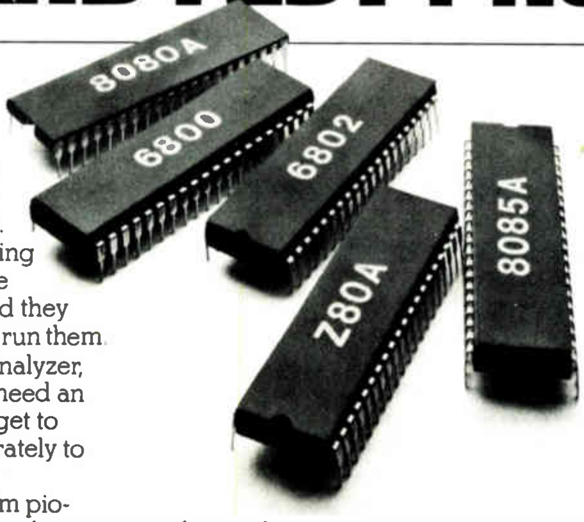

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MILLENNIUM INTRODUCED A NEW KIND OF BOARD TEST SOLUTION.

LR oscillator indicates inductance directly

by John Jamieson
Technical Analysis Corp., Atlanta, Ga.

Inductance measurements accurate to within ±10% may be made simply if the inductor is connected into the frequency-determining portion of this low-cost LR oscillator. Component values have been selected so that the oscillator's period, in seconds, equals 0.01 times the coil's inductance in henries, over the range from 0.5 millihenry to at least 10 H. Thus the inductance can be read directly from a period/frequency counter connected to the circuit's output.

A_1 of the TL084 operational amplifier serves as the integrator in the basic oscillator, with A_2 a Schmitt trigger having trip points at one sixth and five sixths of the supply voltage and A_3 a 1-to-20 voltage divider. A_4 derives a voltage reference equal to half the supply voltage for driving A_1, A_2, and A_3.

A_3 delivers a current into A_1 of magnitude $i_L = (1/L)\int V_L dt$, where V_L is the initially negative output voltage of A_3 and L is the inductance under consideration. As a consequence, the output of A_1 is a ramp of voltage $V_o = RV_L t/L$, where resistor R controls the gain of the stage, and t is time. Thus V_o rises linearly until A_2's trigger point is reached, whereupon it switches and brings V_L high so that V_o begins to decrease linearly. The cycle is repeated when the Schmitt's lower threshold point is reached.

Selecting the period of oscillation to fall in the area of $t = \tau/4$, it is seen that $V_o = (RV_L\tau)/(4L)$, or $L = (RV_L\tau)/(4V_o)$. Because $V_L \approx V_o/13$, then $L \approx R\tau/52$. With R adjusted so that $R/52 = 100$, $L = 100\tau$.

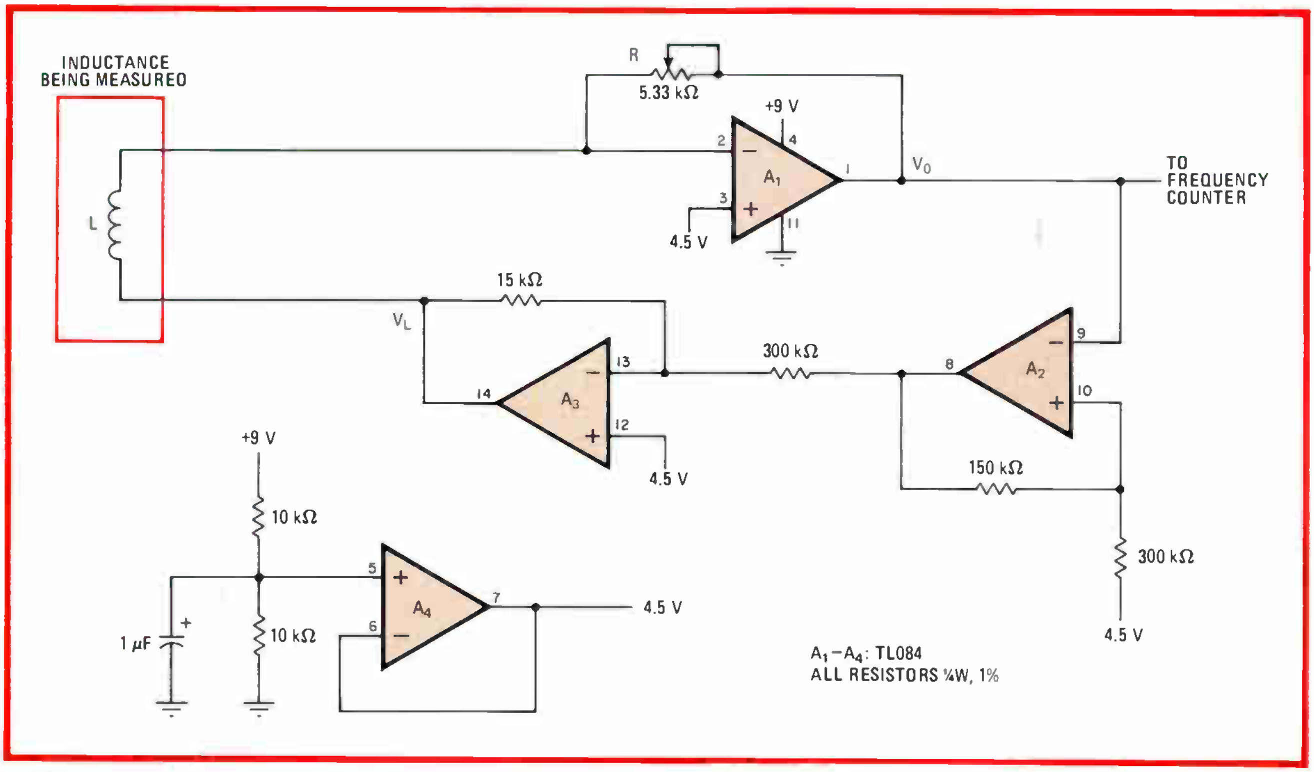
The preceding analysis assumes that the ohmic resistance of the inductor is small. For each ohm of resistance present below 10 Ω, there will be an approximate decrease of 0.1% in the accuracy of the measurement.

For inductors with considerable resistance, it will be noted that:

$$i_L = (1/L)\int V_L(1 - e^{-R_L t/L})dt$$

where R_L is the resistance of the inductor, and so it can be shown that $L = (-R_L\tau/4)\log_e(0.9975R_L)$. Thus to find the inductance, it is necessary to measure its resistance, R_L; place the inductor in the circuit; and note the frequency of oscillation, τ. L may then be calculated. □

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.



Self-measuring. Inductance of low-resistance coils is measured to within ±10% by noting frequency of LR oscillator of which the inductor is a part. Frequency counter may be used to indicate inductance directly, since period of oscillator, in seconds, is 1/100 of the inductance value in henries. Procedure is slightly modified for inductances having high impedance, most of which is ohmic for units having low hysteresis.

One-chip multiplexer simplifies eight-trace scope

by Sam Curchack
EDO Corp., Government Products Division, College Point, N. Y.

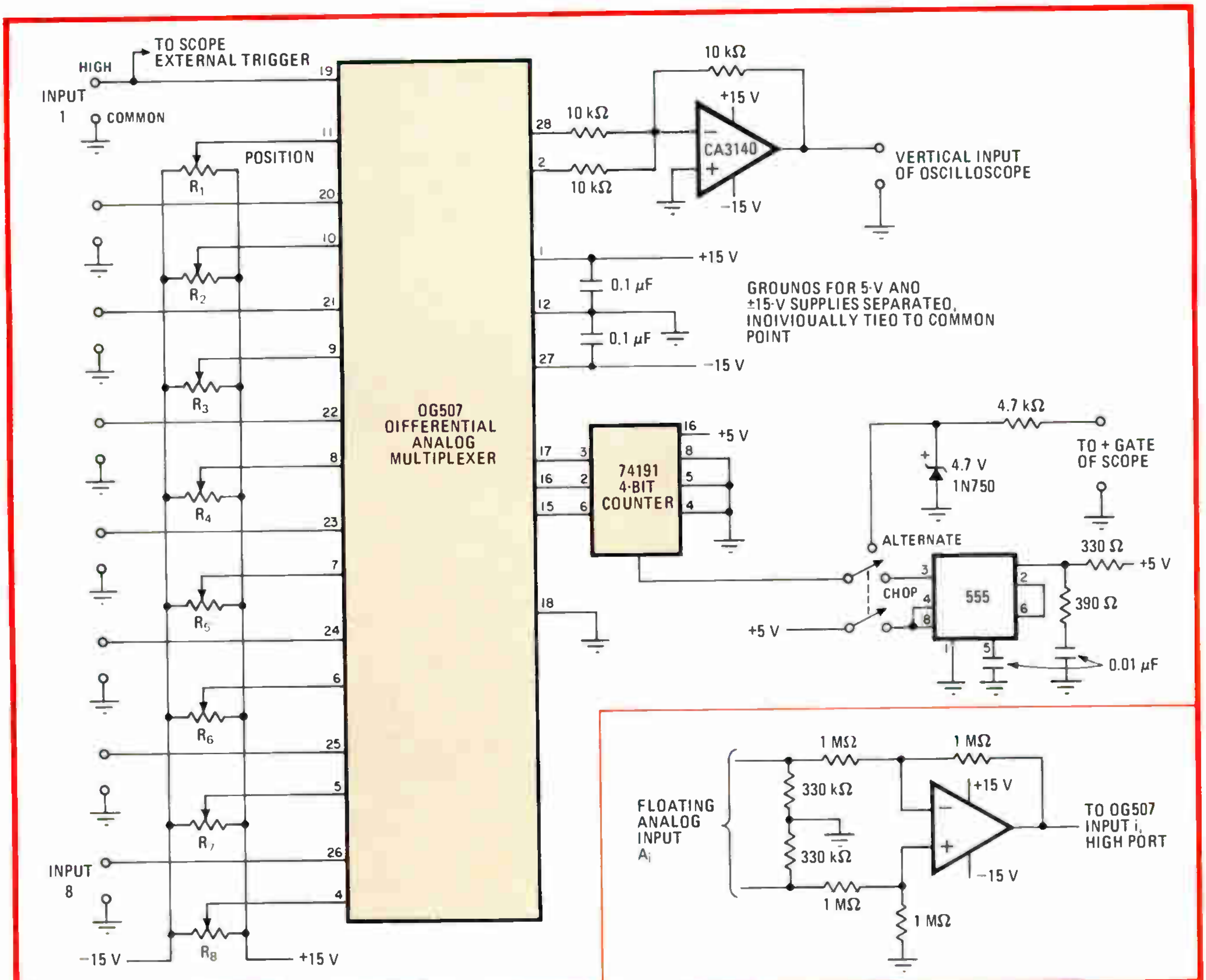
Displaying eight analog signals simultaneously with only a single-trace oscilloscope, this switching circuit can be built for even less ($35) than the one proposed by Wright.[1] Circuitry is simplified, too, by the use of a one-chip, eight-channel differential multiplexer. And unlike most other arrangements, this unit is more versatile, having a chopped-mode and alternate-mode option and trace-positioning controls for each analog input.

In the chopped mode, which can be used at sweep speeds up to 50 microseconds/centimeter, all traces are referenced in time to input 1, which is the signal used to trigger the scope. Operational amplifiers (see inset) may be added for handling floating inputs. The 555 timer, operating as an astable multivibrator, switches the 74191 4-bit counter at a 9-μs rate, the sampling-bit time. This action in turn sequentially switches the DG507 multiplexer. As each input is selected, it is added to the dc output voltage of its positioning potentiometer (R_1–R_8).

At sweep speeds of 1 millisecond/cm and faster, the unit's alternate-mode option may be used. The 555 is deactivated and each analog input is switched in turn at any sweep speed selected by the user. The resulting display, devoid of most switching transients, is somewhat cleaner than can be achieved in the chopped mode. All other settings remain the same. A gating signal is required to synchronize the 4-bit counter, however. This signal is supplied by the scope's +GATE port.

More than 8 traces can be displayed on a dual-trace scope. With an additional 8-trace switching unit of the type previously described, 16 traces can be displayed. A large screen scope such as the Tektronix 7603 will be required for suitable resolution in this case. □

References
1. George O. Wright, "Eight-trace scope display checks analog or digital signals," *Electronics*, Aug. 4, 1977, p. 108.



Sweep switch. Low-cost circuit displays eight analog signals on single-trace scope with aid of one-chip analog multiplexer. Alternate-mode (flicker-free above 200 μs/cm) and chopped-mode options are available. Each trace may be individually positioned on screen.

Pilots will experience the sights, sounds, and feel of flying in combat in a new Hughes simulator. The system will help train pilots of the U.S. Navy and Marine Corps F/A-18 Hornet strike fighter. It includes two 40-foot domes, each surrounding a simulated cockpit. Projected onto the domes will be computer-generated pictures of sky and earth, maneuvering aircraft, missiles, and gunfire. The images will move in response to the pilots' actions as they "fly" the trainer. An instructor at a separate console can pose tactical problems, monitor the mission, and evaluate performances.

Remotely piloted vehicles using a new video processing technique could relay TV pictures with less chance of being detected or jammed by an enemy. The method, developed by Hughes for the U.S. Army, first separates potential targets from background clutter. Background areas are then converted into a white-on-gray outline picture that's updated every second. A window containing the prime target is allowed a fuller range of tones and is updated at a rate of 7-1/2 frames per second. Other targets receive lower resolution or are converted to symbols, and are updated every second. Though standard TV is sharper because it uses twice the line resolution and is transmitted at 30 frames per second, this compression technique transmits all vital data with one-thousandth the bandwidth.

Improvements to the U.S. Navy's Phoenix missile will enable the radar-guided weapon to meet anticipated airborne threats through the 1990s. The current model, the AIM-54A, now carried on the F-14 Tomcat fighter, is the service's primary long-range air-to-air weapon. The new AIM-54C incorporates a digital guidance unit that will be more flexible and reliable than the analog unit it replaces. Other changes include an inertial reference system to improve range and accuracy, a solid-state transmitter-receiver with increased capability over the existing klystron tube, and a target-detecting device developed by the Naval Weapons Center. Hughes is building 15 engineering development models of the improved Phoenix for captive flight tests and actual firings.

Hughes Research Laboratories needs scientists for a whole spectrum of long-term sophisticated experiments. Advanced research programs include three-dimensional microelectronics, digital picture processing, space optics, solid-state devices, fiber optics, integrated optics, integrated circuit design, and electro-optical materials. Send resume to Professional Staffing, Dept. SE, Hughes Research Laboratories, 3011 Malibu Canyon Road, Malibu, CA 90265. Equal opportunity M/F/HC.

Finding wasted energy is one of many ways that a hand-held infrared viewer helps its users save money. The device, a Hughes Probeye® viewer, senses heat to create a red-on-black image for display through an eyepiece. It let workers at a large airport pinpoint underground steam leaks within a 10-foot circle, thereby avoiding costly exploratory excavations that would have disrupted airport operations. Paper manufacturers use the viewer to monitor paper sheets for moisture differences that can cause defects. The scanner picks up temperature changes caused by varying moisture conditions. Inquiries about the energy and safety uses of the Probeye viewer should be directed to (714) 438-9191, Ext. 223.

Creating a new world with electronics

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Test set characterizes FET's AGC response

by John Dunn
Bertan Associates, Syosset, N. Y.

The relationship of a field-effect transistor's gate-to-source voltage (V_{gs}) to its drain-to-source resistance (R_{ds}), and consequently its suitability for use in automatic-gain-control circuits, can be found with the n-channel FET tester described here. Making the FET's R_{ds} a part of one leg of a Wien-bridge oscillator makes it possible for a technician to correlate the bridge's instantaneous output frequency with a bridge-generated voltage that corresponds to the applied V_{gs}. Because the frequency is related to R_{ds} by a simple equation, R_{ds} may be readily plotted against V_{gs}.

Operational amplifier A_1 and zener diode D_1 maintain a voltage of about 7.5 volts for the FET's source, with its uncommitted drain connected into the circuit such that under steady-state conditions the Wien bridge built around A_3 is balanced at any given frequency for:

$$R_{ds}/(R_{fb}+R_{ds}) = (j\omega C_aC_b)/[j\omega R_aC_a(1+j\omega R_bC_b)+(1+j\omega R_bC_b)+j\omega C_aC_b]$$

Because $\omega = 1/(R_aR_bC_aC_b)$, the condition for balance simplifies to:

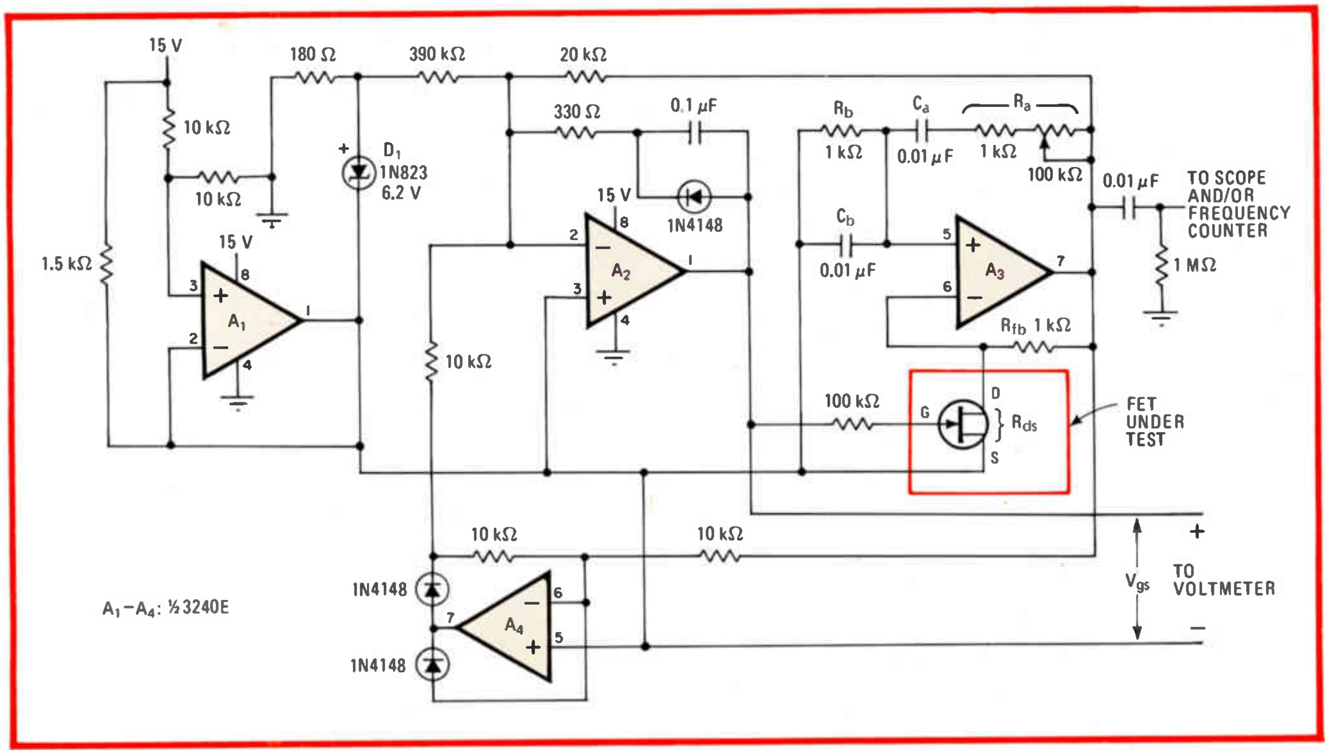
$$R_{ds} = R_{fb}/[(R_a/R_b)+(C_b/C_a)]$$

Noting that $R_a = 1/(\omega^2R_bC_aC_b) = 1/(4\pi^2f^2R_bC_aC_b)$, where f is the frequency of the oscillator, then $R_{ds} = R_{fb}/[1/(4\pi^2f^2R_b{}^2C_aC_b)+(C_b/C_a)]$. Thus R_{ds} may be determined for any frequency selected by R_a, and the AGC plot constructed if the corresponding V_{gs} for that frequency is recorded. Note that the required gate-to-source potential of 0 to −7.5 V is derived from the Wien bridge itself via A_2 and A_4.

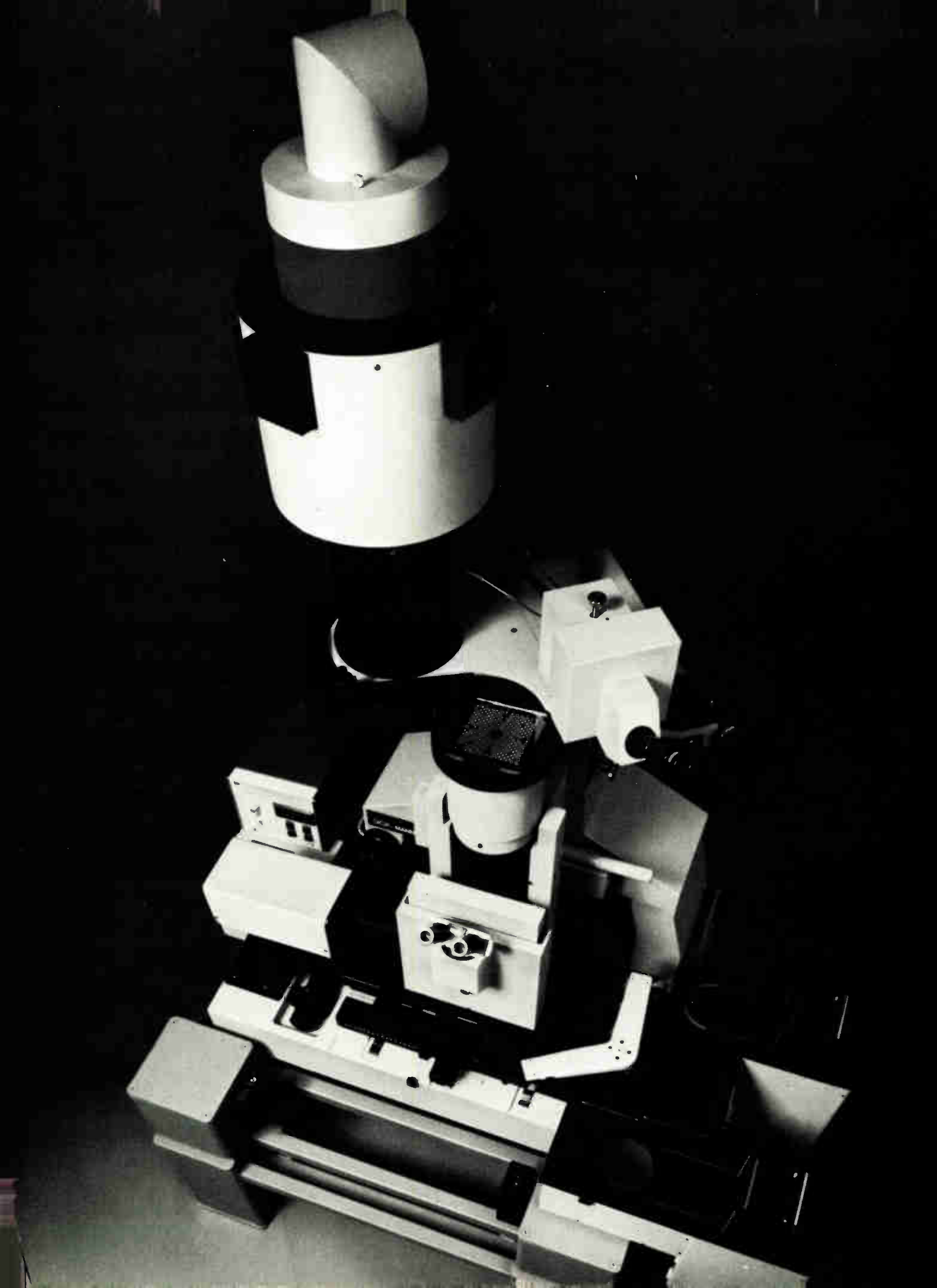
The typical response of a Motorola MPF4391 is tabulated (see table) and may be used to check the tester's operation. □

AGC RESPONSE OF MPF4391 FET

V_{gs}	Frequency, Hz	R_{ds}, Ω
0	2149	17.9
−0.5	2303	20.5
−1.0	2465	23.4
−1.5	2656	27.1
−2.0	2893	32.0
−2.5	3207	39.0
−3.0	3683	50.8
−3.2	3936	57.6
−3.4	4314	68.4
−3.6	4836	84.5
−3.8	5604	110.3
−3.9	6199	131.7
−3.95	6560	145.2
−4.0	6949	160.1



Charting gain. Tester, with n-channel FET placed in leg of Wien-bridge oscillator, helps find relationship of FET's drain-to-source resistance (R_{ds}) to its gate-to-source voltage (V_{gs}), and thus its suitability for use in automatic-gain-control circuits. The common variable is frequency, which has an effect on R_{ds} via feedback voltage V_{gs}. The typical response of Motorola FET (table) aids in checking out the tester.



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The IC imaging system of the future is here today. And, as you'd expect, it's a GCA Mann® product. Specifically, the DSW Wafer Stepper™ direct step on the wafer system.

Today, more than 70 DSW Wafer Stepper systems are installed in production facilities around the world, shaping the future of semiconductor manufacturing. And, we're constantly developing ways to increase its already remarkable performance with features and new systems to automate its operation.

Automatic Wafer Handling

The Automatic Wafer Handler, for instance, automatically loads, pre-aligns and unloads 2 in. to 125mm wafers. And, it virtually eliminates wafer breakage. Since the AWH handles up to 25 wafers at a time, the need for operator access to the DSW's controlled environmental chamber is minimized.

Automatic Wafer Leveling

This feature is especially useful for handling imaging problems on GGG or SOS materials. The AWL automatically corrects for wedge in substrates by using the DSW Wafer Stepper's automatic focus control.

Automatic Wafer Alignment

The repeatable, automatic operation of the AWA also helps ensure consistently high quality and productivity. From wafer to wafer, shift to shift, and operator to operator, the AWA provides faster and more precise alignment than manual methods, so throughput and yield increase.

Automatic Reticle Changer and Aligner

With this system, you can randomly select and align any one of up to 10 reticles automatically. So operation is faster and overall system productivity rises.

Floppy Disk

The floppy disk allows you to load programs quickly and input specifications with high accuracy. Storage capacity is also increased and programs can be changed easily for even greater system flexibility.

Machine-to-Machine Registration

DSW Systems can be matched to within $\pm 0.5\mu m$ so any job can be run on any matched machine. This capability eliminates production bottlenecks and maximizes equipment use.

Wafertrac™ Interface

Combines the Wafertrac™ Wafer Processing System and the DSW Wafer Stepper into a single, integrated wafer production system. Automated operation lets you do processing and direct photoimaging without the breakage and contamination problems associated with manual transfers.

Reticle Stepper

The Reticle Stepper System – GCA's new 4500 – is a significant advance in maskmaking technology. The system steps a single circuit pattern into a block array at 1:1, decreasing pattern generation time – without sacrificing precision or yield. These reticles increase the throughput of the DSW.

The Next Step: See For Yourself

All things considered, for your VLSI effort, GCA's DSW Wafer Stepper system is the only microlithographic imaging system in operation today that can reliably produce such high yields. For more information, write: GCA/Burlington, 209 Burlington Road, Bedford, MA 01730. Or call: (617) 275-5400.

And get ready to step directly into the future.

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Circle 175 on reader service card

Engineer's newsletter

Save yourself testing time

Determining why semiconductors and related devices fail can be a time-consuming task. Applied Reliability Consultants Inc. will **analyze defective semiconductors, microwave components, and electromechanical parts** to determine if the failure was caused during manufacture, by an overstress condition, or by misuse of the device. The company evaluates the electroplating process and performs corrosion-effect studies, as well as integrity tests of the soldering, welding, and bonding methods. After determining the source of the problem or problems, it issues a final report including test data, microphotos, and corrective recommendations. The price of the service varies with each customer's requirements.

For more information, contact Applied Reliability Consultants Inc., 471 Amherst St., Nashua, N. H. 03060.

Toeing the fine VLSI line

As integrated-circuit lithography plunges ever deeper into the very large-scale era, accurate and precise optical measurements of 0.5-to-10-μm line widths on silicon wafers and photomasks become more and more critical to their successful manufacture. The National Bureau of Standards is planning to give **a four-day seminar on this subject** at the NBS site in Gaithersburg, Md., from July 15 to 18. The seminar will be open to a maximum of 30 engineers and senior technicians from the IC industry—IC manufacturers, photomask suppliers, and instrument manufacturers. The fee for the seminar is $300. Applications may be made to Elaine Cohen, Room A-305, Technology Building, Washington, D. C. 20234, or call her at (301) 921-3181.

Diode saves the day with PROM programmer

A single diode provided the fix that A. W. Wiegert of Hammond, Ontario, needed for some mysterious and intermittent problems he was having with a programmable read-only memory programmer that was part of a commercial Z80 microprocessor development system. After quite a bit of trouble-shooting, the fault was traced to a Texas Instruments TIL 497 step-up switching voltage regulator that was starting up intermittently. Evidently, according to Wiegert, **the current-limiting stage of the regulator may be overloaded** by the very large inrush currents caused by the charging of the output filter capacitor during startup. This in turn would cause the regulator to start improperly.

Wiegert's solution was to connect an external diode (a IN 4002) with its anode to the +12-V input and its cathode to the positive regulated output (+27 V in this case). When the diode was added, the circuit started up consistently.

How to get into the V-MOS power FET groove

V-groove MOS power field-effect transistors are still too new to be explained in any current textbook—but Siliconix' new "Power FETs Application Handbook" gathers together a good assortment of practical information on them. It includes circuitry and **explains how to use the devices in IC interfaces,** power supplies, and audio circuits. There are also design aids and tips. The handbook is available at no charge to qualified persons who call Siliconix Marketing at (408) 988-8000 or write on their company letterhead to Siliconix Inc., 2201 Laurelwood Rd., Santa Clara, Calif. 95054.

-Jerry Lyman

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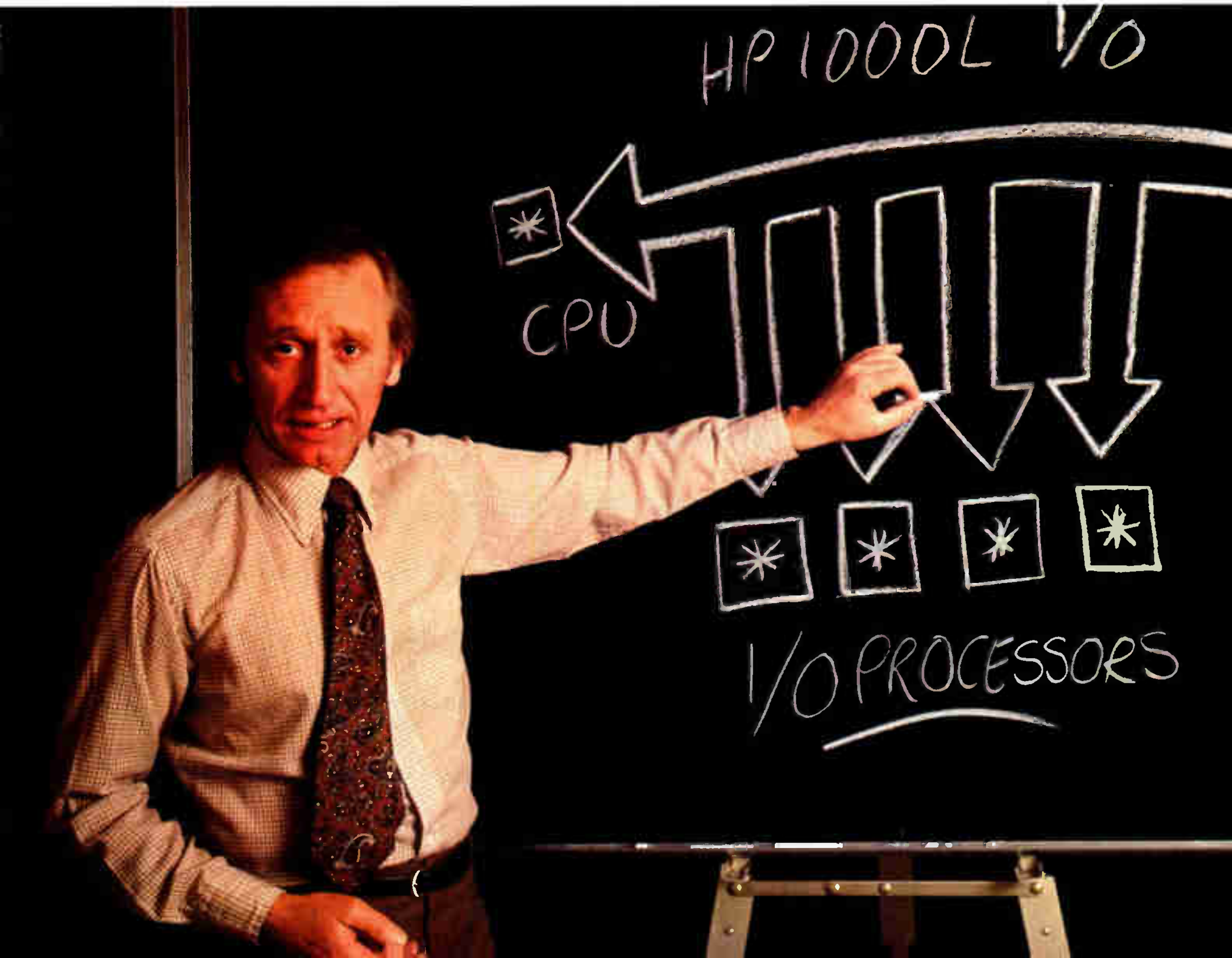

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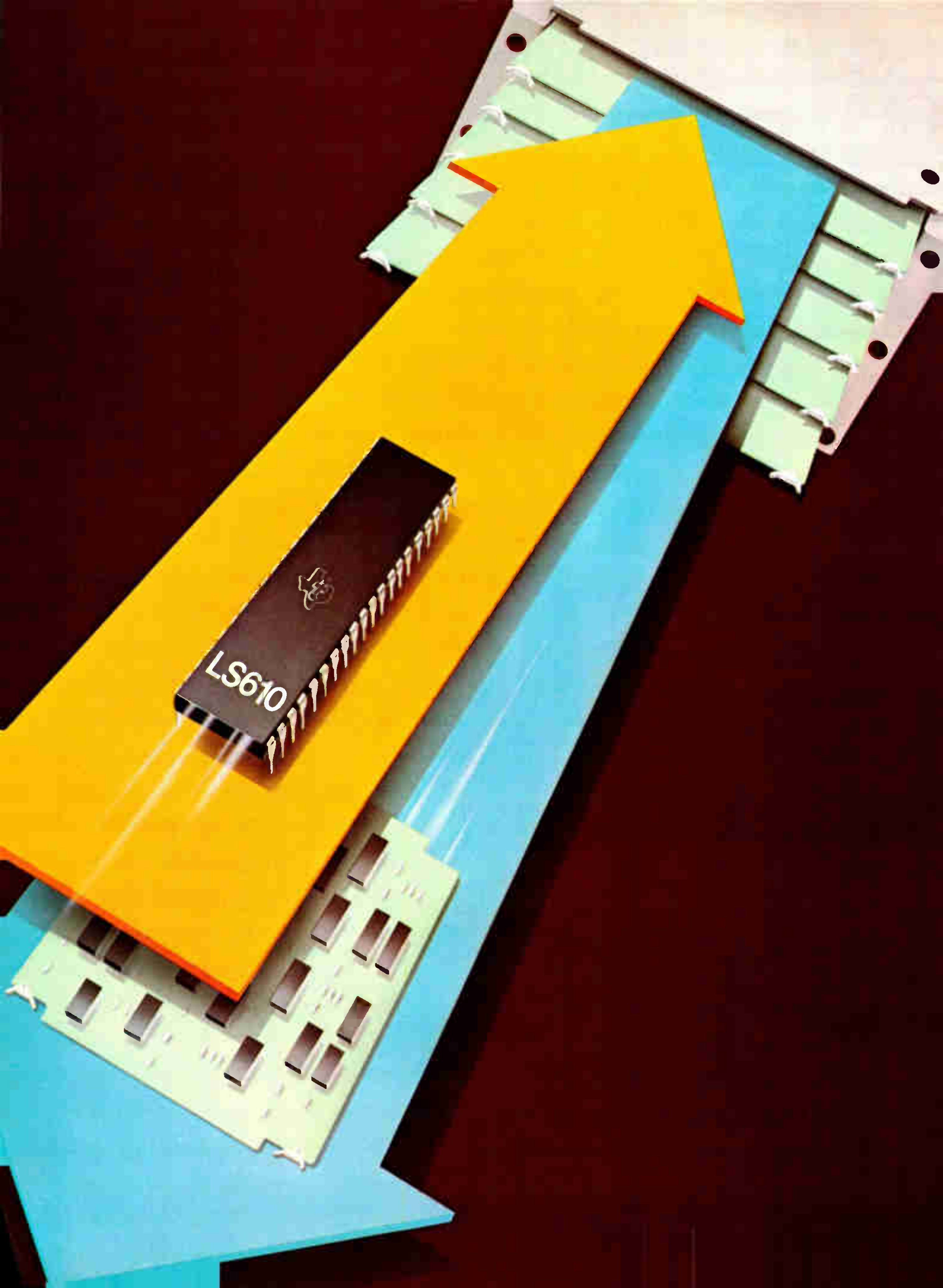
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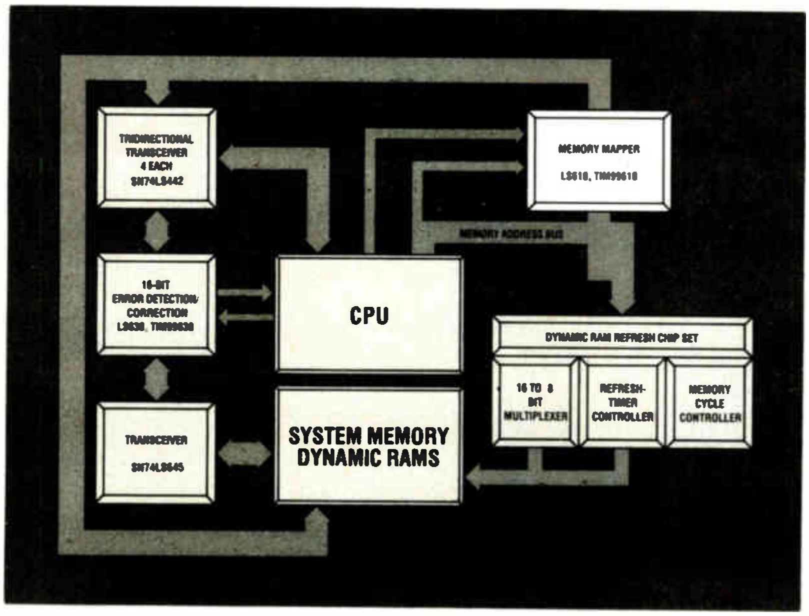

This is the third in a series of Low-Power Schottky devices Texas Instruments is introducing over the next few months. Watch for the new Memory Refresh Controller announcement and find out how you can save design time, production costs and valuable board space.

Now you can expand microprocessor memory address by as much as 8 full lines.

Meet SN54/74LS610 through LS613. Also designated TIM99610 through TIM99613 for the 9900 Family.

An ingenious series of LS devices in 3-state or open-collector outputs. A series of devices designed to expand the amount of memory addressable by today's microprocessors.

These single-chip memory mappers are fully TTL compatible and operate on a single 5-V supply.

So, they offer you all the speed/power benefits of Low-Power Schottky.

These new devices are designed to function with the address system bus — four of the MPU's address lines are used to generate twelve additional memory address lines. Here's how:

Each memory mapper contains a 4-line to 16-line decoder, a 16-word by 12-bit RAM, 16 channels of two-to-one line multiplexers and assorted miscellaneous circuitry — all on a single chip.

Imagine then, the amount of valuable system space you'll be saving.

Memory address expansion is accomplished by using the microprocessor's four most significant address bits to select one of the 16 mapping registers of 12 bits each.

The contents of the selected register are driven through the system via the output latch buffers (LS610 and LS611 only). The remaining least significant bits of microprocessor address are applied directly to the system address bus.

This unique configuration provides a memory mapping operation transparent to all normal system functions. Using paging techniques, the addressable memory is increased by 8 full lines by periodic reloading of the 16 x 12 RAM.

Compatible with TI's TMS9900 16-bit microprocessor, as well as with most of today's popular microprocessors, these devices are offered in a 40-pin dual-in-line plastic package. And, they operate in approved commercial and military temperature ranges.

Like all TI LS circuits, these new devices are low-cost and feature less heat generation, increased densities and improved system performance capabilities.

TI's continuing commitment to innovative Low-Power Schottky technology means that you can continue to design with confidence — tapping the broadest product line available anywhere.

So, design with the line that serves more of your LS needs. The broadest line in the industry. For every low-power, high-performance application. Military systems, data processing, telecommunications, process control — and much more.

And, there's much more on the way from TI. Over the next few months we'll be introducing new devices in the TI LS Family.

You'll want to watch for them. Because, like the new memory mapper circuits, and the proven performance of TI's existing LS line, they'll go a long way toward making your design job easier.

For more information on the new memory mapper circuits, call your nearest authorized TI distributor or field sales office. For data sheets or more detailed specifications, write to Texas Instruments Incorporated, P.O. Box 225012, M/S 308, Dallas, Texas 75265.

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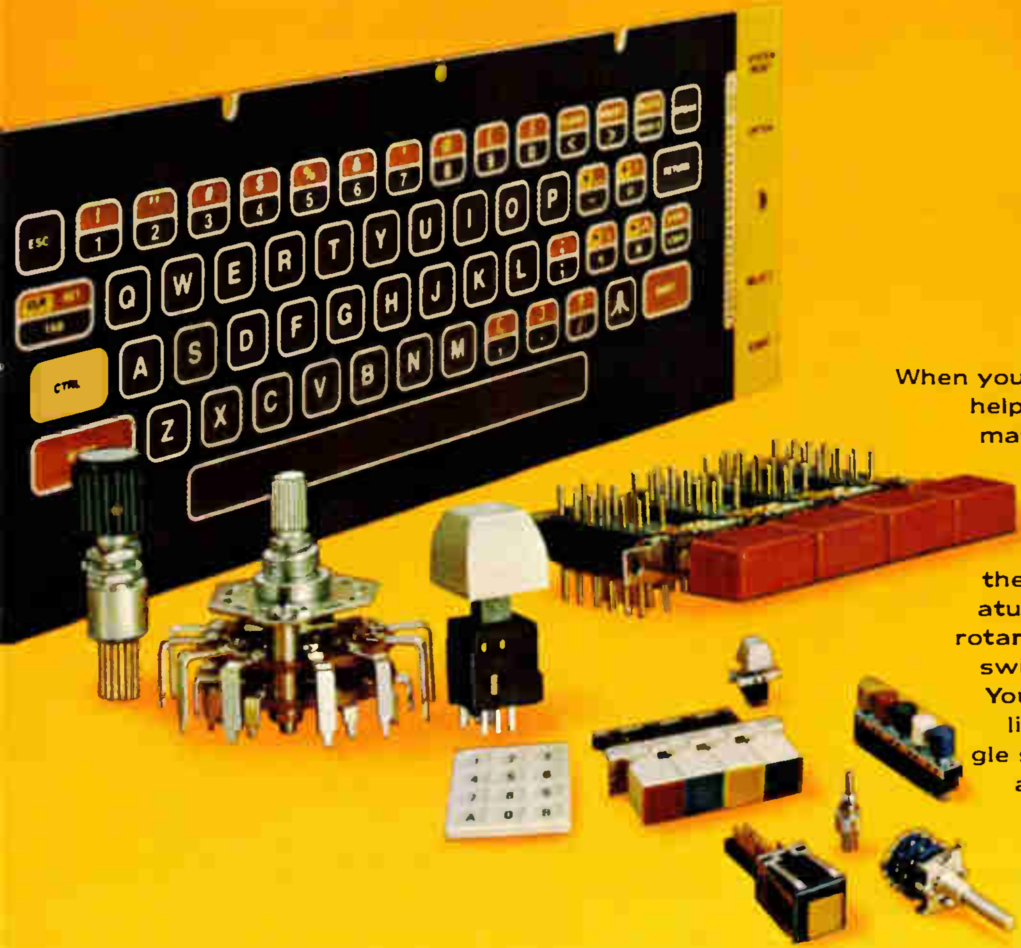

When you're looking for switches that help solve your design problems, match your packaging needs, or control your production assembly costs, you'll find the variety of choice at Centralab. We're best known as the leading supplier of sub-miniature, miniature and heavy duty rotary switches. Our broad line of switches offers you much more. You'll find pushbutton switches, lighted and non-lighted, in single station or ganged assemblies and a range of design options unmatched anywhere. You'll also find modular panel keyswitches and the Monopanel touch switch system that can give your product a competitive edge in appearance, design and function.

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Circle #161 for information on pushbutton switches

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Circe #183 for information on rotary switches

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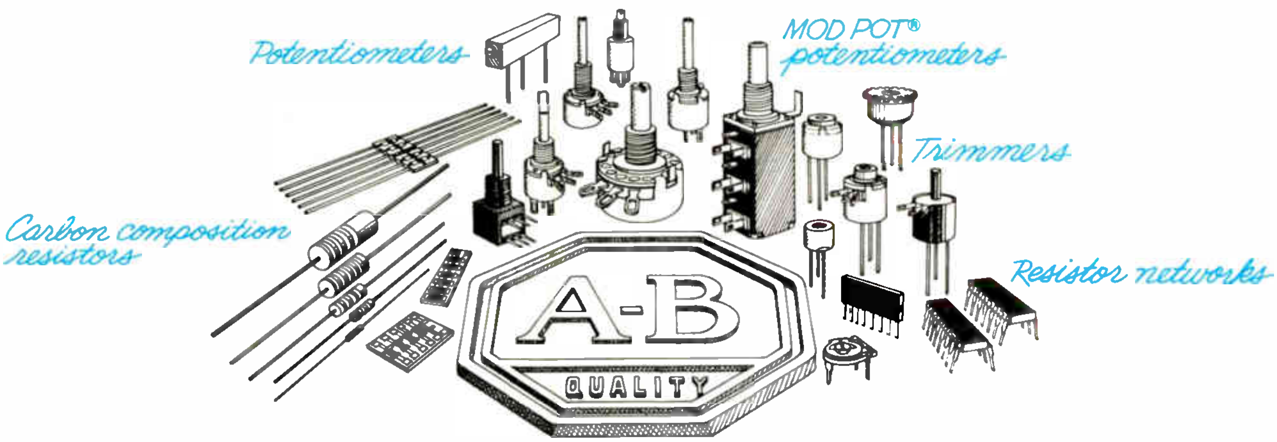

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NCC new products

32-bit computer is 16-bit–compatible

The Eclipse MV/8000 is Data General Corp.'s first 32-bit computer. Though preceded in this market by at least five companies, including International Business Machines and Digital Equipment Corp., the firm's manager of general systems marketing, Edward J. Zander, feels that the new system "is worth the wait."

The MV/8000 is a large system combining multiple processors, multiple caches, and multiple buses in a fast, powerful configuration. Given its characteristics, it hardly seems appropriate to call it a minicomputer: it features a virtual address space of 4.3 gigabytes per process; a maximum program size of 512 megabytes; eight-level software security and protection; built-in diagnostics; and extensive error detection and correction. And its new Advanced Operating System/Virtual Storage supports 256 processes and has an unusual level of compatibility with existing 16-bit systems.

The new Eclipse uses four separate processors to coordinate its operations. There's a 32-bit arithmetic and logic unit, a microNova-based system-control processor to perform housekeeping and diagnostics, an input/output system, and a main memory system.

Because of this division of labor, the central processor incurs little systems overhead and has been optimized for high-speed number crunching. To further enhance the system's speed, Data General engineers use a dual-cache design. There is a 220-ns, 16-kilobyte dual-ported system cache shuttling data between memory and ALU at up to 18.2 megabytes/s and between memory and the input/output system at up to 18.2 megabytes/s.

Instruction cache. Unique is a 110-ns, 1,024-byte instruction cache that permits simultaneous fetching and decoding of instructions with concurrent execution of others. Tying the various processors and subsystems together are nine buses of varying speed, which allow fast, bidirectional communication. The result is a fast, high-resolution processor. Compared with Data General's 16-bit Eclipse M600, the MV/8000 has twice the speed and—with twice the word length—twice the resolution. According to Zander, record I/O operations should be at least 10 times faster on the new machine—in part because of the MV/8000's advanced instruction set—and batch operations should be easily competitive, though the 32-bit machine is optimized for interactive, on-line, multi-user operations.

As for the numbers, Zander notes that a 32-bit register-to-register addition takes 220 ns—880 ns for the equivalent floating-point operation. He adds that the MV/8000 performs more than 1,100 whetstone operations per second.

The MV/8000's set of over 400 instructions includes 250 new 32-bit instructions and is written with full compatibility with 16-bit Eclipse software in mind. But what's novel is that this new instruction set is a superset of the old and is binary-compatible with the older 16-bit instructions. As a result, applications software written for 16-bit Eclipses,

ECLIPSE MV/8000 VS THE COMPETITION

Feature	MV/8000	VAX-11/780	IBM 4341	Prime 750	PE 3240	SEL 32/77
Logical address space (gigabytes)	4	4	16 megabytes	512 Mbyte	16 megabytes	16 megabytes
Maximum program size (megabytes)	512	32	16	32 Mbyte	16	1
Memory bandwidth (megabytes/s)	36.4	13.3	15	8	64	26.7
Input/output bandwidth (megabytes/s)	18.2	9.5	10	8	40	26.7
System cache (kbyte)	16	8	8	16	8	4 bytes
Instruction cache (byte)	1,024	8	no	—	16	4 instruction
Interleaving	4-way	2-way	?	2-way	4-way	4-way
RAM-based control store	yes	yes	yes	no	mix	mix
Number of terminals	128	96	?	63	32/128*	64

*128 terminals in transaction-processing mode only.

SOURCE: DATA GENERAL CORP. AND *ELECTRONICS*

Compact. The 32-bit Eclipse MV/8000 minicomputer works more like a mainframe with 4.3 megabytes of virtual memory.

using the Advanced Operating System and adequate to user needs, can still run on the new machine without recompilation—and at about twice former speed. Also, 16- and 32-bit instructions can be intermixed within the same program without penalty—the machine does not have to switch operational modes. "There's no emulation mode, you just run your program," says Robert C. Downs, manager for large systems software.

"We designed for maximum hard- and soft-ware compatibility," emphasizes Steven J. Wallach, manager of advanced development for Eclipse. Thus, all existing Data General peripherals are compatible with the new machine. "It's even possible to pull a disk pack out of a 16-bit Eclipse system and drop it into an MV/8000 system without any problem," he says.

A key aspect of a virtual-memory system is the software security it provides. Data General's may be the most advanced in its market, since it provides the hardware foundation for an eight-level software-security system. The computers with which the MV/8000 competes have either four levels or none.

The ring idea dates back to the 1960s and Multics. It is a hierarchical protection scheme that places the operating system on the highest-privileged level, innermost ring; user programs inhabit the outer rings and have less privileges. "Privilege" means that outer rings can make requests of inner rings only with the proper access codes and at programmed "points of entry," thus providing the security.

In addition to the new Advanced Operating System/Virtual Storage and its associated compiler, the MV/8000 is available with ANSI-standard Fortran 77, PL/1, and Basic—"with many extensions," adds Downs. The compiler includes a common-code generator and an optimizer to select the most efficient code sequence for the machine and thereby speed program execution; also, since the compiler is based on the concept of common language modules, it could cut the time and cost of software generation while improving operational reliability by reducing the number of new subroutines needed for an application.

SWAT, a high-level, interactive symbolic debugger helps troubleshoot Fortran or PL/1 programs at the program statement level—a timesaver, since it allows programmers to work above the machine—or assembly-language level. For users who need it, AOS/VS supports a 32-bit assembler called MASM, said to offer highly efficient code generation.

Initial deliveries of the MV/8000 should begin in August or September, with the system in volume production by October. Prices will range from a low of about $150,000 for an entry-level system to more than $300,000 for larger systems.

Data General Corp., Rte. 9, Westboro, Mass. 01772. Phone (617) 866-8911 [341]

Options for Naked Minis expand

At this year's NCC, Computer Automation Inc. will present a round of enhancements to the minicomputer line that the company introduced last year. Also at NCC will be its Scout Naked Mini 4/04. The new offerings include four single-function boards that provide mass memory storage, some programming aids to expand automatic self-testing, and the first fully packaged version of Scout in a minimum configuration.

"The new series of Scout boards is further evidence of Computer Automation's commitment to meet the requirements of our target industrial and process control markets," says Richard L. McGowan, Scout product manager.

A 512-kilobyte flexible-disk subsystem, slated as the first of a series of Scout mass-storage devices, heads the list of new boards. Supported by a single-function controller board and operating under real-time programming, the dual, single-sided floppy-disk drive is compatible with all Naked Mini 4s for transportability of application programs and data files. It is available in 60 days, priced at $3,000 for single-quantity evaluation units.

A 32-bit bidirectional input/output board is an inexpensive interface ($220 in single-unit quantities) designed for industrial controls. With interrupt-driven programmed I/O, a user can divide the 32 bits into 8-bit groups and program the interface to transfer data in and out in any combination. Delivery of the board is set for 45 days.

A four-channel digital-to-analog converter has four output voltage ranges available, each of which can be selected by flipping a switch. The voltages that can be selected are ±5 V, 0 to +5 V, ±10 V, or 0 to ±10 V. The converter is priced at $650 and has 90-day delivery.

The last of the boards, a battery backup board, provides temporary power for periods ranging from 3 min for 128 kilobytes to 4.5 min for 32 kilobytes of dynamic random-access memory. It includes a watchdog timer that sets off an external alarm when the central processing unit fails to activate the battery backup by a predetermined time. Those times are selected from intervals between 1 and 30 s. In single-unit evaluation quantities the board costs $230 and can be delivered within 30 days.

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boards come with the company's own on-board, automatic self-test feature, called Isolite. The backup instead has a green light-emitting diode that lights up when power is applied and the cells are good. A toggle switch activates a 0.5-A load on the batteries for self-testing.

The two self-test programming aids "give the customer the software muscle required to create customized routines under the Isolite concept," says McGowan.

With the two aids, the customer can add personalized tests to Isolite, with diagnostics limited only by his programming expertise. The two packages are titled Autogen and Romgen Utilities. Autogen is designed specifically to format binary files for the tester's ROM, whereas Romgen is a more general-purpose utility used to generate programmable-ROM– or ROM–formatted files from computer object programs.

The first packaged version of Scout, in a configuration with the minimum number of components necessary for software development, offers several benefits, according to McGowan. It is easier to order with a single designated number, in comparison to separate numbers for different components, and the user can be certain that all of the parts are available at the same time. Scout was designed originally as a modular unit composed of a series of single boards, often accompanied by programs and data files developed on larger systems.

The packaged computer contains all interfaces and cables and includes the Scout CPU, 54 kilobytes of RAM, a remote programmer console, a nine-slot card cage with power supply, serial I/O for cathode-ray-tube terminals, telecommunications modem serial I/O, CRT controller, and optional instruction set. Buyers of the computer can have real-time executive software, which separately is priced at $500, for no additional cost. The entire package sells for $2,675 with deliveries in 90 days.

Computer Automation Inc., Naked Mini Division, 18651 Von Karman, Irvine, Calif. 92713. Phone (714) 833-8830 [342]

8-in. disk drive is fixed and removable

Combining the best features of old and new technologies, Control Data Corp. has produced an 8-inch disk drive that offers 8 megabytes of fixed media and 8 megabytes of removable media. It's this removable disk cartridge that provides systems builders with what CDC feels is the most convenient form of backup—a means of making a copy of information stored on the fixed disk that can be physically removed for safekeeping elsewhere.

Although the CDC device is not Winchester technology in the strictest sense, it will compete with a wealth of 8-in. disk drives that have been introduced in the past year from disk industry leaders such as Memorex, Shugart, and Kennedy [*Electronics*, June 21, 1979, p. 83].

But all these makers leave the question of backup to the systems builder, who must then choose between floppy disks and tape drives for backup. According to Ron Benton, manager of marketing requirements, CDC saw the cartridge disk technique that is so popular in 14-in. drives as the logical way to go in 8-in. drives as well.

The secret to the CDC model 9455 Lark drive is the combination of lightly loaded Winchester-style heads with conventional drive technology that retracts the heads when the drive stops. In true Winchester technology the heads come to rest on the surface of the specially lubricated media when the drive stops.

Even though the heads are not hermetically sealed into a single unit with the disk the way Winchester units are, CDC ensures air clean enough for the close flying heights that provide high recording densities. During a purge period of almost 1 minute at the beginning of operation, the air inside the drive is passed through a filter. Only after the air is so cleaned are the heads loaded, or positioned over the disks.

An unusual feature of the CDC Lark is that the servo information needed to position the read/write heads is embedded on all the disks in the sector gaps. Most drives in the industry today reserve one disk surface for this servo information.

As a result of this combination of technologies, Lark achieves a density of 237 tracks/in. and has up to 6,774 flux reversals per inch. Instead of recording 1 bit per flux reversal, however, a new proprietary coding technique lets about 30% more data be recorded, CDC says. Called the 2,9 code, with scheme is said to be a run-length–limited approach, but CDC declines to provide details. Four custom emitter-coupled-logic large-scale integrated circuits are used to handle the coding. The on-board

Stable. Control Data's 9455 Lark 8-in. disk drive combines 8 megabytes of fixed media with a removable 8-megabyte cartridge that can be used for backup.

electronics also includes the read/write electronics and an Intel 8049 microcomputer to control the head-positioning servo system.

The linear voice-coiled positioner gives an average access time on the Lark of 50 ms, and its interface is compatible with that of CDC's popular Storage Module Drive, transferring data at a rate of 1.2 megabytes/s.

A little larger than a floppy-disk drive, the Lark measures 8.5 by 5.1 by 21 in. A separate 8.5-by-4.1-by-8.5-in. cabinet contains the power supply and the input/output drives needed to connect to the controller. With this power supply, the Lark is priced at $2,700 each in original-equipment manufacturer quantities, with the removable cartridges selling for $80 each. Evaluation units will be available in November and volume shipments are scheduled to start in early 1981.

Control Data Corp., P. O. Box 0, 8100 34th Ave. South, HQN 08H, Minneapolis, Minn. 55440. Phone (612) 853-3193 [343]

Processor crunches 64-bit data

Even the most powerful general-purpose computers can be overwhelmed by the number crunching needed to process arrays of large numbers fast, a task that's imperative for flight simulation, image analysis, speech synthesis, and similar applications. And since no one wants to tie up a Digital Equipment Corp. VAX 11/780, an International Business Machines 303X, or another machine of that class if it can be avoided, the heavy arithmetic usually is turned over to a front-end processor specialized for manipulating arrays.

Like their general-purpose partners, array processors (so-called because they are adept at manipulating matrixes) are bounding upward in power. Floating Point Systems Inc., the Beaverton, Ore., maker of these specialized machines, has pushed precision to 64 bits in its new FPS-164 machine. That makes the data path a full 26 bits wider than that of the company's predecessor processor, the 38-bit FPS-100.

At the same time, FPS has stepped out in speed and in direct-memory-addressing capacity. At 12 million floating-point operations per second, the FPS-164 is 50% faster than the FPS-100. As for addresses, the word length is 24 bits, so the machine potentially can work with a memory as roomy as 16 megawords. At the moment the maximum main storage is 1.5 megawords, built around 16-K random-access-memory packages. "When the 64-K RAMs come along, that will jump to 6 megawords," insists Carl Haberland, the product manager.

To add this number-crunching capability to their mainframes, owners of DEC's VAX 11/780, IBM's System/370, and compatible systems can count on spending about $225,000 for the basic FPS-164 with 256 kilowords of main memory and some $425,000 for a 1-megaword system. A support processor integral to the FPS-164 handles the interfacing with the host computer, doing such jobs as translating the addresses of different users and interpreting the data-descriptor blocks sent out by the host. The program language is ANSI Fortran 77.

Beyond the numbers. The raw performance numbers alone tend to mask some noteworthy evolutionary advances incorporated in the FPS-164. For example, it has two sets of limit registers that protect memory blocks assigned to one user from access by another. They also guard the operating system from intrusion by any but "privileged" users. In fact, the processor has 33 instructions that cannot be used by the non-privileged, and unwarranted attempts to do so result in a no-operation instruction.

The new processor also takes advantage of a 1-kiloword cache memory that resides between the main storage and the execution-control circuitry. With an access time of about 50 ns, it can perform both a read and a write operation during one processor cycle of 167 ns.

In addition to the main memory there is a 5.5-kiloword read-only memory for tables of constants and up to 32 kilowords of RAM for variables. The FPS-164 will not have a disk interface ready for demonstration at NCC, but when deliveries start next April, each processor will have up to six disk controllers.

The shift from 38-bit precision to 64-bit precision means that a great deal of additional attention had to be paid to error-checking and parity circuitry. The table and cache memories, for example, both contain parity error detection triggered when the memory is accessed.

To aid in data checking, the processor has four classes of interrupts, each with several subclasses to handle special conditions. One class consists of traps: they allow users to examine program functioning under specified conditions or provide jumps to operating-system breakpoints. There are also interrupts for correcting parity errors, for handling input/output data streams, and for "fatal" events like simultaneous errors in the bit stream.

Floating Point Systems Inc., 11000 S. W. 11th St., Beaverton, Ore. 97005 [344]

Software lets 990 process text

The addition of functions to those already available on existing computer hardware represents the leading edge for commercial system manufacturers. One of the latest such additions to be shown at the National Computer Conference will come from Texas Instruments Inc., which will add new word-processing software for its five-year-old family of DS990 minicomputers.

Known as TIPE-990, the new word-processing package will allow users of large DS990 systems to perform word-processing functions at any desired TI model 911 video display terminal—or at several terminals—and simultaneously perform traditional data-processing functions

with TI's DX10 operating system at other terminals in the system.

Up to 16 terminals could be in simultaneous use for any combination of word and data processing when configured in TI's DS990 model 30 system, says Jim Pawlik, manager for commercial applications marketing at TI's Digital Systems group in Austin, Texas. With production shipments scheduled to begin in August, TIPE-990 will be available initially only for TI's high-end memory-mapped computer systems, including DS990 models 4, 6, 8, 20, and 30. The package will not be available now for low-end models 1 and 2.

New printer. As a TIPE option, TI is offering a new letter-quality printer known as the LQ45. Capable of printing 45 characters per second, the 132-column daisy-wheel device will not be manufactured by TI, but purchased for resale from an outside vendor.

For non–letter-quality requirements, TIPE will also work with the model 810 matrix printers used in DS990 systems. Other available options include communications capability, allowing documents to be sent from one 990 system to another.

Pawlik says that the new word-processing package does not mean that TI is entering the market for the so-called office of the future, but "it will be one of the stepping stones," he concedes.

Quick study. According to Pawlik the TIPE package was designed to be easily learned and used, so it "includes only the most commonly used" word-processing functions for creating, editing, and printing documents. TIPE does not include various extraneous functions such as spelling checks, Pawlik notes.

TIPE-990 is packaged in a variety of media including magnetic tape and disk and is priced at $3,500 in most media. No pricing figures were available for the LQ45 printer at press time.

Texas Instruments Inc., Digital Systems Division, P. O. Box 1444, M/S 7784, Houston, Texas 77001. Phone Computer Systems Marketing, Austin, Texas, at (512) 250-7305 [345]

Harris interactive processor fits IBM

Competing in the IBM-compatible marketplace takes a good deal of flexibility these days, what with the industry leader's stepped-up price-performance aggressiveness and relatively rapid product announcements that have kept some vendors off balance and scrambling.

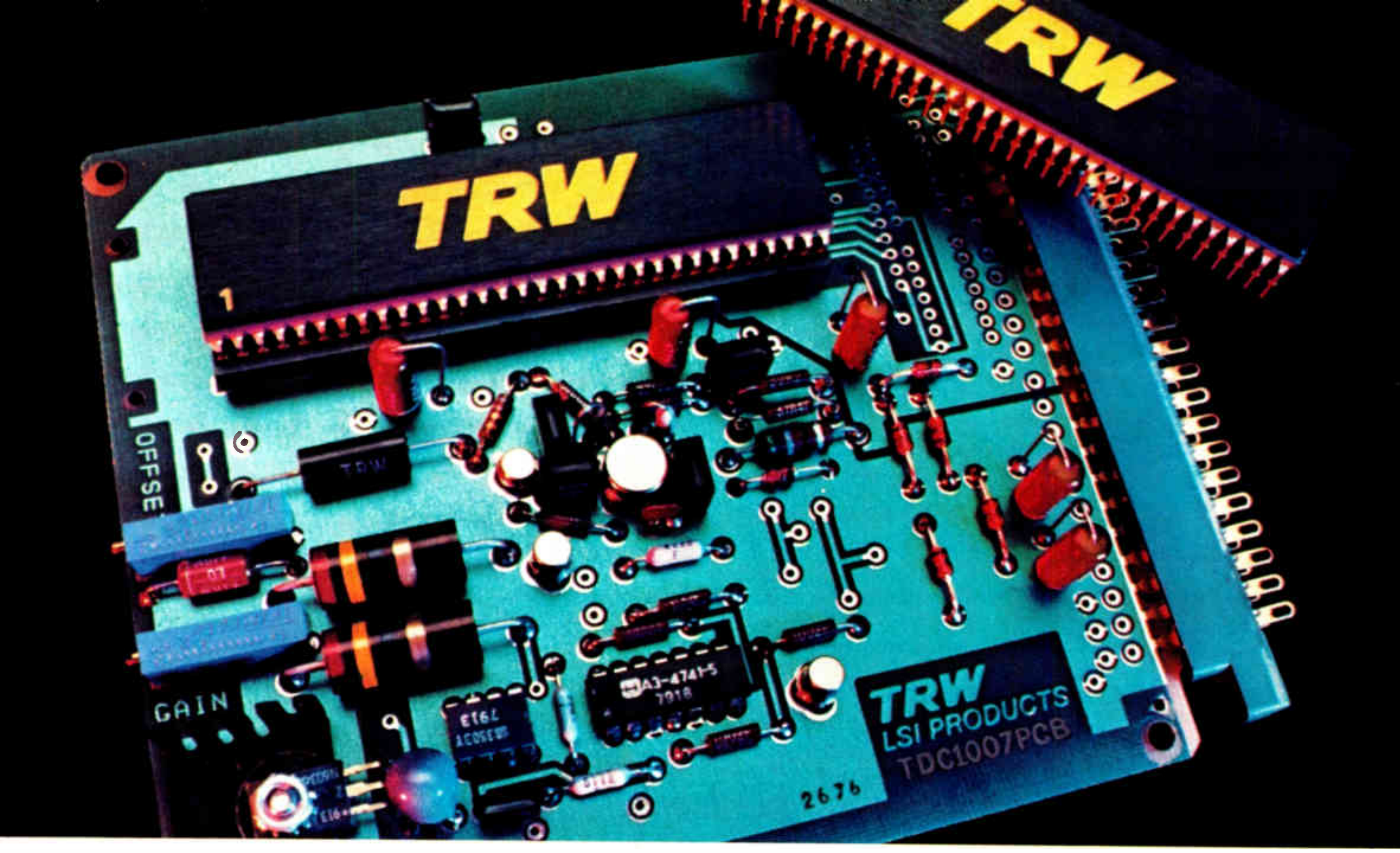
Officials at Harris Corp.'s Data Communications division headquarters in Dallas expect to meet the challenge with a new interactive processor system family to be unveiled at the National Computer Conference. Known as the Harris 9200 line, the family is aimed at growing computer network needs and is built for modular expandability in both its hardware and software design.

Sporting a multiple 16-bit microprocessor architecture and a layered software approach that will allow concurrent communication in differing protocols with multiple hosts, the IBM 3270-compatible 9200 represents a "quantum jump" in capabilities over Harris' seven-year-old 8000 interactive line, says Terry C. Schmidt, product marketing manager in Dallas.

Off the shelf. In designing the 9200, Harris hardware engineers chose to employ standard available large-scale integrated circuits and did not use custom devices. Initially, 18 of 24 card slots in the processor box will be used.

The 9200's multiple microprocessor architecture uses a three-card building-block approach. Contained in each three-card set is a processor board using an Intel 8086 16-bit microprocessor as its central processing unit, an input/output board, and a local memory board that houses 32 4116-type random-access memory chips. In addition to its 64 kilobytes of local memory, each 8086 has access to 32 kilobytes of shared, global memory housed on a separate board, says Sam Mathan, director of systems development.

Each three-card 8086 block will be capable of handling up to eight



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Modular. The modular design of the Harris 9200 family allows maximum flexibility.

devices—either terminal displays or printers. For host communication functions, a separate three-card processor block is required for each protocol supported, he says.

Two at first. Harris will announce plans for two initial models at NCC. The 9210 is scheduled for availability this June, says Schmidt, and will support up to 32 peripherals.

A second model—the 9220—is pegged for availability at year-end and will offer an additional host communications protocol. Later 9200 offerings will include support for other protocols for concurrent multiple-host communication as well as a means of tying 9200 boxes together for peripheral and network expansion.

The 9200 software, like the hardware, is designed for a modular system that includes a dialog manager to monitor the bus for multihost communication. User-insertable system diskettes defining parameters such as printer authorization and display-screen configuration will be provided with the 9200.

Among the 9200's unusual features is a line-tracing facility, a diagnostic designed to let the user isolate line problems by displaying both inbound and outbound message traffic in real time. Unlike some competing systems, which require attachment of a separate box, the 9200's line-tracing facility runs on-line as background and can be called from any terminal, says Mathan.

Variety of terminals. The 9200 system will support IBM 3277 display terminals as well as the Harris 9278 display, which offers screen sizes of from 960 to 3,440 characters. Available printers for the system include a dot-matrix bidirectional model with print speeds of 80, 130, and 180 characters/s. Also available are band printers that run at 240 or 300 lines per min.

The basic 9200 system, including the processor, six display stations, and one 130-c/s bidirectional printer, will be priced at about $24,000. Lease price for a similarly configured system will be $665 per month on a three-year lease, including maintenance.

Harris Corp., Data Communications division, 16001 N. Dallas Parkway, P. O. Box 400010, Dallas, Texas 75240. Phone (214) 386-2000 [346]

Unit prints photos of color video

With computer graphics moving rapidly into color displays—a trend that will be highly visible at NCC—another big product opportunity is opening up: supplying permanent copies of video images. Present choices limit users to costly video copier systems, to low-resolution printers with a limited color range, or to photographing the screen.

To fill what it sees as a niche for producing economically priced quality copies, a firm new to manufacturing, Image Resources, is introducing a line of four Videoprint systems that will sell for $2,990 to $5,950. These units capture a video image before it is displayed and transform it into photographic media for distortion-free color copy.

In operation, the Videoprint units capture the video signal before it goes through to the monitor and gets distorted. In a five-step process, beginning with gain control, the copier's circuitry breaks down signals into their components and, under microprocessor direction, reconstructs them on film. A Chroma demodulator separates the red, green, and blue color parts of the signal, so a matrix can mix the colors, determine their strength, and shape them to suit specific film characteristics. The colors are then fed

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New products

For hard copy. Videoprint unit reconstructs four-color signals on photographic film.

into a monochromatic tube (with 600-line resolution) where a stepper motor positions a filter (red, green, blue, and white) in the optical path. The microprocessor-controlled beam correctly positions and exposes the negative, comparing the film characteristics with data stored in memory.

Slides or prints. The Image Resource unit is entirely self-contained and does not interfere with the computer-monitoring operation, says John Cool, president. Other features include a processing time of less than 2 minutes per picture and handling of either NTSC composite format or RGB-170 format. Image Resources claims that the Videoprint is the only color-display printer to take the NTSC signal output from personal computers. The unit also produces Polaroid SX-70 prints, 35-mm slides or films, 3¼-by-4¼-in. and 4-by-5-in. Polacolor prints, and 4-by-5-in. negatives of any conventional film for enlargement. It has a separate mode for three-color printing separations, and an individual color parameter control lets the user create color prints from a noncolor system.

"The Videoprint is a new product, designed with proven technology by a team with computer, video, and photographic backgrounds," says Cool. He is a co-founder of the firm, which, when it started in 1977, specialized in computer graphics engineering.

"A vacuum exists for color hard copies because of the rapid growth of color graphics," he says, "with users either paying $10,000 or more for a video copier device or actually photographing the screen." Photograph-

ing is unsatisfactory, he says, because it is difficult to keep lighting and alignment consistent. Also, the film reacts differently than the human eye to cathode-ray-tube phosphors, picking up distortions and raster-scanning lines.

The 3000 series, comprising models 3100 and 3200, is intended for the personal computer, education, and small-business systems market. The units sell for $2,990 and $3,550, respectively. Both come only with NTSC video-signal handling. The price difference reflects control features allowing remote and automated operations. For users of higher-performance industrial and commercial computer graphics, there is the 5000 series: models 5100 (with NTSC) and 5200 (with RS-170). Both sell for $5,950 and have master controls for unattended operation. Deliveries will start in July.

Image Resources' president thinks the firm's new line will have up to a two-year head start in the hard-copy market before a major equipment manufacturer is able to bring out a competitive product. Other new entries could appear during the time from offshore companies, however, say other sources.

Image Resources Inc., 2260 Townsgate Rd., Westlake Village, Calif. 91360. Phone (805) 496-3317 [347]

Array processor and CPU share memory

Attaching a peripheral array processor to a central processing unit is an advantage in boosting the number-crunching capability of minicomputers. But there's a drawback in that the input/output data-transfer links are a bottleneck. It can take longer to get data moved than it takes the array processor to carry out the computations. For small array operations (up to 1 kiloword matrix by matrix), there is virtually nothing to be gained.

But if it were possible to get rid of the I/O transfer by making the array processor's memory directly accessible to the central processing unit, the

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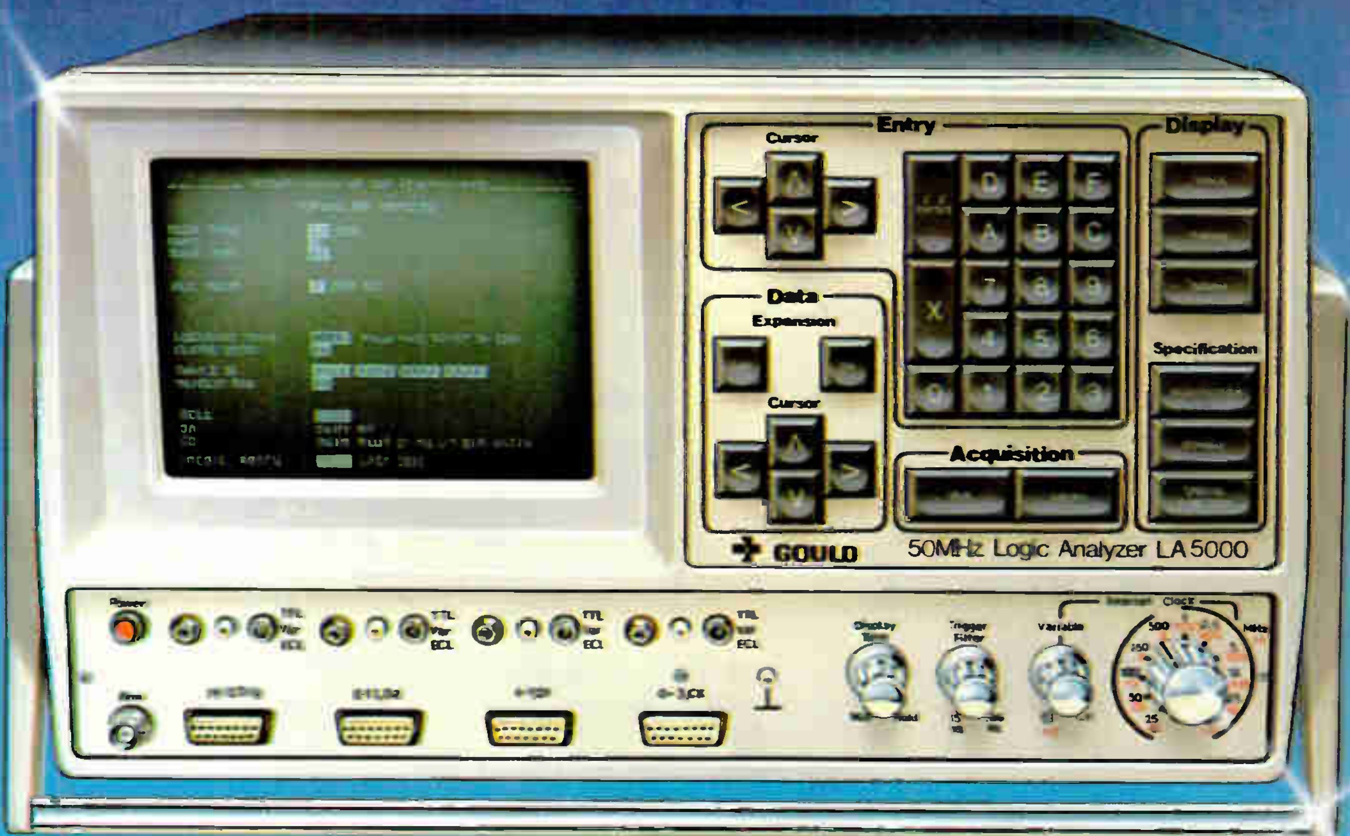

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Three full screen interactive menus—Acquisition, Format, and Special Function—make set-up fast and simple. There are also partial menus of frequently needed parameters as part of the display modes.

Convenience features? The LA-5000 features two memories with an auto-stop function to simplify fault-finding. Reverse video highlighting calls attention to memory differences. The reference memory is easily accessible via the keyboard. And, a memory search feature matches like sequences in both working and reference memories.

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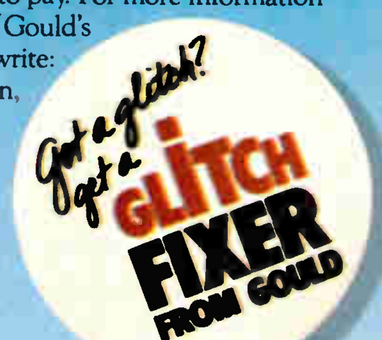

Circle 199 on reader service card

problem would be solved. That's exactly what Systems Inc. (formerly Systems Engineering Laboratories) has done with the introduction of a 32-bit parallel common-memory interface (CMI) for its 32- and 64-bit VPS3300 and VPS6400 vector-processing systems. The result, according to James T. Holley Jr., marketing manager of vector processing for the Fort Lauderdale, Fla., firm, is a dramatic increase in processing speeds, even for small-matrix calculations.

Without CMI, for instance, a VPS3300 system with a 2-megabyte-per-second I/O data-transfer rate and a 170-ns memory cycle time would take 17.2 ms for a 1-kiloword matrix-by-matrix multiplication at 32-bit precision and 71.4 ms for a similar 8-kiloword operation. With CMI, those times drop to 1.3 ms and 5 ms, respectively—a 92% to 93% time savings. That performance jump will cost users only about 4% more than earlier VPS3300 and VPS6400 systems, adding $8,500 to the price tags.

Fully integrated, and including an SEL 32/77 CPU, a 32-bit array processor (in the VPS3300CM) or a 64-bit array processor (in the VPS6400CM), 500 kilobytes of memory, 80 megabytes of disk storage, 75-in./s tape drive, 600-line/min line printer, 300-card/min. reader, cathode-ray-tube terminal, and software, the common-memory versions of the two systems are expected to cost $186,000 and $223,500, respectively.

Sharing pays. CMI benefits vector processing, says Holley, because the array processor is integrated into a multiprocessor, shared-memory configuration rather than performing as a peripheral. CMI consists of two modules: a remote-memory interface on the 32/77 CPU's central Selbus, allowing the CPU access to the array processor's memory; and a shared-memory interface in the array processor itself.

Modifications in the system's software create a common-memory address accessible by the user in the declarative section of the program. "Much of the software change has to

do with eliminating I/O communications protocols; we're simplifying, rather than adding complexity," explains Milton A. Morton, vice president of software at Computer Signal Processing Inc. The Billerica, Mass., firm supplies systems with array processors and is working on the new CMI software. Morton believes CMI will be fairly easy to apply to Systems Inc.'s existing VPS3300S and VPS6400S, introduced last summer [*Electronics*, Aug. 30, p. 81].

Besides the jump in processing speed, CMI will increase flexibility, Morton points out. The ability to add array processors to the central system bus without data-transfer delays means multiple CPUs and array processors can be strung together to handle the particular load of an individual user. "We can put together systems that will fill some of the gaps between current vector-processing systems in the super-mini class and the giants like Cray and Star supercomputers," he adds.

Deliveries of the common-memory system will take 150 days, with the first deliveries being scheduled for September.

Systems Inc., 6901 West Sunrise Blvd., Fort Lauderdale, Fla. Phone (305) 587-2900 [348]

Multiprocessor is expandable

Intended for a time-shared, commercial environment, BTI Computer Systems' 8000 multiprocessing computer can be arranged into "virtual machines" to service up to 200 user terminals. The system's high-speed, 64-megabyte/s centralized bus structure allows any of the hardware—including central processing units, memory, or peripherals—to be expanded without requiring changes in the operating system. It can maintain its operating system while expanding from a one-CPU system to an eight-CPU system by having CPU cards plugged into its bus.

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Circle 203 on reader service card

ports ANSI Cobol 74, ANSI Fortran 77, Extended Basic, and an extended version of Pascal, although it is expected that most programs run on the system will be in Cobol. All processing in the system uses the 32-bit data path of the system bus, which puts the 8000 in the class of a Hewlett-Packard 3000, a Digital Equipment Corp. VAX 11/70, or a Tandem computer

The main memory is shared by all CPU's, and it is expandable from half a megabyte to 8 megabytes. Augmenting this memory is a virtual memory system that accesses bulk memory in 4-kilobyte pages.

Backup. Having more than one bus-structured CPU running under one operating system gives the BTI 8000 flexibility. Should one of its CPUs fail, for example, the system stops and indicates which unit has failed. After pulling the failed board, a system can be restarted—but at lower throughput.

Management of I/O functions is handled by peripheral processing units, each of which can manage four independent I/O channel activities initiated by the CPUs. Each channel can then be connected to controllers for disk drives, tape drives, line printers with rates from 300 to 900 lines per minute, and user communications. One such controller is the asynchronous communications controller, which can handle up to 64 user terminals. Four of these bring the system to 200 terminals.

The CPU boards use neither microprocessors nor bit-slice processors but are built with medium-scale integrated gate logic similar to that used in IBM 370/168s. Add times for such logic are in the 3-ns region. By using double-precision logic, the system can also perform 64-bit integer and floating-point arithmetic.

Although the BTI 8000 will be demonstrated at NCC, first deliveries of the system will not begin until September. Because of the wide variety of configurations the system will offer, its price is expected to range from about $100,000 to $1 million.

BTI Computer Systems, 870 West Maude Ave., Sunnyvale, Calif. 94086. Phone (408) 733-1122 [350]

308 DATA ANALYZER

Big power in a small package.

The 308 operates in four modes: parallel state, parallel timing, serial state and signature analysis.

The 308 Data Analyzer. From Tektronix.

The new 308 Data Analyzer packs an impressive array of logic analysis capabilities inside its trim, 8 pound (3.6 kg) frame. For instance, it operates in the serial and signature modes as well as parallel state and timing. And samples both synchronously and asynchronously up to 20 MHz. With a variable voltage threshold that covers all logic families in addition to TTL.

Two separate memories, acquisition and reference, allow automatic data comparisons. If there's no data difference, the sampling process is repeated until a discrepancy appears. And the acquisition memory can be automatically searched for any given word.

Word recognition can be up to 25 bits and includes an external output to trigger other instruments. And the trigger itself can be delayed up to 65,535 clock pulses past the trigger point. The 308 features a latch mode (5 ns), a memory "window" to let you closely examine portions of the memory and state tables which are displayed in binary, hex and octal.

The 308 Data Analyzer, from Tektronix. Performance? Uniquely versatile. Size? Conveniently compact. Price? Exceptionally reasonable.

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And we're already supplying today's demand for bipolar ECL memories. You can choose from six pin compatible Hitachi part numbers, from 9ns to 70ns, to match most high-speed scratch pad, control store, buffer and main memory applications.

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HM2510*	93415	1K x 1	45, 70	Now
HM2511*	93425	1K x 1	45, 70	Now
HM2112	10415	1K x 1	9	Samples
HM10422	10422	256 x 4	10	Samples
HM10470	10470	4K x 1	20, 30	Samples

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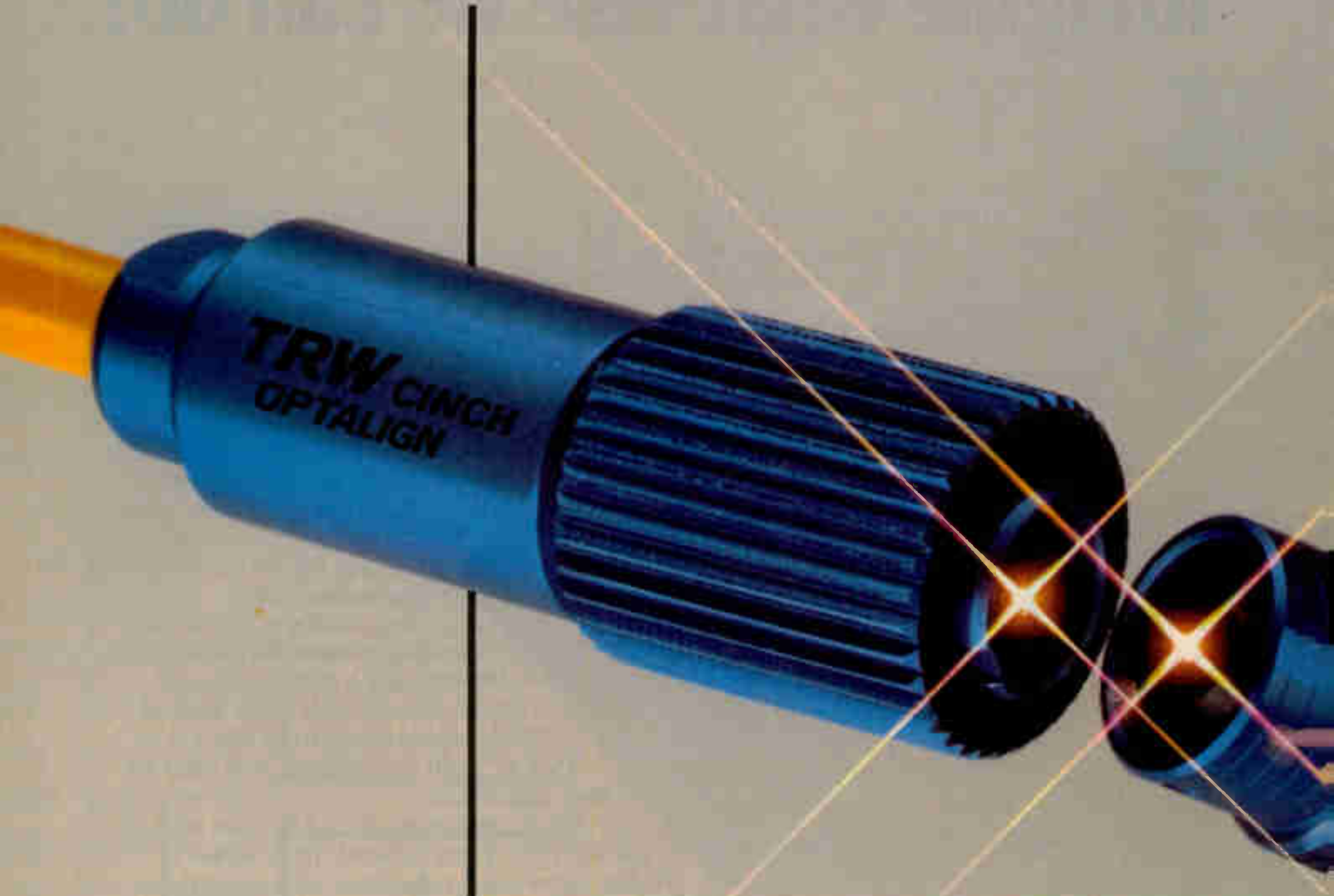

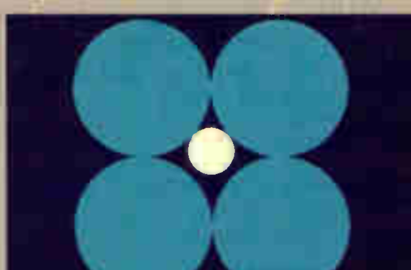
Cross Section of Four Rod Glass Alignment Element


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We call our new single-fiber fiber optic connector, OPTALIGN. It has many exclusive design features that make it consistantly easy to use, dependable and extremely cost-efficient.

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TRW Cinch has developed a unique alignment system that restricts light losses to less than 1db and is compatible with most commercially available fibers. This system is based on a four-rod glass array that is clean, inert, stable, and mates fibers in a manner that yields excellent shock and vibration immunity. The glass array element does not require precision tolerances to achieve ultra-precise fiber alignment and low light losses.

The OPTALIGN connector is designed to give you unmatched fiber alignment accuracy and repeatability everytime the connection is made. Be assured that repeated connect/disconnect will not affect the optical quality, finish, or the mechanical integrity of the fiber.

Another TRW Cinch innovation, the exclusive internal scissors clamps, secures the fiber, strength members, and jacket to the lightweight aluminum OPTALIGN housing.

Compact OPTALIGN plugs and receptacles are ideal for computers, CATV, telecommunications, medical, instrumentation and military applications. Dimensions are 5/8" diam. X 1½" in length.

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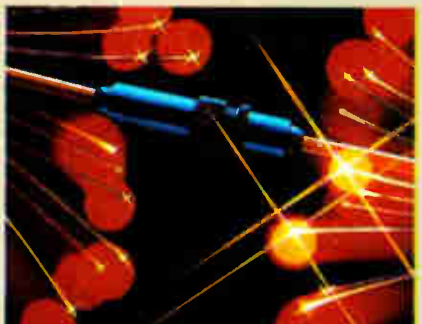

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PCM tester does it all

Signal generator makes it possible to test key parameters in pulse-code-modulation systems used in digital telecommunications

by Harvey J. Hindin, Communications & Microwave Editor

As the telecommunications world has turned digital, testing the pulse-code-modulation communications systems frequently used has often required rigging up a bank of separate instruments to cover all the bases. With its latest entry in the telecommunications test and measurement field—the PCG-1 PCM channel generator—W&G Instruments now has equipment that will automatically test the critical parameters of these systems.

The new unit permits a complete range of PCM tests: insertion loss or gain, level tracking, signal and distortion, and frequency response. Pseudorandom noise can be simulated in a frequency band from 350 to 550 Hz for quantization noise tests. It also puts out either stochastic or fixed idle channel codes for evaluating idle channel noise.

Because it generates highly accurate and repeatable PCM signals, the PCG-1 permits transmission testing on the receiving side of μ-law PCM channel banks and codecs. Furthermore, since the output signal is compatible with the standard DSX-1 test system and procedure, testing is done by connecting the PCG-1 directly to the DSX point. Until now, the only way to test a D1, D2, or D3/D4 channel bank was to loop the bank's output back to its input. Using this method, the distracting effects of the encoding portions of the channel bank could not be separated from the decoding effects.

Tones. The PCG-1 breaks the loop and provides standard test tones stored in a digital memory so that the decoder alone can be checked. Test tones available are either the standard digital milliwatt signal (0 dBm0, 1 kHz) or encoded sine waves. The latter (obtained from the memory) range from 50 to 3,600 Hz and are settable in 0.1-dB steps from +3 to −66 dBm0.

Although the PCG-1 functions as a stand-alone instrument, its utility is enhanced when it is coupled with W&G's PCD-1 PCM channel demultiplexer. This combination makes possible complete transmission testing of a PCM system.

Furthermore, when the PCG-1 and the PCD-1 are used with W&G's PCM-3 automatic telephone channel test set (the remote control board option is required), complete transmission testing on an analog-to-analog, analog-to-digital, and digital-to-analog basis can be made automatically and rapidly. In addition to the transmission tests, channel signaling may be monitored via a display on the PCD-1.

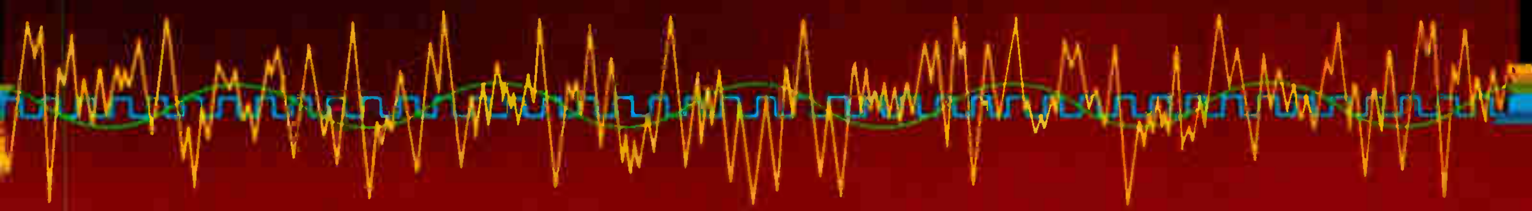
Framing. The PCG-1 has a 100-Ω, ±3-V balanced output that is compatible with WECO 310 jacks and is completely compatible with the DSX-1 cross-connect point. The output includes the standard DS-1 terminal and signaling frame patterns. Front-panel switches permit feeding in any framing pattern or defined framing errors. The normal 7⅚-bit encoding may be selected or the A and B channel signaling bits eliminated and a full 8-bit coding sent instead.

Slide switches on the front panel set both the terminal framing bits and the signaling framing bits to any desired pattern. The PCG-1 can also simulate a failed channel bank or a looped channel bank.

With the DS-0 output a 64-kb/s serial input signal can be multiplexed into the PCG-1 output stream in any 1 of the 24 channels. In addition, the DS-0 64-kb/s output option is available. It provides TTL-level signals for the 64-kb/s signal and the 64-kb/s clock and 8-kHz clock signals.

The PCG-1 weighs 20 lb and measures 7 by 9½ by 15½ in. Delivery takes 60 days after receipt of order.

W&G Instruments Inc., 119 Naylon Ave., Livingston, N. J. 07039. Phone Bob Handrahan at (201) 994-0854 [338]



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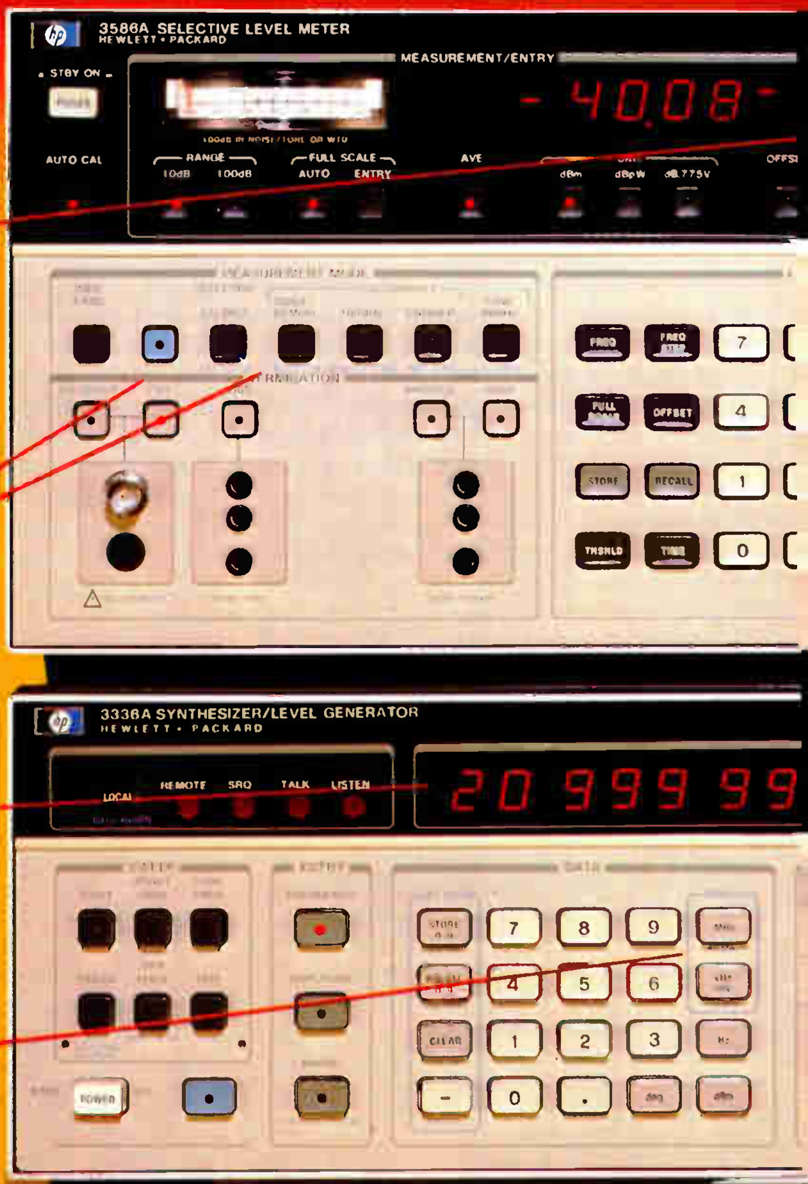

0.1 Hz frequency resolution means precise frequency setability over the full 50 Hz to 32.5 MHz range. ±.2 dB level accuracy allows measurements with .01 dB resolution all the way down to -80 dBm.

Optional Transmission Impairments Measurements allow you to quickly trouble-shoot voice channel problems using phase jitter, noise-with-tone, signal-to-noise-with-tone-ratio, and single level impulse noise, all with one instrument.

Level accuracy is ±.05 dB at full output at 10 kHz with ±0.1 dB flatness to 20.9 MHz, and you can sweep the full band with ±.15 dB leveling.

Amplitude blanking allows testing of operational FDM systems without disturbing adjacent channels while the frequency is changed.

The new Hewlett-Packard Level Measuring Set brings outstanding measurement convenience, precision and automatic control to the design, manufacture, installation and maintenance of Frequency Division Multiplex systems. It consists of two new instruments: the HP 3586A/B Selective Level Meter, and the HP 3336A/B Synthesizer/Level Generator. The A versions are compatible with CCITT requirements, while the B versions are compatible with North American (Bell) standards. In addition, C versions are available for general purpose wave analysis and frequency synthesis applications.

Precise frequency and level measurements are provided by the HP 3586A/B Selective Level Meter. In addition to delivering 0.1 Hz resolution over the full 50 Hz - 32.5 MHz range, the Selective Level Meter lets you make measurements at both FDM voice channel and carrier frequency with one instrument. And, when you select the optional Transmission Impairments Measurements feature, you enjoy a new versatility in FDM system troubleshooting.

The new HP 3336A/B Synthesizer/Level Generator offers extremely stable, accurate signals with harmonics more than 50 dB down, and phase noise 70 dB down in a 3 kHz band. As a precision companion source, the Synthesizer can be

The problem in big board testing is finding the problem.

Introducing the FF323. The first digital in-circuit test system that can test up to 2400 points and pinpoint the problem right down to the component.

Building faults into large, digital PC boards is inevitable. And the bigger the board the more chance of faults. Simple shorts, opens, misorientation and misinsertion faults cause most. But chip faults, such as stuck at one or zero, IC power loss or functional failure can all occur at final test. Until now, finding faults like these was like finding a needle in a haystack.

The new FF323 from Fairchild has changed all that. It's a digital in-circuit test system with 2400 points – more than twice the capacity of any other system. It not only tells you where the fault is, but what the fault is.

It can test a broad range of SSI, MSI and LSI device types, and it can isolate faults on highly complex PCBs. It can handle microprocessors, peripheral chips, bit slices, RAMs, ROMs, shift registers, UARTs, as well as the full range of small and medium scale ICs in technologies like CMOS, NMOS, SOS, TTL and DTL. The FF323 can even pinpoint the analog component problems on your digital boards.

You save time, labor, money and headaches.

The FF323's testing capability delivers complete and precise fault isolation in seconds – not hours. A 100 chip board can be tested in 100 seconds. And the FF323 delivers yields of 95% and better at final test. Fairchild's in-circuit testing strategy safely isolates catastrophic faults, before power-up (testing begins) so costly ICs won't be unnecessarily destroyed. And our patented digital testing technique insures comprehensive, functional interrogation of ICs.

You do more testing, less programming.

FF323 software helps you solve the problems of development costs and turnaround. You get up to speed quickly and stay there with the world's most comprehensive IC testing library. Our FAULTS automatic program generator gets new board testing programs on line in weeks instead of months. And the BASIC editor makes program changes problem free so you respond immediately to engineering changes.

Look closer, and you'll find our software short and simple. CHIPS, the LSI test compiler, allows fast test routine generation. Real time datalogging and analysis helps you keep track of component and board faults. And our foreground/background programming option gives you optimum CPU use with concurrent program execution.

Only Fairchild can offer all the big board testing you need.

FF323's flexibility lets you choose a system configuration to suit your application. Choose from either 1200 or 2400 system point capacity – just plug in 32 point switching modules as you need them. Our range of computer and peripheral options lets you select a well balanced data management subsystem. An instrumentation option is also available and Fairchild's Thinline® fixturing system lets you choose from a wide variety of fixtures, fixture kits and two universal designs.

With Fairchild, you'll also get all the applications engineering, training, service and support you need to keep testing without interruption.

For more information on the FF323, contact your nearest Fairchild Test Systems sales office. Or write Fairchild Test Systems Group, 299 Old Niskayuna Rd., Latham, N.Y. 12110. Tel. (518) 783-3600.

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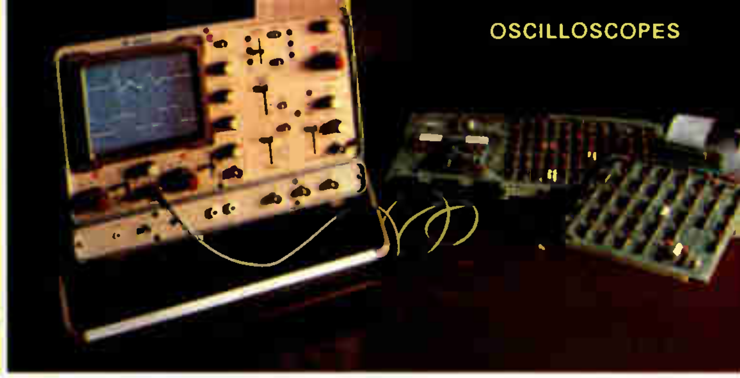
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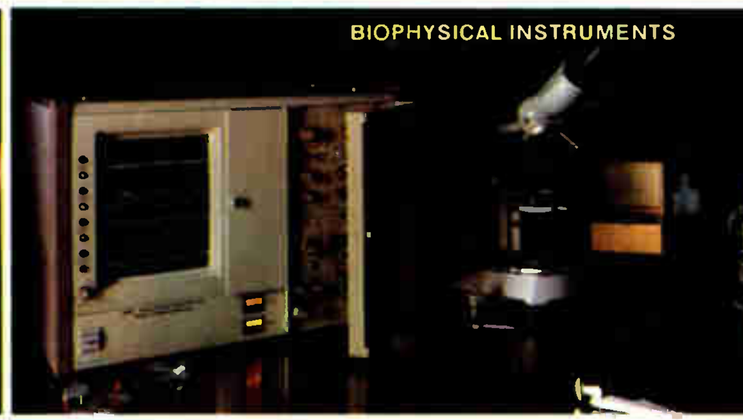
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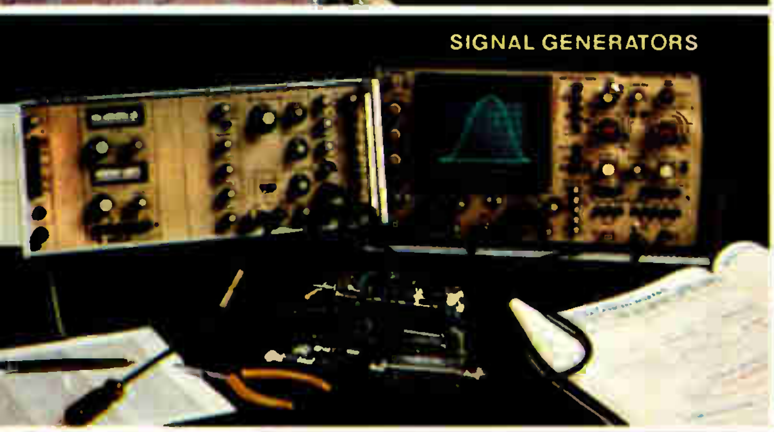
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AUTOMATIC TEST EQUIPMENT


ANALYTICAL
INSTRUMENTS

Instruments

Coupler adapts units to 488 bus

Coupler serves IEEE-488 bus functions; combines instruments into system

Even though a lot of engineers would like to assemble IEEE-488-compatible instrumentation systems in order to automate test programs, they find it difficult to justify replacing otherwise perfectly good instrumentation just because it is not bus-compatible. At next week's Electro, Ballantine Laboratories is unveiling its answer to the problem: the 2488 series of instrument couplers.

On a rear panel, the $995 couplers have 40 parallel output and 40 parallel input lines that accept instruments equipped with TTL-compatible outputs. Also at the rear is an eight-section switch for setting the unit's bus address, plus the standard IEEE-488 connector. The coupler itself performs the necessary data translations—from binary-coded-decimal to ASCII format and the reverse, for example—and IEEE-488 functions such as handshake, single or extended address, talk, listen, parallel poll, clear, and service request. Front-panel light-emitting diodes indicate the operating mode of the system and coupler.

What makes the coupler different from other units? According to Ballantine's chief engineer Jerry Harper, "It can be set up to handle multiple instruments by adjusting internal switches. Also, code translations and formatting are fully programmable." As a practical matter, these capabilities permit several instruments to be tied to one coupler yet addressed independently at the same bus address. Units working with the coupler can be talkers, listeners, or both.

In the basic units, data is translated into ASCII characters by a microprocessor; a 1-K programmable read-only memory stores the program. With the PROM designed as a socketed device, Harper points out, users can easily customize the controller for their particular formats and coding, rather than have the bus controller interpret the ASCII-encoded BCD data. Further, there is space for an additional 1-K PROM, allowing fairly sophisticated translations. Ballantine has customized the models 3620A and 3630A ac/dc true-root-mean-square digital multimeters in this manner and offers a coupler for use with them.

The coupler also incorporates a test feature that permits a user to check the operation of the unit's bus interface. Data can be read into the coupler by a bus controller and stored by the coupler in its internal data random-access memory. The controller can then read back the stored information, thus verifying that the coupler's receivers and drivers are operating properly.

Delivery of the general-purpose and the 3620A/3630A versions takes four weeks. In the future, Ballantine will provide PROMs for more of its instruments and offer a service for customizing couplers to customers' needs.

Ballantine Laboratories Inc., P. O. Box 97, Boonton, N. J. 07005. Phone Roger Stagnol at (201) 335-0900 [351]

Standard clock calibrates time and frequency devices

With the vast array of time- and frequency-dependent instruments crowding the test bench, Global Specialties' new low-cost frequency standard may be welcome not only to keep them calibrated, but also to serve as a precision clock for those based on microprocessor designs.

The introduction of the unit, model 4401, will be at Electro in booths 3118 and 3120. Priced at $199, it has an ovenized crystal oscillator that keeps its 10-MHz standard output accurate to within ±5 ppm over a temperature range from 0 to 50°C. Further, that output is factory-calibrated to the National Bureau of Standards time base, via the bureau's WWVB transmissions; the internal calibration control is accessible to the user so that he can verify that its calibration continues to meet his needs.

In addition to the standard output, which puts a TTL-level square wave into a 50-Ω-load, the model 4401 also lets the user select from up to eight different harmonics and multiply them by factors of 1, 2, or 5. Thus, it provides an additional 24 frequencies, which can be particularly useful for time-base calibrations of instruments such as oscilloscopes.

The scope that never forgets.

Gould's digital OS4000 stores event data for the life of the scope. Solid state memory lets the Gould OS4000 give you instant replay of stored event data for as long as you need it (while the unit is getting power). In addition to the event itself, the OS4000 uniquely stores and displays what happened before the event and after it. The OS4000 can then expand the event display so you can study it in slow motion detail. Plus, it also allows you to compare delayed and original sweeps. And, when needed, the OS4000 can perform as a real-time scope with a bright, stable, flicker-free display.

The Gould OS4000 is easy to operate whether it's being used as a digital storage or conventional oscilloscope, waveform recorder, transient recorder, comparator or signal generator. Interfaced with a recorder, the OS4000 can generate hard copy data from both ongoing events or 'replayed' displays.

For more information on the scope that out-remembers any tube storage scope on the market, contact Gould Inc., Instruments Division, 3631 Perkins Ave., Cleveland, Ohio 44114.

For brochure call toll-free: 800-331-1000 (in Oklahoma, call collect 918-664-8300).

GOULD

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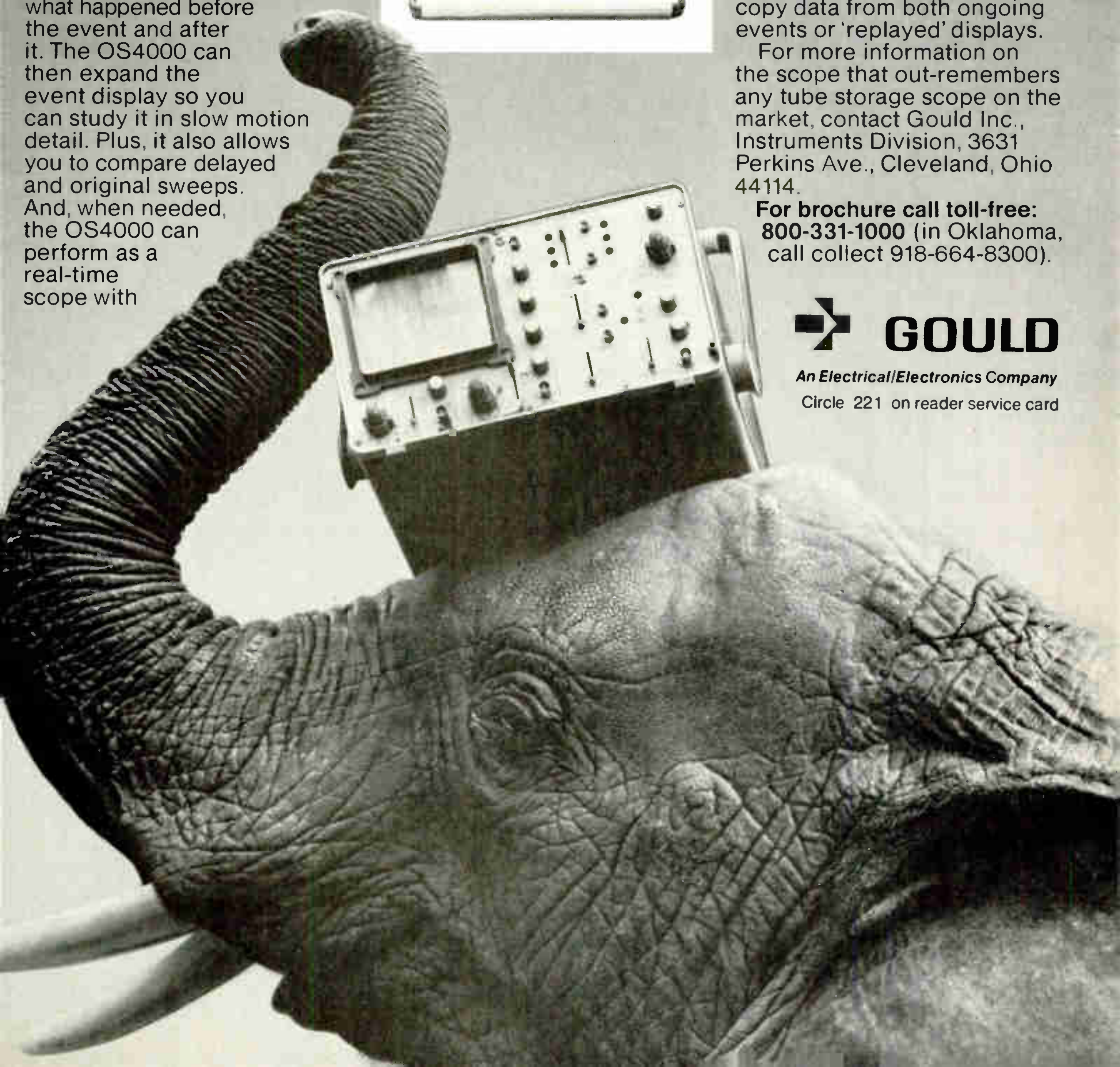
Circle 221 on reader service card



The 2-lb unit measures 3 by 10 by 7 in. and works from a standard 110-V line. It maintains accuracy in spite of line variations of ±3 Hz. It is scheduled for delivery during the coming quarter. In addition, a 220-V version will also be made available.

Global Specialties Corp., 70 Fulton Terrace, New Haven, Conn. 06509. Phone (203) 624-3103 [352]

$1,500 systems counter can be programmed via IEEE-488

For $1,500, the model 5316A programmable counter functions as both talker and listener on the IEEE-488 bus and takes reciprocals to measure frequencies. The instrument measures frequency, frequency burst, frequency ratio, time interval, time-interval average, and period; it also totals. Two input channels operate over the unit's 100-MHz frequency-range, and an optional third channel is available to cover frequencies to 1 GHz for communications applications.

The instrument takes reciprocals for frequencies below 10 MHz, so it can provide eight full digits of resolution over its complete frequency range. The information is displayed on an eight-digit light-emitting-diode display (plus exponent). Both channels have trigger level and sensitivity controls. System controllers—like the HP 9825A and 9835A—can be used to program the counter, run under program control, and manipulate data. The counter responds to all GPIB bus commands except parallel poll.

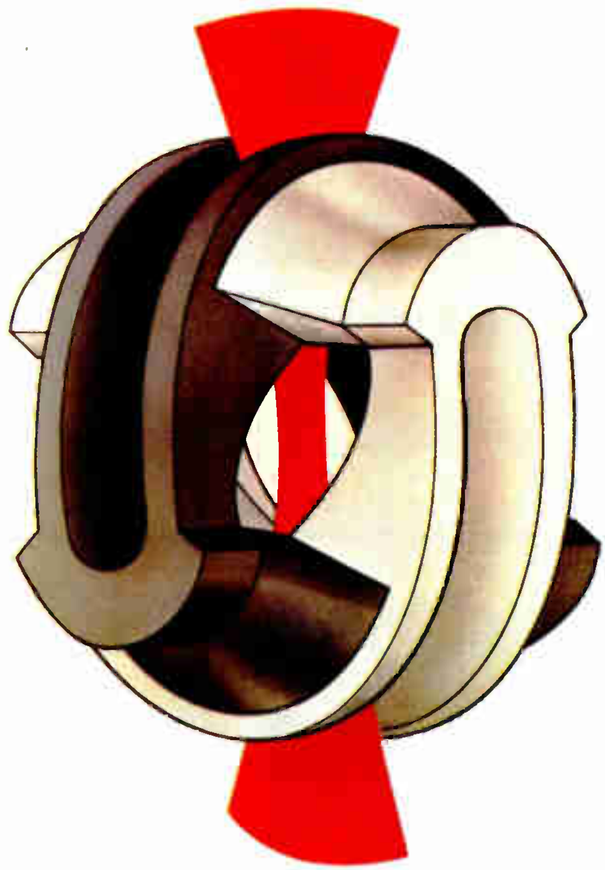
The U.S. price of the model 5316A, now HP's lowest-priced full IEEE-488 programmable systems counter, is $1,500. Delivery is eight weeks after receipt of order. Options available are a high-stability time base for $100, a third channel for $250, and a module that modifies measurements to allow direct readout in scientific and engineering units, for $650.

Hewlett-Packard Co., Inquiries manager, 1507 Page Mill Rd., Palo Alto, Calif. 94304 [355]

For fusion: use the switch tube from Brown Boveri

◀ Single tube for high voltage / power switch and regulator service. Performance data include: 30 sec pulse of 100 A current and 1000 kW anode dissipation followed by hold-off voltages of up to 150 kV.

"Delivered to Aydin Energy Division for their Sealed Neutral Beam Power Supply for Livermore Labs Mirror Fusion (MFTF) Contract."



For full details on the Brown Boveri switch tube technology write to Department EKR-V,

BBC
BROWN BOVERI

BBC Brown, Boveri & Company, Limited
CH-5401 Baden/Switzerland

Circle 223 on reader service card

504579 VI

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Your partner in productivity.

DIP Printing Systems

MARKEM'S Model 521 singulated DIP print/cure system was designed totally around the productivity idea.

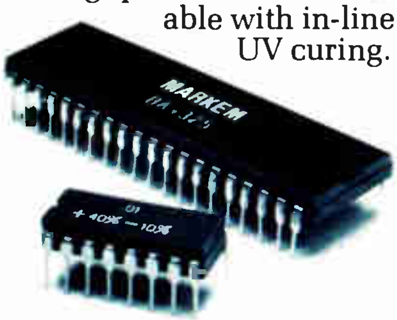
That's why the 521 is designed for one operator. Its L-shaped work area is compact, just 2′ x 2′.

That's why the 521 can handle up to 25 tubes of DIP's at one time.

That's why the 521 has special product control features which minimize damage to ceramic packages.

That's why there are few transfer points – and there's easy access to printing elements, the conveyor belt, tubes in magazine, and inking adjustments.

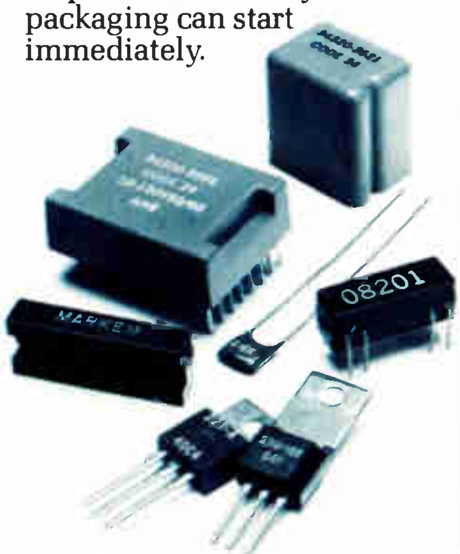
The 521 DIP printer is built for reliable, sustained operations and consistent throughput. And it is available with in-line UV curing.



UV Curing Systems

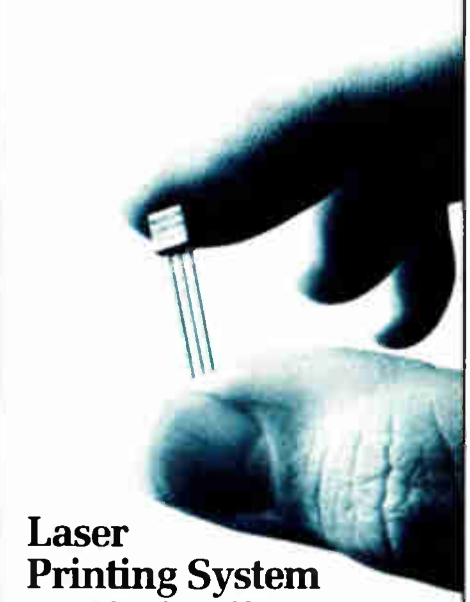
Markem has housed economical ultraviolet light energy in a free-standing, parts-handling conveyor – the new Model 550 UV Conveyor System – for curing imprinted flat-product substrates.

The Markem 550 system cures decorative and identifying prints *instantly* – so inspection, assembly and packaging can start immediately.



The system ends the need for bulky batch curing ovens, drying shelves and storage racks. It also exposes products to less heat, thus reducing the risk of damage to sensitive products.

The 550 requires only one operator.



Laser Printing System

The day of laser printing is upon us.

No conventional printing system can compete with a laser printing system for:

- speed;
- legend quality;
- high printing reliability;
- low cost per print;
- ease of legend change.

Markem's first System 8000 Laser Printer is a microprocessor-controlled TO92 printer. The previously coated TO92's are fed, printed and discharged at rates up to 18,000 per hour. Capitalizing on laser technology, the system sets a new standard for small character legibility, consistent operation and reliability.

For productivity's sake, call Roger Langley in Keene at (603) 352-1130.

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MARKEM

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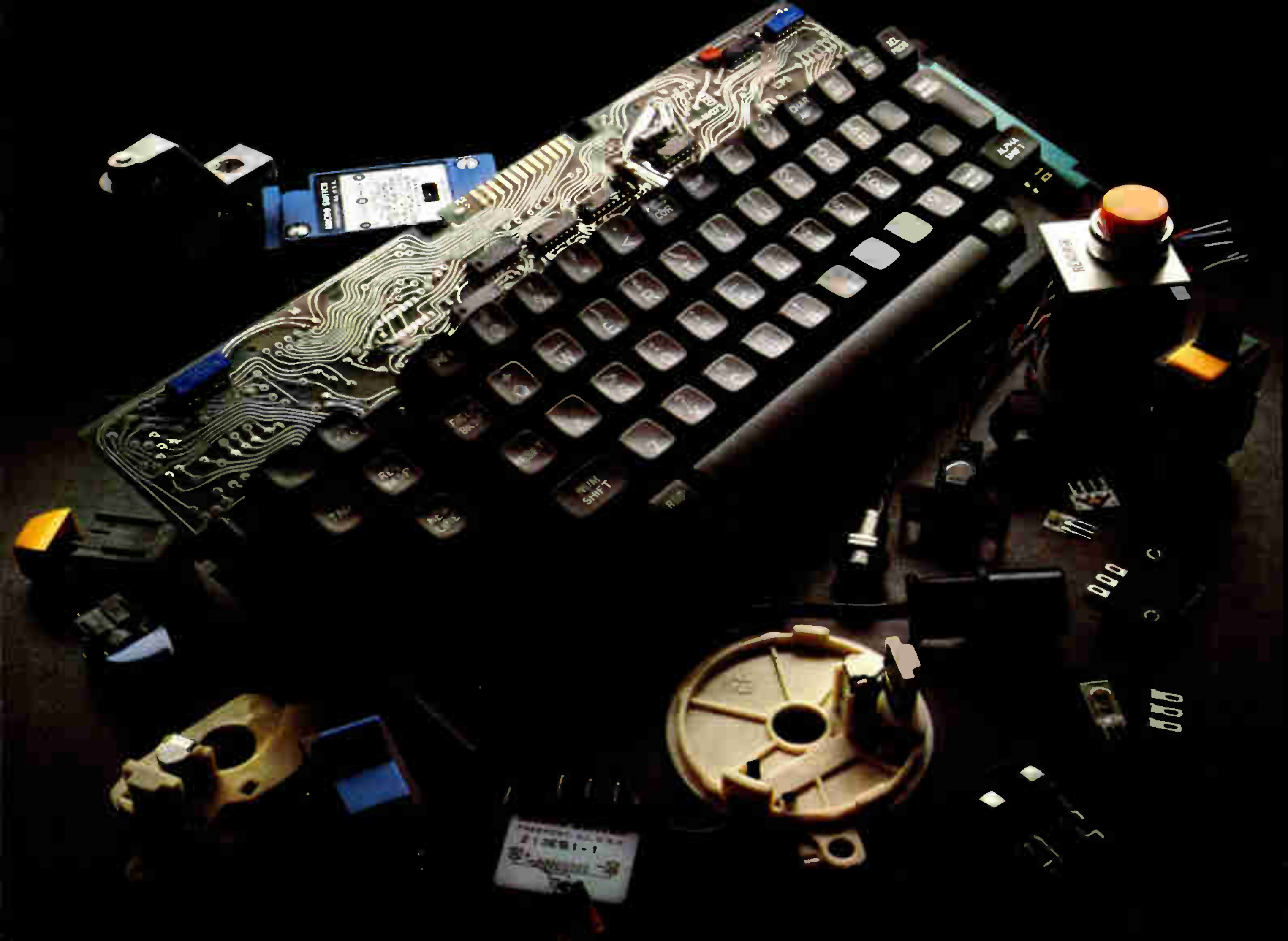
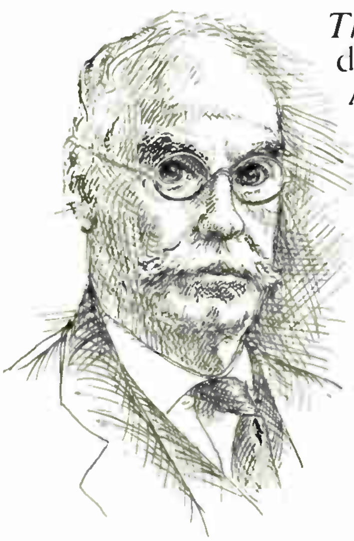
See us at the Semicon / West Show, Booth #1045



"The new force is exceedingly small, so that we cannot predict any practical applications for it."

—*The Nation*, December 25, 1879



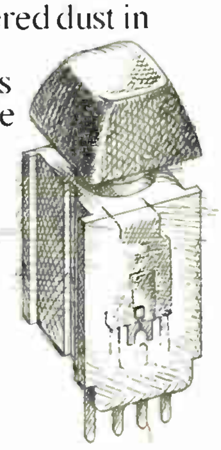
The Nation was talking about the Hall effect, the minute voltage that develops at the edges of current-carrying gold foil in a magnetic field. And back in 1879 when Dr. Edwin Hall first detected it, even the editors of this leading news magazine didn't know what to make of it.

In fact, for eighty-six years, the Hall effect gathered dust in research labs.

But then in 1965, while MICRO SWITCH engineers were evaluating different sensor technologies, they made a major breakthrough.

They invented a revolutionary sensor by building the Hall effect into an integrated circuit.

The sensor they developed was smaller and more reliable than any previously designed. That sensor became part of the world's first solid state keyboard.

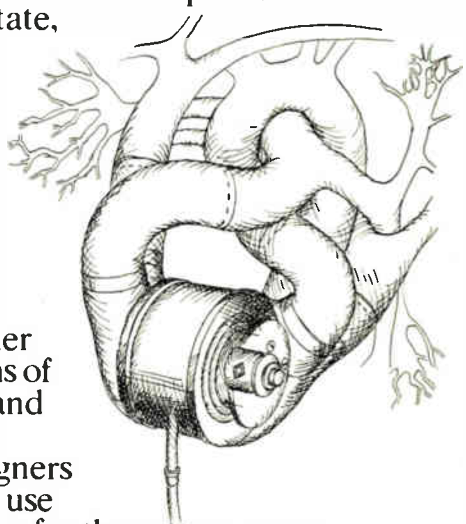


Today, not only is that keyboard still the most reliable one you can buy, our Hall effect technology is the state of the art in the electronics industry.

The fame of Hall.

Since the Hall effect keyboard, we've found other innovative ways to package the Hall effect.

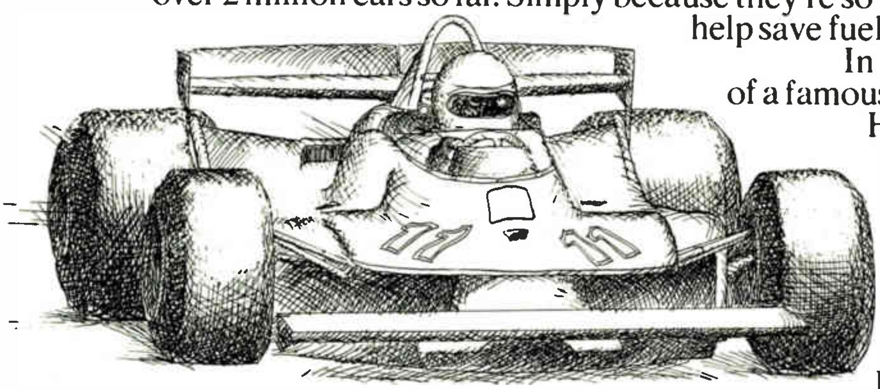
You'll find it in our vane and position sensors. It makes our AML pushbuttons the most reliable ones you can buy. You'll find it in our solid state, oiltight pushbuttons. And now, the Hall effect is in our latest achievement: a linear output position sensor.



Our customers must like the ways we've packaged the Hall effect, because they've found some interesting ways to use them.

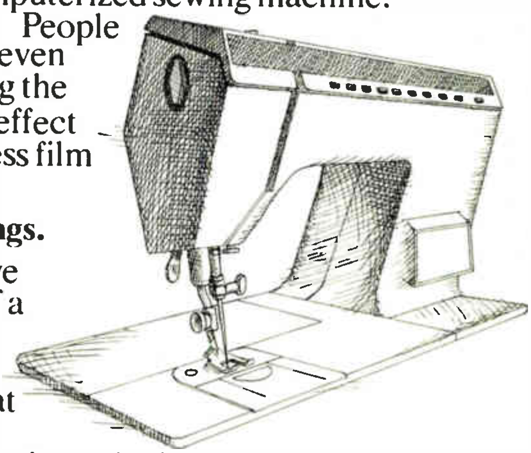
For example, pioneers at a leading medical center came to us for a sensor that would control the rhythm of an experimental artificial heart. They chose a Hall effect sensor for its proven reliability.

Hall effect sensors have replaced mechanical breaker points and magnetic reluctance sensors in the ignition systems of over 2 million cars so far. Simply because they're so reliable, and help save fuel.



In fact, designers of a famous race car use Hall sensors for the same reasons.

And a Hall effect sensor detects the precise needle position for stitching patterns in the first computerized sewing machine.



People are even using the Hall effect to monitor tire pressure, build better refrigerators, process film and bale hay. Just to name a few.

We have other ways of doing things.

Having made nearly 200 million Hall sensors, we figure that if there's a way to improve the performance of a product using a Hall device, chances are pretty good that we'll find it.

On the other hand, we'll be the first to admit that the Hall effect isn't the only way to do things.

That's why we also have products that work on other principles.

We use piezoresistance for solid state pressure transducers. Eddy current in metal detecting proximity sensors. And optoelectronics in photoelectric controls. Not to mention the precision, snap-action principle we invented in 1932.

But whether you eventually choose Hall devices for your designs, or any of the other ways we have to make switches and sensors work better, we can help you best by helping you early.

That way, you get our nearly 50 years' experience helping customers solve problems. And the most cost-effective product for the job. Whether it's one right off the shelf, or one we design especially for you.

Who knows, maybe we'll come up with a practical application that no one has thought about yet.

For some practical suggestions on how the Hall effect can work for you, write MICRO SWITCH, The Sensor Consultants, Freeport, Illinois 61032. Or call 815-235-6600.

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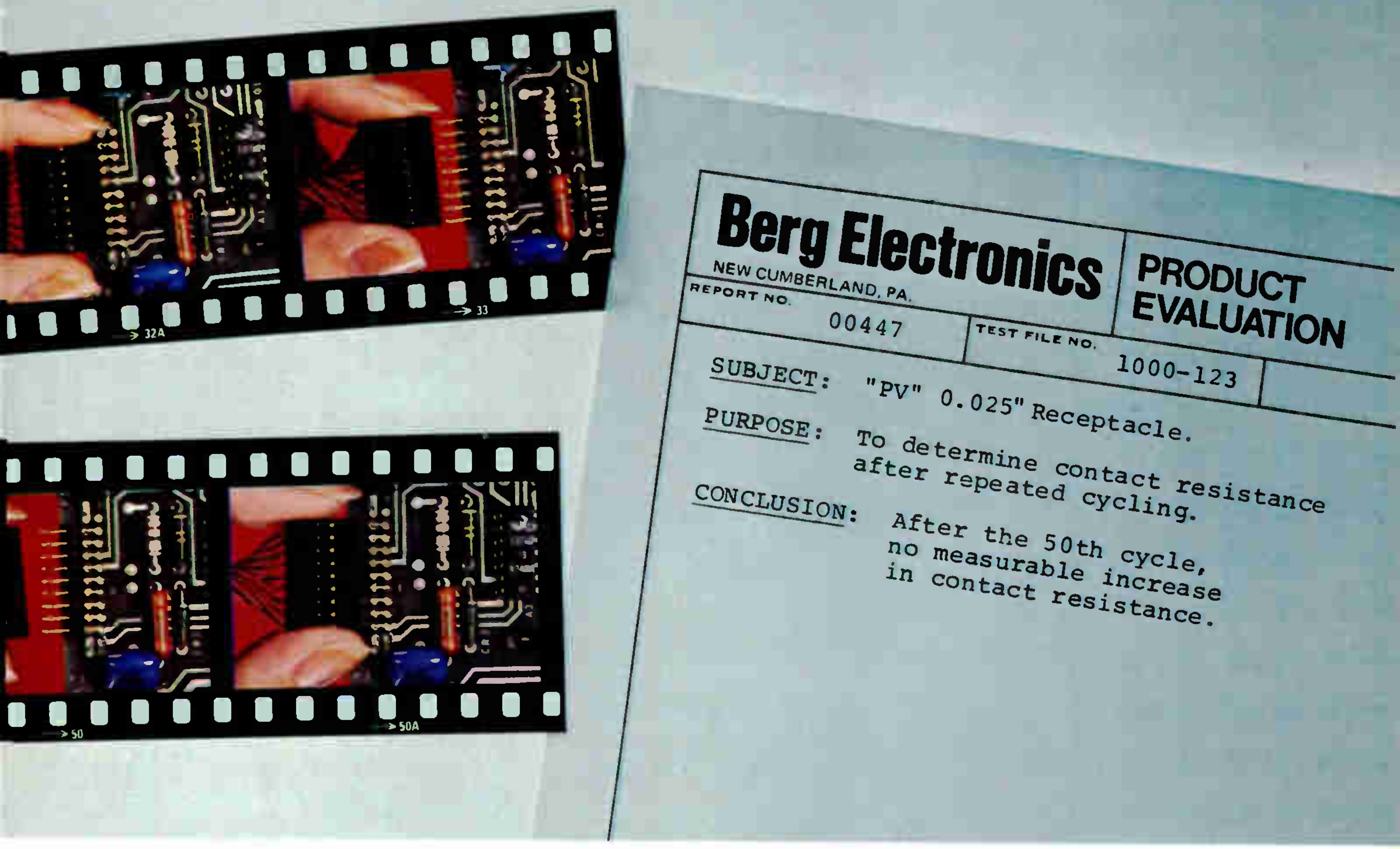

types and sizes, and the option of several gold or tin-lead platings, offer maximum design flexibility.

The Berg "PV" is the heart of the most complete 0.025" interconnection system available today. The BergCon™ system.

The "BergCon" system consists of a variety of mateable terminations for board-to-board, cable-to-board, or cable-to-cable packaging:

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- And the entire "BergCon" system is Underwriters recognized.

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ICs for PCM lines insert right pulses

PCM carrier repeater chips have on-board circuit to compensate for line loss

A new cost-effective monolithic integrated circuit performs all the active functions required for a regenerative repeater serving standard pulse-code modulation transmission lines. That's what Precision Monolithics Inc. promises with its new RPT-81/82 PCM carrier repeater chips, which handle 1.544-to-2.048-Mb/s digital data rates.

Also appealing is the fact that the chips regenerate all pulses that meet threshold requirements without inserting pulses incorrectly during empty time slots. Explains Guido Pastorino, telecommunications senior staff engineer: "In a PCM carrier system, coded information is transmitted over paired cables by the presence or absence of pulses in specified time slots. The wrong pulse in a time slot, if it occurs too often, will make the system bit error rate unacceptable."

ALBO room. Additional system functions of interest to the telecommunications designer have been incorporated right on the chip. These include an automatic-line-build-out (ALBO) circuit, which can compensate for up to 36 dB of line loss, and an automatic clock shutdown circuit.

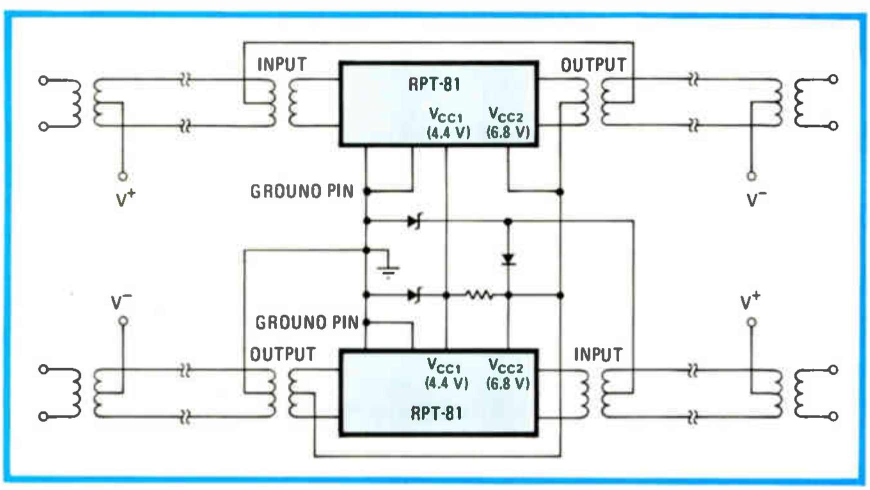
The clock shutdown feature, which appears on the 81, inhibits the clock amplifier when no signal is applied and greatly reduces system noise. When required, an oscillator control pin permits injection-locked free-running operation or pulsed-mode operation.

The RPT-81 chip, which comes in a 16-pin hermetic dual in-line package, has an on-chip 4.3-V regulated voltage supply that is unavailable for external use but provides the chip's internal voltage standard. Both chips operate at the 100-mW level, which is good for such remote applications as hanging the devices on telephone lines.

Added circuits. In a typical repeater system, says Pastorino, it is important to remember that even if the 81/82 chips are used, extensive external circuitry is required. For example, a regulator network, assembled from zener diodes and resistors, is needed to power the chip.

Normally, one common circuit is used with the two chips, each designed to care for one direction of PCM transmission (see figure). Also needed are input and output transformers, attenuators, and feedback resistors, in addition to a group of miscellaneous components.

The 81 needs two power supplies capable of delivering typically 4.4 and 6.8 V at 8.5 and 2.5 mA respectively. For this, the user gets a preamplifier open-loop gain of 48 dB



with a 5-MHz bandwidth at a 60-kΩ input impedance shunted by 2 pF. The 82 has similar specifications.

Prices in 100-piece lots range from $12.00 each for the 81 to $10.00 each for the 82. Delivery is from stock.

Precision Monolithics Inc., 1500 Space Park Dr., Santa Clara, Calif. Phone Virgel Evangelho at (408) 246-9222 [411]

Complementary-MOS chips multiply and divide

The CDP1855 and CDP1855C arithmetic chips are compatible with the complementary-MOS CDP1800 microprocessor, but they also work with most 8-bit microprocessor systems. They can multiply two 8-bit quantities or divide a 16- by an 8-bit number in 5 μs at 5 V or in 2.5 μs at 10 V typically. The devices are structured to permit the cascading of identical units to handle operands of up to 32 bits.

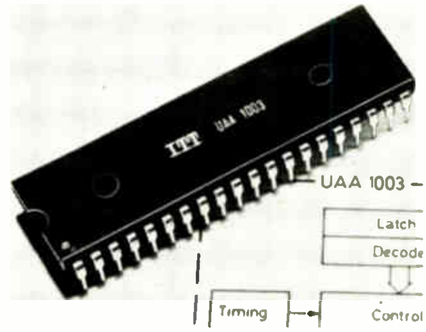
The 1855 operates from 4 to 10.5 V and the 1855C operates from 4 to 6.5 V. The input current for any one input is ±10 mA dc. These multipliers and dividers interface directly with the CDP1802 and the CDP-1804 single-chip microcomputer. In quantities of 100, the 1855CD sells for $48.31 apiece and the CDP1855D for $72.46.

RCA Solid State Division, Box 3200, Somerville, N. J. 08876. Phone (201) 685-6423 [415]

Speech generator gives time in three languages

The UAA1003 voice generator integrated circuit can be mask-programmed to speak in three different languages. With a fixed vocabulary of up to 25 words, the unit can be programmed to announce the time in German, French, or English for talking clock applications.

Each word generated by the n-channel MOS IC consists of a number of staircase-shaped 10-ms pulses. Each pulse is built up from 128 dif-



ferent amplitude values.

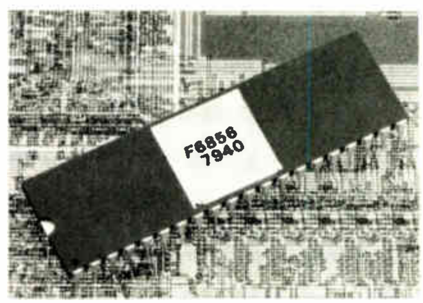
After sounding an alarm, the chip converts the time information delivered by a digital clock in seven-segment code into a spoken announcement. The device draws a maximum of 5 mA and operates from a single 5-V supply.

Currently, only the UAA1003-1, in German, is available in volume. The UAA1003-2 French version is available in smaller quantities, and the UAA1003-3 English version will be available soon. The price varies with language, number of words, and quantity ordered.

ITT Semiconductors, Marketing Dept., 500 Broadway, Lawrence, Mass. 01841. Phone David DeVoe at (617) 688-1881 [413]

Communications circuit handles popular protocols

The F6856 universal protocol controller is designed to provide access to most of the line-control protocols used in data-communications equipment at a low cost. The device can handle both bit- and byte-oriented protocols, including the synchronous SDLC (Synchronous Data Link Control), HDLC (High-level Data Link Control), and Bisync (Binary Syn-



chronous) arrangements.

Four 16-bit address registers within the F6856 are programmed to specify the desired protocol, as well as options within that protocol. The device then performs the bulk of the required processing.

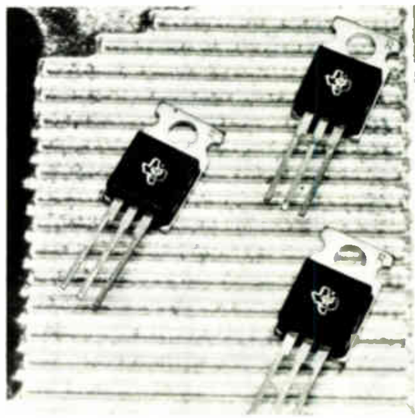
The 6856 MOS large-scale integrated device performs serial-to-parallel and parallel-to-serial conversion, converts transmission codes to computer codes, and performs cyclic redundancy checking. It operates at 1 Mb/s and is TTL-compatible. In quantities of 100 to 999, the unit sells for $24.50 each in the 40-pin plastic package and $29.90 for the ceramic side-brazed package.

Fairchild Camera and Instrument, MOS Products Group, 101 Bernal Rd., San Jose, Calif. 95119. Phone Bill Callahan at (415) 962-3816 [414]

Power FETs have 40-, 60-, 80-V drain-source voltages

The TIPF101, TIPF102, and TIPF-103 power field-effect transistors have a drain-source voltage and continuous drain current ratings of 40 V at 3 A, 60 V at 2.5 A, and 80 V at 2 A, respectively. Their on-state drain-to-source maximum resistances with a gate-to-source voltage of 10 V and a drain current of 0.5 A, are 1.1, 1.5, and 2 Ω. In 100 pieces, the 101 sells for $1.54, the 102 for $1.60, and the 103 for $1.70. They come in TO-220-AB plastic packages.

Texas Instruments Inc., Inquiry Answering Service, P. O. Box 225012, M/S 308, Dallas, Texas 75265 [416]



Protect expensive electronic circuitry.

Now you can protect your circuit with the switch that turns it on.

The new AIRPAX SNAPAK circuit breakers look and operate like switches, but their performance doesn't stop there. They are also snap-acting magnetic circuit breakers that can protect your product and its components from damaging power surges and faults.

For products that never had circuit protection before, the SNAPAK breakers are a great idea — they feature easy, single-hole mounting, they're available in a wide range of delay characteristics and current ratings, plus they come in a choice of baton or paddle handles in six attractive colors.

For products that previously used fuses and thermal devices, they're a better alternative—they eliminate extra stocking and assembly of multiple components, they save space and they reduce product wiring requirements.

You can order SNAPAK circuit breakers in SPST and DPST configurations (they're the only snap-action DPST circuit breakers around). There are shunt and relay versions available. And you can choose from a complete selection of mounting hardware to match your product's panel aesthetics.

All the facts about AIRPAX SNAPAK circuit breakers are contained in our new brochure. To get your free copy, contact us at: AIRPAX, Cambridge Division, Woods Road, Cambridge, MD 21613. Telephone: (301) 228-4600. Or circle our reader service number.

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At Boeing, forty dedicated systems Tektronix 8001s

The Microprocessor Design Support Center (MDSC) is Boeing's innovative answer to large scale microprocessor development. Tektronix makes it possible.

Boeing now supports over 120 engineers working on 35 projects.

Before the creation of the MDSC, Boeing used a variety of different vendors' stand-alone development systems. Each one supported only three engineers at a time, and more than one system was often needed for a single project.

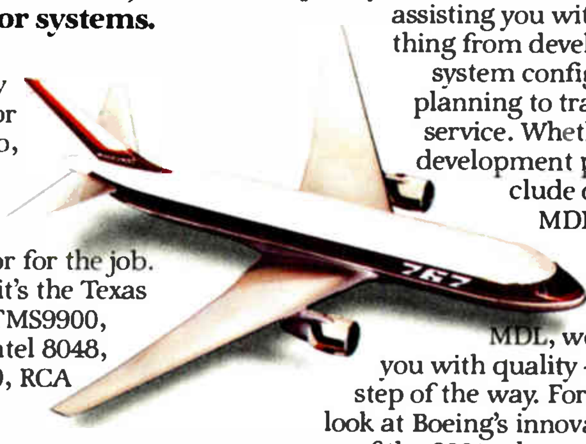
Now, software is developed on a DEC PDP 11/70® computer and transferred to six 8001 Microprocessor Development Labs for in-circuit emulation, debugging, and prototype integration.

By using one multi-user host computer with six distributed 8001s, Boeing is able to more efficiently support 120 engineers. With 8001s costing half as much as stand-alone development systems.

couldn't do what six are doing.

Development isn't limited by dedicated, single-vendor systems.

The 8001 supports every microprocessor Boeing uses, so, they're free to choose the right microprocessor for the job. And whether it's the Texas Instruments TMS9900, Zilog Z80A, Intel 8048, Motorola 6800, RCA 1802, or 14 others — the 8001 emulates it. Tek's multi-vendor support doesn't lock Boeing into one vendor's family of microprocessors.



Engineers get on board much faster.

When every engineer uses the same equipment and the same operating system for every project, it translates into a faster learning curve. And a more efficient, flexible team. For Boeing — or for you.

The world over, Tektronix supports your team with our team, assisting you with everything from development system configuration planning to training to service. Whether your development plans include our 8001 MDL, or our stand-alone 8002A MDL, we'll back you with quality — every step of the way. For a closer look at Boeing's innovative use of the 8001, please call your local Tektronix Field Office or write to us for our Boeing Application Note.

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1980: the first is here

The 8089 I/O Processor Handbook, by Adam Osborne

Intel is developing the co-processor concept; the 8089 is the first of the Intel co-processors. The **8089 I/O Processor Handbook** provides a fully detailed description of this innovative device, its operation, and use in 8086 systems. This Osborne Handbook contains complete discussions of pins, signals, timing, the instruction set, and programming and configuration guidelines. The 8289 Bus Arbiter, which may be required in large system configurations, is also described.

#39-X $5.95

Also in 1980: **The CRT Controller Handbook**

Osborne Microcomputer Handbooks will continue to update the Introduction to Microcomputers, Volume 2 and 3 series.

Update the cumulative volumes: 1978-1979

An Introduction to Microcomputers
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Every major 4-bit, 8-bit and 16-bit microprocessor through 1978 is described in this original 1400+ page volume. Architecture, timing, instruction set and usage are detailed for each of the 20 microprocessors, including the Intel 8086 and TMS9940.

1979 products are covered in the Volume 2 update package. Updates include Zilog Z8 & Z8000, MC6801 & 6809, and 2900 Series Chip Slice Devices.

Books and updates loose-leaf, unbound. Custom Volume 2 binders sold separately.

Volume 2 1978 ed.	#15-2	$25.00
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The first reference book to focus exclusively on microprocessor support devices, the 1978 edition offers 700 + pages of extensive coverage of Memory Devices, Parallel and Serial I/O CPU Single- and Multi-Function Support Devices, and System Busses.

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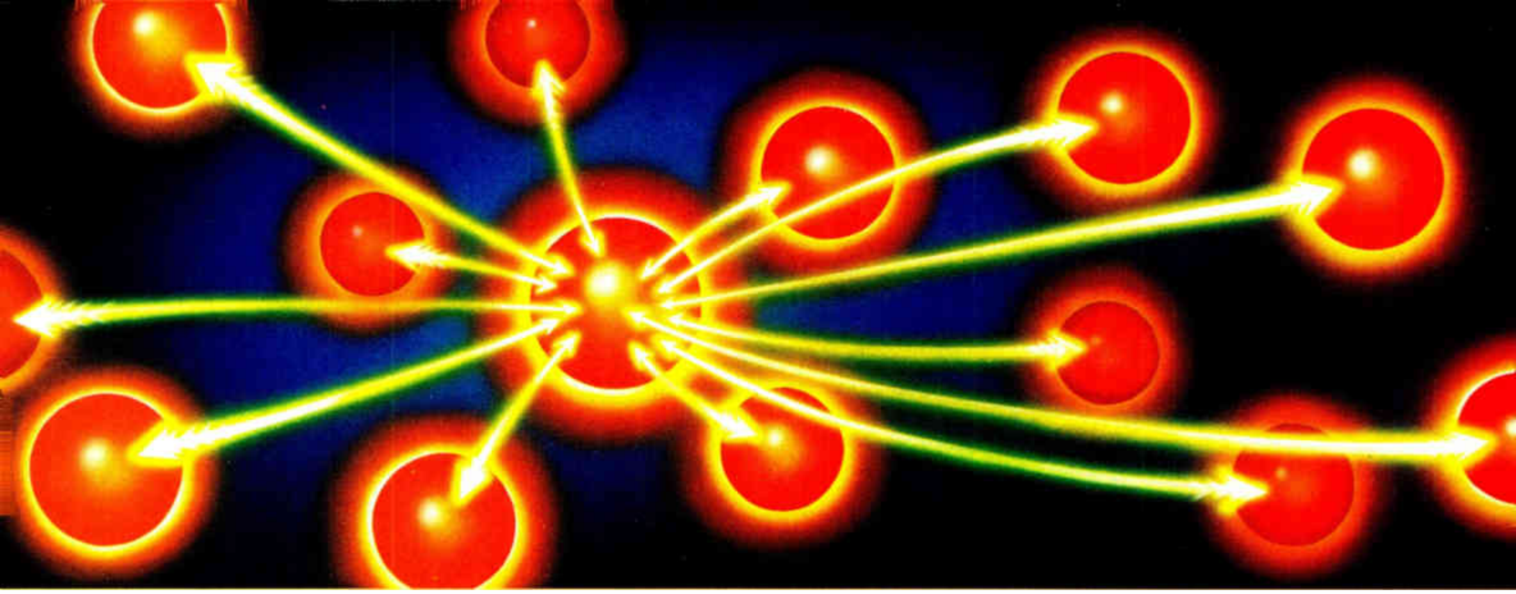
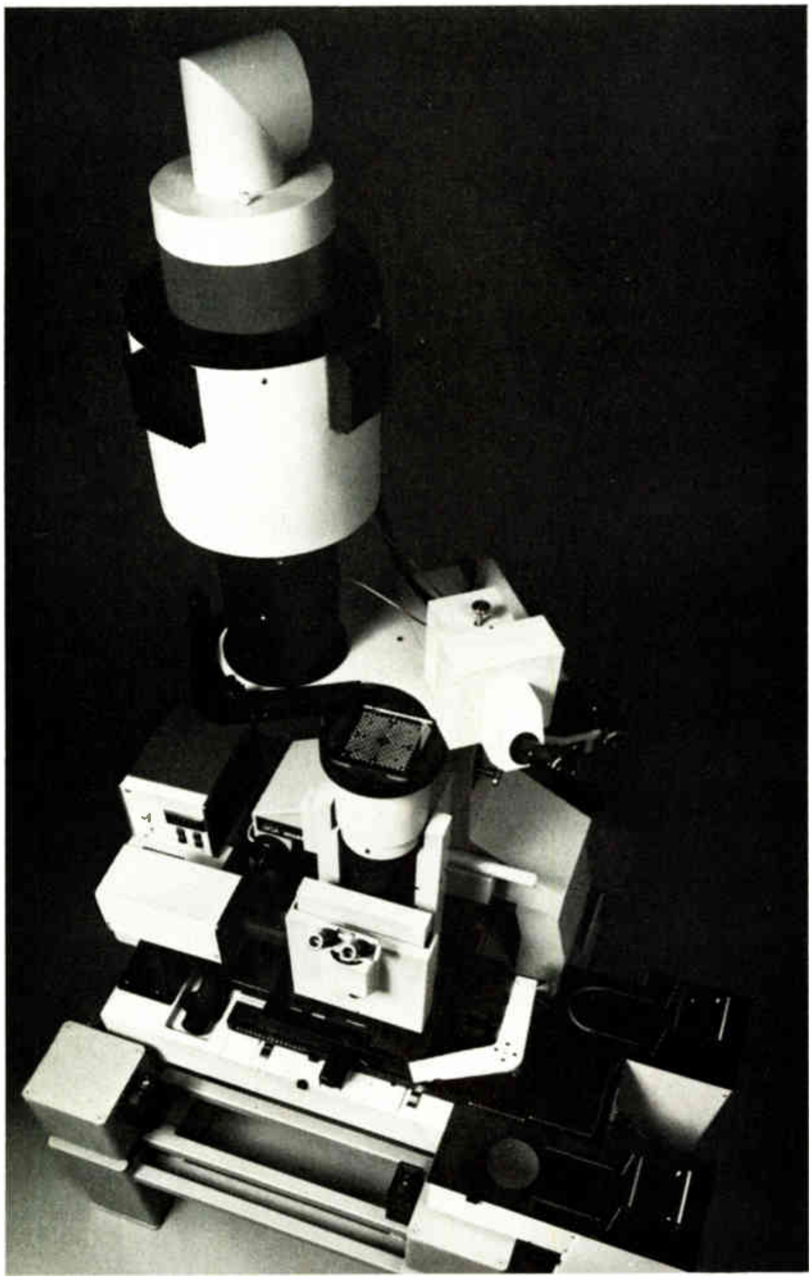


WAFER STEPPER™



Another innovation from the GCA/IC Systems Group.

Our DSW Wafer Stepper™ direct step on the wafer system can produce more bits per hour at a lower cost per bit than any other system available today. It's become a standard in the industry. And an excellent example of the innovative spirit of the IC Systems Group.

We have other examples, of course, including our unique Wafertrac™ wafer processor. And you can expect to see even more. Because we've committed several million dollars annually to an R&D program to support and refine our existing equipment, and to develop new systems for new manufacturing processes.

But that's not all we've been up to. We doubled our work force to increase production. We doubled our service offices so we're never more than a few hours away. We more than doubled our manufacturing capacity.

And we plan to double again in 1981.

In short, our IC Systems Group is committed to providing the best service and the best systems of any manufacturer in the industry.

So if you're involved in the front end of IC manufacturing, get in touch with the IC Systems Group at GCA. You'll find us on the leading edge of technology at Burlington Road, Bedford, Massachusetts 01730.

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Circle 242 on reader service card

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BY USING BLACK ALKYD WITH GOLD INLAY CONTACTS YOU CAN SAVE MORE THAN 30% ON YOUR CARD-EDGE CONNECTORS.

In this day of inflationary price increases which seem to surface with the regularity of the sun, you can once more expect the unexpected from EDAC.

Black Alkyd is now available in card-edge connectors in .156", .125" and .100" spacing. And this insulating material has outstanding molded characteristics which closely match the demanding specifications of Diallyl Phthalate.

Gold Inlay contains 30 micro-inches of gold versus 10-20 micro-inches for gold plating.

You know that you will receive the high quality, integrity and reliability that thousands of companies have come to expect from EDAC.

For real savings on your connectors, contact EDAC today!

EDAC INC.

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Available through Stocking Distributors and Representatives from Coast to Coast.

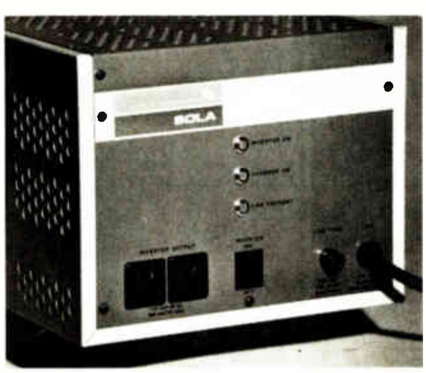
Power supplies

Uninterruptible power source has 20-min backup

The Mini-UPS plug-in uninterruptible power source system, designed to protect small electronic equipment from ac power-line problems, will be shown at NCC. This plug-in unit is available in 400-VA and 750-VA models. They can be used with point-of-sale terminals, electronic laboratory monitors and test devices, process controls, communications equipment, microcomputers, and related equipment.

Containing a lead-acid battery, the 400-VA device provides up to 20 minutes of regulated power to the load during a blackout; the 750-VA model provides 10 min of battery reserve. When drained, the batteries are automatically recharged to 95% of their full potential in less than 10 times the discharge time. The Mini-UPS continuously responds to ac line fluctuations, actively regulating output voltage and isolating the load from transients as well as from brownout conditions.

It operates from a single-phase 115-V ac input and provides an output voltage regulated to within ±3% of nominal value through input fluctuations of +10% to −20%. Input frequency fluctuations of up to ±10% of nominal value (60 Hz) are regulated at the output to ±0.5 Hz in one half cycle. The system also attenuates electrical noise or high-frequency interference, in both common and transverse modes. In addition, it reduces output harmonics to less than 3% total harmonic distortion into a resistive load. Units can withstand a 150% overload condition for two cycles without altering normal operation.

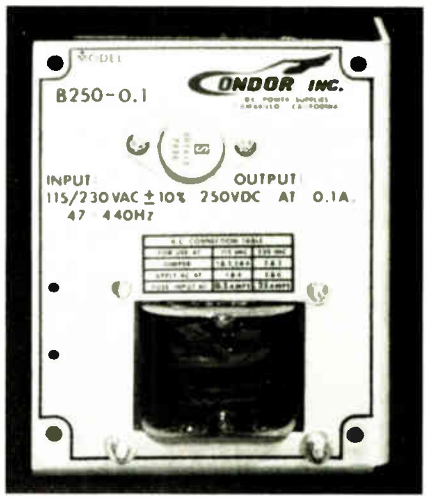


The 400-VA model sells for approximately $900; the 750 for about $1,100. Deliveries are scheduled to begin around August of this year.

Sola Electric, a unit of General Signal, 1717 Busse Rd., Elk Grove Village, Ill. 60007. Phone Pam Samson at (312) 439-2800 [392]

250-, 150-V supplies suit low-current needs

A 250-V dc series and a 150-V dc series of open-frame power supplies provide output power of from 25 W at 0.1 A to 400 W at 1.5 A and 18 W



at 0.12 A to 450 W at 3 A, respectively. They operate from an input of 115 or 230 V ac ±10% at 47 to 440 Hz. For a 10% change in the line voltage and a 50% change in the load, regulation is ±0.02%. At the 50% load change, transients are suppressed in 30 ms. Output ripple is a maximum of 0.02% p-p. The units have a stability of ±0.05% for 24 hours and operate between 0° and 50°C at full power. Units are derated linearly to 40% of power at 70°C.

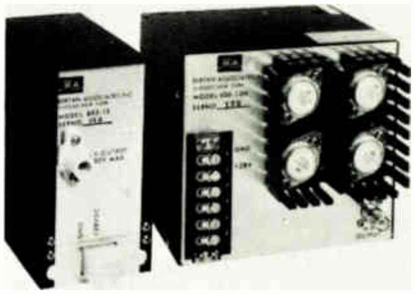
The units have short-circuit and

overload protection and remote sensing capability. In quantities of 1 to 9, both series sell for $34.95 apiece; for 100 to 249 units, the price is $25.60. Delivery is from stock to six weeks.

Condor Inc., 4811 Calle Alto, Camarillo, Calif. Phone (805) 484-2851 [393]

High-voltage modules are adjustable to 15,000 V dc

Intended for use in nuclear instrumentation, medical electronics, cathode-ray-tube displays, and other original-equipment applications, the series 605A/606 high-voltage modules deliver outputs of from 0 to 1,500 v dc and 0 to 15,000 v dc. The 605A module puts out up to 10 W of power and the 606 up to 30 W. Ripple is a maximum of 0.001% peak to peak. Line and load voltage is regulated to within 0.001%. All modules are arc– and short-circuit-protected. Input power is 28 v dc ± 10%. Prices start at $260 each and delivery is from stock.



Bertan Associates Inc., 3 Aerial Way, Syosset, N. Y. 11791. Phone (516) 433-3110 [394]

Supplies work with microprocessor-based units

Specifically designed for logic- and microprocessor-based equipment that requires from 25 to 65 W, two open-frame switching power supplies can operate from dual ac input ranges. Designated the OFS65/1 and OFS65/2, both units operate

SYSTEM 19 NOW PROGRAMS MORE THAN 200 DIFFERENT PROMS WITH ONLY ONE SOFTWARE SELECTABLE MODULE.

Our new System 19/UniPak lets you program most MOS and bipolar PROM'S from AMD, Fairchild, Harris, Intel, MMI, Motorola, National, Raytheon, Signetics and Texas Instruments. UniPak's software assembles the programming algorithm and selects the correct socket for 16, 18, 20, 24 and 28-pin PROMS.

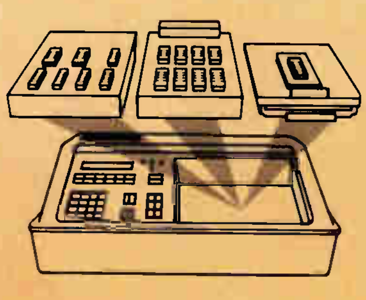
System 19/UniPak gives you design and purchasing freedom. This means you can select the best PROM for each application, and you can second-source for the best price and availability.

Semi-house approvals and easy calibration help maintain higher device yields. UniPak has earned written approval from device manufacturers. And easy calibration lets you keep performance within PROM manufacturers' specifications.

UniPak algorithms shorten programming time enhancing System 19's use as a production tool. UniPak is the first module to use a newly developed algorithm which makes it possible to program a 64K EPROM in less than half the time it takes to program a 16K EPROM using standard methods.

And the System 19/UniPak is easy to operate, with a minimum of operator training.

New System 19 concept is open ended to keep it state of the art. The System 19 is designed around a standard main frame and plug-in modules.



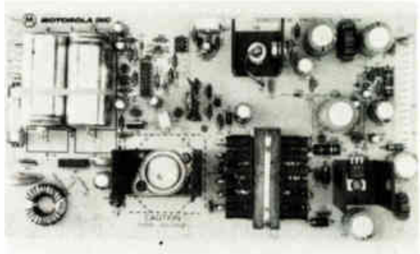
Modules available now include the UniPak, a gang programming pak for MOS devices, and a series of programming paks for logic devices and individual PROM families.

23 communication formats including six for development systems. Development systems, computers, teletypes and CRT terminals interface easily with the System 19. The System 19 accepts micro-processor instruction codes from Motorola, Intel, Tektronix, Fairchild, FutureData and other development systems without intermediary equipment.

Let us show you the future. The new Data I/O System 19/UniPak is available now. To make arrangements for a demonstration or to get your free copy of this valuable 32-page book, circle reader service number or contact Data I/O, P.O Box 308, Issaquah, WA 98027. Phone 206/455-3990 or TOLL FREE: 800/426-9016.

DATA I/O

Circle 247 on reader service card



from 85 to 135 V ac and 170 to 270 V ac over a frequency range of 40 to 440 Hz. Each device offers three different outputs: the OFS65/1 provides 5 V at 6 A, 12 V at 1.5 A, and −12 V at 1.5 A; the OFS65/2 offers 5 V at 6 A, 15 V at 1.2 A, and −15 V at 1.2 A. The 5-V output is adjustable from 4.5 to 5.5 V; all other outputs are fixed, with a tolerance of ±5%.

The units have a 32-ms full-load holdup time that permits protection of information stored in volatile memory, over-voltage protection on the 5-V output, and over-current protection with automatic reset on all outputs. The supplies are convection-cooled.

In quantities of 100 to 249, both units sell for $130 each. Delivery is from stock.

Motorola Semiconductor Products Inc., P. O. Box 20912, Phoenix, Ariz. 85036 [395]

Ac-dc supplies have 0.4-inch profile

Measuring only 2 by 4 by 0.4 in., the H series of low-profile ac-to-dc switching power supplies are designed to be used in printed-circuit boards that go in densely packed systems. The supplies accept inputs of 105 to 125 V ac, 210 to 250 V ac, or 250 to 300 V dc, all selectable by pin choice. They also offer dual outputs of ±12 V dc and ±15 V dc at 150 mA, a feature that makes them useful for powering operational amplifiers. The series delivers up to 4.5 W of output power to 71°C. Minimum input-to-output isolation is 1,500 V ac root-mean-square. Input/output capacitance is less than 50 pF. Other specifications for the power supply units include typical ripple and noise

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Expand your military hi/rel applications with our M8048 single-chip microcontroller strategy. For control applications in avionics, guidance and communications, Intel delivers the solution: the M8048, M8748 EPROM and the M8035L will improve the flexibility and reliability of your system with fewer components which enables you to meet reduced space and weight requirements.

Think about it, three totally self-sufficient 8-bit microcontrollers. Cost-effective controller components available now from the company who pioneered the very first military single-chip microcontroller. Intel.

Each one a proven performer. Begin with our M8048.

When you design Intel's M8048 into advanced military systems, you're making a strategic move. Like our other two family members, it's one of the highest performing controllers you can find... processed and tested to military standards. And screened to full Class B requirements of MIL-STD 883B, Method 5004 and Method 5005.

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Nowhere will you find a military microcontroller with all these features on one chip... plus Intel's field-proven technological leadership.

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Need on-chip erasability for easy prototype development? Want design flexibility? A shorter design cycle? Again, Intel delivers the solution: our M8748 user-programmable microcontroller.

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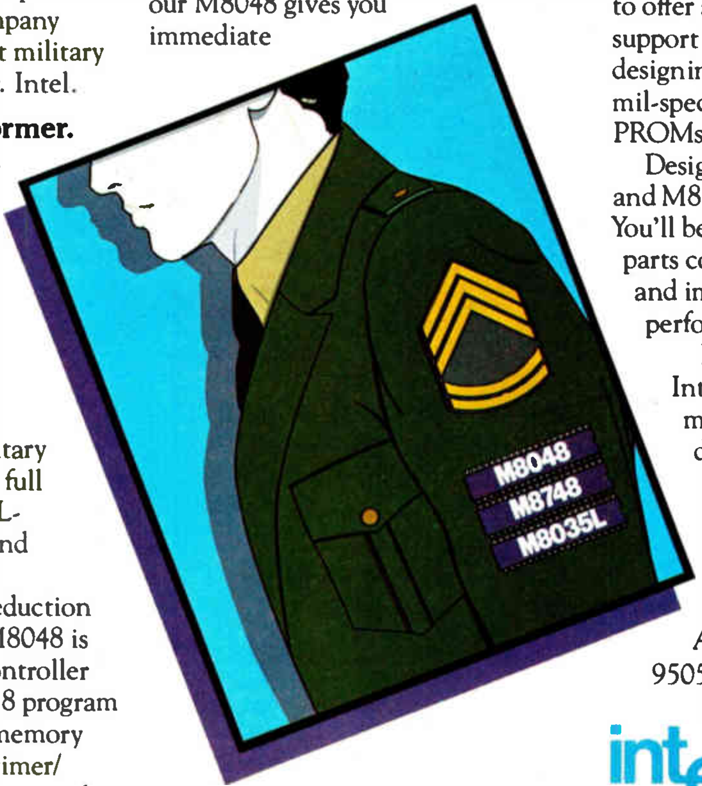

feedback during development and preproduction. Once your design is set, you can use the M8048 for volume production. Or you can stay with the M8748 for continued programming flexibility.

The M8035L, third member of our microcontroller team.

This microcontroller mirrors the M8048 with RAM power down mode, but there's a major difference... no program memory.

With our M8035L, you'll have the flexibility to match program requirements with external ROM or EPROM, such as Intel's M2716. The result? A minimum cost system with maximum component performance.

Development systems for ease of design.

Since Intel is the largest supplier of military microprocessors and microcontrollers, we have the experience to offer all of the development system support necessary for you to start designing today; plus support from our mil-spec RAMs, EPROMs, bipolar PROMs and peripheral devices.

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For more information on Intel's complete family of military microcontroller devices, and development support, contact your local Intel distributor or sales office. Or write Intel Corporation Literature Department, 3065 Bowers Avenue, Santa Clara, CA 95051, or call (408) 987-8080.

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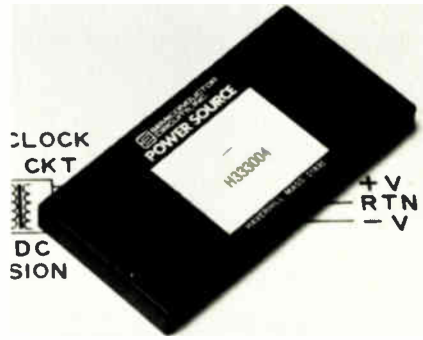
See our booth at the NCC Show
Booth #1354-60

Circle 249 on reader service card

of 2 mV rms and a typical temperature coefficient of 0.02%/°C. Each unit sells for $89.95 with discounts available for original-equipment

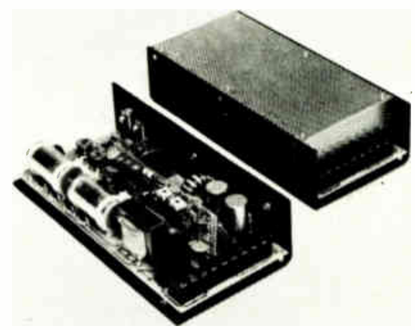


manufacturers. Delivery is in six weeks.

Semiconductor Circuits Inc., 218 River St., Haverhill, Mass. 01830. Phone (617) 373-9104 [396]

75-W supply offers better than 70% efficiency

The 75-W EPS75 series of switched-mode power supplies have output voltages of 5 V at 15 A to 24 V at 3 A, with an efficiency of better than 70%, says the manufacturer. Available in either open- or enclosed-frame versions, they operate from a



dual input range of 90 to 132 or 180 to 250 V ac. Ripple is a maximum of 50 mV peak to peak. In quantities of 250, the open-frame version sells for $127; the enclosed-frame unit sells for $138.

Elpac Power Systems, division of Elpac Electronics Inc., 3131 S. Standard Ave., Santa Ana, Calif. 92705. Phone (714) 979-4440 [398]

We can custom-fit standard motors to suit your special designs.

With a little alteration to any of our standard catalog items, we can tailor the motor configuration you need—without high costs or long delays.

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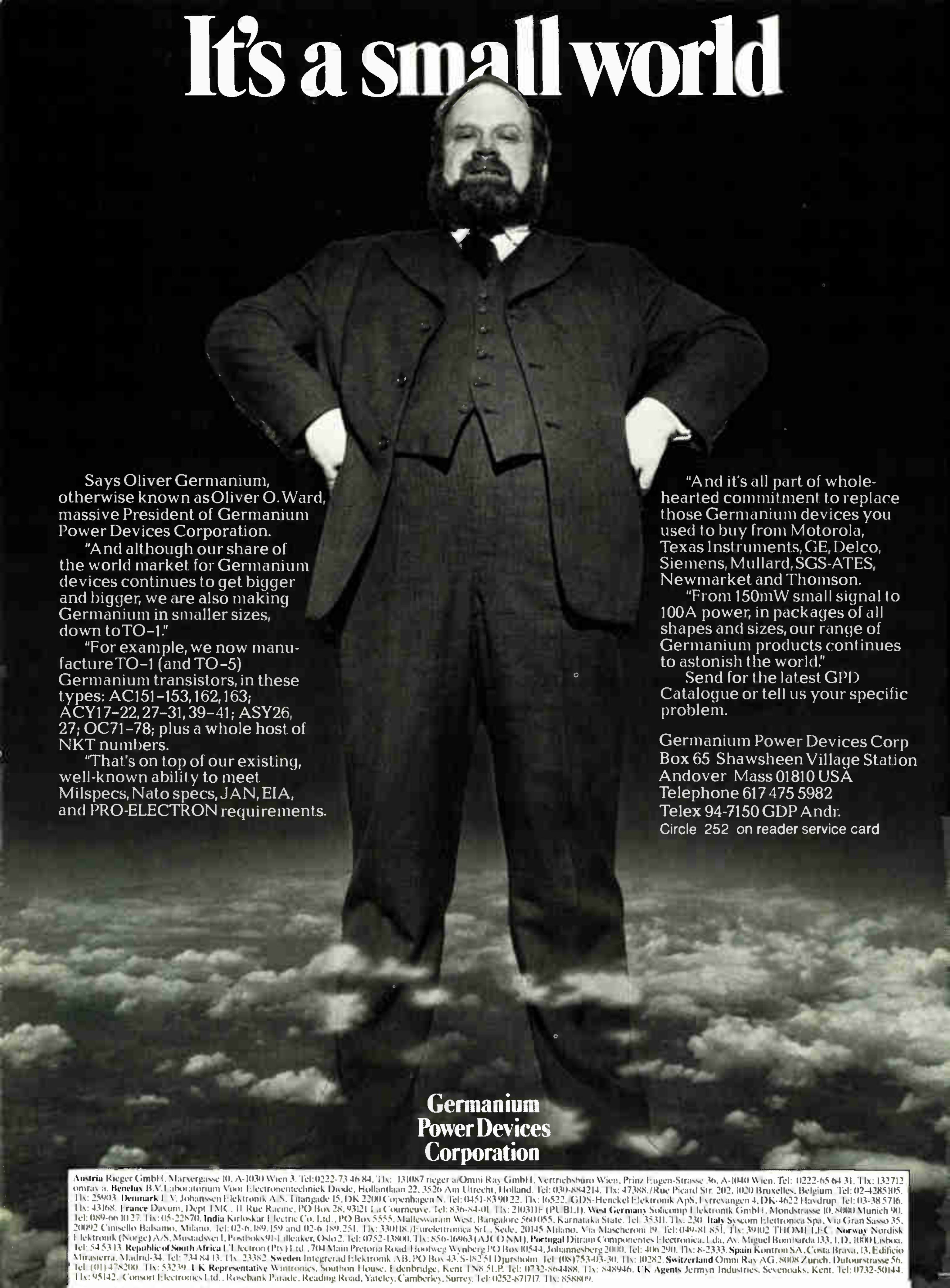
Circle 251 on reader service card



It's a small world
Says Oliver Germanium, otherwise known as Oliver O. Ward, massive President of Germanium Power Devices Corporation.
"And although our share of the world market for Germanium devices continues to get bigger and bigger, we are also making Germanium in smaller sizes, down to TO-1."
"For example, we now manufacture TO-1 (and TO-5) Germanium transistors, in these types: AC151-153, 162, 163; ACY17-22, 27-31, 39-41; ASY26, 27; OC71-78; plus a whole host of NKT numbers.
"That's on top of our existing, well-known ability to meet Milspecs, Nato specs, JAN, EIA, and PRO-ELECTRON requirements.
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Austria Rieger GmbH, Marxergasse 10, A-1030 Wien 3. Tel: 0222-73 46 84. Tlx: 131087 rieger a/Omni Ray GmbH, Vertriebsbüro Wien, Prinz Eugen-Strasse 36, A-1040 Wien. Tel: 0222-65 64 31. Tlx: 132712 omray a. Benelux B.V. Laboratorium Voor Electronentechniek Diode, Hollantlaan 22, 3526 Am Utrecht, Holland. Tel: 030-884214. Tlx: 47388./Rue Picard Str. 202, 1020 Bruxelles, Belgium. Tel: 02-4285105. Tlx: 25903. Denmark E.V. Johanssen Elektronik A.S. Titangade 15, DK 2200 Copenhagen N. Tel: 0451-83 90 22. Tlx: 16522. GDS-Henckel Elektronik ApS, Fyrrevangen 4, DK-4622 Havdrup. Tel: 03-38 5716. Tlx: 43168. France Davum, Dept TMC, 11 Rue Racine, PO Box 28, 93121 La Courneuve. Tel: 836-84-01. Tlx: 210311F (PUBLI). West Germany Soliecomp Elektronik GmbH, Mondstrasse 10, 8000 Munich 90. Tel: 089-66 10 27. Tlx: 05-22870. India Kirloskar Electric Co. Ltd., PO Box 5555, Malleswaram West, Bangalore 560 055, Karnataka State. Tel: 35311. Tlx: 230. Italy Syscom Elettronica Spa, Via Gran Sasso 35, 20092 Cinisello Balsamo, Milano. Tel: 02-6.189.159 and 02-6.189.251. Tlx: 330118./Eurelettronica Srl., Sede, 20145 Milano, Via Mascheroni 19. Tel: 049-81 851. Tlx: 39102 THOMELEC. Norway Nordisk Elektronik (Norge) A/S, Mustadsvei 1, Postboks 91-Lilleaker, Oslo 2. Tel: 0752-13800. Tlx: 856-16963 (AJCONM). Portugal Ditram Componentes Electronica, Lda, Av. Miguel Bombarda 133, 1.D, 1000 Lisboa. Tel: 54 53 13. Republic of South Africa L'Electron (Pty) Ltd., 704 Main Pretoria Road, Hoofweg Wynberg PO Box 10544, Johannesberg 2000. Tel: 406 290. Tlx: 8-2333. Spain Kontron SA, Costa Brava, 13, Edificio Mirasierra, Madrid-34. Tel: 734 84 13. Tlx: 23382. Sweden Integrerad Elektronik AB, PO Box 43, S-182 51 Djursholm. Tel: (08)753-03-30. Tlx: 10282. Switzerland Omni Ray AG, 8008 Zurich, Dufourstrasse 56. Tel: (01) 478200. Tlx: 53239. UK Representative Wintronics, Southon House, Edenbridge, Kent TN8 5LP. Tel: 0732-864488. Tlx: 848946. UK Agents Jermyn Industries, Sevenoaks, Kent. Tel: 0732-50144. Tlx: 95142. Consort Electronics Ltd., Rosebank Parade, Reading Road, Yateley, Camberley, Surrey. Tel: 0252-871717. Tlx: 858809.

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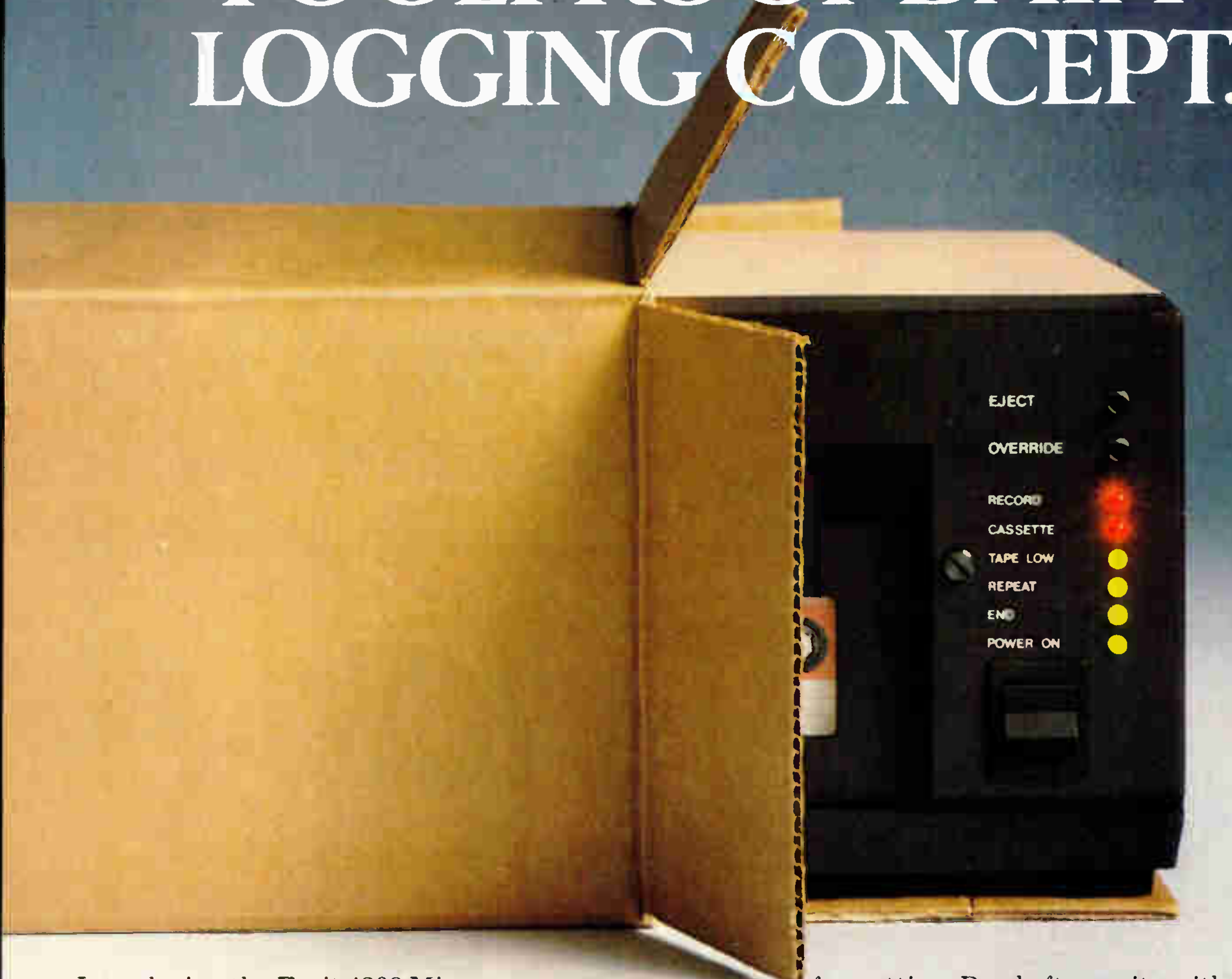

Introducing the Facit 4208 Microprocessor-controlled Cassette Tape Unit.

It's the most complete plug-in unit you can get. Combining absolute data security with truly brilliant system performance.

No restrictions on characters to be recorded. Dual 256 character buffer memory for continuous data transfer. Fully self-contained with battery back-up and extensive power-down programmes ensure 100% security of accepted data. Fully Facit 4070 compatible.

Read/write transfer rates 0-500 ch/s asynchronously with automatic tape handling and data formatting. Read after write with bit by bit compare check and CRC check to ensure correct data on tape.

Storage capacity 230000 ch/track. ECMA 34 and Silent 700® compatibility. Wide range of interfaces both serial and parallel.

All existing mains voltages and frequencies are covered. Noiseless 24-hour stand-by. No moving parts in stand-by mode.

The Facit 4208 foolproof Cassette Tape Unit concept comes from the company that gave you the Facit 4070 tape punch. And emphasizes the same ease of use and plug compatibility.

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Facit, Inc., 66 Field Point Road, Greenwich, Ct 06830, Tel. (203) 622-9150. Telex 965953.

Circle 253 on reader service card

Data acquisition

Transformers star in synchro design

Flux-nulling technique slims core dimensions, cuts number of turns

In the miniaturization arena, the integrated circuit normally stars. But for a new hybrid synchro-to-digital converter offering 12 bits of angular resolution, the limelight has been stolen by three transformers, each occupying a volume of 0.1 in.^{3}

The three transformers fit on a hybrid substrate along with 14 active devices and provide complete isolation between the synchro's signal and reference inputs. The resulting 32-pin dual in-line hermetically sealed package has a profile height of 6.6 mm with a pitch of 22.9 mm.

Two versions of the device—developed by Memory Devices Ltd., a British subsidiary of Analog Devices and to be marketed in the U. S. by the parent firm—have been designed. The SDC 1742 is accurate to ±3.2 arc-minutes, ±1 least significant bit; the SDC 1741 is accurate to ±10 arcmin, ±1 LSB. The U.S. price will be $595.

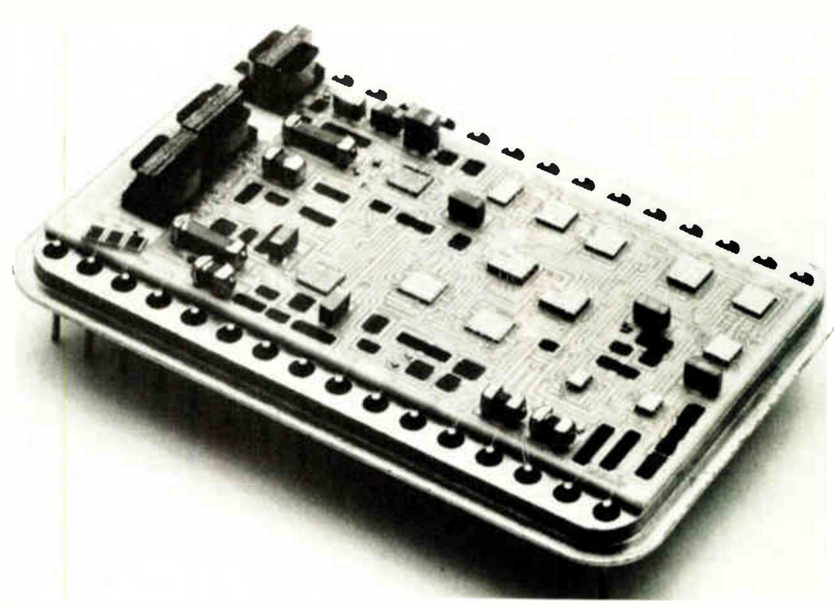
The new hybrid replaces an earlier module measuring 3.5 by 2.5 by 0.4 in., and the resulting space and weight reduction is expected to be a big plus in its favor in avionics, military, numerical-control, and other applications where a shaft position must be precisely known.

Operating in a tracking mode, the converter constantly reduces the difference between the real shaft angle and that stored in an internal up-down counter. Its tracking rate is 18 revolutions per second. The converter handles accelerations of over 20 revolutions per second, with error limited to 1 LSB.

The tracking converter includes a high-speed digital cosine multiplier, operational amplifiers, steering logic, and up-down counters. But a 16,000-mil^2 complementary-MOS large-scale integrated circuit being developed will integrate 10 functions, yielding a five-chip package.

Designing small. The three synchro isolating transformers play two roles. They convert the synchro's 90-V output to a 15-V level compatible with semiconductor technology, and they isolate primary and secondary circuits, thereby avoiding spurious ground loops. Incorporating the transformers in the package also ensures a balanced input and high common-mode rejection.

Conventional transformers tend to hog applied voltage, causing a core



LAST NOVEMBER, DATA GENERAL AND DEC ANNOUNCED NEW COMPUTERS. THE SIMILARITY ENDS THERE.

COMPARE:	SPEED Thousands Whetstone instructions/second		PRICE
	Single Precision	Double Precision	
DEC PDP 11/44 System	314*	231*	$41,900* Includes PDP 11/44 with 256 ERCC memory, 20.8 MB dual RL02 disc sub-system, floating point processor and LA120 console printer
Data General ECLIPSE S/140 System	450	380	$37,450 System including S/140 with 256KB ERCC MOS memory, Model 6100 25MB non-removable moving head disc with integral 1.26 MB diskette floating point hardware and Dasher TP2 180 CPS console printer
ECLIPSE S/140 is:	**43% faster**	**65% faster**	**10% lower price**

*As reported in COMPUTER SYSTEMS NEWS, Dec. 3., 1979; MINI-MICRO SYSTEMS, Jan., 1980.

What more can we say? Our new ECLIPSE® S/140 is not only a great deal faster than the 11/44, it's also a great deal, period.
Read the chart.
Then you'll understand why our ECLIPSE S/140 is your only choice. Break the speed limit without paying the price. Send in the coupon.

Data General Corporation, Westboro, MA 01580, (617) 366-8911. ECLIPSE is a registered trademark of Data General. ©Data General Corporation, 1980.

VISIT US AT BOOTH #1339 AT NCC, ANAHEIM, CA., MAY 19-22, 1980.

Data General

Mail to: Data General Corporation, Westboro, MA 01580
☐ I can read. Send me complete information immediately.
☐ I can read but I can't wait. Send a salesman now.

Name
Title
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The Computer of the U.S. Olympic Sports Medicine Committee flux rise in opposition to the applied voltage, unless the core is large enough and there are sufficient primary turns. To overcome that limitation, product designer Gerry Searle developed a flux-nulling technique using an operational amplifier to limit the core flux to the level needed to ensure transformer action. The op amp is connected across the secondary winding, and its output is applied to a separate winding whose polarity opposes the core flux: the higher the op-amp gain, the greater the flux limitation.

With this design, both the core dimensions and the number of turns can be reduced to miniature proportions. Also, as the core flux is reduced, so is the primary back electromotive force. Consequently, the primary current can be set by a suitable input resistance, and the secondary voltage by a suitably chosen secondary resistance. An added advantage is that different nonstandard synchro voltages can be matched to the converter by incorporating different thin-film resistor networks in the package.

The digital outputs of the converter are of the latched, three-state type and are TTL-compatible. Data can be transferred from the counter to the output in 300 ns by shifting the inhibit line to a logic low; it can be held low indefinitely without risk of opening the internal converter tracking loop. The three-state output has both high and low byte-compatible enable signals, which simplify multiplexing the converter outputs into 8-bit microprocessors. Both units operate from −55° to +125°C.

In U. S.: Analog Devices Inc., P. O. Box 280, Norwood, Mass. 02062. (617) 329-4700 [381]

In Europe: Memory Devices Ltd., Central Avenue, East Molesey, Surrey, England KT8 OSN [382]

Control unit transfers video images to digital tape

This digital tape input/output control unit transfers data between the memory of a Qantex DS-30 digital

video processor and up to four synchronous magnetic-tape transports that use standard interfaces. The unit is compatible with ANSI and IBM seven- or nine-track formats. It accepts tape speeds from 12.2 to 45 in./s and has selectable block sizes of 256, 512, 1,024, and 2,048 picture elements per record. The unit price is $2,500.

Qantex Corp., 252 N. Wolfe Rd., Sunnyvale, Calif. 94086. Phone Joe Clifford at (408) 733-6730 [388]

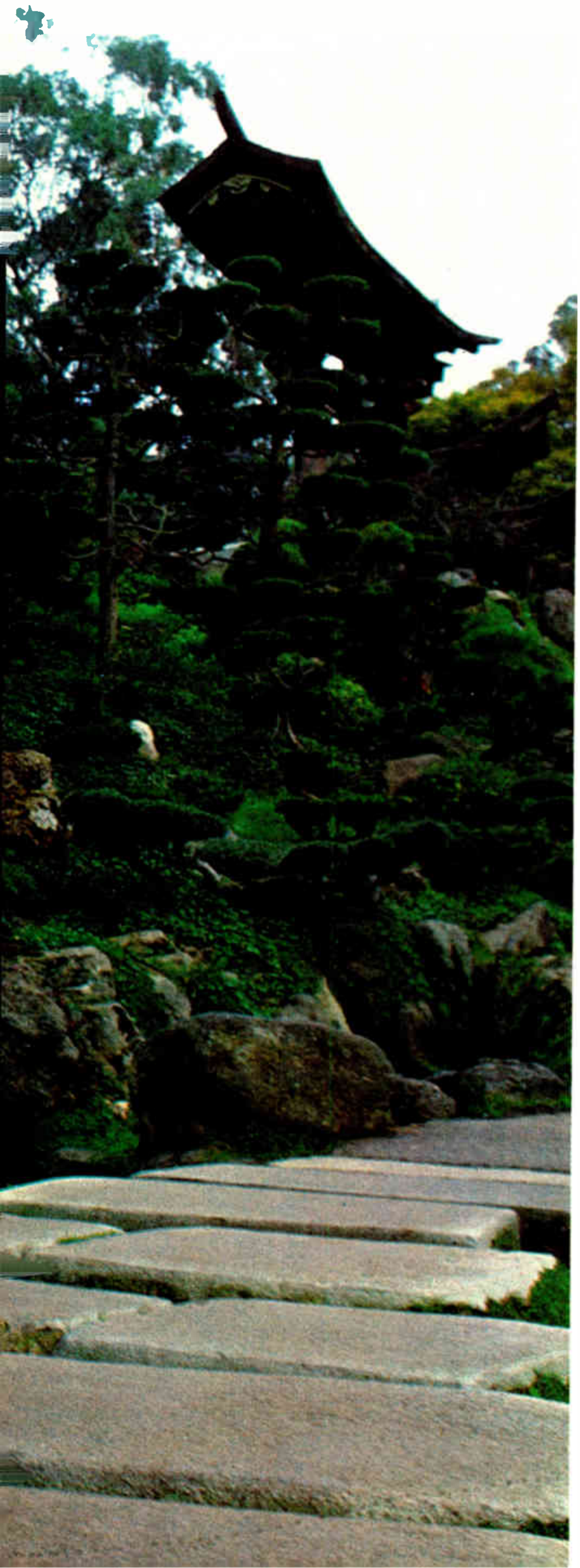
Tape coupler interfaces PDP-11 with 8 tape drives

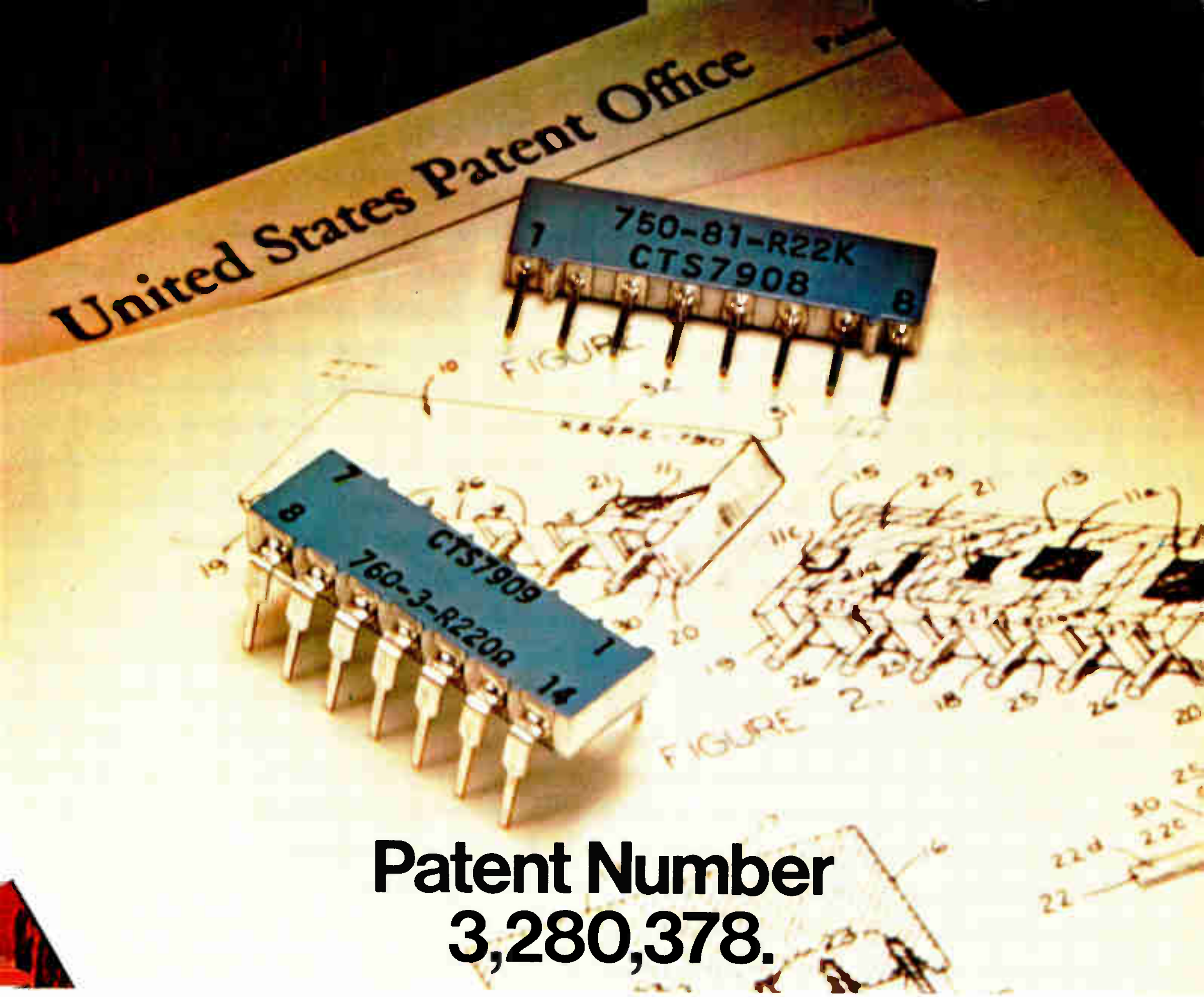
Model DU-130, a quad-sized intelligent magnetic-tape coupler, interfaces Digital Equipment Corp.'s PDP-11 SPC small peripheral controller with up to eight dual-density formatted magnetic-tape drives, including streamer drives. The unit provides emulation and RT-11/RSX-11/RSTS/IAS and MUMPS software compatibility and consumes up to 60% less power than multiple-board embedded controllers. The microprocessor-based coupler is completely contained on one quad printed-circuit module and includes on-board light-emitting-diode indicators.

In operation, the DU-130 couples two formatted tape drives from any manufacturer with three slave units each. The coupler handles nine-track, 800- or 1,600-b/in. industry-standard drives at speeds from 12.5 to 125 in./s. Price is $1,695 and delivery is 30 days after receipt of order.

Distributed Logic Corp. (DILOG), 12800-G Garden Grove Blvd., Garden Grove, Calif. 92643. Phone (714) 534-8950 [389]


We think an OEM computer should be able to take your marketing around the world.





Patent Number 3,280,378.

Termination strength is the key to network reliability—patented CTS Anchor Lock Terminations are the key to strength.

The secret? Our superior process forcefully drives the leads into tapered holes in the substrate, cold forming the lead to the substrate and wedging it tightly in place prior to soldering. Try pulling out a CTS lead; you'll see how much assurance our 5 lb. pull strength gives you. Then try it with a competitive product! You'll see what we mean.

Why risk a loose termination that can alter the resistance value of your network? CTS, and only CTS, can deliver the superior mechanical and electrical reliability qualities of Anchor Lock terminations. The same exclusive insertion process applies to both CTS Series 750 SIP and Series 760 DIP style cermet resistor networks.

Reliability has been our key to success. With more than one billion element hours of extended load life testing, CTS resistors have exhibited a failure rate of only 0.00041%/1,000 hours @ a 95% confidence level. Each SIP and DIP network is 100% value and tolerance tested before shipment.

Ask us about customizing your special network requirements; or choose from 400 standard part numbers available off-the-shelf from authorized CTS distributors.

See for yourself how superior Anchor Lock terminations earned that patent—plus a lot of respect over more than fifteen years of production experience. Ask for your free samples and network catalog. Write CTS of Berne, Inc., 406 Parr Road, Berne, Indiana 46711. Telephone (219) 589-8220.

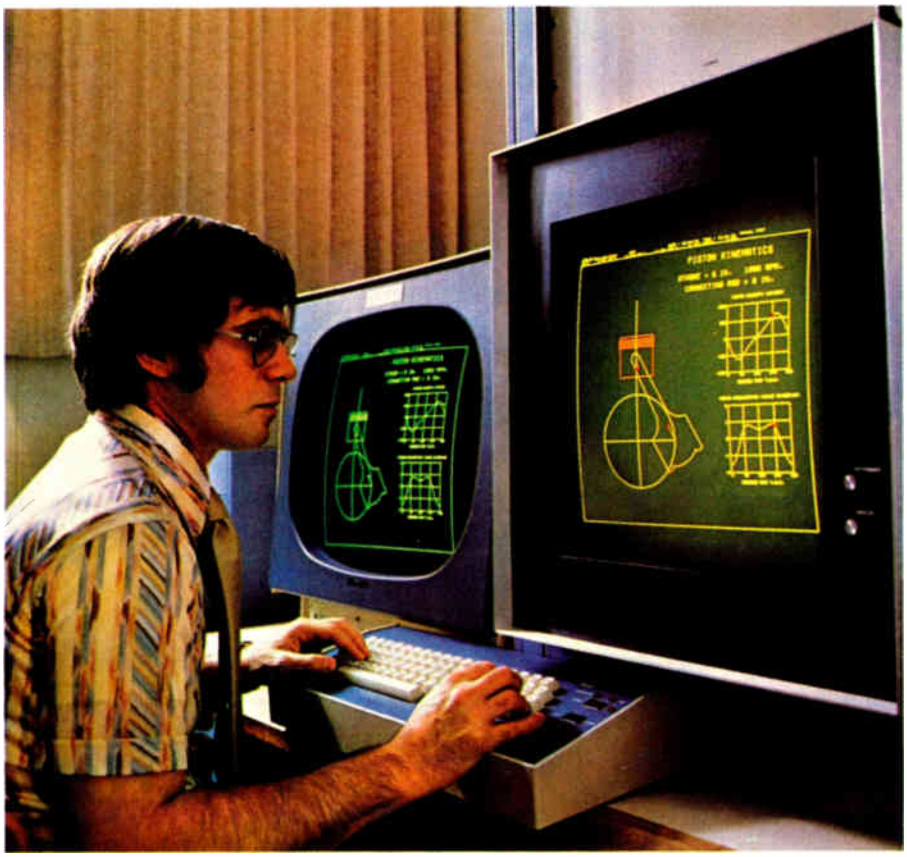
CTS CORPORATION
ELKHART INDIANA

A world leader in cermet and variable resistor technology.

Circle 265 on reader service card

Control Data: Committed to

Control Data people, systems and services are helping manufacturers prepare for the '80's.



Exemplifying what state-of-the-art CAD technology can do for manufacturers, Chrysler Corporation Chief Engineer Robert Brauburger reports dramatic gains in the speed and efficiency of their design process. Above: a Chrysler engineer uses a color graphics terminal to analyze piston performance. Below: the control room at Chrysler's Technical Computing Center, where an operator monitors four interconnected Control Data® CYBER 170 systems.

American manufacturers are challenged by spiraling inflation and increasing competition. They must keep pace with productivity gains abroad to maintain market share and protect the jobs of their employees.

In the U.S., the annual growth in productivity over the last ten years has been half of what it was over the previous two decades. Many manufacturers are turning to computer-based technology to reverse this trend.

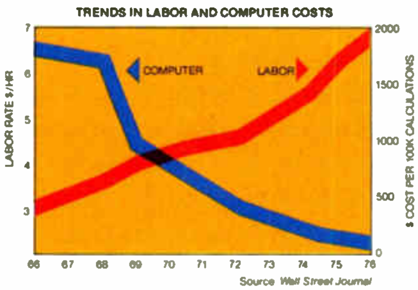
Over half the FORTUNE 500 are using our products and services.

Large scale Control Data computers are recognized for their outstanding ability to perform complex scientific and engineering computations rapidly and with great accuracy. Our systems are installed in major manufacturing companies around the world. And Control Data's recently announced CYBER 170 Series 700 continues in this tradition by offering increased performance at reduced cost.

Control Data also offers manufacturers a wide range of data services through some of the world's foremost data processing networks.

Through our CYBERNET® Services we provide the benefits derived from processing on Control Data computer systems, along with sophisticated application programs

the Manufacturing Industry



for structural, mechanical and electronic design and analysis.

Through our Service Bureau Company, we provide a whole range of services for business planning, analysis and control, plus a complete interactive system for material requirements planning, production control and management information.

In addition, many companies are training their personnel with our PLATO® computer-based educational service.

A new automated design and drafting system

One of the most important ways Control Data is helping manufacturers make better use of human resources is through computer-aided design (CAD).

Recently, we announced AD-2000,* an automated design and drafting system which speeds the design process by eliminating many of the tedious, time-consuming tasks previously performed by hand. AD-2000 offers practical and up-to-date design and drafting capabilities while providing a link to numerical control and other computer-aided manufacturing (CAM) functions.

Coming from Control Data—a fully integrated CAD/CAM system

The critical link between CAD and CAM is the effective control and flow of data among respective systems. Control Data has the products and expertise to allow the interface of design, analysis and manufacturing applications.

And when our new CAD/CAM technology is available, manufacturers will be able to go from a design on a CRT screen to a finished part—all with greater productivity and better use of resources than offered by the present technology.

Control Data is committed to helping industry bridge the gap between the old and new technologies. Through our Manufacturing Consulting Services organization we are helping manufacturers plan and implement their CAD/CAM strategies through training, consultation and technical assistance. And through Commercial Credit Company, an important part of Control Data, we provide manufacturers with a whole range of financial services, including capital equipment financing.

Boeing, a long time user of Control Data computers, recently installed two CYBER 175's in a CAD/CAM center to assist in the design of its new generation of passenger aircraft.

Systems. Services. Solutions. Measures of Control Data's commitment to the manufacturing industry.

For further information, write: Control Data Corporation, Manufacturing Industry Marketing, HQW09F, Box 0 Minneapolis, MN 55440.

*Developed by Manufacturing and Consulting Services, Inc., Costa Mesa, CA.

CONTROL DATA CORPORATION

Addressing society's major needs

New products

Materials

Alloy attenuates vibration, noise

Chromium-iron-aluminum alloy that can be used at 300°C cuts noise in impact printing

The noise produced by teletypewriters, computer print-out terminals, and many other data-processing systems is a problem familiar to operators of such equipment—a problem that, in this environment-conscious world, equipment designers are determined to combat or even eliminate. But such measures as enclosing equipment in padding materials like foam rubber, cork, or felt may prove either too costly or inadequate. Making parts from plastic or hard rubber instead of metal does help a bit, but for many applications these materials have insufficient mechanical strength and hardness or do not stand up to higher temperatures.

However, a German metallurgical firm that caters mainly to the electronics industry thinks it has solved the noise problem: a chromium-iron-aluminum alloy with vibration-attenuation properties. Parts made from the material produce hardly any noise when subjected to vibrations caused by hitting, knocks, or shocks.

Produced by Vacuumschmelze GmbH—a subsidiary of Siemens AG located in Hanau, near Frankfurt—the material absorbs mechanical vibrations by converting them into heat, with the temperature of the material rising by only a negligible 3° to 4° C. Materials with such characteristics have been known for some time, but Vacuumschmelze is among the first to recognize their commercial importance and to improve upon their vibration-damping properties.

Designated Vacosil 010 (from the words Vacuumschmelze, chromium, and silent), the material has an attenuation, or damping capacity, of 30%. That figure stands for the amount of vibration energy that is destroyed in one vibration cycle. The energy content after the tenth oscillation is only about 1% of the initial value. For example, when a piece of loosely suspended Vacosil is struck with a hammer, what is heard is a rather dull thud, like that produced by hitting a piece of lead, instead of the bell-like sound heard when a piece of normal steel is hit.

Besides being used for making keys and other moving parts for printing equipment, Vacosil can be used for fabricating bounceless, vibrationless contact elements for relays and power switches.

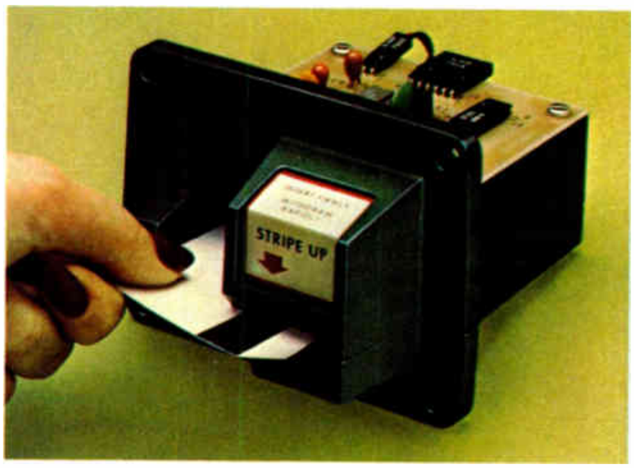
The material can easily be machined and formed. It can be used at temperatures up to 300° C—much more than it will encounter in most applications—and it maintains its damping characteristics over a wide range of vibration frequencies. Significant, too, is the fact that parts made from the material that are subjected to high stress and strain exhibit a long life, says Heinrich Herwig, sales director at Vacuumschmelze.

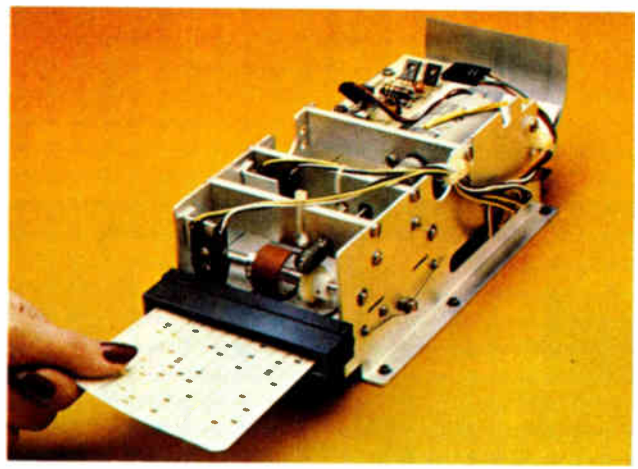
Vacosil 010 is now available in sample amounts, but the firm can supply large amounts of it on relatively short notice. The price per kilogram ranges from 20 to 40 Deutschmarks—the equivalent of about $12 to $24—depending on dimensions and shape. One form in which it is supplied is in 30-cm-wide strips from 0.5 to 5 mm thick.

Vacuumschmelze GmbH, 6450 Hanau, P. O. Box 1209, West Germany [476]

A series of resins can be cured at room temperature and above. The HT (heat-cure) and RT (room-cure) series withstand temperatures of up to 165° and 135°C, respectively. Depending on the type of material, the viscosity of the resins ranges between 1,000 and 50,000 centipoises. Pot life is two days for the heat-cured resins, 2 hr for the room-cured. The materials' dielectric strength ranges from 350 to 375 and the dielectric constant is from 3.9 to 4.25. Both series sell for from $1.80 to $2/lb in bulk quantity. A

"We're using card readers for more and more applications... thanks to the AMP combination of dependability, features, and price."





No other manufacturer has as many card readers for as many applications as AMP. Each of them designed to deliver the right combination of price and performance.

Take the model 801 for instance. It's a miniature, hand-operated magnetic reader that reads all current ABA and ATA data tracks. Electronics are contained in a TTL and CMOS compatible custom integrated circuit that operates from a simple low-power source, and the whole assembly has no moving parts. Combined with a model 211 reader/writer, several 801's make an effective and economical access control system.

For optical reading of mark sense or punched hole data on standard 80-column cards, there is the model 417. It provides character serial, bit parallel data, plus error detection and special interface options, while a simple transport mechanism (that automatically captures or returns the cards), assures an almost infinite service life.

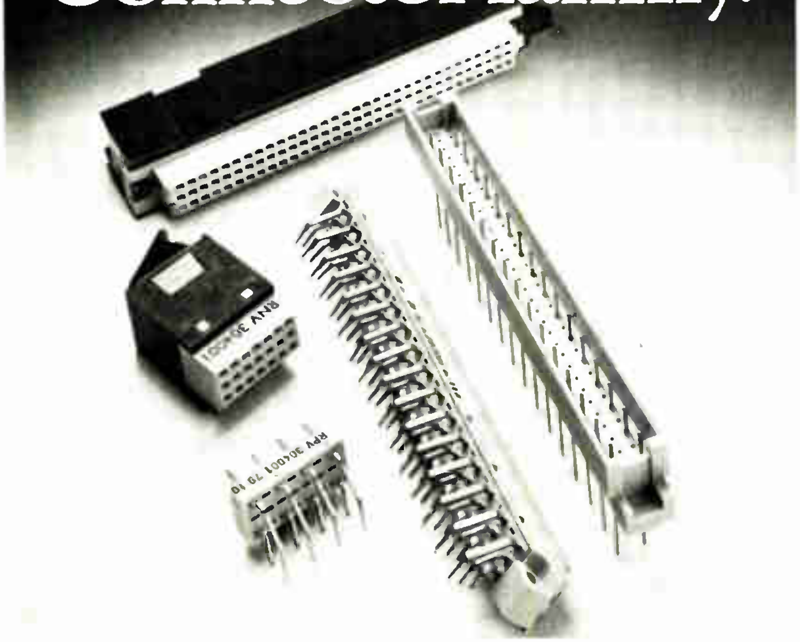
We have more readers to match your needs, such as the compact badge type model 130. It has no moving parts and needs no external power source.

For more information on the AMP reader that's right for you, call the Card Reader Information Desk at (717) 780-8400. Or write us. AMP Incorporated, Harrisburg, PA 17105.

AMP has a better way.

AMP

Modularize, Economize! Use the PCB Connector family.



The full range of inversed European connectors is part of the great family of Ericsson modularized telecomponents. The 8–64 point male and female connectors for back plane, rear or front edge connection to PCBs feature selective gold plating on contact surfaces. This plus Ericsson's big series production, keeps our prices down. Connector forks are extra long, insuring greater reliability and reduced plug-in frequency error. We offer a complete line of 2-pole power supply connectors, locking devices, covers for plugs and other accessories. The connectors are part of a modular system with PCB components, electronic shelves, cabinets and a total range of other modular parts.

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Components Department
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We are a major supplier of components for the industrial market. We belong to the Ericsson Group, one of the world's leading telecommunications manufacturers.

Circle 270 on reader service card

MELO-D

SUBMINIATURE-D CONNECTORS

GENERAL PURPOSE COMMERCIAL DUTY. Versatile. Easy to service. **CONTACTS:** Snap-in, front-removal. **TERMINATIONS:** 5 types. Crimp, solder cup, wrap post, straight and right angle solder tails. **INSULATOR:** Thermoplastic resin. 5 sizes. 9 through 50 positions. **MOUNTING:** Panel or circuit board. **COUPLING:** Friction. Threadlock. Quick-release (Shown). **HOODS:** Metal or plastic. **FREE CATALOG:** Call **800 641-4054** (In Missouri: 417 753-2851)

POSITRONIC INDUSTRIES, INC.
208 W. CENTER STREET
ROGERSVILLE, MISSOURI 65742 USA • TELEX 436445

HARMO-D

MIL-SPEC SUBMINIATURE-D CONNECTORS

FIXED CONTACTS to meet high reliability, high temp, or MIL specs. **CONTACTS:** MIL-C-24308. Stainless steel socket-sleeve. **TERMINATIONS:** 4 types. Solder cup, wrap post, straight and right angle solder tails. **INSULATOR:** Monoblock glass filled DAP. 5 sizes. 9 through 50 positions. **MOUNTING:** Panel or circuit board. **COUPLING:** Friction. Threadlock. Quick-release. **HOODS:** Metal or plastic. **FREE CATALOG:** Call **800 641-4054** (In Missouri: 417 753-2851)

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 Circle 51 on reader service card

Circle 51 on reader service card

New products/materials

30-lb kit of the hardener and resin sells for about $68.50 per kit. Delivery is from stock.

Isochem Resins Co., Cook Street, Lincoln, R. I. 02865 [477]

Fusion-bonded laminates that come in a roll can be used either as the bond between two laminated materials or as the working dielectric for a flexible circuit or capacitor. Used to make flexible circuitry, capacitors, and products that shield against electromagnetic interference, the laminates are particularly suited for circuitry operating at severe high and low temperatures and can also withstand soldering temperatures of 127° C.

Laminate constructions include copper-FEP, copper-FEP-polyimide, copper-FEP-TFE, and copper-FEP-Teflon-glass. The materials have dielectric constants in a range of 2.0 to 2.7 and maximum continuous operating temperatures of 205°C. Bond strength—provided by a thermoplastic film, such as DuPont's Teflon fluorocarbon, FEPs—is greater than 6 lb/in. and has been tested to as high as 16 lb/in. Prices vary with laminate construction and size, from up to 24 in. wide by hundreds of feet long. The laminates sell for $2.87/ft² to $11/ft².

TME Corp., a subsidiary of Chomerics Inc., 16 Flagstone Dr., Hudson, N. H. 03051 [478]

This epoxy and polyamid adhesive is recommended for use with flexible adherents that are subject to cleavage and peel stress. When fully cured, TRA-BOND 2143D adheres to metals, glass, and ceramics, most rigid plastics and laminates, rubber, and wood. It can be used with both organic and inorganic compounds.

A solvent-free liquid, TRA-BOND 2143D has a 50-minute pot life at 25°C and cures overnight. It has a viscosity of 300 centipoises. The material can be delivered from stock in a variety of predispensed Bipax packages as complete epoxy resin systems. Prices range from $0.87 for a 2-g package to $274.50 for a 45-lb, 5-gal bulk supply.

TRA-CON, Inc. 55 North St., Medford, Mass. 02155 [479]

Take a close look at the Houston CØMPLØT® CPS-14 & 15

You'll see the real meaning of plot quality.

Drafting-like plot quality—that's the whole idea behind the new CPS-14 and 15 digital plotting systems. Make us prove it. Just take a look at the output from the CPS-14 and 15...you'll see plot quality comparable to or exceeding that of competitive plotters costing twice as much.

Four pens at speed of 15IPS and a dual microprocessor controller with superior firmware functions combine to make this the ideal plotter for drafting, civil engineering, numerical control, mapping...any application where plot quality is vital.

Prices for the 22″ wide CPS-14 start at only \$9,950 *. Prices for the 34″ CPS-15 start at \$12,950 *.

Let us send you a free sample plot. See for yourself the superior plot quality provided by these newest members of the CPS family. Call or write Houston Instrument, One Houston Square, Austin, Texas 78753. (512) 837-2820. For rush literature requests persons outside Texas call toll free 1-800-531-5205.

houston instrument | DIVISION OF BAUSCH & LOMB

"the graphics company"

Circle #27 for literature
Circle #54 to have a representative call

See us at the NCC Show in Booth 1539

* U.S. Domestic Prices Only
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A few of our customers say Abbott MIL Spec power supplies are 99% perfect.

The others say only 98%. For almost fifteen years we have maintained a customer failure rate of 2% for our "C," "S" and "W" MIL Spec power supplies. That's tried and true proof of reliability . . . in the field.

Our Model "W" family of 400 Hz to DC power supplies is a standard throughout the world for critical military and aerospace applications. They're available with output voltages from 5 to 100 VDC, current levels from 0.3 to 20 amps.

Our "C" family of 28V DC to DC converters and our "S" family of 28V to 400 Hz inverters come in package sizes as small as 2⅛" x 3½" x 3½", and meet the requirements of eleven separate MIL Specs.

For reliability, call Abbott. For delivery, call Abbott. For additional information, write or call Abbott.

See EEM or GOLD BOOK power supply sections.

Circle 274 on reader service card

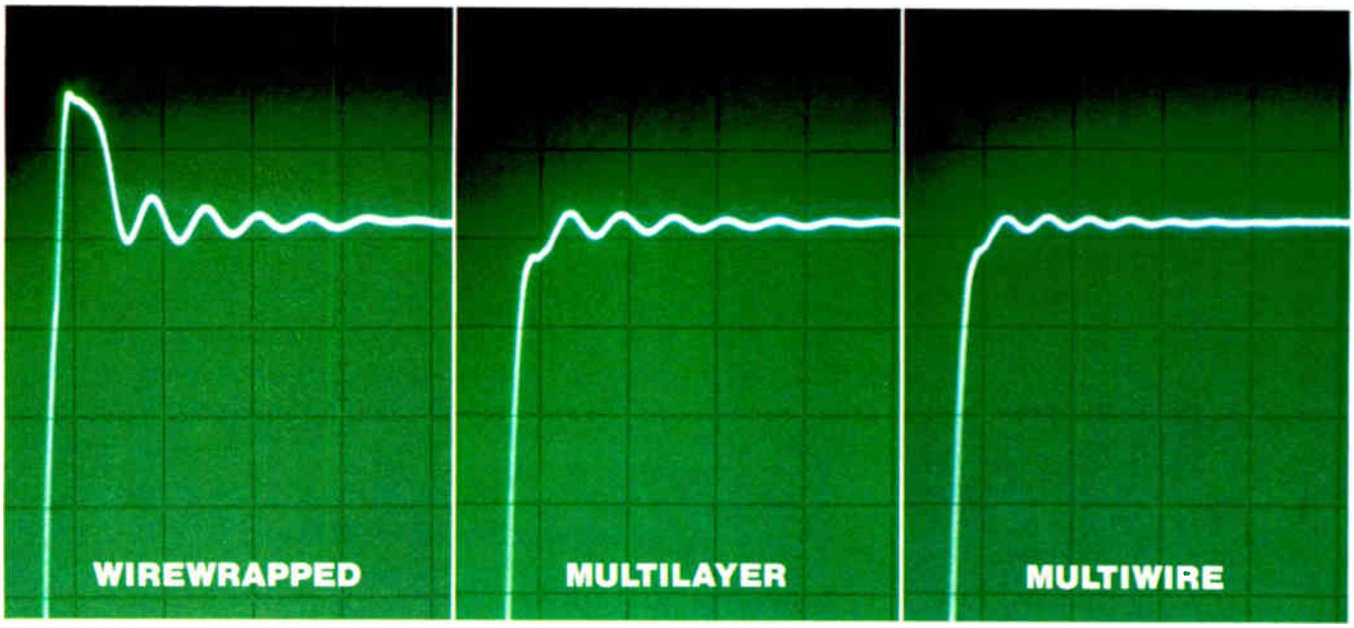
abbott transistor

MILITARY PRODUCTS DIVISION

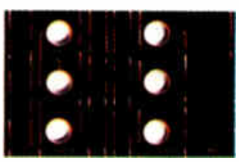
Eastern Offices. 1224 Anderson Ave. Fort Lee. New Jersey 07024 (201) 224-6900 TELEX 13-5332
Western Offices. 5200 West Jefferson Blvd., Los Angeles, CA 90016 (213) 936-8185 TELEX 69-1398

Multiwire* Optimizes ECL.

These traces tell the story.



Wirewrapped and multilayer circuit boards can handle the high speeds of emitter-coupled logic. But Multiwire does it better. With Multiwire, *board impedance is precisely controlled* to meet circuit specs and is *consistent from signal to signal and board to board.* The problem of signal reflections with wirewrapped and multilayer requires the use of discrete series-damping and terminating resistors. Multiwire reduces design problems, provides consistent electrical characteristics, and results in lower cost and better circuit performance. Add to that other Multiwire advantages: less design time, shorter lead times, easy circuit changes, reduced inspection costs, and higher production yields. The choice is obvious. Multiwire is the way to go. Write or call today for details.



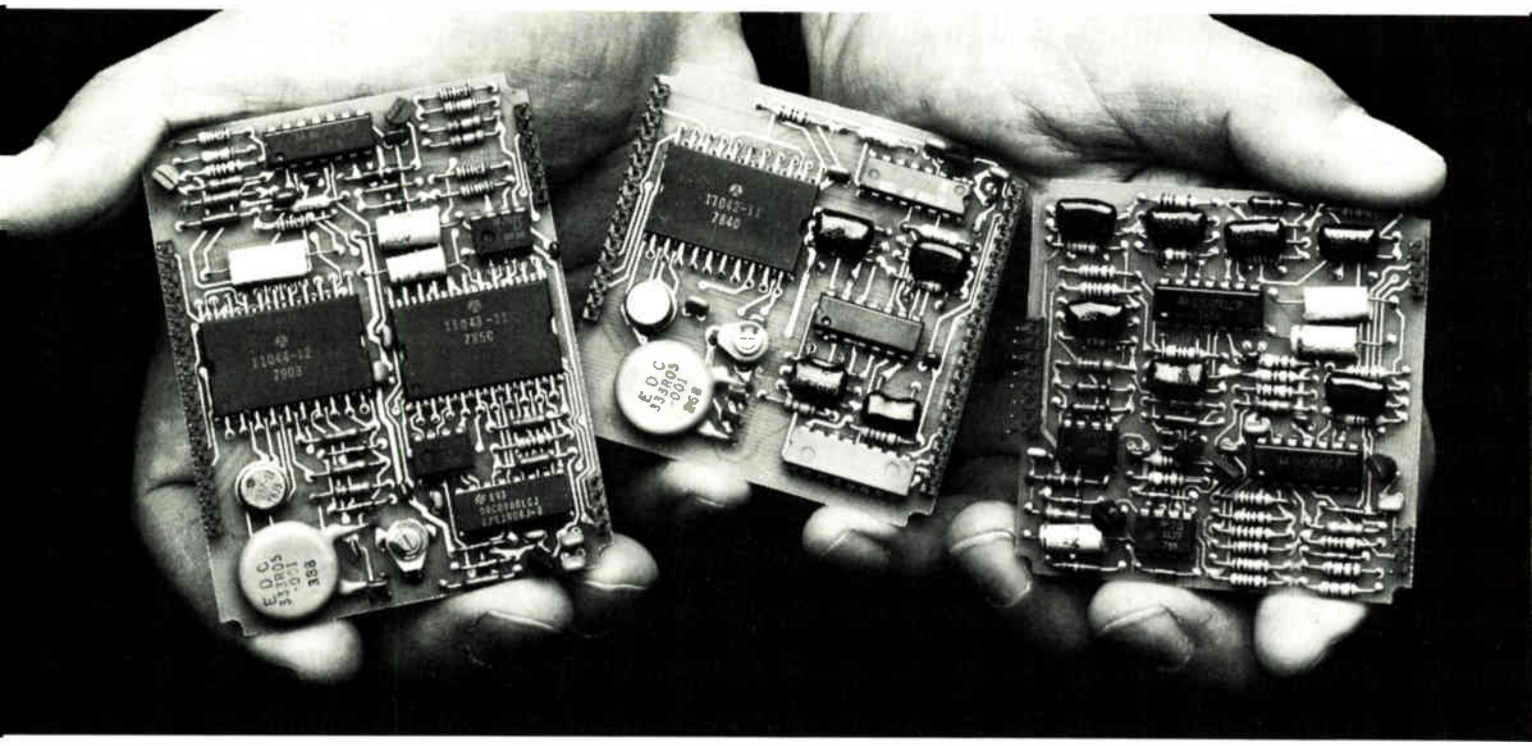
A typical example of the circuit density achievable with Multiwire circuit boards.

Multiwire, 31 Sea Cliff Avenue, Glen Cove, NY 11542. Phone (516) 448-1307

MULTIWIRE DIVISION
KOLLMORGEN CORPORATION

*Multiwire is a U.S. registered trademark for the Kollmorgen Corporation discrete wired circuit boards.

R24. The first 2400 bps modular modem.



Rockwell's compact MOS-LSI modem gives new physical design freedom.

Rockwell's R24 Modem is the most compact 2400 bps MOS-LSI modem available today. Its small size and modularity give designers a whole new form factor flexibility. Requiring only 25 square inches of system area, the R24 is ideal for terminals and communications equipment.

The R24 provides functional flexibility also. Of its 3 modules, one is the transmitter, two the receiver. Terminal designers can offer transmit-only or receive-only options. And, the R24 is Bell 201 B/C and CCITT V.26 and V.26 bis compatible.

With its major functions in LSI circuits, the R24 is solid-state reliable and economical. It can be configured for operation on either leased lines or the general switched network. And, each low-profile module can be plugged into standard connectors or wave soldered onto system PC boards.

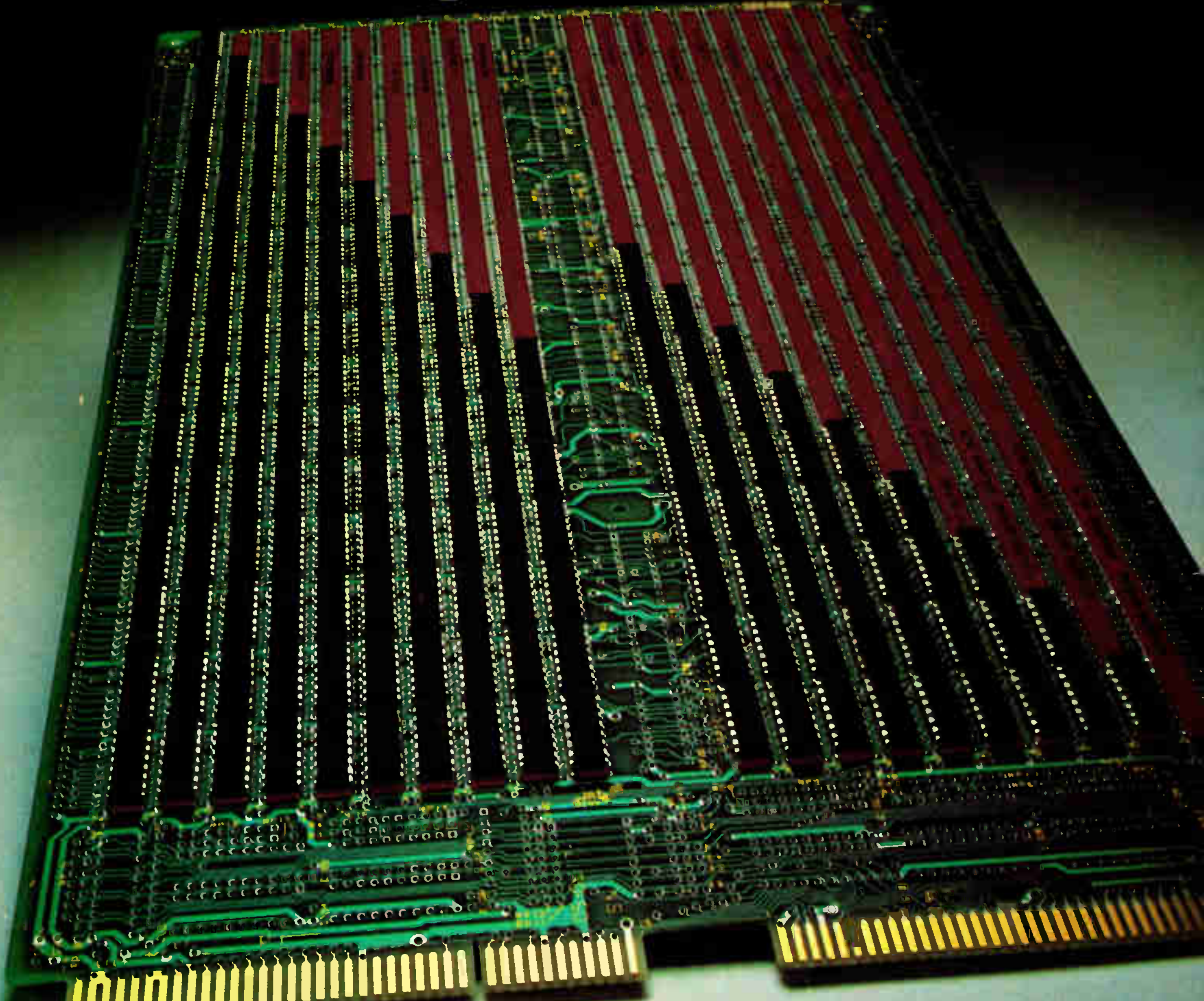
A new generation of modems from the company that's delivered more high-speed modems than anyone in the world. That's Rockwell Micropower!

For more information, contact Modem Marketing, Electronic Devices Division, Rockwell International, P.O. Box 3669, RC 55, Anaheim, California 92803. (714) 632-5535.

Rockwell International

...where science gets down to business

INTEL did it with Rogers' Q/PAC. Now you can too.



Circle 65 on reader service card

Q/PAC™

Intel's new Series 90 half-megabyte memory replaced 352 decoupling capacitors with 20 Rogers' Q/PAC power distribution elements.

Result: a quiet memory with exceptional density for a two-layer PC board. In fact, density is as high or higher than multi-layer boards with discrete capacitors.

Q/PAC elements also heighten board reliability through reduced part count; minimize on-board power traces; and they have low inductance, low impedance and a low dissipation factor.

Capacitance values up to 0.05 μf per inch of length, in lengths up to 16 inches. Available for either vertical mounting or horizontal installation under IC's.

This partially populated Intel memory board shows the space-saving advantages of Q/PAC over discrete capacitors and on-board power distribution.

For detailed information, contact the Q/PAC Product Specialist at (602) 963-4584.

ROGERS

Rogers Corporation
Chandler, Arizona 85224
EUROPE: Mektron, NV, Gent, Belgium
JAPAN: Nippon Mektron, Tokyo

Products newsletter

Wideband video amps use dc coupling

Comlinear Corp., a newly formed company in Loveland, Colo., is bringing to market two versions of wideband video amplifiers that use dc coupling. The $390 CLC101 covers **dc to 100 MHz minimum with gain flatness of ±0.5 dB** and maximum total harmonic distortion of 1%. The dc-to-600-MHz CLC100, priced at $215, has a gain flatness of −0.2, +3.0 dB to 500 MHz, with third-order harmonics down to 60 dBc at 100 MHz.

Intel to deliver bubble-memory controller chip

This month, Intel Corp. will deliver, samples of a six-chip set that controls magnetic-bubble memories, which it described a year ago [*Electronics*, April 26, 1979, p. 105]. Delays on the 7220—the last (and heart) of the set—had prevented offering the set earlier. The 7220 **interfaces with the Santa Clara, Calif., company's Multibus** and forms a complete memory and controller board when combined with the five other large-scale integrated support chips and Intel's 1-megabit 7110 bubble memory. The chip set will take the place of some 100 medium-scale integrated circuits on the IMB 100 and 101 controller boards.

Data-base manager for TRS-80 runs in microForth

Only nine months after it commercially adapted the interactive Forth language to the Radio Shack TRS-80 personal computer [*Electronics*, July 5, 1979, p. 33], Miller Microcomputer Services has written a data-base management system in microForth. The Datahandler **fits any TRS-80 having 32 kilobytes of random-access memory and a single floppy disk.** According to the Natick, Mass., manufacturer, the system performs multiple-field sorts on a 100-record file in about 5 seconds and performs lookups in less than 1 s—perhaps a tenth the time needed for similar operations done in Basic. The $59 price includes documentation.

4-K static RAM cycles in 55 ns

Using its proprietary XMOS n-channel silicon-gate process, National Semiconductor Corp., Santa Clara, Calif., has extended its 2147 4-K static random-access memory family to include a version with 55-ns cycle times. The MM2147-3 is **organized as 4,096 words by 1 bit** and requires no clocks for refreshing. Housed in a standard 18-pin dual in-line package, it is priced at $29 each in lots of 100.

Motorola readies samples of ECL a-d converter

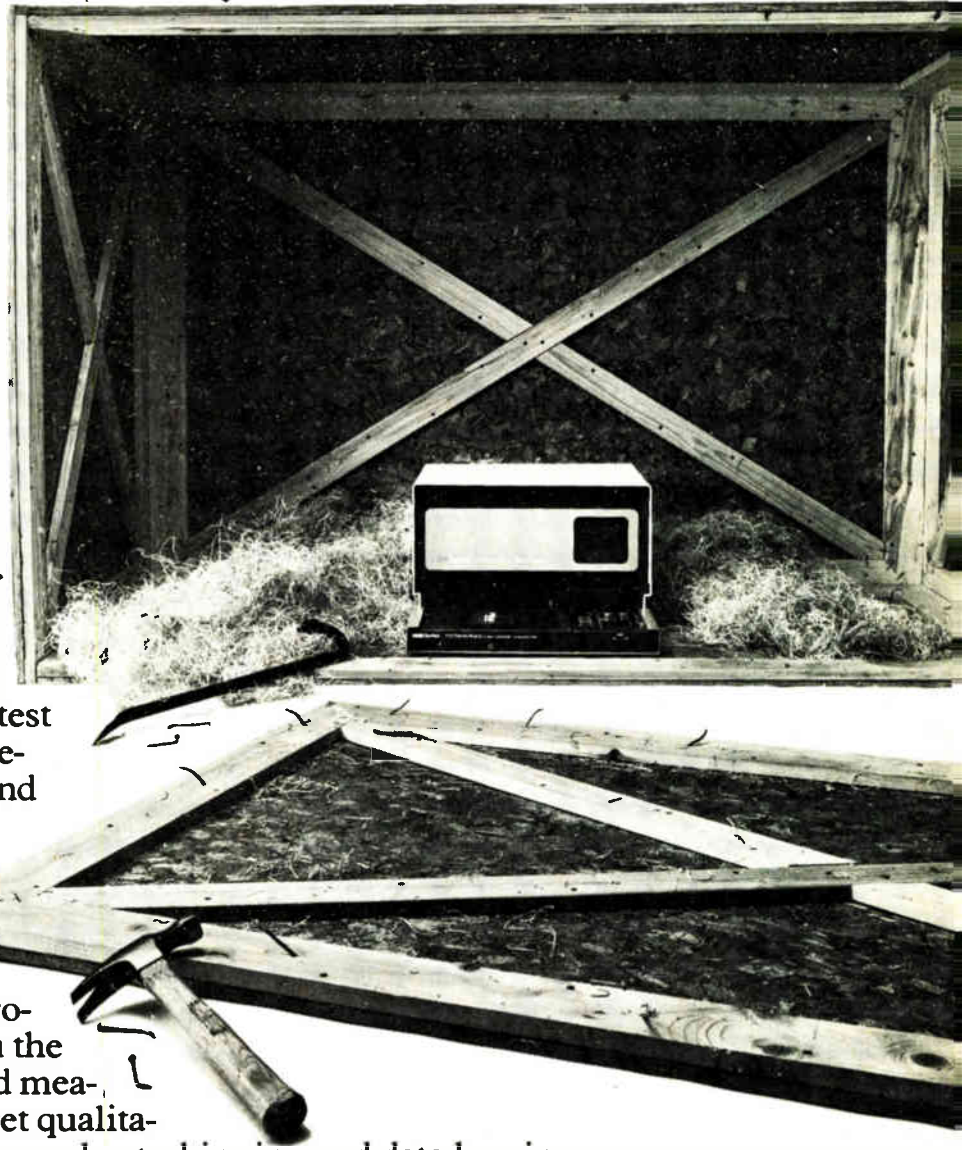
Motorola Inc., Phoenix, Ariz., will soon provide samples of its MC10317, **a 7-bit flash emitter-coupled-logic analog-to-digital converter.** The 30-MHz unit will be priced at about $100 each for orders of 100 units.

Meanwhile, in Austin, Texas, the company is offering **samples of a 40-pin 8-bit n-MOS four-channel data-acquisition system.** The chip includes 64 bytes of random-access memory and an 8-bit microprocessor [*Electronics*, April 24, p. 144].

Programmable-array logic chips from MMI are ready to go

To attract orders for the 16L8, 16R8, 16R4, and 16R6 programmable-array logic chips that had been delayed in production, Monolithic Memories Inc. of Sunnyvale, Calif., is **cutting down prices on the parts by 30%.** Samples of two other new PALs, the 16A4 and 16X4, will be ready this month. Each of these 19,000-mil^2 parts contains four registers and can handle arithmetic functions. Sales will start this summer.

GenRad offers a major reduction in big IC testers.



GenRad's 1731 linear and 1732 digital test systems give you everything you want from big systems at one quarter the price.

A roomful of testing hardware costs a lot. And chances are it'll give you more testing capability than you'll ever need.

Our linear and digital IC test systems are the perfect alternative. Because GenRad's technology has reduced big IC test systems to an extremely manageable, portable, benchtop size. And while we reduced the size, we still offer all the capability you need for comprehensive IC testing.

The secret to small size and big performance is microprocessor control, and it'll give you the flexibility of software-controlled measurements. In addition, you'll get qualitative readouts on each IC, summary sheets, binning and data logging.

And both have "fill-in-the-blanks" software, which means new programs can be developed in minutes—something you can't do with big IC test systems.

GenRad's 1731 linear IC test system offers extensive testing on op amps, voltage regulators, comparators, voltage followers, and current mirror amplifiers.

The GenRad 1732 digital IC test system lets you test SSI, MSI, LSI, and memories. As well as TTL, ECL, I^2L, CMOS, and NMOS technologies.

They both come with a CRT that'll prompt you every step of the way.

Find out more about GenRad's money-saving 1731 linear, and 1732 digital IC test systems. Then order them both. You'll enjoy the benefits of common hardware and software. And be dealing with just one, dependable supplier. GenRad.

The 1731 linear benchtop IC test system.

The 1732 digital benchtop IC test system.

Call Toll Free 1-800-225-7335. (In Mass. call 617-779-2825). Or write: GenRad, Concord, MA 01742.

GenRad

Put our leadership to the test.

We can give you the power to solve a hot problem.

Heat is a rechargeable battery's biggest enemy. At about 45° C life starts to shorten dramatically. The new Polytemp™ is a NICAD® nickel-cadmium battery designed to take the heat and give long life. Satisfactory life to 70° C.

Polytemp's long life in high temperature applications makes it an ideal battery for backup power in memory circuits, emergency lighting and alarms, telephone and telegraph equipment, electronic instruments and process control equipment.

And Polytemp batteries have a unique negative electrode construction which means less voltage depression during overcharge than sintered nickel matrix types. A radial compression seal gives greater protection to surrounding circuits.

A battery that leads a hot life doesn't have to lead a short life. Now there's Polytemp from Gould. The company that makes more different types of batteries than anyone else in the world.

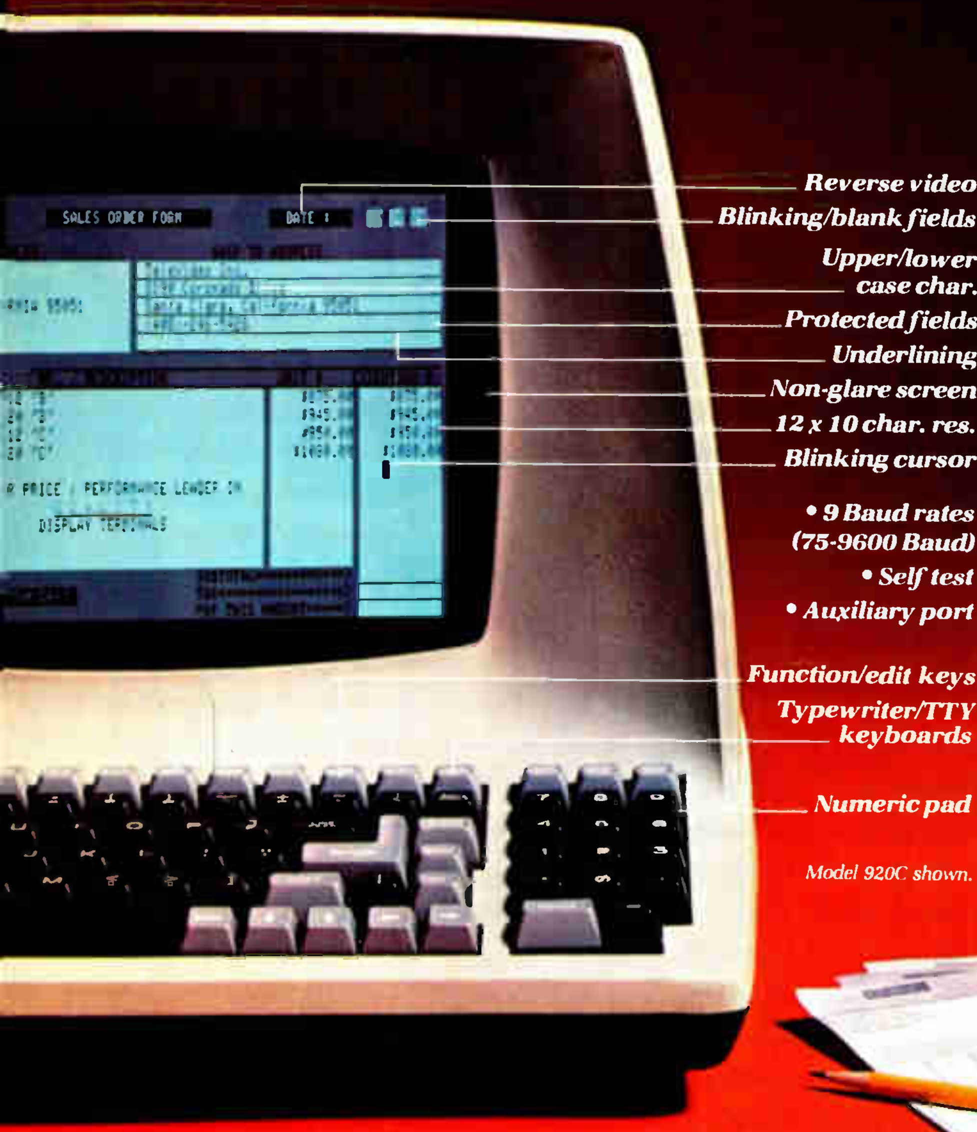
Available in sizes "½ AAA" to "F." (0.070 amp. hours to 7 amp. hours.) For complete design spec's write: Applications Engineering Mgr. Gould Inc. 931 Vandalia St. St. Paul, MN 55114

GOULD

An Electrical/Electronics Company

Circle 68 on reader service card

COMPARE SMARTS.



Model 920C shown.

Feature-for-feature our smart CRT terminals cost less than *their* dumb ones. Much less. Compare smarts. Then compare price. You'll pick TeleVideo.

Four different models to choose from. Each with features you'd expect to pay extra for. But with TeleVideo, they're standard.

We put a lot of engineering savvy into our CRTs. Their modular design means high reliability. It also lets us build in high volume. And sell to you at low prices.

Find out how you can make your next CRT buy a smart one. Contact TeleVideo today for information.

Nationwide Field Service is available from General Electric Co., Instrumentation and Communication Equipment Service shops.

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NEW YORK/NEW JERSEY Paramus (201) 265-1321 • TEXAS Dallas (214) 980-9978

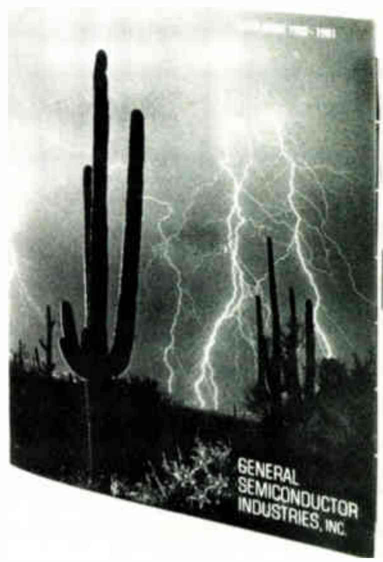
See us at NCC/Booths 1264,65

Circle 72 on reader service card

New literature

Packaging products. More than 1,200 packaging products, tools, and kits are described in detail in a 148-page catalog. The emphasis is on microcomputer interface boards for all conventional buses, card cages and cabinets, breadboarding components, and sockets and terminals. The catalog includes diagrams for almost all products, price lists, and the names and addresses of authorized distributors. Vector Electronic Co., 12460 Gladstone Ave., Sylmar, Calif. 91342. Circle reader service number 421.

Components. General Semiconductor Industries' 1980–1981 product catalog contains a numerical index for its line of silicon transient-volt-



age suppressors, npn switching transistors, zener diodes, temperature-compensated diodes, and fast high-voltage switching transistors. The 286-page publication gives the absolute maximum ratings for the devices, as well as electrical and mechanical specifications. Numerous diagrams are also provided. General Semiconductor Industries Inc., P. O. Box 3078, Tempe, Ariz. 85281 [422]

Proximity systems. A 53-page bulletin gives information on general applications, design, and construction, and operating and dimensional

information for a variety of proximity systems. It discusses: switching amplifiers, isolation units, universal logic gates, bistable relays, speed monitors, synchronization monitors, rotation direction indicators, frequency-to-current converters, current-to-frequency converters, pulse divider units, pulse summators, relay units, and dc power supply units. Gould R. B. Denison, 103 Broadway, Bedford, Ohio 44146 [423]

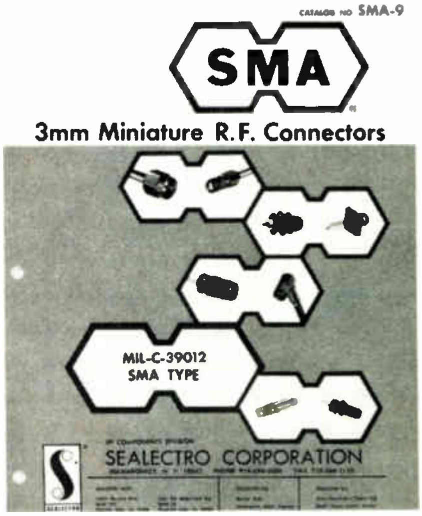
Magnetic circuit breakers. "AP/UPAP-MIL Magnetic Circuit Breakers" explains how these devices can be used and how both the AP and UP devices can be configured for different applications. The catalog also presents the operating characteristics of the units and ordering information. Airpax, Woods Road, Cambridge, Md. 21613 [424]

Semiconductors. A 40-page catalog on power semiconductors provides

New literature

information on such products as Semipack diode-thyristor power modules, bridges, diodes, thyristors, triacs, water-cooled ac switches, heat sinks, and related products. It gives electrical, mechanical, and thermal specifications and includes a table for calculating rectifier circuits. Semikron International Inc., 11 Executive Dr., P. O. Box 83, Hudson, N. H. 03051 [425]

Connectors. A catalog of the series SMA connectors gives their general, electrical, mechanical, and environmental specifications. It also shows the typical construction of semirigid

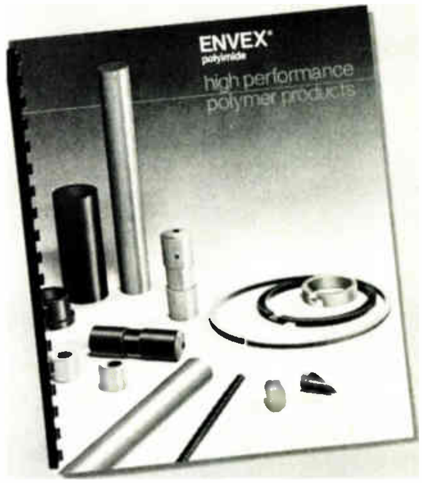


cable and braided-cable connectors and discusses where and how to use them. A connector and cable selection guide completes the offering. Sealectro Corp., RF Components Division, Mamaroneck, N. Y. 10543 [426]

Thermistors. The EMC-6 manual contains detailed information on thermistors, including tables for resistance deviation to beta tolerance, temperature coefficients, and resistance to temperature conversion. A section on how to solve applications problems is also provided. Fenwal Electronics, 63 Fountain St., P. O. Box 585, Framingham, Mass. 01701 [427]

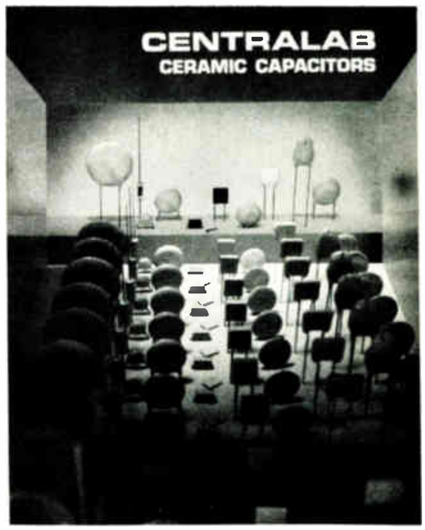
Polyimides. A 32-page catalog describes Envex polyimides. It is

divided into sections that present applications information and part design guidelines, test values, and properties for the materials. Data

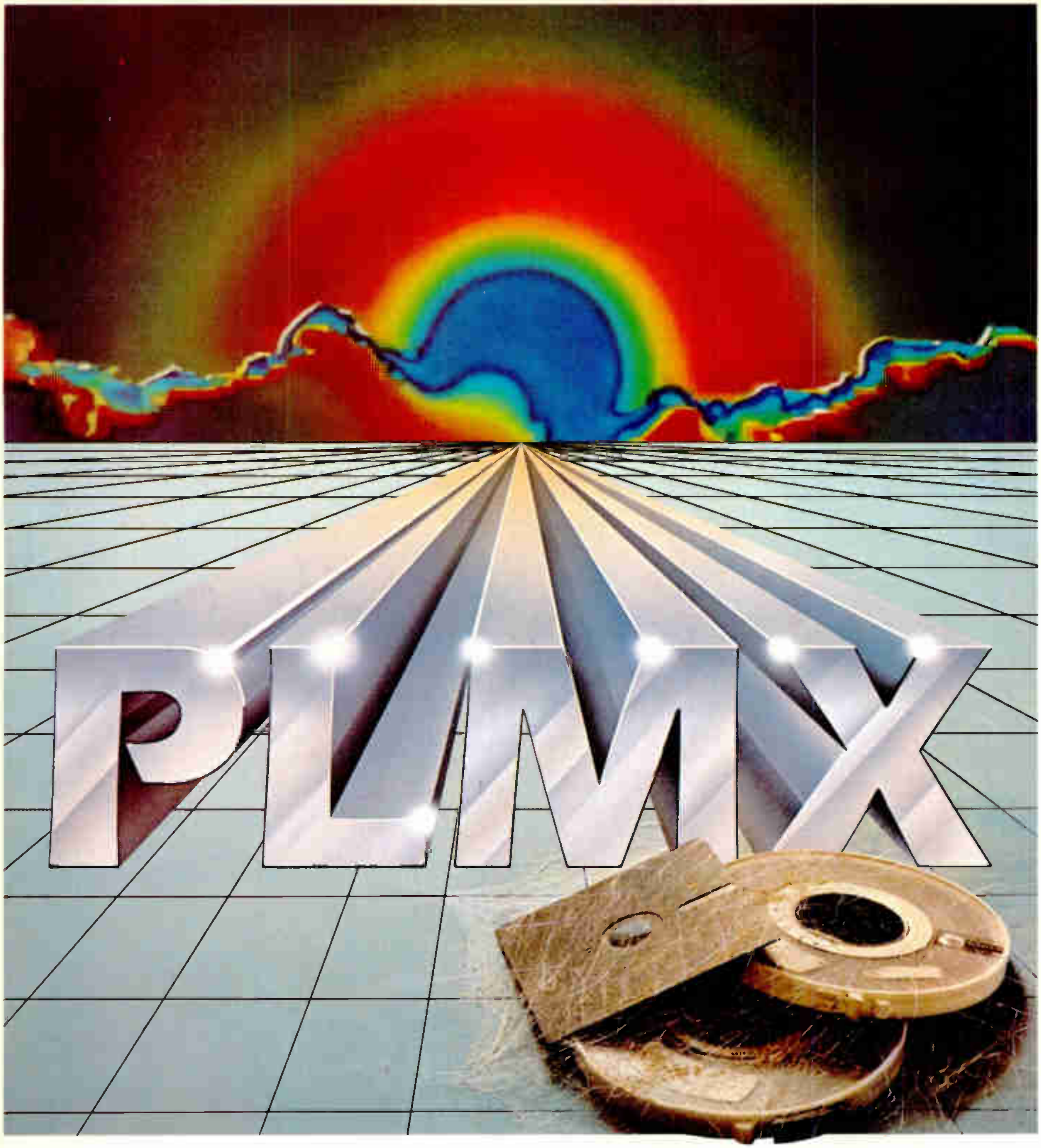


sheets and reprints of design articles as well as pricing information are included. Write to Rogers Corp., 5259 Minola Dr., Lithonia, Ga. 30058 [428]

Capacitors. A line of ceramic monolithic and disk capacitors is presented in a 44-page catalog. The catalog provides a selection chart as



well as data on capacitor performance, and physical characteristics. Centralab Inc., a North American Philips Co., 5757 North Green Bay Ave., P. O. Box 2032, Milwaukee, Wis. 53201 [429]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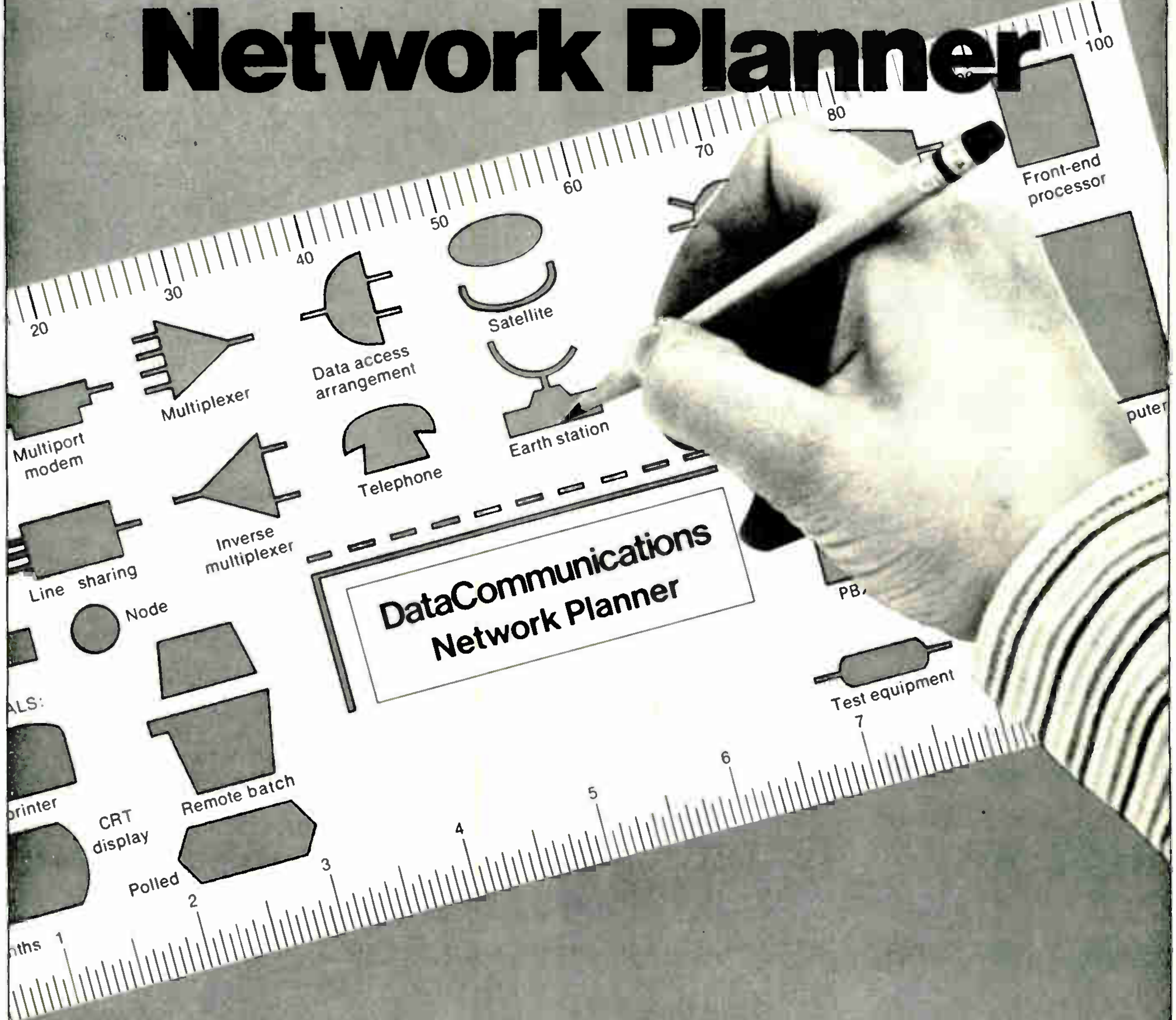

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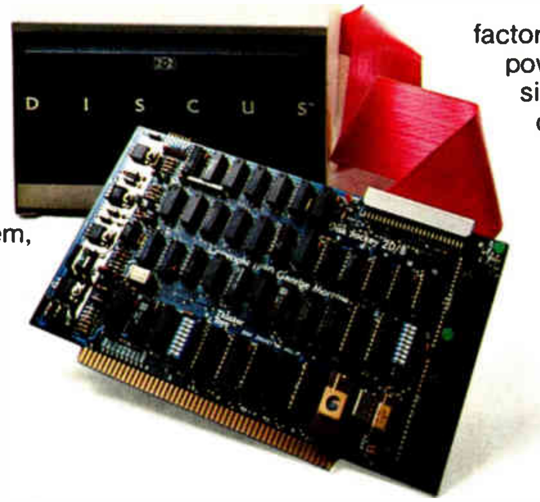

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C³ Subsystem

- ☐ Data Network Architecture Requirements
- ☐ MF Radio Protocols
- ☐ Fiber Optic Cable Protocols
- ☐ Communications Protocols
- ☐ Message Formats
- ☐ Message Responses

Radio Systems

Communications Measurements and Analysis

- ☐ Wideband Atmospheric Noise Measurements
- ☐ Rough Terrain Surface Wave Propagation Measurements
- ☐ Propagation Analysis
- ☐ Mobile VHF System Analysis/Design
- ☐ Communications System Testing Concepts/Analysis

Radio System Design

- ☐ Higher Order Modulating Technology
- ☐ Error Detection and Correction
- ☐ Spread Spectrum Communications
- ☐ Modeling and Performance Estimation
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- ☐ MF Radio Conceptual Design

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Hardened Antenna Development

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- ☐ Triplexer Development
- ☐ Erectable HF Antennas
- ☐ UHF/SHF Satellite Terminal Antennas
- ☐ EMP Mitigation Techniques and ESA Requirements Definition

Ground-Based Antenna Systems

- ☐ Wideband MF Broadcast Antennas
- ☐ UHF/SHF Satellite Terminal Antennas
- ☐ VLF HF VHF and UHF Antennas
- ☐ VHF Mobile Radio Antennas

Airborne Antennas

- ☐ MF Trailing Wire Antennas
- ☐ MF Ferrite Loop Antennas
- ☐ UHF/SHF Satellite Antennas
- ☐ VLF HF VHF UHF and SHF Antennas

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Voice Communication

- ☐ Secure Voice Order Wire Communication
- ☐ Secure Voice Switched Network
- ☐ VHF Mobile Radio Communication

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- ☐ Cable Network Routing Protocol
- ☐ Network Traffic Modeling
- ☐ Survivable Cable Communication Network

Fiber Optic Communication System

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- ☐ Fiber Optic Modem Design
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- ☐ Fiber Optic Component Evaluation

Mechanical Systems and Interfaces

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- ☐ NH & S (Mechanical)
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- ☐ ICD Requirements
- ☐ A & CO Requirements

Security Systems

- ☐ Secure Communications Equipment Integration
- ☐ Computer Security
- ☐ Code Processing
- ☐ Security Studies

Hardness and Survivability

EMP Analysis and Test

- ☐ EMP Analysis
- ☐ SGEMP Analysis
- ☐ EMP Test
- ☐ Requirements Analysis
- ☐ Allocations Analysis
- ☐ EMI/TEMPEST

Radiation Analysis and Test

- ☐ Analysis
- ☐ Requirements Analysis
- ☐ Test

Special Studies

- ☐ Hardness Assurance/Maintenance
- ☐ Subcontractor Support
- ☐ Thermal/Mechanical
- ☐ Fiber Optics

Maintenance Systems

On-Line Maintenance Subsystem

- ☐ Subsystem Design
- ☐ Nodal Requirements Allocation
- ☐ Maintenance Management (CAMMS)
- ☐ Maintenance Monitoring and Control
- ☐ BITE, BIT, SELF TEST Requirements
- ☐ Fault Error Requirements
- ☐ Man-Machine Interface Functions
- ☐ HW/SW Allocations
- ☐ SW Architecture

Off-Line Maintenance Subsystem

- ☐ Intermediate Level/Depot Level MSE
- ☐ ATE Subsystem Design
- ☐ Integration of IL/DL Functions
- ☐ IL/DL Repairable Items
- ☐ IL/DL Test Requirements
- ☐ Test Station Requirements
- ☐ Operating and Diagnostic SW Requirements
- ☐ Test Applications SW Requirements

Organizational MSE

- ☐ Requirements
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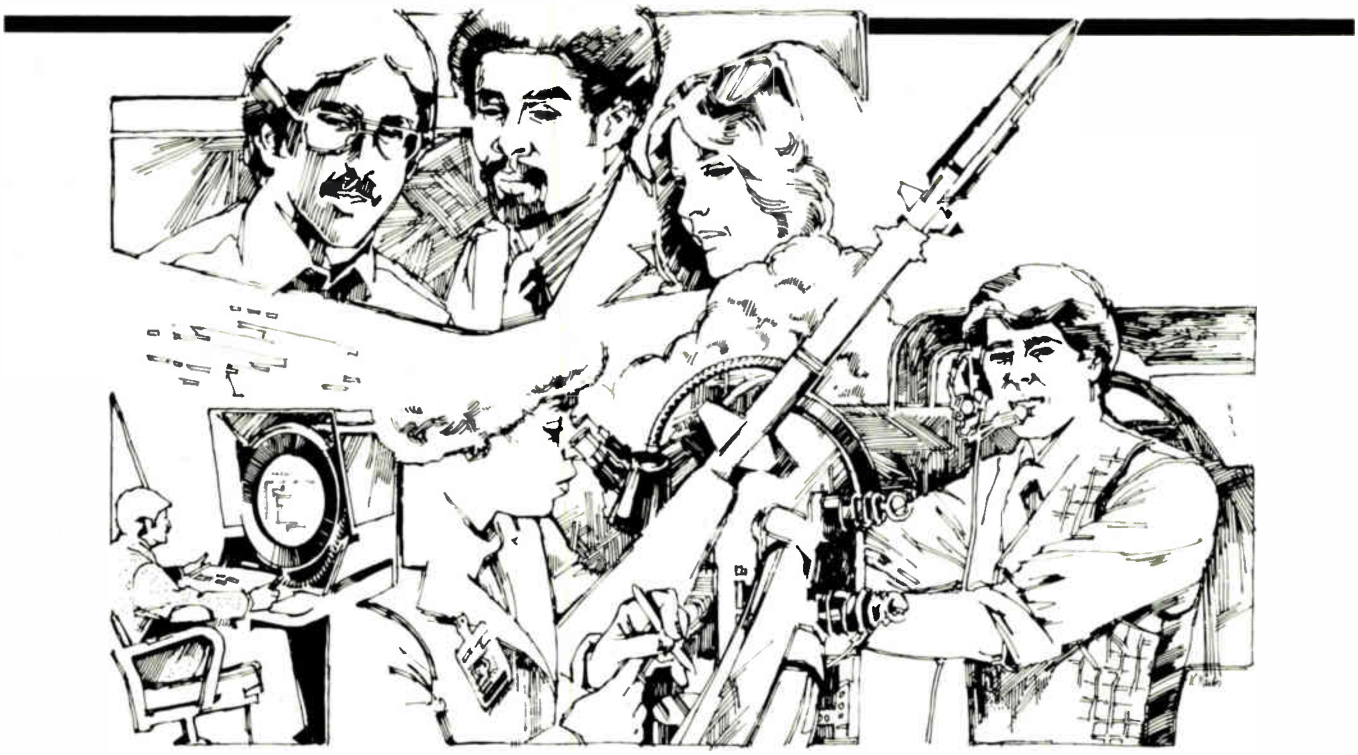

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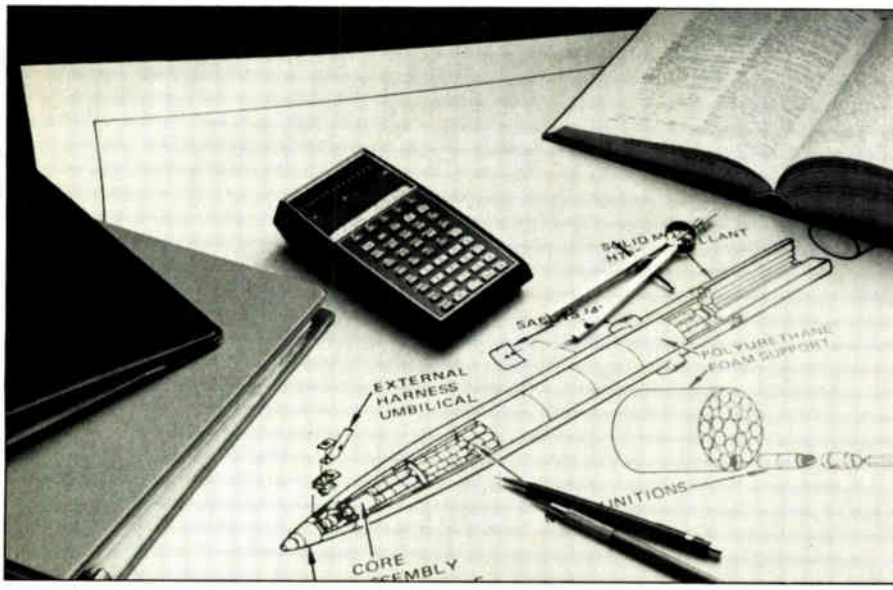

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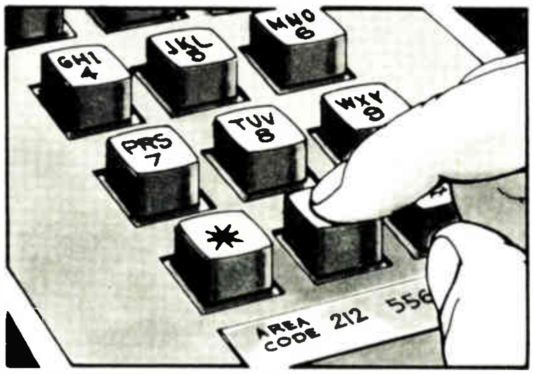

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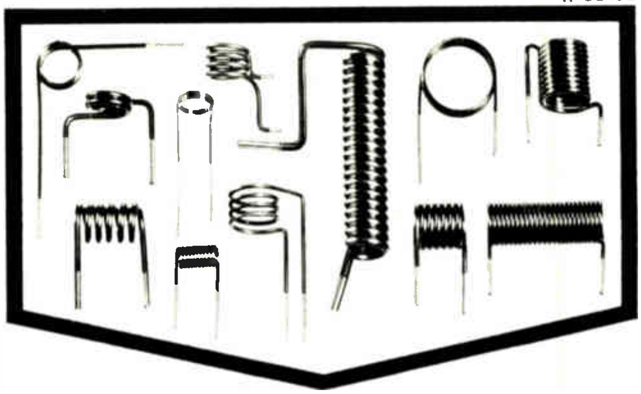

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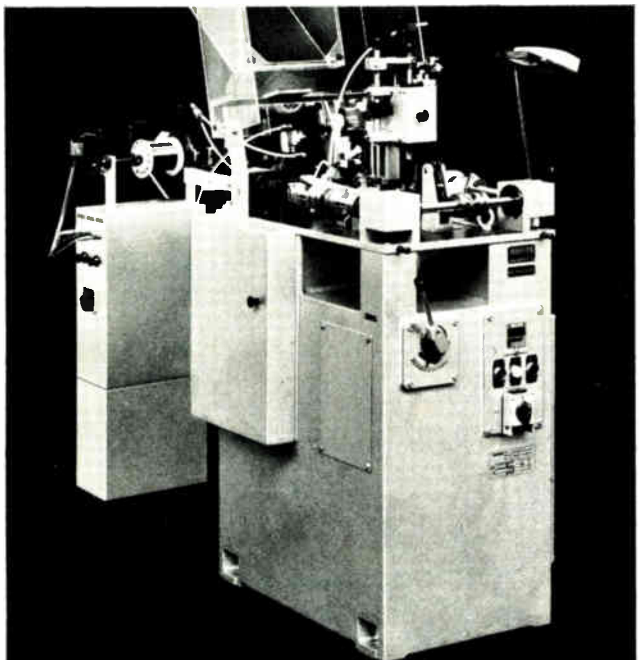

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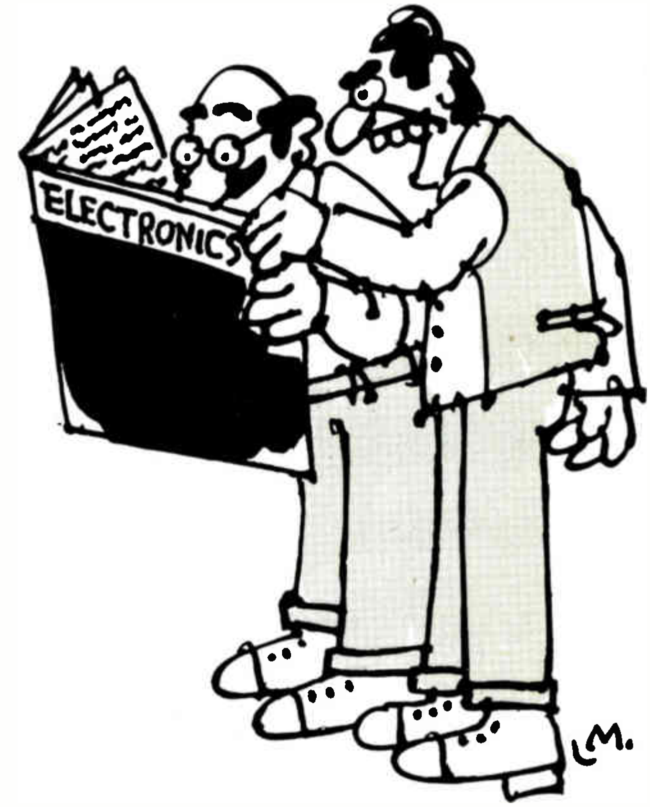

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