MARCH 27, 1980

SID SHOW SPANS FULL DISPLAY SPECTRUM/89

Ion-beam lithography aims at submicrometer world/142

Chip handles communications protocols and error checking/151

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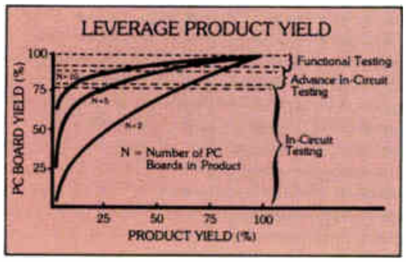

circuit testing provides a relatively small increase in board yield. But as you can see from the accompanying diagram, this small increase can mean a large improvement in product yield. For example, in a 5 PC board product, an increase in board yield of only 8% (from 90% to 98%) will leverage product turn-on rate from about 59% to 90%.

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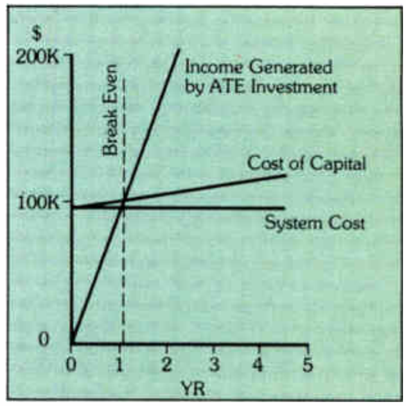

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90/52

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01003

Circle 1 on reader service card

Electronics
The International Magazine of Electronic Technology
Vol. 53, No. 7 • March 27, 1980

113 Technical Articles

Highlights

Cover: Japanese train sights on computer market, 113

After walking away with the U. S. radio and television markets, and with their semiconductor industry operating at or very near the technology's leading edge, the Japanese are in excellent shape to carve large slices from the U. S.–dominated computer pie. The goals are clearly set, government-sponsored cooperative programs in full swing, and competitive hardware already in production. Software is their only admitted soft spot, according to this issue's in-depth special report, and they're hard at work on it.

The cover includes part of a painting by Japanese master Hokusai (1760–1849). The background photo is by Computers & Peripherals Editor Anthony Durniak; the design is by Art Director Fred Sklenar.

Automatic office gear must learn to put up with people, 102

Nobody's perfect, office workers included. And they aren't going to become perfect just to please a bunch of literal-minded machines. Automatic office equipment must be made much simpler to use and more tolerant of errors, according to experts at the Office Automation Conference.

Ion-beam lithography reaching practical stage, 142

Chip makers, casting about for a replacement for optical lithography that will launch them into the era of submicrometer design rules, are looking closely at developing ion-beam techniques. The beams can be focused for direct writing or collimated for production with masks, and they have significant advantages over X rays and electron beams.

Elegantly simple cell makes a fast, dense PROM, 147

"Keep it simple" is a maxim vital to memory design: as the industry pushes ahead to higher densities, simplicity pays off in ease of manufacture. The cells in this programmable read-only memory use polysilicon fuses and are the tiniest yet for a given set of design rules.

Error-checking chip thrives in forest of protocols, 151

The data-communications world is a diverse one, to say the least. The number of different protocols used makes flexibility a must for any chip that is to have a healthy number of applications. Most synchronous or asynchronous character-oriented protocols, including cyclic redundancy checking, are handled by a TTL-compatible n-MOS controller at the rate of 1 million characters per second.

. . . and in the next issue

Microprocessors give digital multimeter new abilities . . . speech-synthesis chip imitates person for natural sound . . . memory management for 16-bit processors . . . a report on this year's Electronic Components Conference.

March 27, 1980 Volume 53, Number 7 101,162 copies of this issue printed

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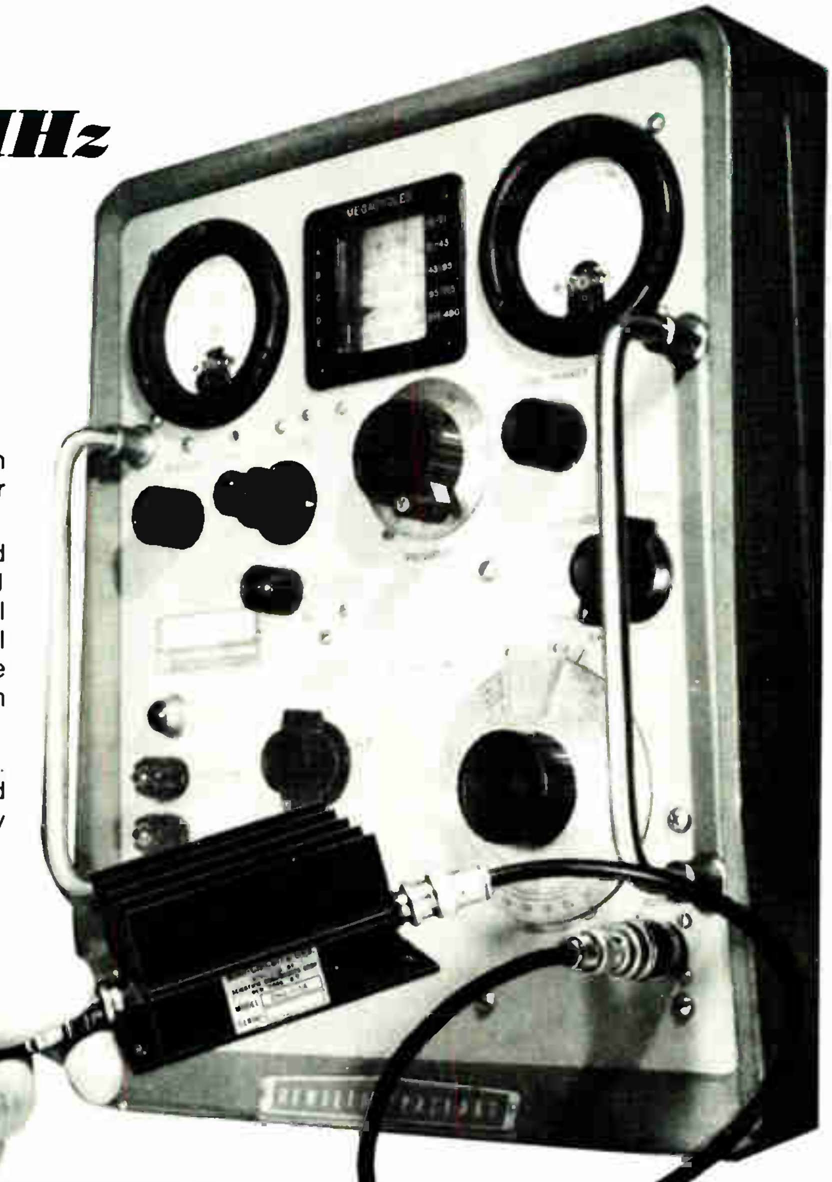

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Circle 5 on reader service card

"After years of preparation and some false starts, they're ready, willing, and able." That's Tony Durniak computer and peripherals editor, describing the Japanese computer manufacturers.

Tony and Tokyo bureau manager Charlie Cohen worked together to produce the in-depth report on Japan's computer technology (p. 113). They interviewed company executives and engineering managers. They toured research labs and plants. And they literally looked under the hood (see photo) of Japanese machines to find out firsthand what makes them tick.

What did they find? There are few differences between the Japanese and American computers. "That's the significance," Tony explains. "It means that they have caught up, and the Japanese are proud of that accomplishment."

While Tony reported on the plans and technical accomplishments of the Japanese makers, Charlie concentrated on describing Japan's domestic market. Charlie has followed this beat since its inception in the mid-1950s. As a result, he has known some of today's computer company executives since they were junior researchers at the government's Electrotechnical Laboratory. In one case, Charlie's acquaintance with a top-level computer executive dates back to when they both attended the Graduate School of Engineering at the University of Tokyo. At present, Charlie points out, the domestic computer market is in flux. But its rough-and-tumble has taught the producers how to compete in a world marketplace.

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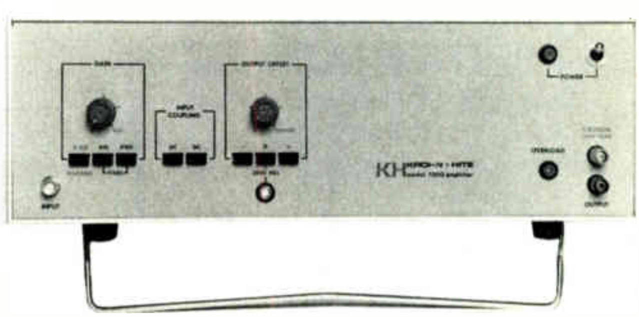

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Circle 7 on reader service card

Readers' comments

Lasers Down Under

To the Editor: It was interesting to learn from the laser story in your issue of Jan. 17 ["Airborne YAG unit to chart ocean shallows with sonar accuracy but 100 times the speed," p. 49] that the Avco Everett Research Laboratory Inc.'s HALS (Hydrographic Airborne Laser Sounder) system may be used by the U. S. Naval Oceanographic Office for worldwide coastal surveys scheduled to begin in 1981.

I draw your attention to the fact that such a system has been operational in Australia for some time. It was developed from our highly successful terrain-profiling system, in use since the early 1970s, gathering data across Australia for compiling a precise relief map of our continent.

Details of the Australian-pioneered "laser bathymetry" equipment and techniques were presented at the first Australian National Laser Conference held in Canberra, March 20–23, 1978, and reported in the Soviet Journal of Quantum Electronics 9 (2), Feb. 1979, pp. 258–59. These systems are now available commercially as a result of AIP (Australian Industrial Participation) programs. Details may be obtained from Mr. B. Balin, Technical Director, Quentron Optics Pty, Quentron House, 75a Angus St., Adelaide, S. A. 5000, Australia.

J. L. Hughes
Canberra, Australia

Registered

To the Editor: "Flat-panel displays find special jobs" [Jan. 31, p. 67] is almost a lexicon unto itself because of the many companies mentioned.

We do want to call to your attention an oversight in the last paragraph of the first column. The term Digivue is a registered trademark of Owens-Illinois for gaseous display panels. Further, it was Owens-Illinois Inc. that worked with the University of Illinois on ac plasma panels, not Owens-Corning Corp.

David R. Birchall
Owens-Illinois Inc.
Toledo, Ohio

Bus bugs

To the Editor: With regard to "Instrument makers score unannounced bugs in GPIB chips" [Jan. 31, p. 39], I would like to illuminate the process of the chips' development over the last several years from a user's point of view.

The vendors have been very cooperative in trying to comply with IEEE-488 and in providing a good user interface in their chips. Each chip has had its share of problems when introduced. Those problems are being designed out and ultimately the chips will, for the most part, be clean and consistent in operation.

We have extensively evaluated these devices here at Tektronix and have been able to dig out several of the bugs on our S3260 test system and in design groups. This information has been given to the designers and a frank discussion of chip function has taken place.

I hope that future devices, especially those which must adhere to external standards, can be developed with similar cooperation between vendors and users. This can work if the following conditions are met:

- Information provided by vendors must be scrupulously protected by recipients as proprietary. This is especially true for new products under development but also applies to "bug lists" on available devices.
- Discussions about device problems between vendors and users must be framed in general terms and not in terms of other vendors' problems or proposed solutions.

I believe that future chips will be much more difficult to design and therefore much more risky for vendors to attempt. Cooperation between vendors and users should be encouraged in order to help minimize the risks as much as possible.

I am willing to discuss those GPIB chip problems which Tek has had a part in discovering with anyone (from a small instrument company!) who wishes to call me at (503) 644-0161, ex. 6303.

Jim Howe
Tektronix Inc.
Beaverton, Ore.

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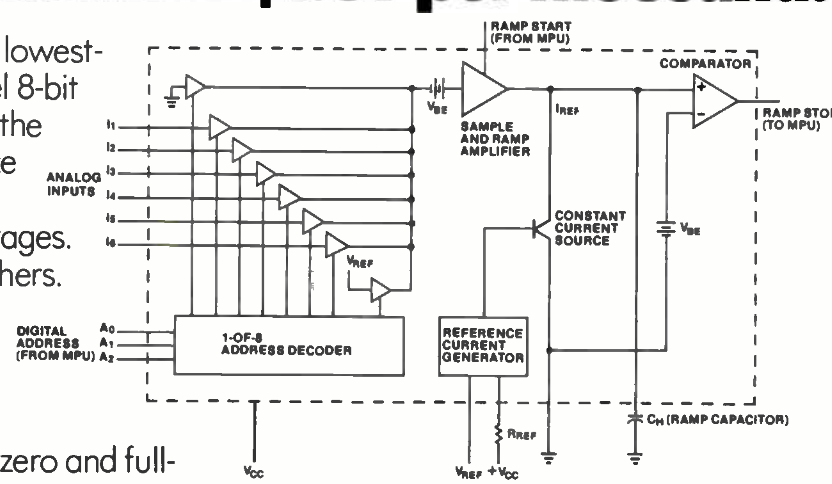

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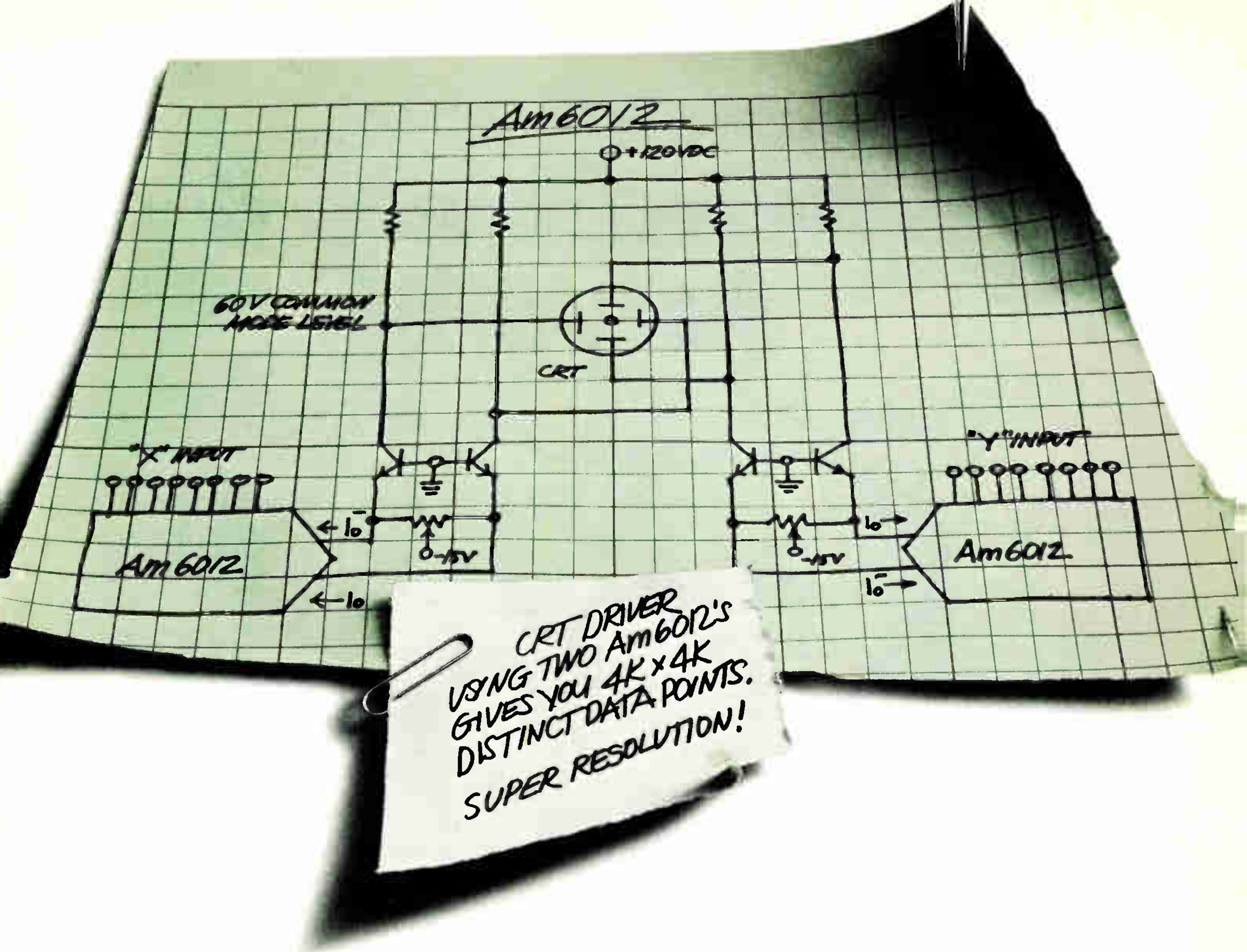


We trimmed the price, not the DAC.

Circle 11 on reader service card

News update

■ When Censor Inc. announced its SRA-100 step-and-repeat projection lithography system, it had ambitious design objectives. The Liechtenstein-based company said it was shooting for a 1-micrometer resolution, through-the-lens automatic alignment with registration to within ±0.1 μm, and a throughput of 60 4-inch wafers an hour [*Electronics*, June 21, 1979, p. 8].

With the prototype unit in debugging, the company's engineers are finding its special 10× reduction Zeiss lens has better than the sought-after performance. The new lens systems easily exposes 1-μm lines in a production mode and has put down 0.7-μm details in carefully controlled experiments, the company now says.

Test runs also have given a throughput as high as 80 4-in. wafers an hour. A contributing factor is the 200-millisecond exposure time (900 ms on competitive steppers), which is due to the powerful light source and high-resolution optics. Also contributing is the automatic wafer handling: transport time is about 200 ms.

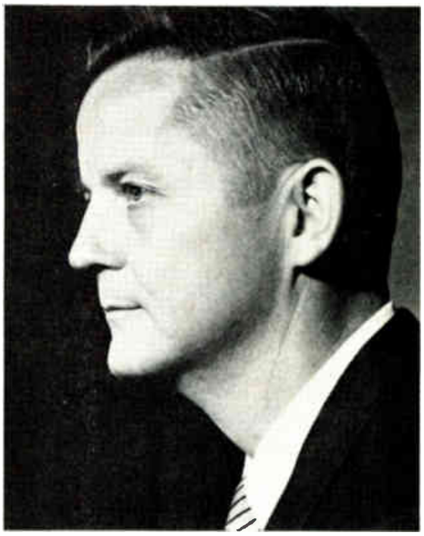
Improvements have been made on the original design to cut contamination of—and operator-induced damage to—the expensive and fragile 10× reticles. A dust-free temperature-controlled chamber holds as many as 15 reticles and automates handling them. Also, a special cover protects the reticle in use from dust.

Unlike other step-and-repeat units, the design of the SRA-100 is compact, at 13.3 square feet, and precludes the need for a separate environmental chamber. To facilitate use on production lines, it is well isolated from vibration and shock.

The testing of the prototype unit should be complete this month, and the company expects to deliver the second and third units to customers in June. It also will show a machine in Palo Alto, Calif., during Semicon West, May 20–22. All together, Censor says, it has 15 to 18 orders from the U.S. and Europe for its machine, and it expects to have produced 20 of the SRA-100 by the end of June. **-Jerry Lyman**

People

Vanderslice brings the word to GTE: it's 'consensus'



Looking big. Vanderslice sees growth areas for GTE in all its business enterprises.

"Nobody comes down from the mountain with the revealed truth," says Thomas A. Vanderslice, 48, president of the GTE Corp., Stamford, Conn. On the job about four months now, Vanderslice spent the first three traveling through the company's worldwide facilities "finding out what our people thought and what they are doing."

Prior to joining GTE, Vanderslice was executive vice president of the General Electric Co., where he developed a management style his new employees should find to their liking. He says that he plans to stress involvement in and enjoyment of the job at all levels; and among key managers, consensus—followed by near-total delegation of authority and minimal centralized control. He sees as one of his most important tasks that of helping managers reach consensus positions.

Open. It is too early to say where GTE will go under Vanderslice, but the possibilities are wide. "We have growth areas across the board," he says, even though 40% of the firm's business is in regulated areas such as telephones and other forms of communications.

Obviously, though, the military area will be of extreme importance, with the firm having just won the command, control, and communications contract for the MX missile [*Electronics*, Feb. 14, p. 47], a pact that could be worth about $3 billion by the mid-1980s. GTE also should wind up on the ground-launched cruise missile (GLCM) team, another multibillion-dollar program. And GTE's operating companies may have more electronic telephone switching in their future in line with Vanderslice's interest in increasing productivity while saving maintenance costs.

Vanderslice also expects renewed emphasis on GTE's technological resources. Activities like GTE Laboratories, GTE's recently revived semiconductor activities, and the firm's strengths in materials science should come in for more attention under Vanderslice.

He also plans to concentrate on productivity—"all managers should"—and GTE's semiconductor activities slant into this picture. "Ten years ago, you made an IC and sold it into a market where volumes were huge. Today, there's more specialization and somewhat smaller quantities. LSI is becoming part of our systems business, especially microprocessors and memories. So," he says, looking for synergy, "we ought to be able to let systems build on semiconductors and vice versa."

Curtis adds the engineering to software in his SDC post

After coming on the scene in the late 1960s, software engineering is finally starting to gain momentum as a separate discipline. It is to regular software, say, as chemical engineering is to pure chemistry, but so far its practitioners are mainly showing up at well-established software houses, of which System Development Corp. in Santa Monica, Calif., is typical. The company has named Edwin P. Curtis manager of software engineering for its product group, which makes text storage and retrieval systems.

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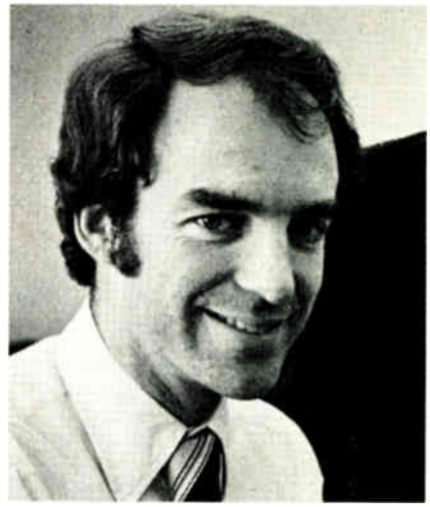

Easy does it. SDC's Curtis seeks user-friendly and catastrophe-free software.

new field as "developing a discipline and methodology that allows predicting in advance how software will perform, on schedule, before putting it into a product."

Though sensible and long applied to hardware, engineering techniques for software were long in coming for a good reason, in Curtis' view. "How do you measure a successful program?" he asks, and what is a permissible number of programming errors? The tools and experience for making such measurements are just taking hold as they diffuse into the design community from the academic centers, he says.

The "reference issue," or lodestone of software engineering, is sensitivity to the user, says Curtis. In other words, the engineer must come up with "user-friendly software that can run without catastrophe." Curtis speaks from experience: his own background before joining SDC several months ago is strong in the user area—in computer design and point-of-sale equipment—and he holds both a BSEE and MBA.

Curtis and other SDC officials think software engineering is at the takeoff point because data processing has matured to the point where the stability and controls offered by engineering techniques are needed for cost reasons. The company, in fact, has had a corporate software engineering vice president since 1978 for these developments. □

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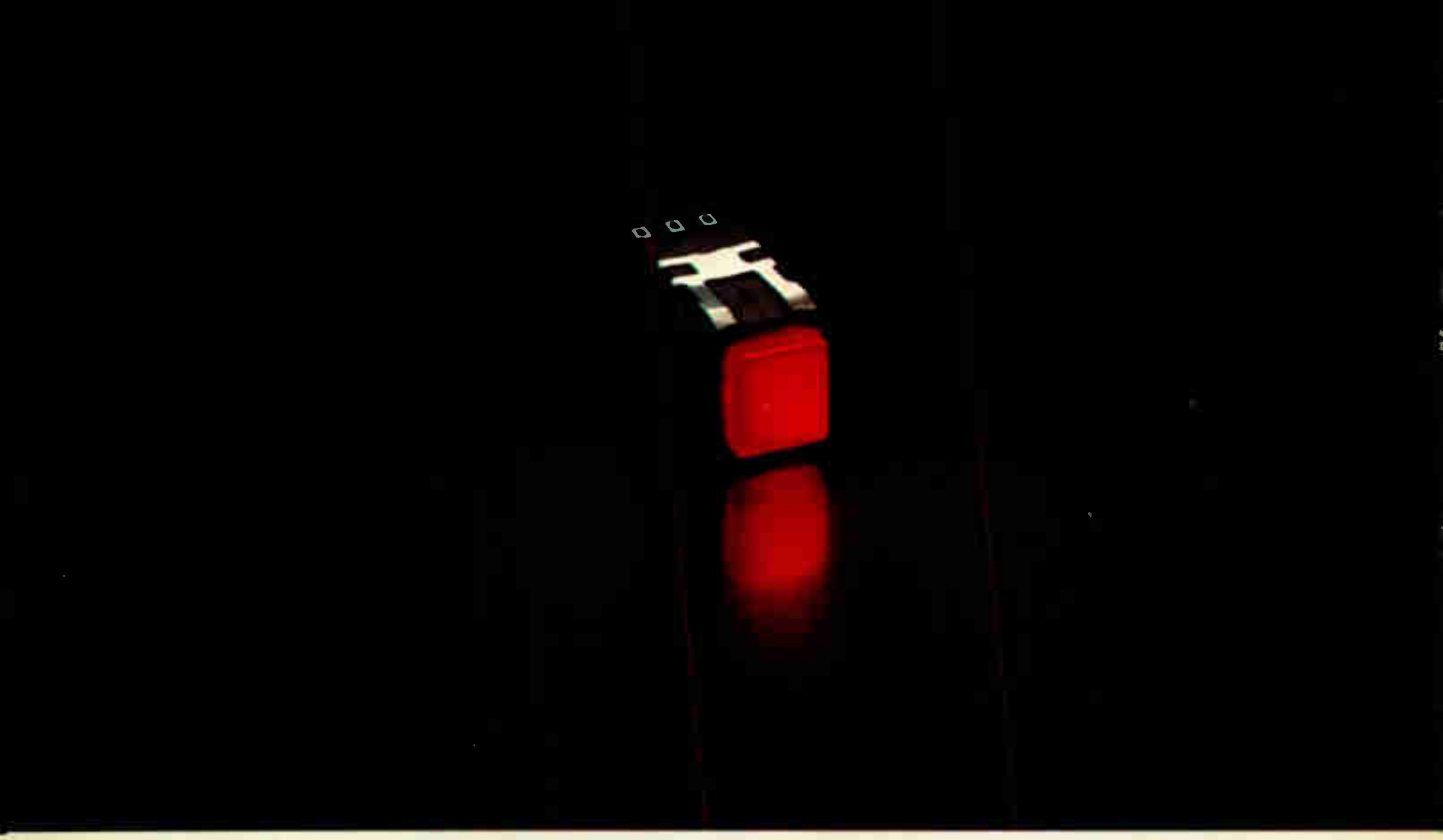

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Circle 17 on reader service card

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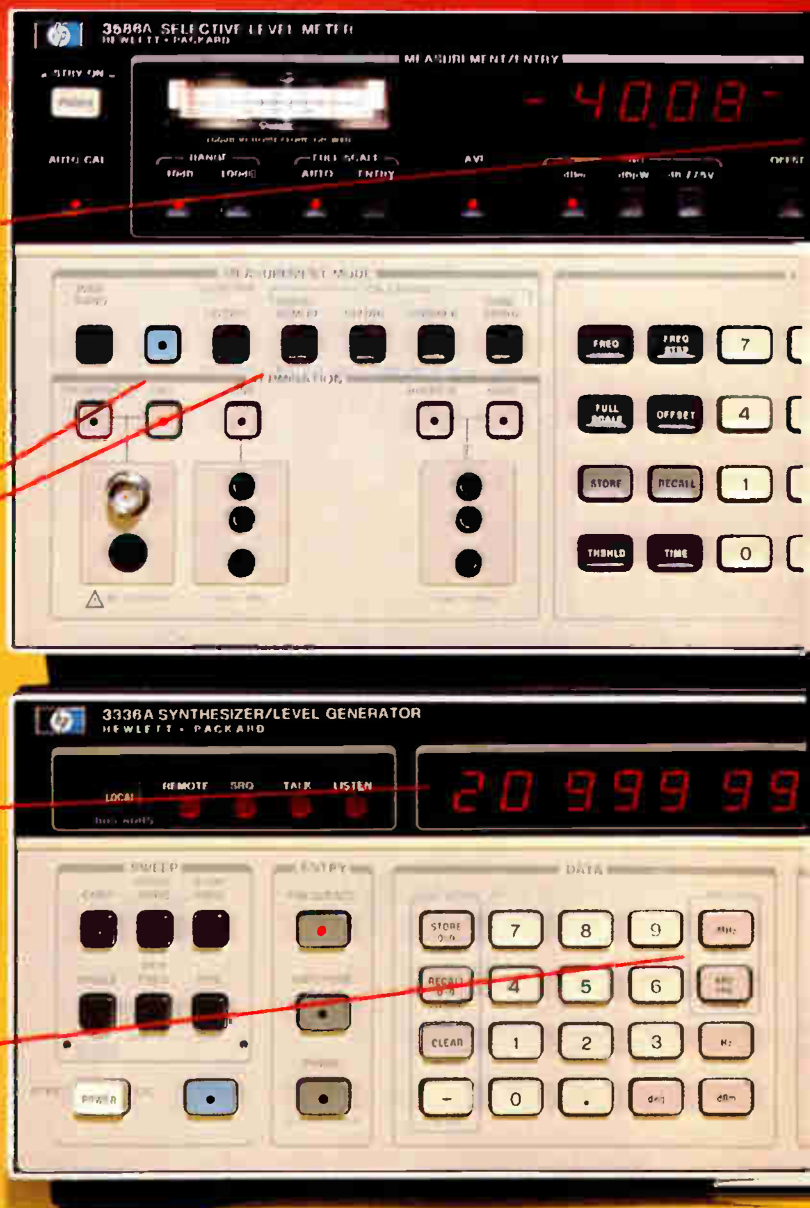


0.1 Hz frequency resolution means precise frequency setability over the full 50 Hz to 32.5 MHz range. ±.2 dB level accuracy allows measurements with .01 dB resolution all the way down to -80 dBm.

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.

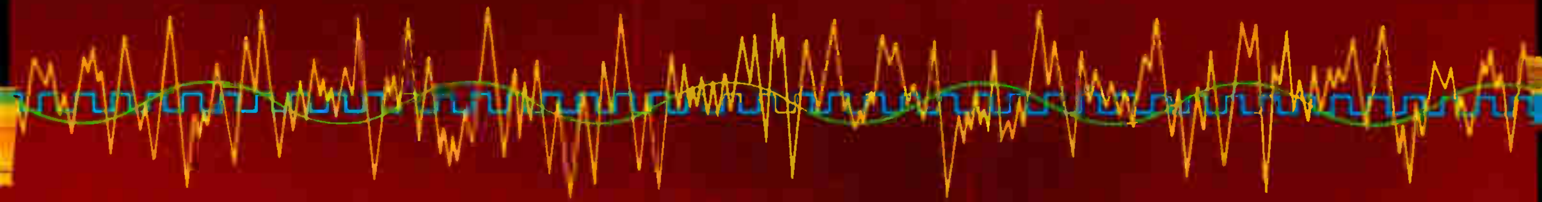
Level accuracy is ±.05 dB at full output at 10 kHz with ±0.1 dB flatness to 20.9 MHz, and you can sweep the full band with ±.15 dB leveling.

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



..nd voice frequency tests with ..evel Measuring Set.

Frequency Counter lets you measure a frequency precisely, then tune to it with one keystroke, eliminating the need for "rocking" the tuning control to peak the signal.

HP-IB control is standard on both instruments, allowing all functions to be remotely programmed for automated testing.

Use the 3586A/B as a "tunable channel bank filter" with shape factors up to 1.2 and 75 dB adjacent channel rejection.

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set to automatically track the frequency of the Selective Level Meter. Or you can use it for stand-alone frequency synthesis applications.

Through HP-IB, the Level Measuring Set is fully programmable. A computing controller such as one of HP's 9800 Series permits automatic operation to reduce manufacturing time and to lower maintenance costs through automated testing.

Prices are $9,200* for the 3586A/B ($475* for Transmission Impairments Measurements option) and $4,100* for the 3336A/B. For full information, write to Hewlett-Packard, 1507 Page Mill Road, Palo Alto, CA 94304. Or call the HP regional office nearest you: East (201) 265-5000, West (213) 970-7500, Midwest (312) 255-9800, South (404) 955-1500, Canada (416) 678-9430.

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099/54

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F100K ECL

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While being the most complex ECL circuit family available, it's still the easiest to use in system design. Because it's fully voltage and temperature compensated and has higher integration levels.

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With five devices, featuring 1,000-gate density and subnanosecond delays, the 8-Bit Slice family allows for excellent flexibility and building-block versatility over a wide variety of general-purpose applications.

F220 8-BIT SLICE		
Device	**Function**	**Availability**
100220	Address and Data Interface Unit (ADIU)	Now
100221	Multi-function Network (MFN)	Now
100222	Dual Access Stack (DAS)	Now
100223	Programmable Interface Unit (PIU)	2nd Q
100224	Microprogram Sequencer (MPS)	4th Q

Where do you use the F100K family?

Anywhere speed is essential. Especially in large high-performance computers. And right down the line, from mainframes to midis, minis and special processors. Even in communications and instrumentation equipment.

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couldn't do what six are doing.

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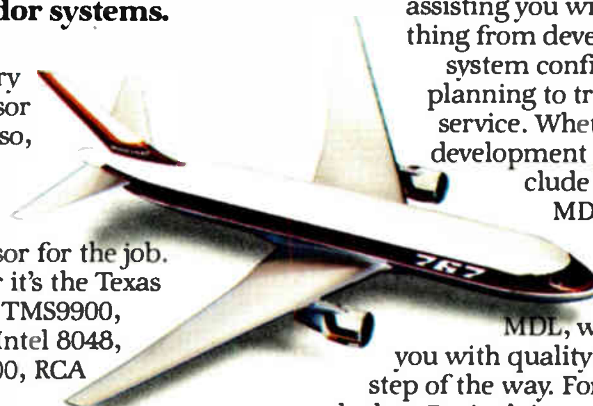

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We don't want to say we told you so . . .

Make no mistake, the Japanese are moving into the computer market with their typical efficiency, high-quality products, and attention to detail. Their appreciation of human engineering—the so-called ease-of-use features—which is obvious in their automobiles and consumer electronics, and which helped them dominate the market first in radio and then in television, will be applied to computers as well. Increasingly sensitive to charges of dumping and also facing a more sophisticated customer, the Japanese appear ready to approach the computer market in a more rational fashion, not competing on price alone.

It would be naive to think they can be shut out of the U. S. market. And even if they were, American companies, which do between 30% and 50% of their business overseas, would still meet them in the foreign markets. Protectionism? That's no solution; this is not a battle for the governments to handle. Rather, this is a battle that must be fought between businesses on the field of competitive free enterprise.

Direct Government aid to the industry is not needed, and indeed could be harmful. But there are several things the Government—and the industry—must do to ensure that America can do what it does best—technically innovate.

■ Let's stop deluding ourselves that the Japanese will not be able to provide the service or software critical to successful computer sales. We have all heard that before—from our friendly auto dealer, for one—and then came the nationwide networks of Toyota and Honda dealerships with their service facilities. They are pouring money and effort into software—and are quite willing to buy American software and hire American programmers.

■ Let's enforce the rules of the game. New rules are not needed, but the quick and fair application of antidumping and other trade regulations already on the books is imperative. Up to now, U. S. action has come after the industry needing the help was dead.

■ Let's make it easier for U. S. companies to compete overseas. It is outrageous that the U. S. Department of Commerce negotiates inequitable tariff arrangements—for example, the 5% levied on incoming Japanese computers is met by a 10.5% Japanese tariff on U. S.-made machines. And the Congress must examine laws of other agencies that pose nontariff barriers to effective American competition overseas.

■ Let's encourage investment, especially in software development. In addition to reviewing capital gains taxes and depreciation schedules, why not borrow a page from the Japanese, who give their software developers tax breaks to help them finance future development?

■ Let's solve the problem of legal protection for software. That sore has been festering for almost 12 years. As software becomes a more important part of computer systems—and a pivotal point in our competition with the Japanese—the ability to protect it is necessary to encourage its development.

It is only through a concerted program to effect such concrete action that we can keep American industry competitive. That way, we won't have to say we told you so.

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The Inside Story.

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	TD1225	24-140	25	200
	TD2405	48-280	5	50
	TD2410	48-280	10	100
	TD2425	48-280	25	200
AC INPUT CONTROL MODELS	TA1205	24-140	5	50
	TA1210	24-140	10	100
	TA1225	24-140	25	200
	TA2405	48-280	5	50
	TA2410	48-280	10	100
	TA2425	48-280	25	200

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Meetings

International Optical Computing Conference and Technical Symposium East, Society of Photo-Optical Instrumentation Engineers (Box 10, Bellingham, Wash. 98225) *et al.*, April 7–11, Hyatt Regency Hotel, Washington, D. C.

Second International Printed Circuits Conference and Exhibition, International Printed Circuits Conference (2 Park Ave., New York, N. Y. 10016), Sheraton Centre, New York, April 8–10.

International Reliability Physics Symposium, IEEE *et al.*, Caesars Palace, Las Vegas, Nev., April 8–10.

International Conference on Acoustics, Speech and Signal Processing, IEEE, Fairmont Hotel, Denver, Colo., April 9–11.

58th Annual Convention, National Association of Broadcasters (1771 N St. N. W., Washington, D. C. 20036), Convention Center, Las Vegas, Nev., April 13–16.

Region 3 Conference and Exhibit, IEEE, Opryland Hotel, Nashville, Tenn., April 13–16.

Spring 1980 Conference of Common, an IBM computer users group, Common (435 N. Michigan Ave., Suite 1717, Chicago, Ill. 60611), Sheraton-Atlanta, Atlanta, April 13–16.

"The DOD FY '81 RDT&E Budget—Outlook and Perspective" Symposium, EIA (2001 Eye St. N. W., Washington, D. C. 20006), Shoreham Americana Hotel, Washington, D. C., April 15–17.

Integrating Business Machines into Local Networks, The Yankee Group (Box 43, Cambridge, Mass. 02138), Harvard Club, New York, April 16–17.

Communications Equipment and Systems, IEE Conference Department (Savoy Place, London WC2R 0BL, England), National Exhibition Centre, Birmingham, England, April 16–18.

Hanover International Fair, German Trade Fair and Exposition Corp. (D-3000 Hanover 82, Messegelände, West Germany), Hanover Fairgrounds, April 16–24.

18th International Magnetics Conference, Magnetics Society of the IEEE, Sheraton-Boston Hotel, Boston, April 21–24.

29th Annual Conference and Exposition, National Micrographics Association (8719 Colesville Rd., Silver Spring, Md. 20910), New York Coliseum, New York, April 21–25.

Electro-Optical Warfare III, Cabrillo Crow Coven and Naval Ocean Systems Center (Dr. P. C. Fletcher, NOSC, Code 015, San Diego, Calif. 92152), NOSC, April 23–25.

International Aerospace Exhibition, German Trade Fair and Exposition Corp. (D-3000 Hanover 82, Messegelände, West Germany), Hanover Airport, April 24–May 1.

Federal Data Processing Exposition, The Interface Group (160 Speen St., Framingham, Mass. 01701), Sheraton Washington Hotel, Washington, D. C., April 28–30.

International Radar Conference, IEEE, Stouffer's National Center Hotel, Arlington, Va., April 28–30.

International Symposium on Circuits and Systems, IEEE, Shamrock Hilton Hotel, Houston, April 28–30.

28th Annual National Relay Conference, The National Association of Relay Manufacturers (D. D. Lingelbach, Oklahoma State University, 202 Engineering South, Stillwater, Okla. 74074), Oklahoma State University, Stillwater, Okla., April 28–30.

30th Annual Electronic Components Conference, IEEE *et al.*, Hyatt Regency Hotel, San Francisco, April 28–30.

Second International Parametrics Conference, International Society of

Meetings

Parametric Analysis (P. O. Box 3104, Dayton, Ohio 45431), Sheraton Poste Inn, Cherry Hill, N. J., April 29–May 1.

International Conference on the Electronic Office, Institute of Electrical and Radio Engineers (99 Gower St., London WC1E 6AZ, England), Penta Hotel, London, April 22–25.

Electronic Distribution Show and Conference, Electronic Industry Show Corp. (222 S. Riverside Plaza, Chicago, Ill. 60606) Las Vegas Hilton Hotel, Las Vegas, May 1–3.

Video '80—Congress and Exhibition on Video Systems, AMK GmbH (D-1000, Berlin, Messedamm 22), Berlin Fairgrounds, May 5–7.

World Electronics—Strategies for Success, Financial Times Conferences (10 Cannon St., London, England) and Mackintosh International, Loews Monte Carlo Hotel, Monte Carlo, May 5–7.

26th International Instrumentation Symposium, Instrument Society of America (A. E. Bowman, Hy-Cal Engineering, 12105 Los Nietos Road, Santa Fe Springs, Calif. 90670) Red Lion Inn/Seatac Hotel, Seattle, Washington, May 5–8.

International Symposium on Computer Architecture, IEEE, La Boule, France, May 6–8.

Short courses

Voice Input/Output for Computers, Pacifica Hotel, Culver City, Calif., April 15–18, and subsequently in other locations. For information, write to Integrated Computer Systems, Box 5339, Santa Monica, Calif. 90405.

Project Management for Engineers, Hyatt Regency, Houston, April 21–23. For information, write to Registrar–14th Floor, New York University Conference Center, 360 Lexington Ave., New York, N. Y. 10017.

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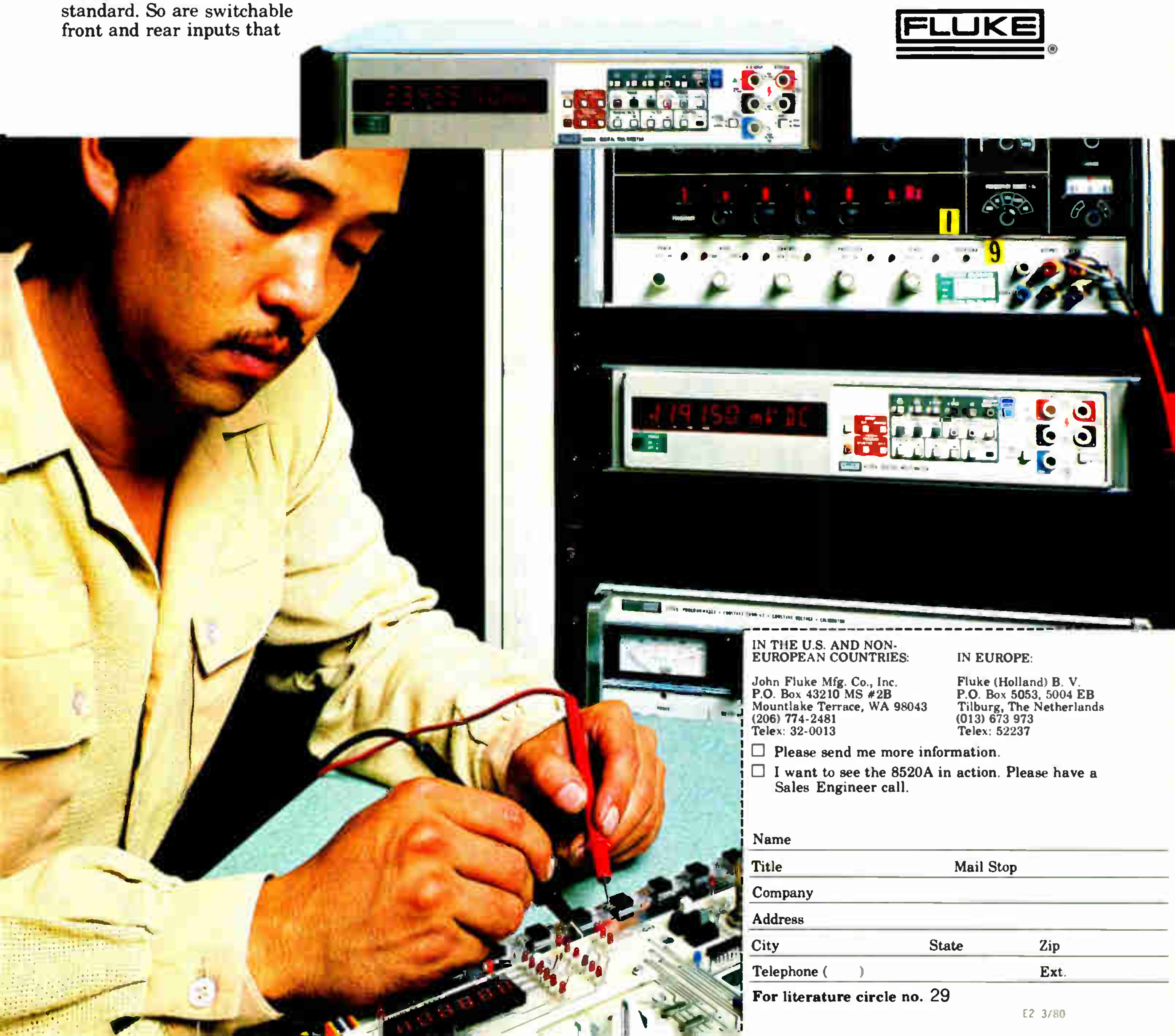

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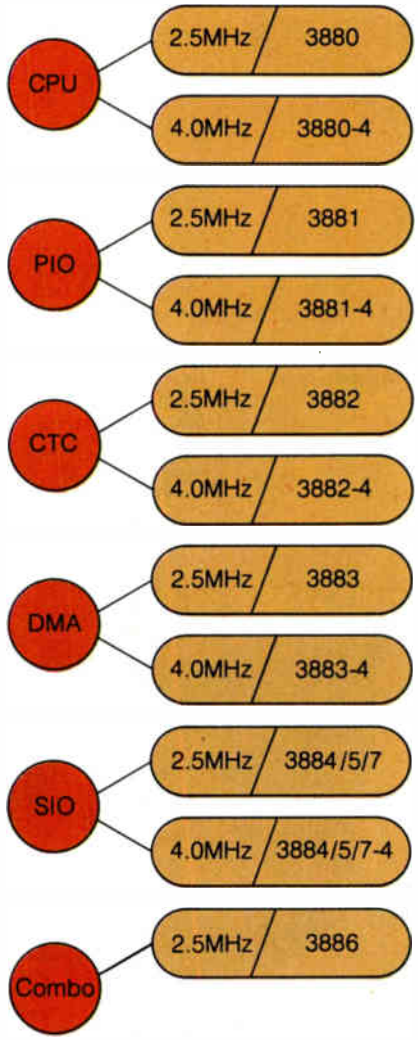
E2 3/80

1 Now you can choose.

The choice? 2.5MHz or 4.0MHz parts from a full product line that includes the SIO and DMA. But other reasons to pick Mostek's Z80 family are equally impressive.

First of all, the Mostek Z80 is recognized and accepted as the industry's foremost 8-bit microprocessor. It's a proven design that's been in volume production for several years.

Then there's the inherent design advantages over the 8085: 158 instructions vs. 80. Fourteen 8-bit CPU registers vs. 7. Ten addressing modes vs. 7. An automatic dynamic RAM refresh. Enhanced 16-bit arithmetic ability. Automatic prioritization of interrupts instead of a separate control device. The list goes on.



2 A practical solution for lower system cost.

Mostek's Combo™ Chip gives you more versatility with fewer parts. It's ideal for minimum chip configuration designs because this single 40-pin circuit contains 256 bytes of RAM with a low power standby mode for 64 bytes. A serial I/O port. Two programmable timers, one of which can be a programmable baud rate generator. Three external interrupts with a programmable vector for each channel. And, of course, a single +5 Volt power supply. So now you can design a complete system with just 3 chips: a Z80 CPU, ROM, RAM, or EPROM memory, and the Combo Chip.

3 A flexible development system.

Mostek's development support includes a variety of choices ranging from single cards to our Matrix™ floppy disk development system with 4.0MHz real time in-circuit emulation. The Matrix system offers a sophisticated resident software package that uses simple commands and comprehensive error messages to save valuable time during program development and debug. Macro Assemblers, BASIC, and FORTRAN are also available for use on the Matrix development system.

4 For all your Z80 needs.

Mostek's complete Z80 family is available now at your local Mostek distributor. So are factory-trained distributor FAEs and demonstration centers at most locations. Contact them for complete information and/or a product demonstration. Military versions are also available. For more information call or write Mostek, 1215 W. Crosby Road, Carrollton, TX 75006, phone 214/323-6000. In Europe, contact Mostek Brussels; phone 660.69.24.

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HP working on desktop computer to replace 9825A . . .

Hewlett-Packard Co.'s Desktop Computer division in Fort Collins, Colo., is understood to have just started development of a low-cost machine that would be a replacement for its current 9825A system. The new system, code-named Chipmunk, will use a Motorola Inc. 68000 16-bit microprocessor and will sell for about $5,000 when it surfaces before mid-1981. Unlike its predecessor, which uses data cartridges and has a light-emitting diode display, **Chipmunk will have a built-in floppy disk with 256 kilobytes of memory** (in addition to its own internal read/write memory of 32 kilobytes) and a built-in 7-in. cathode-ray tube for alphanumeric display. Initially, the system will be programmed in HP's enhanced Basic language, but soon after it will be capable of performing high-level language programming using Pascal. A division spokesman neither confirms nor denies the reports.

. . . and puts Image data-base management system on a chip

A data-base management system will be available for a desktop computer for the first time next month, when Hewlett-Packard Co., Palo Alto, Calif., introduces such a package for its system 45B. This has not been done before because it was felt that the package would take up too much user memory, but this system takes up none. Instead, it puts a subset of HP's Image program onto the computer **by adding two read-only memories containing a total of 40 kilobytes.** The addition will cost $5,000 and will include a 500-kilobyte query program, which is loaded from a 20-megabyte disk. Only the more powerful versions of System 45B, with 187 kilobytes of user memory, will be able to run the data-base management system package, because it requires the use of lookup tables and Basic language code.

LSI to be used in burst-error processor for disks

With large-scale integration finding its way into more computer peripherals [*Electronics,* March 13, p. 46], look for Advanced Micro Devices Inc., Sunnyvale, Calif., to introduce what is **perhaps the first MOS LSI device aimed at the high-performance disk market.** The burst-error processor, designated the AMZ8065, can detect and allow correction of burst errors of up to 12 bits in serial data streams moving at 20 Mb/s. The 8065 is characterized to work with the Z8000 16-bit microprocessor, but it will also be offered as a general-purpose device, the Am9520, characterized for operation with just about any microprocessor.

CAD to grow 25% a year, says study

Products and services for computer-aided design (CAD) will enjoy an average annual growth rate of 25% on worldwide markets through 1984, according to an impact study released by Arthur D. Little Inc., Cambridge, Mass. CAD's increasing affordability for manufacturers with less than $100 million in sales—along with continuing proof that increased productivity and shortened product cycles are worth the investment—**will push its market value from the present $590 million to more than $2 billion by 1984,** the study says. Computer-aided manufacturing markets, meanwhile, should average a 10% growth rate domestically through 1984, as integration of minicomputers expands applications from traditional planning and reporting to the wide variety of parts used in batch production and materials handling.

Electronics newsletter

Shugart offers controller for floppy-disk drives

When Shugart Associates introduced its SA1000 8-in. Winchester fixed-disk drives last September, the Sunnyvale, Calif., firm made much of the drives' degree of compatibility with floppy-disk drives. This simplifies replacement of the floppy-disk drive by a Winchester unit and lets one or more floppy-disk drives be used economically in the same system to provide removable backup storage. Now, the Xerox Corp. subsidiary is about to take the wraps off a bit-slice–based (AMD 2900 series) controller, the SA1400, with on-board data separator logic able to control up to four disk drives **in any combination of the firm's SA1000 fixed or SA800/850 floppy-disk drives.** To be unveiled in mid-April at the Hanover Fair in West Germany, the SA1400 disk controller will feature asynchronous direct memory access and on-board diagnostics.

IC could cut cost of $100,000 IR camera to $20,000

A standard integrated circuit promises to reduce costs of military-grade infrared-sensing cameras from $100,000 to about $20,000 by replacing their expensive, bulky optical sensing systems. Developed by Rome Air Development Center at Hanscom Air Force Base in Bedford, Mass., the chip contains platinum-silicide image sensors sensitive to 4.6-μm wavelengths—the middle infrared range—and can read out to oscilloscopes or standard television monitors. **Cameras using the chip will also have one fourth the weight and use one fourth the power of current models.** Rome has contracted with RCA Corp.'s Sarnoff and Advanced Technology Laboratories for an alarm system and a sensor camera using the new chip; deliveries are slated for 1981.

V-MOS power transistors due from Solitron

Look for Solitron Devices Inc. to make its entry into the V-groove-MOS power-transistor field. The San Diego–based manufacturer has developed, among other devices, a series of V-MOS field-effect transistors that will be alternate sources for the 2N6656 through 2N6666 family of devices produced by Siliconix Inc. **However, the new series will be fabricated with a flat-bottom V-groove structure** like that used by Intersil Inc. The initial family, consisting of about 50 devices, will have a maximum on-resistance of 2 Ω, a current-handling capability of up to 2 A, and breakdown voltages ranging from 30 to 100 V.

Motorola developing speech-synthesis set

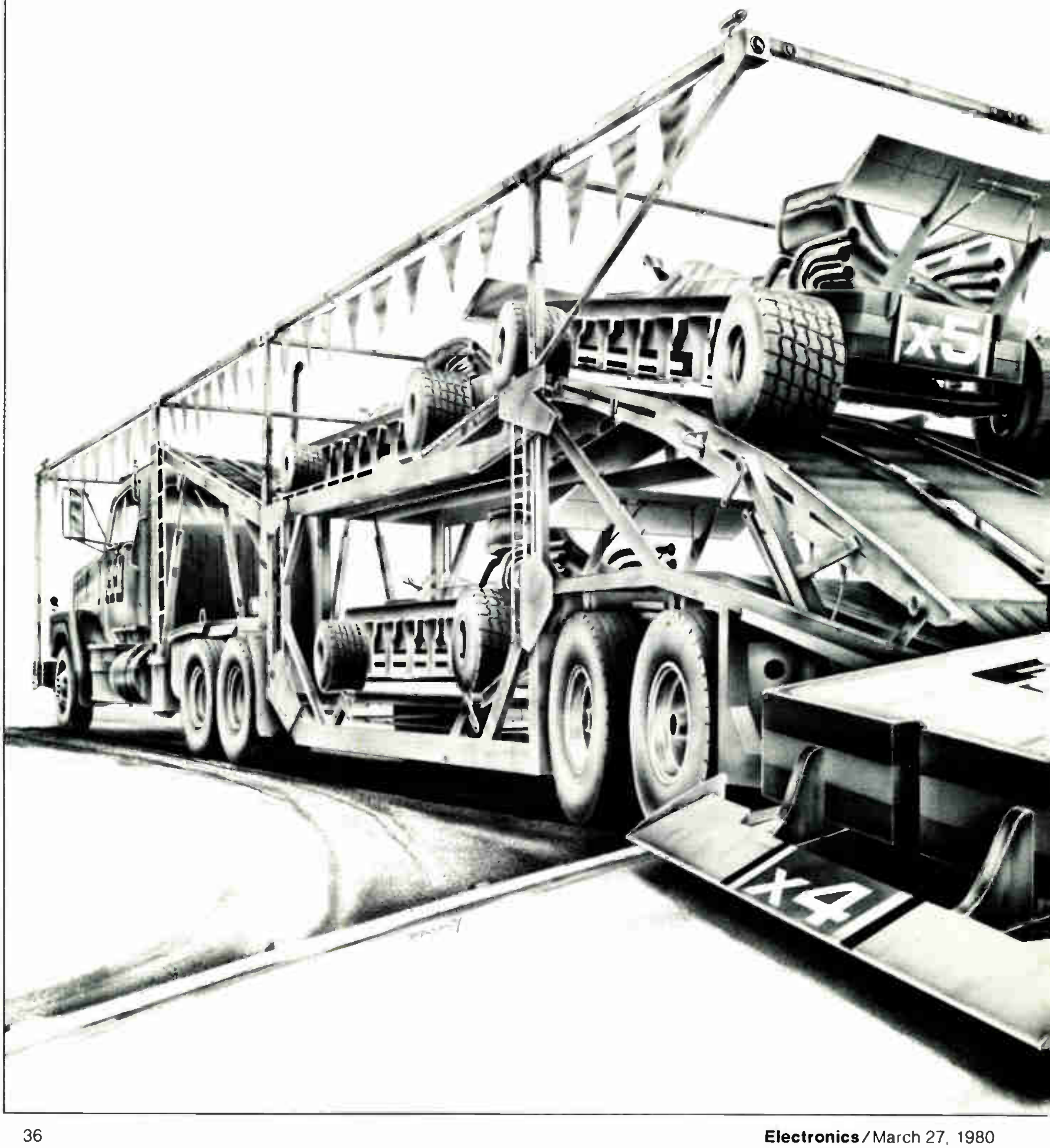
Add Motorola Inc. to the list of manufacturers taking aim at the expected 1980s growth market for speech-synthesis and -recognition devices and systems. Already under development, say sources at the company's Austin, Texas, MOS division, is a speech-synthesis chip set that could lead to a standard product during 1981. **N-channel MOS is believed to be the current technology of choice** for speech synthesis at Motorola and lower-power complementary-MOS devices to be second-generation parts.

Addenda

On April 1, Toshiba Corp. will join the parade of Japanese semiconductor companies with manufacturing facilities in the U. S. Toshiba Semiconductor (U. S. A.) Inc. will produce MOS **memories, mainly 16-K dynamic random-access types, and microprocessors** in a $24 million plant in Sunnyvale, Calif. . . . Computer & Devices Corp., Burlington, Mass., will be showing another version of its portable computer at the National Computer Conference.

Circle 35 on reader service card

Fast FIFOs from inventory.



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But *now* we're also offering the 67401A, with 15 MHz guaranteed, making it perfect for even more demanding applications such as digital video.

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MIL-STD FIFOs from inventory.

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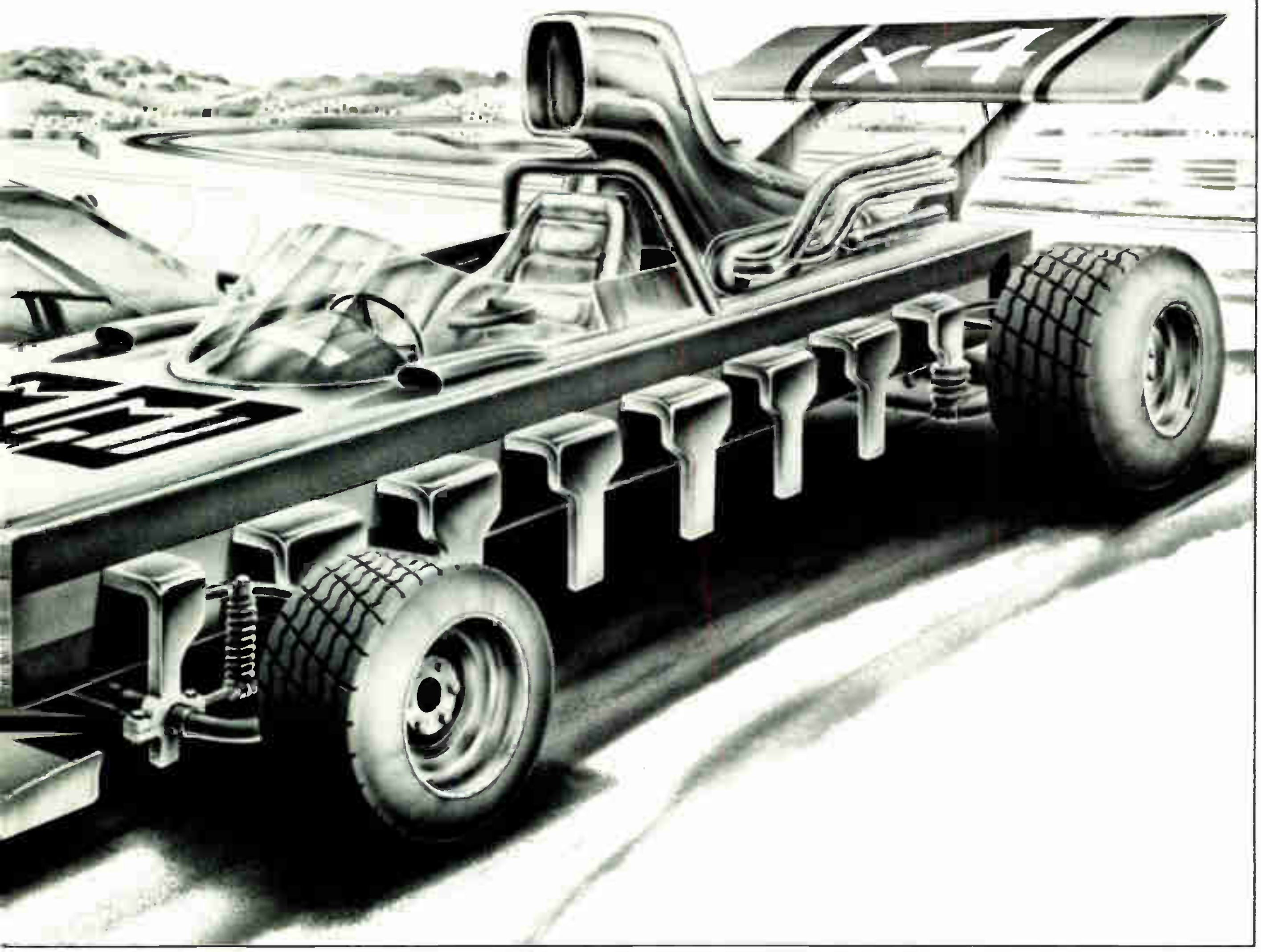

CSC's Model LM-3 Logic Monitor. It's a new breed of test instrument. Here in a single compact package are *forty* high-speed high-impedance precision-threshold logic state indicators with triggerable latching modes.

Just connect the LM-3 Logic Monitor to any combination of bus lines, test points, IC pins or other nodes. Pick the operating mode: the LM-3's display follows up to 40 channels of data in RUN; stores and displays 40 data channels when triggered in LATCH; or updates its latched data display with every trigger in RETRIG. There's even a pushbutton to manually latch the display.

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Circle 38 on reader service card

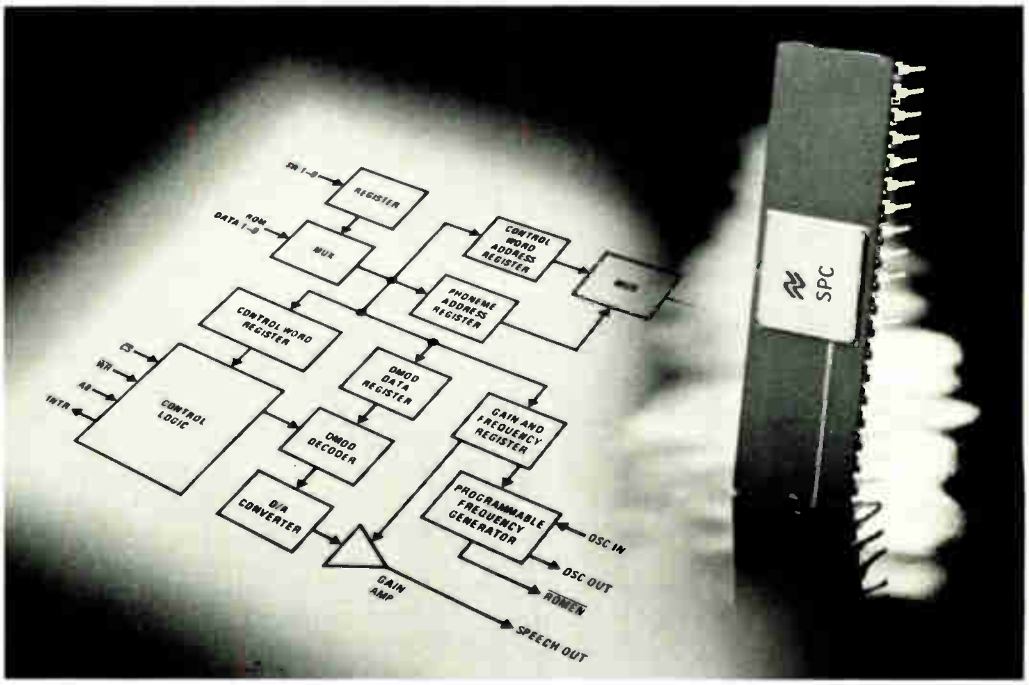
Electronics review

Significant developments in technology and business

Pair of chips synthesizes lifelike speech

by Bruce LeBoss, Palo Alto bureau manager

National's talking chips will be available to OEMs; natural voice quality comes from waveform digitization



Speak to me. National's 40-pin n-channel speech-synthesis integrated circuit uses a delta-modulation scheme (DMOD, above) for the processing of its synthesized words.

The moment anxiously awaited by potential users of talking integrated circuits is here: National Semiconductor Corp. is ready to introduce its speech-synthesis chips. The Santa Clara, Calif., company will be the first to sell speech-synthesis ICs, which will offer surprisingly natural speech quality.

What National will be offering in evaluation quantities in June is its SPC, for speech-processor chip, and a 16-K clocked or static read-only memory that contains both compressed word patterns and the frequency and amplitude information necessary for speech. For a bigger vocabulary, the SPC can address up to 128 K of ROM directly and—under the control of almost any microprocessor—upwards of 2 megabits, says Dan Sowin, director of MOS/LSI marketing.

Techniques. Of course, Texas Instruments Inc. has been producing speech-synthesis ICs for some time [*Electronics*, Aug. 31, 1978, p. 109], but the Dallas firm has yet to make its three-chip set available to original-equipment manufacturers. What's more, National is using a different synthesizing technique for the highly natural voice produced by its two-chip set.

National's two chips require external filtering and amplification for the highest quality speech, whereas TI's three chips drive a speaker directly. Thus the system hardware requirements are similar.

Other speech-synthesis approaches model the vocal tract through formant synthesis or linear-predictive coding (TI's choice), but National opted for waveform digitization, sampling at twice the highest frequency of interest. "It is somewhat similar to a recording technique," Sowin explains. "We start with an original voice recording, compact it, and try to maintain original voice quality."

The resulting amplified voice may be a man's, a woman's, or a child's. "If you know the speaker, you will recognize his or her voice," Sowin says, since the inflection and emphasis of the original recording is closely reproduced. The company also is working on music synthesis for the SPC, but will not talk about it yet.

National's synthesis technique is a relatively simple form of pulse code modulation. However, digitized waveform sampling "minimizes the cost of logic hardware at the expense of memory," Sowin notes.

Software. Thus the company put considerable development effort in its software, obtaining licenses for several data-compression algorithms from the University of California at Berkeley. As a result, memory requirements for vocabularies of several hundred words are competitive with those needed by techniques like Texas Instruments'.

For applications with these limited

vocabularies, Sowin believes the SPC technique will prove more cost-effective than formant or linear-predictive coding, which must store the microprocessor program as well as the information-defining words. "When you get up to a few thousand words, other techniques will be more cost-effective, as they will use phonemes over and over in different words," he notes. "However, the phoneme approach won't provide as good a quality voice."

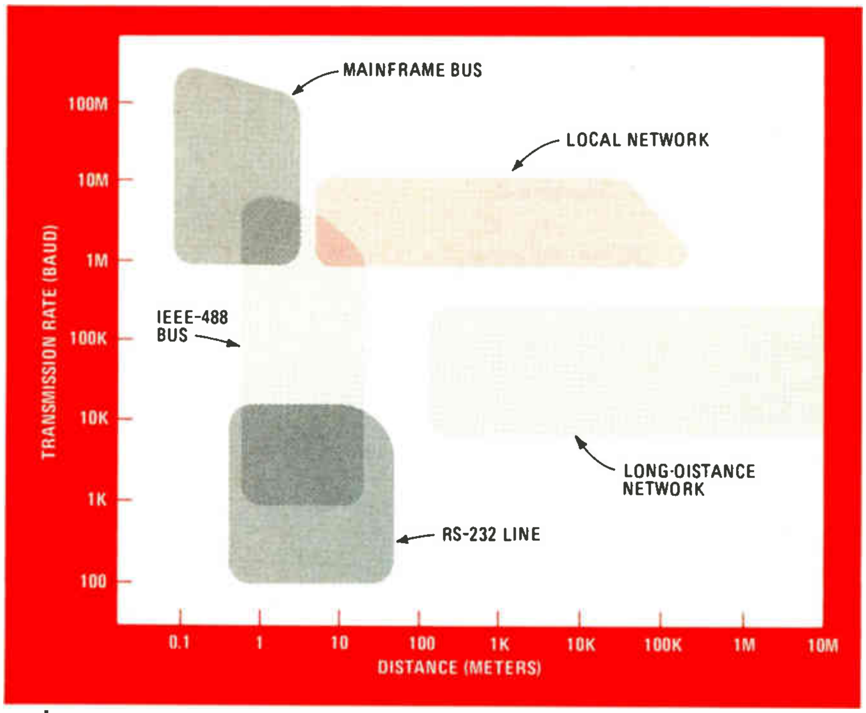
In Japan. Another company looking at PCM speech synthesis is Sharp Corp., which showed some consumer products at the January Consumer Electronics Show in Las Vegas [*Electronics*, Jan. 17, p. 39]. Although the Japanese company said its talking clock and calculator would be ready later this year, it also acknowledged that its speech-synthesis ICs were prototypes.

National sees such applications as likely for its SPC, as well as portable instruments, car dashboards, personal computers, and high-end games and toys. Likely to boost its popularity is the digitizing technique, which OEMs could implement themselves instead of depending on custom ROMs from the makers of systems based on formant or linear-predictive coding, both of which require a complex analysis algorithm running on a big mainframe.

Probably for the rest of 1980, the firm will ship SPC evaluation kits with custom vocabularies of around 25 words. Such kits would cost between $10 and $12 in production quantities of 25,000, Sowin says.

Data communications

Standards push starts on short-run data net



New link. An IEEE standards committee is beginning to wrestle with the specifications for a new, short-run data-communications network to fill an important gap.

As automatic capturing of data spreads, the need for efficient transfer of information over short to medium distances—say, within a facility or among nearby facilities—is also growing. In response, the electronics industries formed a standards committee early this month to work out the specifications for what are being called local networks.

There is widespread interest in local nets because "they fill an important gap," says Maris Graube, interface coordination manager for Tektronix Inc., Beaverton, Ore., and chairman of the new Institute of Electrical and Electronics Engineers committee. As the figure shows, the nets are the missing link between short-run systems capable of various data rates and long-distance data-communications setups like Telenet and Tymnet.

What Graube and his committee are thinking of is packet-switching networks to broadcast addressed digital data, complete with error-correcting codes, in blocks of defined length. In such a scheme, each unit competes for bus time to broadcast its message, which only the addressed unit heeds.

Each unit's interface circuitry will participate in the bus arbitration and enforce the communications protocol. There is no key element like a bus controller whose failure would bring down the whole system, as there is with IEEE-488 systems.

Local networks would transfer data at 1- to 10-megabaud rates, so they would handle computer-to-computer interactions without causing significant delays. Further, they could do away with the need to lease lines from a common carrier.

They would use easily installed coaxial cable, routed throughout the networked area. Equipment would tie into the system in much the same way TVs tie into cable networks, giving access anywhere the cable goes.

Local networks have been custom-built for process control in oil refineries, for example, with the interface for each piece of equipment being built up of discrete TTL parts. For both industrial and commercial interests, agreement on standard designs is highly desirable; users would be relieved of having to design and build their nets, and manufacturers would find new markets.

Gold mine. In fact, the local network could be a gold mine for semiconductor makers. The interface circuitry would eventually be realized by chip sets—much as the IEEE-488 bus interface is now—going into everything from badge readers to intelligent measurement systems to mainframe computers, all of which could be on a single network.

Based on attendance at the first committee meeting, Motorola, Texas Instruments, and Advanced Micro Devices are interested in building local-network interface chips, or L-NICs, and IBM, Honeywell, Digital Equipment Corp., Hewlett-Packard, Tektronix, Xerox, and a host of others see uses for them. Already Xerox has announced plans for such a system, Ethernet [*Electronics*, Dec. 10, 1979, p. 33], and is working with Intel Corp and DEC. Intel's planned chip set may well be the first in the local-net field. If so, then Ethernet stands a good chance of becoming the standard, especially since the National Bureau of Standards has adopted it for internal use.

Graube says the committee, divided into three working groups, will concentrate immediately "on getting the silicon straight." The framework for their effort will be the June 1979 version of the Reference Model of distributed systems, promulgated by the American National Standards Institute [*Electronics*, Dec. 7, 1978, p. 120]. **-Richard W. Comerford**

Military

IBM and TRW top VHSIC awards list for Phase 0 definition studies

International Business Machines Corp. and TRW Inc. rank at the top of the winner's list for Phase 0 of the U. S. military's very high-speed integrated circuits program. The two companies also were the only competitors to propose chip-development efforts on each of the 19 VHSIC weapons systems candidates in the six-year $210 million triservice program (see table).

The Phase 0 awards totaling $10.3 million are for nine months of studies by each prime contractor to define approaches to system architecture, chip architecture and design, circuit-processing technologies, and testing. The nine single-firm and team competitors will be winnowed in early 1981 to between four and six for Phase 1 and eventually for Phase 2 [*Electronics*, Jan. 3, p. 81].

The Department of Defense and the three services not only chose the 9 winners from the 14 original competitors, but also ranked them by the quality of their proposals and the level of effort it appeared they will make. Military officials will not discuss the ranking, but industry observers report that the order in the table reflects it.

Differences. Although IBM's Federal Systems division, Bethesda, Md., and TRW Defense and Space Systems, Redondo Beach, Calif., came out on top, the similarity ends there. IBM—like fourth-ranked winner Texas Instruments Inc.—is keeping its effort in house and its plans secret. TRW, on the other hand, is open about its team approach with Motorola Semiconductor, Sperry Univac, and GCA Mann. So are other leaders like Rockwell International and Hughes Aircraft.

TRW is committed to its own

VHSIC WINNERS AND LOSERS

	AIR FORCE								ARMY				NAVY						
	Multifunction radar signal processor*	Communications signal-processor chip set*	General-purpose computer	Autonomous cruise missile guidance	Power management	On-board signal processor	Medium-range air-to-air missile	Universal signal processor for AWACS surveillance	Battlefield information distribution system	Electronic warfare weapons targeting	Multimode fire-and-forget missile	Target acquisition and firing control	Acoustic signal processor*	Antijam communications modem*	Airborne/shipboard surveillance-radar signal processor	Tactical air-radar signal processor*	Signal sorter for electronic support measures	Imaging system digital processor	General-purpose computer
WINNERS (millions of dollars)																			
IBM (1.02)	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
TRW (1.36)	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Hughes (1.52)	•								•		•	•	•						
Texas Instruments (1.27)	•											•	•		•			•	
Rockwell (1.57)				•							•			•					
Westinghouse (1.21)	•		•		•			•		•		•	•		•		•		•
General Electric (0.51)	•									•		•			•				
Honeywell (0.81)						•					•	•	•						
Raytheon (1.02)					•						•				•				
LOSERS																			
Harris	•	•		•					•		•	•		•	•			•	•
Boeing				•	•			•			•						•		
Western Electric	•								•				•						
Singer		•							•					•					

*indicates programmable system

three-dimensional bipolar process, coupled with Motorola's complementary-MOS technology. Electron-beam lithography will be supplied by GCA. TRW program manager Barry Whalen says the group will concentrate on near-term high yields, ruling out epitaxial processing.

SOS. Rockwell's VHSIC team, comprising its Anaheim, Calif., Electronic Systems group, Sanders Associates, and Perkin-Elmer Corp., is committed to the C-MOS-on-sapphire process and to Rockwell's own high-order language. Down-scaling, critical to VHSIC's success, fits in neatly with Rockwell's computer-aided design system, which industry analysts rate as the most advanced of any contractor's.

Hughes Aircraft's Strategic System division, El Segundo, Calif., has yet to choose between bipolar and C-MOS technologies. It is also looking at the electron-beam-lithography approach with which the company's Malibu Research Laboratory has already demonstrated devices with 0.5-micrometer gate dimensions [*Electronics*, Feb. 28, p. 40], along with X-ray and ion-beam techniques. Hughes program manager Joseph Myers is coordinating a large team effort with Signetics, Burroughs, the Research Triangle Institute, Cornell University, and the University of Southern California.

Westinghouse Electric's George Shapiro, VHSIC manager at the Baltimore Defense and Electronic Systems Center, says his team's Phase 0 CAD approach will employ the Cybernet network initially developed by Control Data, National Semiconductor's process technology and lithography, and Carnegie Mellon's distributed architecture analysis and related studies.

General Electric Co.'s Melvin Beebe at the Utica, N. Y., Aircraft Equipment division, says his team will push on VHSIC's airborne surveillance radar effort, two of the four areas in which the company is slated to make proposals. Teamed with GE are Intersil, Analog Devices, Tektronix, and Stanford University.

Honeywell Inc.'s Aerospace and Defense Group in Minneapolis will look at bipolar technology, along with subcontractors 3M Corp. and Carnegie Mellon. VHSIC business manager Caroll L. Dage says there is a parallel internal effort.

John Decaire, VHSIC program manager for the Bedford, Mass., Missile Systems division of Raytheon Inc. says his team will capitalize on Raytheon's military expertise, Fairchild Semiconductor's solid-state expertise, and Extrion-Varian's lithography expertise. An immediate goal for the team is a usable microcell or similar flexible architecture, he says. **-Ray Connolly**

Solid state

Intermetall to make TI's 9900 family

A new set of international allies in the 16-bit microprocessor marketplace emerged last week with word that Intermetall GmbH plans to second-source the TMS 9900 family of Texas Instruments Inc. In exchange for masks and device specifications on 21 n-channel MOS circuits, the Freiburg, West Germany, company will provide TI with masks and information on 11 devices developed for consumer and specialized automotive applications.

As International Telephone & Telegraph Corp.'s semiconductor arm, Intermetall is known as a strong supplier to the European market and could give the 9900 added impetus there. The agreement may be an indication that ITT plans to use family parts in telecommunications.

Intermetall says it plans to promote a variety of 9900 applications, notably in the consumer, automotive, and data-processing fields, as well as telecommunications. TI officials say the circuits obtained from Intermetall will fill out its product lines and will initially be manufactured and marketed in Europe.

The agreement does not include the Dallas company's integrated-injection-logic versions of the 16-bit family. The Intermetall circuits are made with complementary-MOS, p-channel MOS, or bipolar technology,

New IBM-compatible computer bows

Were there any doubt that the IBM-compatible market still lives, Formation Inc. is doing its part to dispel it. The Mt. Laurel, N. J., company has just unveiled its Formation 4000, which is software-compatible with the IBM System/370 line.

The minicomputer-based 4000 features a novel bus-oriented architecture and has power comparable to that of the low-end IBM model 138, the company says. The 32-bit central processing unit, which is built around low-power Schottky 2900 bit-slice processors, operates with a cycle time of 200 nanoseconds, somewhat faster than the 275-ns cycle time IBM quotes for the 138.

The CPU is attached to a 32-bit-wide bus that operates at a data-transfer rate of 5 megabytes per second. Also attached to this bus are up to 4 megabytes of main memory—four times the amount available on the 138—that operates with a cycle time of 800 ns. Disk controllers, which can support up to eight 70-megabyte fixed-media Winchester-type disk drives, and other input/output controllers also hook to the bus.

An unusual feature of the bus is that it allows redundant units to be attached to improve system reliability. Like many of the latest mainframes, the 4000 includes a separate service processor to handle diagnostics.

Priced between $52,000 and $150,000, the new offering is said to be price-performance competitive with IBM-compatible units from firms like Control Data Corp, Two-Pi Co., and Magnuson Systems Corp. First deliveries are scheduled for August. The 10-year-old company, which says its revenues are now about $20 million, has specialized in designing custom data-processing systems, primarily ones compatible with the old RCA Sigma computer line. **-Anthony Durniak**

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The pact gives TI its first overseas second source for the three-year-old 9900 family. In the U. S., American Microsystems Inc. is an alternative source. Standard Microsystems Corp. holds a license to manufacture 8-bit data-bus versions of the 9900—the 9980 and 9981—but so far has not elected to build these parts.

Elsewhere. Market sources say the 9900 family is the leading-volume 16-bit machine shipped last year. It is richly endowed for interrupt-driven, real-time control applications, but its overall performance lags behind that of the emerging generation of 16-bit devices, which includes Intel's 8086, Motorola's MC68000, and Zilog's Z8000. Announced alternative sources include:

- For the 8086, Mostek and Siemens AG.
- For the 68000, Rockwell International, Hitachi, and EFCIS (jointly owned by Thomson-CSF and the French atomic energy agency).
- For the Z8000, Advanced Micro Devices, SGS-Ates, and Sharp.
- General Instrument Corp. is likely to sign up several second sources: for its metal-gate 1650, Plessey in England and a U.S. firm; and for its forthcoming silicon-gate 1670, another U.S. manufacturer.
- Also, TI Japan makes the 9900 family, and National Semiconductor's NS16000 is likely to be second-sourced by its French joint venture with St. Gobain Pont à Mousson.

Reports are circulating on TI's plans to introduce a second-generation 9900 fully compatible with existing software, perhaps by the end of the year. It would put the family on a par with or ahead of competitors' 16-bit specifications. TI officials admit the planned machine had a bearing on Intermetall's decision.

The TI-Intermetall deal involves a product exchange only. Thus it does not include any process technology swap or financial remuneration. Intermetall will receive a 9900 software license and will also have rights to market 9900 family development tools. -**Wesley R. Iversen**

C-MOS processors get more attention

The demand for low-power microprocessors has begun to accelerate, and almost all semiconductor manufacturers with complementary-MOS expertise are planning a C-MOS microprocessor. One of the most bullish is National Semiconductor Corp., which sees a major market developing.

"We expect the low-power segment to represent almost a third of the mid-range microprocessor business by 1985," declares George Chao, director of microprocessor marketing at the Santa Clara, Calif., company. However, the key is shrinking the parts to a manageable size, something Chao's firm is pulling out all stops to accomplish.

Plans. National introduced the C-MOS NSC800 microprocessor family last year [*Electronics*, Nov. 22, 1979, p. 111], roughly equivalent to Intel Corp.'s 8085 family in architecture but with the instruction set of Zilog Inc.'s Z80. Chao says that the company plans to follow with a single-chip microcomputer within the year and eventually to shrink its C-MOS process while moving to high-end 16-bit machines (see table).

The microcomputer will be an implementation of Intel's 8048 microcomputer in P²C-MOS—National's double-polysilicon C-MOS process. "The chip will become an industry-standard for low power, since Intersil has already announced it," says Chao.

Intersil Inc.'s introduction of the 87C48—the version with erasable programmable read-only memory on chip—came early last year [*Electronics*, May 10, 1979, p. 44), along with other parts (the 8048 and the 8041 peripheral control chip in Intel's 8-bit family) to be built in C-MOS. But the 87C48 has only begun to reach the sampling stage now, because of the large die sizes involved.

C-MOS, with significantly less density than n-channel MOS, has caused Intersil's first pass on the 87C48 to come out at about 90,000 mil²—twice the area of the n-channel version. National's first pass on its NSC800 central processing unit is itself a large chip—around 70,000 mil²; but the 5-micrometer design rules it uses will scale readily to 3.5 μm for better-yielding devices by next year, Chao says.

NATIONAL'S LOW-POWER MICROPROCESSOR PLANS		1979	1980	1981	1982	1983
Word size		8	8	8	8/16	8/16
Technology		C-MOS	P²C-MOS	P²C-MOS	P²C-MOS II	P²C-MOS II
Feature size (μm)		5–6	5–6	3.5–5	2.5–5	2–3.5
Instruction cycle time (μs)		2–5	1–1.5	0.6–1	0.4–0.6	0.4
Addressing range (bytes)		64 K	64 K	> 1 M	> 1 M	> 1 M
Memory size per typical application (bytes)	ROM	2 to 8 K	2 to 12 K	4 to 16 K	4 to 16 K	6 K or more
	RAM	128 bytes to 1 K	128 bytes to 2 K	256 bytes to 4 K	256 bytes to 8 K	256 bytes to 10 K

Too large C-MOS processor chips have delayed the production schedules of other manufacturers as well. For example, Mitel Corp. of Kanata, Ontario, Canada, has slipped its C-MOS version of Motorola's 6802 microprocessor [*Electronics*, Dec. 7, 1978, p. 41] by more than a year. Sample availability of the MD46802 is now scheduled for summer.

Others. RCA Corp., which had announced plans to bring out Intel's 8085 in C-MOS on sapphire substrates, will bring the 1804 single-chip version of its 1802 microprocessor to market first—promising mid-year availability—and will follow later with the 8085. Motorola is

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For this first shipment, please bill me —
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among the few with available small volumes of a C-MOS processor, its low-end single-chip 146805; plans for a higher-performance device have not been disclosed.

What is clear is that the process is nearly capable of n-MOS performance, though it lacks the density. Others sure to be in the race within the next two years will be American Microsystems Inc., which will likely enter with a 6800 family member in C-MOS, and Harris Corp., which makes the 12-bit 6100 microprocessor but has ambitious plans for the next two years: first will be an enhanced 6100 design this summer, followed by second-source products in the 8-bit single-chip and 16-bit arenas. —Raymond P. Capece

HMOS 8048 shrinks to stay in the game

Upping the ante in the crowded single-chip microcomputer game, Intel Corp. is announcing an HMOS version of its 8-bit 8048 with clock speeds as much as 5 megahertz higher than the older version's 6 MHz. The chip signals a new approach for the solid-state leader: although the 8048 has turned into a commodity part, the company plans to continue its presence in the market. In the past, it has allocated its resources to sole-source products, deemphasizing them as other firms duplicate the offering.

The HMOS process, with its 3-micrometer design rules, is being phased in at the company's new Phoenix microcontroller operation in place of the 5-μm n-channel MOS process. This switch undoubtedly will be applied to parts like the 8049, already at 11 MHz.

The upgraded 8048H uses an 8-MHz clock rate; the H-1 has 11 MHz. "They will reduce the instruction time from 2.5 microseconds [for the 8048] to 1.88 μs and 1.36 μs" for the H and H-1, respectively, says marketing manager George Adams.

The new versions [*Electronics*, Feb. 28, p. 33] are about 30% smaller—175 square mils versus 205 mil² and now undercutting the competition in size. "We start with about 40% more die per wafer," says Adams. Such an improvement translates into increased production capacity, also helping to lower the cost of the new microcomputers.

The 8048H will cost about $11 in thousands, "about the same as the existing 8048," Adams says. The H-1 is likely to cost 20% to 40% more when shipping of both starts in the third quarter. **-Bruce LeBoss**

Microwaves

Nonthermal effects found in low doses

Soon-to-be-published experiments on the nonthermal effects of low levels of microwave radiation are bound to heat up public interest in the subject.

High doses, of course, have distinct thermal effects, but many researchers have doubted whether low levels have any impact at all on living organisms. Experiments conducted behind the Iron Curtain have indicated their responsibility for certain nonthermal changes, but other Western efforts to duplicate those findings have so far failed.

Reports. Now U.S. researchers are readying papers that report such effects. Work at the John B. Pierce Foundation, New Haven, Conn., and at the University of Rochester in New York suggests that there is interference with the body mechanism regulating internal temperatures. The experimenters note that the results with laboratory animals are difficult to extrapolate to human beings, however.

At the Pierce Foundation, squirrel monkeys trained to regulate their cage temperatures lowered them after 10-minute exposures to 2.45-gigahertz continuous-wave radiation of an incident power density of 6 to 8 milliwatts per square centimeter. However, their body temperatures had not changed; that took a power density of 22 mW/cm².

The University of Rochester group reported similar results with rats. Moreover, in another Pierce experiment, 2.45-GHz cw radiation at 10 mW/cm² produced measurable dilation in the monkeys' tail veins, an effect also normally caused by a rising body temperature. Again, though, there was no change in the animals' deep body temperatures.

Although the U.S. standard for human exposure is 10 mW/cm², there is no consensus that this level is safe. In fact, European standards are an order of magnitude lower.

Navy. In work in the Naval Medical Research Institute in Bethesda, Md., researchers have determined that the stimulating effects of dexadrine amphetamine on rats increases greatly at dosages as low as 1 mW/cm². The work follows tests in which Librium at 2.45 GHz produced odd behavioral effects in the rats [*Electronics*, April 26, 1979, p. 46].

The Navy researchers are not prepared to speculate on possible changes in body regulatory mechanisms caused by the drug and radiation combination. But interest is growing in studying longer-term effects of low doses of microwave radiation—a program scheduled to begin at the University of Washington this summer will look at the behavior of rats that are exposed to microwave radiation over a period of years. **-Pamela Hamilton**

Production

Ion beam may be 3 process tools in 1

Focused ion beams, already printing chip patterns with dimensions as small as 0.1 micrometer in the laboratory, may also be used in ion implantation for the selective doping of semiconductors and for ion sputtering to machine openings in thin films, with the same ultrafine resolution. What's more, the same machines can perform any two of these three processing steps simultaneously in many cases.

Engineers at Hughes Aircraft Co.'s Malibu, Calif., research labo-

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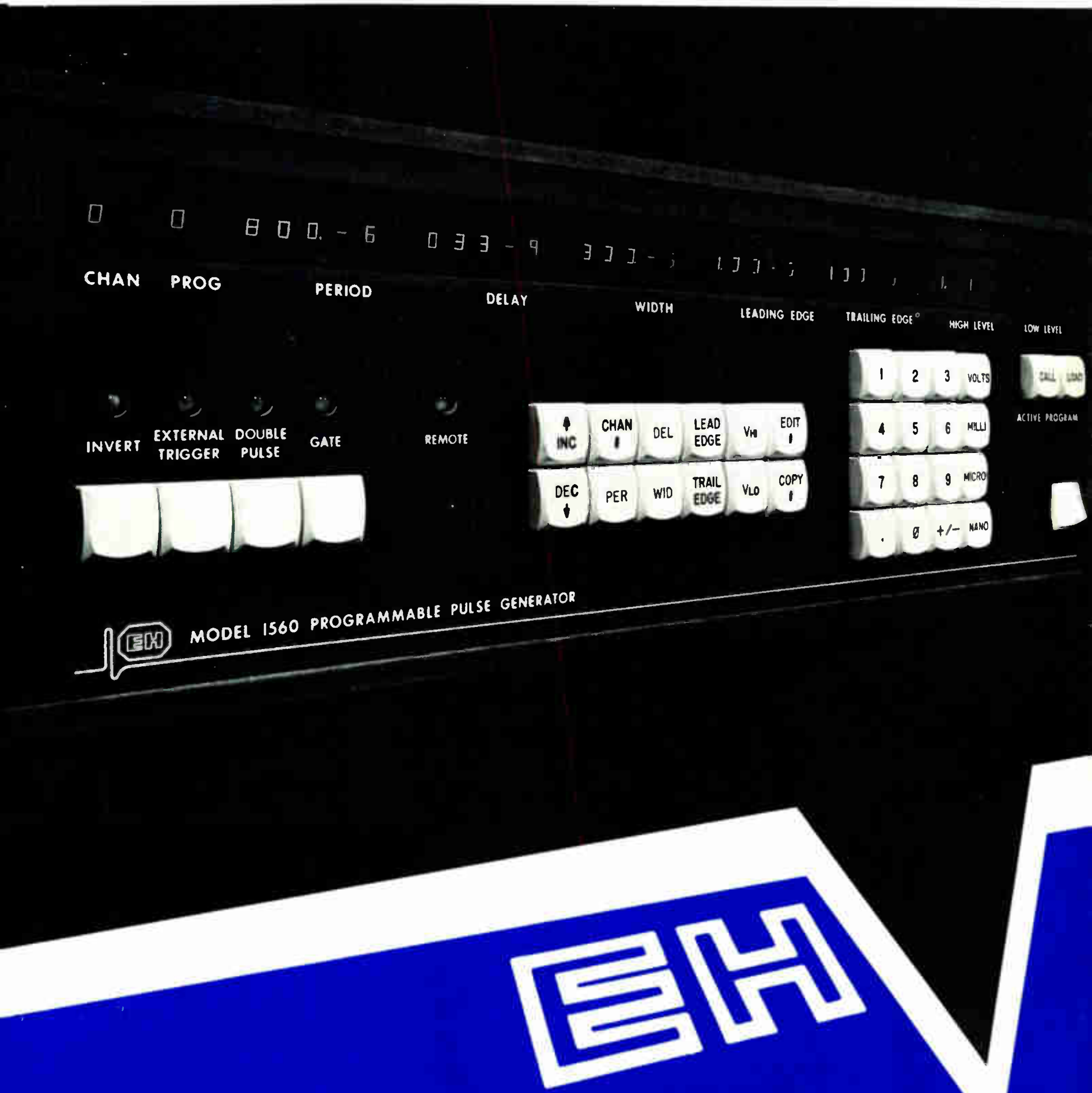

E-H International, Inc. • 7303 Edgewater Drive, Oakland, CA 94621 • PH: 415/638-5656 • TWX 910-366-7258 ratories have already performed the three processes individually. "The next step is to put them all together into a device with features below half a micrometer," says Robert L. Seliger, head of ion beam technology at the labs.

Program. The extremely fine resolutions and the equally extraordinary registration accuracies possible with ion beams are the chief impetus for the attention paid to the technique in semiconductor research labs around the world. The Hughes labs are investigating both direct-writing focused ion beams and a mask-based system, under contract with the Defense Advanced Research Projects Agency.

Much of the work has been in lithography (see p. 142), but Seliger and his co-workers are equally excited about both the separate applications of implantation and sputtering and the potential for pairing them. A beam can sputter the oxide layer to create the emitter opening, then dope the silicon substrate below with arsenic to make up the n^+ region, he notes. Also, it may be possible to pair resist exposure for lithography with implantation when both need the same ion dose.

Of ion implantation alone, Seliger says, "It is one of the truly unique properties of a focused ion beam, smoothly varying the doping profile in both depth and the X-Y axis." Thus there can be a gradual and precise change in dopant characteristics—not attainable with any other implantation technique—that makes possible sloping, or three-dimensional gate and device geometries.

Micromachining with a sputtering ion beam, the Hughes scientists already have done several basic microcircuit fabrication jobs. These include forming very fine line structures down to about 400 angstroms wide and cleaning up spots on masks in place of usual laser trimming.

Generally, the more precise control of the focused ion beam gives it an edge over direct-writing electron-beam lithography at the submicrometer levels where research microcircuit production is centering. It has, for instance, registration accuracy of

News briefs

Fairchild bests Data General in court

Setting a precedent for the emulation of one firm's computer architecture by another, a judge of the U. S. District Court for Northern California issued a summary judgment in favor of Fairchild Camera & Instrument Corp. in its antitrust suit against Data General Corp. The Mountain View, Calif., subsidiary of Schlumberger Ltd. alleged that Data General illegally tied the licensing of its software to the sale of its central processing units. Judge William H. Orrick found that the Westboro, Mass., company did just that and that this tie-in "affects a not insubstantial amount of commerce in the CPU market." A jury trial will decide whether Data General has sufficient economic power in the operating-systems market to restrain competition in the central processing unit market.

Data-base management goes solid-state

Incorporating software for data-base management into solid-state memory, Intel Corp.'s Commercial Systems division last week announced the FAST 3805 data-base assist processor. Offered as an option in Intel's FAST 3805 semiconductor disk, the new package is a result of Intel's acquisition early last year of MRI Systems Corp., the Austin, Texas, software company. By housing certain pointer functions in solid-state memory, the package can improve transaction throughput of the company's system 2000/80DBMS by up to 100%, compared with the systems that house the pointer functions on disk.

Bell to give Datran parent $50 million

American Telephone & Telegraph Co. agreed to pay $50 million to Wyly Corp., Dallas parent of the now defunct Data Transmission Co. (Datran) in final settlement of a 1976 antitrust suit. The settlement closes the books on the ambitious Datran effort, which had sought to establish a nationwide digital data-communications network beginning in the late 1960s. It ended with the company's collapse and subsequent $285 million suit against AT&T alleging unfair practices.

HP expands use of sapphire technology

Hewlett Packard Co., the only computer manufacturer now using silicon-on-sapphire semiconductors, has brought that technology to its HP 1000 line of 16-bit minicomputers. The new HP-1000 L-series is based on a 1,170-mil-square central processing unit, fabricated in complementary-MOS on sapphire, that can support up to 64 kilobytes of main memory. Another custom SOS chip functions as an input/output processor on separate I/O boards, and a third type of SOS chip is placed on each board to handle the HP-internal bus interface between the various boards in the system. The HP-1000 L series is priced starting at $2,250 for the board version, or $4,450 for the boxed version. The company says it will not outdate the older HP 1000 M-series, because that unit has additional features, primarily memory mapping that lets it address 2 megabytes. An L version of HP's Real Time Executive operating system was also introduced for the new series.

High technology export ban extended

The U. S. ban on high technology exports to the Soviet Union is being extended indefinitely by the Commerce Department although it still will not apply to East European nations of the Soviet Bloc. Nevertheless, officials say high-technology export-license proposals for Eastern Europe that show "substantial signs" of probable transshipment to Russia will be blocked. The ban [*Electronics*, Jan. 17, p. 55], invoked after the USSR's invasion of Afghanistan, will be widened to include turn-key manufacturing operations that could have military relevance, officials said. The vagueness of the Commerce Department's disclosure, like its January announcement, provoked criticism from international marketing executives of U. S. electronics firms.

No. 8

NATIONAL ANTHEM

SEMICONDUCTOR NEWS FROM THE PRACTICAL WIZARDS OF SILICON VALLEY

Shedding a new light on fiber optics.

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New 100μsec 8-bit A/Ds

A better approach to Custom MOS/LSI

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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)
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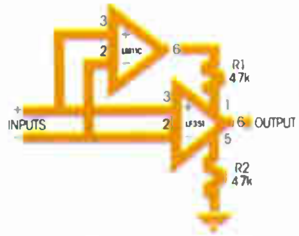
- 3μV/°C drift (max)



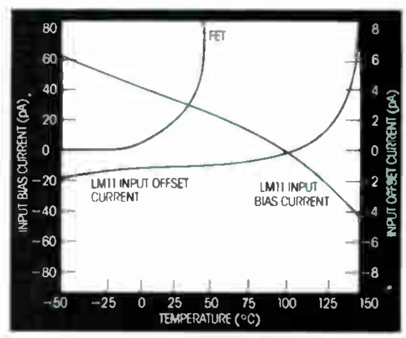
Here, the LM11 is used to stabilize the V_{OS} of a fast amp The combination is fast even hooked as a follower

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.

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.



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

LH0082 fiber optic receiver amp lightens the load.

National now in fiber optics with versatile high-speed interface.

National has good news for anyone designing commercial fiber optic applications. Their new LH0082 general purpose receiver amp eliminates the cost and hassle of building your own high-speed amplifier.

But there's more. The LH0082 not only expedites development, it also improves performance while allowing an unprecedented degree of design flexibility.

All you need, all in one. The self-contained LH0082 requires only a single 5V to 12V power supply. So it can act as the interface between all of the most popular photodetectors and any standard logic family or any analog circuit.

The LH0082 transimpedance amp also features a 2GHz gain bandwidth, excellent sensitivity (to 30nW), data rates up to 50Mbps, and high immunity to noise in a fiber optic environment. All hermetically sealed for reliability in a standard 14-pin DIP.

The possibilities are endless. National's new LH0082 lends itself perfectly to fiber optic communications both guided and broadcast. It can, for example, be used for computer interfaces with peripheral devices, word processing systems, remote graphic terminal data links, and point-of-sale data links.

The LH0082 is also ideal for industrial control devices, robotics, telecommunications on T1, T2, or T3 carriers, as well as airborne and shipboard multiplex communication and control systems.

And to top it off, all of this performance is now available at a surprisingly low cost.

When you come right down to it, it's no surprise that National would be the first to offer a truly versatile necessity to the fiber optic designers. After all, that's what Practical Wizardry is all about.

New family of 8-bit A/Ds.

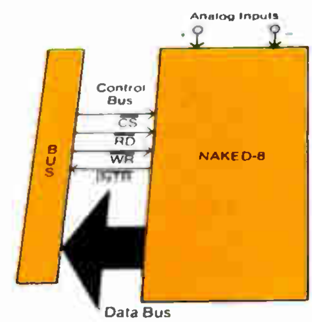
National's 8-bit A/Ds not only interface to any μP bus, they also feature absolute or ratiometric operation, and require just a single 5V supply at almost no current at all.

Of the 8-bit A/Ds on the market, only National offers single-channel differential analog input A/Ds in 20-pin DIPs – the ADC0801/2/3/4. In addition, their ADC0808/9 8-bit converters feature 8-channel analog input multiplexers, each in a 28-pin DIP. The top-of-the-line ADC0816/17 each contain a 16-channel analog input mux in 40-pin DIPs.

The new line of 100μsec A/D converters eliminates the need for external zero and full-scale adjustments and features an absolute accuracy as good as $\pm\frac{1}{4}$ LSB.

National, the leader in innovative, cost-effective data acquisition products, now has the best price/performance of any A/D available. In 100-piece lots, the ADC0804 costs only $2.95; and the ADC0809 a low $3.60; the ADC0817 costs just $7.95.

Practical Wizardry strikes again – all the way down the bottom line.



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Custom MOS LSI

"The key to the success of a high-technology product is the quality of its basic design.

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abbott transistor

MILITARY PRODUCTS DIVISION

Circle 49 on reader service card

0.001 μm, two or three times better than an electron beam.

At this fairly early stage, the Hughes focused ion beam machine should be considered "an excellent tool to study device work below 0.5 μm," says Seliger. Actual production would appear to be years in the future, he notes. **-Larry Waller**

Microsystems

Smaller units expand one-board computers

A new architectural idea from Intel Corp. will let users of single-board computers add specialized functions relatively inexpensively. The concept is realized in a new line of 10-square-inch specialized cards called Multimodules, which plug right into the base motherboard.

These smaller boards cost about $150 each, compared with the main board's $550-plus cost. They mate with a 36-pin connector that the Santa Clara, Calif., company is adding to the big boards (see photo).

As well as its own line of Multimodules, the company expects peripherals like analog-to-digital and d-a converters to come from other firms. Intel believes its new, smaller interface will become an industry standard, just as the Multibus did for the single-board computer.

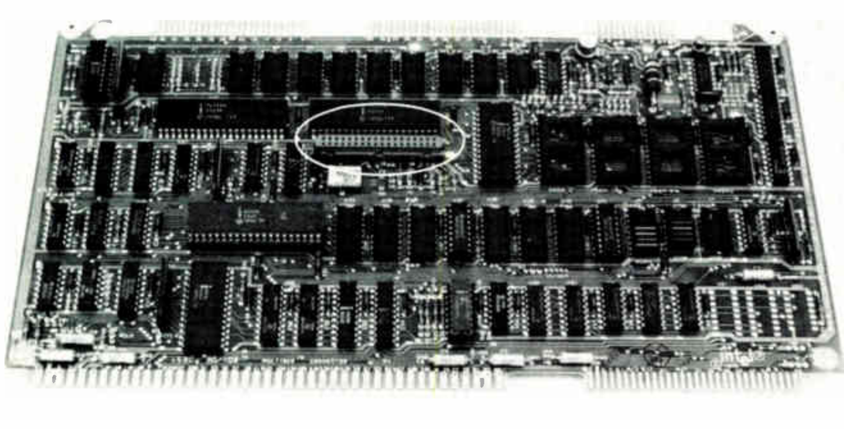
The typical one-board computer in the present iSBC line is packed with memory and input/output chips. Users needing slightly more capability have had to buy another expensive module, possibly stuffed with unneeded functions.

Upgrade. Hence the Multimodule, which is first being applied to the iSBC 80/10B main board, an upgrade of the 80/10A. It keeps the 8080 microprocessor and the on-board read-only and random-access memory expansion, but three of the smaller new boards give heightened I/O and processing power.

The three are the iSBX 350 and 351 for parallel and serial I/O, respectively, and the iSBX 332 for floating-point mathematics. A package of five of the specially designed 36-pin connectors, called the iSBC 960-5, is also being offered.

The bus between the main board and the Multimodules—the bus that runs through the connector—is called iSBX for single-board expansion. Besides power and clock lines, it incorporates three address lines, an 8-bit data bus, two chip-select signals, read and write lines, two interrupts, and a wait line.

There will be other main boards with the connector and more Multimodules, according to Gary Sawyer, marketing manager for the product line. He says that a 16-bit unit like the 86/12 will eventually be introduced with the connector. A main board could hold as many as three connectors. **-John G. Posa**



Plug-in. Intel is adding a 36-pin connector to its single-board computers to accommodate a bus for a new line of relatively inexpensive, specialized add-on boards.

Communications

Fax, teletypewriters talk to one another

A computerized store-and-forward packet-switching service from ITT's Domestic Transmission Systems Inc. lets users of dissimilar facsimile machines talk with each other. It also allows teletypewriters to interface with fax machines, something unavailable before now.

Faxpak emulates the modulation pattern of the fax machine through software in a front-end processor at one of the system's six central U. S. transmission facilities. The modulation technique, which is unique to each type of fax machine, is what determines the correct resolution and the different horizontal and vertical scanning rates. The front-end processor—comprising an Intel 8080 as the main processor and a Signetics 8X300 to run the emulation software—digitizes the analog signal from the fax machine and passes this data on to a Modcomp Mark 465 minicomputer for sorting and sending of the individual packets.

Not virtual. "We don't establish a virtual circuit like Telenet or Tymnet," notes Thomas F. Murawski, vice president and director of engineering for the ITT subsidiary. As a result, the information packets move quickly over open paths, rather than over the limited predetermined routes of a virtual circuit.

The fax machine, or other data terminal, interfaces with the front-end processor by an acoustical link using a Touch-Tone telephone. Each processor can handle 64 simultaneous calls, providing a computer-simulated voice response and identification that the user punches in on the phone key pad.

In use since December [*Electronics*, Nov. 8, 1979, p. 86], the Faxpak service will support transmission between word processors with telecommunications capabilities by the fourth quarter of this year. And by 1981, ITT will be servicing ASCII data terminals. **-Pamela Hamilton**

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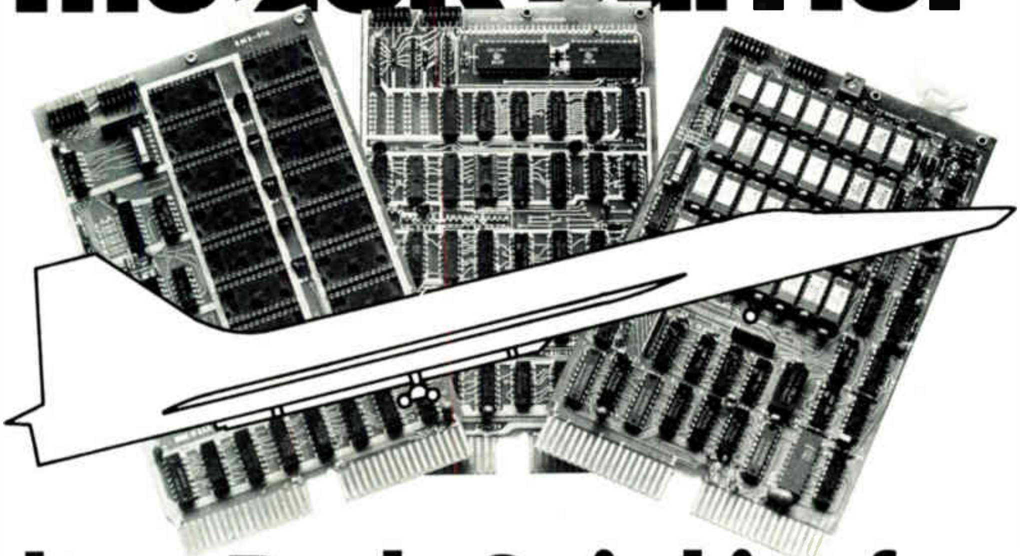

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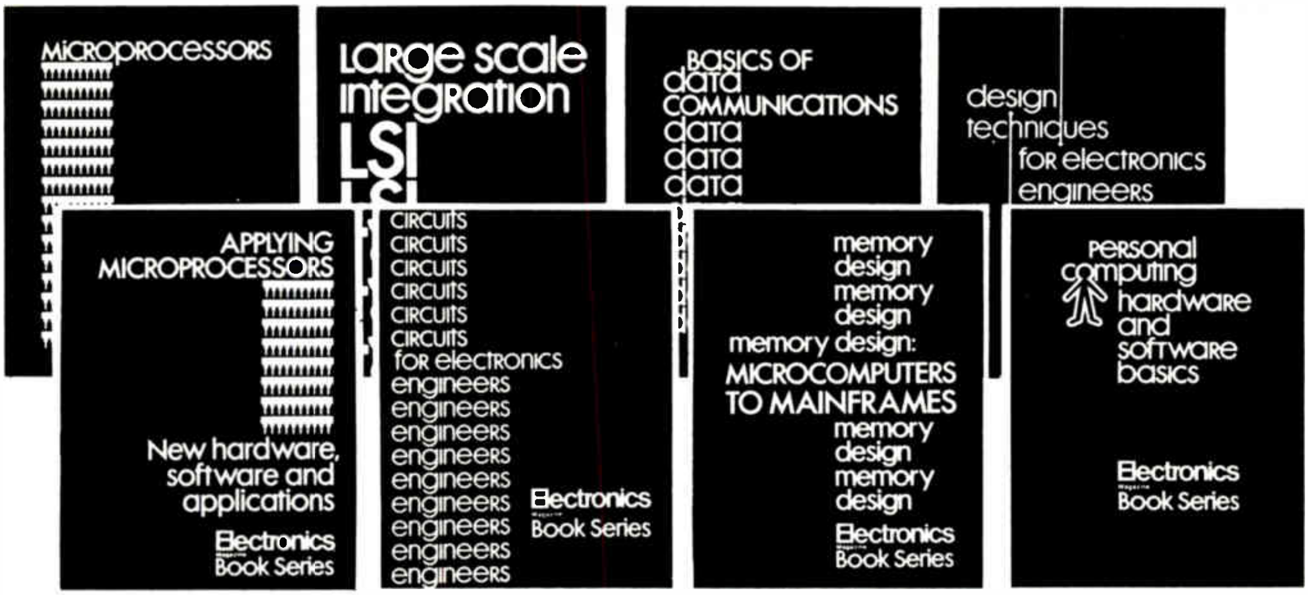

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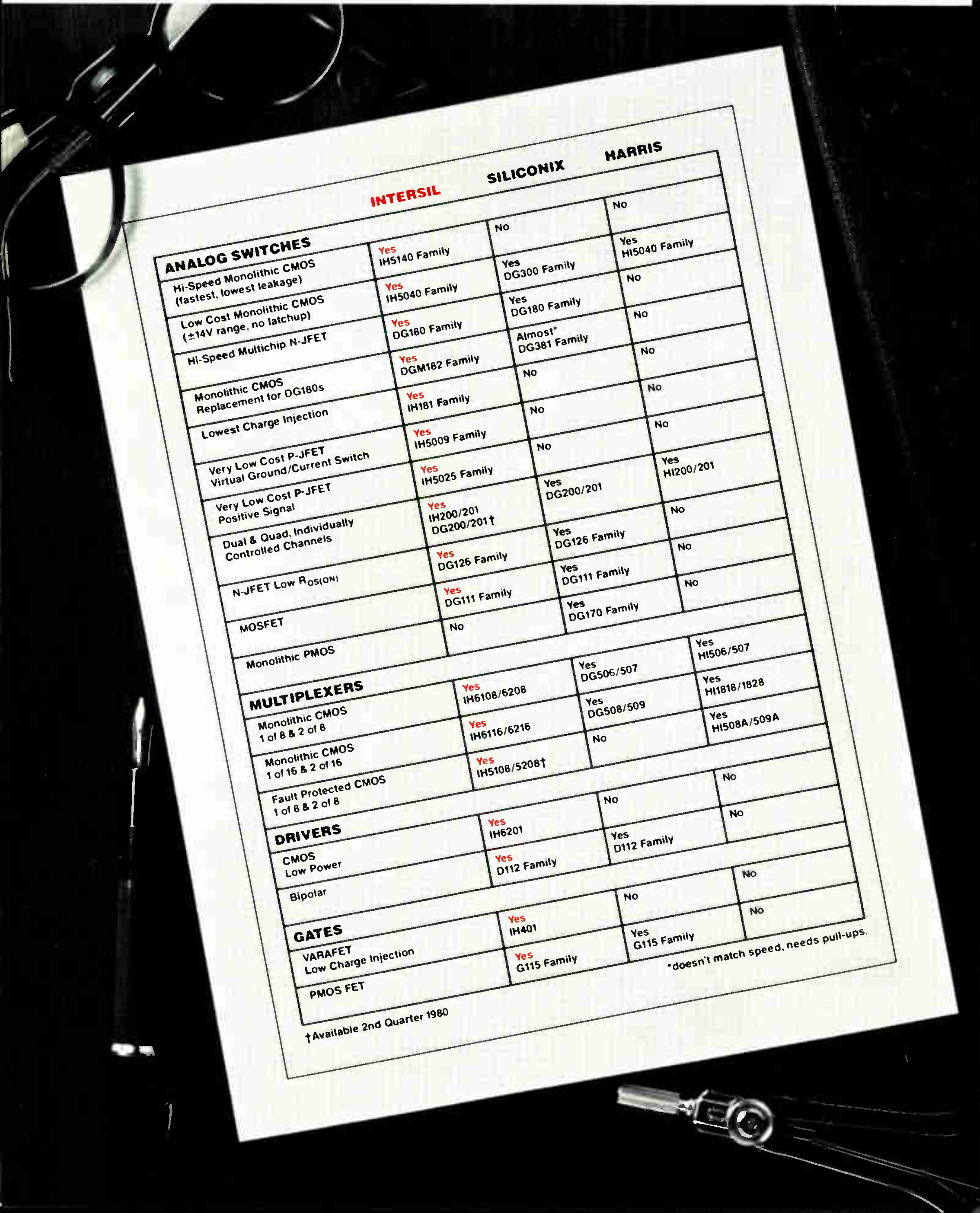

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Hi-Speed Monolithic CMOS (fastest, lowest leakage)	Yes IH5140 Family	No	No
Low Cost Monolithic CMOS (±14V range, no latchup)	Yes IH5040 Family	Yes DG300 Family	Yes HI5040 Family
Hi-Speed Multichip N-JFET	Yes DG180 Family	Yes DG180 Family	No
Monolithic 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
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Dual & Quad, Individually Controlled Channels	Yes IH200/201 DG200/201†	Yes DG200/201	Yes HI200/201
N-JFET Low $R_{OS(ON)}$	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 IH6108/6208	Yes DG506/507	Yes HI506/507
Monolithic CMOS 1 of 16 & 2 of 16	Yes IH6116/6216	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.

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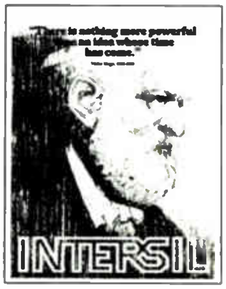

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Washington newsletter

VHSIC Phase 3 awards in April to exceed $10 million

At least $10 million in short-term technology-support contracts for the military's Very High Speed Integrated Circuits program will be on tap in April, according to the Defense Department's Larry W. Sumney, director of the triservice effort. **Upward of 50 contracts will be signed in the initial round of awards for VHSIC Phase 3**, which is budgeted for roughly one third of the six-year program's $210 million budget. Nine prime contractors for VHSIC Phase Zero definition studies were named in March (see p. 41). Successful device concepts, IC testing, silicon quality, and packaging will be phased into the program as it proceeds.

Supreme Court agrees to review software patent issue

The patentability of computer software will get another look by the Supreme Court during its fall term, when it will review two cases—one involving Honeywell Information Systems Inc. and the other the Federal-Mogul Corp. Although the court ruled two years ago that software and other mathematical formulas are not patentable, **that judgment set off a dispute between the U. S. Patent and Trademark Office, which refused the companies' applications, and the U. S. Court of Customs and Patent Appeals, which supported the patent applications' appeal.** The Supreme Court decided late this month to hear Government lawyers for the two agencies argue the issue once more.

Antitrust suit against MCI filed by Comnet of Texas

MCI Communications Corp., the Washington-based specialized common carrier now litigating its antitrust suit against American Telephone & Telegraph Co. in Chicago, has itself been charged by a small Texas company with trying to monopolize the specialized carrier market. Communications Network Systems, popularly known as Comnet, **has filed a suit in the Washington Federal District Court charging that MCI actions threaten to put it out of business as a reseller of MCI's long-distance business service known as Execunet.** Comnet says it puts together groups of users to qualify for MCI volume discounts and then contracts for and resells the service at a profit. Comnet charges that an MCI plan effective April 1 would limit the number of group users to 15, eliminating service for 75% of Comnet's 330 customers. MCI countercharges that Comnet is reselling Execunet illegally.

Washington subway evaluates fixes to fare system

Washington's Metro subway system will continue until May testing the Cubic Western Data Corp. improvements in its breakdown-prone automatic fare-collection system before deciding on system-wide implementation [*Electronics*, Nov. 9, 1978, p. 57]. The San Diego, Calif., contractor says its in-house investment of $5 million and two years of research have raised system availability to 99% and cut maintenance costs by more than 25%. **Dust and dirt produced most of the breakdowns, the company notes,** though it says these have been effectively eliminated. For example, Cubic replaced electric-eye sensors on entry and exit gates with electromagnetic units unaffected by dust and replaced the automatic fare-card vending machines' plunger-type solenoids—which break down when filled with dust—with clapper-type solenoids.

Washington commentary

Carter's imprudent and irresponsible economics

Prudent and responsible: that is how Jimmy Carter characterized the fiscal 1981 Federal budget when it went to Congress at the end of January. The proposed $616 billion spending level for the year beginning in October was 9% above this year's level, he said, and would produce a deficit of $16 billion—far less than the $40 billion deficit that the President forecast for fiscal 1980.

Imprudent and irresponsible seem to better describe the President's initial budget plan now that he has rushed to balance it in a desperate effort to control inflation and save his job in an election year. Though the White House is heralding the proposed $13.5 billion in cuts to bring the budget into closer balance, budget specialists almost never mention the other side of the coin—the offsetting $9.5 billion in upward revisions in spending figures—that would reduce the net spending level by no more than $4 billion. That is just six tenths of 1% less than the January figure. Inflation, meanwhile, has climbed in two months to an annual rate of nearly 20% from 13% in January.

No time for waiting

If their eyes have not yet glazed over from one more discussion of Washington's ongoing numbers game, then observers will be dismayed at Carter's cosmetic economic plan and surely ready to ask: can the nation's economy afford to wait until October before measures to control inflation begin to take effect?

The answer is no, according to an increasing number of House and Senate members, who see a tottering U. S. economy beginning to affect the stability of allied economies in West Germany and Japan. "We must contain this problem" of inflation within the U. S. "if Congress is to deal with it effectively," asserts one member of the Senate budget committee staff.

Nevertheless, the President has also yet to identify the specific program areas where his budget will be cut. Even so, Wisconsin Democrat William Proxmire, chairman of the Senate Banking Committee, castigates the summary Carter plan as "weaker than I had hoped for" and one that "fails to take definitive action." But, muses one Senate Republican staff member, "How would Proxmire respond if, say, the President proposed a cut that would eliminate support of programs for Wisconsin's dairy industry? That represents our biggest problem: everyone favors spending cuts, but no one wants his pet ox gored in the process, particularly in an election year."

The President's decision to withhold identification of specific budget cut recommendations until after completion of this month's presidential primaries is clearly political and is only compounding his credibility problems with Congress and those voter coalitions who would be damaged by such cuts. These are known to affect Federal aid programs for cities, states, education, health care, job training for minorities, and airport and highway construction.

Further frustration

The fires of frustration in those lobbies are also being stoked by the advocates of increased defense spending in the House and Senate, who want to add between $30 billion and $50 billion more in weapons procurement and research and development spending to Carter's $158.7 billion military budget [*Electronics*, Feb. 14, p. 95].

For the electronics industries, moreover, it is still uncertain whether House and Senate Republicans as well as some Democrats will succeed in their push for spending cuts that would leave enough of a budget surplus to allow for new tax credits. Such credits would stimulate corporate fund raising, help investment in research and development, and speed equipment depreciation. But they are still far down the road in view of the Administration's opposition to any such action until the budget is in fact in balance—this despite Carter's January promise that "if the economy begins to deteriorate significantly, I will consider tax deductions."

Is anyone in charge?

The reality, again, is that stronger economic measures are needed much sooner. Even though the House and Senate agree on that point in principle, their individual members are far apart on the specific steps to be taken. As for the President, his actions have yet to match his rhetoric. Back in January 1979, Carter called his fiscal 1980 budget "lean and austere." But spending is rising this year by 16% above his $532 billion forecast. This will push the Federal deficit well above $40 billion, some 38% higher than planned.

More distressing is that Jimmy Carter still does not seem to be able to cope effectively with the problem. "For me," says one Washington-based electronics executive privately, "dealing with the Carter Administration on economic issues produces the same feeling that the nation has after trying to deal with Iran and its leaders. You can never be sure who is in charge or what will come next." **-Ray Connolly**

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UDN-2844B	−1.5 A	−50 V	Source (4)	5 V to 12 V	PMOS, CMOS	
UDN-2845B	1.5 A/−1.5 A	−50 V	Sink (2) Source (2)	5 V	5 V Logic	bridge motor drives
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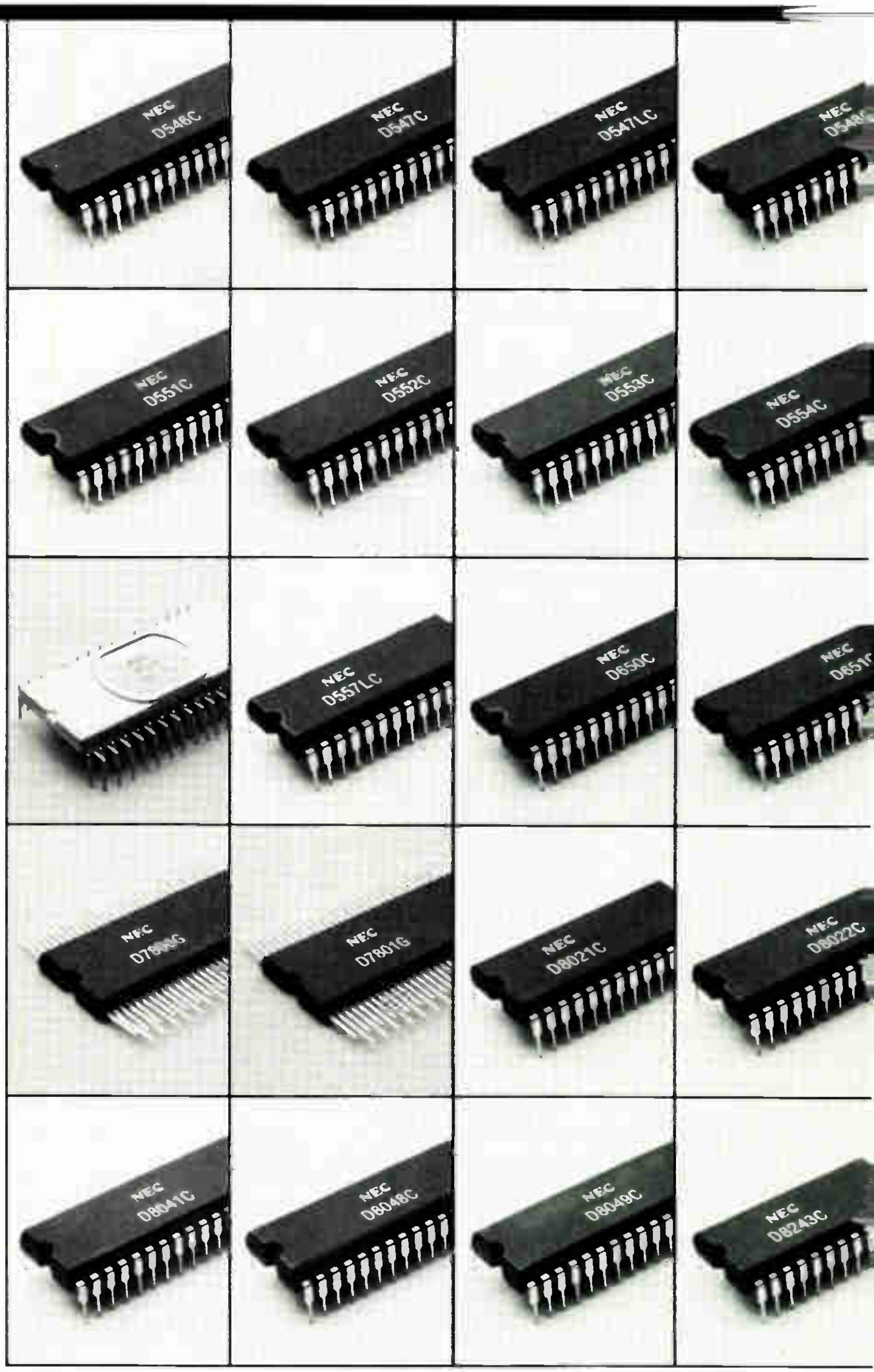
μPD548	1920 x 10	96 x 4	35	PMOS	−10	ECR/Scale Applications
μPD550	640 x 8	32 x 4	21	PMOS	−10	FIP Drive/TTL Comp Outputs
μPD550L	640 x 8	32 x 4	21	PMOS	−8	Low Power μPD550
μPD551	1000 x 8	64 x 4	27	PMOS	−10	On Chip A/D
μPD552	1000 x 8	64 x 4	35	PMOS	−10	FIP Drive
μPD553	2000 x 8	96 x 4	35	PMOS	−10	FIP Drive
μPD554	1000 x 8	32 x 4	21	PMOS	−10	FIP Drive/TTL Comp Outputs
μPD555	External	96 x 4	35	PMOS	−10	Development Chip
μPD556	External	96 x 4	35	PMOS	−10	Development Chip
μPD557L	2000 x 8	96 x 4	21	PMOS	−8	Low Power/ Small Pkg μPD546
μPD650	2000 x 8	96 x 4	35	CMOS	+5	Icc = 2 mA Max.
μPD651	1000 x 8	64 x 4	35	CMOS	+5	Icc = 2 mA Max.
μPD652	1000 x 8	32 x 4	21	CMOS	+5	Icc = 2 mA Max.
μPD7520	768 x 8	48 x 4	24	PMOS	−6 to −10	On-chip Display Cntrlr
μPD7800	External	128 x 8	48	NMOS	+5	Development Chip
μPD7801	4096 x 8	128 x 8	48	NMOS	+5	Addresses 64K Memory
μPD8021	1024 x 8	64 x 8	21	NMOS	+5	Zero Cross Detection
μPD8022	2048 x 8	64 x 8	28	NMOS	+5	On-chip A/D
μPD8035L	External	64 x 8	27	NMOS	+5	8048 Compatible
μPD8039L	External	128 x 8	27	NMOS	+5	8049 Compatible
μPD8041/A	1024 x 8	64 x 8	18	NMOS	+5	Peripheral Cntrlr
μPD8048	1024 x 8	64 x 8	27	NMOS	+5	Industry Standard
μPD8049	2048 x 8	128 x 8	27	NMOS	+5	11 MHz Clock
μPD8243			16	NMOS	+5	4, 4-Bit I/O Ports
μPD8741A	1024 x 8	64 x 8	27	NMOS	+5	UV EPROM Version of 8041A
μPD8748	1024 x 8	64 x 8	18	NMOS	+5	UV EPROM Version of 8048



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VLSI Co-op Labs unveils final electron-beam system

The prototype of a system that can process 1-Mb memory chips on 4-in. wafers has been developed by Japan's VLSI Cooperative Laboratories, which ends its four-year life on March 31. **A vector-scanning electron-beam unit is designed to directly expose wafers with about 50 chips, each having 1-Mb memory capacity.** The throughput is about 4 wafers an hour, and a dry-etching system with six chambers processes 40 wafers an hour. In addition, an advanced software system corrects off line for proximity effects, deflection distortion, and wafer warping; it also performs pattern processing. A laser scanning system operating at speeds of up to 10 MHz measures electrical signal levels on chips without making physical contact. Finally, a prototype pattern generator produces various signal sequences needed for memory testing at rates of up to 300 MHz.

Plessey teams with General Instrument for push in TV market

Plessey Semiconductors Ltd., Swindon, and General Instrument Microelectronics Ltd., Glenrothes, Scotland, **have joined forces to launch a highly integrated frequency-synthesizing television tuner** at the International Electronic Components show in Paris, March 27–April 2. Such tuners have been winning out over varactor tuners in top-of-the-line models because of their crystal-controlled frequency stability and the fact that they can be adjusted without a transmission signal. Plessey brings to the partnership the fast bipolar technology needed for the front-end prescaler and a sister n-MOS synthesizer chip. General Instrument is providing its microprocessor and electrically erasable programmable read-only memory capability. In the resulting five-chip set, Plessey's synthesizer is controlled by GIM's PIC 1650 single-chip microcomputer, with selected stations stored in a 1,400-bit EE-PROM; the fifth chip is a peripheral control circuit. Under the deal, each firm may make the PIC 1650 and the synthesizer, but will market the chip set independently, Plessey as part of its Key range and GIM as its Economega IV.

LED puts out red, green, and in between

A four-layer light-emitting diode developed by Sanyo Electric Co. of Osaka emits red, green, or any color light in between. **The diode consists of n, p, p, and n layers of gallium phosphide on a n-type gallium phosphide substrate.** The two top layers constitute the green diode, and the two lower layers the red diode. Conduction of forward current simultaneously through both diodes produces intermediate colors. For example, 3 mA through the red diode and 5 mA through the green produce orange light with an effective peak at 590 nm. In all cases, the light output is 4 mcd.

East Germans unveil new LSI generation

Indicative of East Germany's efforts in microelectronics development is the country's second-generation large-scale integrated MOS microcomputer system, announced at the March 9–16 Leipzig Fair. The U 880 D system, which follows the first generation, shown three years ago [*Electronics*, March 31, 1977, p. 53 or 55], uses n-channel silicon-gate technology and consists of an 8-bit central processing unit, a counter-timer circuit, and parallel and serial input/output devices. **It operates from a single 5-V supply** and can be supplemented with an 8-K read-only memory and a 2-K erasable programmable ROM. Incorporating a 64-byte store, the CPU can execute 158 commands. Like its forerunner, the new family is a product of VEB Funkwerk Erfurt.

International newsletter

West German color TVs to be made in China

Telefunken GmbH, the entertainment equipment arm of West Germany's AEG-Telefunken, is **about to become the first European firm to engage in color TV activities in the People's Republic of China.** Following the recent visit by a Peking delegation to its north German television plants, the Hanover-based company has agreed to send engineers and to supply manufacturing technology to China within a few weeks to help that country get ready for the production of Telefunken-designed PAL color sets. The firm says that further details of the deal will be specified in an agreement of cooperation to be signed this June.

Philips eyes market for office of future

In a move that is likely to be repeated in other European countries, Philips Industries Ltd. is integrating four of its British operating units into a single $220 million group—Philips Business Systems—aimed at the electronic office of the future. The new group will initially supply equipment now marketed by Pye TMC Ltd., Philips Data Systems, Pye Business Communications Ltd., and Philips Business Equipment Ltd. But **the long-term aim is to develop integrated office systems exploiting the group's telecommunications expertise.** Underlining Philips' move, Mackintosh Publications Ltd. in Luton, Beds., has simultaneously produced a new report, "Electronic Office Equipment Markets—European Trends to 1983," that **predicts the European market will grow threefold from 1980 to reach $5.9 billion by 1983,** an average annual growth rate of 28%. Over the same period, office computers will triple in sales to $3.2 billion, and word processors will double to $0.84 billion, it says.

French interactive graphics terminal gets good start

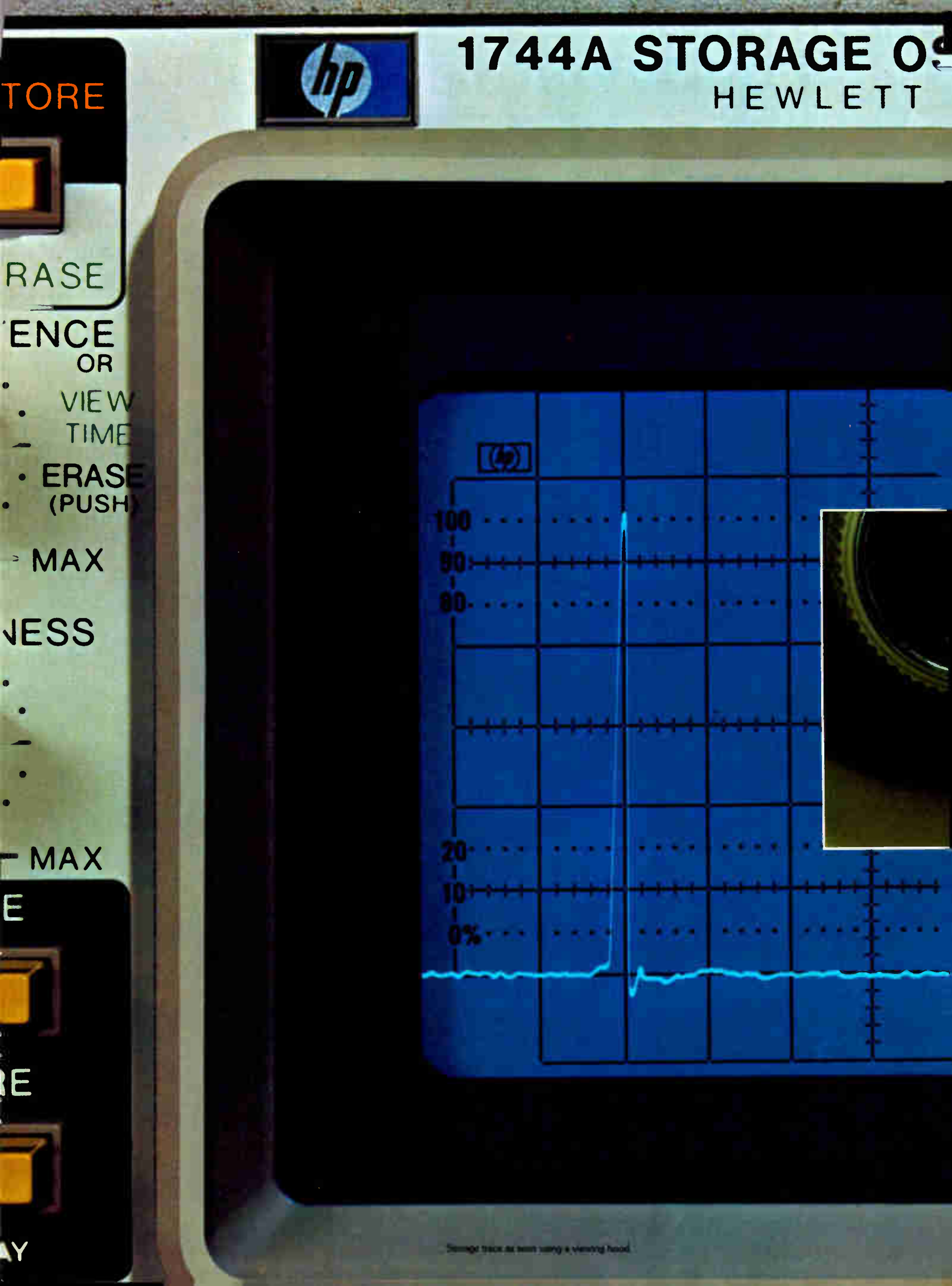
Paris-based CSEE (Compagnie de Signaux et d'Entreprises Electriques) already has a year's worth of orders for its new interactive graphic terminals, thanks in part to the Carter Administration's ban on the export of high-technology goods to the Soviet Union. **The 6080 series, to be unveiled at the April 16–24 Hanover trade fair, uses vector scanning and a rapid-phosphor tube** made by Kratos Inc.'s Instruments division, Pasadena, Calif. Though the tube itself displays 1,024 by 1,024 points, the internal electronics are based on a 4,096-by-4,096 grid. Prices start at $27,000 with 8 kilobytes of memory.

ITT Semiconductors readies 4-K static

Aiming to cash in on the famine for 4-K static parts, ITT Semiconductors Ltd. in Footscray, Kent, plans to deliver first samples of its 2147 4-K-by-1-bit fast random-access memory by the second quarter of 1980, with first production quantities to be shipped by the fourth quarter. Access times for the chips are 55, 60, or 90 ns. Meanwhile, **masks have been completed for its 64-K dynamic RAM,** and the first wafers, for internal use, should be processed within two months; first samples are due in a year.

Addenda

After months of discussions, Thomson-CSF has decided not to use the flat-screen thin-film transistor technology developed by T. P. Brody of PanelVision, Pittsburgh [*Electronics*, March 13, p. 134]. . . . East Germany has joined the growing league of countries getting involved in optical transmissions. Its communications industry has **demonstrated a glass-fiber system designed for a transmission rate of 8.448 Mb/s,** allowing it to handle 120 pulse-code-modulated voice channels.



Storage trace as seen using a viewing hood.

For a 100 MHz storage scope that can capture its bandwidth and display glitches this sharply...

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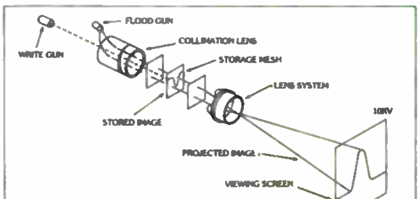
The key to this storage scope's superior performance is HP's advanced CRT design. It's called Expansion Storage. And this faster-writing technique lets you capture single-shot and low-rep-rate events over a larger display area with greater clarity.



EXPANSION STORAGE CRT

Take a good, hard look. Any input signal within bandwidth specification will be displayed cleanly by the 1744A, even at the maximum writing speed of 1800 cm/μsec when using a viewing hood. That provides the sharpness you need for detailed evaluation of hard-to-catch waveforms. Our Auto Erase/ provides hands-off operation while Auto Store prepares the scope to snare the troublemaker the instant it occurs. Both are powerful tools for capturing the spurious spikes that disrupt your logic circuitry.

Catch that glitch. Expansion Storage technology combines a small storage mesh (about the size of a postage stamp) and an expansion lens system. This exclusive arrangement permits a writing speed of 1800 cm/μs and a fine spot size, which lets the 1744A write faster and further than any other 100 MHz storage scope. That gives you full-scan glitch capture capability over a broad range of sweep speeds and repetition rates.

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Rounding out the 1744A's capabilities are these convenient measurement features: **Easy-IC Probes** to improve closely spaced probe connections and eliminate shorting hazards; a selectable input impedance (1 megohm/50 ohm) for general purpose probing or 50 ohm matching; and measurement sensitivity as low as 1 mv/div to 30 MHz on both channels without cascading. Priced at $5250*, the 1744A furnishes the state-of-the-art technology and performance needed today in digital design and trouble-shooting applications.

For complete details, or for information on the 100 MHz HP 1741A, a lower-cost, high quality scope for applications where an extremely fast writing speed isn't required, write to Hewlett-Packard, 1507 Page Mill Road, Palo Alto, CA 94304. Or call the HP regional office nearest you: East (201) 265-5000, West (213) 970-7500, Midwest (312) 255-9800, South (404) 944-1500, Canada (416) 678-9430.

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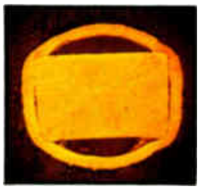
Your design flexibilty is virtually unlimited when you utilize Elfab's modular, press-fit systems. And, with press-fit technology, it's easy to stay within reasonable production budgets while you get the superb reliability demanded by today's applications.

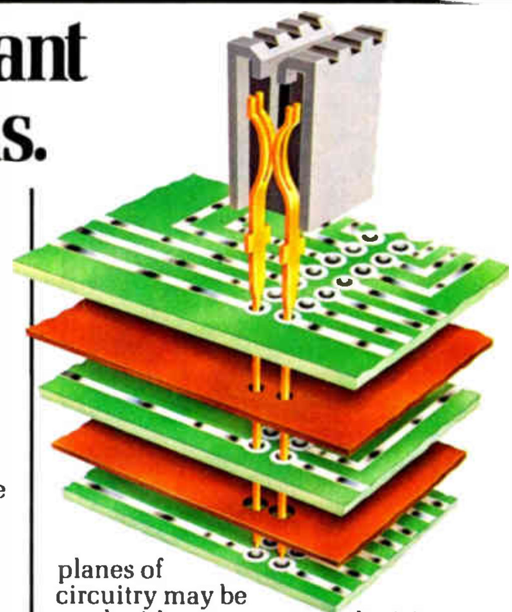
Key to the excellent reliability of the press-fit system is the gas tight joint formed as the contact pin, with a rectangular interface section or "bullet," is pressed through a plated-thru hole in the PC Board. The diagonal of the bullet is slightly larger than the diameter of the plated-thru hole, so that the hard phosphor bronze pin deforms the softer copper, forcing the copper plating to conform totally to the pin. Four complete lines of contact asperities run the full depth of the hole. The reliability of the Elfab press-fit is proven. With more than 500,000,000 contacts now in service—and that number growing at a rate of more than 1,500,000 every day—not a single interface failure has ever been reported.



Basically, an Elfab modular system is composed of the PC board, contact pin, and insulator connector housing. You have the flexibility to interconnect to as many voltage, ground and signal planes as you need. Standard options are available in sufficient numbers to cover almost any application. But if your design calls for a special configuration, almost any adaptation can be made—and with all the reliability and economy for which Elfab press-fit systems are noted.

Let's start the design of your system with the printed circuit board. A basic system would start with a single-board, card-edge backpanel. Two layers of etched circuitry may take the place of part or all external wiring. Plated-thru holes accept the contact pins, making the board a structural part of the connector. Since no soldering of contacts is required, this system can effect savings of 5-10% over conventional soldering methods.

To achieve maximum circuit density, just stack additional boards together; all held fast by the press-fit contacts. Up to eight

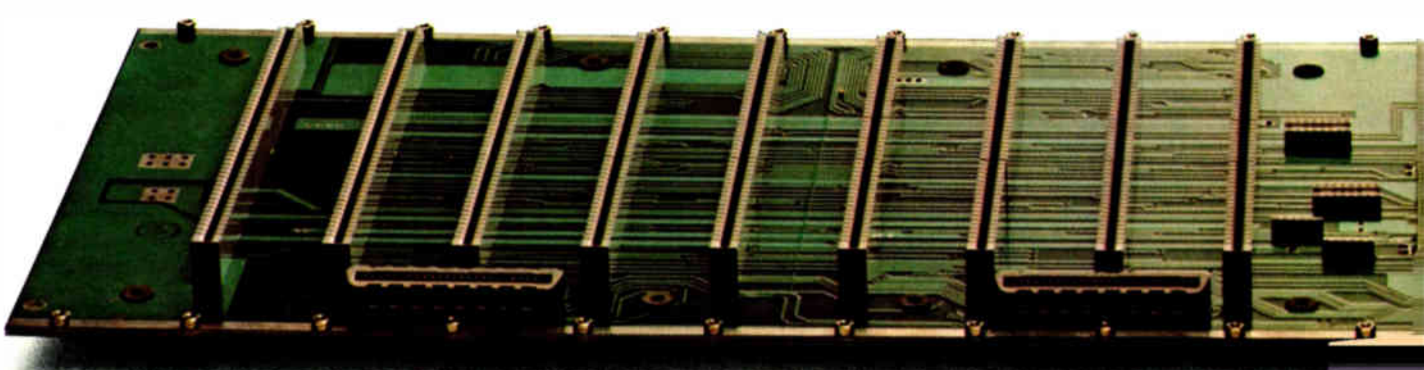


planes of circuitry may be used without any external wiring. This method is much more economical and much more flexible than the traditional laminated boards or metal plate and discrete connector assemblies.

Need extra high current capacity or positive voltage control? Make a hybrid out of the stack with pure copper insulated planes. This is excellent for today's high speed logic circuits. Select your own input/output specifications.

If electro-magnetic sensitive components are utilized, low-carbon steel sheets may be used between circuit layers for EMI, RFI shielding.

In short, whatever your circuitry



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Electron-beam system permits inspection of fine-line masks

by Charles Cohen, Tokyo bureau manager

Scanning electron microscope from VLSI Co-op Labs, Hitachi measures up to 10,000 details an hour as fine as 0.5 μm

The same inherent limitation of optical methods that makes them unusable for printing fine-line patterns—wavelength—renders them unfit to check the masks made for such circuits. Instead, electron-beam systems will be needed.

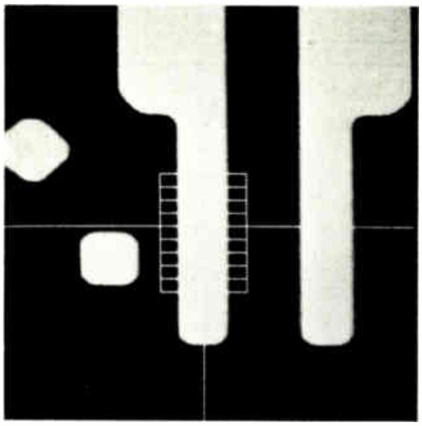
A prototype system using a scanning electron microscope has been developed by Japan's VLSI Cooperative Laboratories and built by Hitachi Ltd. [*Electronics*, Feb. 20, p. 63]. It may become the first such commercial product after further refinement.

Glass masks. Already on sale in limited quantity are glass masks designed to prevent charge-up when scanned with an electron beam; they were developed by film manufacturer Konishiroku Photo Industry Co. as part of this project. These masks are desirable even when electron-beam inspection will not be used because they do not attract dust, nor can high-potential discharges occur that are thought to damage masks. The 100-angstrom-thick conductive coating on the glass causes only a 17% loss of light at a wavelength of 2,000 Å and 6% loss at 3,500 Å.

The system can automatically make up to 10,000 precise measurements an hour on a 4-inch mask; somewhat more time may be required for the same number of measurements on a 5-in. mask, the maximum size handled by the system. A mask can call for up to 25,000 measurements. Line widths down to 0.5 micrometer can be measured with a repeatability of ± 0.03 μm ($3\ \sigma$), and the position of a pattern can be measured to ± 0.2 μm ($3\ \sigma$).

The prototype is designed so that the beam can be directed to any point in a 1,640-by-1,640-μm area with 16-bit, or 0.02-μm, resolution. Actually, 6 bits of information are used for positioning the beam and only 10 bits for scanning, giving a maximum scan width of 25 μm. Positioning exceeding the range obtainable by deflection of the beam is achieved by motion of the work table. The table can be moved 150 millimeters in the X direction and 110 mm in the Y direction. Laser measurement of the table position is accurate to within 0.008 μm.

The system is controlled by a 16-bit Hitachi Hitac-20 minicomputer with 64 kilowords of main memory and a 4.9-megaword disk. A 6800 microprocessor, also from Hitachi, controls the system console. The electron-beam column features a lanthanum hexaboride emitter and has a maximum accelerating voltage of 20,000 volts.



On view. VLSI Co-op Labs and Hitachi's scanning electron miscroscope shows lines as narrow as 0.5 μm. Shown is mask section as seen at the operator's console.

West Germany

Siemens readies integrated SLIC

Siemens AG is looking to be in the front line of the SLIC parade. These subscriber-loop interface circuits are one of the hot new items of telephony on which many semiconductor manufacturers are working. They handle most of the tasks required to interface existing analog subscriber loops with the pulse-code-modulated switches increasingly being used in central and private automatic branch exchanges.

A subject of discussion at the March 24–28 Eurocon '80 conference in Stuttgart, West Germany, Siemen's integrated circuit is now in the final phases of development. It takes care of off-hook detection, dial-pulse indication, ring-signal injection, ac and dc feeding and terminating, ground-fault detection, off-hook detection during ringing, and loop-back control.

Borsht. Stated differently, SLICs go a long way to implementing what communications engineers call the Borsht—battery, overvoltage, ringing, signaling, hybrid, and testing—functions. Normally, most of these functions are handled with discrete devices like relays, resistance networks, and transformers.

According to Peter Picard, who

More SLICs in the works

TRT (Télécommunications Radioélectriques et Téléphoniques), a Paris-based subsidiary of NV Philips Gloeilampenfabrieken in the Netherlands, is working with the Semiconductor division of Harris Corp., Melbourne, Fla., on what they hope will be one of the first fully integrated subscriber-loop interface circuits. TRT says it has already produced a thick-film prototype, and Harris says it will use its dielectric isolation technique to convert TRT's design into a single integrated circuit.

Though TRT says it is not yet ready to reveal details of its design, technical director Gilbert Ferrieu is sure that it will fulfill all Borsht functions, including battery-polarity inversion, loop detection during ringing, and overvoltage protection. Harris's dielectric isolation technique, in which a 100-angstrom-thick silicon dioxide wall isolates various circuit elements, permits precise reproduction of circuits breadboarded with discrete components, he says.

Development of the fully integrated SLIC should take 15 to 18 months. Testing of the first production models is slated for the end of next year, says Philippe Klejtman, sales manager for Harris Semiconductor, France.

Texas Instruments Inc. is also working on an integrated SLIC, but is opting for its Bidfet technology, which puts bipolar, double-diffused MOS, and complementary-MOS devices on the same chip [*Electronics*, July 6, 1978, p. 40], according to Frank F. E.-Owen, the company's European telecommunications strategy manager based in Nice. "Because of the low yields we have experienced with TCP 4420 cross-point switches, I don't believe dielectric isolation will work with SLICs, which are considerably more complex," he remarks.

Although the TI development group is based in Dallas, about half its engineers are Europeans. "There will be three or four versions of the SLIC for the European market," Owen says, but TI will not reveal any more details of its plans.

-Kenneth Dreyfack

heads the SLIC development effort at Siemens' Munich-based components group, the four prime requirements for such a device are: operation over a supply voltage range of −42 to −58 volts, a power dissipation of no more than 2 watts, the ability to withstand overvoltage pulses up to 1 kilovolt (as may be caused by lightning), and common-mode suppression of better than 60 decibels, which necessitates that resistance values be accurate to within 0.1%. These requirements, imposed by European communication authorities, must be met if subscriber loops are to be compatible with existing central switches or PABXs.

Built with bipolar high-voltage junction-isolated technology, Siemens' device satisfies all these requirements except one, the 1-kV overvoltage protection. Handling that function is an external network consisting of two resistors and a four-diode bridge. The supply voltage requirement is met by designing the device for a collector-to-emitter voltage of better than 60 V.

The worst-case power dissipation is 1.5 W, a result of the device's being designed as a relatively large chip—28 square millimeters (43,400 square mils). The requirement for resistance accuracy to within 0.1% is met by employing nickel-chromium thin-film resistors having a low temperature coefficient instead of the high-temperature-coefficient types commonly used in bipolar technology. The resistors are laser-trimmed on chip such that the required accuracy is obtained.

Circuitry. In the circuit, two current sources (designated A tip and A ring) feed the subscriber loop in the off-hook state with a constant current of 23 milliamperes, the current required by the handset's carbon microphone. Controlling the two current sources is the ac signal in the receiving path.

Two other current sources (B tip and B ring) serve to reverse the feeding polarity. The device has on-chip ring-signal injection requiring less than 1 V. Controlled by the ring signals, the four current sources produce an alternating current in the subscriber loop with a peak-to-peak voltage of nearly twice the supply voltage. The off-hook-during-ringing detector recognizes the off-hook status by determining whether the B current sources are in the active or the saturated mode.

The test function is implemented by applying a TTL-level test signal to the device. This signal, which also implements loop-back control, activates switches and routes the feed current in the circuit such that an off-hook condition is detected. Ac feeding and terminating of the subscriber line are attained by a feedback design, and the off-hook indication is achieved by measuring the dc loop current.

The device—preliminarily designated G 150—has excellent linearity. It comes in a 24-pin ceramic package. First samples will be ready toward the end of this year, Picard says.

-John Gosch

France

Software project aims to speed LSI design

A stroll through the ordered rows of long, low corridors at CII-Honeywell Bull's research center helps explain how researchers at the Paris-based computer company came up with the basic structure for its automated large-scale integration project, Statos (Système de Tracé Automatique pour la Technologie MOS). The software project is designed to drastically reduce integrated-circuit design delays by fully automating the placement of standard-sized circuit elements on chips 1 by 1 centimeter.

"Our goal is to reduce the entire development process, up to the actual prototype stage, to one month," explains François Maison, director of the center, in the Paris suburb of Louveciennes.

Low yields. "Yield is not a terribly significant economic factor as far as we are concerned because we never need more than several thousand, or at most, several tens of thousands, of

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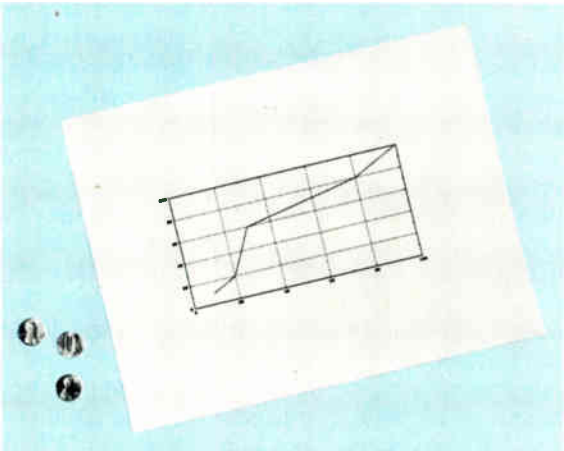

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any particular circuit," Maison says. Therefore, despite the probability of very low yield, the company has opted for chips with a pitch of 200 micrometers and 30 pads along each of their four sides.

Another reason for the standard-pitch decision is that Statos will be used to redesign a substantial number of TTL printed-circuit boards, which generally have 120 connection pins. Maison says the goal is to place 10,000 n-channel gates, with 1.5-μm channel lengths, on each plasma-etched MOS chip.

The automated design system is based on a library of several dozen circuit elements in three categories. The basic element, termed a "microcell," is a simple circuit like a flip-flop or a multiplexer. Standard combinations of such microcells are connected to form what are called "macrocells." Maison cites the example of eight flip-flops in parallel, forming a byte-wide register.

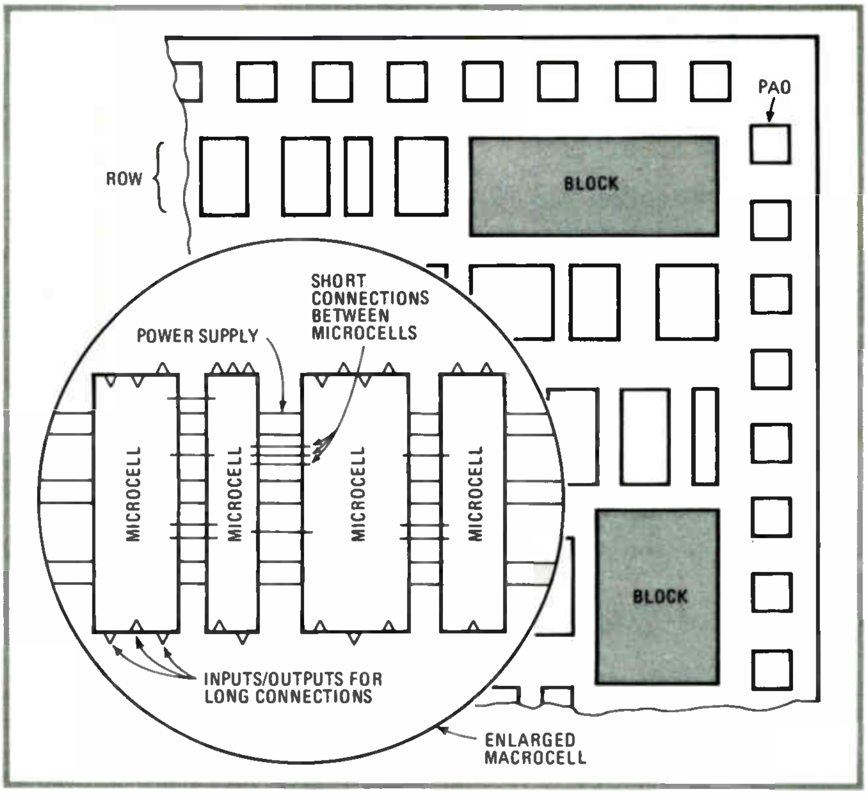
The two types of cell will have either one or several standard heights (the question is still open) so that they can be placed side by side in rows. The width will not be standardized, so as to accommodate more or less complex circuit elements (see diagram).

The third type of element is a complex component, such as a microprocessor, called a "block." Blocks have no standard size and so are positioned without regard to the row organization that determines the placement of simpler elements.

Connections. CII-HB is developing a set of algorithms to determine optimum circuit layouts within the basic structure. Algorithms likewise determine connections between circuit elements, the most critical factor in the design process.

"Longer connections decrease performance," Maison notes, "and that is our biggest problem." The chips have three connecting layers, one of polysilicon and two of aluminum.

He goes on to explain that connections between microcells in the same row are generally horizontal. Connections between microcells in different rows or between microcells and blocks are, in general, essentially vertical—that is, perpendicular to the axis of the rows.



Blocked out. CII-HB's automated LSI design project relies on a library comprising three types of circuit elements to cut design and prototype development down to one month.

Because polysilicon tends to show strong parasitic capacitance, as well as relatively high resistance, the polysilicon layer will be used for the short horizontal connections as much as possible. CII-HB decided on a three-layer circuit design instead of the more common two-layer scheme for MOS chips in order to make connections more flexible.

The automated system will design circuits that are about 1.4 times less dense than their engineer-designed counterparts would be. But the vacant real estate turns out to be an advantage for Statos. In conventional LSI circuits, somewhere between 50% and 70% of the chip surface is actually active. If there is a flaw somewhere in the silicon, chances are therefore good that the circuit will be defective.

Well-spaced. However, since Statos makes less efficient use of space, the nonactive area is greater. Thus chances are that silicon flaws will not affect the circuit.

To attain its goal of a one-month design and development period, CII-HB is also building its own semiconductor lab [*Electronics*, Jan. 31, p. 56]. Maison estimates that it will take two weeks to design a circuit and then test the design by simulation. Once the design has been tested and, if necessary, corrected, the company will use an electron-beam device to fabricate reticles, for use in a stepper in a low-temperature, plasma-etching MOS production process. Maison says the first test circuits using Statos should be ready by the end of this year. **-Kenneth Dreyfack**

Great Britain

CCD devices aid feedforward AGC

Charge-coupled-device technology has been harnessed to good effect by researchers at Bath University's department of electrical engineering to implement a very fast-acting auto-

Let's Talk!

To: D. Richards, Microprocessor Project Manager

From: B. Jones, Design Engineering

Subject: A nifty new buck-saving, space-saving solution from OKI - a Realtime MPU Clock/Calendar on a single chip!

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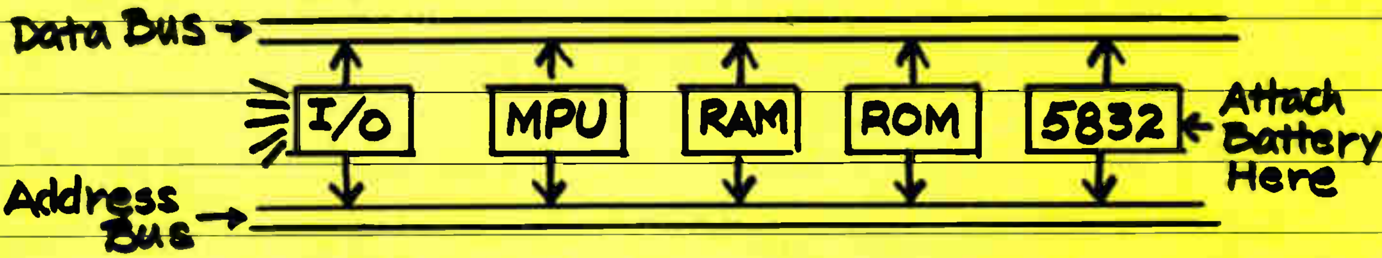

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B Jones

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Around the world

West German firms call for help against Asian entertainment gear

Worried about the ever wider inroads Far Eastern entertainment equipment producers are making into West Germany's consumer markets, the country's Central Association for the Electrotechnical Industry has appealed to the government to take countermeasures. The association is backing its plea by pointing out that the entertainment electronics sector's "competitive stance, jobs, and economic future are seriously threatened and [it] is faced with problems it can hardly master on its own." To help support the sector's four main pillars—color TV, high-fidelity audio, video recording, and car radio equipment—the Frankfurt-based group is clamoring for an orderly marketing strategy on the part of the Japanese, specifically for a temporay cutback on exports to Western Europe. The government is also called upon to stop granting favorable import duty rates to countries like Singapore and South Korea, as they can no longer be considered developing countries in certain industrial sectors.

Microprocessors to control European Airbus flight surfaces

A British and a West German company are collaborating to supply the leading-edge slat and trailing-edge flap controls for the new European A310 Airbus. The Flight Controls division of Marconi Avionics Ltd. of Rochester, England, will provide the microprocessor-based high-integrity electronics, and Liebherr-Aero-Technik GmbH of Lindenberg, West Germany, will supply the slat and flap control systems. To ensure fail-safe operation, the new system uses a dual microprocessor configuration, with one processor controlling the slats and flaps and the other—of a different type—monitoring their operation. The system guards against pilot errors by checking that the flight surfaces are not retracted or extended prematurely. The microprocessors will also monitor themselves. Each aircraft will have two electronic units to control the operation of electrohydraulic motors, which work together to operate the flaps and slat surfaces.

matic-gain-control circuit. It is being used to counter fast fades in a spectrum-conserving single-sideband mobile-radio system being developed at the university, but it could find applications in any a-m system.

The technique, called feedforward AGC, will be discussed at this week's Eurocon '80 in Stuttgart and at the Institution of Electrical Engineers' International Conference on Radio Spectrum Conservation Techniques to be held July 7–9 in London.

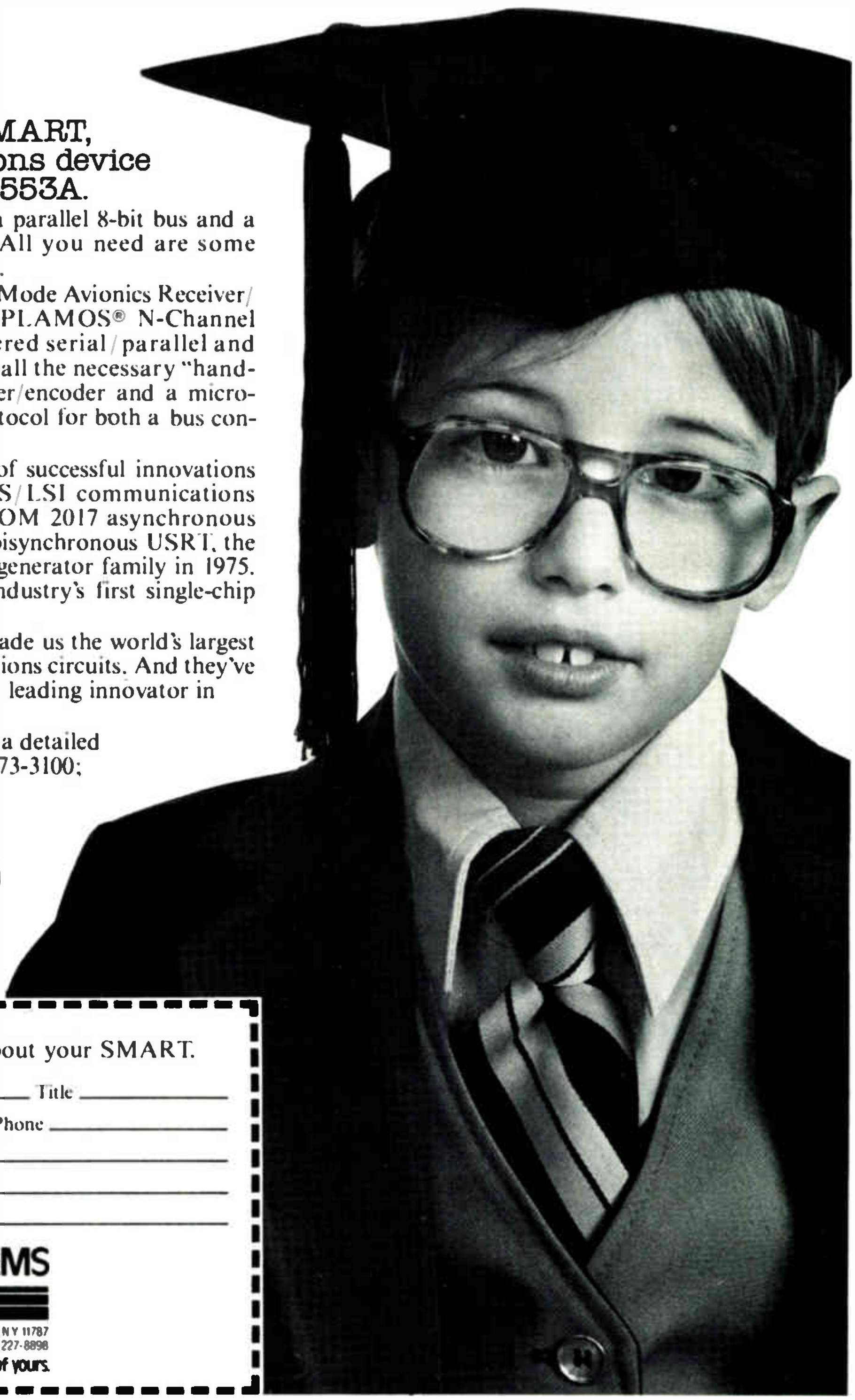
It derives fade information from a constant-amplitude audio tone—or the carrier—injected at the transmitter and extracted at the receiver. When this signal is divided into a suitably delayed version of the incoming signal, deep fades of up to 30 decibels occurring at rates of up to 100 hertz can be reduced to less than 1 dB, according to Joseph P. McGeehan, who heads the program. In contrast, conventional feedback AGC can only cope with fade rates of up to 2 Hz.

Fast fading of the sort caused by reflections from buildings and by terrain changes has been the bugbear of all a-m systems. To a mobile radio, the effect is like moving through a choppy electromagnetic sea. The effect gets worse the higher the frequency and the greater the car's speed. At 70 miles per hour and a transmitter frequency of 450 megahertz, signal strength can fluctuate 100 times per second.

This problem contributed to the eclipse of a-m systems by 25-kilohertz channel-spacing fm systems in mobile applications. But researchers, particularly at Bath Univerity and Philips Research Laboratories, Redhill, Surrey, have been looking anew at a-m systems—with just a single 5.5-kHz sideband—as a means of doubling and even quadrupling spectrum utilization.

This time, advances in solid-state technology have come to the rescue. Using a CCD transversal filter from Reticon Corp., the Bath University

To meet MIL-STD-1553A you're going to need some "SMARTs"



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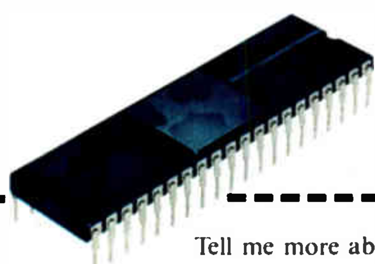

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researchers were able to resurrect a dormant suggestion for feedforward gain control and have proved it in the laboratory and in field trials.

Pilot tone. In the Bath University approach, a small portion of the audio signal is notched out and replaced by a low-level reference tone at 1.67 kHz before transmission. The tone is extracted by a bandpass filter in the receiver and used by the feedback automatic-gain- and frequency-control circuitry.

The incoming audio signal is split into two paths. In the lower path, the reference tone is extracted from the audio signal, and its envelope is then detected by a precision rectifier and filtered to obtain the fading information.

To compensate for the delay in this control path, an equal time delay is added to the upper signal path. If all frequency components in the upper and lower paths suffer the same processing delay, the unwanted fading component can be eliminated by feeding the output signals of the two paths into the appropriate inputs of a simple analog divider.

"If." Though simple in concept, the catch comes in the word "if," as, says McGeehan, "the effects of small amplitude and phase errors are severe" and cannot be contained using conventional analog components. Reticon's R5602 64-point CCD transversal filter provides the solution. Since it works as a sampling and switching system, the phase versus frequency characteristic is linear to within 0.1°.

The R5602, however, has a low sampling rate. To take out the resulting aliasing components, the group uses broadband switched-capacitor filters, also from Reticon, at the input and output. A custom CCD transversal filter with a higher sampling rate would eliminate this problem, and McGeehan is talking to one British manufacturer about such a device.

For the upper signal path, the group uses a CCD delay line and clocks both CCD devices from a single 4-MHz master oscillator to avoid differential time delays between the two. **-Kevin Smith**


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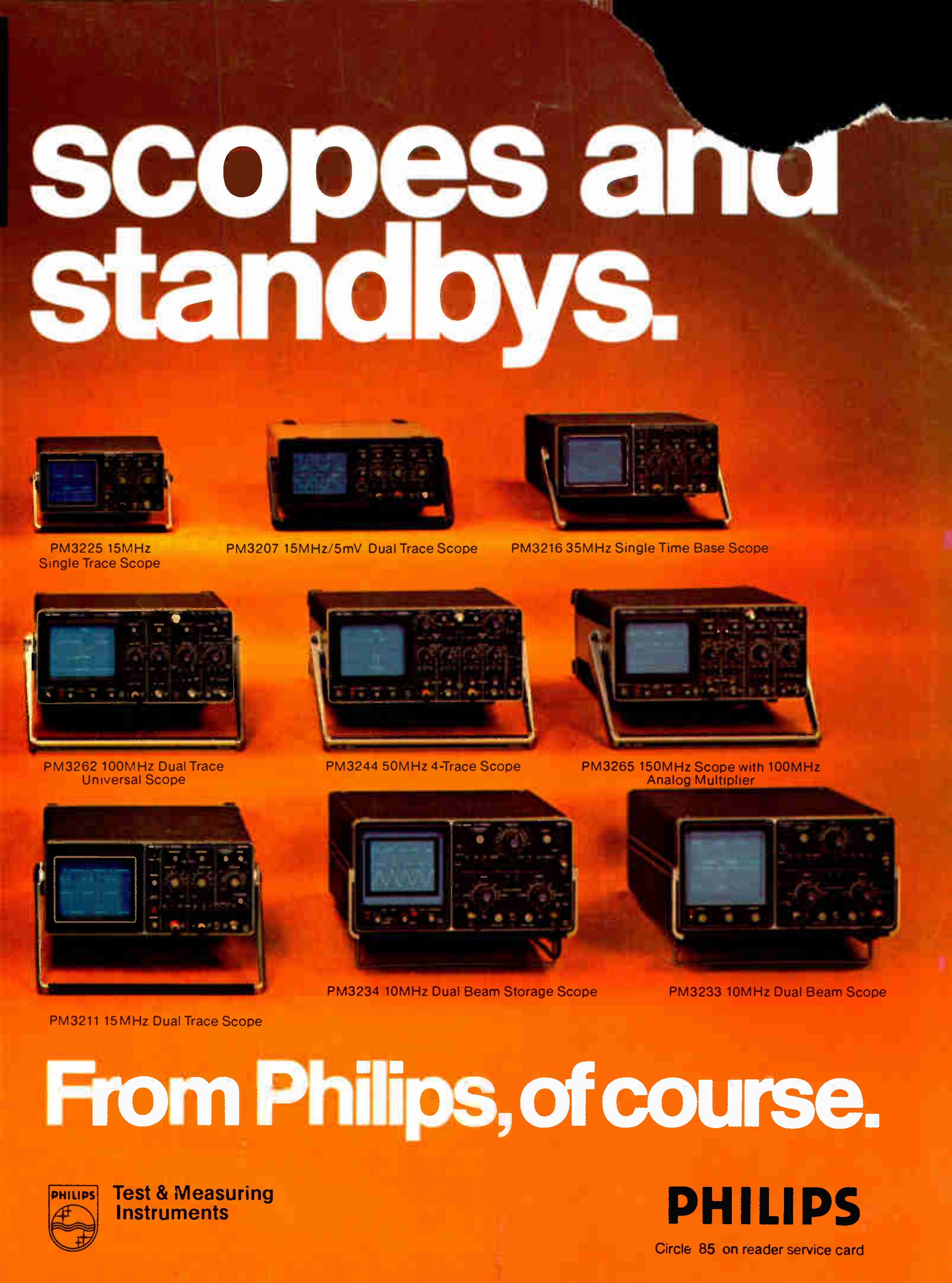
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Annual display meeting broadens view

Office automation, electronic mail, and computer graphics are among highlights of sessions at SID seminar/symposium

by Roger Allan, Components Editor

The technical program for this year's Society for Information Display International Seminar/Symposium points up the impact of information processing on display technologies. Besides the usual papers on the leading research and development efforts in display technologies, there are several other interrelated sessions. These include data-base management, image processing, graphics, and hard-copy printing. All together, some 85 technical presentations, as well as 10 half-day tutorial seminars, are on the program. Three evening panel sessions round out the meeting, which takes place from April 28 to May 1 at the San Diego, Calif., Town and Country Hotel.

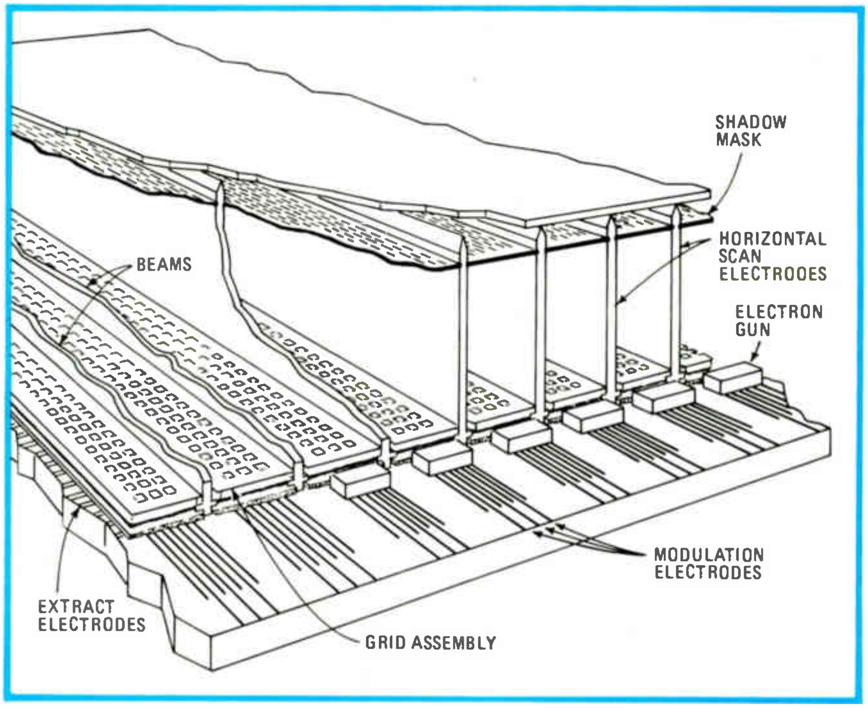
The subject of information management figures heavily at this meeting, particularly as the dawn of the all-electronic automated office approaches (see p. 102). In addition, many of the technical papers emphasize the component level of equipment design, a level that is fast taking on larger perspectives as components themselves evolve into subsystems and systems.

"We can no longer afford to look at the office of the future on just the systems level," echoes I. F. Chang, SID technical program chairman and a member of the research staff at IBM Corp.'s Thomas J. Watson Research Center, Yorktown Heights, N. Y. "The component designer must have as much say," he adds. "Now that we have all this distributed intelligence and the necessary communications lines in place, the question arises as to which component technology will be used. The designer's challenge will be to tie all these technologies together."

Judging from the breadth and depth of the technical papers presented at the meeting, that challenge will be made easier, since every conceivable display technology is discussed. They are all there, from flat-panel to projection to avionic displays. Technologies represented include ac and dc plasma, liquid-crystal, and ac and dc electroluminescent, vacuum fluorescent, electrochromic, eletrophoretic, cathodoluminescent, and cathode-ray-tube displays.

Despite the fact that many of these technologies are looking to compete with it and have registered important advances at that [*Electronics*, March 13, p. 127], the venerable CRT is still the display king, as evidenced by the large number of technical papers on its behalf. No less than 17 papers deal with the CRT and associated circuitry, with a 7-paper session on the physics of CRT drive and display techniques and a 7-paper session on CRT display trends.

Nevertheless, many non-CRT technologies are making notable gains, many of which are coming from overseas, giving the symposium a truly international outlook. In fact, more than one third of all technical presentations are from overseas, with Japan showing a very strong representation. Other countries represented include France, England, the



Flat-panel TV. Cathodoluminescence is the promising concept behind this 30-by-40-inch panel, less than 4 in. thick. Guides selectively deflect its electron beams to screen.

Netherlands, Belgium, Finland, Sweden, West Germany, the Soviet Union, India, and Taiwan. The Soviet paper, presented by a member of the Soviet ministry for the electronics industry, is on the subject of electron optics for penetration CRTs.

Flat panels. Nearly all of the non-CRT technology discussions are on flat-panel displays, again with Japanese researchers accounting for a large number. A paper from the NHK Technical Research Laboratories, Tokyo, reviews flat-panel developments in Japan and shows why that country may well outrace others in perfecting a host of flat-panel display technologies.

One of the more interesting Japanese developments in that technology is a random-access vacuum fluorescent display from Ise Electronics Corp. in Ise, which has a resolution of 26 by 258 0.4-millimeter-square dots within a 16.55-by-167.35-mm viewing area. Japan is already nearing practical applications of electrochromic displays, at present considered too exotic for practical use. A paper from the Daini Seikosha Co., Tokyo, will discuss how some of electrochromic displays' noted drawbacks—slow color response and short lifetimes—have been improved with novel processing methods. Daini intends to use the new electrochromic displays in consumer watches.

Although Japanese researchers have shown a lot of tenacity in sticking with display technologies that were once written off by others and seeing them through—an example is the ac thin-film electroluminescent display technology that the Sharp Corp., Osaka, is credited with making viable—U. S. and other researchers are not sitting still. From General Electric Co.'s Research and Development Center, Schenectady, N. Y., researchers report on some exciting liquid-crystal–display developments including a 2-by-5-inch LCD matrix controlled by varistors. Three of the five papers in the session on electroluminescent displays are from researchers from the Rockwell International Corp.'s Electronics Research Center, Thousand Oaks, Calif., where large efforts to perfect ac thin-film electroluminescent technology are under way. Another paper on this technology comes from Sigmatron-Nova, Chatsworth, Calif., and the University of Southern California in Los Angeles, in a co-written presentation.

From overseas, liquid-crystal–display matrixes for television and color graphics are explored by LETI (Laboratoire d'Electronique et de Technologie de l'Informatique), part of the French atomic energy agency in Grenoble [*Electronics*, Nov. 8, 1979, p. 67]. Researchers from Phosphor Products Co., Dorset, England, discuss a dot-matrix dc electroluminescent display panel [*Electronics*, July 1, 1977, p. 36]. And AEG-Telefunken, Ulm, West Germany, will unveil details of a pulsed dc plasma panel with multiple-color capability.

A promising new display concept for flat-panel TV will be unveiled by researchers from RCA Laboratories, Princeton, N. J. Two papers will be presented on a cathodoluminescent flat-panel display that uses new display structures (see illustration). Intended for consumer TV applications, the panel has a 30-by-40-in. display area, is less than 4 in. thick, has 100 foot-lamberts of peak brightness, has video and color uniformity comparable to that of conventional color CRTs, and dissipates less than 500 watts. Electron beams within the panel are selectively deflected to the panel's phosphor screen by mechanical guides. Two types of guided-electron-beam cathodoluminescent panels will be described at the meeting. □

Highlights of the sessions

Here are highlights of the SID technical program:

Session 4, Invited Addresses. Two talks on advanced system planning for the U.S. Postal Service and consumer information display systems.

Session 5, Flat-Panel Displays. A review of Japanese flat-panel developments, cathodoluminescent panels, and liquid-crystal panels from Japan and France.

Session 6, Avionic Displays. Hardware, software, and optics developments for military aircraft.

Session 7, Physics of CRTs. Focusing, deflection, and cathode temperature-control developments for cathode-ray tubes.

Session 8, Electroluminescent Devices. Ac thin-film electroluminescent and vacuum fluorescent panel developments.

Session 9, Ac Plasma Displays. Repair, memory, drive electronics, and characteristics of ac plasma panels.

Session 10, Image Processing. The processing of video and graphics for display terminals, printer-display units, and digital light tables.

Session 11, Electroluminescent Display Materials. Material details for ac and dc thin-film electroluminescent displays.

Session 12, Passive Displays. Electrochromic display developments in the U. S., Japan, and England; also magnetic-particle and dye-foil digital displays.

Session 13, Display Graphics. Graphics generators, image processors, and software discussions.

Session 14, Dc Plasma Display Technology. Systems and materials for dc plasma panel displays.

Session 15, Data-Base Systems. Mass-storage optical-disk, interactive video, and Chinese-terminal developments.

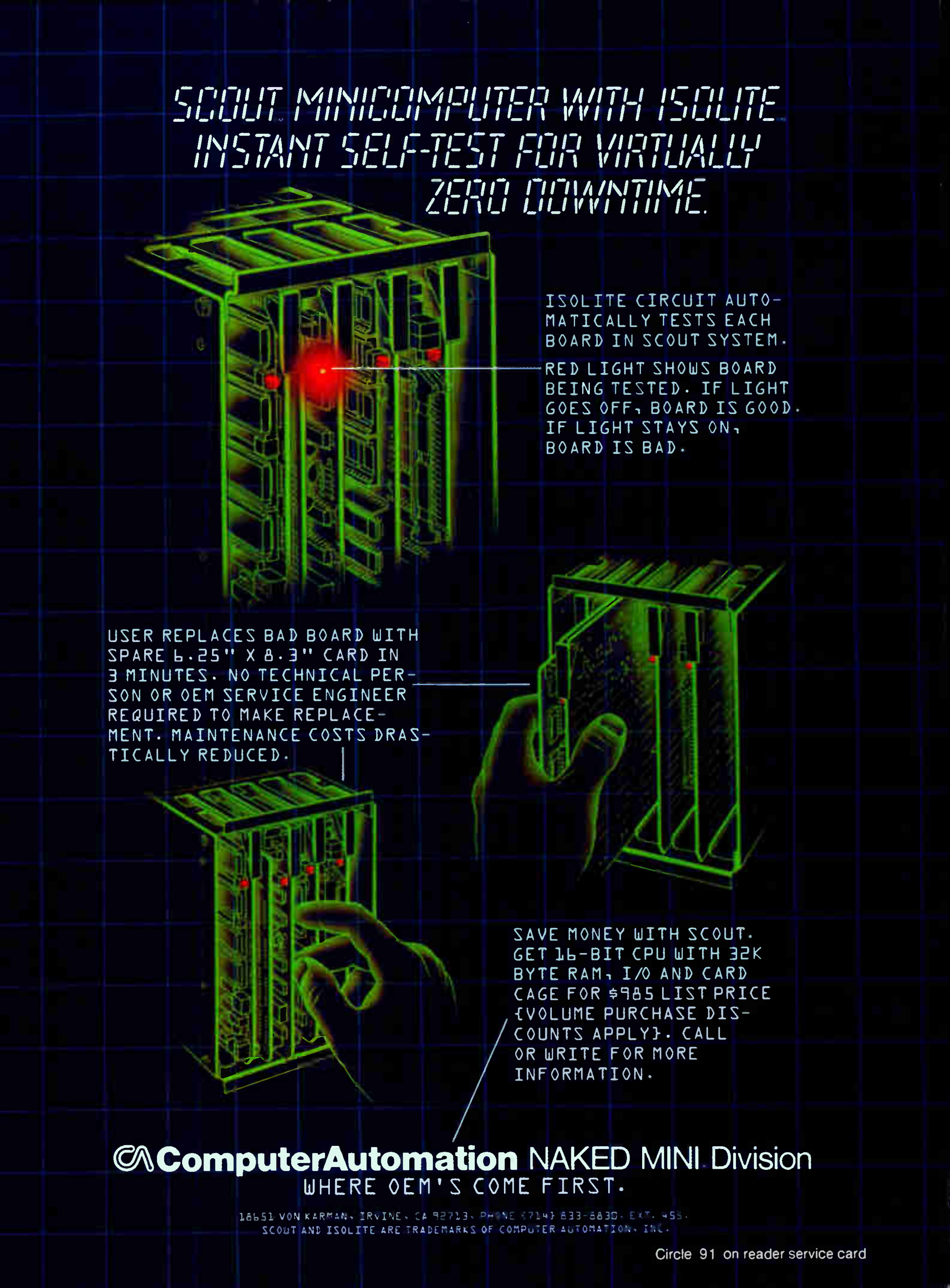
Session 16, CRTs. Color CRT design, phosphors, and filters.

Session 17, Image Quality and Visual Perception. Selectivity characteristics, color coding, evaluation and prediction, masking, fonts, and standards for displayed images.

Session 18, Liquid-Crystal Displays. Dichroic, touch-entry, double-layer-electrode, and varistor-controlled LCDs.

Session 19, Hard Copy/Printers. Computer-output printing techniques in the U. S., Japan, and West Germany.

Session 20, Projection and Image-Storage Devices. Cathodochromic, gas-laser/fluorescent-screen, photoferroelectric, fluoroscopic, holographic, and heat-sensitive and reversible-material projection and image-storage developments.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Computers

New direction predicted for IBM

Analysts see architecture changes in crystal ball and predict H, S, G, and Olympic series will appear before 1985

by Martin Marshall, West Coast Computers & Instruments Editor

A new era of computers from International Business Machines Corp. is about to dawn, according to the projections made this month by industry analysts who have closely tracked the giant's movements. It will not involve a wrenching software recompilation, as was required by the introduction of System/360 in the early 1960s, but it will involve new architectural configurations to go along with a highly attractive set of new price-performance ratios.

That new architecture may involve the linking through fast communications channels of as many as four nearly new IBM mainframes, creating a system with highly interconnected storage control units and mass memories.

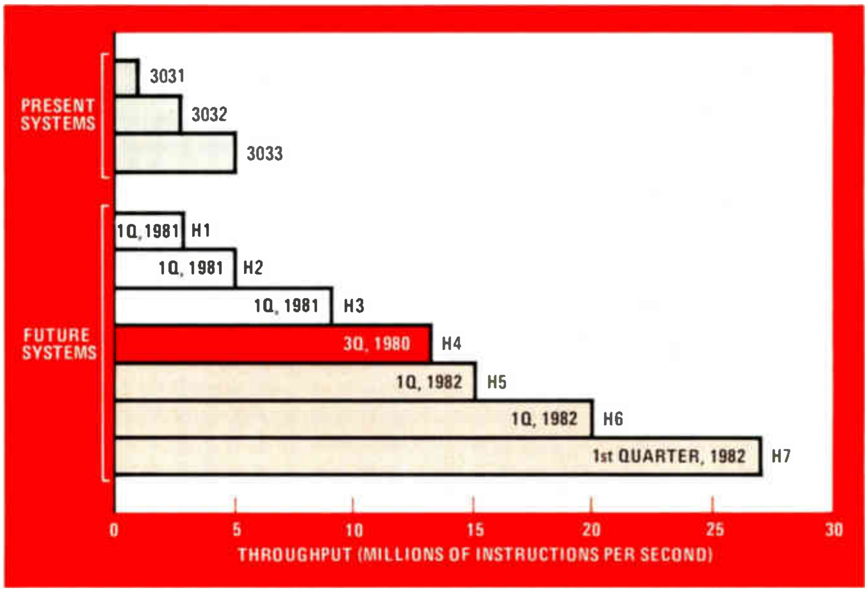
According to one industry analyst, Robert T. Fertig, vice president of Advanced Computer Techniques Corp. of New York, "Those interlinked mainframes are also likely to be unequal in talent."

His view is supported by Donald H. Czubek, president of Communications Solutions Inc., a San Jose, Calif., consulting firm specializing in IBM systems network architecture. "In the upcoming H series of IBM mainframes, we expect to see configurations in which one of the mainframes has been optimized as a database machine, with another mainframe with a different power rating optimized for multiple applications." Czubek expects that, in many networks, the mainframes will be close together. The high-speed protocols are expected to follow IBM's Systems Network Architecture concept.

Earlier this month at the Future Systems Forum in Scottsdale, Ariz., Fertig unveiled the most detailed projections yet of the hardware specifications, model announcement dates, and expected prices of the closely guarded H, or Adirondack, series. He suggested that the so-called H4A, the first mainframe in the series, had already been canceled in favor of a version called H4B capable of 12 million to 14 million instructions per second. Drawing a deep breath, he named September or October for the announcement of the H4B, with deliveries to follow nine months later. Fertig expects the H3 (8 million to 9 million instructions/s), H2 (5 million instructions/s), and H1 (3 million instructions/s) to be introduced in the first quarter of 1981. They will be followed by the H5 (15 million instructions/s), H6 (20 million instructions/s), and H7 (27 million instructions/s) in the first quarter of 1982.

"The H series will not bring the four times price-performance improvement that we saw with the 4300 Series," the New York analyst asserted. "Instead, we should see a 2 to 2.5 times improvement over the 303X series." In Fertig's view, the H series will contain a full 32-bit address field, enough to address 9 billion bytes of memory, although initial units may have only a 30-bit field available. A key architectural improvement, this size compares with the 24-bit field available on 303X models that limits them to just 16 megabytes of memory. The new mainframes are expected to contain single-level virtual storage, with 20 to 25 nanoseconds required for a full cycle, and a 10-to-15-ns cycle cache memory of 256 kilobytes or less.

There may also be an additional 1-megabyte buffer with a response



Future power. Forecast of the power that IBM's upcoming H series of computers will deliver shows them outstripping the current 303X line. The first, the H4, is expected this year.

time of about 100 ns, Fertig concludes. Main storage is expected to be from 16 to 96 megabytes, with response times varying from 300 to 400 ns. The series is expected to use closed-circuit freon units to cool its 700-circuits-per-chip logic instead of the more traditional plumbing of the 303X models. Fertig even went so far as to predict a $3.5 million selling price for the H4B, with a gross rental of $90,000 a month and software and services at $19,300 a month in 1979 dollars.

Though not making a definite projection of what kind of memory chips the H machines will use, Fertig responded to a question by noting: "IBM did not go outside to purchase 30% to 40% of the world's 16-K RAM chips without cause. The reason is that they didn't want to hamper their own development of 256-K chips."

In citing the shortcomings of the 370/303X model, Fertig noted that data security is not embedded in the hardware of these mainframes. It will, however, be an integral part of the H series.

Among other peripheral proucts to be introduced in the third quarter of this year will be a drive, code-named the Intrepid, using a 0.5-inch, 32-kilobit/in. tape cartridge. A successor to the 370X front-end processor and a successor to the 3850 mass-storage system should also be announced in that quarter. At the end of the year, the Prospector, a floppy-disk stack containing over 4 billion bytes, will likely be introduced. To manage all this new capability, a sophisticated file processor should be announced by IBM in early 1982.

Better buffering. In the area of peripherals, the long-awaited 1.2-billion-byte Whitney disk—now dubbed the Coronado—is expected to be announced in the second quarter of this year. It is believed to contain an improvement in buffering over the 3880 that will allow it to handle transfer rates of 3 megabytes to 6 megabytes per second. The McKinley disk, containing 2 gigabytes is projected for introduction in early 1982. The H series will also help reduce the cost of main storage. By the end of this year, Fertig predicts, main storage prices will shrink to $25,000 per megabyte. By the end of 1984, that price will be a phenomenal $5,000 per megabyte.

An important aspect of the H series, Fertig maintains, will be its ability to act in multiprocessor systems containing up to four mainframes, not necessarily of equal talent. "Some of the H series, if not all, will be field-upgradable to multiprocessor systems," he maintains. Users of IBM's Information Management System, or IMS, he further asserts, will be pleased to know that it will not be dropped. Rather, it will be extended, with a relational data base placed underneath it.

At the forum, in making projections about IBM's E series, or 4300 line of mainframes, Fertig was joined by Ulric Weil, vice president for electronic data-processing research at Morgan Stanley Inc. in New York. The two were in near agreement on the E4, or 4351 member of the series. They project that it will all but make the 3031 obsolete because it will be able to process 1.4 million instructions per second and will cost less than $500,000. Although Weil did not predict a time, Fertig expects to see the 4351 announced in the second quarter of this year, along with the E2. Weil designated the E2 member as the 4331-2, whereas Fertig called it the 4336, but their basic numbers were similar. Weil predicts the 4331-2 will process about 1.4 million instructions/s and cost roughly $140,000. Fertig predicts about the same cost, but says it will process 0.45 million instructions/s. In addition to these two mainframes, Weil projects a model 4361 mainframe handling about 2 million instructions/s and costing about $750,000.

A former strategic planner at Sperry Univac, Fertig is known for the boldness of his projections. A fellow analyst assesses them this way: "Fertig may have the best connections in the industry and he doesn't hesitate to make projections, but a few of his projections have been very wrong." A company spokesman for a major IBM competitor concurred, noting that "Bob Fertig is either very right or very wrong, and he is more often right." Weil, a former manager of marketing evaluation for IBM's System Development division, is more conservative in making projections and is generally regarded as highly accurate. □

Beyond IBM's E and H series

Not content with predicting the near-term prospects of IBM's E and H series, Robert T. Fertig of Advanced Computer Techniques Corp. went on to forecast plans for three new series, all to be introduced by the end of 1984. The G (for gap) series should fill in the 1-million-to-10 million-instruction power range between the E and H series computers. The S (for Sierra) series should be the 10-million-to-50-million-instructions/second follow-ons compatible with the H series. The Olympia series should succeed the 4300 line.

Prices listed here in 1979 dollars are only rough approximations, but they give an idea of the price-performance improvements introduced by each series. The first to appear should be the G5A (3.7 million instructions/s, about $425,000) and G4 (less than 2.5 million instructions/s, less than $400,000) in the first quarter of 1982. These should be followed in the third quarter by the G3 (2 million instructions/s, $325,000) and G2 (1.5 million instructions/s, $240,000). In the first quarter of 1983, the G5B (3.5 million instructions/s, unpriced), G6 (6 million instructions/s, about $700,000), and G7 (10 million instructions/s, $1.6 million) should be announced.

Along with these last G series models, the first of the S series may appear. Fertig guesses that the low end of the Sierra series may have 10-million-instruction/s processing power as $160,000. He also expects 15-million-and-30-million-instruction/s Sierra mainframes in 1983, with Sierra mainframes capable of 40 million and 50 million instructions/s in 1984.

The Olympia series should be the last to appear, in late 1984. The series would include a 300,000-instruction/s mainframe, costing less than $40,000; a 700,000-instruction/s mainframe for less than $70,000; and 1.7-million-instruction/s mainframe costing about $150,000.

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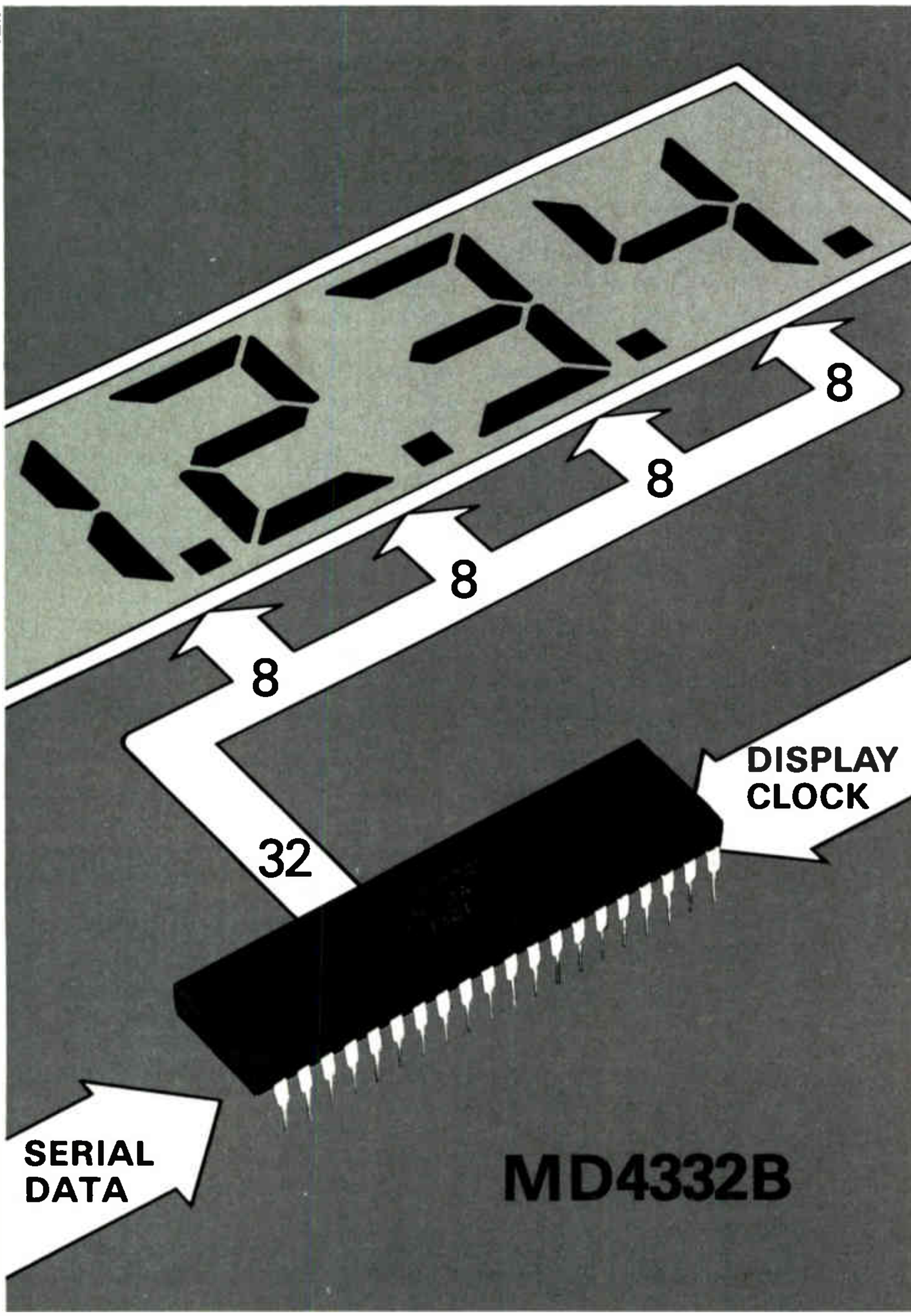

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Circle 95 on reader service card

Commercial electronics

They're cashing in on ATMs

Automatic teller machines are climbing the sales curve now that they have become less costly and more reliable

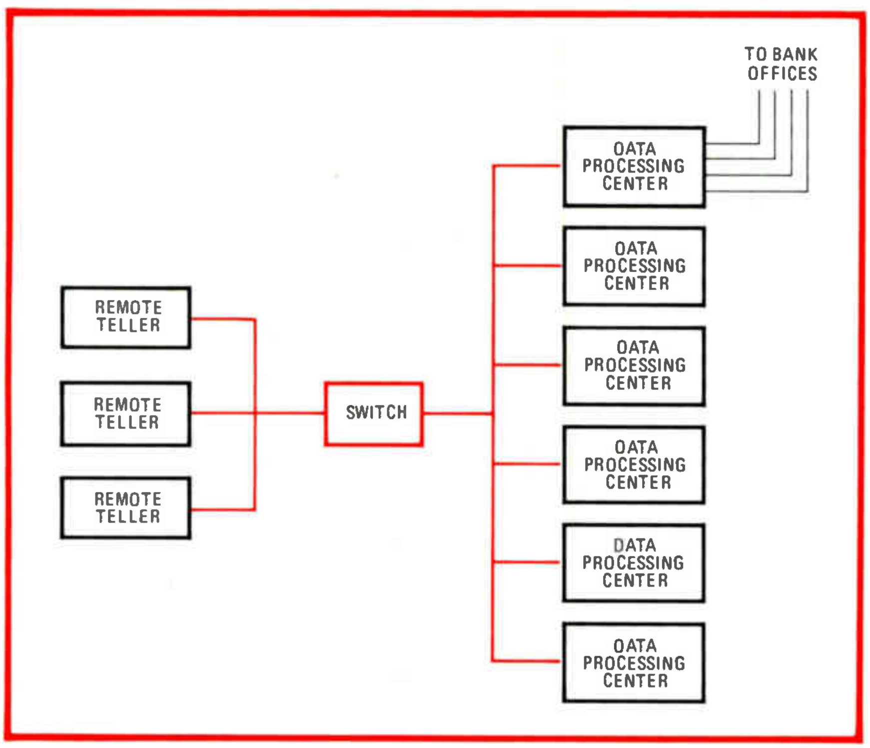
by Larry Marion, Midwest bureau manager

At least one portion of the long-dreamed-of nationwide electronic-funds-transfer network is viable and growing. Automatic teller machines, after many years of high costs and poor reliability, are a red-hot hardware market for major makers of data-processing gear, as well as for specialized vendors.

Lower prices and operating costs, more reliable technology, fewer legal obstacles, and heightened consumer interest have combined to create a booming business for the $15,000-and-up ATM devices. Bank officers now see strong consumer demand for the convenience of a 24-hour, 7-day cash dispenser and funds-transfer device, as well as reduced operating costs from the automating of routine deposit and withdrawal functions.

International Business Machines Corp., TRW Inc., Honeywell Inc., and other big names in the data-processing business are all participating in the sales boom. And a boom it is: more than 5,000 devices were installed in the U.S. in 1979, which is double the level of 1978 sales and a 50% increase in the total number that were in operation at that time.

No cooling. Furthermore, the pace will remain hot for the next few years: Jim Drumright, director of terminal products at Burroughs Corp., Detroit, predicts 35% annual increases in total unit sales for the next few years. Though he is less bullish, Bob Feaganes, ATM promotion manager at NCR Corp., Dayton, Ohio, nevertheless expects 15% to 25% increases.



Money mover. This is part of an EFT network in Des Moines, Iowa. Tellers are linked to a switch—an NCR computer—which, in turn, is joined to six data-processing centers.

New installations planned in Illinois, for example, will include networks of shared ATMs among several banks, with communications links for the various data-processing centers to settle accounts in on-line or off-line modes. Although new regulations and a conservative attitude preclude rapid deployment of ATMs—once prohibited in remote installations—Illinois bank officials expect to see about 400 connected into about a half-dozen networks within a few years. "We've believed in electronic funds transfer for a long time, because hardware costs go down while labor costs go up," says Bruce Burchfield, assistant vice president and EFT chief at First National Bank of Chicago [*Electronics*, Jan. 17, p. 42].

Out in front. The Illinois networks will just be larger versions of systems already operating in the Midwest. For example, Iowa and Wisconsin banks banded together several years ago and created multibank networks with hundreds of devices in each. Explains Feaganes of NCR: "The Corn Belt states are light-years ahead of the major metropolitan areas."

The action is not just stateside. A group of Swedish banks are now installing a nationwide cash-dispensing system, including 11 minicomputers and software, worth more than $3.6 million, from a Honeywell susbsidiary. About 400 ATMs will be linked on line via a new public data network.

Advances help. A number of technological advances are also behind the surging demand: a new generation of hardware introduced in the last 18 months reduced purchase prices and operating costs while improving the reliability of the devices. Wall-mounted devices that once cost $50,000 are available for $25,000, and cost per transaction with Docutel machines has plummeted to 0.1 cent from 5.31 cents. Uptime is now more than 99%, compared with 95% or lower. To achieve these improvements, vendors had to redesign their ATMs inside and out, integrating various subsystems and eliminating failure-prone mechanical parts.

Problems with early units from Docutel Corp. of Irving, Texas, were especially painful and costly. The company's once commanding market share is now at 50% and will further sink to 30% to 40%, concedes N. A. Stuart, executive vice president, because Docutel halted sales in 1977 of earlier models and redesigned its product line in 1978. "One of the burdens that you have to carry when you're a pioneer is that you're on the front end of the problems," Stuart says.

For example, early ATMs needed a minicomputer to operate, and the display was a preprinted roll of instructions viewed by consumers through a window in through-the-wall installations. In the new generation of machines, mechanical displays are replaced with electronics, such as a cathode-ray tube driven by locally programmable microprocessor logic.

Logical change. The key changes required the adoption of microprocessor logic. Vendors used the local processor to upgrade control of the ATM's mechanical functions, such as currency presentation—the devices spit out the bills directly to the consumer, rather than into a drum that has to be repositioned for consumer access. ATM designers incorporated light-emitting diodes and other solid-state components as sensors and sharply reduced the number of vulnerable mechanical sensors in an ATM; as a result, the new IBM 3624 has a 3-foot currency channel, for example, compared with a 10-ft version in the previous model.

Intel Corp. microprocessors are the most popular logic devices. Vendors such as industry leader Diebold Inc., Canton, Ohio, and NCR are sticking with the old reliable 8080, whereas Burroughs' new machines are built around the new 16-bit 8086. Drumright of Burroughs explains that its philosophy is to put as much intelligence as possible into the ATM, to permit independent operation in case of a temporary failure of an on-line data-processing-center–based network: a deadbeat card file, for example, can be included in the ATM's own internal 96-kilobyte random-access memory to be available during system crashes.

However, though NCR and others share that "intelligence at-the site" philosophy, Docutel and Diebold recommend controllers, front-end signal processors, and memory files for networks with dozens of ATM devices and a host computer. Docutel says that reliance on mainframe memories and communications links led to some downtime problems in the past, and its ATM-controller package includes up to 128 kilobytes of core memory—at a 20% or higher price premium—to ensure device operation during system outages. In fact, Docutel's redundancy philosophy also includes dual microprocessors, one for each of the two currency bins in an ATM, says marketing vice president Frank R. Marlow.

Cutting the payroll. Increased consumer acceptance of electronic technology is also leading to the often-promised economies of automation. One bank reports that its lobby tellers cost less than $2 an hour to operate, far below its payroll costs, and the units expand the operating capacity of existing branches.

For the hardware vendors, the improved performance of automatic tellers is one of the factors behind an increase in back-office conversions to on-line operations. "When we first started selling ATMs, it was hard to justify, an uphill battle. However, ATMs provided the seed of an idea," explains Stephen A. Grosky, vice president and general manager of Bunker Ramo Corp.'s Banking and Commercial Systems division in Trumbull, Conn. □

Commercial electronics

Sony heads back to broadcast market

With its position in the consumer area eroding, the company will direct its attention to institutional gear

by Robert Neff, McGraw-Hill World News

When Sony Corp. last month converted its 30-person Palo Alto, Calif., research and development division into a separate company to build broadcast video equipment, a sense of *dèjà vu* struck veteran Sony watchers. Though most of the world knows the 34-year-old company for its fine consumer products, it actually spent its first few years in business as a supplier of electronic components, tape recorders, and other broadcast equipment to the Japanese institutional market.

Now, chief executive officer Akio Morita, a company cofounder, is steering Sony back into that market in search of fatter profit margins and faster growth. Both are increasingly elusive in the ferociously competitive consumer field, where strong challengers have eroded Sony's opportunities and preeminence. Consumer gear, which three years ago was generating about 76% of its sales, is now down to about 65%. The balance comprises sales of tape, accessories, and nonelectronic items. Upgrading the Palo Alto facility is the latest manifestation of the emerging strategy to get Sony back to its place in the sun.

Morita reveals that by 1985 he wants to boost industrial sales to fully 33% of revenues from 10% three years ago and 15% to 20% now. Included are broadcast-quality video tape recorders and editors, portable U-matic video cassette recorders for point-of-sale and training applications, and dictating equipment. Another indication of Sony's new emphasis is the fully 10% of sales it is spending on research and development of institutional products, as against the 6% to 7% that is being expended on the rest of its product line companywide.

"The consumer business is growing less profitable because of competition from all over the world," Morita explains. "Many manufacturers of consumer electronics are going to disappear." Sony itself is showing symptoms of tired blood. It is a truism that companies tend to grow more slowly as they get larger, and Sony is no exception. For the five fiscal years ending in 1974, the company's sales grew by a most satisfying 166%, but during the five ending last November, they rose by only 57%, to \$2.7 billion. And even after a notable recovery from a lackluster 1978, operating margins in 1979 were almost 2 points lower than 1970's margin of 13.4%.

Meanwhile, Sony's share of the tepid U.S. television market has stalled at about 7%. Its Betamax-format video cassette recorder, though selling briskly, is being overtaken by Victor's VHS design. And to further chew away at its profits picture, rivals have beaten Sony to the market with such hot products as metal-tape audio decks, video disk players, and home computers.

Rerouting. Akio Morita, chief executive officer, wants Sony to return to its roots.

Such problems probably have less to do with stagnation at Sony than with the growing quality of competitors, although some critics fault Morita for stressing marketing over engineering. "Sony used to be a special company," says a Tokyo stock analyst. "Now it's just a little above average."

The ticket? Morita's institutional strategy could be the ticket to rejuvenated growth and profits, as well as technical progress. Industrial products boast profit margins almost twice as high as Sony's current 11.6%. As for growth, Sony's Industrial Video Products group has zoomed to about \$270 million in sales since it was launched eight years ago. Some 40% of that comes from broadcast gear, which Sony did not start making until four years ago. Those sales are growing so fast that senior managing director Masahiko Morizono expects broadcast hardware to exceed 50% of his group's total sales volume within three years.

"Sony is the fastest-growing company in the institutional video market, especially broadcasting," Morizono maintains.

Part of Morita's strategy is to tap the willingness of institutional customers to pay the high prices required for state-of-the-art products in their early days. Eventually, according to the chief executive officer's scenario, economies of scale and public awareness make consumer applications feasible. That, in

Probing the news

fact, is how the Betamax was born.

Sony also plans to market digital audio and video disk gear first to professional customers. "Our idea is to utilize the most advanced industrial technologies in the consumer field," Morita explains.

As the majordomo of Sony's ambitious institutional plans, Morizono will head the Palo Alto firm, Sony Technology Center Inc. Operated as an R&D facility since 1977 by New York–based Sony Video Products Co., the center last autumn started making remote-control units for the Sony BVH-1100, a studio-quality video tape deck. The center is selling the tape decks to customers throughout the world for about $11,000.

Sony makes the BVH-1100 at its Atsugi plant in western Tokyo, which also turns out U-matic ¾-inch video tape recorders. The U-matic, models of which range from $1,800 to $11,000 and which is also manufactured by Matsushita Electric Industrial Co. and Victor Co. of Japan, now accounts for almost 100% of the worldwide nonbroadcast industrial VCR market, Morizono claims. He guesses Sony's share of the broadcast market, still paced by Ampex Corp., at perhaps 30%. But with the Emmy-winning BVH-1100, Sony has grabbed the sales lead in the hottest product area—helical-scan 1-inch tape recorders for production use. Since deliveries started in early 1978, it has sold about 2,500 units of three different models and has 400 orders for the new recorders on the books.

World losing an inch. One-inch helical-scan gear is replacing conventional 2-in. equipment around the world. Not only is it smaller and cheaper, but it offers such features as fast forward and reverse and freeze frames and consumes far less tape. The key to the conversion to the narrower measure is cramming signals closer together by recording them at an angle in a continuous track with a single head.

Sony's ultimate goal is to replace film with tape, from home movies to the motion picture industry. "Our competitors don't have that overriding aim," Morizono says. For the movie industry, which is already experimenting with tape, the new medium means easier editing and special effects, instant prints of a particular day's shooting, better sensitivity to light, and economy, because tape can be reused. But Morizono figures it will take another three to four years to sell it as artistically desirable.

Until now the industrial market has been relatively uncrowded. But competition is heating up. Toshiba Corp., Nippon Electric Co., and Hitachi Ltd.'s subsidiary, Hitachi Denshi, are entering the broadcast VTR market; Universal Pioneer's recent foray into industrial video with its disk machines means Sony will no longer have that field to itself. Morita's and Morizono's most compelling task now is to preserve their head start. □

Office automation

Designers told to take a new tack

Experts say office of future will not arrive until more than warmed-over computers and dedicated processors are provided

by Anthony Durniak, Computers & Peripherals Editor

Although talked about for several years now, office automation is still a long way off. And unless the computer and word-processing industry's engineers adopt a fresh design approach, it may never get here.

That was the message from participants at the first Annual Office Automation Conference, held earlier this month in Atlanta, Ga., under the sponsorship of the American Federation of Information Processing Societies.

Most of what claims to be office automation equipment today is either adapted computer gear or dedicated word-processing equipment designed primarily to speed clerical tasks or the typing process. But, as keynoter C. Jackson Crayson, director of the American Productivity Center, Houston, Texas, says, "The greatest gains in productivity will come from automating the management and professional areas, not the clerical areas."

In the words of a former computer

company executive, "The word-processing industry wouldn't exist today if the data-processing manufacturers had paid attention to the human interface," says Jim Folts. "Text editors were on computers for some time, but they weren't easy to use." Now marketing vice president at Syntrex, a company he helped found, Folts says his company is using new design concepts to make special office automation "appliances" that it hopes to introduce later this year. "In the computer business you generally strive for performance and ease of use takes a back seat. But in office automation those priorities are inverted," Folts says.

John J. Connell, executive director of the consulting firm Office Technology Research Group, Pasadena, Calif., feels such human engineering will be critical to the success of office automation systems. "It's a matter of design philosophy; we must adapt the machine to the person."

Howard L. Morgan, a specialist in office automation and a professor at the Wharton School of the University of Pennsylvania in Philadelphia, says a key point in getting executives to use electronic office systems will be "a consistent user interface that is tolerant of errors and friendly." He points out, for example, that executives, generally more familiar with dictating than typing, will find it imperative to have the system cor-

Small-business market attracts newcomers

One of the signal events at the Atlanta Office Automation Conference was the introduction of a trio of new products from companies new to the field. One of the newcomers is Matsushita Electric Industrial Co., whose American subsidiary, Panasonic Co. of Secaucus, N. J., is marketing the BC-5000. Based on the 8085 microprocessor, it features a novel 96-key touch keyboard that is adapted from the machine's Japanese language keyboard. It contains soft keys whose functions can be changed to synchronize with descriptive pages played beneath the transparent keys.

Commodore Business Machines Inc. of Santa Clara, Calif., famous for its Pet personal computer, is introducing a business-oriented desktop computer with a larger display and more software than the Pet. And another oil company—Shell Canada Ltd.—is getting into the electronics business by backing Artel Inc. of Palo Alto, Calif., which introduced its 8086-based Series 1000 Office Workstation.

Probing the news

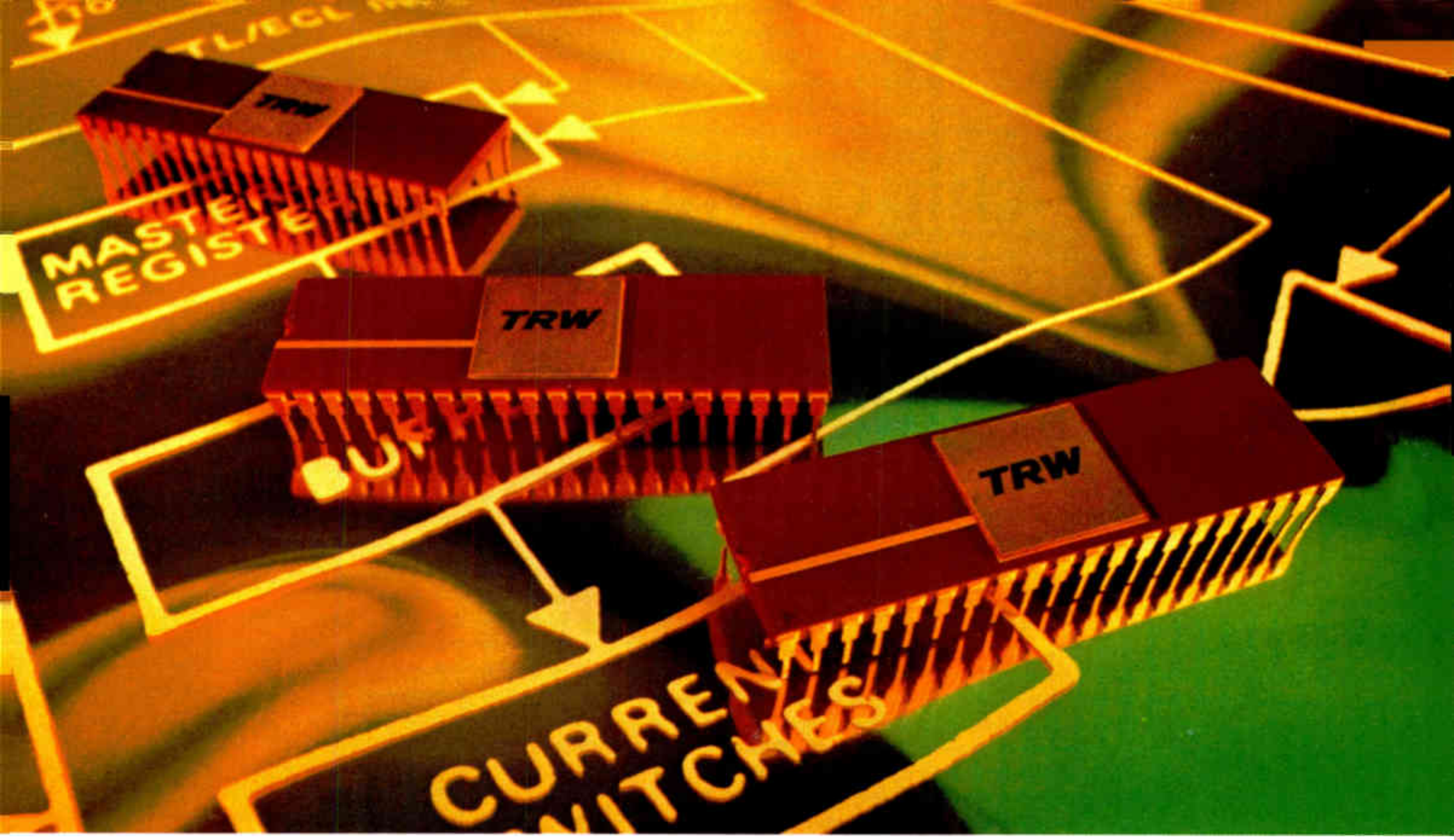
rect their spelling and other typographical errors. And the methods used to enter information into the system and manipulate it must be the same whether the information is text, data, or graphics. But such sophisticated interface techniques require a great deal of software; that occupies a large portion of computer memory, and it can thus serve to reduce the machine's overall throughput.

Dampers. The limitations reduced the popularity of previous attempts to automate the office—most notably with the management information systems (MIS) that were so popular in the early 1970s. Dan Hosage, senior vice president and general manager of Datapoint Corp.'s Office Systems division, San Antonio, Texas, says, "Technology inhibited MIS. You couldn't place a computer with 256 kilobytes of memory next to the accounts-receivable clerk—that was a small IBM System/360 model 30 mainframe." But today, Hosage says, that is a small desk-sized unit.

Along with simpler user interfaces, these machines must have many times the reliability of current data-processing gear. Once the majority of an office's information is stored electronically and all its workers use the same integrated system, a failure in any element of the system could shut down the entire office.

For instance, Michael J. Winkler, manager of marketing support for Xerox Corp.'s Printing Systems division, El Segundo, Calif., notes that nonimpact printers, shared by various terminals, offer a great degree of output flexibility to these office systems. But "the traditional reliability of the office copier is unacceptable, as the entire office becomes dependent on them," he adds.

If the electronics engineers overcome the design obstacles to office automation, users will be faced with other problems. Wharton's Morgan warns that the easy availability of an electronic system makes "quantitative knowledge drive out qualitative knowledge," or, in other words, "the use of computerized information can be counter-productive." □



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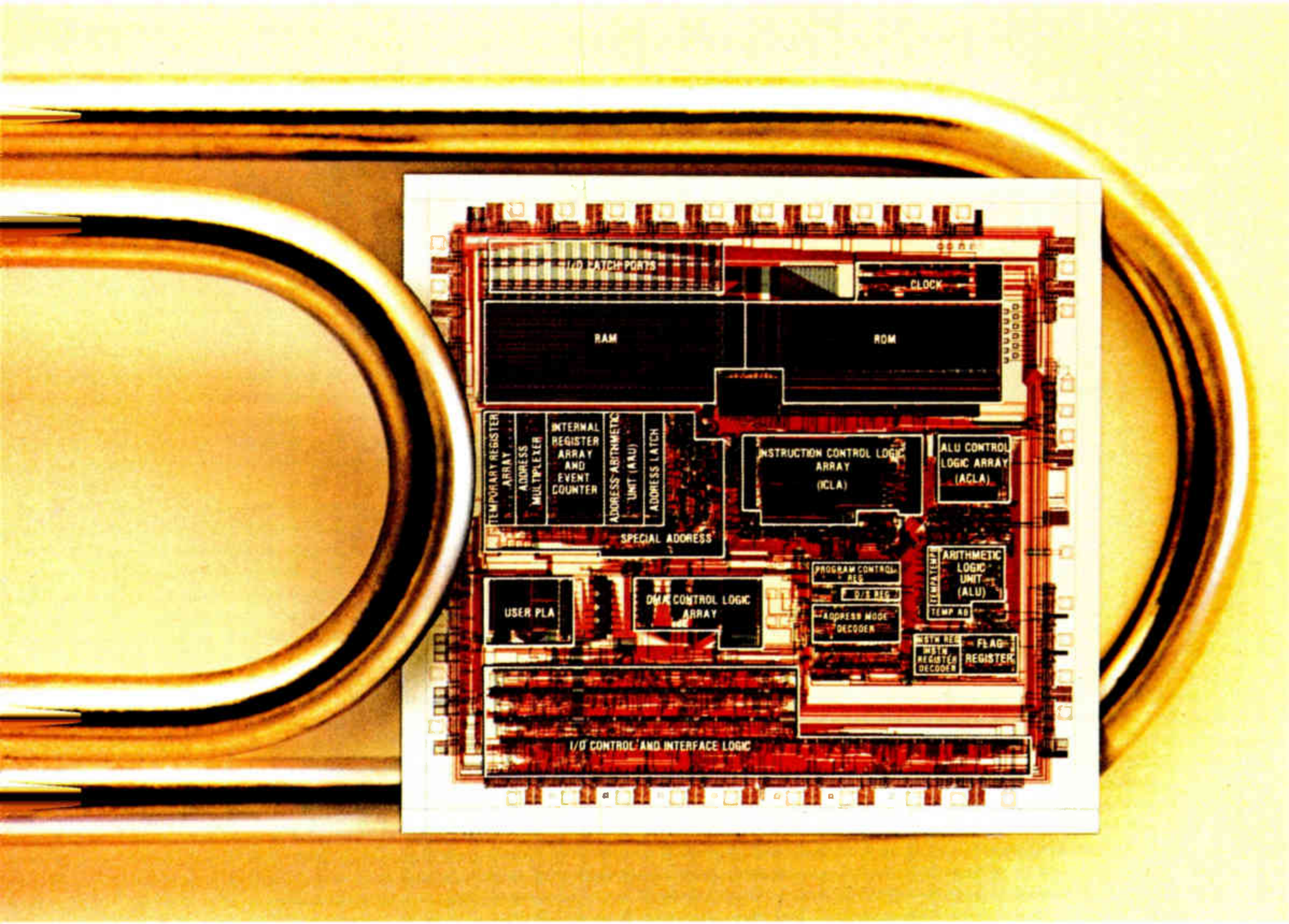

The MAC-4 one-chip computer, developed for a variety of telecommunications applications, is compared to a standard-sized paper clip. The chip's numerous functional areas are labeled.

One of the transistor's latest descendants is the Bell System's 30,000-element MAC-4 "computer-on-a-chip." It's another in a long line of microelectronic developments that have come from Bell Laboratories.

The MAC-4 is so efficient that a program written on it takes 25 percent less storage space than that required by most other microcomputers. Its assembler language, C, also developed at Bell Labs, has features that make MAC-4 easier to program, debug and maintain. And the MAC-4 can handle anything from nibbles to bytes to words with its 4-, 8-, 12-, and 16-bit operations capacity.

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Today, we continue to make important contributions to solid-state technology. For example, we've developed a rugged 65,536-bit RAM that can tolerate processing faults. Corrections can be made on the chip itself, so we can get more usable chips out of each manufacturing batch—and thus lower unit costs.

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Other advances, in X-ray lithography and new resist materials, for example, promise to help place more elements on microelectronic devices and thus enhance their ability to perform important tasks.

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From Science: Service

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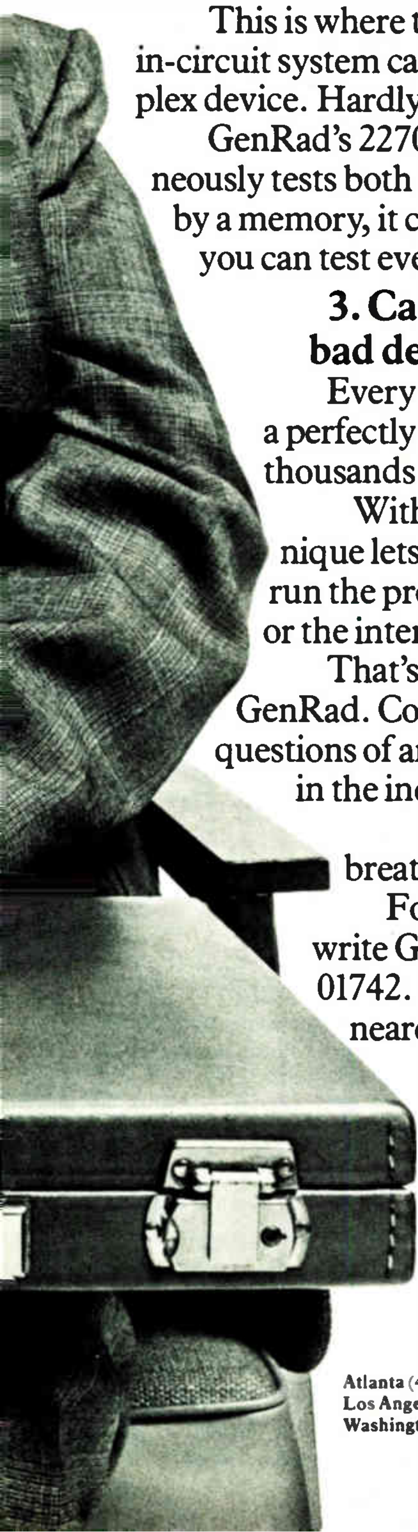

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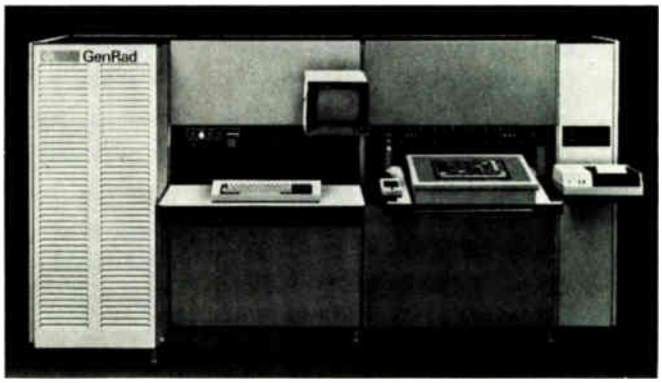

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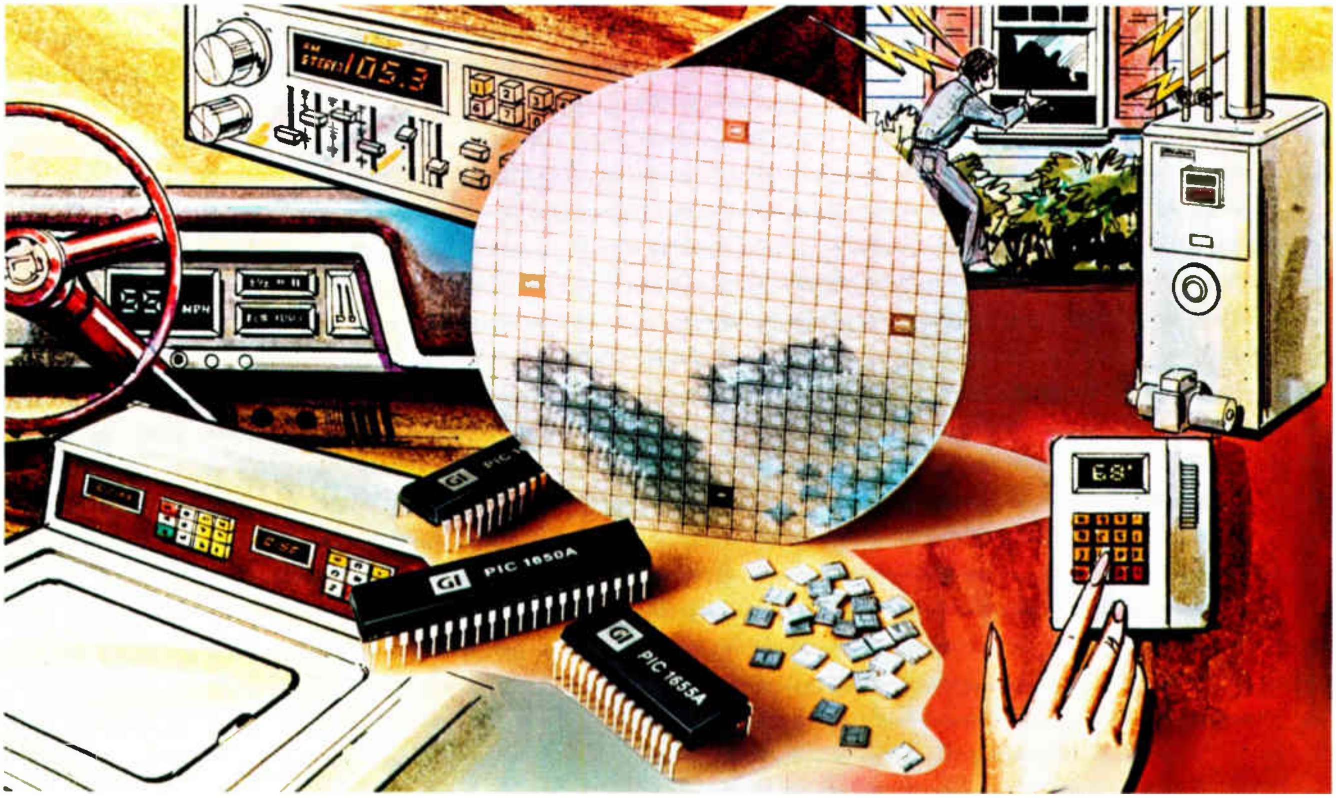

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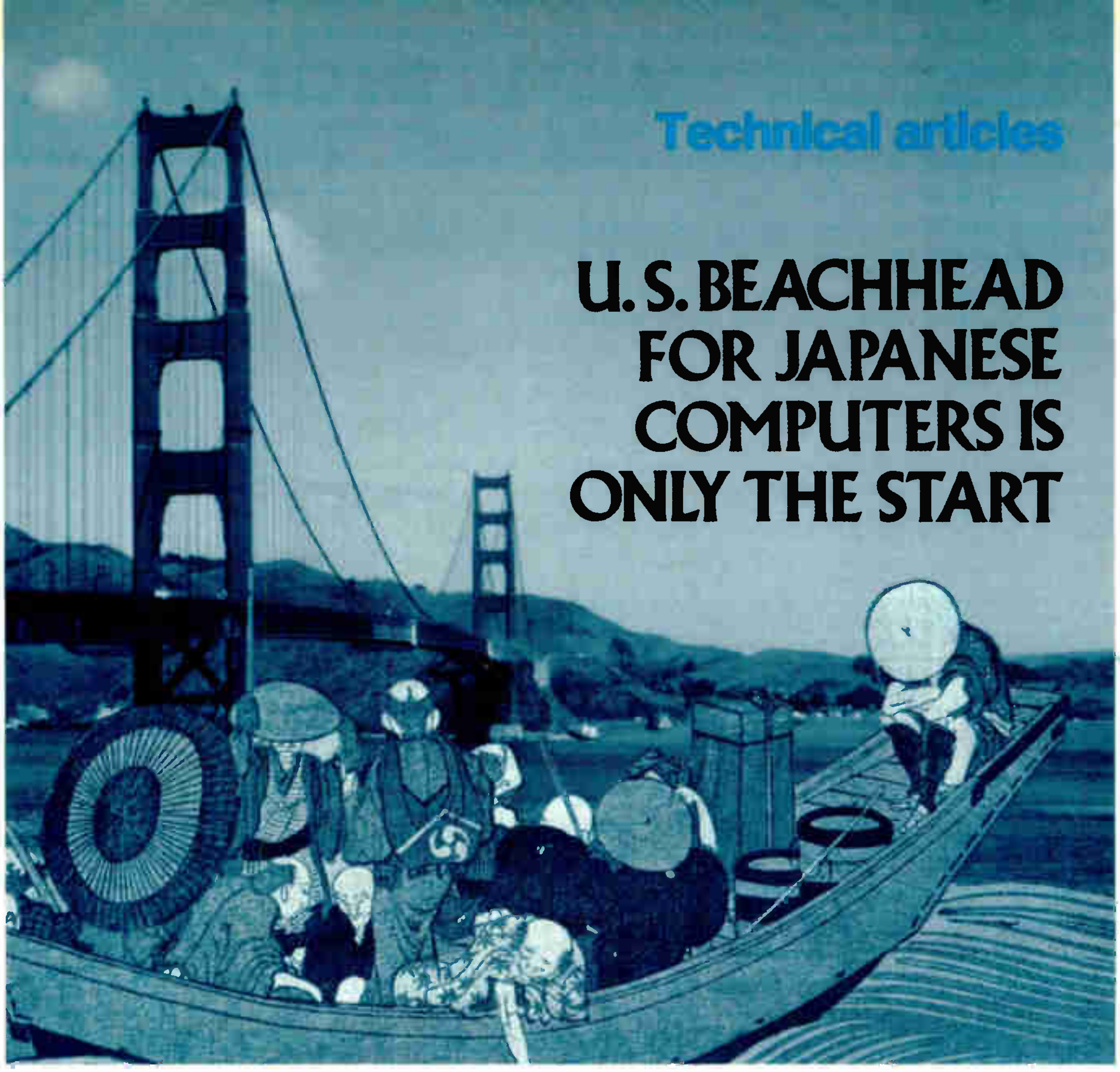


U.S. BEACHHEAD FOR JAPANESE COMPUTERS IS ONLY THE START

by Anthony Durniak, *Computers & Peripherals Editor*, and Charles Cohen, *Tokyo bureau manager*

☐ Japan's electronics companies, now well positioned in consumer electronics and semiconductor markets, are intent on establishing themselves strongly in computers. They already have a foothold in the U. S. marketplace, but they are after far more than that.

"We're planning to be an international competitive power in computers and communications," states Akira Koike, a director of Nippon Electric Co. and executive vice president of its Information Processing and Industrial Systems group. "If we cannot supply computer systems in the U. S. we cannot even compete in [our] domestic market."

This year will see the Japanese intensify their efforts to export computers, with the United States their biggest target. They realize they cannot establish computer marketing, service, and support operations overnight. But they are committed to spending the time and effort it will take. By 1985 they plan to sell some ¥384 billion ($1.66 billion) worth of computers in the U. S.—some 15% to 20% of their total production and 60% of their total exports, *Electronics* projects, based on its survey of the manufacturers. (Because of currency fluctuations, values will be reported in yen throughout this report. For convenience, conversions to dollars are included at ¥240 to one dollar.)

Such expectations do not appear to be wishful thinking, either. Over the past eight years, the Japanese have developed computers and peripherals that are at least as good as and in some areas even better than those of American manufacture.

The Japanese already export over ¥71.7 billion ($298 million) worth of data-processing gear, or some 10% of their production, as Fig. 1 on page 114 shows. But 70% of that is peripherals, and of the total only 31%, or $93 million, is shipped to the U. S., primarily to original-equipment manufacturers and other third parties that sell under their own label. Now, however, the Japanese want to increase the volume of computer products so that exports by 1984 surpass imports. Furthermore, they want to sell complete systems under their own brand names—especially in two target markets: IBM-compatible computers and small-business machines. And they view success in the U. S.—the biggest, oldest, and most sophisticated data-processing market—as the cornerstone of their plans to expand their exports to the rest of the world.

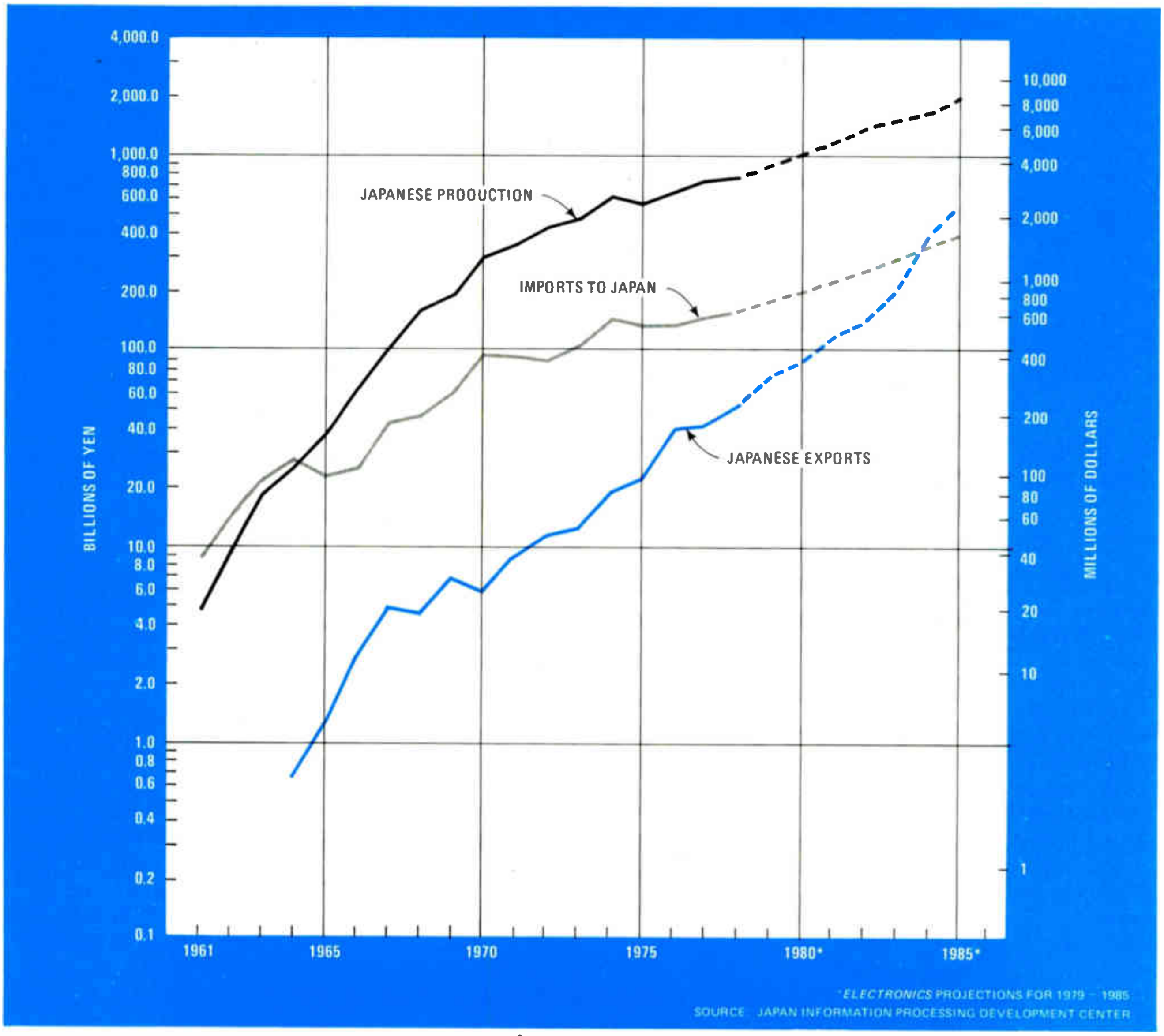
Unlike earlier machines derived from American designs obtained through licensing agreements, the latest Japanese products are almost totally independent of imported technology. Their semiconductor technology is acknowledged to be at the leading edge [*Electronics*, June 9, 1977, p. 99], and the Japanese now export more semiconductors than they import (see "The wave hits the beach," p. 116).

Less obvious but equally important, however, are their creative packaging designs, novel hardware organizations, and sophisticated manufacturing techniques. In addition, the unique demands of working with the Japanese language have encouraged advances in cathode-ray-tube terminals, nonimpact printers, facsimile transceivers, and optical character and speech recognition that are unmatched anywhere else. And their machines are noted for superior reliability.

Soft spot

In fact, the only area in which the Japanese admit to be lagging is software. But they are well aware that software, especially systems software like operating systems, high-level language compilers, and communications packages, is more important than ever before to the operation—and hence marketing—of computers.

This past year the government kicked off a new joint project with the industry to concentrate on those areas. Objectives, still being chosen, include operating system



1. Intensifying exports. Already exporting some ¥71.7 billion ($298 million) in data-processing gear, the Japanese plan to ship some 30% of their production, or ¥585.7 billion ($2.4 billion), by 1985, surpassing the amount they import. The U. S. will receive 60% of that amount.

Slow but steady movement on tariffs

While the Japanese computer makers move to compete in worldwide markets—especially the U. S.—the American makers have been raising a clamor for the ability to compete unfettered in Japan. The most obvious barrier to such fair trade is tariffs.

As a result of the multilateral trade negotiations—the so-called Tokyo Round—completed this past year, the Japanese import tariffs on both computers and peripherals will be gradually lowered over the next eight years. The Japanese import tariff on computers, now 10.5%, will be lowered to 4.9% by 1987, while the duty on peripherals, now 17%, will be reduced to 6%. The Japanese industry feels this shows its willingness to compete. In comparison, the United States agreed to reduce its import duty on computers from 5% to 3.7% over the period and lower those on peripherals, which range between 5% and 6%, to between 3% and 4%.

An official at the U. S. Trade Representative's Office said the government felt it was an accomplishment to get the Japanese even that low. **-A. D.**

kernels, network and data-base management, virtual-machine techniques, and very high-level language processors. The ultimate objective is to facilitate Japanese language processing.

In addition, the government has just started giving tax breaks to computer makers and software companies to encourage separate pricing of software and the growth of an independent software industry that would provide applications and systems programs—and train more programmers and software engineers.

Who they are

Currently five companies dominate the Japanese computer industry—Fujitsu Ltd., Hitachi Ltd., Nippon Electric Co., Toshiba Corp., and Mitsubishi Electric Corp. All are vertically integrated manufacturers of a broad range of computers and—with the exception of Fujitsu Ltd.—are divisions of large, well-financed industrial conglomerates.

Just how competitive the Japanese computer technology is is evidenced by the fact that Japan is the only country outside the U. S. where the domestic manufacturers have more than half the market. Admittedly, the market is ringed by tariffs, but most other countries have also tried to protect their domestic data-processing industries from dominance by U. S. firms—and failed. It is just this success in competing with the American makers in Japan that gives the Japanese manufacturers the confidence to compete with them elsewhere.

"About 47% to 48% of the machines in the Japanese market are American," notes Hideo Ohta, a Mitsubishi director and deputy general manager of its electronic products and systems group. "So even if you're selling in Japan, you're competing with the U. S. If you can't be competitive in the U. S. market, you'll also lose the Japanese market."

The American computer industry has mixed feelings about the Japanese. Most industry observers agree the Japanese are ready to take the plunge, and some even go so far as to voice fears that the American computer industry could go by the boards, much as the U. S. consumer electronics did, or at least suffer financially as the American steel and auto industries have.

"In the last few years they've proven they are up to par, if not ahead, in technology," notes Oscar H. Rothenbuecher, a senior staff member of the consulting firm of Arthur D. Little Inc. in Cambridge, Mass. "And since the domestic market is approaching saturation, they are looking outside to continue expanding sales." His associate, senior researcher Norman Weizer, says

2. International competitor. Akira Koike, a director of Nippon Electric Co. and executive vice president of its Information Processing and Industrial Systems group, says NEC is planning "to be an international competitive power in computers and communications."

3. U. S. is key. Mitsubishi Electric Co. director Hideo Ohta says that since computers made by American manufacturers account for about 48% of the machines installed in Japan, "if you can't be competitive in the U. S., you'll lose the Japanese market."

the Japanese "will really take hold when the electronic office takes hold. I see the convergence of computer and communications happening by 1985, and by then the Japanese will have their act together."

Gideon Gartner, a long-time computer industry watcher and president of his own consulting firm, the Gartner Group of Greenwich, Conn., says exports of $3 billion by 1985 "would make the Japanese in aggregate as big as either Honeywell, Univac, NCR, or Burroughs in the non-Japanese foreign markets." Even though the projected exports of $1.6 billion to the U. S. would still give them only a small share of that market, "at that level people would have to start worrying," he says.

Gordon Bell, engineering vice president of Digital Equipment Corp., Maynard, Mass., says their manufacturing capability will "make them more competitive than we are." The television industry could not compete with sets manufactured in Japan, he says, and as a result "was devastated and almost destroyed. And that industry, like a lot of others, will never be rebuilt again, because the people have left electronics manufacturing and gone off to cook hamburgers for McDonald's."

Could the same thing happen to the computer industry? "Yes—as we get old, fat, and mature, it's easier to impact us," he says.

IBM Corp. has also voiced concern about the Japanese and the lack of free trade there. Howard Figueroa, who until just recently was Far East vice president for IBM World Trade Americas/Far East Corp. and is now vice president for management services with IBM World Trade, says he believes "the world economy benefits from fair trade and from minimizing the barriers that distort trade. We don't want protection, but we do want the opportunity to compete freely." Although they continue to be lowered, Japan's import duties on data-processing gear are higher than those that are charged by the U.S. (See "Slow but steady movement on tariffs," p. 115).

DEC's Gordon Bell recites a list of Government agencies that he sees hindering the U. S. computer industry's competitive efforts: "It's not just American industry versus Japan Inc., but also versus the Commerce Department, the National Bureau of Standards, Justice Department, Occupational Safety and Health Administration, and so on." He points, for example, to the Bureau of Standards' attempts to standardize computer input/output interfaces over the objections of U. S. manufacturers. "They're not just giving us design requirements, they're telling us how to design. I'm scared to death that they'll do something that will make us less competitive."

4. Negotiating. With Fujitsu America Inc. successfully established in Santa Clara, Calif., to sell semiconductors, Fujitsu Ltd. is currently negotiating with TRW Inc. to market its computers in the U. S., according to Michio Naruto, manager for international planning.

Others are less fearful, however. They note that though the Japanese have been talking about entering the U. S. market for some time and in some cases have even tried, they have met with little success so far.

"All of the export goals set five years ago have not been met yet," notes Lou Casanova, vice president for joint ventures—Japan, at Sperry Corp.'s Sperry Univac division. "They've been especially hurt by IBM's announcement of the model 4300 computers," with their aggressive price-performance ratio.

The wave hits the beach

Three years ago *Electronics* reported that a wave of Japanese semiconductor technology was gathering [*Electronics*, June 9, 1977, p. 99]. That wave has already hit American shores. For the first eleven months of 1979 Japanese semiconductor exports increased 82% to $402.7 million, surpassing imports—just $381.8 million—for the first time [*Electronics*, Jan. 17, 1980, p. 63]. Of that amount, 38%, or $154 million, went to the U. S., more than double the amount exported there the year before.

Such success in the semiconductor market—especially in memory chips—has not gone unnoticed by American vendors. The Semiconductor Industry Association told Congress last fall that the Japanese had captured 42% of the American memory market, a good deal more than the 25% Japanese manufacturers predicted in 1977 that they'd achieve [*Electronics*, Oct. 25, 1979, p. 40]. The SIA also charged the Japanese with dumping the semiconductor memory chips on the U. S. market at prices 25% to 50% below American prices, a charge the Japanese deny.

But even in 1977 the Japanese made clear their intentions to supply more than the semiconductor components. They want to become major suppliers of complete computer and peripheral systems—intentions that are examined in this special report. **-A. D.**

NEC's pieces are in place

"All the pieces are in place" for three-year-old NEC Information Systems Inc. to start growing very rapidly, says John C. Cooper, director of marketing. Although the Lexington, Mass.-based subsidiary of Nippon Electric Co. does not reveal its exact revenues, industry observers say it is nearing $100 million in sales and could reach $250 to $300 million in five years, making it one of the best-established Japanese computer operations in the U. S.

Already established as a supplier of character printers—it is now shipping 2,500 of its Spinwriters a month—NEC Information Systems began last year to position itself in the small-business computer market. Cooper has been building a dealer network rather than a direct sales force because he says it is a more expedient way to enter the U. S. market. And now he hopes to make NEC's Astra small-business system, unveiled last year [*Electronics*, March 29, 1979, p. 38], a larger portion of NEC Information's total business. "We'd like our revenues to be balanced between peripherals and the Astra, with the Astra contributing 60% of the revenues in two or three years," Cooper says.

The fact that the computer is made in Japan does not pose a marketing problem and in fact may be an asset. "Now that the Japanese have established a reputation for superior technical products, we find most of our dealers and customers look at our product expecting outstanding quality," he notes.

NEC Information Systems imports all its hardware and systems software, but about one fifth of its 200 employees concentrate on fine-tuning the systems software and on creating applications packages for the American market. In addition, a staff of 18 people writes the documentation for the systems—something Cooper says is critical for success in America. "Clear documentation is our pride and joy and one of the reasons for our success with the Spinwriter," he says.

In addition to selling the Astra, Cooper is test-marketing a 14-inch Winchester disk drive and a high-speed band-line printer, both imported from NEC in Japan.

Overall, however, the 36-year-old Cooper, previously director of marketing for Nixdorf Computer Corp., does not see a big difference between working for a Japanese company or any of the other companies he worked with previously in the U. S. in his 12 years in the computer industry. "Our operation would be the same if we bought our product from southern California. It just happens that we import it from Japan." **-A. D.**

Even after they readjust their product marketing, they will have trouble in the U. S., Casanova says. "From a technology standpoint, they're equal, but they can't give the kind of support IBM or the other U. S. manufacturers give, and that's what holds them back. They'll attack microprocessors because it's like a TV or transistor radio—a high-volume item that you sell and walk away from. But for computers you have to set up a complete organization."

The pragmatic Japanese executives readily admit the presence of obstacles to their sale of computers in the U. S. And they are overcoming those obstacles in different ways. Two are using a dealer network; one is looking for a joint venture for sales, customer support, and service operations and another is selling through a third party but hopes to go direct. Only one is undecided.

Perhaps the worst stumbling block to overcome, American observers feel, will be the software. But the Japanese executives sound determined to succeed and are convinced they can overcome the hurdles.

The largest Japanese computer maker, Fujitsu Ltd., a broad electronics manufacturer, already has three ventures going in the U. S. It is a 28% owner of and supplier to Amdahl Corp., Sunnyvale, Calif., and an 80% owner of American Telecom Inc., the Anaheim, Calif., supplier of telecommunications systems. Fujitsu America Inc. in Santa Clara, Calif., is a wholly owned subsidiary that distributes semiconductors and peripherals.

Almost 15% of Fujitsu Ltd.'s ¥440.9 billion ($1.83 billion) in sales were exports last year and of that ¥64.47 billion ($268.6 million), about 40%, went to the U. S.

But of those exports, which include computers, semiconductors, and communications gear, "the figure for North America is low and we want to raise it and make it 50% of our exports," says Michio Naruto, manager for international planning and control.

The avenue for this increase will presumably be the agreement Fujitsu began negotiating with TRW Inc. last September. Although the agreement is not yet final, company sources say it should be completed this spring.

One advantage of going the joint venture route with TRW, Naruto points out, is that "we will build a marketing organization much more quickly than if we had a 100%-owned subsidiary, both in terms of human resources and company reputation." That reputation and resources will be especially helpful since, as Naruto notes, "our company doesn't yet have customers' trust so we have to use some resources to achieve that." He rules out acquisition of a U. S. company for the time being "because that would compete with TRW," but concedes, "We're always thinking about it."

Naruto is also taking advantage of the experience gained by Fujitsu in its abortive attempt to sell in the U. S. in the early 1970s and in its wholly owned subsidiaries in Australia, Brazil, Korea, and Spain. "We've learned how local employees will think about Japanese management and how users will react to Japanese computers." More importantly, the experience persuaded them to go the joint venture route. "To establish our subsidiary in Australia took eight years and we can't wait that long in the U. S. market," Naruto says. In the European market Fujitsu has a two-year-old agreement with Siemens AG.

Hitachi goes head on

Japan's No. 2 computer manufacturer, Hitachi Ltd., is planning to take the direct approach. "The U. S. is the largest segment of the computer market—that's why we want to be in it directly," says Katsushige Mita, senior executive managing director of Hitachi and head of the Electron Devices group (that includes semiconductor and instrument divisions among others) and the Computer Group. Mita says that Hitachi exported only 15% of its computer production, and a large portion of that went to the U. S. under the label of Itel Corp., the San Francisco, Calif., leasing firm that has since left the computer business. But Mita would like to see sales to the U. S. alone reach 15% of Hitachi's total computer sales in two or three years, out of a total export of 25% to 30% of their production.

Shigeru Takahashi, the former deputy general manager of the computer group, who just recently left to become a professor at Tsukuba University, said while still with the company that Hitachi would like to start direct sales in the U. S. sometime during 1980—"we will start small and grow steadily." It does not have to set up a special subsidiary "because we can do business through Hitachi America Ltd. [its wholly owned subsidiary], particularly through the San Francisco office, which is more devoted to computer sales." In the meantime, Hitachi will continue to sell in the U. S. under an agreement that it has made with National Semiconductor Corp.'s National Advanced Systems, which bought Itel's business.

Takahashi recognizes that Hitachi "cannot market computers in the U. S. without American employees. We have to hire capable persons like salesmen and service engineers." These hiring requirements are one reason for starting small. "If we're in a hurry, the quality of the people we gather will be poor," he notes. Hitachi believes it would be difficult to acquire another company with its own way of doing business and integrate it into Hitachi's way of doing business.

Mita adds that computer exports will also be important to the Japanese economy as a whole, especially as developing Asian countries begin competing in other industrial areas. "We've already lost most of our textile business, and in the future we'll lose some of our market share in color television sets, steel, and automobiles. So we have to find new business in the electronics industries." The chorus of the company song of its U. S. subsidiary probably sums things up best: "Hitachi America in the U. S. A., Hitachi America is here to stay."

The third largest Japanese manufacturer, NEC, right now exports only 5% to 6% of its computers. But director

Mitsubishi's far-sighted approach

"Not flashy, but gradual growth" is the goal for Melcom Business Systems Inc., the U. S. subsidiary of Mitsubishi Electric Corp. In practice, that means the Compton, Calif., firm formed in December 1978 and one of the first Japanese computer marketing operations in America, has not rushed to put its small-business computers into user's hands. Instead, it has concentrated on two basic jobs, explains Akira Takei, president.

"Building a dealer network is more important," and Melcom now has eight of them spotted in western U. S. cities. In the meantime, operating software and applications packages have been translated from Japanese and revamped for American users.

Takei and dealer marketing manager Dennis A. Dunn consider Melcom's arrangement with dealers more attractive than most since it offers them generous credit, proven software, and service backup, in addition to strong national and local promotional campaigns and exclusive territories. Melcom does not mind that any of its dealers may also represent other computer firms because "some are the best marketeers of computers, period," says Dunn.

Melcom's computer is the model 18, already proven in Japan for 2½ years, where Takei says it has 25% to 30% of the market for office computers. The basic machine has dual 8-bit processor and 48 kilobytes of memory, expandable to 96 kilobytes, a keyboard, cathode-ray-tube display, matrix printer, and floppy-disk drives. It sells for about $18,000, with optional features adding $10,000 to $15,000 or more.

Takei has much experience in office computers, having started in them 12 years ago, and for this reason was chosen by Mitsubishi to shepherd Melcom. He sees the firm as essentially an American company, headed by a U. S. national after it is off and winging, probably in about two years. But Takei thinks the management philosophy should be a "hybrid combining the best of both the Japanese and American systems." To that end, he wants to install the "family feeling" that marks Japanese companies rather than the U. S. "corporate lookdown" point of view where managers send orders in military fashion to workers. As an example, Takei points to the way he operates: "I'm a very fast decision maker, but I use everybody's opinions."

With only 35 employees of its own, seven of them Japanese, Melcom still imports its computers, but plans to assemble in California as sales grow. **-Larry Waller**

5. Direct approach. Hitachi Ltd. already exports to America through National Advanced Systems (formerly Itel). But Katsushige Mita, senior executive managing director, would like to see Hitachi export 30% of its production—and to do it by selling directly.

6. No push. Although Norihiko Maeda, director of the Electronics Policy division at the Ministry of International Trade and Industry, admits that the Japanese government likes the computer industry, he claims that "we're not trying to artificially promote exports."

Koike says that four years from now it would like computer exports to the U.S., Europe, and Southeast Asia to represent 20% of their sales. To that end the company has established wholly owned subsidiaries in Australia, Brazil, Europe, and four in the U.S. NEC Information Systems and the NEC Systems Laboratories are located in Lexington, Mass., and NEC Microcomputers is in Wellesley, Mass., with NEC Telephones Inc. in Melville, N.Y. NEC Information Systems started marketing its Astra series of small-business computers a year ago [*Electronics*, March 29, 1979, p. 36] as well as peripherals, primarily a teleprinter terminal (see "NEC's pieces are in place," p. 117).

Koike says that "software for the U.S. is being developed in the U.S. by Americans." In fact, he notes, only two executives of NEC Information Systems are Japanese. Currently most of the Americans are in sales, but Koike says the number of both service and software people will increase. Besides its headquarters operation, NEC is represented in the U.S. by 12 dealers who handle maintenance: "We sell systems only where they can supply maintenance." An acquisition is a possibility, Koike says.

There are no plans right now to sell medium-scale or large mainframes in the U.S., but "the current combination of communications and computers is increasing around the world—we won't sell a discrete mainframe, but when necessary as part of a communication system, we'll sell it," says Koike.

Mitsubishi's approach.

Also already in the U.S. market is Mitsubishi. Its Melcom Business Systems, established in December 1977, began sales of its small-business system this past summer (see "Mitsubishi's far-sighted approach," p. 118). Mitsubishi director Ohta says the company will avoid other world markets for the time being, preferring to "marshall its strength in the U.S. and make that operation a success."

Ohta admits software has been an obstacle. "Although we sold over 10,000 computers in Japan and developed many application software packages, those were of no help in the U.S. We needed new applications software." As a result the company purchased the Business Basic software and has hired mainly American employees to continue the software development effort. Melcom also has dealers, who provide service and sales assistance.

The last of Japan's big five computer makers, Toshiba, has not yet reached a decision on how to market in the U.S. But according to Masayuki Sakurai, senior manager of the planning department at the computer division, it wants to reach a decision by the second quarter of this year. It recognizes, however, "that we can't do business independently in the U.S."

The Japanese government recognizes that all this determination should not go unencouraged—although it will not say it is encouraging it either.

"The computer industry is the least resource-consuming industry and is therefore very fit for Japan," explains Norihiko Maeda, director of the Electronics Policy division of the government's Ministry of International Trade and Industry. "At the same time the industry is very promising since the market is experiencing a high rate of growth and demand elasticity."

Americans should not fear some concerted Japanese export effort, he says. "We're not at all trying to artificially promote exports," Maeda maintains. In fact, Japan's other export successess may put a temporary damper on computer exports. "One restraint on our economic growth was our poor balance of payments," Maeda says, remembering a time when the trade deficit concerned the country. "But now we're more worried about a surplus than a deficit, so we have no plans for heroic efforts to export."

COMPETING AT HOME PREPARES JAPANESE VENDORS FOR EXPORT

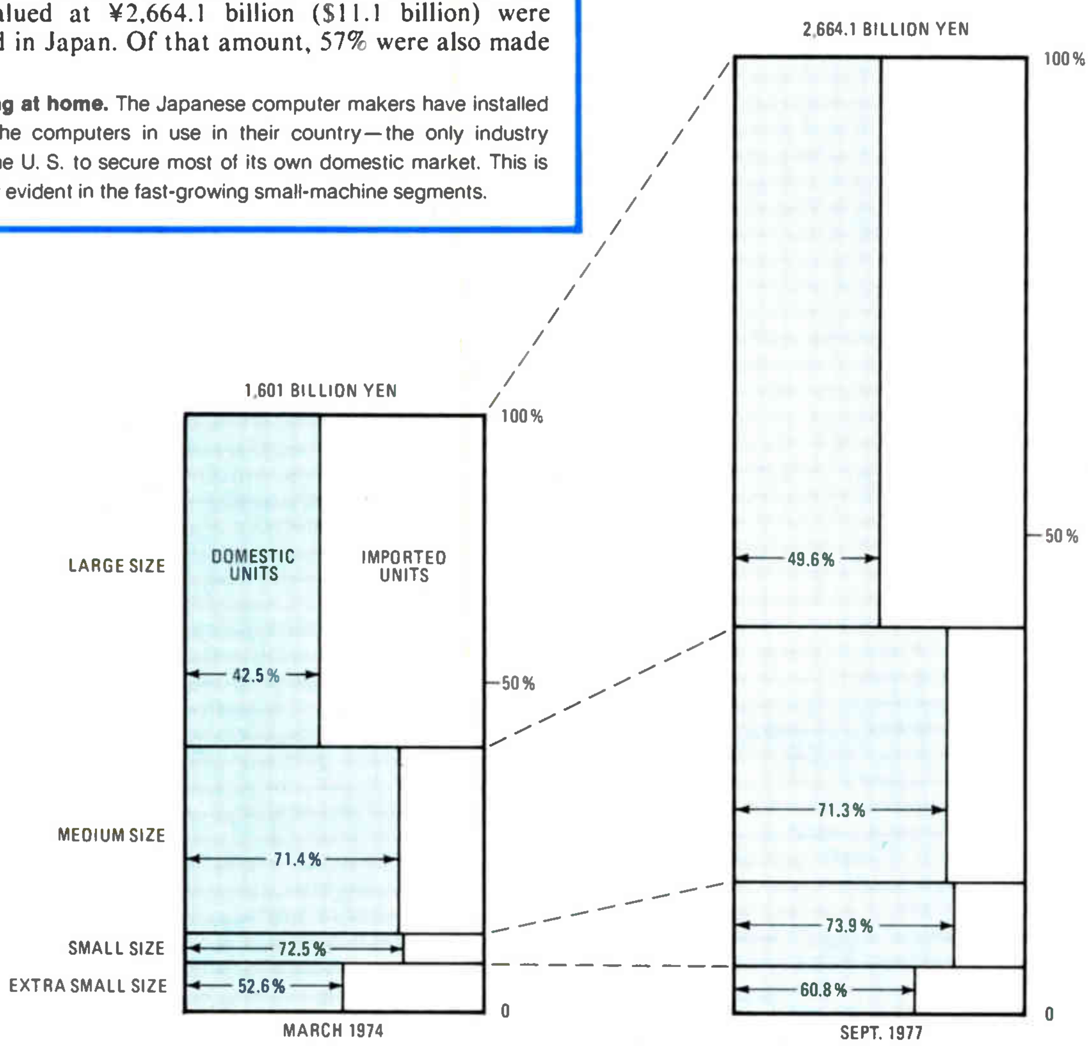
☐ Although many foreigners view them as a single conglomerate, Japanese computer manufacturers are a fiercely competitive group. And their resulting success within their home market will also help launch them abroad.

Electronics' annual market report estimated the computer market last year in Japan at 1,435.7 billion yen (or $5.982 billion), making it second only to the U. S. computer market [*Electronics*, Jan. 3, 1980, p. 148].

Moreover, the Japanese computer industry is the only one outside the U. S. to have more than 50% of its home market. As of September 1977, the latest year for which official figures are available from the Ministry of International Trade and Industry, over 43,900 computer systems valued at ¥2,664.1 billion ($11.1 billion) were installed in Japan. Of that amount, 57% were also made in Japan, according to a report released last summer by the Japan Information Processing Development Center.

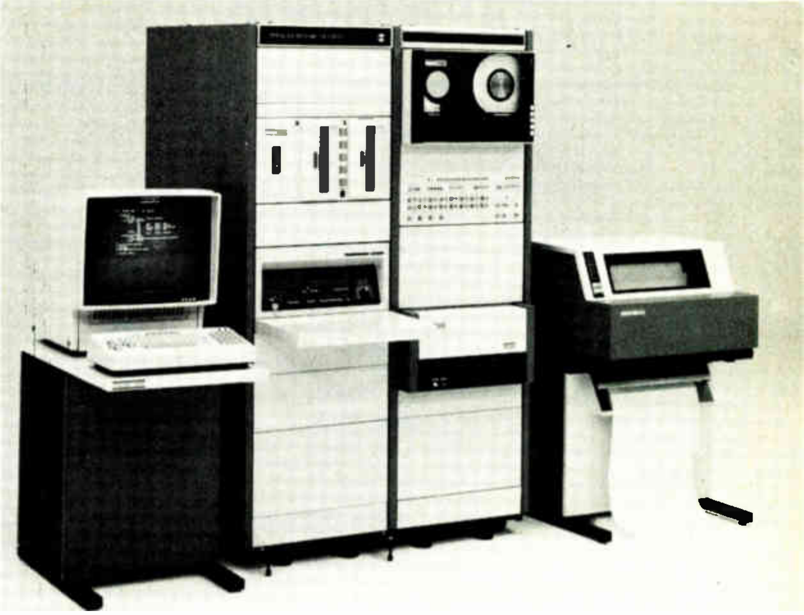
As may be seen in Fig. 7, the Japanese have installed an even greater proportion of the small and medium-scale systems, a fast-growing market segment. Since the chief foreign rival, IBM, emphasizes large-scale mainframes, their outlook for the future could be even better. Office computers, the most active area, are almost totally domestic, so that the growth in numbers of these entry-level and smaller-mainframe customers should guarantee expansion for the future.

7. Leading at home. The Japanese computer makers have installed 57% of the computers in use in their country—the only industry outside the U. S. to secure most of its own domestic market. This is especially evident in the fast-growing small-machine segments.



From its infancy in the late 1950s, the Japanese computer industry was a favorite child of the Japanese government, which nourished it with subsidies while protecting it with restrictions against imports and local manufacture by foreign firms. Japan's six mainframe manufacturers—Fujitsu, Hitachi, Nippon Electric, Mitsubishi, Toshiba, and Oki Electric—developed through the 1960s largely by manufacturing Japanese versions of American machine designs obtained under license. In 1972, in preparation for opening the market to foreign competitors, the government grouped the companies into three teams to develop domestic computers competitive with IBM's System/370 mainframes. Fujitsu worked with Hitachi, Nippon Electric and Toshiba joined forces, and Mitsubishi and Oki teamed up.

The government continues to support this domestic industry with the Law of Extraordinary Measures for the Promotion of Specified Data Processing and Machinery Industries—commonly called Kijoho in Japanese—that went into effect in July 1978 and will continue for eight years. Besides moral support, the law provides for low-interest loans through the Japan Development Bank to aid capital investment and for rapid depreciation of some types of capital equipment.



8. Static. Although all the vendors make minicomputers, most are used internally, resulting in a rather static market. The only independent minicomputer maker is Panafacom, a joint venture of several companies, that makes the 16-bit model 1300 shown here.

Five mainframe manufacturers

As Japan enters the 1980s, it has five mainframe manufacturers, of whom three are large, as well as several U. S. suppliers established in Japan and some 50 or 60 makers of small-business computers. Only in minicomputers is Japan lacking a large industry.

Fujitsu Ltd. and Hitachi Ltd., never close partners, have now split. Fujitsu, with about 22% of the market, Hitachi, with about 15%, and Nippon Electric Co., with some 13%, dominate the Japanese market, according to Ichizo Yamauchi, a computer industry analyst with Nomura Research division of the investment house of Nomura Securities Co. in Tokyo. Meanwhile, Mitsubishi Electric Corp. plans to increase its 4% market share by breaking into the IBM-compatible computer business.

Toshiba is in the process of dropping out of the mainframe business. It recently merged its sales force in a joint venture with NEC called NEC-Toshiba Information Systems, which sells the computers the two companies developed, and is instead turning its attention to small-business systems and minicomputers. Oki Electric Industry Co. now concentrates on manufacturing peripherals, although it makes and markets computers through a joint venture with Sperry Univac in the U. S.

On the foreign side, IBM Corp., with a wholly owned subsidiary that makes many of its products in Japan, has about 28% of the market. Univac, which makes computers in a joint venture with Oki, has another 12%, and NCR's 70%-owned subsidiary, which primarily imports, has 2%, rounding out the list. Honeywell and Control Data Corp. have just recently established subsidiaries.

Producing some ¥6,965 billion ($29 billion) worth of products last calendar year, electronics is very important to the overall Japanese economy and represents 5.88% of the gross national product. By fiscal 1978 the electronics industry was second only to the automobile industry in production. The computer industry represents some 15% of all the electronic goods produced, according to the Japan Electronic Industry Development Association. Especially to the conglomerates that manufacture them, computers represent an increasing source of revenue.

Fujitsu, an established telecommunications and electronics supplier, is closest to being solely a computer manufacturer. Computers accounted for ¥303,030 million ($1,262 million) or 68% of its ¥440,921 million ($1,837 million) in revenue for the 1978 fiscal year that ended March 31, 1979, the last full year for which data is available. (In Japan, fiscal years are named for the year in which they begin, not the one in which they end, as in the U. S. All the computer companies fiscal years end on March 31.)

Hitachi, a giant industrial conglomerate that produces a variety of products from wire and cable and batteries to nuclear-powered electricity-generating stations, had revenues of ¥2,574 billion ($10.72 billion) for fiscal year 1978. Of that amount, the communications and electronics equipment group, which includes computers and semiconductors, accounted for ¥478,829 million or 19%. Yamauchi estimates ¥190,000 million ($791.6 million) is from computers.

Originally a communications equipment supplier, NEC has since diversified into several areas and had 1978 revenues of ¥809,890 million ($3,374 million). Of this, data-processing gear was ¥175,670 million ($731.0 million) or 22%.

Toshiba, also a diversified industrial firm, had revenues of ¥1,770 billion ($7.375 billion) of which its industrial electronics group, which includes computers and semiconductors, earned 22%.

Mitsubishi, another industrial giant, had revenues of ¥1,018 billion ($4.24 billion), of which its electronics and industrial group, which sells computers, electronic devices, elevators, and other industrial equipment, accounted for 31%.

Profits, however, may be more elusive for the computer makers. Yamauchi estimates that only Fujitsu and Hitachi have computer operations that are profitable today, although he thinks NEC and Mitsubishi are breaking even. Mitsubishi director Hideo Ohta, deputy general manager of its electronic products and systems group, sums up the attitude of many of the manufacturers. "We're not thinking of loss or profit just for computers, but for the whole company. And we use computers in all our businesses. When we can't follow computer technology, we'll be in trouble all over."

Mini market for minicomputers

Although there are five Japanese mainframe makers, three of which compete head on with IBM, there is a dearth of specifically minicomputer companies. In fact, the only large native company is Panafacom Ltd., a joint venture of Fujitsu Ltd., Fuji Electric Works Ltd., and Matsushita Communication Industrial Co. Panafacom, with ¥10 billion ($41.6 million) revenues for fiscal 1978, claims 25% to 30% of a market estimated by the U. S. Department of Commerce at only ¥45,799 million ($191 million) last calendar year. Perhaps another 10% each goes to Digital Equipment Corp., Yokogawa-Hewlett-Packard, and Nippon Mini Computer Corp., a subsidiary of Data General Corp.

The mainframe manufacturers all make minicomputers, but they do not market them as aggressively as might be expected. A major reason is Japan's lack of independent original-equipment manufacturers. Most industrial companies make minicomputers for use in their own industrial-control, process-control, and other systems. Panafacom, for instance, was set up specifically to provide its parents with minis. And instead of adapting minicomputers to business applications, the Japanese mainframe makers design special central processors and other hardware. Indeed, most of the independent companies that compete in the small-business market also build their hardware from scratch, rather than just purchasing computers and peripherals and integrating the system—a technique popular in the U. S.

For the major Japanese computer manufacturers to talk about their minicomputer market shares is "like acorns comparing their height," says Mitsubishi's Hideo Ohta. Nevertheless, minicomputers are being developed by Japanese manufacturers and have benefited from the technological fallout from the more dramatic mainframe and small-business computer developments.

Panafacom Ltd.'s line consists of the model U-1100 that fits between Digital Equipment Corp.'s PDP-11/03 and 11/05, the U-1300 that competes with the mid-range PDP-11/34 (Fig. 8), and the U-1500 that has the price of DEC's PDP-11/60 but the performance of the high-end 11/70. The units are based on bit-slice processors (like the 2900) and custom Schottky TTL chips, all obtained from Fujitsu. The 16-bit n-channel MOS microcomputer L-16A is based on a chip from Matsushita and is available from Panafacom in a range of products from the chip level to board packages. With this product, Panafacom claims to have captured three fifths of the domestic market.

Similarly Toshiba's Tosbac and Mitsubishi's Melcom 70 minicomputer lines range from single-board microcomputers to high-end 32-bit minicomputers (see "The 32-bit question," below).

NEC two years ago introduced its System 50 and 70 minicomputers, which the company primarily uses internally for its communication equipment. Hitachi also uses most of its Hitac 20 and Hitac 10II minicomputers internally and keeps its operation relatively low-key.

The role of NTT

Another unique feature of the Japanese home market is the role of Nippon Telegraph and Telephone Public Corp., the country's telecommunications supplier. Unlike American Telephone and Telegraph in the U.S., NTT has no captive manufacturing capability. It works with private industry, a relationship that provides a cross fertilization of research and development.

While it is not a commercial hardware supplier,

The 32-bit question

Although most of the major computer vendors have competitive 16-bit minicomputers, the only Japanese companies with the more powerful 32-bit machines are Toshiba and Mitsubishi.

Toshiba's Tosbac Series/70 was the first of the Japanese 32-bit machines, introduced in January 1979, just after Digital Equipment Corp. announced its 32-bit VAX 11/780 in the U. S. Masayuki Sakurai, senior manager of the computer division's planning department, says the machine is comparable in performance to the VAX line and can handle up to 2 megabytes of main memory. Last year Mitsubishi introduced its 32-bit Melcom M70/150 with a 2-megabyte memory, also to compete with VAX.

Although Panafacom does not currently make a 32-bit machine, Masahiro Yamashita, director of market planning, says it has "plans because it will be necessary in the 1980s. But we'll have to change our style of business because more software support will be needed."

The other manufacturers are not sure if 32-bit minicomputers are needed. NEC's executive vice president Akira Koike says the company "is developing the next stage for minicomputers for the future," but will not specify whether those are 32-bit machines.

And Shigeru Takahashi, former deputy general manager of Hitachi's computer group, said, while still with the company, that he sees no great need for large minicomputers because they are comparable in performance with small mainframes. "If software is completely unbundled, it should be possible to sell mainframes at comparable prices," he says. **-A. D.**

Watanabe's *noren wake*

Of all the people and companies creating the current surge in the popularity of small computers in Japan, probably none has been involved longer than Akio Watanabe. His goal is a computer very simple to program.

"But there is no possible way that a child (or a businessman) could learn to program a computer whose software is designed around an operating system," he observed. Instead, Watanabe wants his machines to be programmable directly on the computer in a simple, easy-to-learn version of the Basic language. The programmer's usual pad and pencil will be out.

His emphasis on simplicity and easy learning is clear at Systems Formulate Corp., a small-computer retailer of which the 46-year-old Watanabe is president. Unlike most of the electronic equipment shops that abound in the Akihabara section of Tokyo and sell the same hardware as Watanabe, his four facilities provide technical support and software training. Watanabe's staff also modifies hardware and writes software. But so clear is the emphasis on training that Watanabe calls his sites "campuses." He opened the first in Tokyo in 1978, added a second and third in Osaka and Niigata last year, and recently opened another in the U. S., in Palo Alto, Calif. He markets standard hardware—the Commodore Pet, the Apple, and Nippon Electric's PC-8001 are his best sellers.

Watanabe has been on the forefront of the small-computer movement since he left the computer department of an automaker in 1964 to join Fujitsu as a hardware designer and worked with the late computer pioneer Toshio Ikeda, then head of computer engineering, to set the course for Fujitsu's small computers. This led to his designing the widely used Facom 230 series that preceded today's Facom V-series of small-business systems. His design work on the series won him four company awards before he decided to leave in 1978.

Watanabe did not leave Fujitsu on unfriendly terms, though. Instead, company president Taiyu Kobayashi encouraged his intention to get into the small-computer business on his own, by offering technology, personnel and financing. Watanabe says he took no money, so as to retain his independence, but—a surprise to those unfamiliar with Japanese ways—he did take the 230-series development group.

Watanabe likens Fujitsu's actions to *noren wake*, the traditional Japanese name for setting up an employee in the same business. As experts on Japanese culture note, this is only done when the parent company is convinced the newly independent branch will increase the market and thus indirectly increase the earnings of the parent—something Watanabe is sure he can do by popularizing small computers. **-C. C.**

NTT—or Dendenkosha for short in Japanese—is the only organization allowed by Japanese law to function as a data utility, providing computer power to many customers. Computers used for these services are invariably purchased from domestic manufacturers, making NTT a major stimulus to the domestic industry.

The first service of this type was a nationwide funds transfer system provided for the local banks' association in 1968. This service, coupled with the cash orientation of Japanese society, stimulated the early development of electronic funds transfer networks, which are now among the most sophisticated in the world. In 1973 NTT started its Demos-E timesharing service, which is available to any subscriber for fees covering installation and rental of terminals, the time the service is used, and memory.

Although all of the early installations for Demos-E used commercial computers, NTT also developed its own computers, cooperatively with leading manufacturers Hitachi, NEC, and Fujitsu for this and newer services on a large scale. The three companies supply different sizes of computer, the DIPS-11 Series, but all are large systems and share a common architecture and instruction set. They feature multimegabyte main memories, virtual memory, large disks, cache memories for high speed, and a large number of input/output channels for high throughput in on-line applications.

The original Dendenkosha Information Processing System came in three models: one each manufactured by Hitachi, NEC, and Fujitsu. The line is currently being upgraded by the three companies.

All three will also supply communications control processors with 64-K dynamic random-access memory chips developed as a joint project by the companies and NTT. Fujitsu delivered the system last year, and the other companies are scheduled to deliver this year. In addition, Hitachi will supply a file-control processor, a modification of one of the upgraded models to provide management of a large data base without processing. Among the technological benefits to come out of the work with NTT are high-capacity memory chips, emitter-coupled-logic LSI, and high-capacity disk drives.

Japan's burgeoning office computer market is divided among 50 to 60 companies. The top three companies—Nippon Electric, Toshiba, and Mitsubishi Electric—have about 40% of a market estimated by the Japan Electronic Industry Development Association to be growing at 28% annually. On the basis of Jeida's estimates, the market is projected to reach ¥168.59 billion ($702 million) for fiscal 1979, which ends this month. The top 10—including the five mainframe computer manufacturers plus Oki, Casio, Canon, and Sharp—have about 90%. IBM has perhaps another 2% or 3% (see "Watanabe's *noren wake*," p. 123).

Prices for low-end systems run from about ¥2 million ($8,333) and up, about half of which is for software. Software rather than hardware appears to be where the interesting features lie. The strongest market segment appears to be in the area of about ¥5 million ($20,000), with prices gradually inching up.

Matsushita Electric Industrial Co., perhaps best known in the U.S. for its Panasonic consumer products, jumped into the fray late last year with an 8085 microprocessor-based system. It confidently expects to grab 5% or 6% of the market on the strength of its complete software packages. The company has also started selling it in the U.S. through its Panasonic subsidiary this month.

Atsu Kimura, marketing manager for Hitachi's computer group, says that sales of office computers in the ¥2-million-to-¥5-million (about $8,000-to-$21,000) price range are booming because the rental is less than the salary of a clerical worker.

9. Evolving. Typewriters are practically unknown in Japan. But computer-based word-processing systems are gaining popularity. One of the first was Toshiba's JW-10, shown here, that converts Japanese syllabic katakana characters into kanji ideograms.

Most small-business computers available in Japan can display at least the katakana Japanese phonetic syllabary and some Chinese kanji characters—ranging from perhaps a dozen Chinese characters for a desktop personal computer to several hundred for the typical office computer. In February 1979, when Nippon Electric modified the hardware of its year-old office computer line, it also added an optional package of displays, line printers, and software capable of handling almost 4,000 Chinese characters, taking the lead in this area.

Entry of text containing Chinese characters is not particularly convenient, and users generally have dealers enter lists of customers, products, and so on, before accepting delivery. Many custom business programs are also entered by dealers using Cobol. Although demand for word processors for the Japanese language is also increasing, at present they are separate product lines for most companies (Fig. 9).

A unique feature of the Japanese market is the Japan Electronic Computer Co. (JECC), which was established in 1961 to finance leasing for the computer industry. The six major manufacturers supplied initial capital to form JECC, along with government-backed loans through the Japan Development Bank at favorable interest rates. JECC purchases the computer leases from the manufacturers, allowing them to record it as a sale, and finances the lease for the customer.

The presence of JECC has encouraged leasing in general in Japan, and an estimated 65% of the systems now installed are leased.

According to the U.S. Department of Commerce study, Fujitsu's equipment as of 1978 accounts for 42.7% of the JECC leases, NEC for 30.1%, Toshiba for 12.6%, Oki for 6.3%, Hitachi for 5.8%, and Mitsubishi for 2.5%. Hitachi is withdrawing from the JECC system, however, and is now financing its own leases.

Single sources

Another outstanding feature of the Japanese market is that users want to buy their entire system—mainframe, peripherals, and application software—from one vendor, says Yoshiteru Ishii, a director of NEC, associate senior vice president and general manager of its EDP planning office. Japanese users, unlike Americans, do not buy their peripherals from the cheapest supplier and then pick up their software from a software house. The only exception they make is for data-communications terminals, which have clearcut interfaces.

This attitude keeps software houses from functioning independently, and since most manufacturers cannot turn out all the software required, there are very close ties between manufacturers and software houses.

Nippon Electric, for example, works with about 140 software vendors, ranging from very large to small. Two wholly owned subsidiaries do most of this work, but true outside orders still equal 40% to 50% of the total. Although the subsidiaries are being enlarged, outside vendors are desirable because they increase efficiency and pin down responsibility, NEC's Koike says.

A Nippon Electric executive says that the Japanese

Hitachi's guiding light

"It is not a healthy approach to develop various computer architectures without taking into account the burden of developing software," Shigeru Takahashi believes. And this belief has helped the Japanese computer pioneer shape the IBM-compatible approach being taken by Hitachi Ltd.

The designer of Japan's first two transistorized digital computers built by the government's Electrotechnical Laboratory between 1955 and 1959, Takahashi joined Hitachi in April 1962. At the time, Hitachi was working with the then Radio Corp. of America on the design of the Spectra 70 line of computers that was intended to be similar to IBM's. Takahashi realized it was not enough to be similar to IBM—it was necessary to be the same.

And for his 18 years with the company, he has been promoting improved compatibility, both within Hitachi's product line and with IBM.

After RCA left the computer business, Hitachi decided to continue the development of IBM-compatible computers, and Takahashi supervised the design of the M-Series, starting in 1971. "Design of an IBM-compatible computer is difficult because engineers tend to invent," he says. "It is sometimes easier to make your own design than a compatible one. Compatibility is a constraint, and engineers like to escape from constraints."

Although many in the industry both in Japan and America say it is increasingly difficult to stay compatible with IBM, Takahashi disagrees. "An examination of the IBM documents shows that the architecture is getting cleaner. The model 4300 has only one kind of memory—virtual—and is thus simpler than the System/370, which has two kinds—real and virtual."

The deputy general manager of Hitachi's computer group and its spokesman when he was interviewed for this report, Takahashi left the company in mid-January to become a professor at Tsukuba University, a little more than a year before he would have reached Hitachi's mandatory retirement age of 60.

In his new role he will have the opportunity to practice his theory of engineering education. "Young engineers should get their work-related training in on-the-job training at individual companies," he says. A basic theoretical grounding is what the university should provide, "with just the flavor of computers thrown in."

Logical thinking is also important, and programming is good training for that. But Takahashi feels students should not start with high-level languages. "Although machine-language-programming is no longer practical [commercially], it is not possible to understand computers without passing through that stage." **-C. C.**

companies are at an advantage in that they can introduce their users to a software house. IBM salesmen cannot because such introductions are prohibited by the company's business conduct guidelines, which tell the customer to find a software house itself.

But according to Sakurai of Toshiba, Japanese users dislike the smallness of systems houses. At present, he says, application software is a big problem because each user tends to think that his problems are unique and wants his own software to match his own way of doing business and accounting.

To encourage this software industry and promote the separate pricing of software by manufacturers—so-called unbundling—the Japanese government last April began giving the industry tax breaks. Under the program, any company in Japan writing and selling general-purpose software can register that program with the the semi-governmental Information-Technology Promotion Agency. Fifty per cent of the revenues from those packages, once accepted for registration, is exempt from taxes and can be placed in a reserve fund for five years to finance the development of more software. After five years the company must pay tax on only 25% of the amount held in reserve. The law runs until March 1981, but industry observers expect it to be extended.

Perhaps more important than the financial aid this program gives the industry is the support for the unbundling concept it implies. In addition, the JECC maintains a registry of software packages to help vendors sell their software separately. Such unbundling is slowly gaining headway, Ishii says, adding that the trend is more advanced for office computers than for mainframes.

Takahashi said, while still with Hitachi, that the firm had increased the degree of unbundling on its latest M-series H-suffix computers in order to remain competitive with IBM, which has further unbundled its 4300 computers. The unfamiliar arrangement will be hard to sell to Japanese customers, he says, and "normally we must do things the Japanese way, but if IBM takes the lead the change is accepted."

NEC's experience illustrates the need for a phasing-in period. Koike says that the company is receiving extra payments for software for about 70% of its new Acos 250 installations. But rather than receiving a fixed price for software as IBM does in Japan, the company negotiates with each customer. Thus at the moment much of the cost of software must still be absorbed by NEC.

Yukio Mizuno, senior vice president of NEC-Toshiba Information Systems Inc., says that it is even more important for a systems house like NTIS to unbundle software because it does not make its own hardware. Instead it stresses system creation.

Unfamiliarity with unbundling is not the only obstacle to it in Japan. As Yuji Ogino, a market analyst with International Data Corp.'s Tokyo office, notes, "Japanese people in general feel intangible assets should be made available free of charge."

Japan for the foreseeable future will have more trouble with software than the U. S., because of the obvious language barrier—Cobol, Basic, and most other high-level programming languages are based on English. This tends to restrict the programming field to college graduates, keeping the price of programmers high.

But the Japanese realize that the price of not developing competitive software will be even higher. And Norihiko Maeda of Miti confidently predicts that the Japanese will solve the software problem, "as they have solved the problem of hardware."

SPECIAL REPORT

MADE-IN-JAPAN HARDWARE MATCHES BEST FROM U.S.

☐ Just as the Japanese learned to culture pearls, so have they learned to nurture computer technology.

Their first efforts were in developing state-of-the-art semiconductors. These efforts have met with such success and the Japanese are producing so many exports that they have now come under attack from American firms. But it is not the Japanese intent to merely be a supplier of semiconductor components—they want to supply complete computer systems.

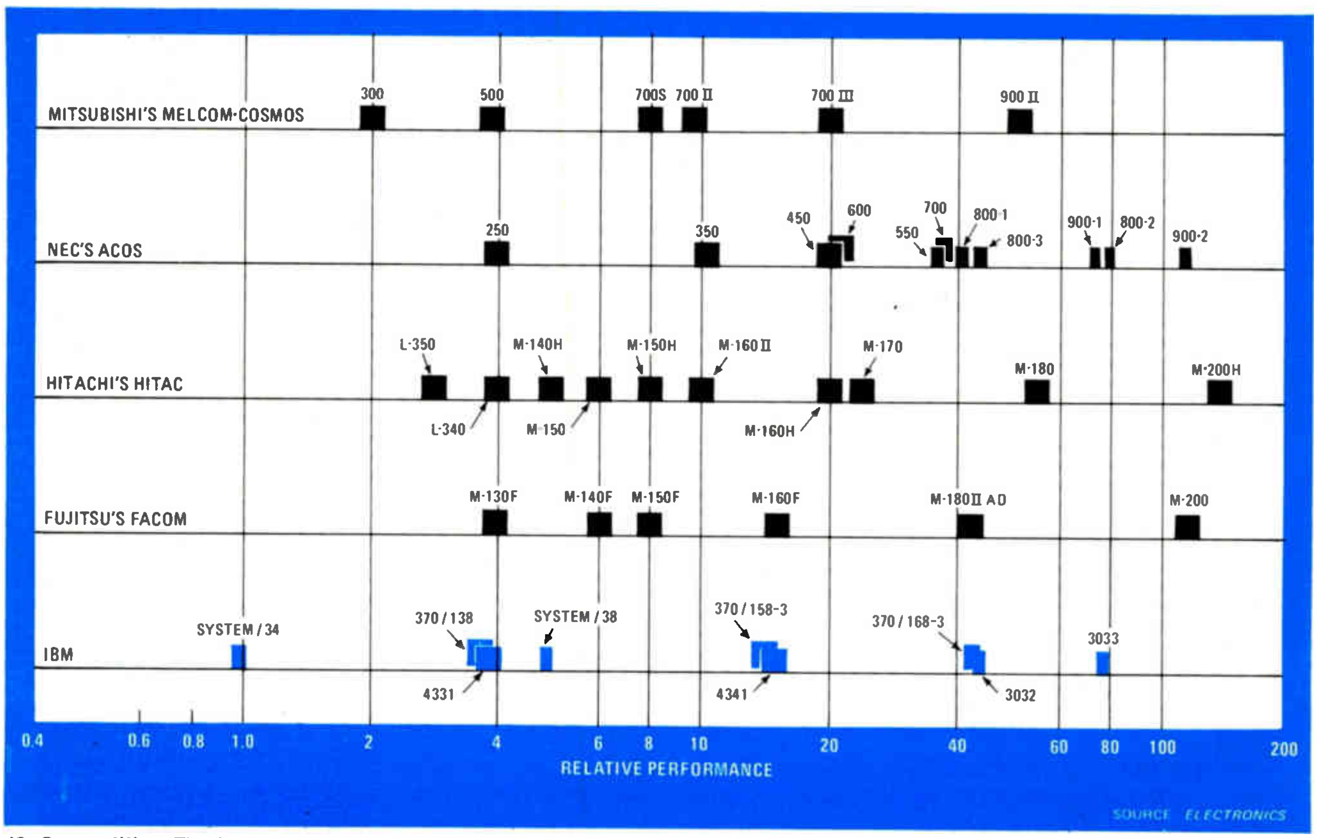
Just as a piece of sand placed in an oyster becomes the seed around which the pearl is formed, this semiconductor progress is the seed around which they are building their computer technology—which to Japanese industry has a price above pearls.

"The Japanese feel computers not only are important as an industry but also lead the technical growth of all other industries," says Ichizo Yamauchi, a security analyst with Nomura Research. "They won't drop out of the computer business, even if they're losing money."

Mitsubishi's Electric Corp.'s Hideo Ohta, deputy general manager of the electronic products and systems group, agrees that "computers and integrated circuits are leading-edge technologies. And as you pull up the leading edge, its skirts broaden and impact all Mitsubishi products and improve them."

Because of this recognition of the pervasiveness of computer technology, all the Japanese computer makers—themselves divisions of larger electronics and electrical machinery makers—are vertically integrated. And where the vertically integrated electrical machinery makers in the U. S., such as General Electric and RCA, got out of the computer business, their Japanese counterparts are determined to stay in.

The Japanese are not shy about their increased technical maturity, originality, and independence of U. S. technology. Kimio Ibuki, director of data processing development at the Nippon Telegraph and Telephone Public Corp.'s Yokosuka Electrical Communications Laboratory, Yokosuka, Japan, is one that sees the Japanese industry as more independent. "We were taught a lot 10 years ago, but the amount coming in today is smaller, and is starting to flow out." Perhaps the best evidence of



10. Competitive. The four major Japanese mainframe computer lines illustrate how competitive the country's technology has become. The manufacturers, now independent of imported technology, compete head to head with IBM, which sets the *de facto* industry standard.

this increasing independence is Nippon Electric Co.'s decision not to renew its 18-year-old technology exchange agreement with Honeywell last December [*Electronics*, Jan. 3, p. 34].

George Champine, former director of research and development for Sperry Univac and now vice president of research and product development for word processor maker Vydec Inc., the Exxon affiliate located in Florham Park, N. J., perhaps sums up the state of Japanese technology best. "Their strength is in semiconductors, and semiconductors are the basis of almost everything we do in computers." Although he considers their computer architecture rather conventional, Champine says what sets it apart is the fact that they have "so many different techniques all together in one place." And the Japanese will continue their technical advancement because "they have a good aptitude to take the next logical step." And just like their semiconductors, the Japanese computers are very competitive.

Competitive product lines

This is most evident in the current product lines of the five leading manufacturers. The results of an eight-year development effort, these machines embody the state of the art in numerous ways, from their components and packaging to their hardware architecture and input/output peripherals. Although they may reflect American design influence of an earlier period, the new machines are truly made in Japan.

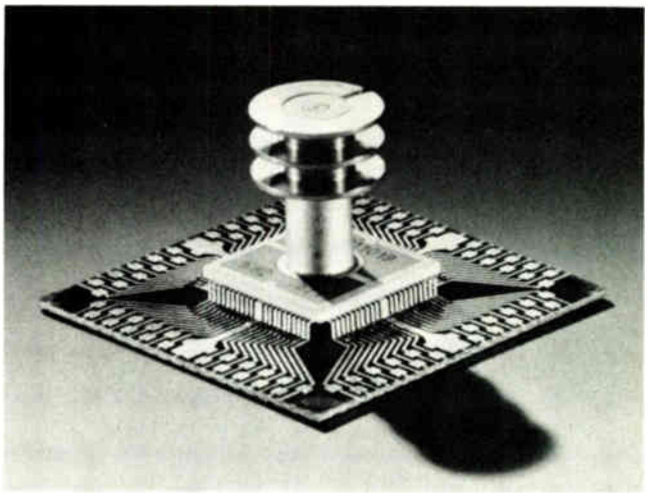
Intended to match the System/370 line of mainframes that International Business Machines Corp. introduced in 1970—the *de facto* industry standard—these products did just that by the time introductions started in 1974. Since then, as the chart shows (Fig. 10), the Japanese manufacturers have expanded their lines. The M-Series from Fujitsu Ltd. and Hitachi Ltd. are perhaps the broadest lines, spanning from IBM's new low-end 4331 to past IBM's biggest model, the 3033. (Although the companies originally worked together on the M-series, they have since started manufacturing independently, so that the performance differences show up in similarly numbered models.) NEC's and Toshiba Corp.'s Acos family similarly starts with a unit comparable to the 4331 and ends with the 900-2 that surpasses the 3033. Mitsubishi's Melcom-Cosmo line starts at the same place and its newest model, the 900 II, extends its reach to the 3032.

The sophistication of the Japanese industry is especially evident in its response to IBM's model 4300, unveiled last January. Although it took them almost four years to respond to the System/370, the Japanese responded to the 4300 almost immediately. NEC and Mitsubishi announced competing products the following month, with Fujitsu following in April and Hitachi in June.

Although the companies teamed up in 1972 to cooperate with the government in the development of three basic machine designs, each is now becoming more independent. The joint efforts are becoming fewer and less important as the companies' own spending overshadows the government subsidies.

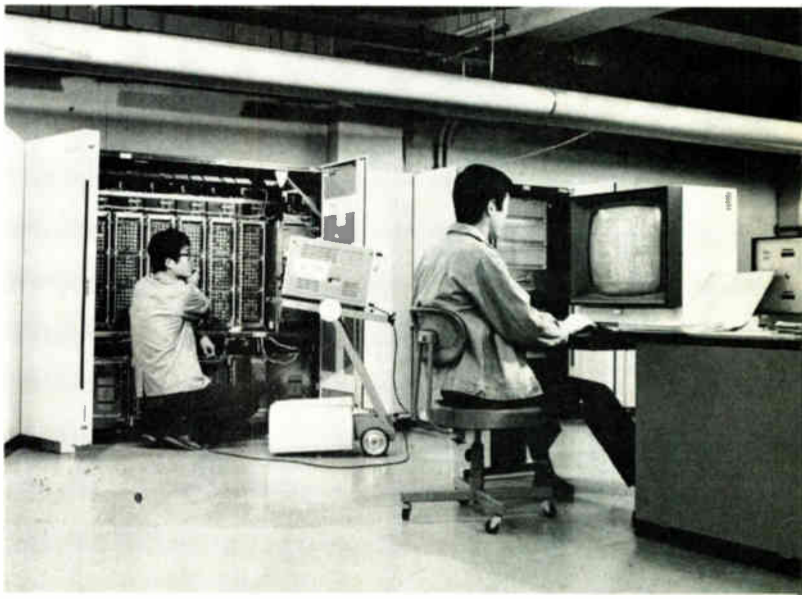
Traditionally considered the most independent of the Japanese manufacturers, Fujitsu had no ties with American companies until it invested in Gene Amdahl's fledgling computer company, Amdahl Corp. of Sunnyvale, Calif., almost 10 years ago. Although Fujitsu executives maintain they learned more about American management than technology from Amdahl, the emitter-coupled-logic gate arrays that are the basis of its large-scale computers were developed by Amdahl and are manufactured under a license of the Amdahl patent. (Amdahl also buys the same chips from Motorola.)

Still, Michio Naruto, deputy manager of international operations planning and control says, "Fujitsu's technical know-how is better than that of U. S. companies in many areas." Fujitsu feels its IBM-compatible M-series of computers are the best examples of its technical competence, especially in their pioneering use of emitter-



11. Pagoda. This emitter-coupled-logic gate array made by Fujitsu for Amdahl and its own high-end machines is typical of the company's advanced hardware. It contains 100 ECL gates with 700-picosecond delay times. The pagoda-like fins dissipate 3 watts.

12. The quality goes in. Japanese computer makers are noted for their meticulous manufacturing and highly reliable products. Technicians at Fujitsu's Numazu complex complete final systems testing on a model M-190, the firm's second-biggest machine.



coupled-logic gate arrays (see "Matching the ratio," p. 134). The company began using gate arrays in 1974, almost five years before IBM.

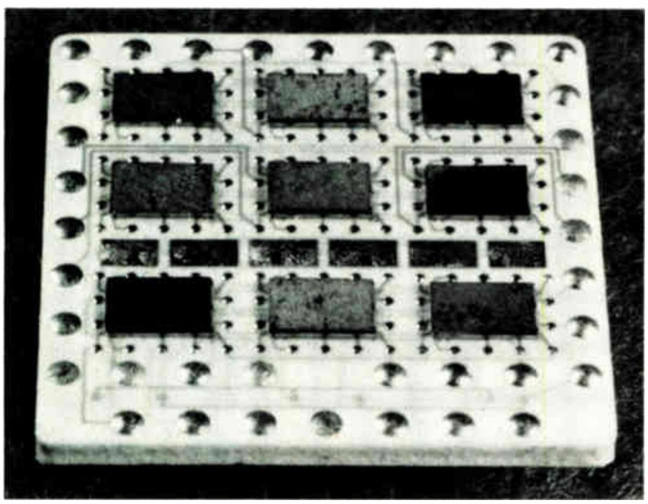
The 157-mil-square chips contain 100 ECL gates arranged in an array of five by five functional blocks, or macro cells, with gate-propagation delays of 700 picoseconds. By customizing the final two layers of metalization with a computer-aided design system, Fujitsu can produce a variety of parts. The most memorable feature of the chips, however, is the unique finned heat sink that resembles a top hat (or a small pagoda to the Japanese) and is mounted atop the chip to dissipate the approximately 3 W the chip produces (Fig. 11).

Each ECL chip is mounted on a ½-inch-square ceramic carrier with 84 input/output connections. These in turn are mounted on a multichip carrier—a 10-layer 7.5-inch-square printed-circuit card that can hold 42 chips.

In addition to being employed in Amdahl's 470V-series machine in America, these chips form the heart of machines at the top of Fujitsu's line: models M160, M180 II, M190, and M-200 computers (Fig. 12).

Its newest additions to the M-series, the M-160F, M-150F, M-140F, and M-130F, introduced to compete with IBM's 4300 units [*Electronics*, April 26, 1979, p. 64], use a macro-cell approach with Schottky TTL arrays that contain some 600 gates. Each cell is a quad two-input NAND gate and there are between 10 and 20 cells in a row, with 10 to 20 rows in the array. Each chip is packaged on a 1-inch-square ceramic carrier containing 60 pins arranged in two rows around its perimeter.

This use of unique semiconductors continues in the Facom V-830 line of small-business computers unveiled this past fall. In addition to the bipolar macro-cell array used in the M-130F through M-160F, a complementary-MOS microcomputer chip is used to control the channels and system console. Although basically a 16-bit machine, the use of a 24-bit address, which is transmitted through the bus in two cycles as a combination of 16 and 8 bits, allows the V-830 to address as much as 16 megabytes of main memory—a staggering amount for a small-business machine.



13. Multiple memories. Hitachi packages static random-access memories on a six-layer ceramic substrate 23.4 mm (0.92 inches) square for its writable control store. Collapsed-solder-dot bonding techniques similar to those employed by IBM are used.

But Fujitsu's technical achievements are not limited to semiconductors. Among the more obvious features of its M-series machines are the optional color monitors on the system's console, a feature not available from IBM.

More subtle is the use of dynamic address translation in the input/output channels on the biggest models, M-190 and M-200. This design—not found in Amdahl or Hitachi machines and only last year added to IBM's 4300—lets the channel use the same virtual memory addresses as the central processing unit does. This saves address translation time, speeding I/O operations.

Fujitsu also points out that it offered multiprocessor configurations of its M-180 and M-190 practically a year before IBM made a similar capability available on its top-of-the-line model 3033 computers in April 1978.

Partners against IBM

A licensee of RCA Corp. since 1961, Hitachi became familiar with the concept of IBM compatibility through the RCA Sigma series computers. When RCA left the business in 1970, Hitachi decided to continue to pursue IBM compatibility. It seemed only natural, therefore, that it team up with Fujitsu in the government-coordinated development effort starting in 1972.

Although both companies worked together on the basic design of the M-series computers, Shigeru Takahashi, former deputy general manager of the computer group, is quick to point out that "the logic and machine organization is completely different from Fujitsu's" [see "Hitachi's guiding light," p. 125]. The most obvious difference, he notes, is that the Hitachi machine is a microprogrammed design, whereas Fujitsu's is hardwired, much the way Amdahl's machine is.

Another innovation is in the latest M-series models. The M-140H, M-150H, M-160H, which compete with the IBM 4300, use Hitachi's version of an ECL gate array that holds up to 124 gates per chip with 1.1-nanosecond propagation delay per chip [*Electronics*, June 21, 1979, p. 65]. A standard Hitachi chip, the same master slice is also used in the older M-160II, M-150, M-170, and M-180 machines, as well as the Advanced System-6 model it sells in the U.S. through National Advanced Systems. But the new machines being shipped for the first time this month are designed to use state-of-the-art 64-K random-access memory chips.

The memory for their writable control store is a 4-K static random-access memory that uses a memory array of n-channel MOS but has complementary-MOS outputs and operates with an access time of 55 nanoseconds. A novel packaging scheme puts nine of these chips onto a ceramic substrate 23.4 millimeter (0.92 inch) square that has six levels of metalization for interconnection (Fig. 13).

The package is arranged so that it appears to the computer system as a single 4-K-by-9-bit device. Hitachi, one of the few to do so, uses a collapsed solder-dot bonding technique similar to IBM's.

Combining technologies

Yoshiteru Ishii finds his combination of backgrounds very useful in a world in which communications and computers are merging. Now a director and associate senior vice president of Nippon Electric Co. and general manager of its electronic data-processing planning office, the 62-year-old engineer has had a leading role in NEC's computer planning and engineering since 1963.

Ishii's first job was developing analog transmission equipment for sale to Nippon Telegraph and Telephone Corp. His exposure to digital electronics began in the early 1950s, when he helped develop a 4-gigahertz pulse-phase-modulation communications system.

Shortly after the project's completion, Ishii fell seriously ill. Upon his return to work in 1955, Koji Kobayashi, then the plant manager and now NEC's chairman, decided to give him a fresh start and assigned him to a new computer development program.

Ishii seized the opportunity, becoming a renowned pioneer in the field. He designed one of the first Japanese computers, the Senac, which used parametron logic elements—a unique invention that applied ferrite transformers as switching elements. But it was his design of the medium-scale Neac 2204 shortly after, which allowed multiple input/output devices to operate concurrently, that won him a Meritorious Patent Award from the government's Science and Technology Agency.

NEC's thrust, he explains, is to merge computers and communications. "Our architecture is both high-level-language oriented and on-line-communications oriented, with batch capabilities included, of course," he says.

Unlike competitors Hitachi and Fujitsu, NEC has resisted making IBM-compatible hardware, although Ishii admits it would be an easier route to IBM markets. "But a company following IBM is likely to be three years behind and will be unable to race ahead in the development of a better architecture," Ishii says.

Ishii points to NEC's new Acos 250 as proof of the success of his non-compatible planning. It has a design that takes into account the estimated life cycle of current products and was ready for production before IBM announced its 4300 models. Thus NEC announced the new computer on Feb. 6, 1979, on the heels of IBM's introduction, and made first shipments in July.

Ishii believes microprogramming, and its ability to change operating "personality," will be more important in the coming generation of virtual machines. It also makes for a much cleaner logic design, and with VLSI it "can eliminate a good deal of the risk of logic mistakes and the long turnaround time needed to correct them." **-C. C.**

Hitachi's technical accomplishments are probably best reflected in its premiere system, the M-200H. Announced in September 1978, eight months after Fujitsu's M-200 system, the Hitachi machine takes the design a step further through the use of ECL gate arrays that cram as many as 500 gates onto a single chip 5.6 mm (218.4 mils) square. The gates operate at a 700-picosecond delay, and the chip has 108 pins. Hitachi, which just began deliveries of the M-200H in January, claims the machine has 1.6 to 1.8 times the performance of IBM's top-of-the-line model 3033.

Also unique to this computer are logic-in-memory chips. One of these devices combines 3,072 bits of bipolar memory with 470 ECL logic gates on a chip measuring 5.9 by 5.7 mm (230 by 222 mils). The logic performs a comparison function, and the device is used in the table-look-aside buffer that is part of the M-200H's virtual-address translation mechanism.

Although the M-200H, like all the Japanese machines, does not dramatically alter the basic computer architecture that has been the staple of the industry since its early days, it points out how the Japanese have matched the state of the art. The most innovative feature is the integration of both a special high-speed floating-point arithmetic unit and an optional array processor into the CPU (Fig. 14). As Kisaburo Nakazawa, deputy general manager of Hitachi's Kanagawa works where the M-200 is manufactured, points out, IBM's model 338 array processor for the System/370 line is channel-attached. This arrangement is not only slower but also requires the user to specifically program instructions to activate the array processor. "But our Fortran compiler automatically detects program segments that can take advantage of the IAP," Nakazawa says.

Takahashi reports that the M-200H performed 4 million floating-point instructions per second, some 42% more than IBM's 3033. With the integrated array processor the M-200H performs some 9 million floating-point operations per second, or almost half of the 20-million-per-second rate of a Cray-1 supercomputer.

Breaking from U. S. influence

Like Fujitsu, NEC began as a communications manufacturer, but now also makes sophisticated computers [see "Combining technologies," above]. NEC licensed Honeywell technology in July 1962. In 1972, however, it teamed with Toshiba, a former General Electric licensee transferred to Honeywell, to develop the Acos 77 Series. Although there are architectural similarities between Acos and Honeywell series 60 equipment, the two units are not compatible.

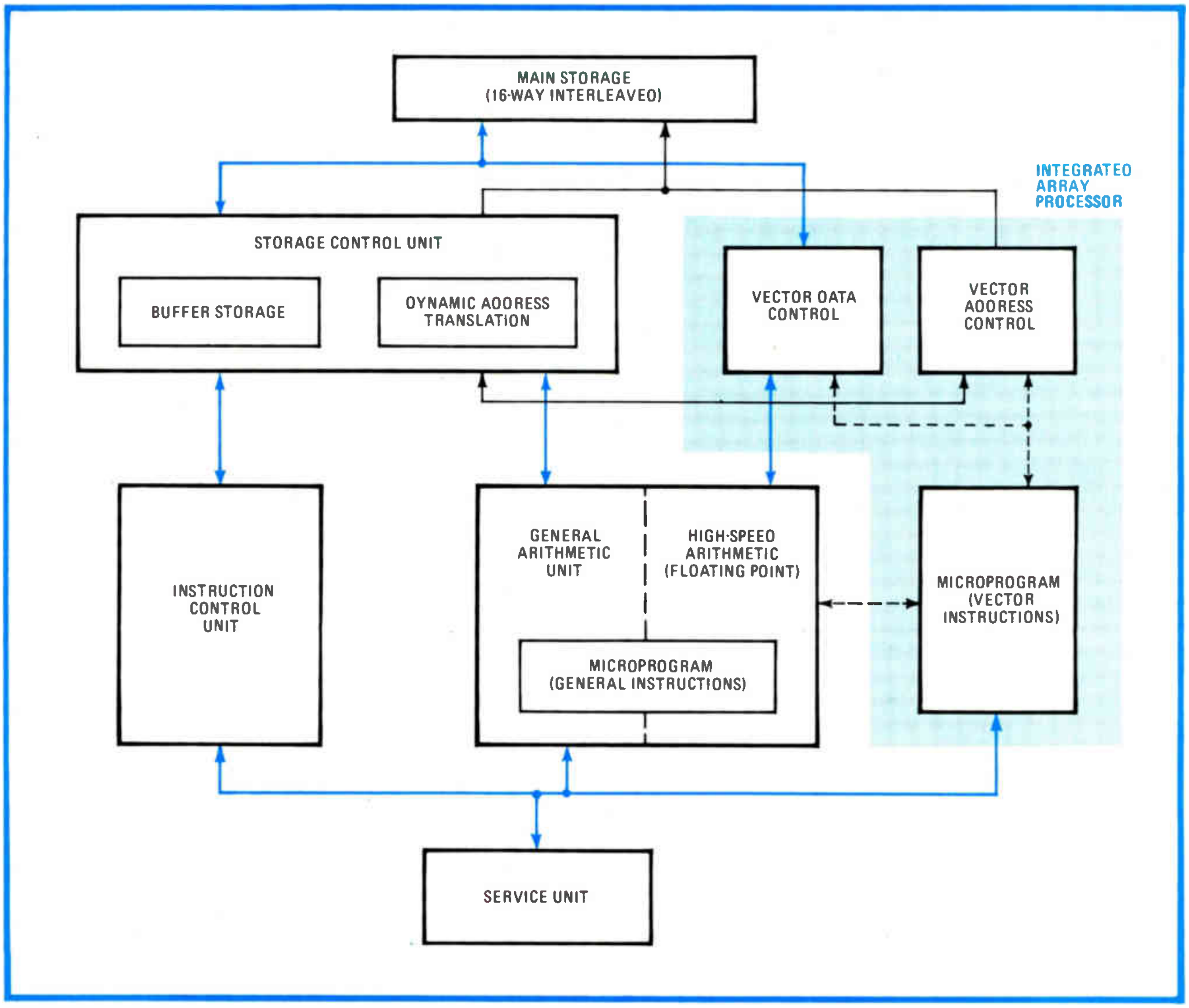
NEC executive director Koike says NEC's strategy is "not to make an IBM-compatible computer. In our next generation of Acos computers, we expect to continue with the basic Acos system and improve it in the same manner as we did with the recent models 250 to 550."

These additions to NEC's line, introduced last year, reflect the company's technical competitiveness. The low-end model 250 competes with IBM's System/38 and low-end model 4331 [*Electronics*, Feb. 15, 1979, p. 63], and the three medium-scale models compete with the larger 4341 [*Electronics*, Oct. 24, 1979, p. 64]. Just being delivered this spring, the 350, 450 and 550 feature unique current-mode-logic bipolar chips that place up to 1200 gates on to a chip 5 mm (195 mils) square. The gates operate with propagation delays of 1 nanosecond and dissipate 1 milliwatt each.

And Shunzo Hamada, manager of business marketing and product planning departments, notes that despite its Honeywell roots, "the new 50 series is completely original. The new models employ a new bus structure with multiple subprocessors." Bus-oriented mainframe designs, although increasingly popular, are currently employed only by NCR and Burroughs in commercial American mainframes. NEC's version uses a minimum of six subprocessors, one each for peripheral control, the input/output processor, central processor, service processor, control processor, and communications processor.

The smallest of the new machines, the Acos 250, is based on a different logic chip. This is a bit-slice processor 4 bits wide, similar to the popular 2900 device produced by Advanced Micro Devices in the U. S. But the NEC version uses its proprietary CML internally and buffers the chip's input/output pins to TTL-compatible levels. Another feature of the new 250 is its use of a four-layer printed-circuit backplane with wire-wrapped connections. This increased the board density in the computer enough to halve the machine's size, as compared to the predecessor Acos 200.

The company's Acos 900, about equal in performance



14. Integrated features. Its integrated array processor is a distinguishing feature of Hitachi's top-of-the-line M-200H. Faster than IBM's channel-attached 3838 array unit, it does 9 million floating-point operations per second—almost half the rate of a Cray 1 supercomputer.

to IBM's 3033, features the company's sophisticated chip packaging technique that is used to some extent on all its computers from the model 350 up (Fig. 16). NEC puts up to 60 assorted chips onto a single 80-mm-square ceramic carrier that has three layers of chip interconnections.

Toshiba aims at the office

Although Koike is vague about future products and when VLSI will be applied, he clearly delineates NEC's intentions. "We have two important programs. The first is integrated circuits. We must have ICs for computers and we have a strong production capability in ICs. Secondly, we must increase the tie-up between communications and computers."

NEC's development partner Toshiba also manufactures some of the Acos product line, specifically the models 600 and 700, even though it no longer directly markets mainframes. But, echoing the sentiments of many Japanese computer executives about the importance of computers, Masayuki Sakurai, senior manager of the planning department for the computer division, says Toshiba will always manufacture mainframes, even if it does not market them. "Computers are important because every area today is related to computers, and, technically, mainframes are the most important."

As for its own product line, Toshiba is most active in the small-business computer area and especially proud of its designs aimed at office automation. These include the Tosbac System 15/60 introduced in April 1979 to compete with IBM's System/34 and the Tosbac System/65, unveiled last November to match the System/38. In addition, Toshiba was, in September 1978, the first company to introduce a Japanese-language word processor. Its JW-10 accepts input in the hiragana—a phonetic Japanese syllabary—and converts it to a combination of hiragana and the kanji ideograms that are the basic Japanese written language.

Sakurai makes it clear that Toshiba's primary direction is office automation. He points to a pilot system the company displayed last November that linked small-business computers, Japanese word processors, facsimile transceivers, and optical character-recognition readers to an on-line system that can handle printed or handwritten documents as well as digital data.

Although it was teamed with Oki Electric, Mitsubishi developed the Cosmo series of mainframes itself, with Oki concentrating on the peripherals. Compatible with the Xerox Sigma 7 architecture, the Cosmo series is different internally. As Kazuya Shimamura, general manager of the computer works, notes, "We added virtual storage and enlarged the memory span." Whereas the original Sigmas were limited to 2 megabytes of main memory, the Cosmo series can handle up to 16.

Like many other Japanese computers, the latest Cosmo machine, the 700S, competes with IBM's 4300 [*Electronics*, March 1, 1979, p. 63]. It is built from ECL gate arrays that contain up to 164 gates and are considered equivalent by Mitsubishi to 100K-type ECL. And the machine is organized around an 8-byte-wide internal bus to which a basic processing unit, system control processor, and several general input/output processors are attached. Another distinguishing feature of the Cosmo 700 is its integrated array processor that can perform Fortran arithmetic three to four times faster than the basic unit. And last December the company topped off its line with the Cosmo model 900II that has three times the processing power of the older model 900, putting it in the class of IBM's 3032 [*Electronics*, Jan. 3, 1979, p. 64]. It is based on a denser form of ECL with up to 250 functions per chip and a gate delay of 0.7ns.

The company's Melcom 80 small-business computers are based on the same central processing unit as its Melcom 70 minicomputers. Built around 2900-type bit-slice microprocessors, Mitsubishi also used gate-array chips to fabricate various peripheral chips for the CPU.

Of all the manufacturers, Mitsubishi is the most frank about its future intentions. The company is developing an IBM-compatible computer line that it hopes to start shipping by the spring of 1983. Not to orphan its current users, the new line will also support the existing Cosmo architecture. Shoichi Iikawa, a research engineer in the product planning department, says semiconductor technology will let the company do this where previous attempts to support two architectures, most notably IBM's future systems program, had to be scrapped. "The technology has advanced to the point where we can in essence include a CPU for the Cosmo and another for IBM." This does not mean two distinct CPUs, he points out, but one physical unit that is "more complex than if it ran only one architecture."

Up-to-date peripherals

The Japanese are not merely content to have state-of-the-art computer hardware technology. Their peripheral products are also up to date, and they are working hard to keep their software competitive as well (Fig. 15).

Fujitsu and Hitachi, for example, both own Nippon Peripherals, a tiny development and manufacturing firm located in Fujisawa. This setup enables them to share development costs, although most of the manufacturing is done at the parent companies' facilities.

Through this arrangement both companies have secured peripheral devices equal to IBM's best. Last year, for instance, both introduced mass-storage systems compatible with IBM's model 3850. Just like the IBM version, these store billions of bytes of data on magnetic-tape cartridges that are stored in a honeycomb retrieval system. Both also used the Nippon Peripherals model NP-25, a disk drive compatible with IBM's 317.5-megabyte model 3350. Although Nippon Peripherals is not yet developing a match for IBM's latest top-of-the-line 3370 disk drive, it is preparing to launch an 8-inch Winchester model similar to IBM's 3310 by this summer.

Hitachi has independently developed the model 8597 635-megabyte disk drive for use with its new 140H, 150H, and 160H computers. To be delivered at the end of this year, the new drives use dual actuators, just like IBM's 3370, but store 11% more data due to the 11% increase in track density to 720 tracks per inch. And unlike the IBM drive, heads on the two actuators can be active simultaneously.

NTT's laboratories have developed an 804-megabyte disk drive for use in its data-base management system [*Electronics*, Dec. 21, 1978, p. 62]. The head flying height has been cut from between 0.5 and 1.0 to 0.35 micrometer, producing recording densities of 8,636 bits per inch and 660 tracks per inch.

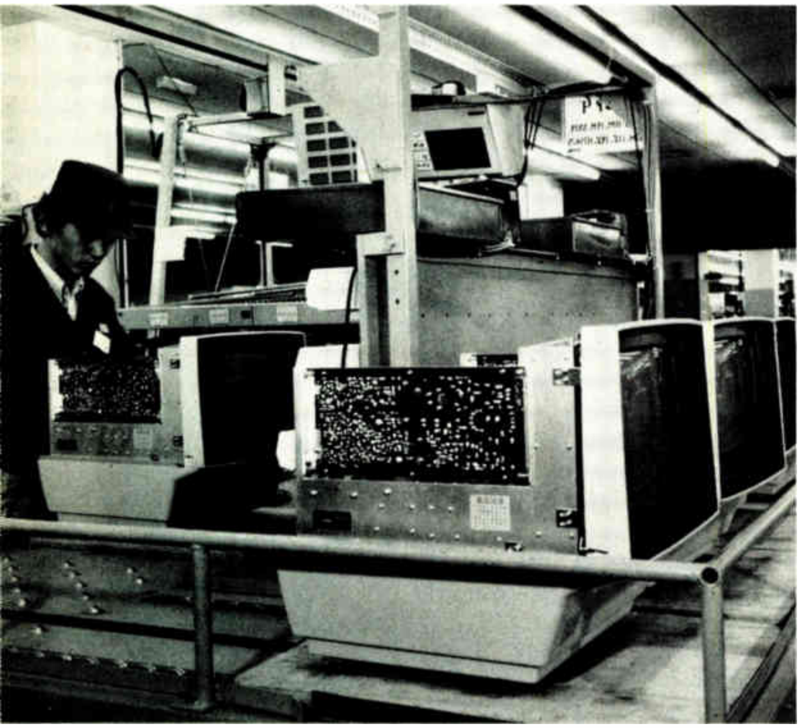
The other manufacturers are equally accomplished in peripheral technology. Mitsubishi, NEC, and Toshiba manufacture their own floppy-disk and cartridge disk drives and in some cases tape drives as well. Oki Electric is a major supplier of such products to original-equipment manufacturers in Japan and the U. S.

But it is the unique demands of handling the Chinese characters of the Japanese language that motivated the Japanese to develop some of the most advanced input/output peripherals. In printers, for instance, Fujitsu will start shipping this spring its model 6715D laser printer that produces a high resolution of 240 dots per inch to print a 30-by-30-dot character matrix. The unit can print 2,000 lines per minute and store about 8,000 characters. IBM's 20,000-lpm model 3800 prints a maximum of only 180 dots per inch.

Hitachi has developed its Hitac model 8195 laser kanji printer that produces 7,000 lines per minute, and NEC has the 15,000-lpm model 7371. Mitsubishi currently makes a 10,500-lpm kanji laser printer and will begin producing a 15,000-lpm version this August.

It is the Japanese success with semiconductors that is especially responsible for the progress they have been making in Japanese language processing lately. As Yasunori Kanda, manager of Fujitsu's development engineering department, where they are working on Japanese language processing, explains, the intricate kanji characters require at least a 24-by-24-dot matrix to be clearly represented. That translates into 72 bytes to store the pattern for a single character so a minimum set of 2,000 kanji characters would require almost 150 kilobytes of memory. And Kanda notes that this memory—an amount that previously constituted the entire memory for a computer—will be placed in just a terminal or printer. "In addition, the overall technology of higher-resolution CRTs improved, but the biggest thing was the improvements in memory," he says. Previously kanji displays were as much as five times more expensive than Roman alphanumeric terminals, he notes. "Now they're just a little more expensive." Every Japanese manufacturer has increased the variety of kanji terminals in the past year, and U. S. competitors in the Japanese market have introduced similar terminals.

15. Talented terminals. Japanese computer makers have developed sophisticated input/output devices, including disk drives, nonimpact printers, and high-resolution cathode-ray-tube terminals, such as those shown being assembled at Hitachi's Kanagawa works.



Keying in kanji

A remaining problem, however, is how to feed the large kanji character set into the system. A system keyboard using one key for each character would result in an unweildy keyboard of several thousand keys.

A popular way to get around this problem is to key in the popular—and smaller—katakana or hiragana syllabaries and have the computer convert to kanji based on a dictionary stored in its memory. Toshiba pioneered in this area in September 1978, when it introduced the first Japanese word processor. Fujitsu added a similar system called the Japanese typewriter this past fall, and most of the other manufacturers are expected to follow.

But these systems will rely on keyboards or touch-sensitive tablets—devices unfamiliar to the Japanese population, which has never used typewriters and hand-writes almost all personal and business communications. Optical-character recognition systems are also offered by all the manufacturers. Unlike American OCR units that primarily read machine-written print, the Japanese units can proficiently read handwriting. And prices are competitive. A Toshiba model OCR-V195, for example, is priced at ¥10 million or about $42,000.

The next step may be voice input—a topic of much Japanese research. Toshiba, for instance, currently has a prototype of a voice-recognition typewriter that recognizes speech syllable by syllable. But Toshiba's Sakurai says the prototype is trained for just one speaker, and it will be at least two or three years before a commercial product is available.

But these peripherals promise to improve. The industry is currently winding down an eight-year effort to develop pattern-recognition technology useful for OCR and a host of other applications. And as part of the new Japanese language software effort, some 70 billion yen ($29 million), or 12% of the total budget, will be devoted to perfecting a kana-to-kanji conversion input device, kanji OCR, Japanese speech input, as well as large-capacity magnetic disks and magnetic-bubble memories needed to form the data-base storage for Japanese language processing.

All this hardware can be used on Japan's sophisticated data-communications networks. Over 60,000 leased data-communications lines are used in Japan and the Japan Electronic Computer Co. says circuit usage is growing 20% annually. Further encouraging data communications is a circuit-switching data-communications network offered by NTT since last December. Called the Dendenkosha Data Exchange System (DDX), the service is now available in a limited number of cities, but NTT hopes to have 100 cities on line by 1985.

To aid customers in both communications and distributed processing, all the major computer makers have network architectures [*Electronics*, Dec. 7, 1978, p. 118]. Currently under development at NTT is its own Data Communications Network Architecture, which promises to support what Ibuki calls an intelligent network. This network will support data switching and allow a variety of dissimilar devices to be interconnected—much like the Advanced Communications System proposed by American Telephone & Telegraph. AT&T's ACS has gone back to the drawing board, but NTT will begin releasing the first basic details of its network architecture this spring, with service to follow in about a year.

Software

If the Japanese are behind the Americans in any area, it is software. But they recognize the problem and are working hard on overcoming their shortfall. And as E. Douglas Jensen, a professor of computer science at Carnegie-Mellon University, Pittsburgh, notes, it won't be long before they catch up because "the Japanese are learning at faster than real time."

A. D. Little's Weizer points out that in software the Japanese are "doing their normal thing. They follow the leader and take something and enhance it, and enhance it so much they're innovating."

Don McDougall, vice president at Data General in charge of their Japanese subsidiary, agrees the Japanese software is behind but warns "we have to stop saying that. The mistake for us to make is to say it will take the Japanese another 10 years to develop good operating systems. They're probably good enough today to go sell if they want to."

And the Japanese recognize the importance of software. They are proud of the progress they have already achieved and confident they can accomplish more. For instance, Fujitsu points with pride to its 0S4/F4 operating system that is functionally similar to IBM's most sophisticated OS/VS2 MVS operating system. Although compatible with IBM's software, Akira Tabata, deputy general manager of Fujitsu's software division, which employs 3,200 software specialists, says the Fujitsu F4 outperforms it—a fact that A. D. Little's Weizer substantiates. And coupled to this operating system are systems support programs that handle Japanese language and data-base management. The Japanese Processing Extended Feature (JEF) was added to the product line last year. A major feature of this software package is the Kanji Information Generator (King) that contains the rules for format, type sizes, and graphics. Fujitsu's AIM data-base management system outperforms IBM's widely used IMS, Tabata says, because the methods of referencing the data are more flexible. And last December Fujitsu started a test of its Relational Data-Base File in Kyoto University.

Hitachi's software works, with some 3,000 employees, is second only to Fujitsu's and is Hitachi's single biggest factory in terms of staff, according to Takahashi. The company's IBM-compatible Virtual Operating System is available in three versions: VOS 1 for the smaller machine is equivalent to IBM's Disk Operating System/Virtual Storage; the intermediate VOS 2 competes with IBM's OS/VS1; and the most advanced VOS 3 outperforms IBM's OS/VS2 MVS. The VOS 3 supports multiple virtual storages, either tightly or loosely coupled multiprocessor configurations, and according to Teruji Yamamoto, section manager in the product planning department of the software works, uses a special virtual-storage-access method to increase the efficiency of systems with large storage capacities.

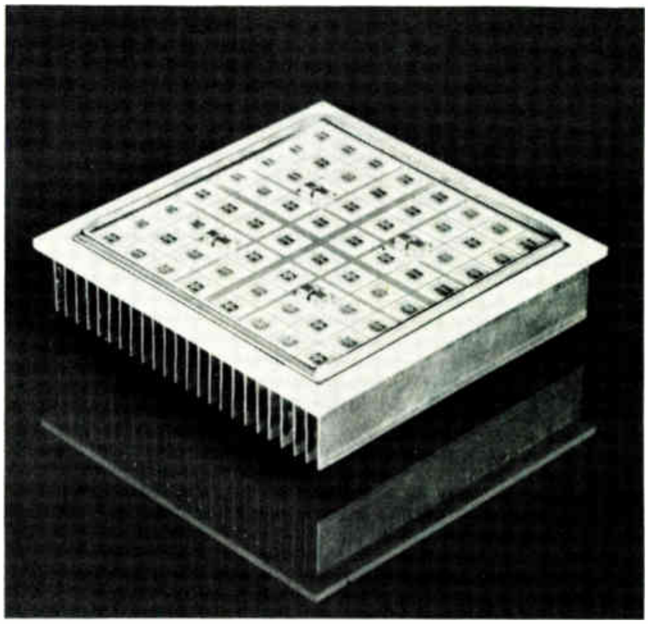
Hitachi is instituting standard-structure design techniques to improve productivity. And wherever possible, the company uses its own Hitachi Programming Language, a high-level language similar to PL/1, for programming systems software, Yamamoto says.

NEC has about 1,300 software professionals in house, in addition to two software subsidiaries, the NEC Software Corp., with 800 employees, and NEC Kansai Software Corp., with another 200 software people. In addition, executive director Koike says another 50% of the software work is done by outside subcontractors.

To increase the productivity of its programmers, NEC is promoting what it calls a structured programming procedure to encourage software engineering. Among the more novel research projects NEC is undertaking is a Cobol-oriented high-level machine, which will be able to handle programs directly in that language.

Koike is confident that the Japanese can master the

16. Packaging prowess. Nippon Electric's unique packaging technology places a mixture of up to 60 chips onto a single ceramic carrier 80 mm (3.14 inches) square. It contains three layers of interconnections, as well as three planes devoted to power lines.



software problem. "It should be well suited to Orientals because it requires great perseverance," and Orientals are famous for their patience, he notes.

Paying for the intangible

Toshiba's Masao Tanino, deputy manager of Toshiba's planning department, feels, "In operating systems we've caught up," though he admits, "in the applications area we're behind." Summing up the comments of the other manufacturers, he points to the idiosyncracies of the domestic market where the customer does not want to pay for something he can't see and demands customized work. "In Japan each user wants his own software to match his own way of doing business, so mass-produced applications software is not popular."

To disabuse Japanese users of this attitude, all the domestic manufacturers have started to unbundle their software pricing in the past year. And as discussed in "Competing at home prepares Japanese vendors for export," p. 125, the Japanese government has passed a tax law that will encourage the development of software.

The government is also funding a joint software-development effort with the manufacturers. Although ostensibly aimed at developing the ability to process the Japanese language, its research topics will include operating-system kernel technology, network and data-base management technology, virtual machines, and very high-level language processing.

After having its budget approved last year [*Electronics*, Jan. 18, 1979, p. 63 and Aug. 16, 1979, p. 76], the cooperative group set up shop last July as the Computer Basic Technology Research Association. Unlike the very large-scale integrated circuit project that ended last year, a centralized lab will not be set up, according to Masato Nebashi, the program's executive director. Nebashi, who was also head of the VLSI program, says that, as in the VLSI program, "the thinking is for the next generation. The purpose is for future Japanese computers to be competitive with IBM's next generation," although "there is no emphasis on compatibility."

Nebashi is quick to point out that of the ¥56.4 billion ($235 million) five-year budget, the government is providing only ¥23.5 billion ($98 million), and the companies must provide the rest, including ¥9.4 billion ($39 million) for administrative costs. "And the companies have to pay the money back to the government,"

Matching the ratio

"There is no princely road to success," says Ichiro Nakajima, manager of the computer engineering department at Fujitsu's Kawasaki factory. But he and his company are determined to succeed in "keeping reliability while cutting prices to stay ahead of IBM."

The 42-year-old Nakajima appears typical of the engineering managers directing the design and manufacture of Japan's modern computers. With Fujitsu's computer design department for 18 years, Nakajima is in charge of the lower half of Fujitsu's IBM-compatible M-series of computers, from the model M-180 down.

"If you consider what IBM is doing, in two to three years the price-performance ratio will be one half of what it is today," Nakajima says. He sees his challenge as being able to match that ratio. But "this will be very difficult to

achieve considering the current rate of technology advancement." And no single design or technique will accomplish it, either.

"It must be an accumulation of many small improvements," he says. First of all, "the design group must improve its efficiency and not make mistakes." One way to accomplish this, Nakajima says, is through extensive use of design automation. Fujitsu, he points out, uses simulation to test logic designs and then has its test group use the same data in order to rapidly develop tests for those circuits.

Echoing other engineers working with ICs, Nakajima says that as circuits get denser "it becomes more difficult to test the integrated circuits, so we must design for testability." One of these test techniques is similar to IBM's level-sensitive scan design in which special registers capture the state of all internal circuitry.

Although they face similar problems, Nakajima sees one basic difference between the techniques of U. S. and Japanese engineers. "Americans have a strong top-down structure. If an engineer is given a set of design specifications he will design within those parameters." But in Japan, an engineer is more willing to "tell his boss that the parameters are strange and try to resolve the difference with his boss through a dialogue."

Nakajima observes that whereas previously 100% of his design group did logic design, now "more than half are doing software." He says they are doing microprogramming—something many American companies include under hardware design. These microprogrammers produce firmware for the M-series service processor and support tools for customers who microprogram.

In general, Nakajima sees himself working more closely with both integrated-circuit specialists and software people from now on. **-A. D.**

17. Shortfall. The only area in which the Japanese admit to being behind is software, but Akira Tabata, deputy general manager of Fujitsu's software division, recognizes that "hardware will become a black box. What can be done with it depends on software."

18. Thinking ahead. The latest joint government-industry program is aimed at the development of software and peripherals. Masato Nebashi, executive director of the program, emphasizes that "the thinking is for the next generation of computers."

although he says the government has not decided how long a time the companies will be given to do so.

He admits the software research will not be as straightforward as the VLSI effort, because "in VLSI it was simpler because everybody said VLSI would be used in the next generation of computers. But in software it is not as obvious what will come along."

Competition and cooperation

But he emphasizes that the program is only to do basic research, not product development. Risk always accompanies research and development, but since it is basic research it should not be changed greatly. Although the final research plans will not be ready until later this year, and even then will probably not be released, it is clear that operating-system and programming-language work is on the agenda. In operating-systems kernel technology, techniques for compartmentalizing the program head the list, along with network and data-base management and virtual machine techniques. It is not yet known what type of data-base structures will be studied. In languages, a very high-level language processor will be researched along with Japanese language processing. Once again it has not been decided if a Japanese-language compiler will be developed or not.

Although the new software-development effort points out the changing complexion of the computer industry in general, it points to the changing nature of the Japanese industry in particular. As the chart (Fig. 19) on page 136 shows, the latest joint government-industry project is budgeted at far less than previous programs. And given the increased size of the companies and inflation, the government subsidy represents an even smaller portion of the R&D spending.

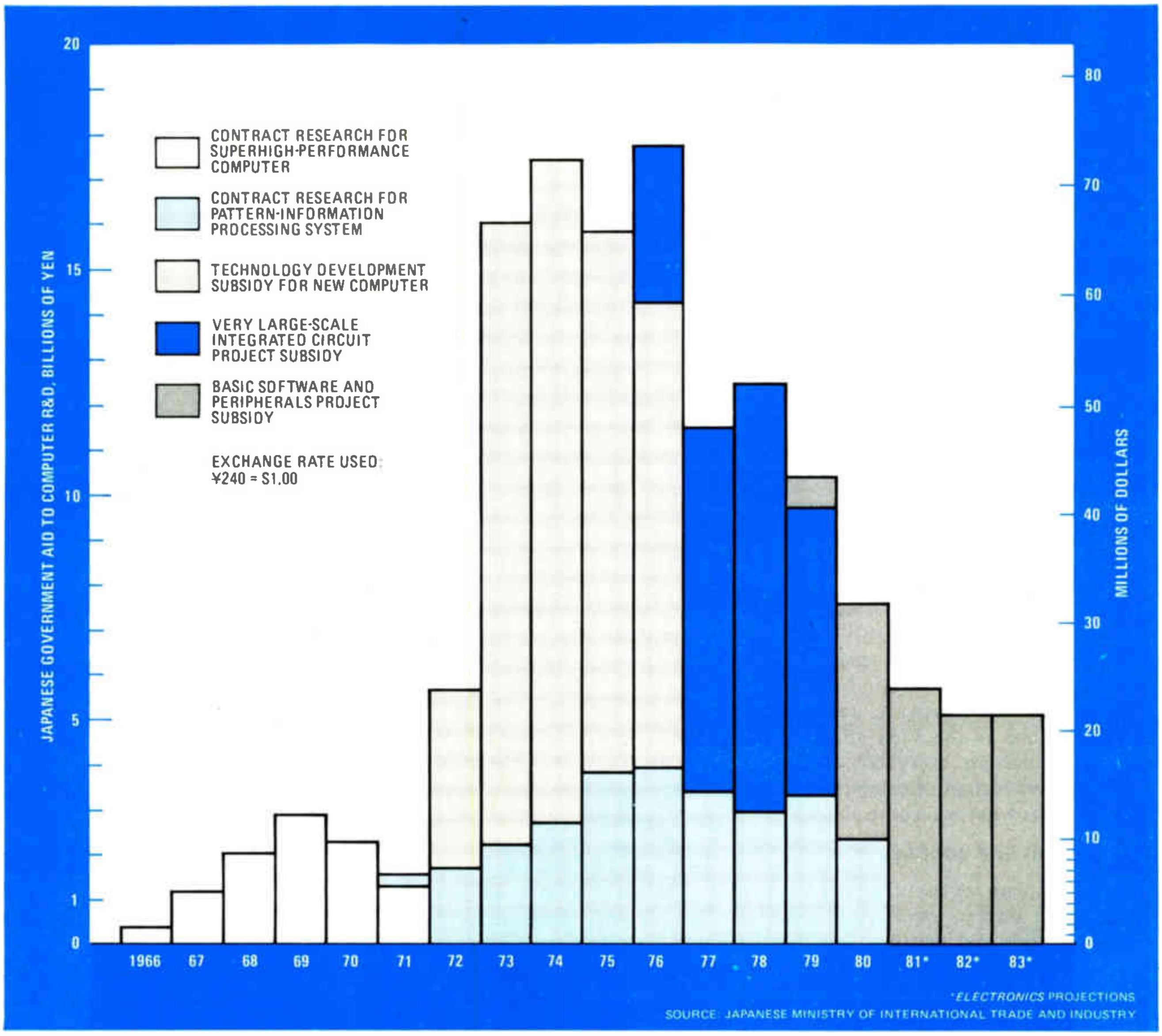
Fiercely competitive Japanese companies give the impression that the days of such technological cooperation are numbered. Nebashi remembers that when the VLSI effort started, "everyone worried whether we could get cooperation from five competitors." But "despite the problems they had, it went over well, and this experience will be helpful" in running the Japanese software effort, even though different people are involved.

And the computer manufacturers have mixed feelings on cooperating with their competitors. Yukimaro Kawatani, general manager of domestic-market planning at Fujitsu, says his company will cooperate with Hitachi "in areas where we both start out at the same level, in order to save money." He points to their joint venture, Nippon Peripherals, as the one example of that policy. In general, however, he expects that "if IBM remains one big company we must cooperate to survive, in something like the VLSI program or Nippon Peripherals.

Mitsubishi's Hiroshi Matsumoto, manager of computer product planning, says the companies can "cooperate on basic research and compete on applications, so in the future we will continue to both cooperate and compete."

Others, however, are convinced that as the Japanese computer industry becomes more mature the cooperation will decline. The Japan Electronic Industry Development Association, the manufacturer's association that coordinates these cooperative efforts and aids the government in setting policy, is one group that sees cooperation declining. "Right now cooperation is at a peak and will decrease in the future," says Jeida executive director Tadashi Yoshioka. "Once the basic research is finished it's difficult to cooperate on the final machines using those technologies."

Hitachi's executive director Mita agrees that "in the past we cooperated on product development and found many problems, so if we're to cooperate in the future it will be on basic technology only." The computer industry, he continues, like a growing child, wants less guidance as it matures. "The computer industry is the favorite child of the government, and when we were a child we



19. Declining support? The amount of government support for computer research and development is decreasing in absolute value as well as influence as the growing industry invests more of its own money. Moreover, unlike the contracts of the past, subsidies have to be repaid.

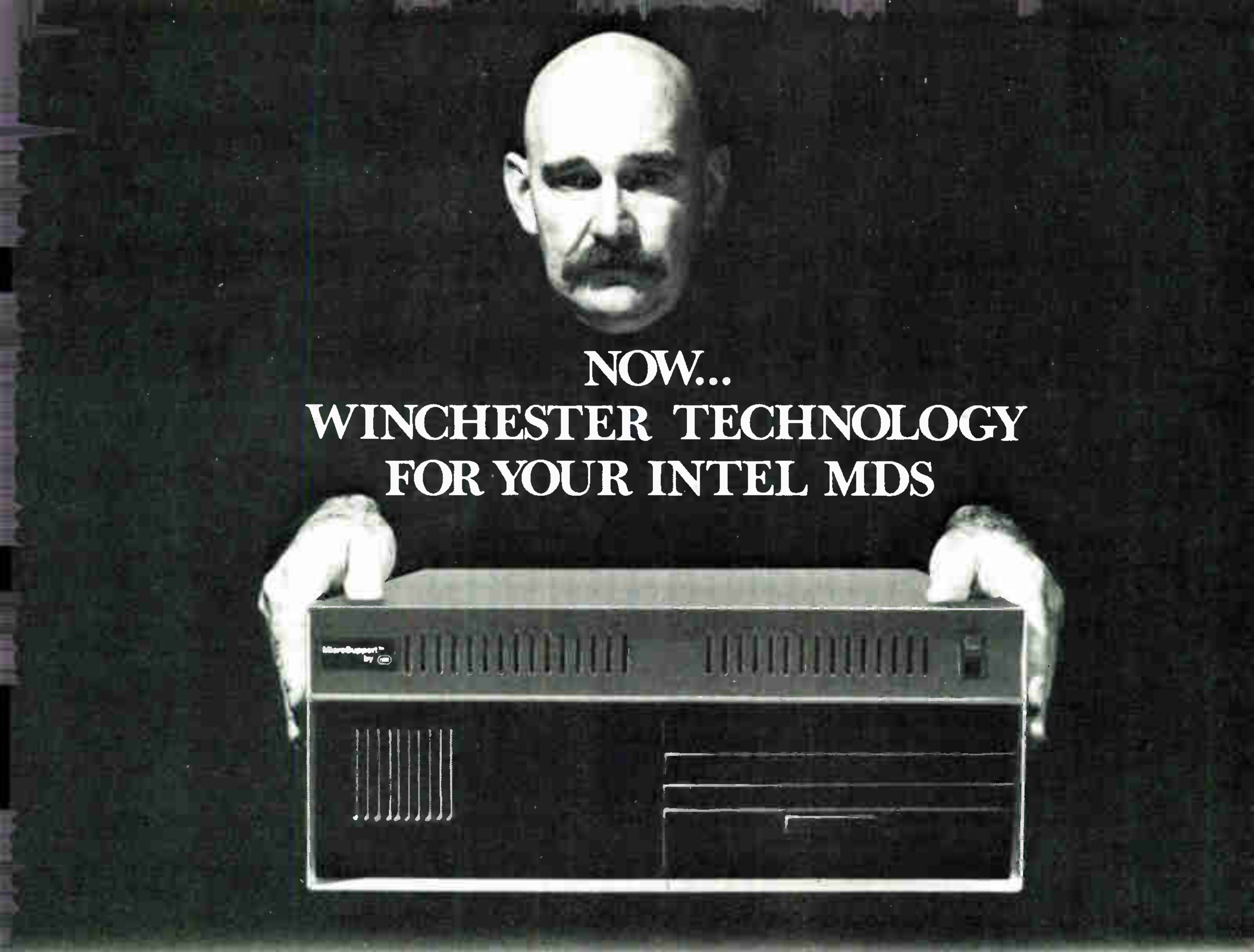
were happy with their attention. Now we've grown up and too much attention can become a nuisance."

IDC's Ogino adds that the companies are less likely to cooperate with the government now that the Ministry of International Trade and Industry (MITI) is trying to avoid balance of payments surpluses by carefully watching their export volumes. "MITI is trying to control computer exports through administrative guidance." And products developed with MITI subsidies are especially vulnerable to such guidance.

Government-industry relations

MITI's Maeda does not think the government is trying to control the industry, noting that it has little legal power. "Our role is to be sort of a think tank organization." And MITI influence will diminish in direct proportion to its budget. "The amount of subsidy is decreasing and productivity is increasing, so the role of the subsidy is decreasing," Maeda points out. Even so, he sees continued cooperation. "Sales people can compete because that's their job, but the headquarters executives can cooperate on long-term planning, because that's their job. It's more efficient when they cooperate."

It is obvious the cooperation is continuing to some extent. Most notably, the industry started a project last April to examine the fifth generation of computers. The two-year project, funded with ¥40 million ($167,000) from the Japan Information Processing Development Center, Jeida's computer counterpart, is under the direction of Tohru Moto-oka, a professor of electrical engineering at University of Tokyo. He says the committee will study architecture, fundamental theory, and the social impact of computing "to decide what projects should be started in 1981 by research organizations for the purpose of developing information-processing systems for the years 1990 to 2000." □



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Semiconductor thermometer is accurate over wide range

by Larry G. Smeins
Hewlett-Packard Co., Loveland Instrument Division, Loveland, Colo.

Reducing the circuit complexity and simplifying the calibration of thermometers that use the base-emitter drop of a transistor to detect temperature changes, this circuit provides readings accurate to within ±2°C over the range of −40°C to +150°C. Using the low-offset, low-drift characteristics of National's micropower LM-10 operational amplifier and Motorola's MTS-102 temperature sensor, the thermometer will compete with the more expensive platinum-resistance units.

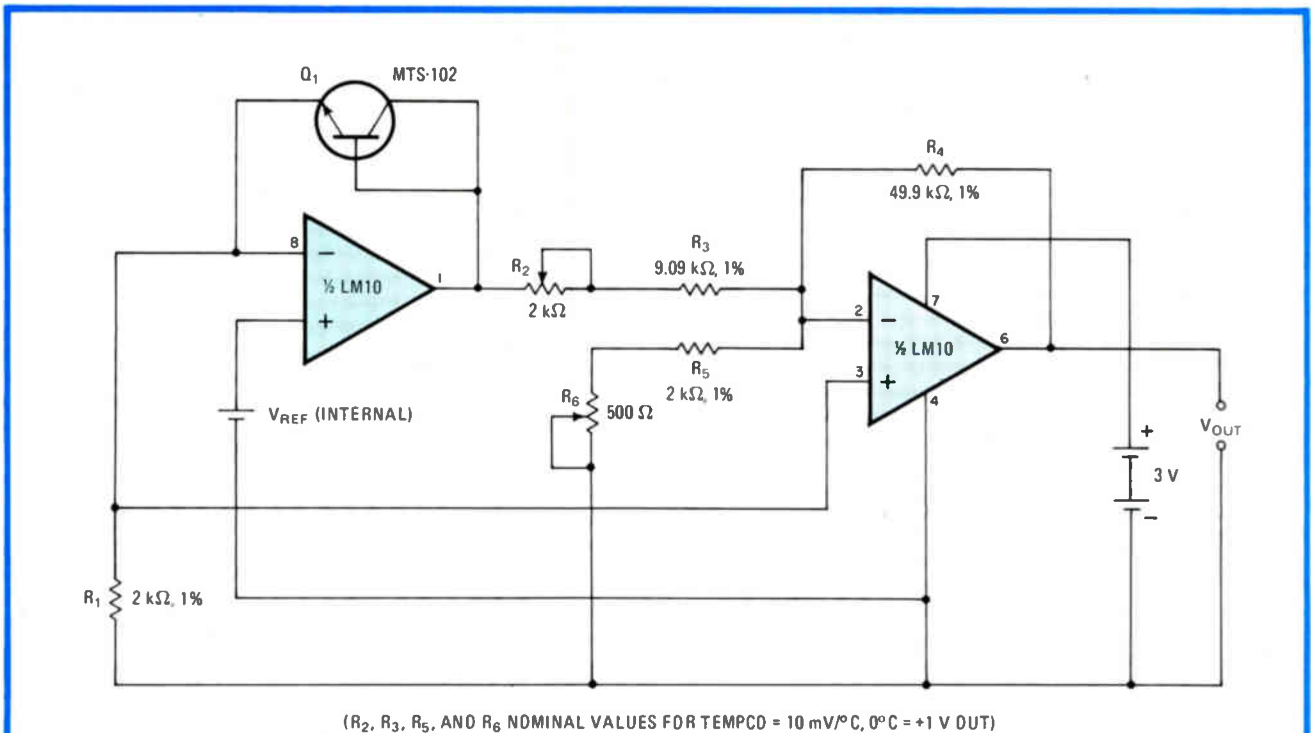
The LM-10 is used to bias, scale, and zero the MTS-102 sensing transistor, thereby removing the need for a separate constant-current bias source for the sensor and an additional scaling and nulling circuit. Further, the well-defined characteristics of the MTS-102 permit single-point calibration of the thermometer.

The MTS-102, Q_1, is placed in the feedback loop of the LM-10 reference amplifier. A constant-current bias is created by V_{ref} across resistor R_1 giving I_{bias} = 0.2 V/2kΩ = 100 μA. The voltage at the output of the reference amplifier will thus be $V_{ref} + V_{be}$. The second stage of the LM-10 is configured to provide a gain that is constant with respect to the temperature coefficient of the V_{be} drop and to subtract V_{ref} and V_{be} from the output at any desired reference temperature.

For a typical MTS-102, the V_{be} is 600 millivolts at 25°C, and its temperature coefficient is −2.25 mV/°C. The actual temperature coefficient for a particular device is thus TC = $-2.25 + 0.0033(V_{be}' - 600)$ mV/C, where V_{be}' is the measured base-emitter drop for the given sensor at 25°C. A corresponding offset voltage therefore appears at the output of A_1.

The gain-controlling elements of A_2, resistors R_2–R_4, can be set so that the circuit's output-voltage-to-temperature slope will be correct for any sensor. The actual gain will be $R_4/(R_2+R_3)$. Once the gain is set, R_5 and R_6 are adjusted to null the offset and yield the desired output voltage at any calibration temperature within the operating range of the circuit.

For very accurate calibration, a reference temperature source should be used to keep Q_1 at 25°C. The V_{be} of Q_1 can then be measured with a digital voltmeter and R_2 and R_3 set to null the offset. R_5 and R_6 are then set to yield an output voltage corresponding to the value that should be measured at 25°C. Using this technique, the calibration will be accurate to within ±1°C.



Hot number. Micropower op amp and semiconductor made specifically for temperature-sensing applications reduce complexity and calibration procedure of thermometers that use V_{be} of transistors to detect temperature changes. Accuracy of device, no worse than ±2°C over the range of −40°C to +150°C, and its simplicity enable it to compete with much more expensive units.

A simpler alternative is to set R_2 and R_3 to correspond with TC associated with the nominal V_{be} of the particular MTS-102 device used, zeroing the circuit at a reference temperature provided by an ice bath. Each MTS device is marked with their respective $V_{be} \pm 2$ mv. This technique will provide calibration accuracy to ±2°C. Either technique will provide accuracy to 4°C for all interchanged devices marked with the same V_{be}. But interchangeability accuracy will vary to a greater degree with the MTS-103 and MTS-105 devices.

The circuit will also work with a conventional silicon transistor, such as a 2N3904, but for calibration purposes, its V_{be} should be measured between at least two points because it is not a specified parameter. The circuit is relatively insensitive to power supply voltage and it will operate satisfactorily over 2-to-40-V range. □

Linear sense amplifier raises sensitivity of touch keyboard

by Jerry Dahl
IBM Corp., Research Triangle Park, Raleigh, N. C.

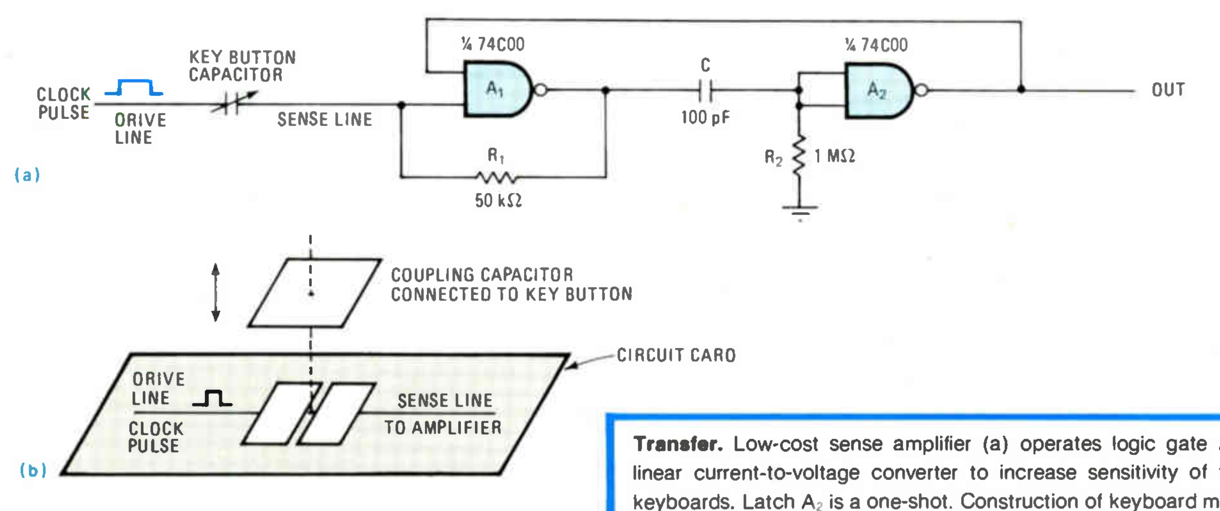
Keyboards relying on hand capacitance to simulate contact closure require a sense amplifier to detect the capacitive changes and thus determine when a key is depressed. Using one half of a complementary-MOS gate array, where one gate is operated in a linear mode to detect currents as low as 50 microamperes, this sense amplifier is not only simple and inexpensive but sensitive as well.

A_1 of the 74C00 quad NAND gate (a) serves as the amplifier, with A_2 functioning as a latch. A_1 is ac-coupled and operates as a self-biasing current-to-voltage converter with a gain of 50 millivolts/μA. Its open-loop gain falls above 100 kilohertz, so the drive-line clock should have a frequency of about 10 kHz. For higher gain, A_1 can be cascaded with other stages within the feedback loop R_1.

When signals having an amplitude of at least 50 μA are coupled to the sense line via the coupling capacitor connected to the keybutton, A_1 goes high and triggers A_2 for about 70 μs. A_2 operates as a one-shot and thus it does not need to be reset.

The construction of the key module capacitor is shown in (b). The coupling capacitor is connected to the keybutton directly. The circuit-card pads are coated with a thin insulating epoxy covering that serves as the dielectric. When the keybutton is depressed, the clock pulse on the drive line will therefore be coupled to the sense line through the electric field of the capacitor. □

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.

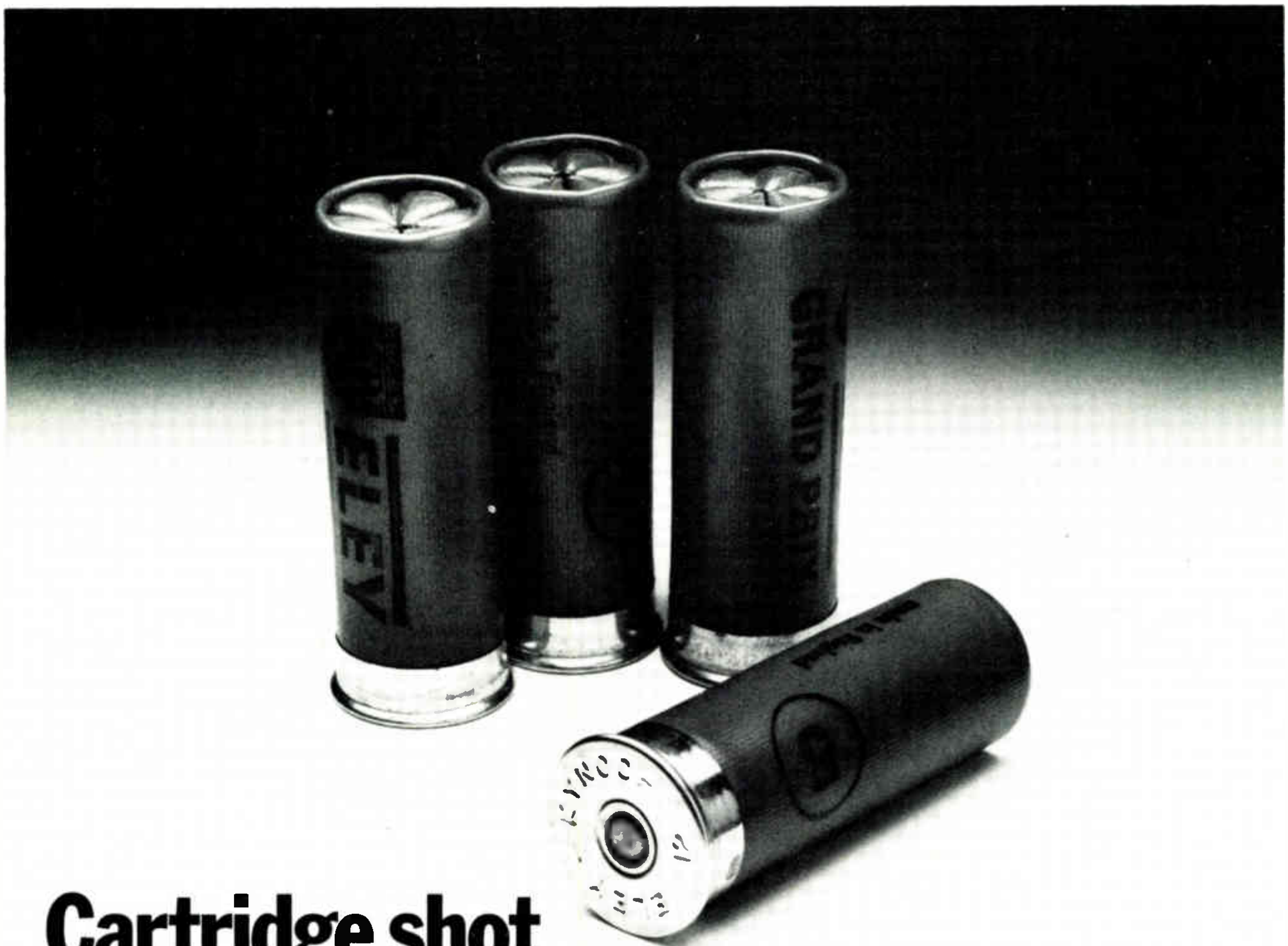


Transfer. Low-cost sense amplifier (a) operates logic gate A_1 as linear current-to-voltage converter to increase sensitivity of touch keyboards. Latch A_2 is a one-shot. Construction of keyboard module capacitor (b) is simple.

Level shifter builds high-voltage op-amp block

by Leon C. Webb
Ball Corp., Aerospace Systems Division, Boulder, Colo.

Placing a level-shifting network inside the major loop of an operational amplifier adapts it for high-voltage applications. The output swing of the circuit, which can be in the hundreds of volts, is limited only by the breakdown voltage of the active devices (in this case, transistors) used. At the same time, the op amp is isolated from high potentials, even in the absence of its ±15-volt supply voltages, by the attenuator formed by the amp's gain-



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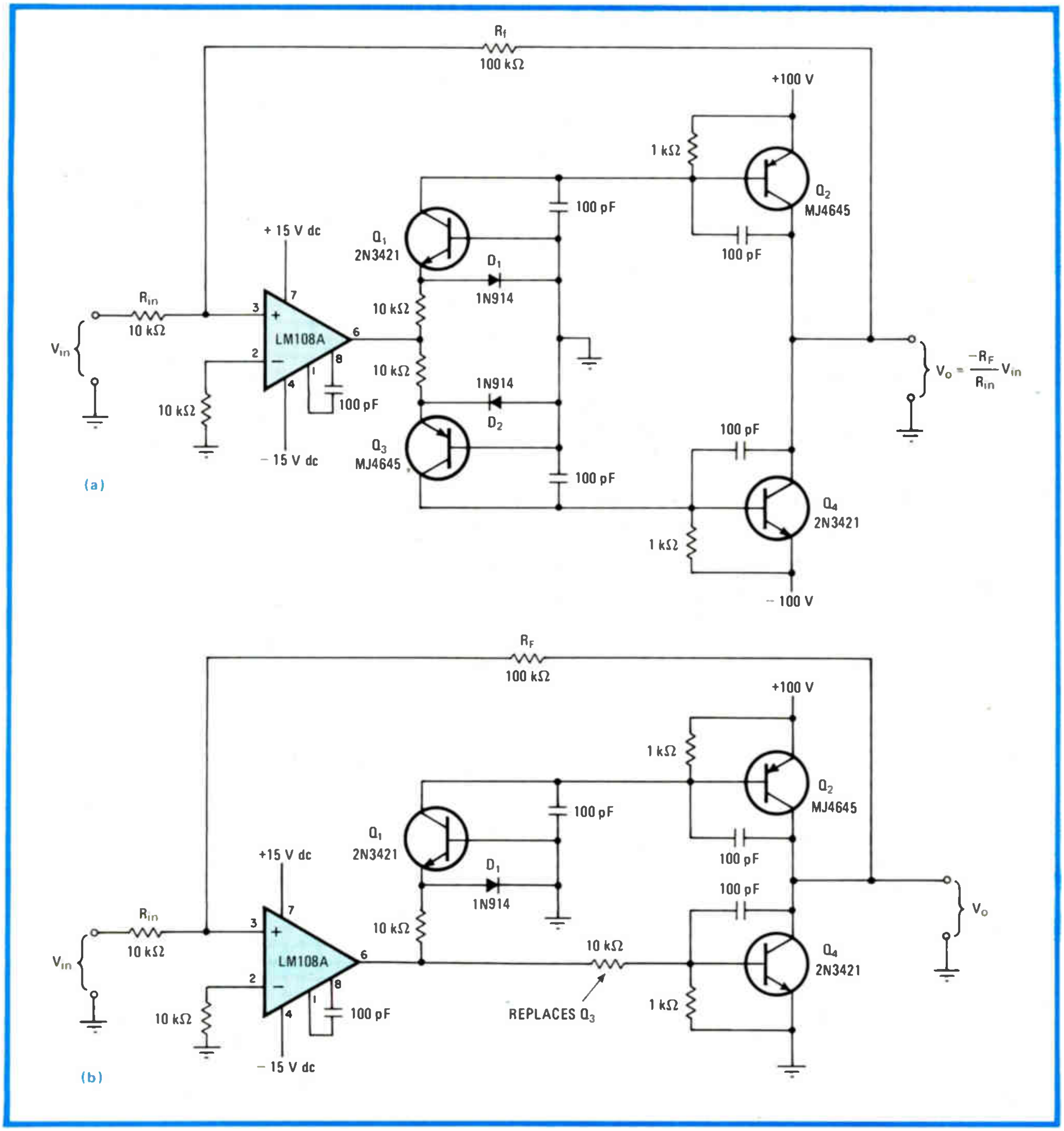
controlling resistor and the input resistance of the circuit and by the clamping action of the circuit's common-base stages.

The method can be applied to op amps that will generate either bipolar or unipolar voltage swings. As shown in (a) for the general voltage amplifier, which generates a bipolar swing, the op amp's output is transformed into an emitter current that flows through either transistor Q_1 or Q_3, depending upon the polarity of the output voltage from the LM108A. As a result, a corresponding base current is applied to either transistor Q_2 or transistor Q_4, respectively, thereby turning it on to a greater or lesser degree. Thus, V_o assumes a value equal to a $-10V_{in}$, where the voltage multiplication holds true for $-10\ v < V_{in} < 10\ v$.

If only a unidirectional output is desired, the configuration shown in (b) will suffice. This circuit, which delivers only positive output voltages, has the same transfer function (that is, $V_{out} = -10\ V_{in}$) for $-10\ v < V_{in} < 0\ v$. If a negative-only voltage output is required, stage Q_1 is replaced by a 10-kΩ resistor. The level-shifter's supply voltage must also be negative. □



Translation. Level-shifter adapts operational voltage amplifier (a) for high-voltage duty. Output swing of circuit is limited only by the shifter's supply voltage and the breakdown voltage of transistors used. For unidirectional output swings (b), simplified circuit will suffice.

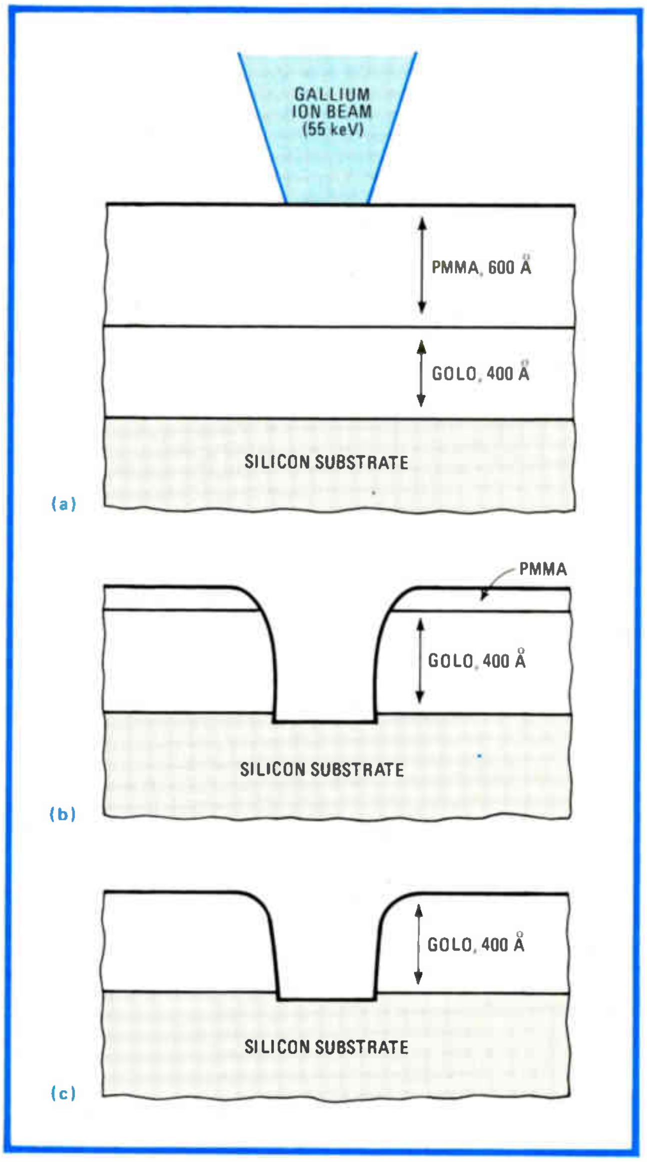
Ion beams promise practical systems for submicrometer wafer lithography

Focused and masked techniques could compete with scanning E-beam and X-ray methods, respectively

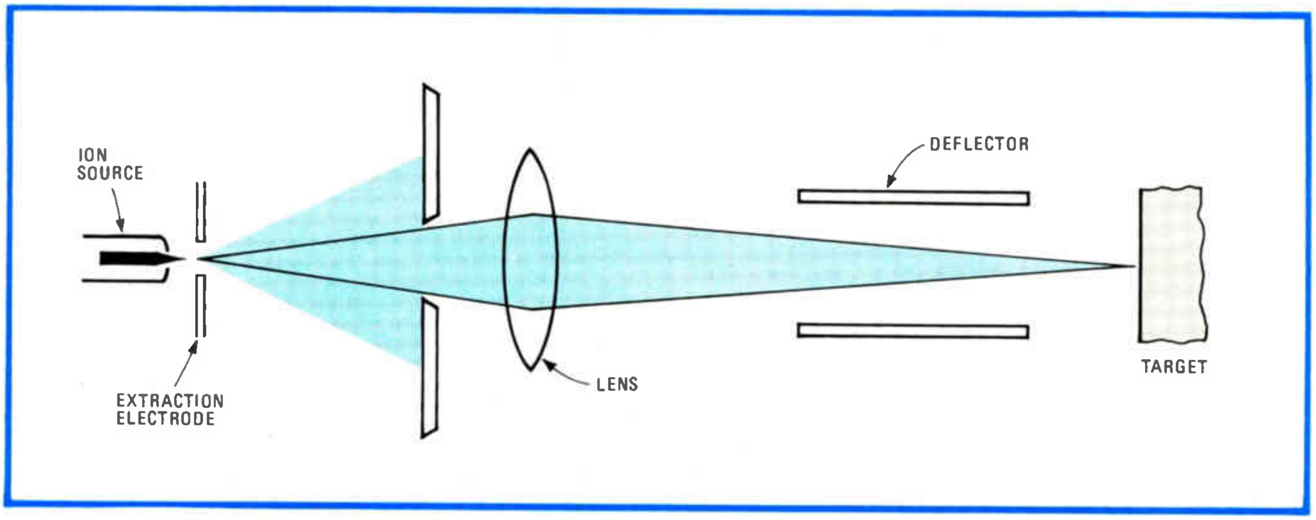
by Robert L. Seliger and Paul A. Sullivan
Hughes Research Laboratories, Hughes Aircraft Co., Malibu, Calif.

☐ Lithography for large-scale integrated circuits has now reached the stage where lines 2 and 3 micrometers wide are becoming routine. In the foreseeable future, very large-scale integrated circuits will be made with features of less than 1 μm. However, present-day lithography—mostly optical projection—is limited to line widths of about 1.5 μm. Two new lithography techniques, both based on exposing patterns in resist using a stream of ions, show great promise for the fabrication of integrated circuits with submicrometer details.

In one of the techniques, a focused ion beam is deflected across a resist-coated substrate in order to write a pattern. Focused ion-beam lithography (FIBL) is similar to direct writing with a scanning electron beam. Experimental work with a laboratory model at Hughes Research Laboratories has resulted in submicrometer patterns in both positive (polymethyl methacrylate, or



2. Transfer. To view a submicrometer pattern in resist, it had to be transferred to an underlying gold film. The PMMA is first exposed by a focused ion beam (a). It is then developed and the bare gold is sputter-etched away (b). Finally, the resist is removed (c).



1. Focused ions. This 55-keV column focuses a gallium ion beam to spot sizes of less than 1,000 Å in diameter. Source brightness is comparable to that of a lanthanum hexaboride source of the type commonly used in direct-writing electron-beam lithography.

PMMA) and negative (polyglycidyl methacrylate co-ethyl acrylate, or COP) resists, and the potential exists for writing such patterns at reasonable speeds.

In the other technique, a collimated ion beam floods a mask in close proximity to a resist-covered substrate, and openings in an ion-absorbing film on the mask define the exposure pattern. Experimental work at Hughes' labs with this method has exposed 0.5-μm lines in both positive and negative resists. Masked ion-beam lithography (MIBL) is similar to X-ray lithography in that both use an unfocused power source and almost the same type of mask. Potentially, a step-and-repeat version could print 0.5-μm features on one 4-inch wafer every 2 minutes, an acceptable production rate by today's standards.

The experimental work on both ion-beam methods was partially supported by the Defense Advanced Research Projects Agency and by the U. S. Navy.

Advantages

Ion beams have several advantages over the other means of printing IC patterns. They are of course inherently capable of finer lines than optical lithography, which is limited by wavelength. Focused ion-beam lithography has another major advantage over existing optical techniques: since in this approach the pattern is written directly onto a resist, the costs, delays, fragility, and optical defects associated with masks are eliminated.

As for electron-beam and X-ray lithography, the resists used are much more sensitive to ions, because their energy is more efficiently absorbed, and the greater sensitivity means that patterns can be printed more quickly. In addition, unlike X rays, ion beams can readily be focused or collimated, which increases resolution.

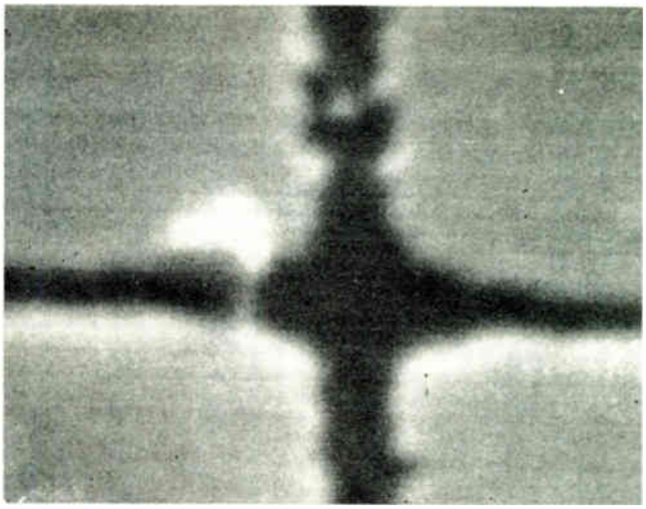
Finally, ion beams are virtually free of the proximity effect, which limits the resolution of scanning and projection electron-beam machines. In direct electron-beam exposure, the desired region is significantly irradiated by electrons backscattered from the substrate, as well as by electrons from the beam. The backscattered electrons broaden the exposed regions, thus creating the proximity effect. In ion-beam lithography, this effect is negligible because ions do not backscatter appreciably and because the secondary electrons generated in the resist have very low energy and will travel less than 0.01 μm.

Uses

The focused and masked ion-beam techniques will most likely be put to different uses. Focused ion-beam systems will probably be applied to exploring the very high-resolution domain of 0.03 to 0.3 μm—far beyond the limits of present-day IC processing. Because this type of machine will be complex and therefore expensive it promises at first to be used mainly for research and prototype work, as is the case with scanning electron-beam machines writing directly on wafers.

Masked ion-beam lithography, on the other hand, offers a potentially fast technique for printing 0.5-μm patterns. The masked ion-beam machine, which is much simpler than the focused type, will be used in actual production for such circuits.

The technology for both systems is at an early stage. Beam sources and focusing methods for a focused ion-beam system are advancing, and new machines of this type may be reported within the year.



3. Submicrometer pattern. A focused ion beam can expose extremely fine details. Shown is a scanning electron photomicrograph of a gold pattern transferred from a PMMA resist. The vertical line is 970 Å (0.09 μm) wide, the horizontal line 400 Å (0.04 μm) wide.

Mask technology and mask-to-wafer alignment are the major obstacles to the development of a masked ion-beam lithography system. However, use of the step-and-repeat technique will lessen the latter problem, as alignment of a smaller area, instead of the entire wafer, is an easier task.

A focused beam

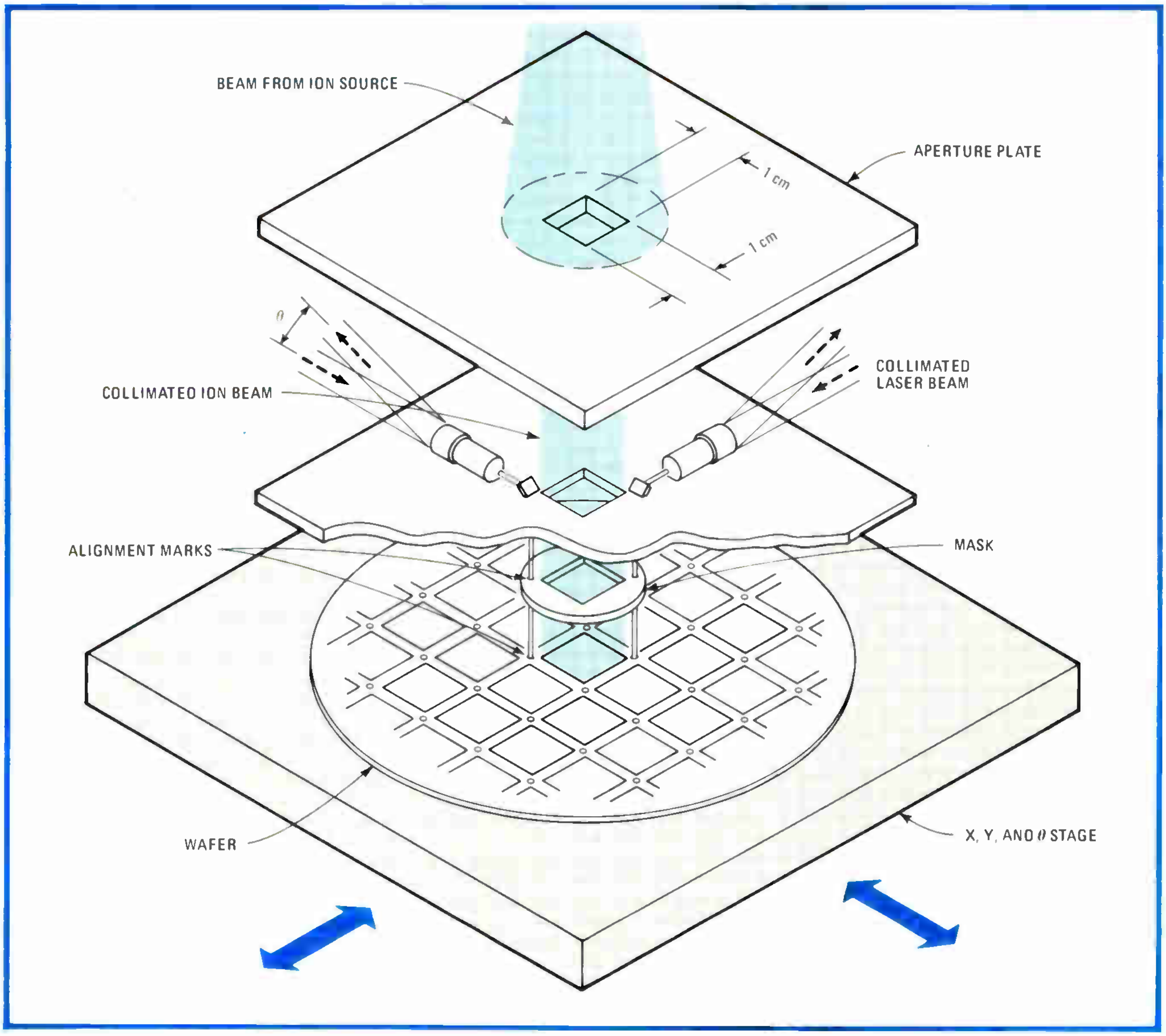
In a direct-writing machine, ions emitted from a source are formed into a beam by a lens system and focused onto a resist-coated wafer. To expose a pattern in the resist, the focused ion beam is accurately positioned on and scanned across a small, square field on the wafer by an electrostatic deflector. The size of the scanned field is limited to less than 1 square millimeter by beam enlargement at the field's edges. Fields are "stitched" together to cover the entire wafer.

The ability to align the focused ion beam on the wafer is essential to stitching the fields and to multilevel lithography. Registration marks are placed in each field for that purpose. When the ion beam scans across an alignment mark, a varying secondary-electron signal is generated and is measured by particle detectors. The gain, offsets, and rotation of the electrostatic deflection field are then adjusted so that any other point within the field can be found. Subsequent fields are addressed by moving the stage, or table, on which the wafer rests; the stage position may be monitored by a laser interferometer.

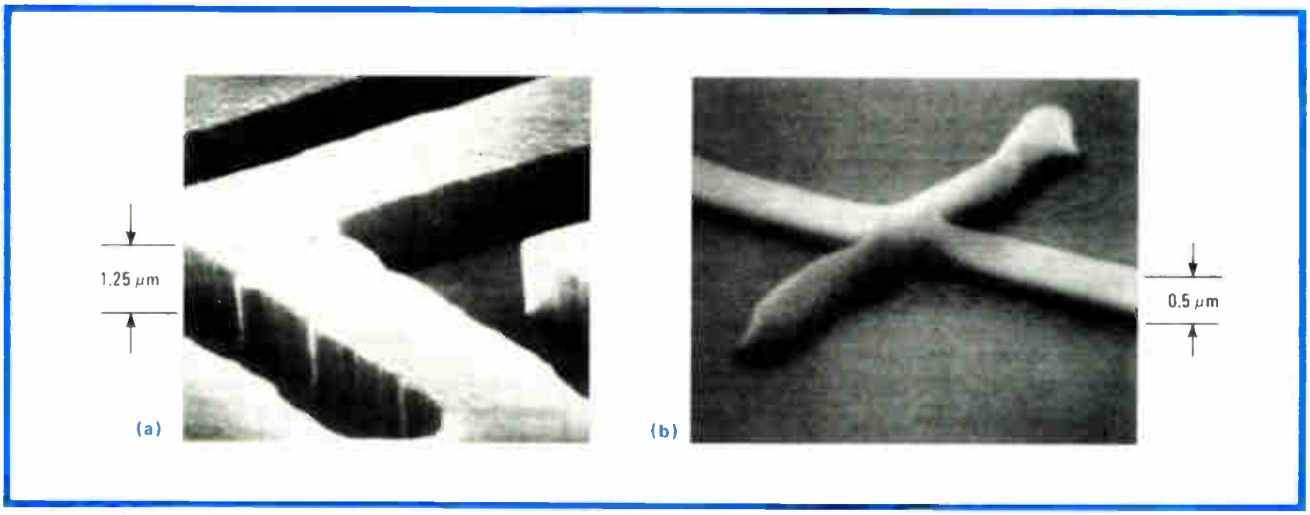
Investigations

The focused ion-beam process was investigated using a 55-kiloelectronvolt liquid-gallium ion source focused by a single-gap accelerating lens with a post-lens electrostatic deflector (Fig. 1). The ion source brightness is about 3.3×10^6 amperes per square centimeter steradian—comparable to that of the lanthanum hexaboride source commonly used for electron-beam lithography.

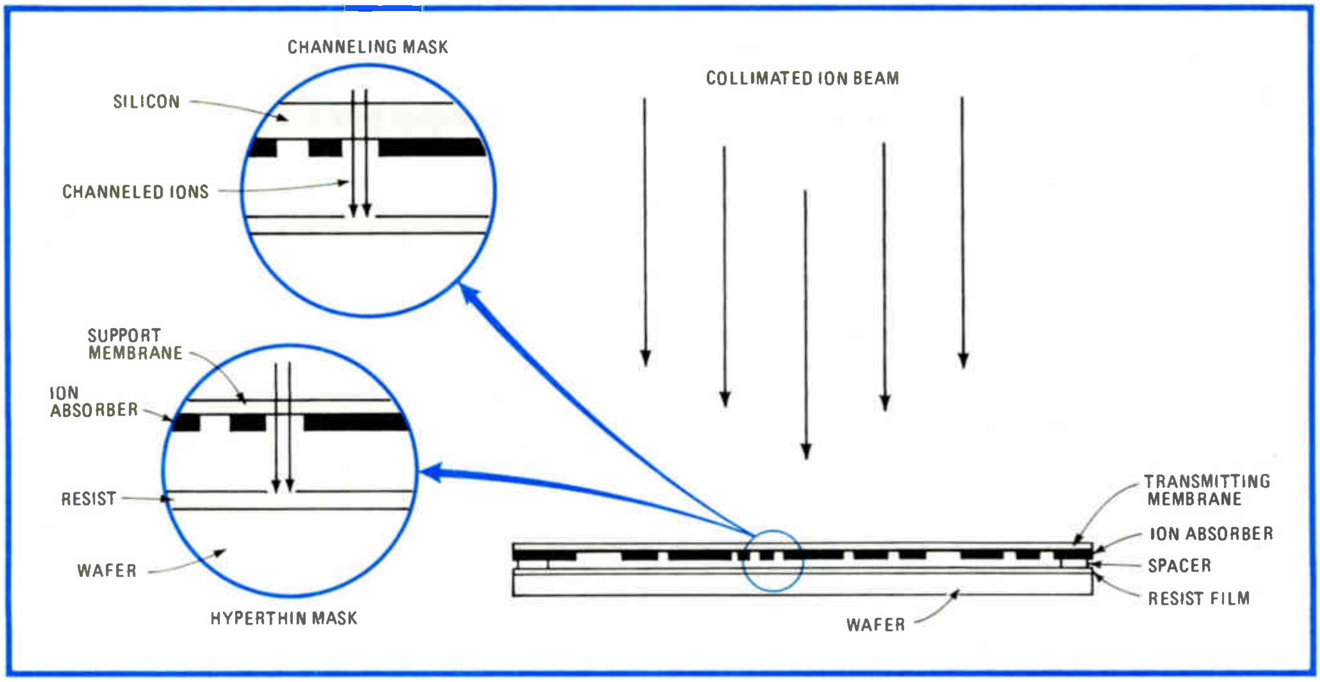
PMMA and COP resists, both used frequently in the



4. Step and repeat. The step-and-repeat technique popular in optical projection systems can be adapted to masked ion-beam lithography. The wafer is stepped by the movable stage and aligned at each site. This surmounts wafer distortions caused by thermal processing.



5. Opening the mask. Ion-exposed patterns have been made in PMMA (left) and COP (right) resists with an open-stencil mask. Though replication and resolution are excellent, patterns that close on themselves are impossible with such a mask, making it impractical.



6. Ion masking. Two types of mask seem feasible for ion-beam lithography—channeling and hyperthin. A channeling mask uses a membrane of single-crystal silicon film. A hyperthin membrane is constructed from an aluminum oxide film stretched taut over a Pyrex ring.

electron-beam approach, were exposed using the ion beam. The high current density of the focused beam (1 A/cm²) made the dose rate many orders of magnitude higher than those for flood-beam ion exposure through masks. Exposing the resists with the beam at various scanning speeds made it possible to evaluate correct doses, resolution limits, and proximity effects.

Initially, 1,200-angstrom-thick PMMA films were spun on silicon wafers, but they were too thick and the 55-keV gallium ion beam could not penetrate them uniformly. Films 600 Å thick were eventually used instead.

For the first patterns, several squares 100 by 100 μm were outlined in the resist, and within each square several perpendicular lines were written at different doses. The PMMA was later developed and coated with 100 Å of gold for scanning electron microscopy, since at line widths of less than 1 μm inspection and measurement can be done only by this method. However, even though the exposed lines were completely developed, they could not be easily seen with a scanning electron microscope (SEM) because of the small topographical features of the 600-Å resist.

In order to make the lines more distinct, the developed resist patterns were used as a mask to transfer the lines onto an underlying thin gold film (Fig. 2). The resulting gold pattern against a silicon background is highly visible (reflective) under a SEM.

First a 400-Å (0.04-μm) gold layer was deposited on a silicon substrate. Next, a 600-Å layer of PMMA was placed on top of the gold.

The ion beam was focused by scanning it in the X direction across a nickel mesh in the same plane but remote from the sample to be exposed. Secondary emission from the scanned mesh was electronically detected. The resulting pulse train created by the scan was displayed on a scope and adjusted for its sharpest rise time, indicating an optically focused beam. Next, the beam was blanked and the system's stage was moved to position the sample for exposure.

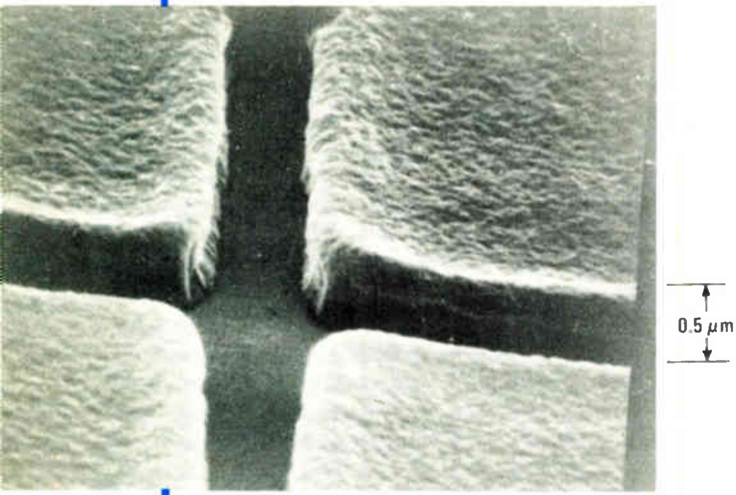
The beam was then scanned at several rates in the X and Y directions to expose the PMMA (Fig. 2a). After development, the wafer was sputter-etched with a 500-electronvolt argon plasma to remove the gold where the resist had been exposed (Fig. 2b). Finally, the remaining PMMA was removed (Fig. 2c). The line pattern was then observed with both optical and scanning electron microscopes (Fig. 3).

Results

Although some astigmatism was present in the focused beam, the narrow lines were written with minimal proximity effects at the intersections. These lines, typically 400 to 970 Å wide, are 70 times narrower than earlier lines made in focused ion-beam experiments at Hughes in 1974, which had been exposed in PMMA using 60-keV helium ions. A typical exposure dose with this source was 6×10^{-7} coulomb per square centimeter. The nominal developing time for such an exposure was 1 minute. The high resolution and sensitivity demonstrated on this sample show that a focused ion beam can be used to create extremely fine details with heavy ions and PMMA resist.

The characteristics of 600-Å-thick COP negative resist were also investigated with a focused beam of gallium ions. A pattern-transfer process similar to that for PMMA was used, but in this case a reverse image was formed in which gold lines were left on the substrate where the resist was exposed. A 2,200-Å intersecting-line pattern was produced with a dose of 2.5×10^{-8} C/cm². Development took 30 seconds typically.

The extremely high sensitivity of COP (2.5×10^{-8} C/cm²) corresponds to 1.6×10^{11} ions/cm², or to an



7. Hyperthin. To evaluate the effects of a hyperthin aluminum oxide membrane on scattering, a 1,950-Å-thick membrane was placed between an open transmission mask and a PMMA-coated wafer. The overall widening of the resist pattern was about 0.15 μm.

average ion-ion spacing of about 250 Å. Although the exact mechanism is not well understood, it appears that the polymerization process of the resist spreads from the original ion trajectory by about 125 Å or more.

In masked ion-beam lithography, as in X-ray lithography, a transmissive mask with a pattern that absorbs the beam is used to cast a shadow on a resist-coated wafer. However, the use of a highly collimated ion beam, obtained with conventional ion-optical techniques such as electrostatic deflection and focusing, eliminates penumbral distortion, which is caused by the use of a distant point source.

Figure 4 illustrates Hughes' present conception of a masked ion-beam system employing step-and-repeat replication of a 1-cm^2 mask. Automated precision alignment would be used for each field to compensate for in-plane distortion of silicon wafers occurring during thermal processing. Because of the stringent registration requirements between mask levels (0.1-μm maximum error), step-and-repeat exposure rather than complete wafer exposure (1:1) is believed necessary for submicrometer replication.

For 0.5-μm design rules, it is expected that alignment accurate to within 0.1 μm or less can be achieved for a field of about 1 cm^2.

Masking the beam

Existing resists and collimated ion sources already surpass the basic requirements for a masked ion-beam system. However, as noted, present masks are a problem. In fact, scattering and distortion resulting from the mask are currently the limiting factors for this technique.

In general, the membrane commonly used to support the mask causes the incident ion beam to attenuate, lose energy, and scatter. Scattering, which is related to membrane thickness and membrane material, degrades the edge resolution of the pattern exposed. This line widening is proportional to the scattering angle and the space between the membrane and the wafer.

Three types of mask have been tried for ion-beam lithography: open-stencil, thin amorphous, and channeling. Open-stencil masks do not use a membrane and hence do not scatter, attenuate, or decrease the energy of the beam. The resolution and resist profile obtained have therefore been optimal (Fig. 5). However, this type of mask cannot define patterns that close in on themselves and as a result is impractical. Accordingly, work has concentrated on the other two types.

These two differ mainly in their support structures (Fig. 6). In both, the pattern is formed by an ion-absorbing layer—in this case gold—and supported by a membrane that allows the ions to pass through. The membrane material must of course be chosen to minimize scattering.

The amorphous, or hyperthin, membrane is made by stretching a film of aluminum oxide, which is transparent to ions, taut over a Pyrex ring. This film is formed by anodizing an aluminum sheet and etching away the excess material to leave a layer 700 to 2,000 Å thick.

A silicon channeling membrane uses a single-crystal silicon film (about 1 μm thick) oriented in a direction that allows ions to channel through the crystal lattice with very little scattering.

Evaluation

Comparative experimental evaluations of both mask types were done with protons to minimize damage to the masks and to yield a high resist sensitivity. To measure the effect of the hyperthin membrane on scattering, a 1,050-Å-thick aluminum membrane was placed between the opened transmission mask (used for the exposures of Fig. 5) and a wafer. A membrane-to-wafer spacing of 20 μm was set by a mechanical spacer. Figure 7 shows a scanning electron photomicrograph of the replicated pattern. Some overall widening occurred. For line widths greater than 0.6 μm, the increase is about 0.15 μm. It can be cut to 0.1 μm if mask-to-wafer spacing is reduced.

For comparison, pattern exposures were done through 1.4-μm-thick silicon channeling masks and with PMMA-coated wafers. Before exposing the mask-pattern area to the proton beam, the goniometer was moved so that the portion of the mask containing only the silicon membrane was exposed to the proton beam. The goniometer was adjusted such that the mask would receive the maximum current—in other words, that the axis of the silicon crystal was aligned to the proton beam. The goniometer was then moved and the mask pattern exposed. The exposure time was adjusted so that the mask-pattern area received a specified dose.

For this type of mask, a pattern was replicated in PMMA. The energy and dose of the proton beam were 175 keV and 2×10^{13} protons/cm^2, respectively. The thickness of the remaining resist was 0.65 μm. The pattern's edge profile was nearly vertical, and the increase in feature size was 0.15 μm. The mask-to-wafer spacing was not accurately known in this first trial. However, the mask alignment was straightforward, and the printing was of very high resolution. □

NOTE: A version of this article was presented last fall as a paper at a regional technical conference of the Society of Plastics Engineers.

Simple process propels bipolar PROMs to 16-K density and beyond

Double-level metalization and polysilicon fuses guarantee dense high-speed memories and cleanly burned links that don't grow back

by Robert K. Wallace and Arthur J. Learn, *Intel Corp., Santa Clara, Calif.*

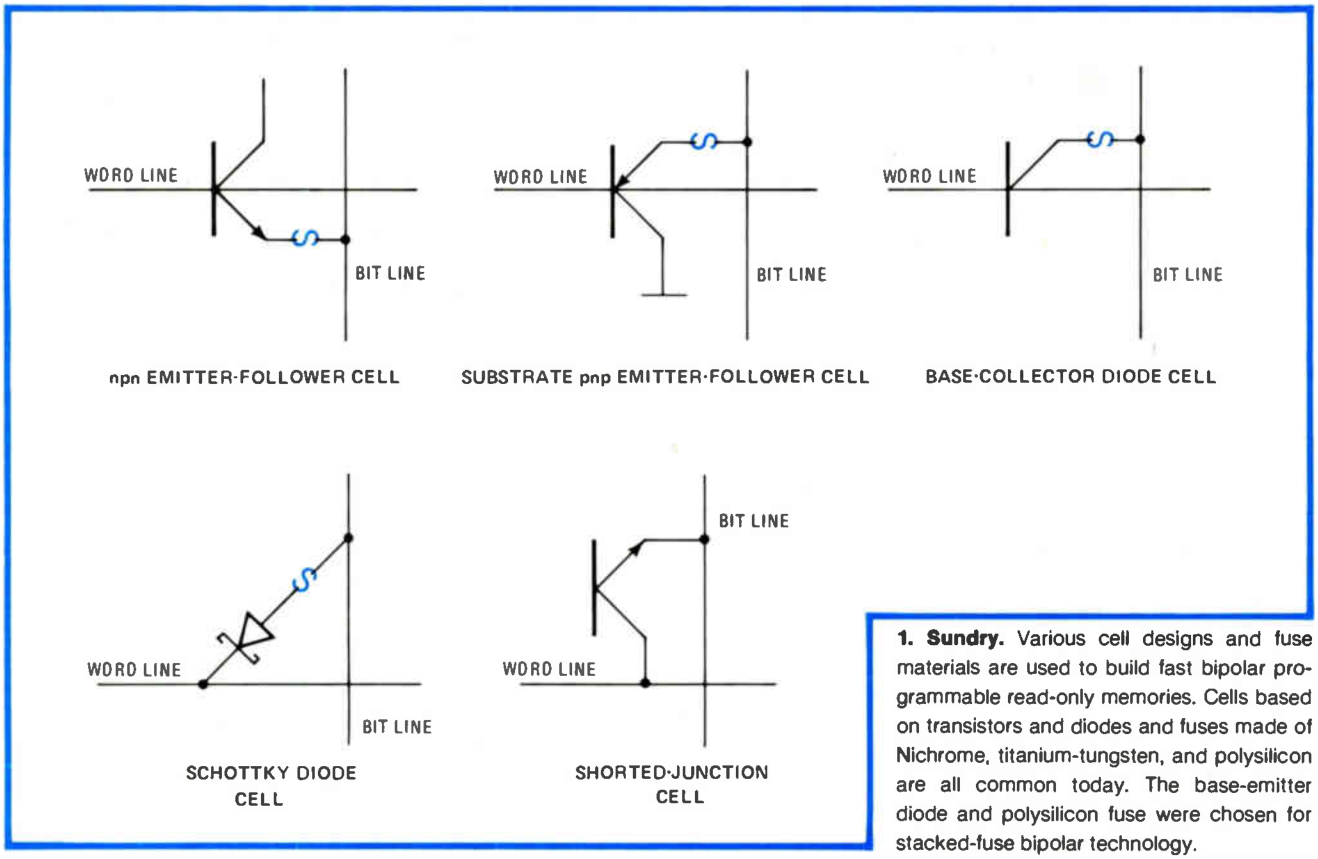
☐ At present, high-speed bipolar programmable read-only memories are being manufactured with an assortment of memory cell designs and programming techniques. Cells made of npn or pnp transistor emitter followers, base-collector diodes, or Schottky diodes are programmed by blowing Nichrome, titanium-tungsten or polysilicon fuses or by shorting out reverse-biased junctions with aluminum.

Eventually, though, under the twin pressures of increasing PROM complexity and the need to optimize manufacturing, the simplest and densest technology will dominate. For this position, stacked-fuse bipolar technology is a likely candidate.

The base-emitter diode it uses for the memory cell (see Fig. 1) takes maximum advantage of the polysilicon fuse materials, which makes direct contact to the emitter region. Such a diode in an emitter-follower array has the added advantages of providing current gain, relatively good conductance per square micrometer, and self-isolation. A double, rather than single, level of metalization ensures high speed while guaranteeing each cell highly consistent fusing current. It also yields a clean and permanent break of the polysilicon fuse and aids in reducing cell size (see Table 1).

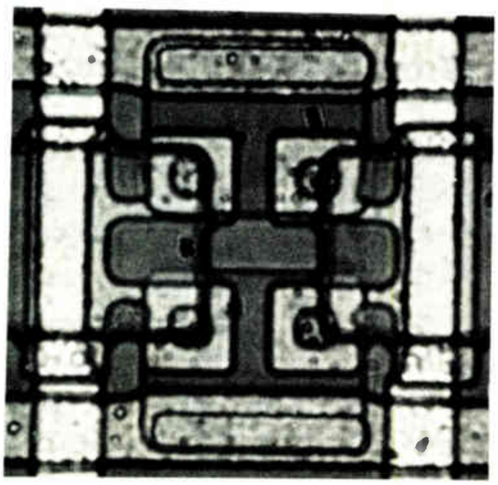
The technology is currently being used to produce 4-K and 16-K devices. The 4-K 3625A memory has a worst-case access time of 50 nanoseconds; the 16-K 3636, one of 65 ns. A scaled-down variation of the process recently yielded a typical access time of 25 ns at the 16-K level (see "A super-fast new PROM," p. 150).

The stacked-fuse cell is shown in Fig. 2. The word lines are of bottom-level metal, and the bit lines are of

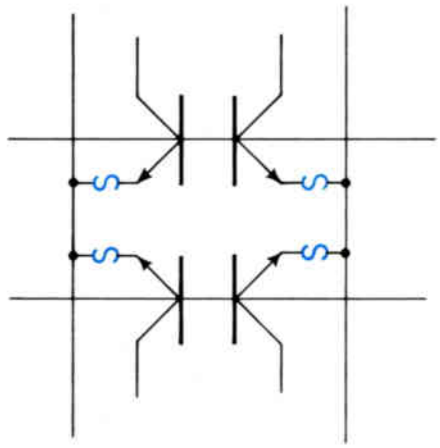


1. Sundry. Various cell designs and fuse materials are used to build fast bipolar programmable read-only memories. Cells based on transistors and diodes and fuses made of Nichrome, titanium-tungsten, and polysilicon are all common today. The base-emitter diode and polysilicon fuse were chosen for stacked-fuse bipolar technology.

CELL AND DIE SIZE ESTIMATES FOR VARIOUS PROM TECHNOLOGIES			
Cell type	**Fuse type**	**Cell area**	**4-K PROM die size**
Emitter-follower	polysilicon	1.3 mils^2	119 mils/side
Emitter-follower	nichrome or titanium-tungsten	2.1 mils^2	150 mils/side
Schottky diode	nichrome or titanium-tungsten	1.8 mils^2	140 mils/side
Base-collector diode	nichrome or titanium-tungsten	1.8 mils^2	140 mils/side



(a)



(b)

2. Layout. The photomicrograph on the left and the schematic on the right depict 4 bits in a stacked-fuse array. The word lines are of bottom-level metal, the bit lines of top-level. The 1.3-mil² cell is the smallest because some masking tolerances are eliminated.

top-level metal. There are two key cell features. First, the bit line (upper-level metal) makes direct contact to the bit-line side of the polysilicon fuse instead of using the traditional top-metal-to-bottom-metal contact.

Second, the other end of the fuse makes direct contact to the emitter of the emitter-follower circuit element. In so doing, the traditional masking alignment tolerances associated with making contacts to the silicon and between metal layers are eliminated. This results in a cell size of less than 1.3 square mils, 30% smaller than any other material and cell combination using the same design rules.

Moreover, each bit has its own bit- and word-line contact, virtually eliminating bit-to-bit nonuniformities. This design is superior to other two-level–metalization PROM cell designs where a contact is shared by 8 or even 16 cells in order to make a small cell viable.

Technology considerations

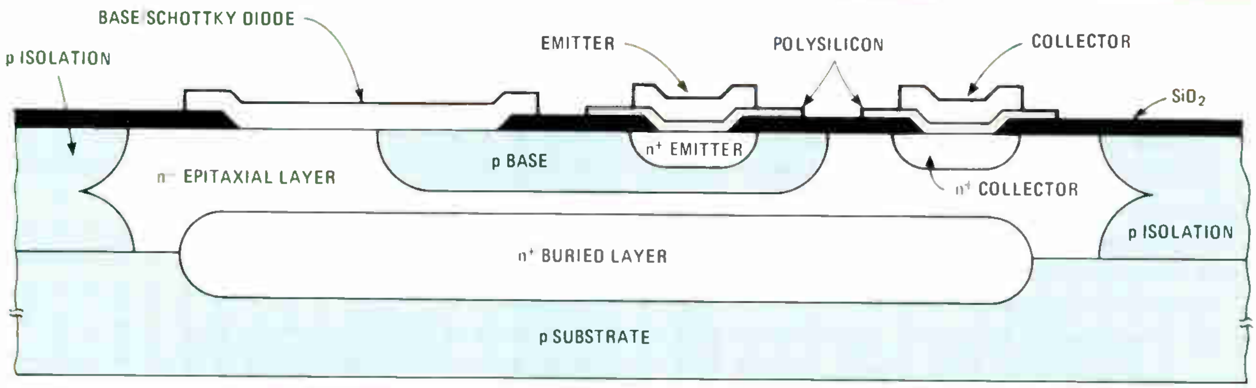
Impurity diffusion through polysilicon to form transistor emitter regions creates a structure similar to the so-called "washed" emitter (Fig. 3). No allowance is necessary for the emitter contact and the most compact geometry is thus achieved.

Additional benefits are realized through use of the polysilicon emitter. Since the polysilicon shields the epitaxial silicon from dissolution in the metal, no other precautions need be taken to avoid spiking (and hence, shorting) of the emitter-base junction. Also, a low donor concentration at the surface of the epitaxial silicon aids in minimizing collector-emitter shorts. Presumably because of this low surface concentration, the emitter push effect is absent, too. All such factors simplify processing, increase control, and raise yield.

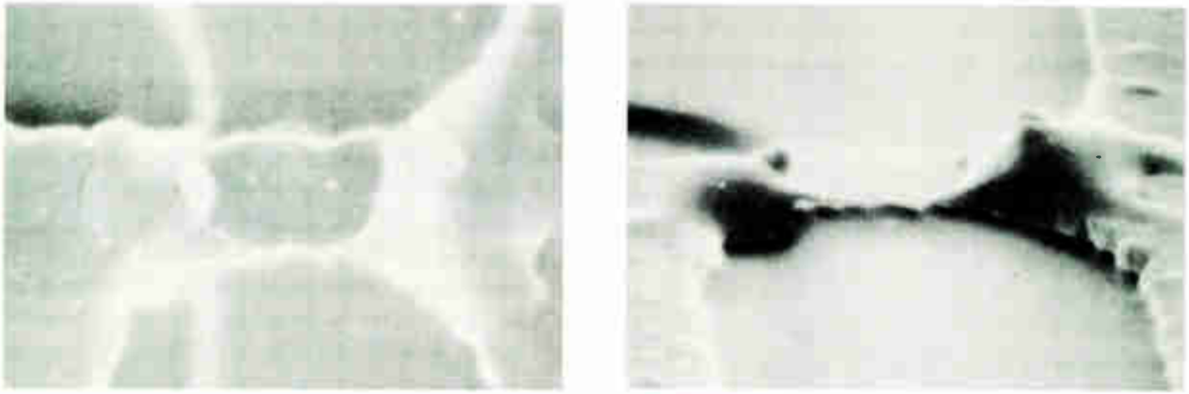
A second level of metalization in lieu of diffused conductors ensures ample power delivery to the fuses even in the case of very large memory chips. This also minimizes the emitter-collector area, greatly reducing the probability of collector-emitter leakage or shorts. The result: higher yields.

Two-level metalization is conducive to higher density as well, further enhancing yield. With the two-level design, excellent fusing is achieved even at the most remote fuse locations, as indicated in the example of Fig. 4. The wide gap, free of fuse material, together with the absence of any regrowth phenomena for the polysilicon fuse, guarantees superior reliability.

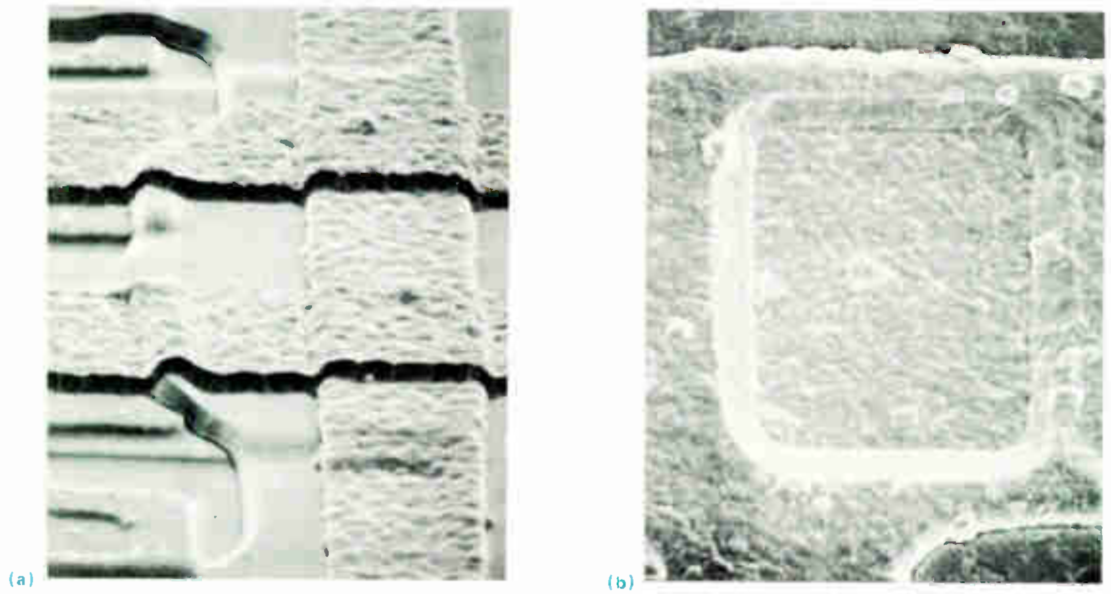
Careful attention must be accorded the choice of materials and processing techniques if two-level metalization is to realize a high degree of manufacturability



3. Section. Standard diffused-isolation Schottky bipolar technology is used for stacked-fuse memories because of its long history in manufacture. Impurities are diffused right through the thin polysilicon layers to increase alignment tolerances.



4. Blown. With stacked-fuse bipolar technology, consistent fusing current is guaranteed, even if the fuses are in remote locations. The top view (left) and side view (right) of a blown fuse show a wide gap free of fuse material. And polysilicon fuses exhibit no regrowth phenomena.

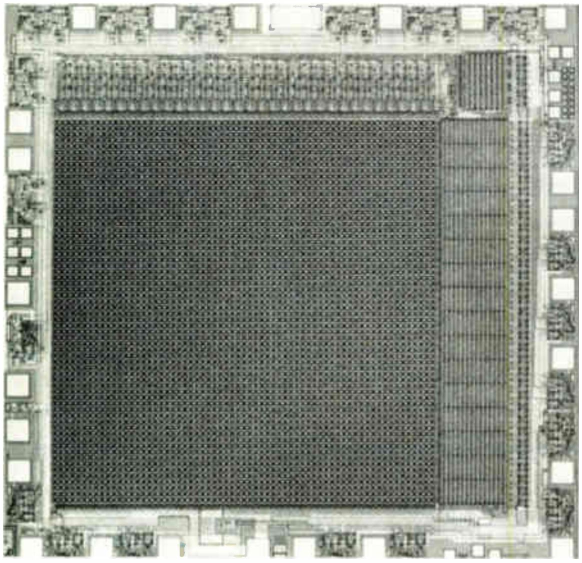


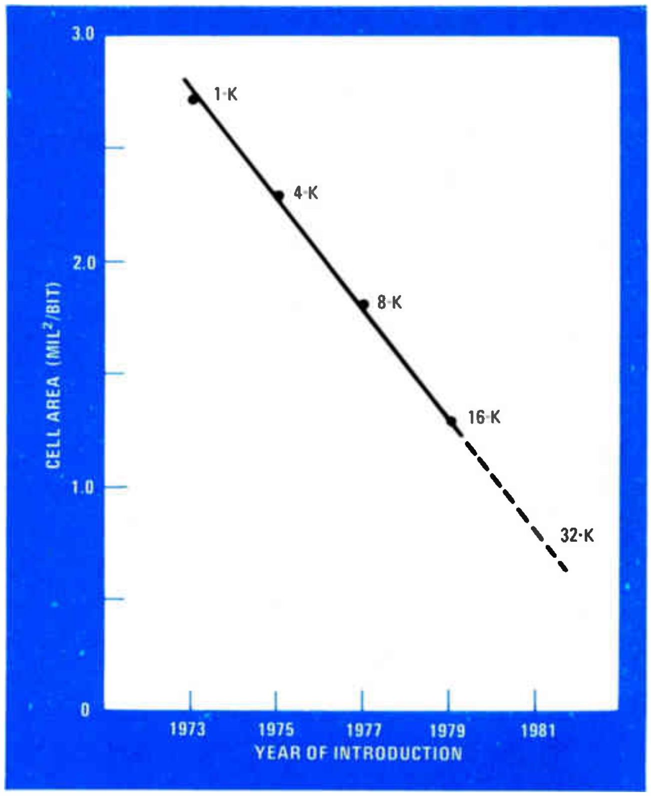
5. Two-level metal. Key to the density, speed, and consistent fusing current is stacked-fuse technology in the use of double-level metalization. The side view (left) shows the uniform coverage by the second level. At right is a metal-metal via.

A super-fast new PROM

Positive-resist photolithography and 3-micrometer design rules have recently been applied to polysilicon stacked-fuse technology. The result is a 2-K-by-8-bit memory, now in development, with a typical access time of only 25 nanoseconds (35 ns maximum). The device was described at the International Solid State Circuits Conference, held last month in San Francisco [*Electronics*, Feb. 14, 1980 p. 138].

The memory, shown below, is fabricated on a 140-square-mil die and consumes 600 milliwatts. It uses the same two-level metalization scheme and polysilicon fuses as the devices described in this article. In fact, it was brought out at the conference that the stacked-fuse process, which employs lateral fuses, may be used to build high-speed 64-K devices. This is a significant finding, because formerly it was thought that vertical fuses—which may pose more manufacturing and reliability problems—would be necessary for this high density. **-John G. Posa**





6. Learning curve. The stacked polysilicon fuse has successfully been applied to PROMs ranging in capacity from 1 to 16 K. Density has doubled about every two years and higher-density lithography and dry processing may even accelerate this trend.

and reliability. Aluminum-alloy metalization exhibits freedom from factors that degrade reliability, such as electromigration, and yield, such as surface reconstruction under heating. The latter is particularly important in promoting pinhole-free insulation between the two metal levels.

In the presence of surface reconstruction (hillock growth), difficulties will arise in achieving uniform and complete interlevel dielectric coverage or photoresist coverage (with concomitant dielectric etching at unwanted points). Plasma-enhanced deposition of the dielectric alleviates the coverage problem to some degree, however, and provides a topography more amenable to a second level of metalization. The technique promotes higher-integrity insulation between levels.

Plasma etching processes are also useful in providing a more gentle taper to the vias in the interlevel dielectric. This, in turn, enhances second-level metalization coverage and minimizes the resistance associated with vias. Examples of the two-level metalization structure and an enlarged view of a via are presented in Fig. 5.

Use of the two-level metalization and polysilicon stacked-fuse method on Intel's 3625A 4-K PROM has dramatically increased yield and decreased worst-case access time by 30% from 70 ns to 50 ns. Organized as 1,024 by 4 bits and housed in an 18-lead dual in-line package, the 3625A has a density of 1.3 mil^2 per bit and a die size of 14,000 mil^2.

The potential of polysilicon fuses for higher density has also been demonstrated on the Intel 3636, a high-speed 16-K PROM. No technology changes were necessary to go from the 4-K to the 16-K level. The 3636 has the same cell as the 3625A, but has a die size of 38,000 mil^2 and a worst-case access time of 65 ns from 0° to 75°C at a supply voltage of 5.0 volts ±10%.

The device is arranged as 2 K by 8 bits and is packaged in a 24-pin DIP to be compatible with existing 512-by-8- and 1,024-by-8-bit 4-K and 8-K PROMs. Despite the increased density, total power consumption remains unchanged from the older 4- and 8-K PROMs.

Future applications

The polysilicon cell has now been applied successfully to PROMs ranging in bit density from 1 to 16 K. Figure 6 shows the evolution of cell size from the 1-K to the 16-K level and beyond; memory density has doubled about every two years. Application of higher-density photolithography and dry etching techniques may even accelerate this trend. Polysilicon fuse technology promises to remain viable through the 64-K density level. □

Control chip handles error checking and character-based protocols easily

16-pin TTL-compatible n-MOS synchronous/asynchronous IC processes up to 1 million characters per second

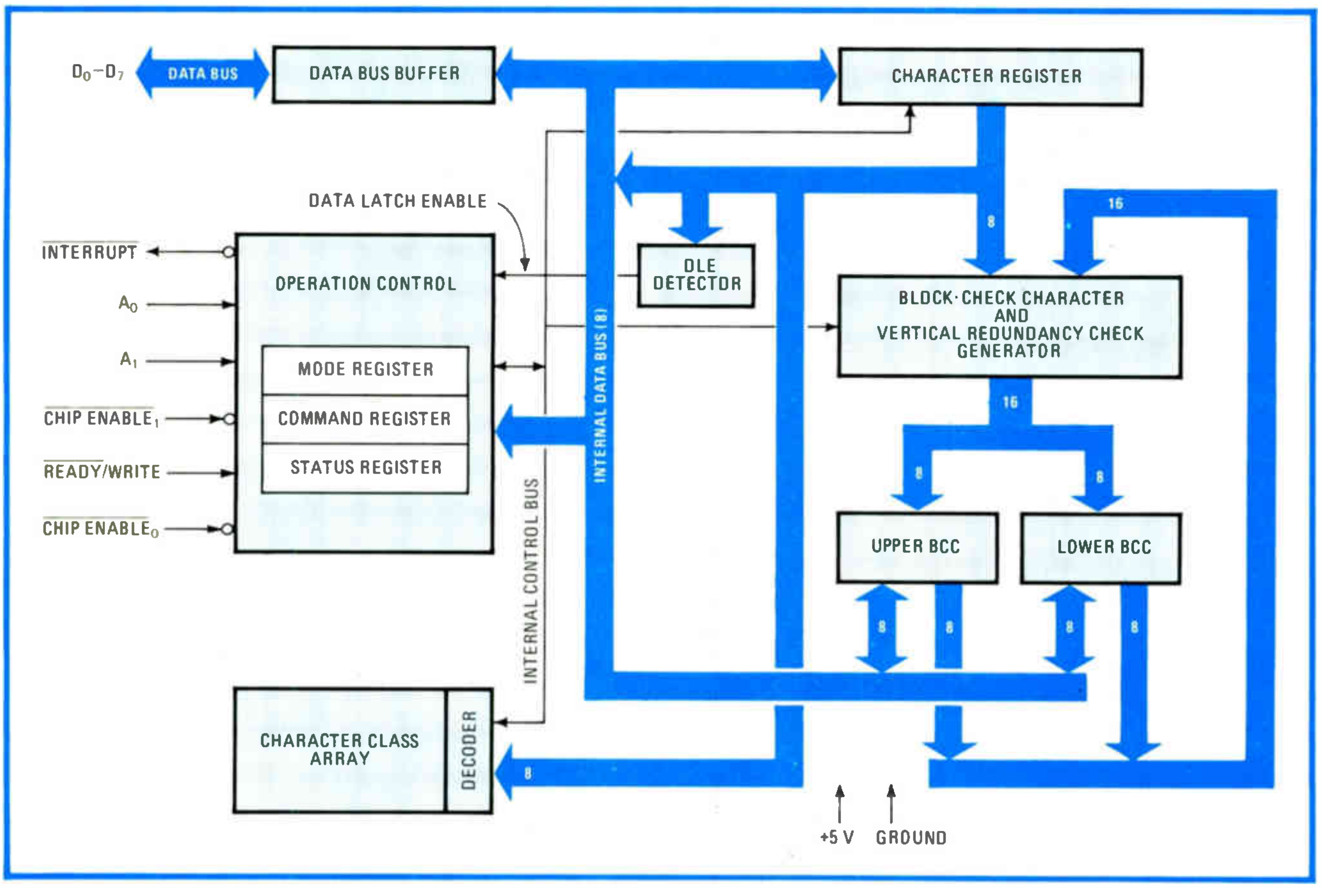
by Alan J. Weissberger,* John Yarborough, Suresh Vasa, and Yesh Mehta, *Signetics Corp, Sunnyvale, Calif.*

☐ The orderly transfer of information between computers, terminals, peripherals, and modems is the goal of every data-communications engineer. Software or a combination of hardware and software has been the traditional method for accomplishing it. But software is costly, takes time to develop, and limits communications speed and the number of lines a communications processor can service. Hardware, on the other hand, eats up board space.

For systems whose operation is based on character- rather than bit-oriented protocols, an integrated circuit is now available that substantially reduces the amount of hardware and software needed to control the data sent from a transmitter to a receiver. Independently of the specific protocol used, the system designer can replace the combination of hundreds of lines of programming, multiple peripheral chips, and random logic previously required for system monitoring and control.

What's more, the chip—a Signetics 2653 polynomial generator checker, or PGC (Fig. 1)—can be programmed to check the data it handles for errors. It is called a polynomial generator checker because it uses preprogrammed algebraic polynomials to test for errors. This checking includes the vertical, longitudinal, and cyclic

*Now with Memorex Corp., Sunnyvale, Calif.



1. Versatile. The 2653 is both a polynomial generator checker and a character comparator that works in support of character-oriented data-link protocols. It has TTL-compatible inputs and outputs, needs but a single 5-V supply, and comes in a 16-pin dual in-line package.

redundancy schemes that are the error-finding procedures specified by all character-oriented protocols (see "Cyclic redundancy," p. 153).

The 2653 operates with asynchronous, synchronous, or parallel receivers and transmitters, so that there is no transmitting and receiving hookup it cannot deal with. In any of these configurations, it performs what what is known as block-check character (BCC) generation and detection. Since generation of these characters is the basic step for cyclic and longitudinal redundancy error checking, the ability of the 2653 to generate such characters is, for the designer of a data-communications network, its most important feature. Notably, when the 2653 is combined with the Signetics 2661 enhanced programmable communications interface (EPCI), this feature leads to capabilities that are unique for a pair of communications chips.

Very special

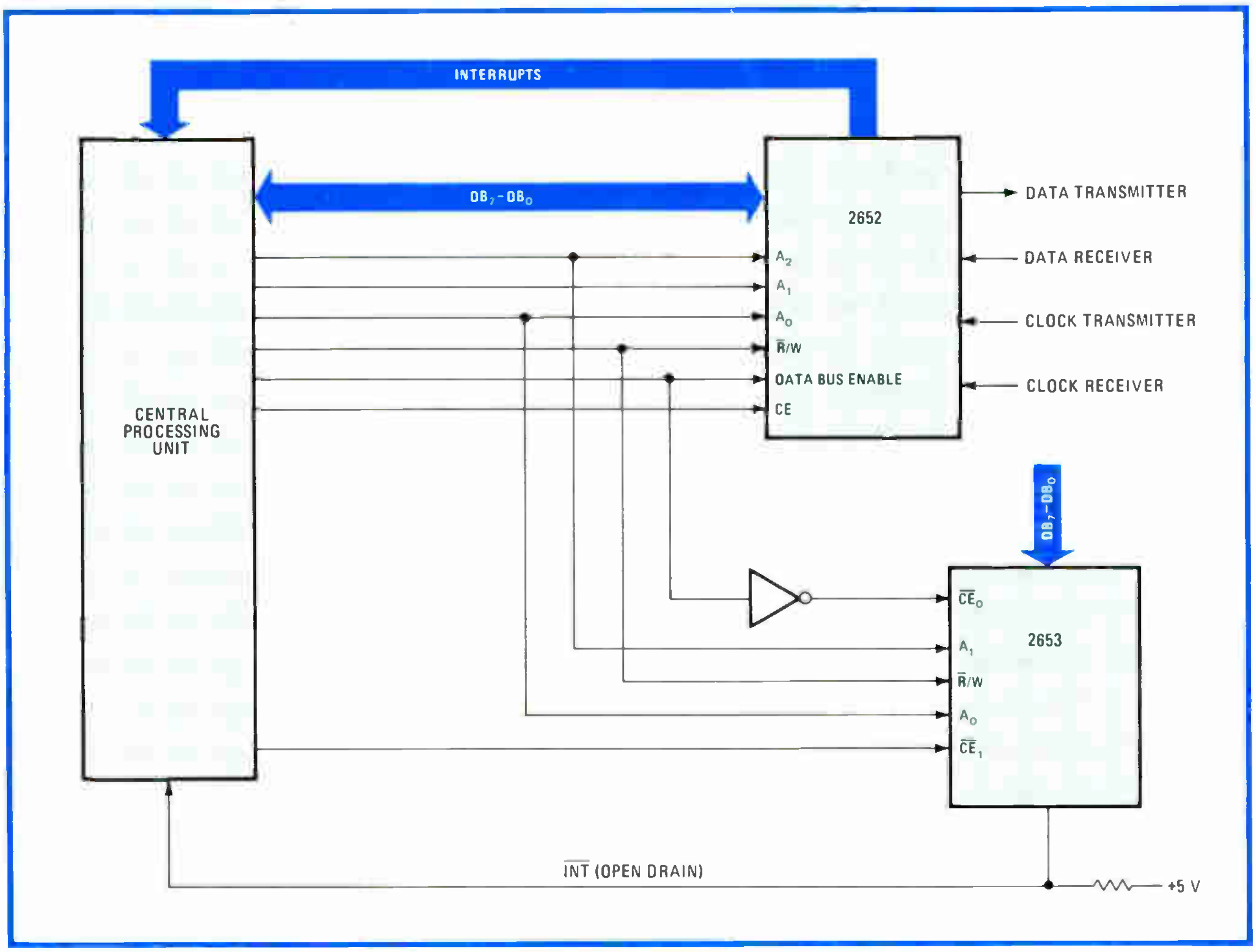
No other available communications control chip set will enable blocks of data in either the normal or the transparent version of IBM's Binary Synchronous Communications, or Bisync, protocol [*Electronics*, June 8, 1978, p. 104] to be checked in blocks without the intervention of the central processing unit. Without this provision, the central processing unit must examine each character passed from the receiving and transmitting circuit in order to determine which ones are to be included or excluded in a calculation. Using the 2653 and 2661, this character-by-character examination is unnecessary. As a result, many more input/output lines can be used for direct data communication.

As a bonus, the two chips can facilitate direct-memory-access storage of incoming or outgoing data blocks. The hardware implementation of this unique capability is totally dependent on the system's CPU and must be tailored accordingly.

Although the 2653 can be used with any receiver or transmitter to support character-controlled protocols, it is optimized for use with the 2661. The latter is really a universal synchronous/asynchronous receiver-transmitter with an on-chip baud-rate generator.

Typically, the two devices are interfaced with an 8-bit CPU. The circuit shown in Fig. 2 is an example of a synchronous/asynchronous hardware solution that requires a minimum of software intervention to implement all the synchronous protocols.

Another major use for the 2653 is to support both character-controlled and bit-oriented protocols by combining it with a Signetics 2652 or the equivalent. Both



2. Partners. The 2653 may be combined with a Signetics 2652 multiprotocol communications controller to simultaneously support both character- and bit-oriented protocols. Only a single inverter is needed for the transfers between the interface and the data bus.

Cyclic redundancy

Data-communications, data-storage, and computer-to-peripheral data-transfer systems all need a scheme for detecting errors in their serial data streams. In most cases, this feat is accomplished by a procedure called a cyclic redundancy check.

In fact, a CRC is capable of detecting multiple-bit errors, a common problem with any data-communication channel. For example, power-line impulse noise can cause up to three characters in a data stream to be garbled. A CRC has no trouble with such a nonrepetitive burst of errors, which can easily overcome simple coding procedures like parity checks.

The mathematical theory explaining how a cyclic redundancy check does its job is a subject usually best left to experts in algebraic coding theory. But a general idea of the procedure can be had.

The bits in any data message may be pictured as being represented by the coefficients (0 or 1) of a polynomial of the nth degree if there are n + 1 bits in the message block of interest. In a cyclic redundancy check, logic gates divide the data bits (represented by the appropriate polynomial) by another user-chosen set of bits represented by a "generator" polynomial. The CRC circuitry does this division as it cycles (hence the name of the procedure) through the data bits in carefully predefined chunks.

Once the division is performed, there is usually a remainder set of bits (known as the CRC check bits) represented by another polynomial. It is appended to the original set of data, and the new, longer data word is transmitted to the data recipient. The appending operation is done with feedback shift registers of conventional design. The recipient of the message performs the same division. However, his data is the original message plus the appended bits. The recipient uses the same generator polynomial as the sender, and it can be mathematically proven that there will be no remainder bits only if the message was transmitted without any errors. Any remainder signals the recipient that a transmission error occurred.

The probability of detecting an error with a CRC depends first on the length of the message block and second on the degree of the generator polynomials used in the calculation. The degree is chosen based on considerations of the kind of errors that may occur in the system, how many may occur, and how probable they are. Higher-degree polynomials can handle more complex combinations of errors, but their hardware implementation is more costly than that needed for lower-degree polynomials.

The cyclic redundancy check is not the only way to detect errors. Others such as longitudinal redundancy checks not only can indicate the presence of errors as the CRC does, but also can pinpoint the position of the bit in error. However, a longitudinal redundancy check cannot readily detect commonly occurring burst errors. Therefore it is not as effective as a CRC for data communications, although some protocols require its use.

types of protocol can then be handled simultaneously.

The 2652 multiprotocol communications chip is designed for bit-oriented protocols. It can send and receive data in the commonly used Extended Binary Coded Decimal Information Code (EBCDIC), American Standard Code for Information Interchange (ASCII), and the European Six-Bit Transcode (SBT) formats. However, it cannot support character-controlled protocols, as it has no way of knowing which characters to include in the BCC accumulation. This makes the chip's 16th-degree polynomial cyclic redundancy check useless for Bisync. Furthermore, no provision is made for handling data in the "transparent," or pure, data mode or for detecting special characters.

Bit and character control

Combining the two chips greatly increases flexibility. For example, the 2653 can be used to compare characters in the Synchronous Data Link Control (SDLC) and High-level Data Link Control (HDLC) protocols and in Digital Equipment Corp.'s Digital Data Communications Message Protocol (DDCMP). Software overhead otherwise needed to perform this function is greatly reduced. Hardware requirements are minimal, too. Only a single inverter is required to interface the 2652 and 2653 such that 2652 data-bus transfers are monitored and controlled (Fig. 3).

The polynomial generator chip has still more applications that the designer of a data-communications system can apply to his own problems. But to effectively design the circuits incorporating this device, the user should understand its internal workings.

All the data-management requirements of character-oriented protocols can be satisfied with the 2653, as a reading of its data sheet will show. While performing these functions, it can process information at speeds of up to 1 million characters per second. But more important, the n-channel MOS chip can be programmed to accumulate the block-check characters and compare them in the four different operating modes needed for character-oriented data transmission: Bisync normal, Bisync transparent, automatic accumulate, and single accumulate. With this capability the 2653 can handle character-oriented processing for commonly accepted protocols such as Bisync, the American National Standards Institute's 3.28, the International Standards Organization's 1745, and DDCMP. Thus most, if not all, potential system applications can be handled.

In these protocols, a specified set of communications control characters and character sequences governs the operation of the data line between sender and receiver. All the control messages or acknowledgments are one or two characters long, and the data messages usually comprise less than 1,000 characters. For text (information) messages, an optional header may precede each text block.

Half and full duplex

Character-controlled protocols employ a stop-and-wait automatic-repeat-request procedure [*Electronics*, March 29, 1979, p. 96] that limits operation to the half-duplex mode. In this approach, each transmitted message block must be acknowledged before the next message is sent. Consequently, the 2653 is a half-duplex device. But this limitation can easily be overcome.

Since it monitors parallel data transferred between a CPU or memory and a serial receiver-transmitter, the 2653 is designed to work from a data bus. In the usual half-duplex mode its data bus receives inputs from either the receiver-transmitter or the CPU. For full-duplex (two-way simultaneous) operation, the user need only add a second PGC.

The 2651 has another feature to make the designer's life easier. A 16-pin dual in-line package—the same as used in small- and medium-scale ICs—is a convenience, since with this size the system's printed-circuit boards can be simplified. This package was made possible by adding an internal power-on reset and chip-enable timing logic, eliminating the need for a reset pin and a system clock pin (see "An evolutionary design," p. 155).

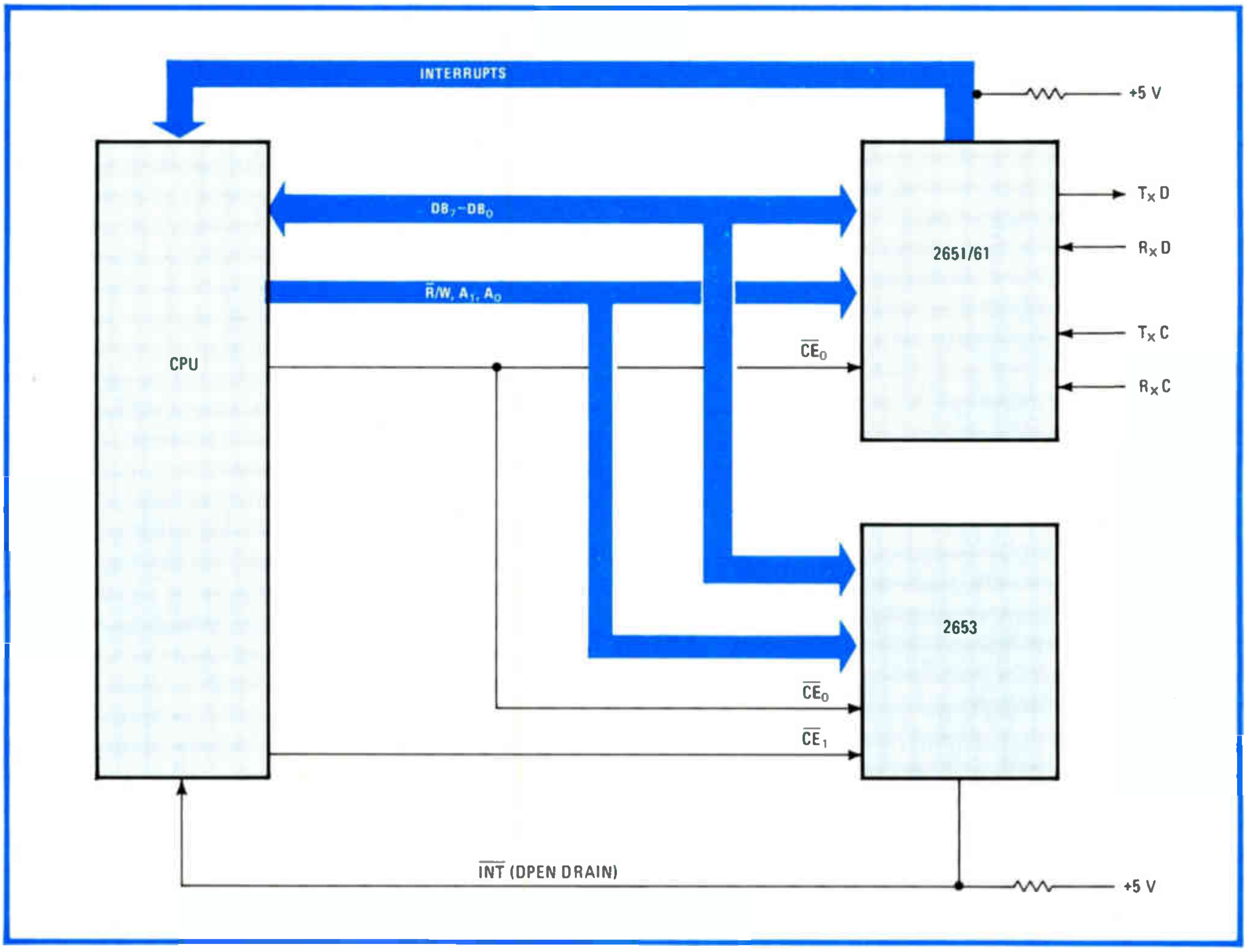
Generating polynomials

As stated earlier, the 2653 accumulates block-check characters for error checking in the Bisync normal, Bisync transparent, automatic-accumulate, and single-accumulate modes. Within each of these modes it must handle the standard generating polynomials used for the redundancy computation. Which polynomial is chosen by the chip's software is determined by the user and depends on the nature of the data to be examined and how much error can be tolerated.

The operating mode chosen by the designer is determined by the nature of the data-communications system and its governing protocol. As far as the 2653 is concerned, its operation in accumulating the block-check characters necessary to check the transmitted data for errors is different for each protocol. The circuit designer must understand these differences in order to come up with a working prototype as early as possible in the design cycle.

The Bisync normal mode calls for all the characters loaded into the character register to be accumulated except for a special synchronization signal. When data is being received the BCC accumulation will stop after either one or two characters have been collected, depending on the redundancy checking method used. For example, for an 8th-degree polynomial longitudinal redundancy check, one character is sufficient. On the other hand, for a 12th- or a 16th-degree polynomial cyclic redundancy check, two characters are needed.

In contrast, in the Bisync transparent mode the protocol requires that several characters be excluded from the BCC accumulation. Whether the chip is receiving or transmitting, termination of the accumulation works as



3. Optimized. The 2653 is best used with the 2661 enhanced programmable communications interface, although any receiver-transmitter may be chosen. The circuit shown is a complete hardware implementation for the various synchronous and asynchronous protocols.

An evolutionary design

The process that led from the first attempts to define a device that filled only a few specific needs to the multifunction 2653 polynomial generator checker is a good example of just how large-scale integrated circuits evolve. During this evolution, the 2653 changed from an IC that performed some redundancy checks under the rules of IBM's Bisync protocol to one that can be used in a wide number of applications with numerous protocols.

Two factors were key to this transition. First, there was the realization that none of the existing microprocessor peripheral circuits could do an adequate job of performing block character checks for the Bisync protocol. Second, the 2653 had to be able to work in conjunction with the universal synchronous/asynchronous circuits already available. In order to do that, the block-check data would have to be accumulated in parallel—preferably in a way that was invisible to the system processor.

The design of the 2653 was also strongly influenced by the fact that manufacturers of LSI devices build circuits that are functional building blocks. These blocks are complex systems that replace hardware and drastically reduce the amount of required software. This approach, though, has a major drawback: circuits that replace software tend to be rather inflexible, since their electrical connection cannot be changed. Most of the design efforts for the 2653 were therefore aimed at reducing software requirements while retaining much of the flexibility arising from functions performed by software. Flexibility is particularly important when supporting a protocol like Bisync because it has many variations.

The desire for flexibility led to the incorporation of a character class array feature. With this feature, the chip can group the characters according to their basic nature: data, synchronization, parity, and signal status, for example, plus those containing errors. This makes it easier to count them and provides ready access for processing.

The 2653 must recognize certain classes of characters in accumulating the block check. The idea of programming these characters was soon discarded because the user would have no say in picking them. However, programmable registers to hold the various control characters were a possibility. Each register would need a character comparator, but it was not known exactly how many characters each user would want to place in each class. If a large number of characters were to be accommodated, the registers and associated comparators would occupy a great deal of chip area.

Consequently, an attempt was made to eliminate the need for a separate comparator for each register. Consideration was given to encoding each special character into a class and then identifying the class code for each character as it was received. This idea led to the use of a lookup table containing the required encoding. Since there are three classes of special characters, the lookup table has to be 2 bits wide, with one 2-bit code reserved for characters in no special category.

The lookup table is implemented as a random-access memory that has as many locations as there are characters in the code set. To determine what class a character belongs to, the character data is used as the RAM's address and the address of that location becomes the encoding of the character's class. In this way each class can contain as many characters as the user wants.

The desire for flexibility also led to the inclusion of interrupts that may be masked out by the user. Since one goal was to limit the 2653 to a 16-pin package, only 1 pin could be used for an interrupt output. Depending on the user's needs, not all four available interrupt conditions might be of interest. If there were no mask feature, each time one of the conditions occurred the user would receive an interrupt and his service routine would have to read the status register to determine the condition responsible.

---

in Bisync normal with only minor variations.

In the automatic-accumulate mode, all characters loaded into the character register are checked and gathered. In this case, the BCC accumulation is not automatically terminated and the CPU must use the single-accumulate mode to stop it. When the chip is in the receiving mode, the BCC error bit is set and reset after each character is accumulated, and the CPU must therefore examine it after the last character is accumulated.

In the single-accumulate mode, all characters are checked and gathered after the CPU issues a command to start accumulation. If it does not, the BCC accumulation is stopped. Otherwise, operation in this mode is identical to that in automatic accumulation. It can be used to selectively perform under CPU control or to accumulate characters that were unintentionally excluded in one of the other modes.

Still more applications

The 2653 can be employed in a variety of applications other than as a dedicated BCC generator for a single channel. For example, it may be multiplexed among several data channels, it may function as a programmable character comparator, or it may serve to check parity on a system-address or system-data bus.

When multiplexed, one PGC may be time-shared among several receiver-transmitters if the CPU saves and restores the contents of the mode register and partial BCC results in the BCC registers. A separate "save" area for each receiver-transmitter and a channel pointer indicating the last unit that transferred or received a data character are needed.

The 2653 can also be used as a programmable comparator to monitor data-bus character transfers (CPU-peripheral, CPU-CPU, CPU-memory, or memory-peripheral via DMA). It is easy in this case to have the DMA controller or a slave CPU handle data-bus transfers. Meanwhile the PGC interrogates the data bus and the host CPU responds to the PGC's interrupts.

In addition, the 2653 can be used to check the parity of transactions on a system's data bus. First, control information is written into the chip. All other bus operations are then checked for parity, with external address decoding used to generate the proper commands. Parity bus checking is useful in data transfers between a CPU and peripherals or a CPU and memory. In fact, some computers check parity on both halves of a 16-bit word during all system-bus transfers. □

8080 efficiently computes 32-by-16-bit quotient

by A. Fiechter
Industrial Data Technology Inc., Rudolfstetten, Switzerland

Occupying about half the space in memory as the routine proposed by Swift and Eisenstein[1], this program quickly performs a 32-bit-by-16-bit division. Also included with this tightened version is an efficient 16-bit-by-16-bit program of the type often used to multiply the result of a 32-bit-by-16-bit division by a third number.

The divider program is similar to Swift and Eisenstein's routine, subtracting the divisor from the most-significant 16 bits of the dividend. The appropriate bit of the quotient is set or cleared, depending upon whether the subtraction process yields a 0 or 1 for that bit. The dividend is then shifted 1 bit with respect to the divisor, and the process is repeated. Sixteen such subtractions are necessary in order to generate the quotient and the remainder.

The dividend is stored in registers HL-DE, with the most significant digits in HL. The divisor is placed in register pair BC. The quotient will build up in DE, with the remainder in HL.

In the multiplication routine, the multiplicand is stored in BC, and the multiplier in HL. The result will appear in registers HL-DE. □

References
1. G. W. Swift and J. P. Eisenstein, "8080 program computes 32-by-16-bit quotient," *Electronics*, May 10, 1979, p. 143.

Tight. Shortened version of 32-by-16-bit divider routine retains all of the capabilities of the quotient program of Swift and Eisenstein[1], but occupies only half the space in memory. 16-by-16-bit multiplier program (opposite page, top) is a useful companion to the divider routine.

TABLE 1: 8080 PROGRAM: 32-BY-16 DIVISION

Label	Source statement		Comments
DIV	MOV	A, L	;
	SUB	C	;
	MOV	A, H	;
	SBB	B	;
	RNC		; RETURN ON OVERFLOW
	XRA	A	; INITIALIZE COUNTER
LOOP	DAD	H	; SHIFT LEFT MUST SIG. PART OF DIVIDEND
	PUSH	PSW	; SAVE COUNTER AND CARRY
	XCHG		; SHIFT LEFT
	DAD	H	; LEAST SIG.
	XCHG		; PART OF DIVIDEND
	JNC	L1	;
	INX	H	; CONVEY CARRY IF THERE
L1	MOV	A, L	; SUBTRACT
	SUB	C	; DIVISOR
	MOV	L, A	; FROM
	MOV	A, H	; MOST SIG.
	SBB	B	; 16 BIT
	MOV	H, A	; OF DIVIDEND
	JC	L2	; JUMP IF DIVISOR GREATER
	POP	PSW	; UNSAVE COUNTER AND CARRY
L3	INX	D	; APPEND '1' TO QUOTIENT
	JMP	L4	;
L2	POP	PSW	; UNSAVE COUNTER AND CARRY
	JC	L3	;
	DAD	B	; RESTORE DIVIDEND
L4	ADI	10H	; INCREMENT COUNTER
	JNC	LOOP	; LOOP 16 TIMES
	RET		

TABLE 2: 8080 PROGRAM: 16-BY-16 MULTIPLICATION			
Label	Source statement		Comments
MUL	XRA	A	; INITIALIZE COUNTER
	MOV	D, A	; INITIALIZE LEAST SIG
	MOV	E, A	; PART OF PRODUCT
LOOP	DAD	H	; SHIFT LEFT MULTIPLIER
	RAR		; SAVE CARRY
	XCHG		; SWAP FOR
	DAD	H	; SHIFT LEFT PRODUCT
	JNC	L1	;
	INX	D	; CONVEY CARRY IF THERE
L1	RAL		; UNSAVE CARRY
	JNC	L2	; IF SET
	DAD	B	; ADD IN MULTIPLICAND
	JNC	L2	;
	INX	D	; CONVEY CARRY IF THERE
L2	XCHG		; SWAP BACK
	ADI	10H	; INCREMENT COUNTER
	JNC	LOOP	; LOOP 16 TIMES
	RET		;

Calculator notes

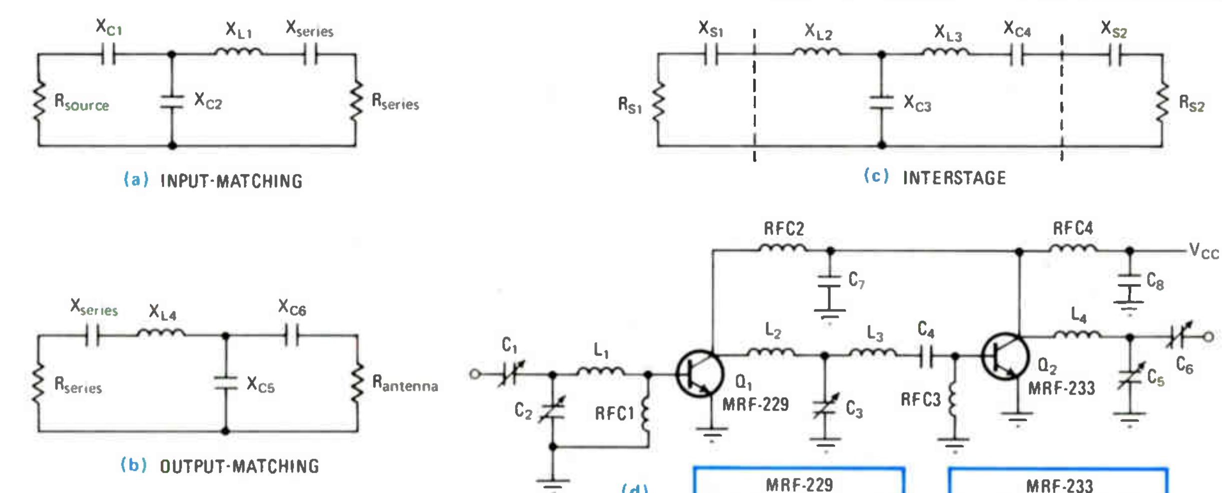
HP-97 speeds design of rf amplifiers

by Karl Tonis
EWC Inc., Kenilworth, N. J.

Complementing the calculator note presented by Tula[1] for designing Class C tube-type amplifiers, this HP-97 program drastically reduces the time needed to build low-power radio-frequency amplifiers of the transistor variety. Given the large signal parameters and characteristics of the transistors used and the reactances of the decoupling inductors and capacitors, the program quickly yields the values of the elements required in the amplifier's input and antenna-matching networks (for a one-stage amp) or the matching and interstage networks (for a two-stage design).

The program first finds the parallel-equivalent output resistance of one or both of the amplifiers from $R_P = (V_{cc} - V_{ce(sat)})^2/2P_o$, where V_{cc} is the specified collector voltage, P_o is the desired output power, and $V_{ce(sat)}$, the collector-to-emitter saturation voltage, is typically 2 volts. The loaded Q of the amplifier is then found from $Q_L = f_o/BW$, where f_o is the frequency of operation and BW is the bandwidth required.

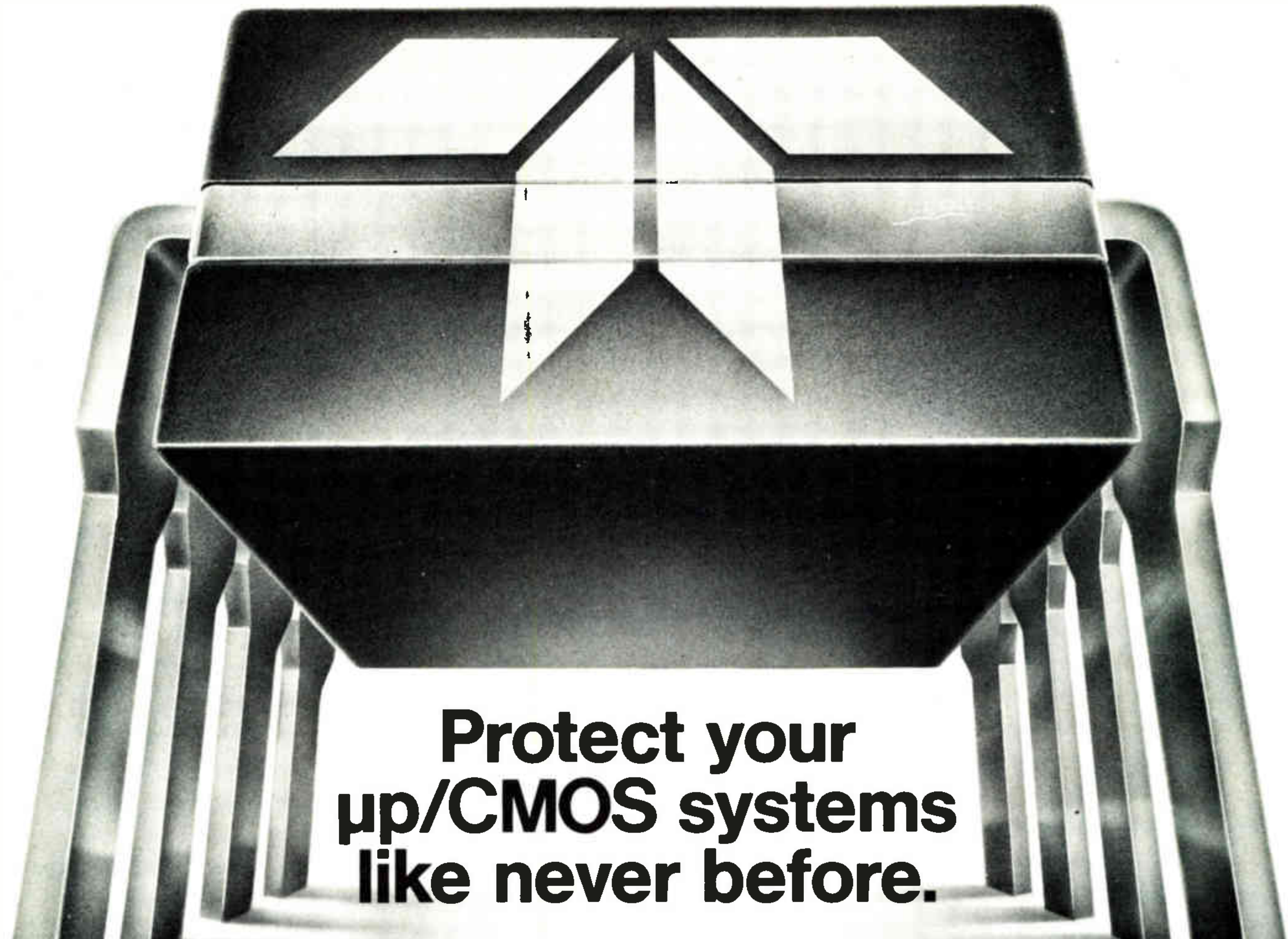
Following this very simple calculation, the series-equivalent resistances and reactances are readily found



MRF-229	
P_O	1.5 W
$X_{C\,out}$	49 pF
$R_{P\,in}$	23 Ω
$X_{C\,in}$	10 pF

MRF-233	
P_O	17 W
$X_{C\,out}$	11 pF
$R_{P\,in}$	6 Ω
$X_{C\,in}$	3.5 pF

Transformation. Given transistor and circuit parameters and reactance of decoupling elements in Class C amplifier, program determines values of components in matching networks (a), (b), and (c). Design of two-stage amplifier (d) is discussed in text example.



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002	STO0	035	GSB1	068	−	101	STO0	134	RCL7	167	RCL0
003	P⇌S	036	RCLA	069	÷	102	RCL4	135	Pi	168	ENT↑
004	STO0	037	GSB2	070	GSB3	103	STO2	136	×	169	RCL0
005	P⇌S	038	RCLB	071	RCL6	104	GSB5	137	2	170	RCL2
006	R/S	039	GSB2	072	RCL1	105	RCL9	138	×	171	÷
007	STO1	040	RCLE	073	×	106	RCL1	139	STO7	172	X^2
008	R/S	041	GSB3	074	RCL0	107	÷	140	P⇌S	173	1
009	STO2	042	RCLI	075	+	108	1	141	STO7	174	+
010	R/S	043	GSB3	076	GSB2	109	−	142	P⇌S	175	÷
011	STO3	044	5	077	F2?	110	√X	143	RTN	176	STO1
012	R/S	045	GSB3	078	GTO0	111	STO8	144	*LBL2	177	RCL0
013	STO4	046	*LBLC	079	GTO7	112	RCL1	145	RCL7	178	×
014	R/S	047	SF2	080	*LBL0	113	×	146	÷	179	RCL2
015	STO5	048	RCLC	081	RCL4	114	RCL0	147	PRTX	180	÷
016	R/S	049	GSB2	082	STO0	115	+	148	RTN	181	STO0
017	STO6	050	RCL0	083	RCL3	116	5	149	*LBL3	182	RTN
018	P⇌S	051	GSB2	084	STO2	117	+	150	RCL7	183	*LBL6
019	STO6	052	GSB4	085	GTO0	118	GSB2	151	×	184	RCL6
020	R/S	053	*LBL0	086	*LBL7	119	RCL9	152	1/X	185	X^2
021	STO7	054	GSB5	087	P⇌S	120	RCL6	153	PRTX	186	1
022	P⇌S	055	GSB6	088	RCL3	121	RCL8	154	RTN	187	+
023	STO7	056	RCL5	089	X=0?	122	+	155	*LBL4	188	RCL1
024	R/S	057	÷	090	R/S	123	÷	156	RCL0	189	×
025	P⇌S	058	1	091	GSB4	124	GSB3	157	2	190	STO9
026	STO4	059	−	092	GSB5	125	P⇌S	158	−	191	RTN
027	R/S	060	√X	093	RCL1	126	R/S	159	X^2	192	*LBLB
028	STO3	061	STO8	094	RCL6	127	*LBL1	160	RCL1	193	GSB1
029	R/S	062	RCL5	095	×	128	RCL6	161	2	194	RCLE
030	STO2	063	×	096	RCL0	129	÷	162	×	195	GSB3
031	R/S	064	GSB3	097	+	130	STO6	163	÷	196	GTOC
032	STO1	065	RCL9	098	GSB2	131	P⇌S	164	STO0	197	R/S
033	P⇌S	066	RCL6	099	GSB6	132	STO6	165	RTN		

Registers (R-S)	
R_0	V_{CC}
R_1	P_0 (Q_2)
R_2	$X_{C\ out}$ (Q_2)
R_3	$X_{C\ in}$ (Q_1)
R_4	$R_{P\ in}$ (Q_1)
R_5	$R_{L,S}$
R_6	BW
R_7	f_0
R_8–R_9	used
S_0	V_{CC}
S_1	P_0 (Q_1)
S_2	$X_{C\ out}$ (Q_1)
S_3	$R_{P\ in}$ (Q_2)
S_4	$X_{C\ in}$ (Q_2)
S_6	BW
S_7	f_0
S_8	used
S_9	used

Registers (A-I)	
A	X_{RFC1}
B	X_{RFC2}
C	X_{RFC3}
D	X_{RFC4}
E	X_{C7}
I	X_{C8}

Instructions

- Key in program
- Enter reactances of stage's bypass networks
  (X_{RFC1}), STO A, (X_{RFC2}), STO 2, (X_{RFC3}), STO 3, (X_{RFC4}), STO D, (X_{C7}), STO E, (X_{C8}), STO I
- Specify transistor parameters
  (V_{CC}), A, (P_0 (Q_2)), R/S, ($X_{C\ out}$ (Q_2)), R/S, ($X_{C\ in}$ (Q_1)), R/S, ($R_{P\ in}$ (Q_1)), R/S, ($R_{L,S}$), R/S, (BW), R/S, (f_0), R/S, ($X_{C\ in}$ (Q_2)), R/S, ($R_{P\ in}$ (Q_2)), R/S, ($X_{C\ out}$ (Q_1)), R/S, (P_0 (Q_1)), R/S
  The program will calculate and print out, in order, RFC1, RFC2, C_7, C_8, C_4, RFC3, RFC4, C_6, C_5, L_4, C_1, C_2, L_1, L_2, L_3, and C_3.
- For single-stage amplifiers, enter
  (X_{RFC1}), STO C, (X_{RFC2}), STO D, (X_{C3}), STO E, (V_{CC}), A, (P_0), R/S, ($X_{C\ out}$), R/S, ($X_{C\ in}$), R/S, ($R_{P\ in}$), R/S, ($R_{L,S}$), R/S, (BW), R/S, (f_0), R/S, B
  The program will calculate and print out C_3, RFC1, RFC2, C_5, C_4, L_2, C_1, C_2, and L_1.

from $R_S = R_P/[1+(R_P/X_c)^2]$ and $X_S = R_S R_P/X_c$. The reactances of the elements required to match the source impedance, R_{source}, to the load, R_{series}, is then determined, as seen in (a) in figure, as are the components of the output matching network (b):

$$X_{C1,C6} = R_{L,S}[R_{series}(1+Q_L^2)/R_{L,S}-1]^{1/2} \rightarrow C_1,C_6$$
$$X_{C2,C5} = R_{series}(1+Q_L^2)/\{Q_L - [R_{series}(1+Q_L^2)/R_{L,S}-1]^{1/2}\} \rightarrow C_2,C_5$$
$$X_{L1,L4} = R_{series}Q_L + X_{series} \rightarrow L_1,L_4$$

where $R_{L,S}$ corresponds to R_{source} for X_{C1} and X_{C2} and $R_{antenna}$ for X_{C5} and X_{C6}. The values of the components in the interstage "T" network (c), which is recommended for matching the low impedances encountered in transistor design, are then found:

$$X_{L2} = R_{S1}Q_L + X_{S1} \rightarrow L_2$$
$$X_{L3} = R_{S2}[R_{S1}(1+Q_L^2)/R_{S2}-1]^{1/2} + X_{S2} + X_{C4} \rightarrow L_3$$
$$X_{C3} = R_{S1}(1+Q_L^2)/\{Q_L + [R_{S1}(1+Q_L^2)/R_{S2}-1]^{1/2}\} \rightarrow C_3$$

where X_{C4} = 5 ohms capacitive reactance. The program is shortened for a single-stage amplifier, since no interstage-coupling calculation is required.

An amplifier design example illustrates the usefulness of the program. A two-stage amplifier operating at 90 megahertz (d) is to provide a minimum power gain of 20 decibels and a bandwidth of 5 MHz. The interstage network must transform the input impedance of the second stage into the output impedance of the first stage, and the output amplifier must work into a 50-Ω load.

Selecting the MRF-229 transistor for Q_1 and the MRF-233 for Q_2 (see table), and keying in the parameters as instructed for a desired $P_o(Q_1)$ = 1.5 watts, setting X_{RFC1} = 1,500 Ω, X_{RFC2} = 1,200 Ω, X_{RFC3} = 2,000 Ω, X_{RFC4} = 1,100 Ω, X_{C7} = 2, and X_{C8} = 1 yields the following values RFC1 = 2.65 microhenries, RFC2 = 2.12 μH, RFC3 = 3.54 μH, RFC4 = 1.95 μH, L_1 = 131 nanohenries, L_2 = 780 nH, L_3 = 204 nH, L_4 = 96.5 nH, C_1 = 7.41 picofarads, C_2 = 19.7 pF, C_3 = 20.6 pF, C_4 = 354 pF, C_5 = 25 pF, C_6 = 8.25 pF, C_7 = 884 pF, and C_8 = 1.77 nanofarads. □

References
1. Fernando Lucio Tula, "TI-58 aids design of rf power amplifiers," *Electronics*, Feb. 28, 1980, p. 158.

Engineer's newsletter

A far, far better way of protecting a breadboard

Everyone who has ever built a breadboard knows the feeling of surprise when something doesn't burn up when power is first applied. Fuses and circuit breakers are both too slow to protect semiconductors, and usually, too, these safety devices are available in a only few widely separated trip current values. A new device called the Breaker Box has recently been built by the Long Range Co. specifically to protect breadboards without the disadvantages of traditional approaches.

The $49.50 unit is **a circuit breaker whose trip current may be selected from the range of 250 mA to 7.75 A by weighted toggle switches.** The switches are weighted with 0.25, 0.5, 1.2, and 0.5 A. A trip current is selected by closing various combinations of switches; a tripped condition is indicated by a light-emitting diode and reset with a push button. If all switches are down, the unit is in a supersensitive mode where the breaker trips around 10 mA. The internal circuitry is floating and power is supplied by a 9-V battery. For information, contact Lawrence Edwards, The Long Range Co., P. O. Box 911, Amado, Ariz., 85640.

A TRS-80 quick fix

Here's a little circuit improvement for Radio Shack's popular TRS-80 home computer. Cass R. Lewart of System Development Corp., Eatontown, N. J., notes that the electromechanical cassette relay in the TRS-80 is a frequent source of difficulties. Though a dc relay, it can easily be replaced with an inexpensive solid-state triac relay (Radio Shack number 275-236 at a cost of $1.99).

Ordinarily an ac relay cannot replace a dc type. But in this case, an ac type relay will work since **the tape recorder motor interrupts the current flow, thus turning off the triac in the solid-state relay.**

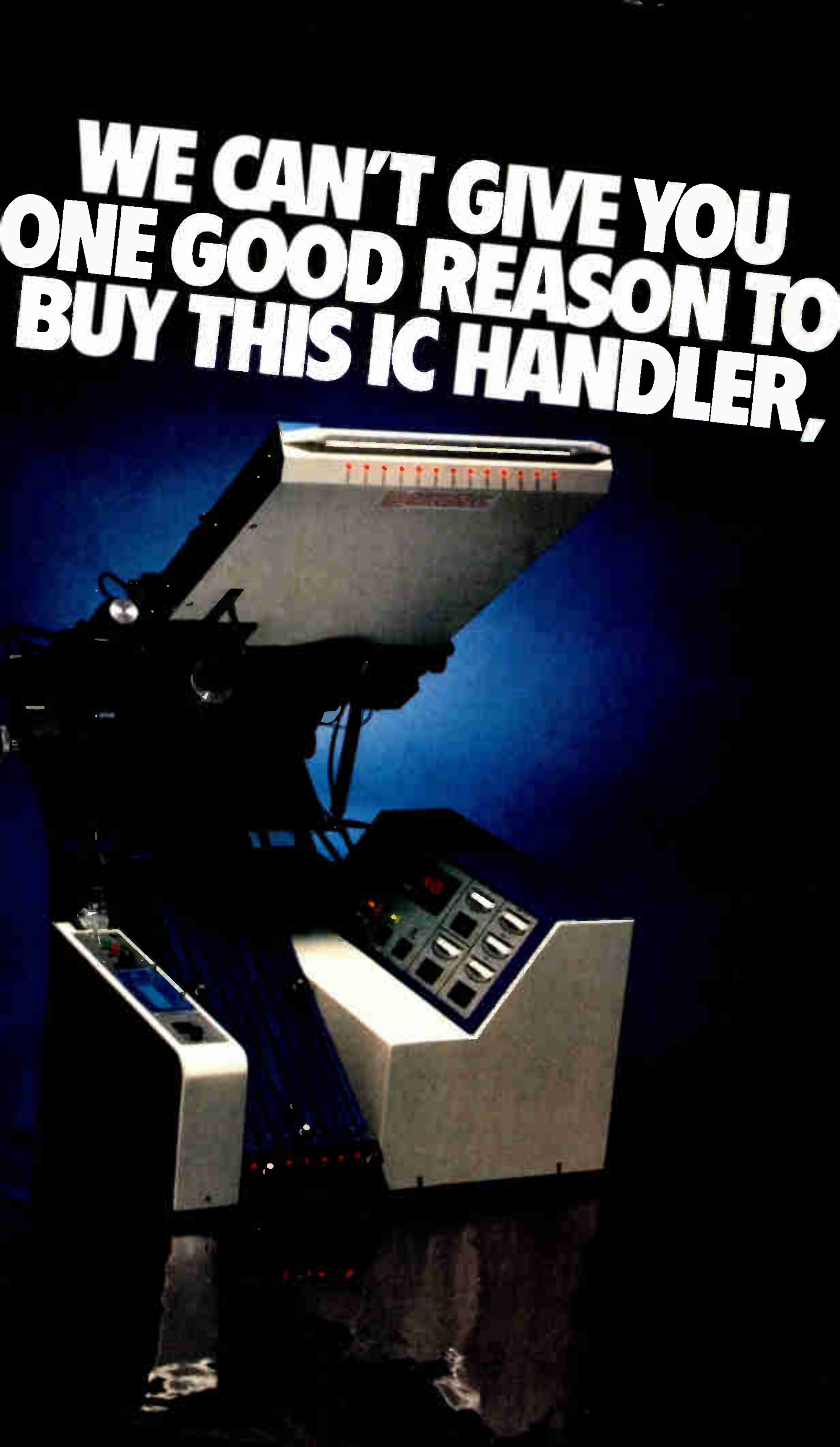
Do-it-yourself fiber optics

Are you about to get started in fiber optics? A new kit put together through a cooperative effort of AMP Inc. and Motorola can assist you, for it provides the data-communications engineer with a pair of modules he can build himself. These **transceiver modules are the heart of full-duplex TTL data link that can handle data up to a 20-megabaud rate and fiber path lengths in excess of 100 meters.** The kit includes: printed-circuit boards, integrated circuits, emitters, detectors, rf- and other electromagnetic-interference shields, ferrite chokes, fiber-optic connector components, a length of terminated fiber-optic cable, and complete instructions and specifications of all manner of components. For further information, contact AMP Inc., Harrisburg, Pa., 17105.

Primer discusses thick-film laser trimming

A 16-page booklet from Teradyne called "A Primer on Thick-Film Trimming Principles" gives the basic objectives of resistor trimming, the factors that affect trim stability, and guidelines for increasing yield. The primer discusses the major principles of laser trimming such as **controlling the laser beam and determining Q rate and bite size.** In addition, it describes the various types of cuts: straight cuts, L cuts, L cuts with vernier cut, double cuts, etc. Diagrams and recommendations for use accompany the description of each cut. Copies are available free from Teradyne Inc., 183 Essex St., Boston, Mass. 02111.

-Jerry Lyman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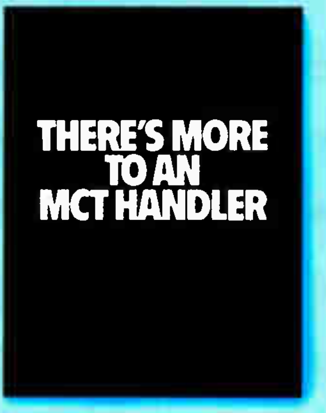

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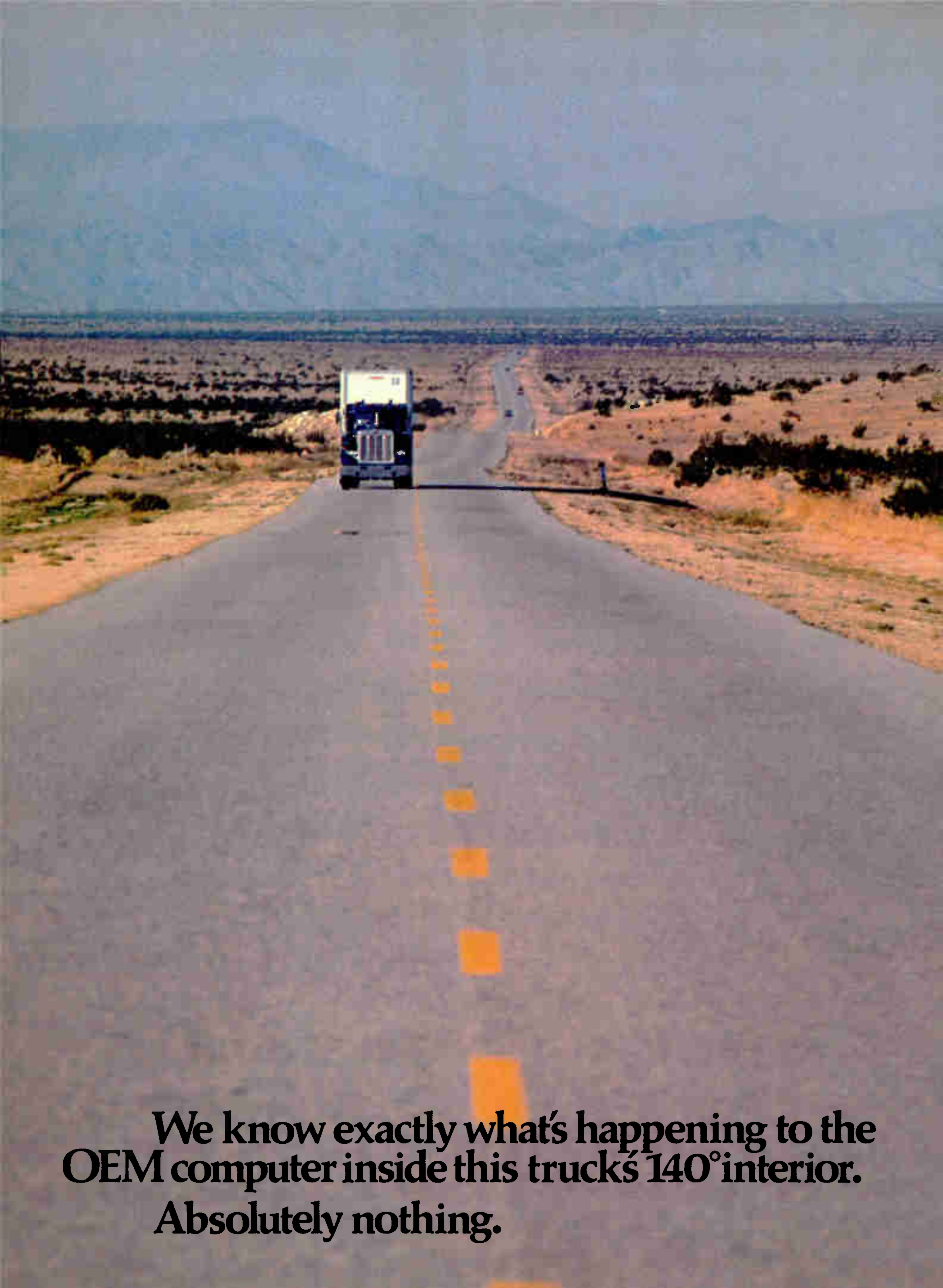
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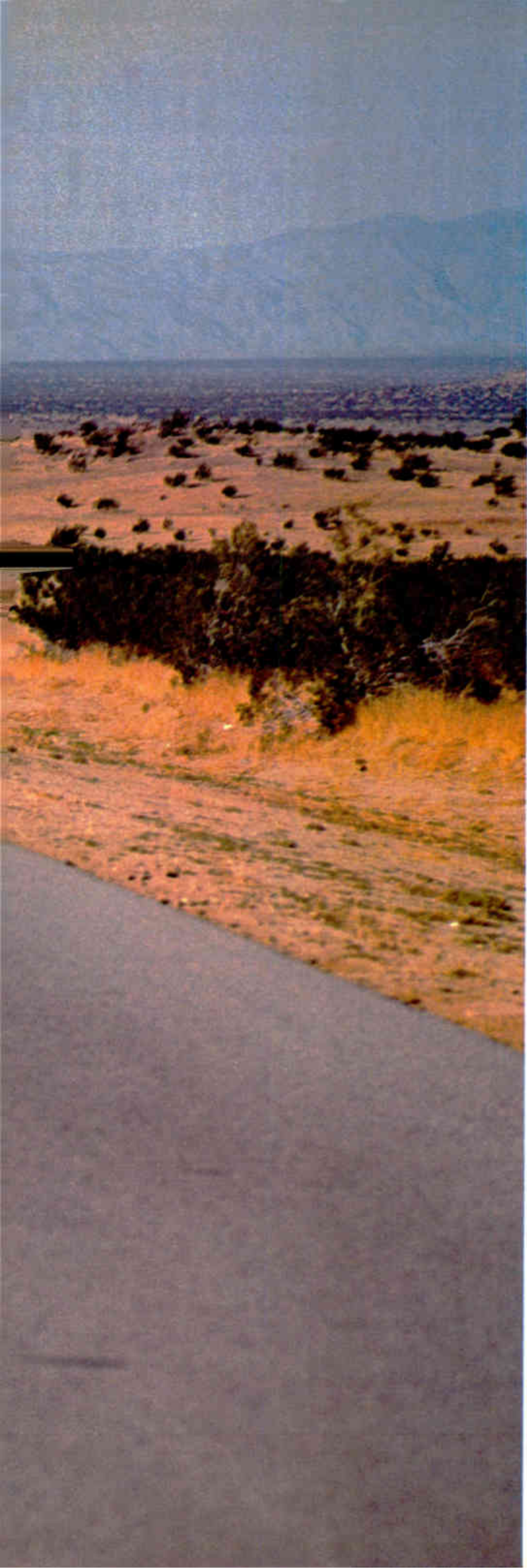

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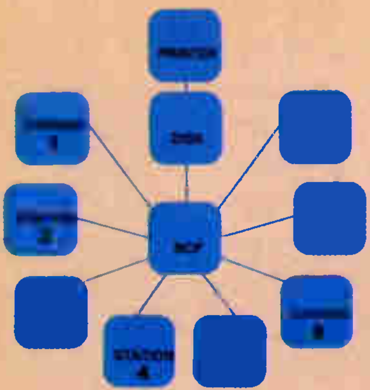

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Digital scope gets broader horizon

Service instrument digitizes at 25 megasamples/second, stores 10-MHz signals, and solves problems of aliasing and display jitter

by Bruce LeBoss, San Francisco regional bureau manager

Since their debut several years ago, digital storage oscilloscopes have had a major drawback—limited storage bandwidth. Typically, bandwidth has ranged from a few hundred kilohertz to 1 MHz, about one to two orders of magnitude less than that of analog storage scopes. Now Tektronix Inc. is about to make available an instrument that performs faster than other digital storage scopes and increases the range of signal frequencies that can be stored and displayed.

Designated the model 468, the new portable scope in the nonstorage mode has all the capabilities of Tek's 465B 100-MHz unit, which has become an industry standard. However, the 468 has a maximum digitizing rate of 25 megasamples/s that allows viewing of a faster signal than prior scopes.

Controlled by an Intel Corp. 8085 8-bit microprocessor, the 468 uses an 8-bit digitizer and a unique display interpolation technique to achieve a 10-MHz "useful storage bandwidth." That specification highlights the maximum-frequency sine wave that can be stored usefully in a single sweep. "By 'useful' we mean a visually usable and accurate representation of a waveform with less than 5% envelope error," notes Michael Turner, marketing program manager for portable oscilloscopes.

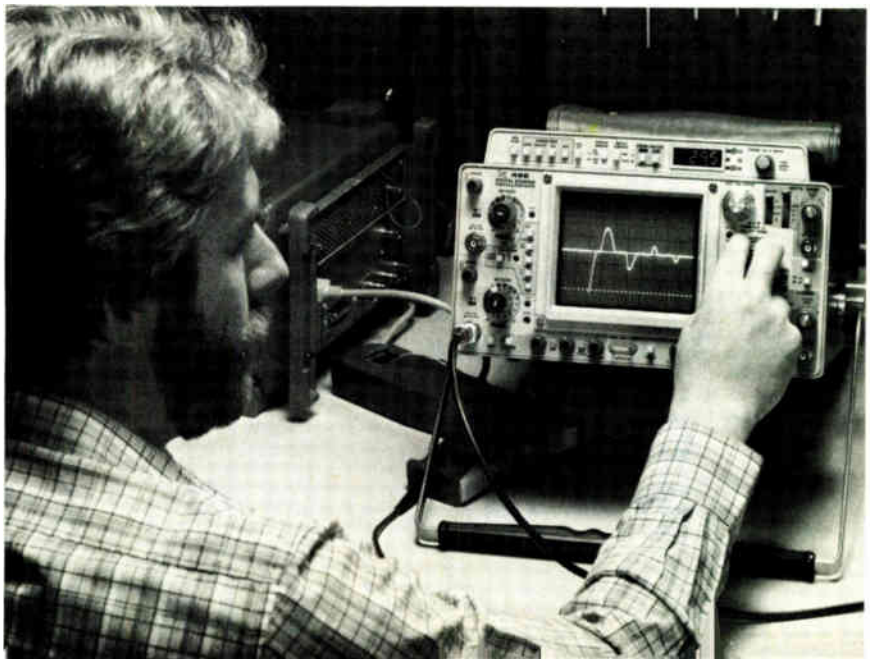
The design of the 468 solves a number of problems that plagued earlier instruments. The new scope can capture signals that other digital storage scopes would alias, that is, display as a subharmonic of the actual real-time waveform. It can also correct for display jitter and has a special sine interpolator mode that makes digitally stored sine waves appear normally, not as jagged lines as in other digital storage scopes.

High rate. To capture and display a waveform accurately, the designers realized that a minimum of 2.5 samples/s would be needed. They therefore set out to overcome the low sampling rate that limited other digital storage scopes, building an analog-to-digital converter able to handle 25 megasamples/s. With it, the 468 achieves a useful storage bandwidth of 10 MHz.

In the envelope mode (used for anti-aliasing, among other things), the 468 samples at twice the rate specified by the time/division switch. It also records maximum and minimum values of a waveform envelope in the scope's 1,024-data-word memory, which can store up to two 512- or four 256-word waveforms. This can be done over a selectable number of sweeps, in binary increments ranging from 2 to 256, or continuous setting. If aliasing is occurring because a signal is undersampled, the 468's envelope mode will display a solid band across the cathode-ray tube. If there is no aliasing, the envelope mode will simply look like the normal storage acquisition display.

Navarro says that the envelope serves other useful functions, such as capturing and displaying signal excursions that occur between the normal sampling points. It also allows the user to automatically catch minimum and maximum signal values over long periods of time, "acting somewhat like a babysitter," and it provides the ability to view as much of the waveform as necessary (as captured by the time/div setting) and still catch glitches (with the faster rate).

The 468 all but eliminates the horizontal jitter that occurs with multiple acquisitions of a signal, a characteristic of most, if not all, prior digital scopes. The 468 uses a jitter circuit to correct for the ±0.5 sample interval uncertainty that is caused by an inconsistent timing



relationship between the scope's digitizing clock and the trigger event. When the 468 is used, Navarro claims, "jitter is unobservable even during horizontal expansion of repetitive signals."

Fast lane. In the storage modes, the 468 continues to drive like a nonstorage scope. Pushing a button sends the instrument into the storage mode and waveforms are acquired and stored as easily as they are viewed in the nonstorage mode. Like other digital storage scopes, the 468 provides a brighter, crisper display with improved contrast from that of conventional analog storage scopes. Because a waveform cannot bloom, or fade positive, there are no storage-level/intensity-control interactions needed between user and scope. These features, as well as signal averaging and cursors for the time and voltage differences, make operation of the 468 more convenient and thus should help increase engineering productivity.

The 28-lb 468, to be shown formally for the first time at the Hanover Fair next month, will be available in August with a $5,000 base price. The instrument has a general-purpose interface bus (GPIB) option that makes it usable in manufacturing and research and development, for signal processing and data logging and manipulation. "We see a great future for waveforms on a data bus," states Turner. A signal-averaging option is available as is a read-only memory that performs service routines that, in addition to those already resident in the 468, check out the scope's performance.

Although the storage bandwidth of the 468 is significantly less than the levels achieved by its analog counterparts, its performance features aim at medium-storage applications in medical, industrial/manufacturing, and communications markets, Navarro points out. For example, "it's ideal for pulse-testing or stressing parts, such as a transistor, to be used in switching power supplies or television broadcasting equipment," he adds.

Tektronix Inc., P. O. Box 500, Beaverton, Ore. 97077 [338]

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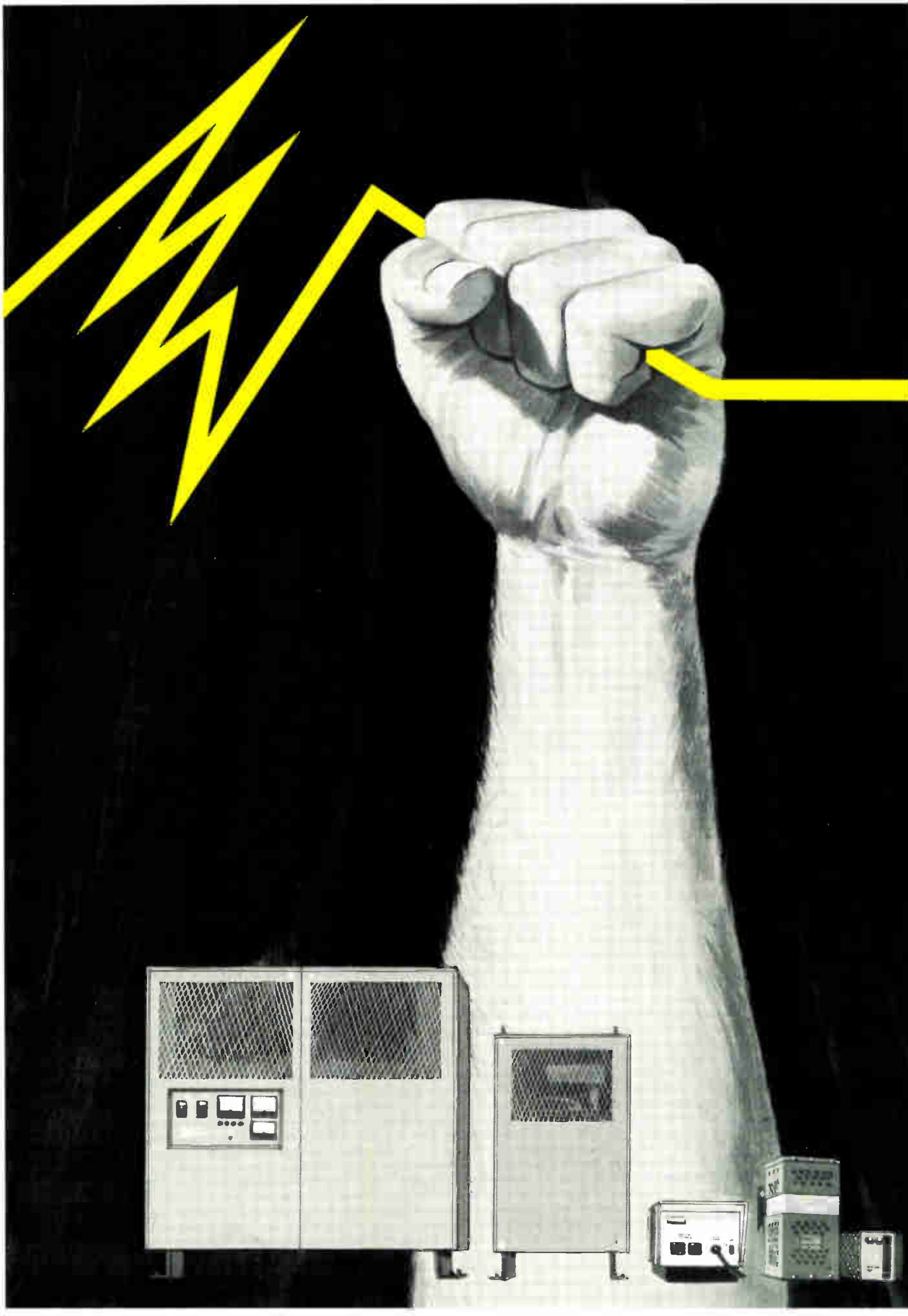

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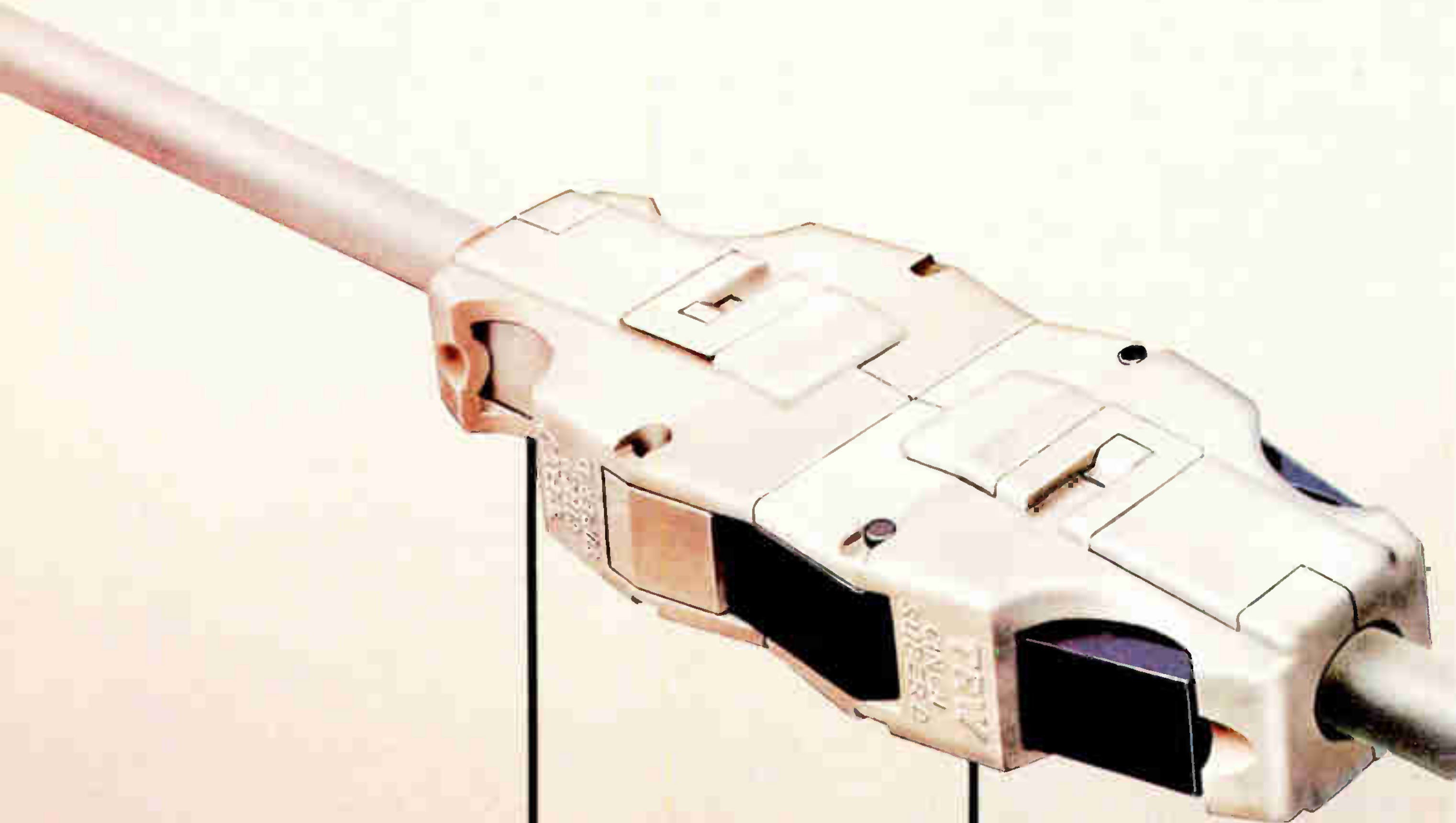

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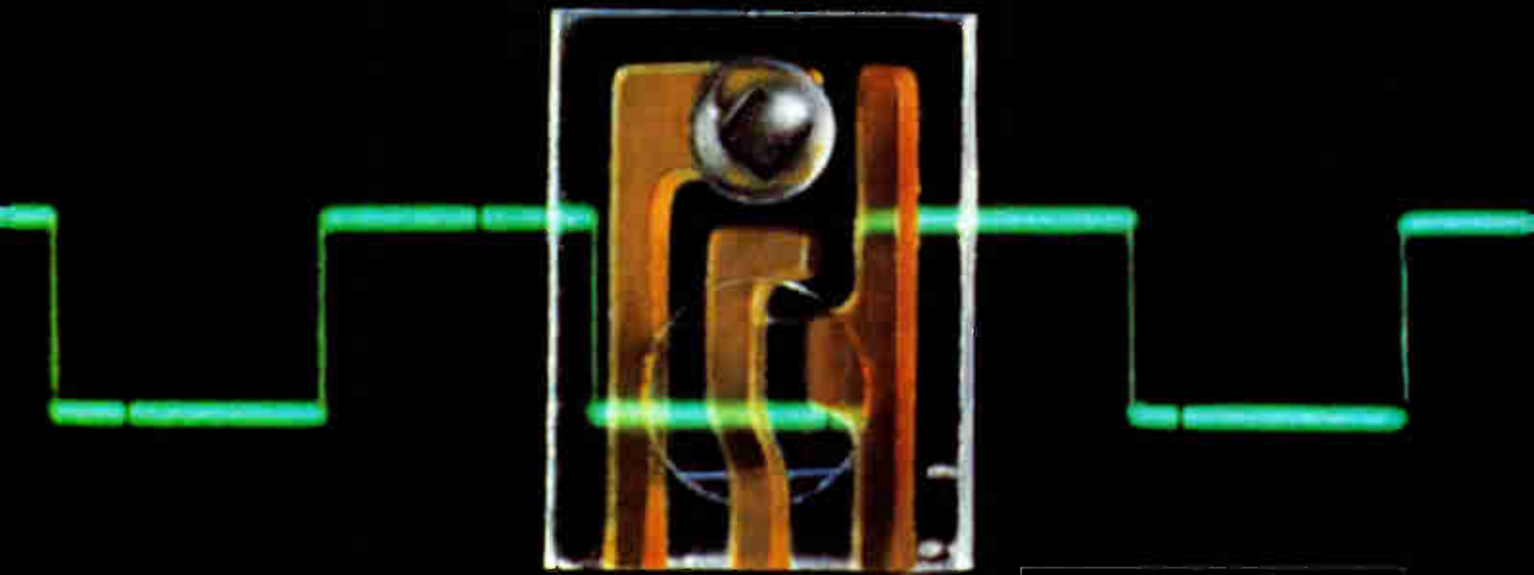

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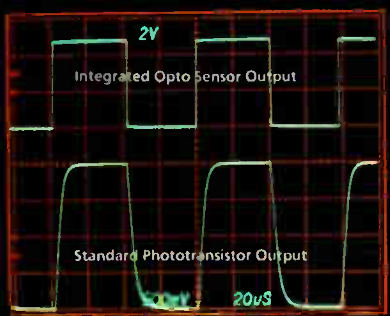
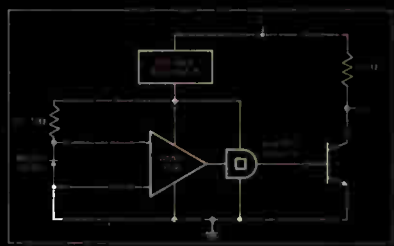


The SDP 8600 integrates a Schmitt trigger, voltage regulator, differential amplifier and photodiode onto the same substrate—replacing a complete PC board. This neat integration hasn't cost any performance. It has a propagation delay time of only 5 μs and a 50 ns rise and fall time.

Designed for use with an infrared LED, it's ideal for sensing applications such as computer peripherals, toys and automatic cruise control systems. With significant benefits like improved



noise immunity, higher reliability and better performance.

The 8600 is just one example of a long line of optoelectronic firsts from Spectronics.

So, if you're looking for better design solutions, call Spectronics. We do smart things with light.

For more information, contact a Spectronics distributor. Or call us at 214/234-4271. Address: Spectronics, 830 East Arapaho Road, Richardson, Texas 75081.

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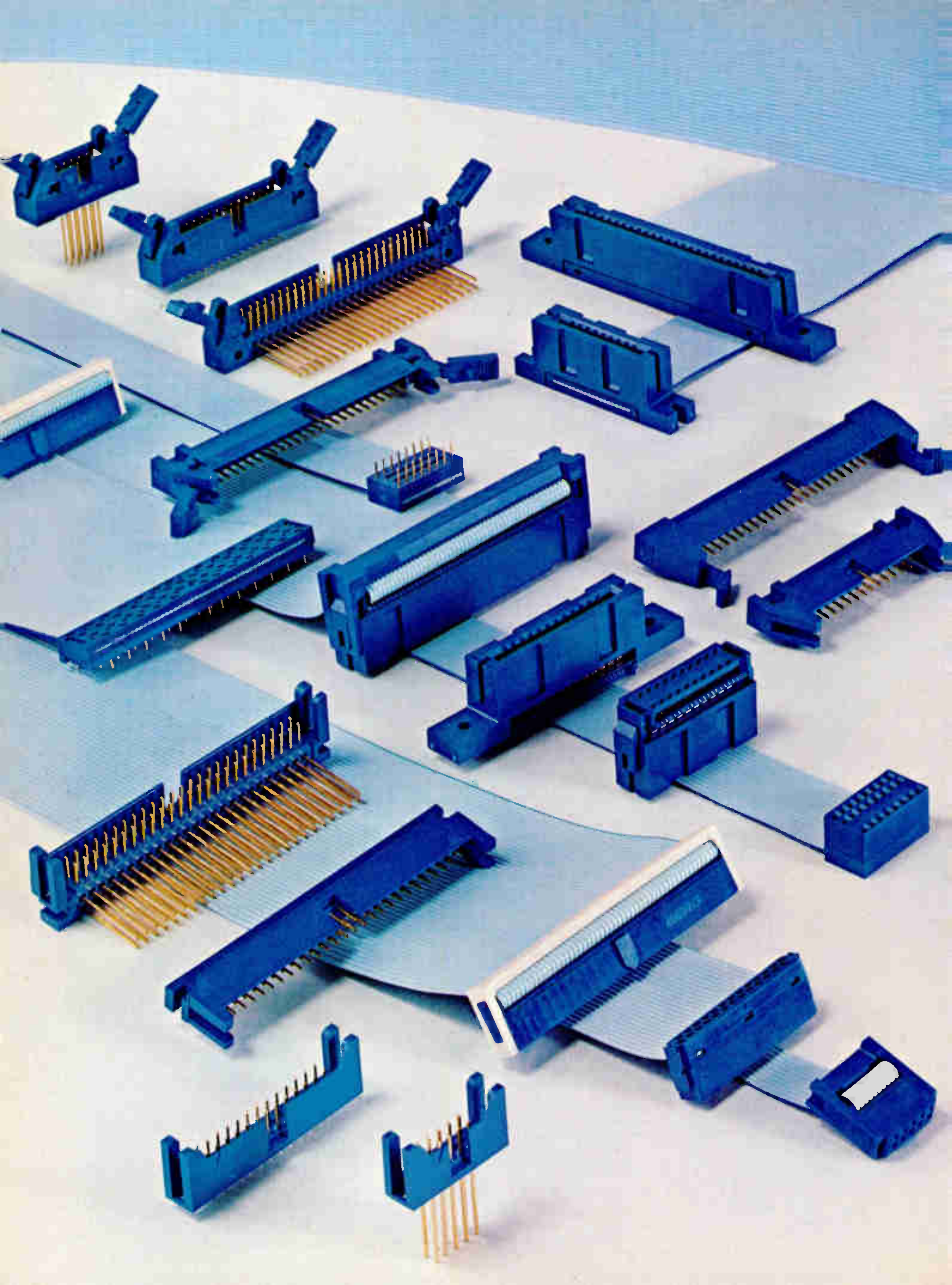
Light years ahead.

Circle 179 on reader service card



Quickie™: the total IDC System for design flexibility, fast assembly, reliable connections.

Meets a variety of interconnect needs.

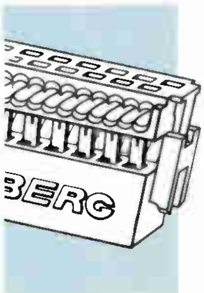
• A wide choice of connectors: "Quickie" and "Quickie" low-profile females, female IC, edge card, male DIP, PCB, and quick-eject vertical and right-angle headers ... all in a broad range of sizes.

• Round conductor, flat cable on 0.050" centers.

• A selection of hand and air operated presses, cable shears, accessories and strain reliefs.

Efficient assembly saves time, material and money.

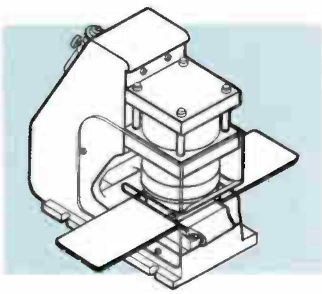
All connectors in the Quickie* system deliver reliable terminations in just a few seconds because:



• Cable slot designed to precisely position conductor for reliable termination, higher yields.

• Sight holes in cover permit visual inspection before and after assembly assuring proper cable alignment.

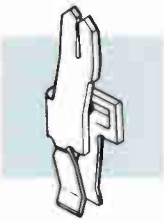
• The semi-automatic applicator completes terminations with a slide motion reducing assembly time. Or choose the manual applicator designed to minimize operator fatigue.



Over seven years proven performance. You can rely on "Quickie".

"Quickie" connectors are now specified by many of America's most quality conscious companies. Three high performance features demonstrate why:

1. Askewed tines firmly hold the wire for reliable termination.



2. Dual-beam contact assures redundant positive pin connection, even when subjected to vibration.

3. High-strength plastics withstand severe environments.

For a brochure giving details and complete specifications, write or call:

The Du Pont Company, Berg Electronics Division
New Cumberland, Pennsylvania 17070.
Telephone: (717) 938-6711.

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Circle 183 on reader service card

*Du Pont's trademark for its mass termination connectors, cable, presses and accessories.

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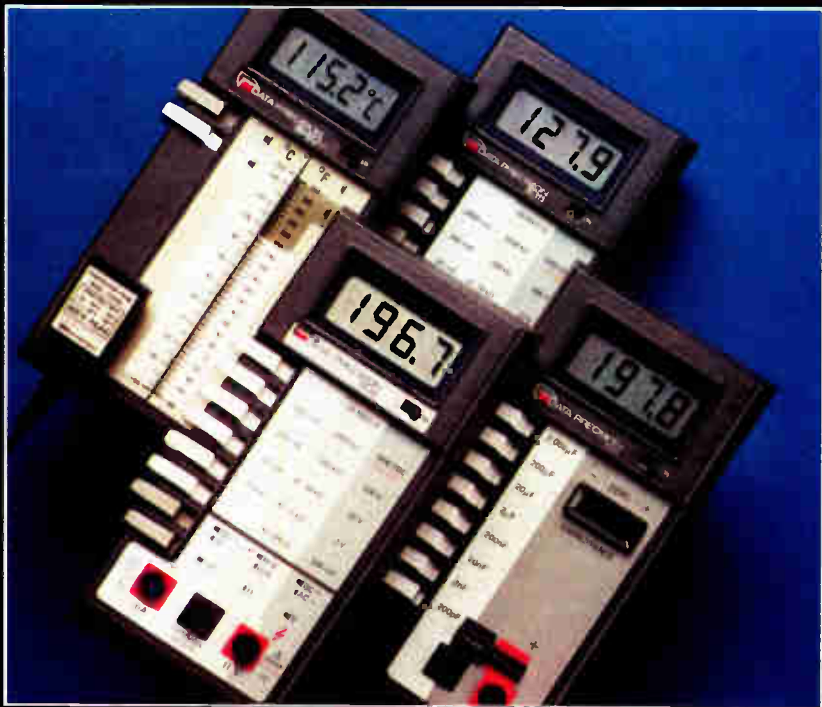

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Capacitance Meter
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Capacitance Meter...Model 938: $169.
This 3½ digit 0.1% accuracy capacitance meter features measurement ranges 0.1pF to 2000 μF, immediate direct reading, push button selectability, exceptional accuracy and easy operation. The 938 will outperform all other capacitance meters, DC time constant meters, and even bridges costing 2 to 5 times as much!

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For demonstration circle #184

For additional information circle #257

Microcomputers & systems

Compiler carries portable software

System on diskettes uses combined Pascal and assembly language

"This approach to a compiler provides the user with more software portability than he is likely to see anywhere else in the near future." So boasts Bruce Ravenal, president of Language Resources Inc., describing the compiler he has developed for the 8080, 8085, 8086, and 8088 microprocessors using a combined Pascal and assembly language.

He adds that the Pascal Language System can be run on a number of host computing systems, allowing both cross and resident development capabilities. Initial hosts include CDC's Cyber, DEC's PDP-11/Unix, Intel's MDS/ISIS-II, and computer systems using CP/M-8080.

Two elements are essential to the software portability—the compiler's ability to change hosts and its high retargeting rate. It can change hosts because of its adherence to machine-independent coding standards and also because of its modular program design. The compiler is organized into six phases adaptable for operation in a single-pass, multiple-pass, or pipeline configuration.

Tailored target. The package's high retargeting rate, or ability to switch microprocessors, is achieved by the selection of algorithms that are independent of the target microprocessors for many tasks performed by the compiler's back end. These are tailored to a particular target microprocessor by supplying the minimal information needed to describe the properties of each aspect of the target machine. The general philosophy underlying this method is that it is faster and less error-prone to supply data about the target machine than it is to modify the compiler's algorithms.

The complete Pascal Language System, which sells for about $2,500 on protected diskettes, consists of binder, loader, assembler, and run-time library modules in addition to the Pascal compiler module. This organization, Ravenal points out, contributes to the system's manageability and to its ease in retargeting and rehosting. The fact that the package itself is written in a subset of the standard Pascal language, which it compiles, is perhaps an even greater contributor to its portability.

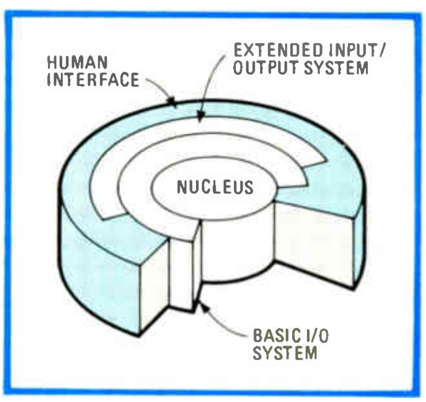
In addition to providing software for the basic central processing units, the Pascal Language System can also be used to program coprocessors such as the Intel 8087 math chip and 8089 input/output processor.

The Pascal Language System also offers some niceties to make the designer's task easier. One is the fact that its loader program supports symbolic debugging. Another is that the binder program allows iterative linking, because the module's output is encoded the same way as its input. Deliveries of the system will begin in May.

Language Resources Inc., 1307 South Mary St., Sunnyvale, Calif. 94087. Phone (408) 737-2525 [371]

8086 operating system runs multiple tasks and programs

RMX/86 is a sophisticated yet easily used operating system that can reside in read-only memory or on disk. Although similar in many ways to RMX/80 for the 8080 and 8085 microprocessors, RMX/86 is specifi-



cally designed for the higher-performance and megabyte-addressing capability of the 16-bit 8086. RMX/86's nucleus provides an environment for the execution of multiple real-time tasks within multiple programs through a priority-structured, event-driven scheduling algorithm. It runs on single-board computers such as the Multibus-compatible iSBC 86/12 [*Electronics*, Oct. 12, 1970, p. 105].

The operating system is modular, meaning that it comprises flexible units that can be manipulated by the user for an optimal system organization. Indeed, RMX/86 is actually a library of functions to which the user's extensions are added.

A real-time operating system has what it takes to monitor and control concurrent, asynchronous events in the real world. RMX/86 has all the hooks: priority-based system resource allocation, interprogram and intertask communication and control, real-time clock control, and interrupt handling. RMX/86's task scheduling mechanism, which recognizes up to 255 priority levels, responds to these interrupts. The levels, designated by the user, specify a task's eligibility for execution.

Like the application-oriented systems derived from it, RMX/86 is constructed in modular fashion, as the diagram shows. The nucleus supports the communication between, and synchronization and mutual exclusion of, the multiple tasks and programs. The nucleus also provides the facilities for real-time control as well as managers for critical sections, free space, and exceptions. The exception-handler immediately detects software failures and makes several recovery methods available.

Surrounding the nucleus is a comprehensive, device-independent input/output system. Device independence refers to a standardized interface that greatly simplifies the interchange of peripheral devices. Drivers for the iSBC 204 single-density diskette and iSBC 206 hard-disk controllers are included in the system, as is a random-access driver that can be customized for specific applications.

Closest to the user is a human interface that provides extensive console services. A command-line interpreter decodes for applications and system utilities and can even be given customized instructions. Commands can be added and deleted dynamically, and they can originate from a terminal or from a disk file. A terminal-handler provides keystroke control over starting, stopping, and line-editing.

RMX/86 also features invaluable error-handling and -debugging facilities. The error-processing subsystem detects and traps errors such as those caused by the incorrect coding of new programs and tasks. Each task in the system may have its own error handler. The debugger allows memory examination and modification. The stack overflow can be closely watched and breakpoints set for task execution.

The license fee for RMX/86 is $7,500 plus royalties of $300 per use for 1 to 24 yearly uses; $225 per use for 25 to 49 yearly uses; or $160 per use for 50 or more annual uses. The base price includes eight diskettes, six manuals, a registration card, one week of training, an iSBC 957 execution vehicle, and free updates for 12 months after the initial license.

Intel Corp., 3065 Bowers Ave., Santa Clara, Calif. 95051. Phone (408) 987-8080 [372]

Cross assembler for 8086 operates at 1,000 lines/m

Software for 8086 microcomputers can be written on any 8080 or Z80 development system by using the XMACRO-86 cross assembler. The unit, which is compatible with the CP/M, ISI-II, and Tekdos operating system, assembles at over 1,000 lines per minute. The assembler is of the traditional kind and does not use symbol types. Like the popular MACRO-80, it features relocation, macros, conditional assembly, and listing and loader control. It supports a complete Intel 8080 standard macro facility, and its expanded set of conditional pseudo-operations includes the testing of assembly pass, symbol definition, and the setting of

The surprising leader.

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LEADER's oscilloscope line includes 11 models, single and dual trace versions, for bench or field use. All models offer comprehensive triggering controls, TTL compatible Z-axis modulation, front panel trace alignment control and convenient, color-keyed front panel layout. Probes are furnished with every oscilloscope and options include probe pouches, carrying cases, front panel covers and rack mounting adapters.

30 MHz delayed sweep – $1,530.

LBO-515B is a compact, precision oscilloscope at a moderate price. Using a PDA 4-inch CRT with parallax-free internal graticule, it features 5 mV sensitivity and delayed sweep for viewing and measuring complex waveforms. Also has 120 ns signal delay, trigger hold-off and x-y operation at full sensitivity.

30 MHz with signal delay – $1,100.

LBO-520 combines a 11.7 ns rise time with 5 mV sensitivity and 120 ns signal delay lines. Has single shot triggering, X10 sweep magnifier and bright, sharp PDA CRT. Triggers to 50 MHz.

20 MHz dual and single trace – $835., $610.

LBO-508A and LBO-507A give you versatility at low cost. Rise time is 17.5 ns with 1 MΩ (35 pFd) input impedance. Automatic or external triggering, X5 sweep magnifier, 10 mV/cm sensitivity and add/subtract modes.

10 MHz with 1 mV sensitivity – $645.

LBO-514 has both vertical and horizontal X5 magnifiers. Sensitivity is from 1 mV/cm to 10 V/cm. Sweep speeds from 0.2 s/cm to 0.1 μs/cm. Auto or normal triggering. Z-axis modulation. (Single trace version, LBO-513, $495.)

20 MHz battery/ac portable – $950.

LBO-308S provides lab performance and high reliability in field service applications. Sensitivity is 2 mV with a complete set of triggering controls and 18 sweep ranges to 0.1 μs/div. with X5 magnifier. Compact, lightweight with 3-inch rectangular, internal graticule CRT. (Optional 2 hour internal battery pack is recharged during ac operation, $75.00.)

Two-year warranty. Evaluation units.

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parameters to macros.

The X-MACRO-86 package includes the cross assembler, a linking loader, a cross-reference facility, and documentation and is priced at $300. The documentation is available separately for $15.

Microsoft, 10800 N. E. 8th, Suite 819, Bellevue, Wash. 98004. [373]

Computer uses Winchester or floppy disks and Basic II

The Series 80 microcomputer system features an enhanced 8080A microprocessor, Winchester disk memory, and an advanced Basic language — the MicroDOS/Basic II. The system may use up to four 12.5- or 25-megabyte Winchester or floppy-disk drives or combinations thereof.

The standard unit has one asynchronous communications port for transmission speeds of up to 9,600 bauds. More asynchronous ports may be added for a total of eight ports for speeds of 19,200 bauds. One or two synchronous ports may also be supplied for speeds up to 50 kb/s. An interface for the X.25 communications protocol is optional.

A basic Series 80 system consists of the central processing unit and disk drives in a modular desk, along with the MicroDOS/Basic II software. With one 12.5-megabyte Winchester drive and one dual-density floppy-disk drive, a cathode-ray-tube console, and a printer, the Series 80 sells for less than $10,000.

Applied Data Communications, 14272 Chambers Rd., Tustin, Calif. 92680. Phone Joe Sandoval at (714) 731-9000 [374]

Versatile single-board computer sells for $995

The Applications-Controller Series 10A is a single-board computer for programmers and designers. It uses the Motorola 6800 microprocessor family and has a four-disk flexible-disk controller, four direct-memory-access channels, an RS-232-C serial port, and two 8-bit parallel ports

Why do people buy Digital's high-performance micros more than anyone else's?

Maybe it's because there's more to buy.

Digital Equipment Corporation has sold more 16-bit microcomputers than any other company in the business.

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You can choose from eight different configurations of our LSI-11/2 and -11/23 micros, in both boards and boxes. With high-performance features like general-purpose registers. Double-precision floating point processor. Up to 256Kb memory addressing. And the full instruction set of the PDP-11 family.

You also get the best form factor in the industry, because our micro boards measure just 5.2" x 8.9".

More options on the industry-standard bus.

Once you have the micro you want, your possibilities are wide open.

You can choose from dozens of micro products: 9 different memory boards, 11 I/O modules, 9 communications options, even kits for designing your own custom interfacing.

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And the whole family runs on Digital's industry-standard LSI-11 Bus, the most widely copied bus structure in micros.

The only high-performance hardware with software to match.

Digital's micro software is literally years ahead of the competition.

There's RSX-11M, the multitasking real-time operating system that sets performance standards for superminis. RSX-11S, a streamlined run-time version of -11M. And RT-11 for smaller single-task applications.

You also get development tools like an optimized FORTRAN IV-PLUS compiler and BASIC-PLUS-2. Even a ROM-mable FORTRAN for RT-11.

And Digital's development systems let you break your complex applications into manageable pieces, so several programmers can work on the same application at once.

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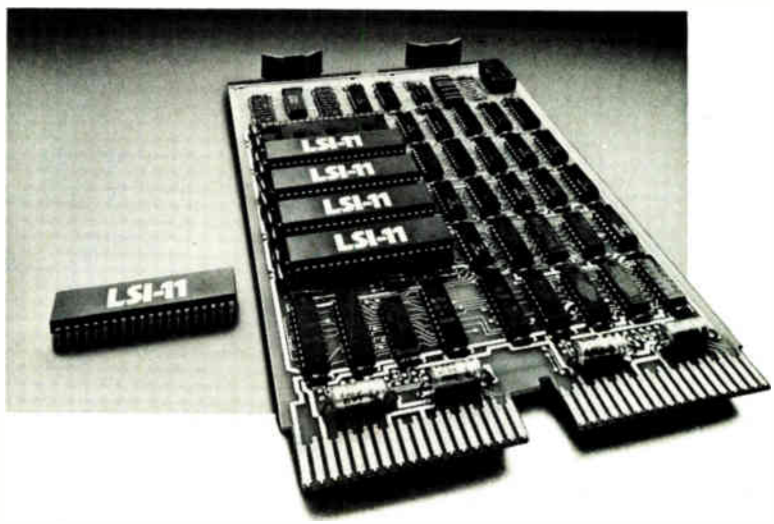
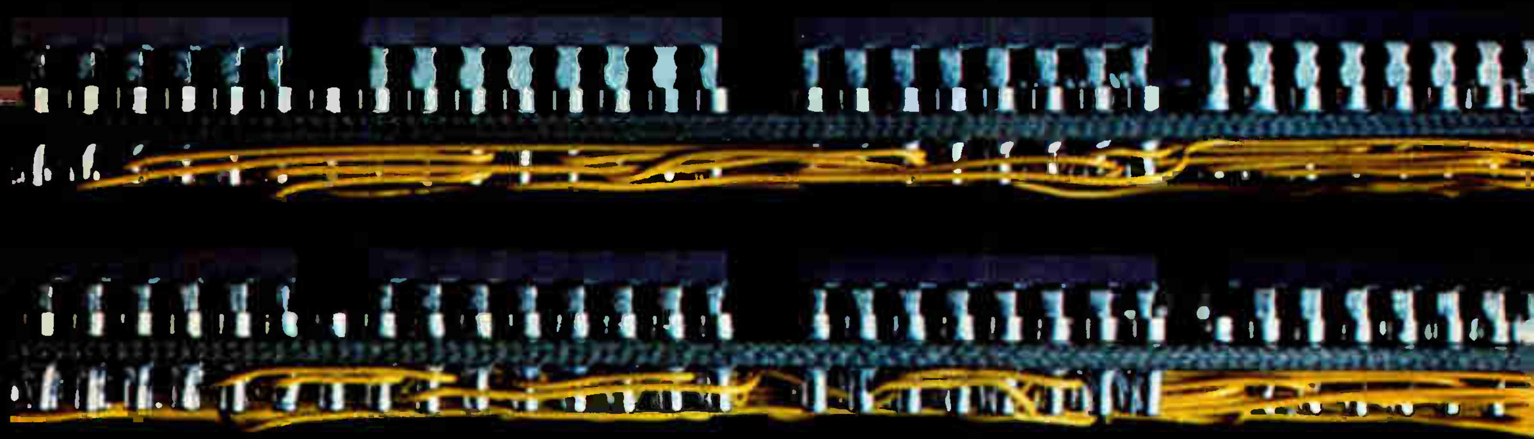


It took the minicomputer company to make micros this easy.

Circle 193 on reader service card

digital

AUGAT'S SOLUTION TO PACKAGING DENSITY AND DESIGN FLEXIBILITY... THE PLANAR STITCH-WIRE SYSTEM.



Planar socket-type boards on 0.5 inch centers   Photograph shown 2x size.

Augat's Planar stitch-wire concept is unique. This patented, high-speed, low-cost system reduces the substantial engineering time of complete circuit card prototyping and debugging. As a result, turn-around time can be cut by one-third to one-half. Augat's stitch-wire system works like this: after components or sockets are mounted on the Planar boards, a stitch-wire machine welds Teflon-insulated nickel wire to stainless steel pads. In certain configurations, the bare board may be wired first.

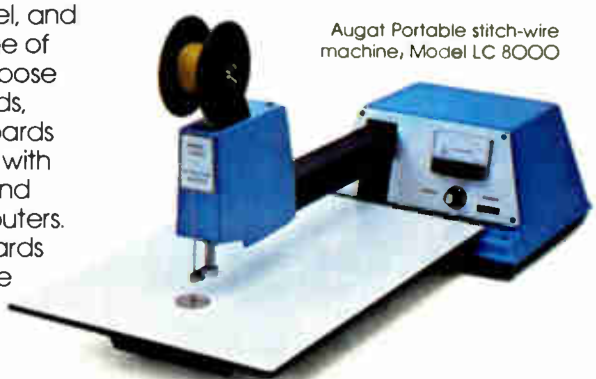
Wiring instructions can be furnished using key-punch card or wire lists. Your logic design can be debugged using our Data-Logic program. We provide all final wiring documentation, or can supply total wiring service at any of our four service facilities located in—Van Nuys, CA, Houston, TX, Attleboro, MA, Fresnes, France.

Changes can be made by stitch-wire machines or by hand soldering. Adopting stitch-wire is easy, because Augat provides the wiring machines, including portable models (LC 8000 shown), a high-speed, numerically controlled model, and a wide range of general-purpose Planar boards, including boards compatible with most mini- and micro-computers.

These boards feature large etched power and ground planes making them ideal for high-speed logic. We can design and produce stitch-wire boards to your specifications, or provide the boards and equipment you need to do the job in your own shop.

Augat stitch-wire offers density and flexibility advantages you can't get anywhere else. To find out how to start with Planar stitch-wire, write or call, Augat Inc., Interconnection Systems Division, 40 Perry Avenue, P.O. Box 1037, Attleboro, MA 02703. Tel. (617) 222-2202.

Europe—Augat SA, B.P. 440 Cedex/94263 Fresnes, France. Tel: 668.30.90. Telex: 201.227. AUGSAF.



Augat Portable stitch-wire machine, Model LC 8000

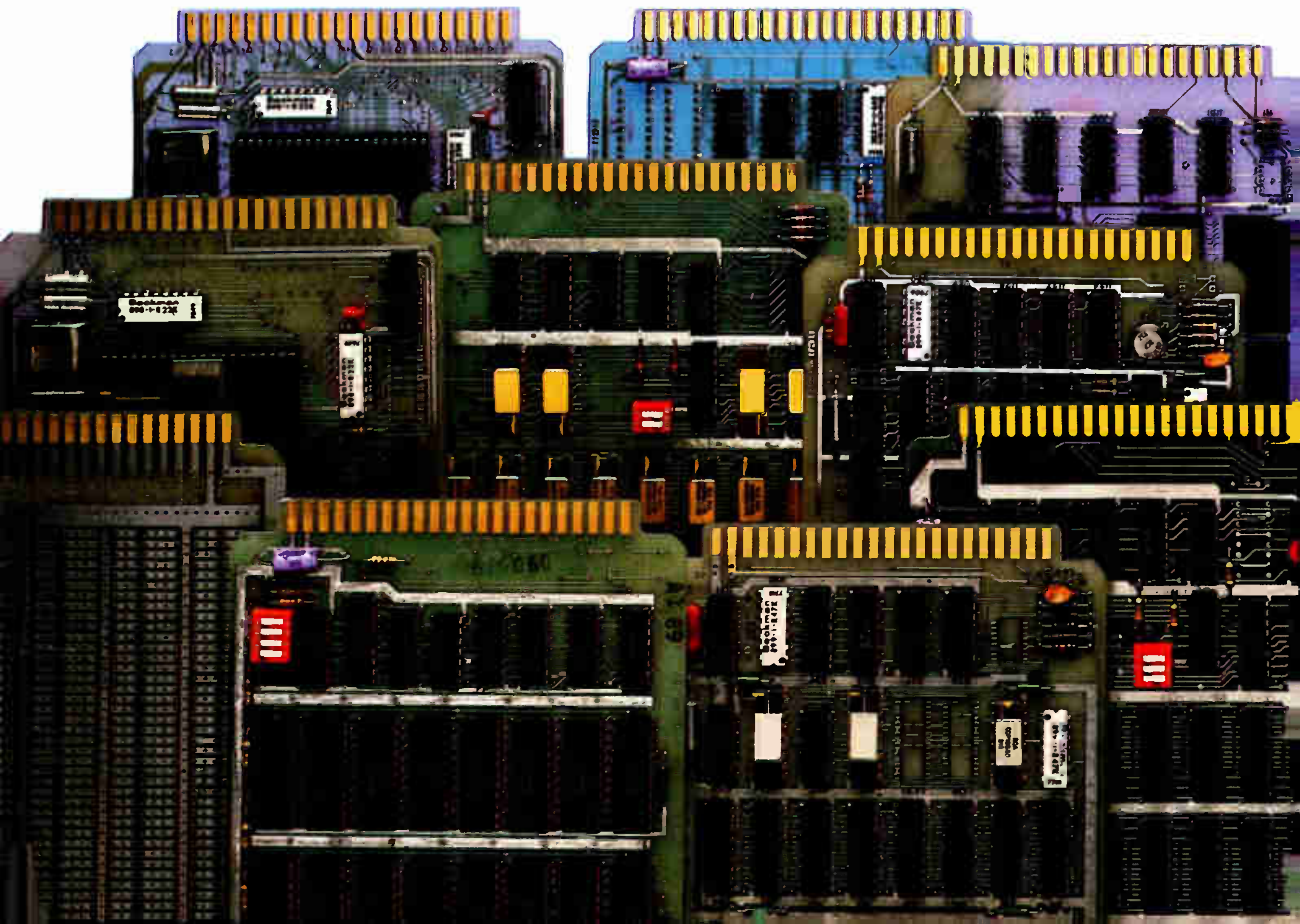
AUGAT®

Augat interconnection products, Isotronics microcircuit packaging, Alco subminiature switches and Datatex computer-aided design and wire-wrapping services.

Circle 195 on reader service card

CMOS takes another giant step against NMOS.

RCA adds 12 new Microboards now, 7 more by the end of 1980.



RCA CMOS Microboards consume far less power (7.0 milliamperes), give off far less heat, and provide more functions in less space (4.5 x 7.5 inches) than any NMOS board on the market. And at competitive prices.

With 17 boards available now (24 by 4th quarter 1980) plus a range of chassis and accessories, RCA can provide a CMOS system to suit a wide variety of applications.

Microcomputer boards.

CDP18S601	Microboard Computer w/4K CMOS RAM, 4K/8K ROM/PROM sockets, serial I/O port, 20 programmable parallel I/O lines
CDP18S602*	Microboard Computer w/2K CMOS RAM, 2K/4K ROM/PROM sockets, UART, parallel I/O port
CDP18S603	Microboard Computer w/1K CMOS RAM, 4K/8K ROM/PROM sockets, serial I/O port, 20 programmable parallel I/O lines
CDP18S604*	Microboard Computer w/512 bytes CMOS RAM, 1K/2K ROM/PROM sockets, parallel I/O port

Memory boards.

CDP18S620	4K Static CMOS RAM
CDP18S621	16K Static CMOS RAM
CDP18S621V1	16K Static CMOS RAM
CDP18S622	8K Static CMOS RAM/ Battery backup
CDP18S623	8K Static CMOS RAM
CDP18S624	4K Static CMOS RAM/ Battery backup
CDP18S625	8K/16K ROM/PROM

Combination memory I/O.

CDP18S660	40 I/O Lines, 2K CMOS RAM, 4K/8K ROM/PROM sockets

I/O boards.

CDP18S640	Control/Display Module
CDP18S641	UART Interface
CDP18S642	12 Bit D/A Converter
CDP18S643	12 Bit A/D Converter
CDP18S644*	8 Bit A/D-D/A Converter
CDP18S646*	Parallel I/O
CDP18S649*	LCD Interface/Display
CDP18S661V1*	Video-Audio-Keyboard Interface
CDP18S661V3*	Video-Audio-Keyboard Interface (PAL Version)

Chassis and accessories.

CDP18S023V1	5 Volt Power Converter (100 V, 50-60 Hz)
CDP18S023V3	5 Volt Power Converter (220 V, 50-60 Hz)
CDP18S480	PROM Programmer
CDP18S502	Extender Card
CDP18S659	Breadboard w/prewired power and ground
CDP18S670*	25 Card Chassis w/power supply
CDP18S675	5 Card Naked Chassis
CDP18S676	5 Card Chassis w/Case

Prototyping systems.

CDP18S691	Microboard Prototyping System with CDP18S601 Computer Board
CDP18S692*	Microboard Prototyping System with CDP18S602 Computer Board

Full design support.

RCA Microboards are backed up by a complete line of hardware and software compatible development systems.

Plus, 36 RCA "Systems Appointed Distributors" offer technical assistance, systems demonstrations, and off-the-shelf delivery.

A complete list of RCA Systems Appointed Distributors appears on the following page.

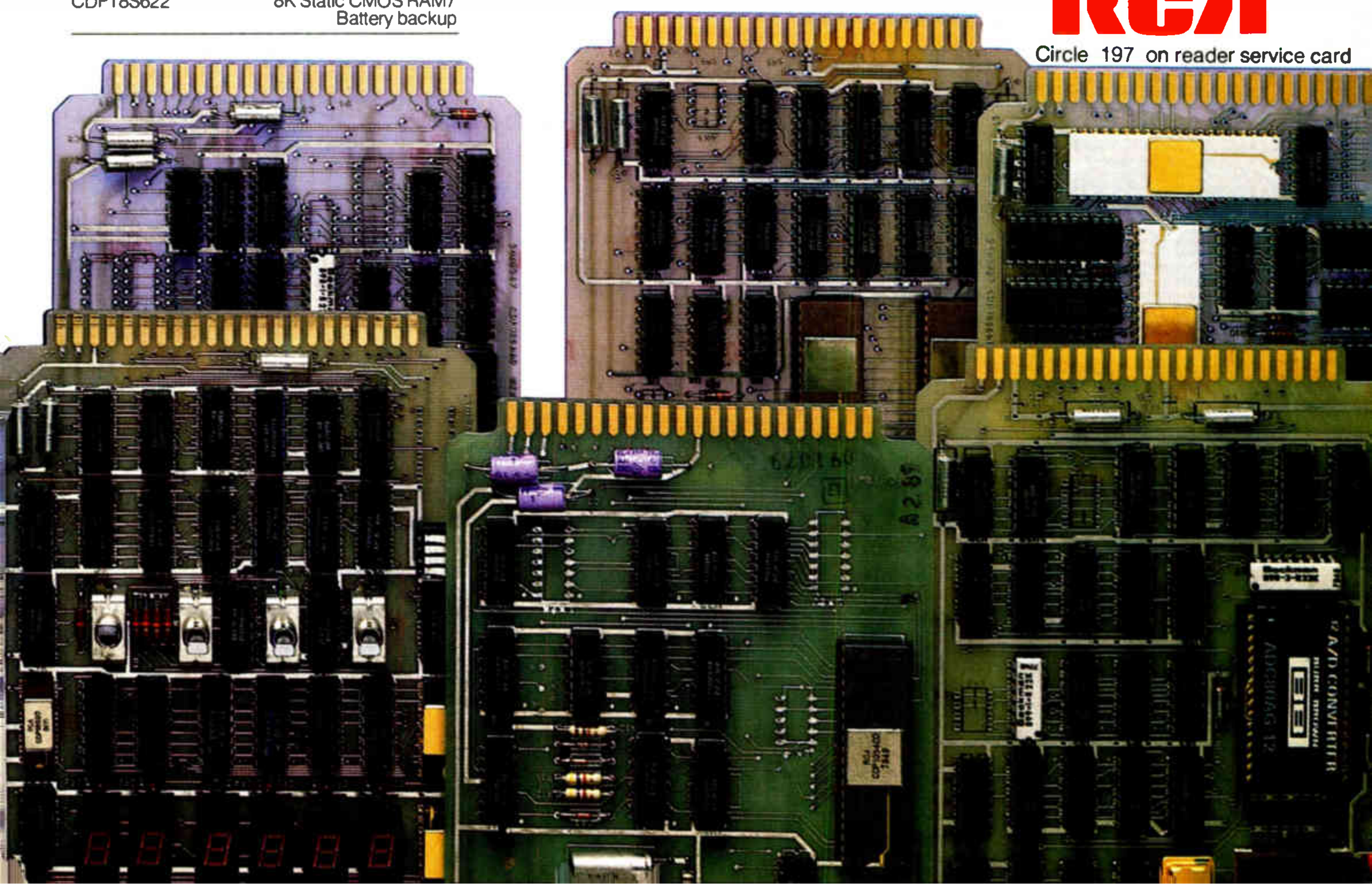
For more information and a free brochure on RCA Microboard Computer Systems, contact your local RCA Distributor.

Or contact RCA Solid State headquarters in Somerville, New Jersey. Brussels, Belgium. Tokyo, Japan.

*Coming in 1980

RCA

Circle 197 on reader service card



See our ad on previous pages.

New products

Data acquisition

18-bit unit aims at microprocessors

D-a converter also sports 50-mW power dissipation and costs as little as $210

The DAC 370-18 is the newest in a series of digital-to-analog converters with a good price-performance ratio from Hybrid Systems Corp. [*Electronics*, Jan. 31, p. 124]. Hybrid's director of advanced development, G. James Estep, nails it as the first d-a converter to combine 18-bit resolution, 16-bit linearity, and input latches in a double-width dual in-line package for interfacing with microprocessors.

As little as a year ago, compact 18-bit converters were just not available—there were only modular or board-mounted systems. Now, the 370-18 is not only far smaller than earlier devices, but may also be one of the least expensive. Its commercial version is priced at only about $210 in hundred-unit lots, with military temperature capabilities increasing the price to about $470. Single-unit prices are about $300 and $700, respectively.

Since it is still possible to pay more than $800 for a d-a converter with only 16-bit resolution, and that in a larger package, the 370-18 should look quite attractive to design engineers.

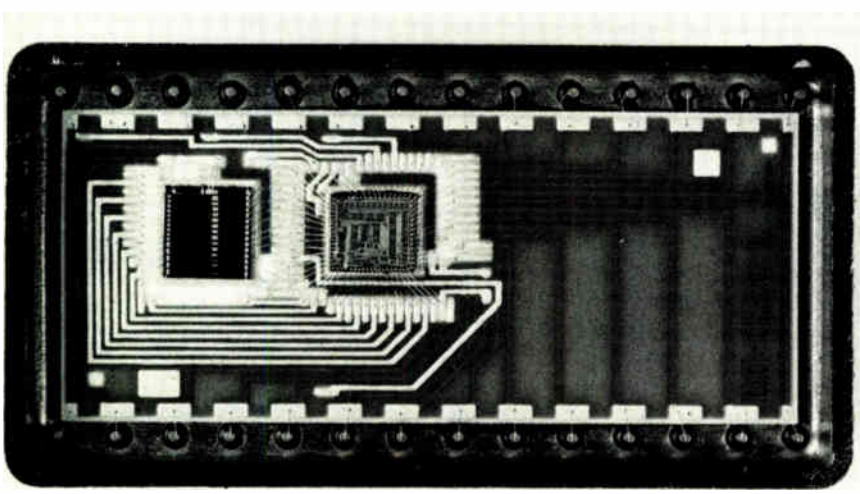
Power dissipation is low at a rated 50 mW, which turns out to run nearer 30 mW, according to Estep. This compares with as much as 3 or more W for less capable units, and the 370-18 requires only a single +15-V supply.

Admittedly, some of this low dissipation is due to the lack of an output operational amplifier and to the 10-V reference. But in the former case, the user can either choose the 370-18's current output or pick an output amplifier to suit the application, optimizing around a given parameter such as speed or noise.

The 370-18 also has a two- and a four-quadrant multiplication capability, suiting it to synchro applications. Its input latches are accessible in either byte-sized chunks or full-width words; there is a separate latch for the 17th and 18th bits. The unit is compatible with 5- and 15-V complementary-MOS and operates with TTL and diode-transistor logic.

Linearity drift is less than 1 part/million/°C over the military operating range of −55° to +125°C and probably better within the more forgiving 0° to 70°C commercial range. And the 370-18 is fast—current output, of course, but settling to 0.01% of full scale within 2 μs is impressive nevertheless.

The unit is a hybrid, but where it counts, it is almost all monolithic. On its alumina substrate are two



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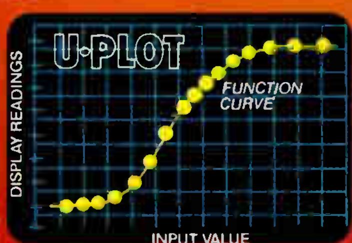

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New products

chips, one a laser-trimmed thin-film resistor network and the other a proprietary C-MOS switch set with 29 dual- field-effect-transistor switches, all matched to within 5%. Fourteen of the switches are used for low-order bits and 15 for four decoded higher-order bits. Also aboard are 29 latches and drivers, 18 exclusive-OR gates, and 16 decoders.

With 18-bit resolution for sale, Hybrid is finding that part of the sales problem is teaching users to apply the unit without degrading its performance. The reason is straightforward: with a 10-V reference, the size of the least significant bit, or the voltage at the end of the ladder network, is only about ±76 μV—an amount easily lost in the electrical noise common around test benches.

Estep points out that quality assurance on this product may have been as difficult to reach as the basic design itself. Thus, the company is encouraging its customers to pay more attention to otherwise unimportant reference instabilities, offset voltages, leakage currents, and other aspects of circuit design that could prevent the 370-18 from living up to its design-level performance.

For its part, Hybrid has added proprietary circuitry to minimize the effect of output-amplifier offset voltages, plus temperature compensating electronics on the switch chip. Still, to get real 18-bit performance, users will have to select adjacent components with care.

The 370-18 already is attracting attention from Hybrid's traditional aerospace customer base, initially in high-resolution radar applications. There is also advance interest from firms with digital-recording and automatic-test applications.

Hybrid Systems Corp., Crosby Drive, Bedford, Mass. 01730. Phone (617) 275-1570 [381]

Portable data-acquisition system sells for $695

The MS788 digital data-recording system, a portable, battery-powered data logger that employs comple-

Circle 201 on reader service card

mentary-MOS circuitry, is suited for remote data accumulation of the kind needed in meteorological research and pollution monitoring. The $695 bench model is intended for use by manufacturers of industrial control systems; a watertight field model is available for $725. Both versions can acquire data at intervals of from 1 s to 60 h over a temperature range of −40° to +70°C. While totally unattended, they will collect data hourly for three months or daily for more than a year.

A 4-K C-MOS random-access memory (expandable to 34 K) stores the data, which can be read out either on a light-emitting-diode display or via an optional microcomputer—the model 65. The $2,500 Microcomputer 65 is a portable interrogator that produces both a paper tape and a magnetic-tape cassette whose data can also be processed by a larger computer. Numerous optional input interfaces make the MS778 compatible with almost any type of sensor.

Aeolian Kinetics Inc., P. O. Box 100, Providence, R. I. 02901. Phone (401) 421-5033 [383]

Usart card interfaces with 8-bit processors

A dual-channel, universal synchronous/asynchronous card for receiving and transmitting (Usart) with a real-time clock interfaces with 8-bit processors that use the STD 7000 bus. Designated the MA-1000, this bidirectional serial input/output card features compatibility with RS-232-C for use with instruments.

A flexible interrupt structure permits its users to interface it with such 8-bit processors as the 8080, 8085, and Z80. Baud rates may be varied by software from 110 to 9,600. Having a 50-pin edge connector, the card may be linked by cable to standard 25-pin male or female D connectors.

The MA-1000 is priced at $315, with quantity discounts available.

Martindale Associates Inc., 212 Main St., North Reading, Mass. 01864. Phone Neil Shapleigh at (617) 942-0514 [385]

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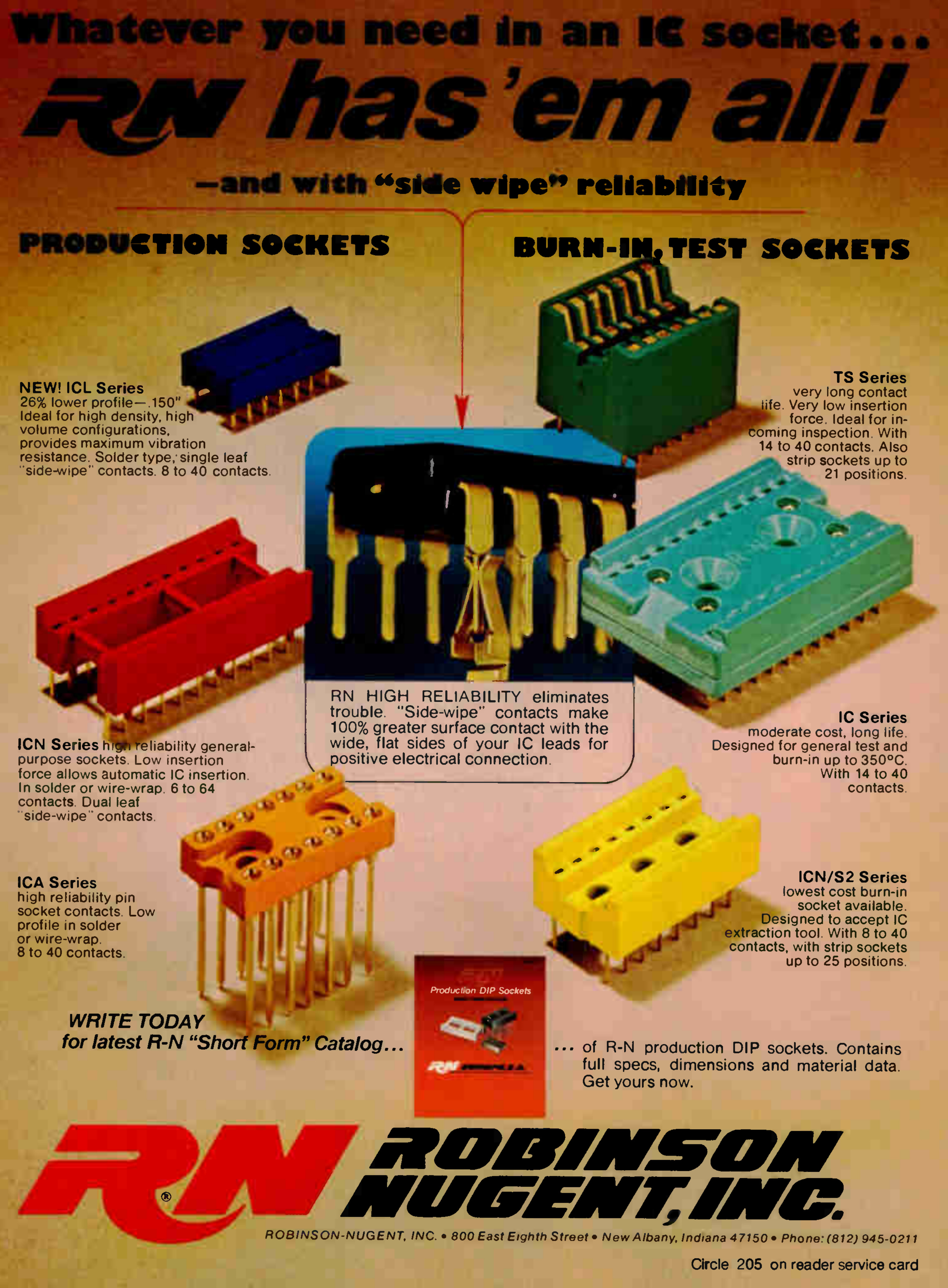
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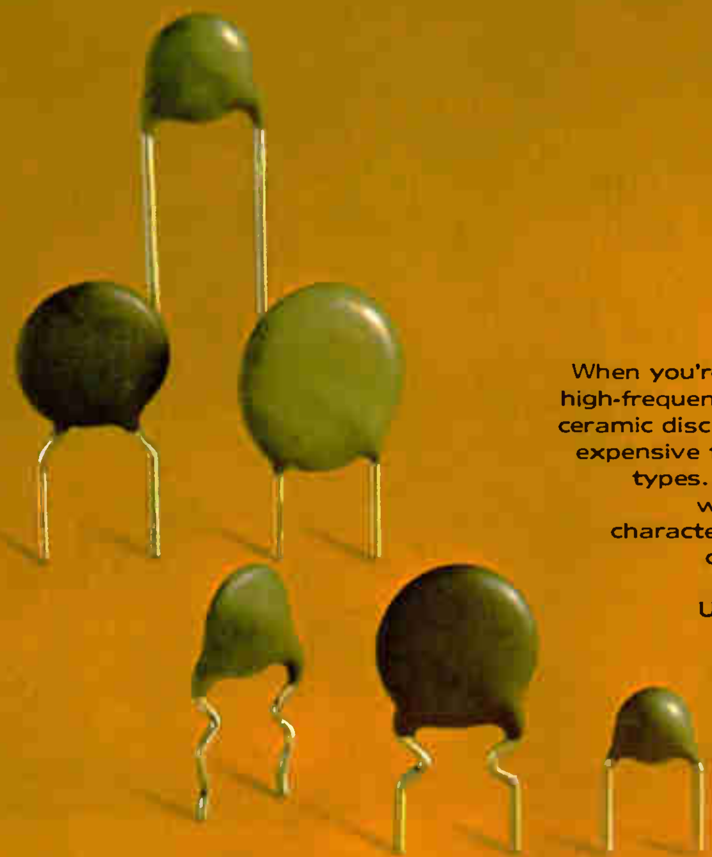

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Circle 208 on reader service card

Computers and peripherals

8-in. disk drives have features of 14-in. drives

Using the design and interface arrangement of its 14-in. disk drives, Priam Corp. has come out with two 8-in. Winchester drives with capacities of 20 and 34 megabytes. Data separation and modified frequency modulation encoding/decoding circuits, for example, are on board.

As a result, Priam Winchester disk drives with capacities ranging from 20 to 154 megabytes can now be used with a single low-cost controller. Also, like the 14-in. versions, the 8-in. models have fully servoed voice-coil positioners and brushless dc motors.

Two disks are used in the Diskos 2050 20-megabyte model and three disks in the Diskos 3450 model. By doubling track density, the company expects to introduce drives that will have capacities of 40 and 68 megabytes housed in the same floppy-sized package.

The brushless dc spindle motor is dynamically braked to minimize head/disk rubbing contact during start/stop, eliminating the mechanical brake required in Winchester drives with ac motors. The linear voice-coil head positioner using a closed-loop control provides fast access time. Average access time is 50 ms, and track-to-track access is 10 ms. Average latency is 6.4 ms.

Thanks to the design of the linear positioner, it was possible to fit the Diskos 2050 and 3450 onto the length of a standard 8-in. floppy disk drive, that is, 14.25 in. The height of the units is 4.62 in. and the width 8.55 in. They weigh less than 20 lb.

The linear actuator is designed to support a track density of 960 tracks/in., though the initial offering

is rated at only 480 tracks/in.

In original-equipment-manufacturer quantities, the 2050 sells for a price of $1,800 and the 3450 for $2,250. Shipments of evaluation units will begin in the second quarter and production will begin in the third quarter.

Priam Corp., 3096 Orchard Dr., San Jose, Calif. 95134. Phone (408) 946-4600 [361]

$1,250 CRT-and-keyboard is compatible with Teletype

The Telex 310 is a Teletype-compatible cathode-ray-tube display and keyboard terminal priced at $1,250 in single-unit quantities. Incorporating many of the features of the earlier Telex 278, the 310 has a high-resolution 15-in. display, easy-to-read 7-by-11-dot-matrix characters, and a detachable keyboard with 128 ASCII characters and a numeric keypad. Twenty-four lines of information are displayed, and a 25th is reserved for diagnostic data or displays that prompt the operator.

Other features of the terminal include full keyboard cursor movement and different display possibilities, including reverse video, programmable brightness levels, and character or field blinking. The microprocessor-based unit also features self-diagnostic routines, as well as support of ASCII protocol communications at speeds to 9,600 b/s.

The 310 will sell for $900 in quantities of 100 or more.

Telex Computer Products, 6422 East 41st St., Tulsa, Oklahoma. Phone John Hawkins at (918) 627-1111 [364]

Single-board controller links Unibus with drive modules

A microprocessor-based single-board controller interfaces Winchester and other high-capacity disk drives that have a storage-module interface with Digital Equipment Corp.'s Unibus. A new command protocol is used on the model MSC-1101 to achieve the kind of performance increase and input/output-processing techniques available on mainframe computers but is not compatible with existing DEC software drivers. Therefore, the controller is aimed at original-equipment manufacturers who use the PDP-11 and VAX series.

The new unit, like the rest of the MSC-1000 series, is based on the company's own bipolar microprocessor. Communication with the controller is accomplished via control blocks assembled in main storage and Unibus registers assigned to the controller.

Command chaining allows the MSC-1101 controller to execute multiple data transfers at the maximum interleaving rate of the disk drives after command processing is initiated. The only software overhead needed is acknowledgment of command completion. The controller also corrects single-burst errors of up to 11 bits per sector within its full-sector buffer before initiating data transfer to main storage. In addition, if it detects drive faults, seek errors, or uncorrectable data errors, it performs such recovery operations as recalibration and multiple retries. Other standard features include automatic head and cylinder switching, direct-memory-access load regulation, and two-drive, dual-port control. The manufacturer provides software integration for RT-11, RSX, IAS, RSTS/E, and VAX/VMS operating systems.

The MSC-1101 is available for 60-to-90-day delivery at a price of $4,850 for a single unit, with OEM discounts available.

Microcomputer Systems Corp., 432 Lakeside Dr., Sunnyvale, Calif. 94086. Phone Don Sumner at (408) 733-4200 [366]

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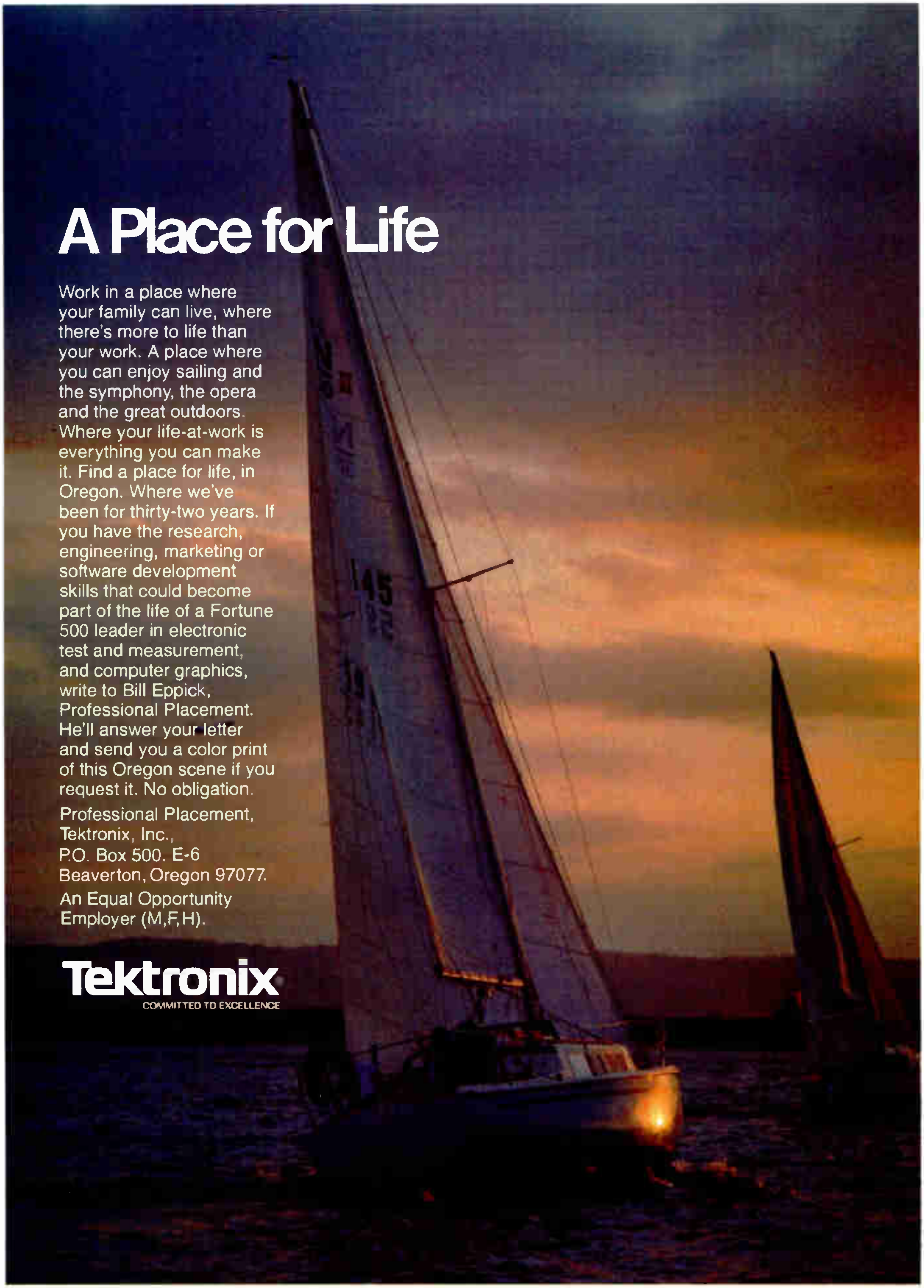
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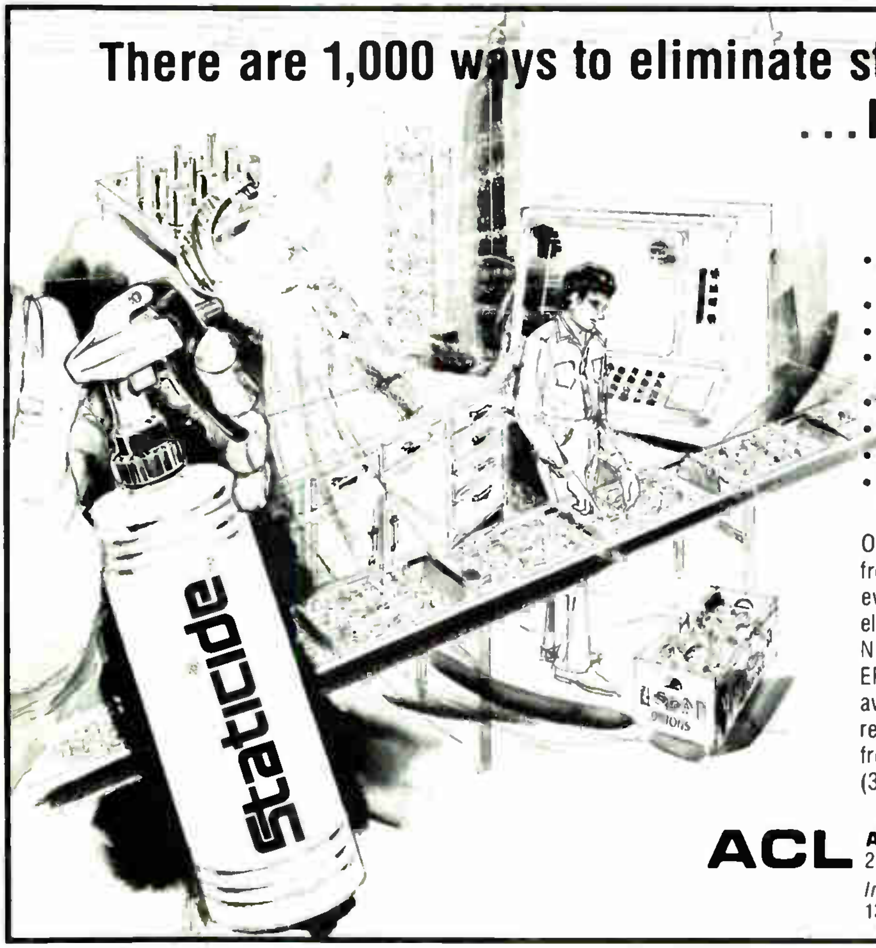

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Industrial

Plug-in modules give multipoint monitor variety

"Plug-ins with plug-ins" is a good basic description of a new multipoint instrumentation system for process control, called Unipak.

At the core of Unipak is a pair of transmitters—one, an isolating transmitter for amplifying and converting the input signal, the other a limit-alarm transmitter that adds to this high- and low-limit sensing. Both are packaged on 5¼-in.-high edge-mounted printed-circuit boards, each with an on-board power supply. The transmitters plug into a mainframe that fits into a standard 19-in.-wide rack.

However, before being plugged into the rack, each transmitter board is tailored to perform a specific input and output function. This is done by plugging into the transmitter circuit card any of about 10 personality modules, each in a choice of ranges set at the factory.

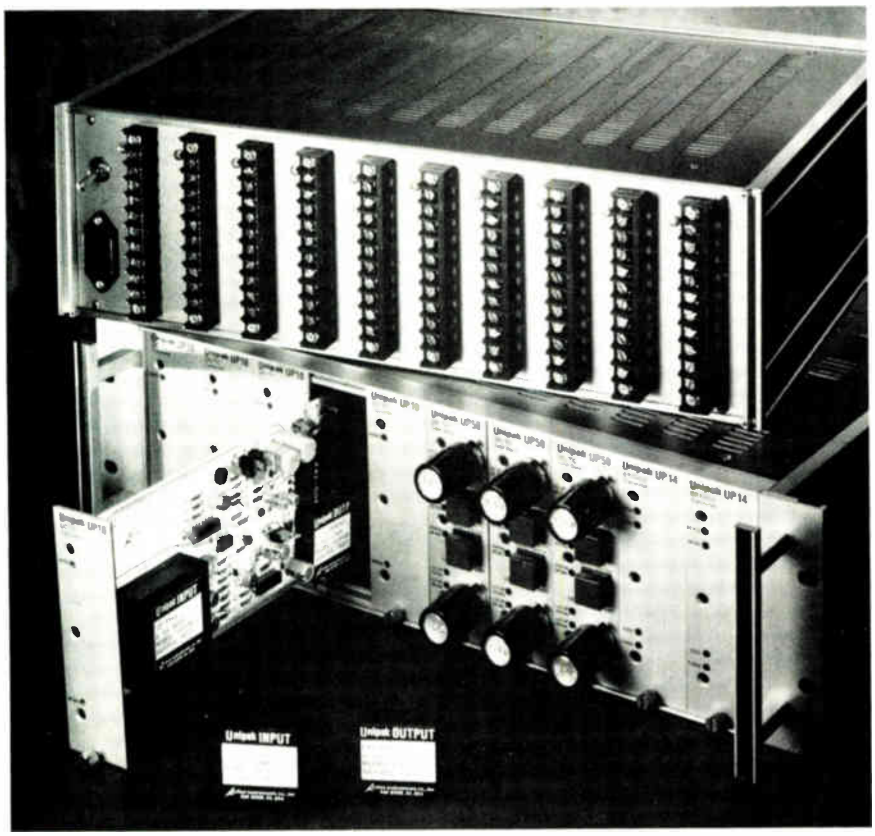
The specifics of each transmitter board are noteworthy. For example, the isolating transmitter employs pulse-width modulation and optical coupling effective up to 600 V dc or peak ac. The response time of both boards is adjustable for optimum noise immunity. High and low set-point relay timers are fully independent and offer normally open or closed states as well as latching or non-latching operation. Set-point deadband, or hysteresis, is also adjustable and the response time can be individually set for each alarm point.

Unipak's input modules match a wide range of ac or dc voltage or current, thermocouples, resistor temperature detectors (RTDs), and photocell or frequency-dependent sensors. Finally, ranges may be specified for zero-based, offset, or bipolar swings.

Output modules offer ranges of dc voltage to 10 mV or 10 V full scale, dc current to 50 mA, or frequency varying to 10Hz or 100 kHz. Any grouping input and output modules is feasible. Replacement consists of pulling the old module and dropping in a new one. The rack-mountable 19-in. card cages hold up to 10 transmitter boards. They are available with or without double-pole, double-throw relays for the high and low trip set points of the transmitting limit alarm cards. An optical 10-turn digital dial allows fine adjustment of the set-point values.

Operating ambient-temperature range is −20° to +70°C and overall accuracy is 0.1% of span. Starting prices are $150 each for the isolating transmitter and $225 each for the transmitting limit alarms. Typical input and output ranging modules are $25 each. Availability is in four to six weeks, and the units are offered with a three-year warranty.

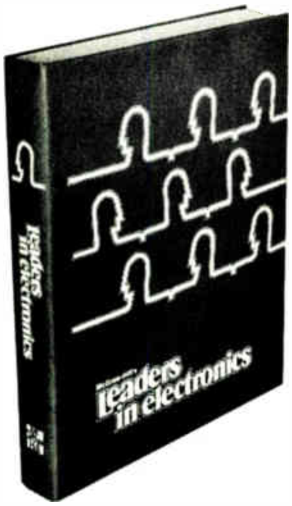
Action Instruments Co., 8601 Aero Drive, San Diego, Calif. 92123. Phone (714) 279-5726 [351]



Portable unit reads coating thickness on various surfaces

Field measurement of paint, plastic, enamel, and similar coatings, whether on ferrous or nonferrous surfaces, may be made accurately with a battery-powered, hand-held instrument called the Dualscope. Its virtual independence of substrate type is due to its use of two kinds of measurement techniques: eddy current and magnetic induction. It measures thicknesses of 0.1 to 8 mils on nonferrous substrates and 0.1 to 20 mils

Leaders in Electronics



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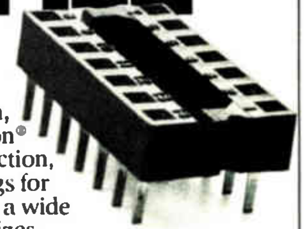

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on a ferrous base material with an accuracy within ±3%.

A hold function, which retains the indicated thickness measurement for as long as necessary, simplifies the unit's use in locations where its display is hard to read. Designed for inspection applications where conventional laboratory equipment would be difficult to use, such as for on-site inspection, the Dualscope will operate for 70 hours with batteries or can be connected to a power supply for 120-V ac use.

The $1,150 price does not include probes, which cost from $195 to $350 according to function. Delivery is from stock.

Fischer Technology Inc., 750 Marshall Phelps Rd., Windsor, Conn. 06095. Phone (800) 243-8417 or (203) 683-0781 [353]

Reference junction measures temperature difference

The NDT-150 differential thermocouple reference junction is designed for applications where temperature differences need to be accurately monitored. Measurement error is effectively canceled because the two separate inputs of the differential unit are compensated for and referenced by the same internal circuits. Applications include differential temperature measurements for inlet-outlet comparisons, inside-outside temperatures, heat-exchange evaluation, or any system where control or measurement is a critical function of two different temperatures.

The miniature encapsulated unit

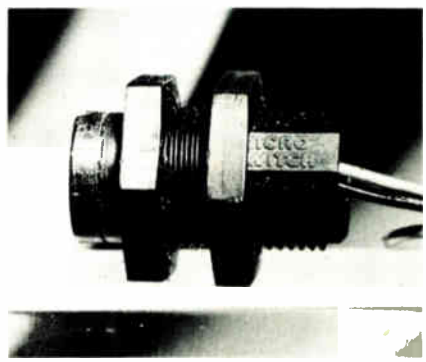
measures 1.5 in. on a side and is 0.4 in. high. It is available in versions for all thermocouple types and a wide range of excitation voltages.

The price is $74.25 in lots of one to nine pieces and delivery takes up to four weeks.

Hades Manufacturing Corp., 151A Verdi St., Farmingdale, N. Y. 11735. Phone (516) 249-4244 [354]

Hall-effect sensor sells for $8.25

The manufacturer of the 200SR series Hall-effect sensor says the unit's thermoplastic mounting shaves the price to 25% below metal-encased equivalent sensors. Responding to local magnetic fields, it is suitable for motion detection; high-speed sorting; limit or tachometer sensing; and cam-, lever-, or shaft-



position detection.

The switching speed is specified up to 100,000 operations per second with no damaging effects from overdriving magnetic fields. The output will sink 40 mA of current for direct interfacing with digital or other components and in most cases without the need for an amplifier. Two voltage ranges are offered, 4.5 to 5.5 and 6 to 16 V dc.

The 200SR is 1 in. long, has a diameter of ½ in., and is guaranteed to operate between −40° and +105°C. A typical unit sells for $8.25 and limited samples are available.

Micro Switch Inc., division of Honeywell, 11 W. Spring St., Freeport, Ill. 61032. Phone (815) 235-6600 [355]

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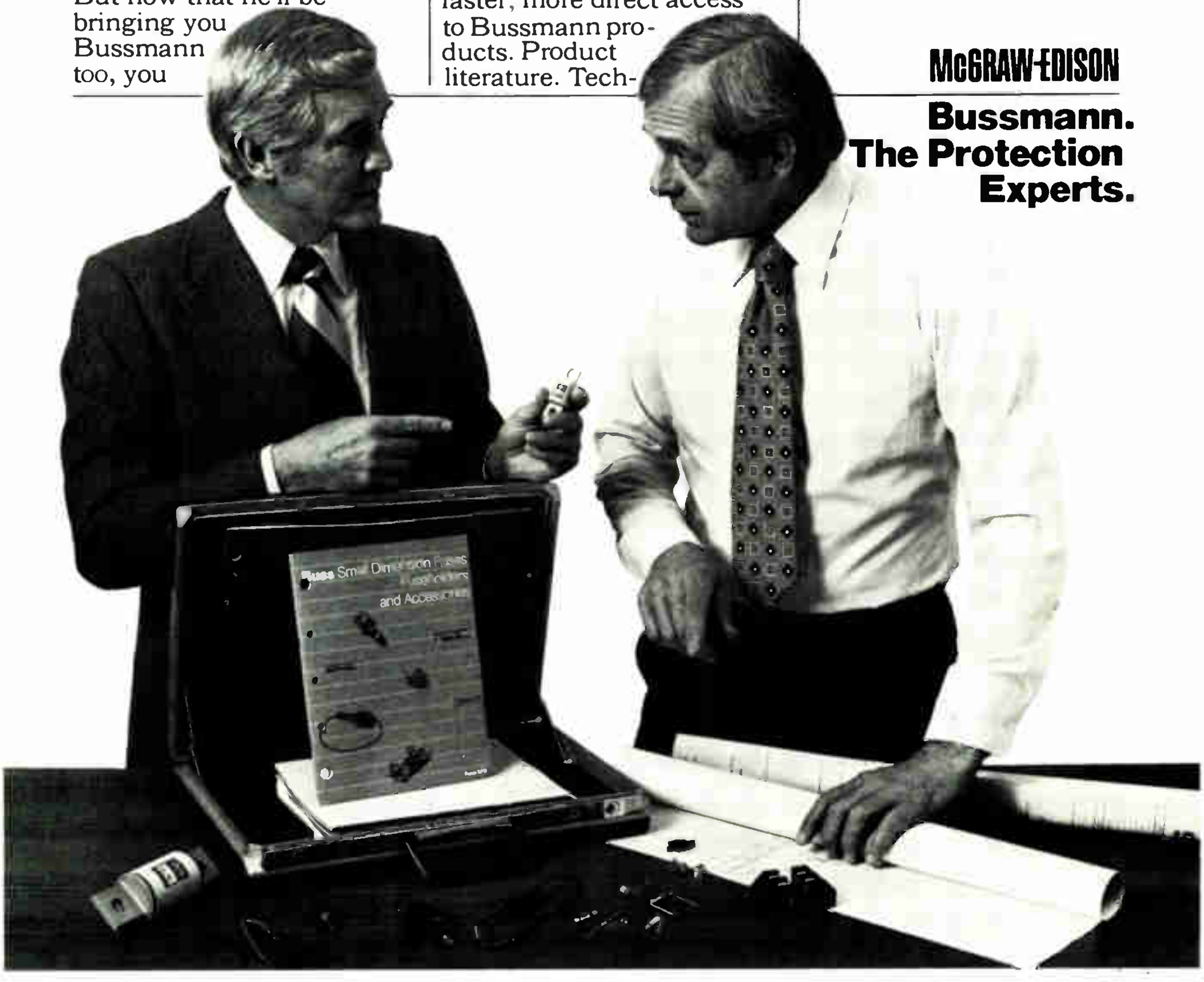

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New products

Components

Power Darlingtons isolate collectors

50- and 100-A, 450-V units have new chip and package designs for added flexibility

High-current/high-voltage power transistors have been available for some time, but in nearly all cases the collector terminals must be isolated from the mounting heat sink using insulating washers. The Hi-Line series of 50-A (D66DV) and 100-A (D67DE) power Darlington transistors, with V_{ceo} ratings of 450 V and isolated collectors, have eliminated this drawback.

Designers of amplifier push-pull output stages, half- and full-wave bridge rectifiers, six-step ac synthesizers, and other power output stages can now mount these transistors directly onto a common heat sink.

The epoxy-encapsulated Hi-Line units feature high isolation ratings of more than 2,500 V root mean square to meet National Electrical Manufacturers Association and Underwriters Laboratories creep-and-strike requirements for electrical equipment using 230-V ac power.

Each power Darlington chip is mounted on a low-stress and high-thermal-conductance ceramic substrate and packaged in a dry-nitrogen–filled chamber that is sealed with a cover. This assembly is then attached to a copper base plate whose mounting holes match standard TO-3 package spacings.

Peak power ratings for the D66DV and D67DE are 30 and 60 kW, respectively. Both units' base connections are accessible to the user for circuit-design flexibility and ease of wiring. The former unit is available with quick-connect terminals and the latter has screw-type terminals for the emitter and collector.

They have continuous peak current ratings of 75 A and 150 A, respectively. The typical V_{ce} (saturated) rating is 1.5 V dc at maximum collector currents. Minimum current gain is 75, also at maximum collector currents. Thermal impedances are 1.0 and 0.4°C/W, respectively.

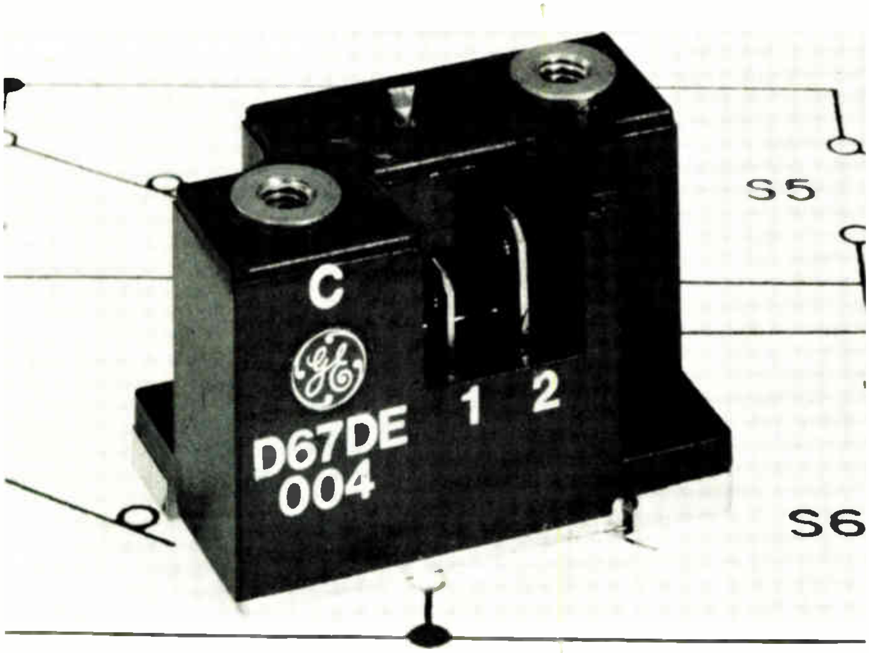
Other specifications include an operating-temperature range of −40 to +150°C, maximum power dissipation of 125 W (D66DV) and 312.5 W (D67DE), and total resistive switching times of less than 10 μs at maximum collector current.

These Darlington transistors weigh approximately 35 grams (D66DV) and 76 grams (D67DE). The dimensions are 1.5 by 0.98 by 1 in. for the D66DV and 1.8 by 1 by 1.5 in. for the D67DE.

Applications include uninterruptible power supplies, ac and dc motor speed control, inverter control, switching regulators, high-power pulse generators, and all types of power conversion equipment. When used in 230-V ac motor speed-control inverters, a single D66DV transistor can handle ratings of up to 5 hp, and a single D67DE can be used for up to 10-hp ratings.

In 100-piece quantities, single-unit prices are as follows: $155, $140, and $127 for 500-, 450-, and 400-V D67DE devices, respectively. For D66DV units, 100-piece unit prices are $75, $60, and $52.50 for 500-, 450-, and 400-V models, respectively.

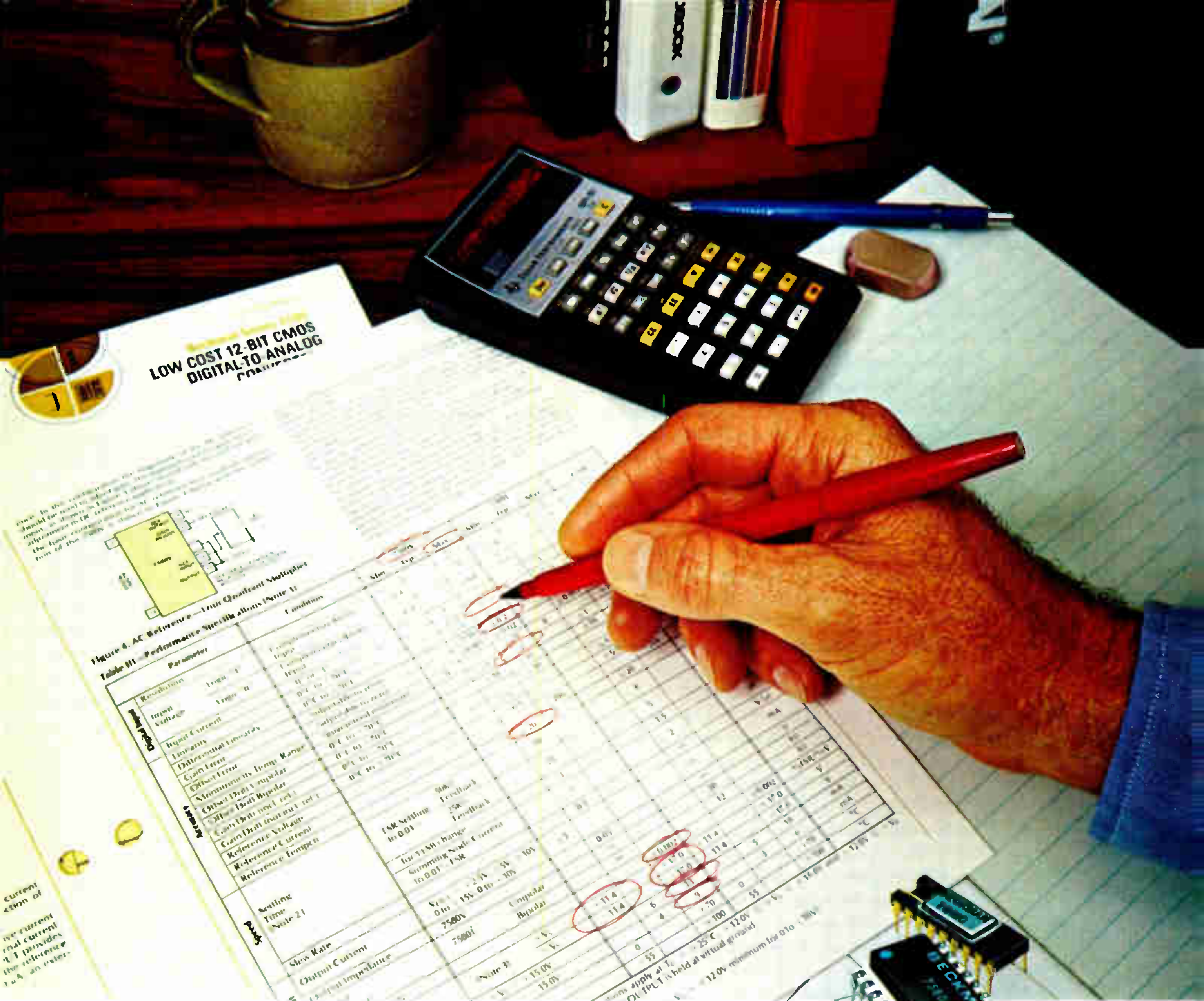
General Electric Co., Electronic Components division, Semiconductor Products Dept., West Genesee St., Auburn, N.Y. 13021. Phone (315) 253-7321. [341]



Npn silicon transistor has consistent oscillator output

The HXTR-4101 is a silicon bipolar transistor designed for consistent high oscillator output. The output power of this device is guaranteed to be a minimum of 19.0 dBm and is typically more than 20 dBm at 4.3 GHz. The guaranteed performance at 4.3 GHz makes it suitable for use in radar altimeters, transponders, and other devices that operate from 2 to 10 GHz. The unit has a collector-emitter breakdown voltage of 30 V at a collector current of 100 μA and a collector-emitter leakage current of a maximum of 500 nA at a collector-emitter voltage of 15 V.

Supplied in a rugged hermetic package, the transistor can meet the environmental requirements of MIL STD 19500 and the test requirements of MIL STD 750/883. In quantities of one to nine, the HXTR-4101 is priced at $39, and for 100 to



Check Beckman's specs before you select your source for Converters.

Beckman's Series 7580 and 7541 12-bit D/A converters replace the popular DAC 80 and 7541 pin-for-pin. But they offer better performance, use less power and are priced competitively.

Now *you* can write in better specs because *our* specs are better over a wide range of temperature and power supply variations. And Beckman converters offer much tighter end-point linearity specs than other manufacturers, resulting in better full-scale accuracy. Calibration is simpler, too. You need only to set zero and full scale once to fully calibrate your system.

Circle 228 on reader service card

You can also expect greater design flexibility because Beckman's CMOS DACs consume less power and are TTL and CMOS compatible.

Just as important, the 7580 and 7541 are competitively priced in both military and commercial versions. And they're available now–from stock.

Better performance, lower power consumption, greater design flexibility and competitive prices right from stock. Maybe you should check Beckman's specs. You might just find us to be your prime source for converter products.

For more information, contact your local Beckman representative or write: Advanced Electro-Products Division, Beckman Instruments, Inc., 2500 N. Harbor Blvd., Fullerton, CA 92634. (714) 773-7935.

Design Beckman converters in. Design problems out.

BECKMAN

240 pieces, the unit price is $28.50.
Hewlett-Packard Co., Inquiries Manager, 1507 Page Mill Rd., Palo Alto, Calif. 94304 [344]

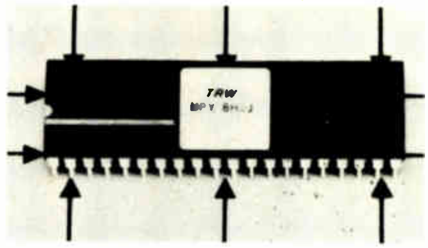
Zero-bias Schottky detectors provide high sensitivity

A series of Schottky diode detectors featuring microwave integrated-circuit construction has an output voltage sensitivity of 600 mV/mW and a typical flat response of ±0.1dB over the frequency range from 0.1 to 18 GHz. The model 2086-6040-00 has a minimum tangential sensitivity of −45 dBm. The voltage standing-

wave ratio of the zero-biased detectors is typically 1.6:1 and is a maximum of 1.8:1. The detectors are available in biasable versions as well as zero-bias types and come in both matched and unmatched models. They are available from stock.
Omni Spectra Inc., Microwave Component Division, 21 Continental Blvd., Merrimack, N. H. 03054. Phone (603) 424-4111 [343]

45-ns multiplier accepts unsigned inputs

The 45-ns 8-by-8-bit multiplier is a high-speed device with a number of additional features commonly found in more expensive multipliers. The MPY-8HUJ TTL parallel array multiplier accepts unsigned magnitude 8-bit inputs and produces a 16-bit double precision product. It has on-chip input and output registers



and operates from a single 5-V supply.

Suitable for digital video signal processing, digital filtering, and other related applications, the 40-pin ceramic device sells for $48 in lots of 100. The MPY-8HUJ-1, another version, operates at a maximum of 65 ns at 25°C and sells for $56 in the same quantity. Delivery is from stock.
TRW LSI Products, 2525 E. El Segundo Blvd., El Segundo, Calif. 90245. Phone (213) 535-1831 [345]

Panel-mount annunciator displays timed messages

The first member of a family of compact displays is a panel-mount annunciator that displays timed messages. The display is intended to be an alphanumeric prompter for industrial and medical applications.

The model SPA-402 stored-program annunciator uses an 8085 microcomputer to store up to 16 messages in permanent memory. Each 16-word message is displayed at a preset time for a specific period. A sonic alarm announces the presence of a new message. When the alarm is silenced manually, the time display is resumed.

The 16 custom messages and their on and off times are loaded into memory at the factory. The unit's real-time clock can be set or changed from the front panel by the operator.

The SPA-402 will be housed in a metal case with snap-on bezels. The display operates on 12 V ac or dc. It is available four to six weeks after receipt of order for $595. Discounts are also available.
Adco Electronics, 2182 DuPont St., Suite 222, Irvine, Calif. 92715. Phone John Schuler at (714) 833-1528 [348]

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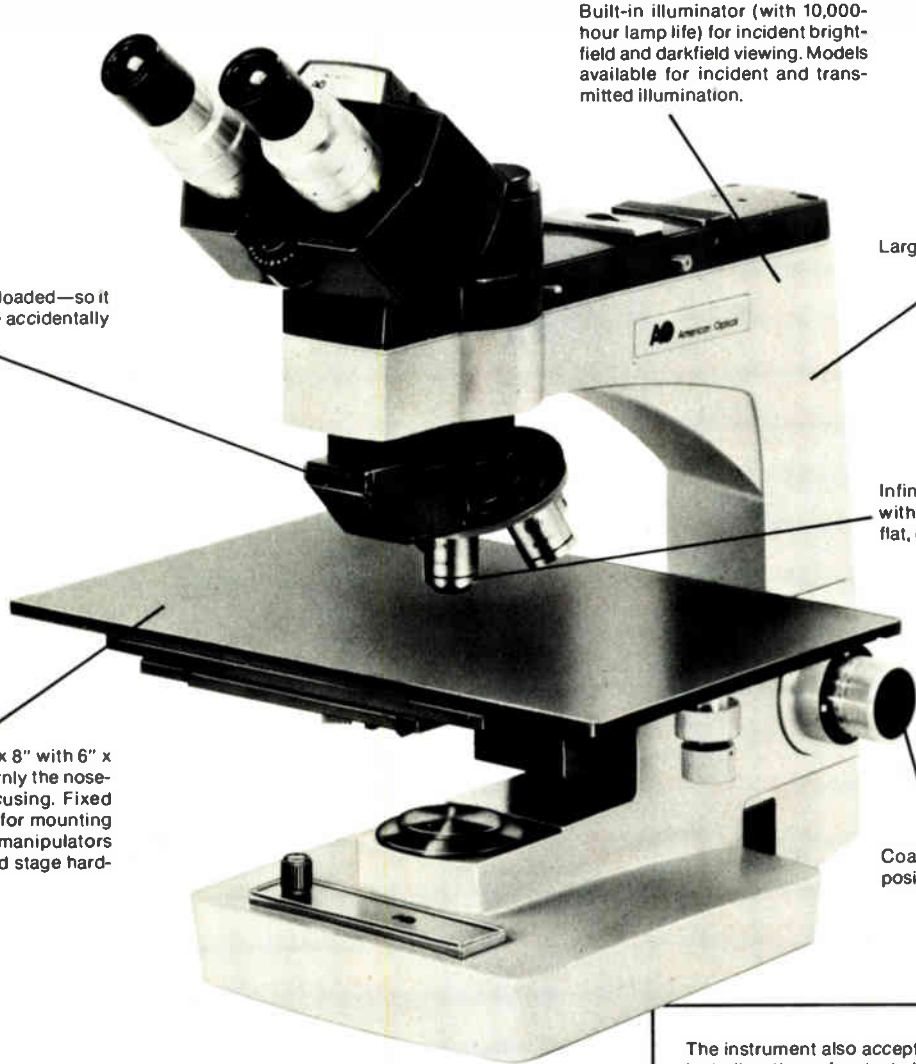
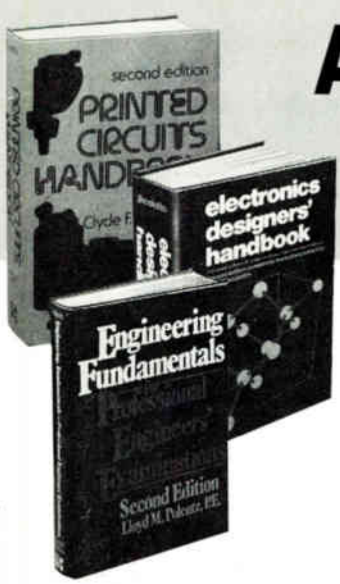
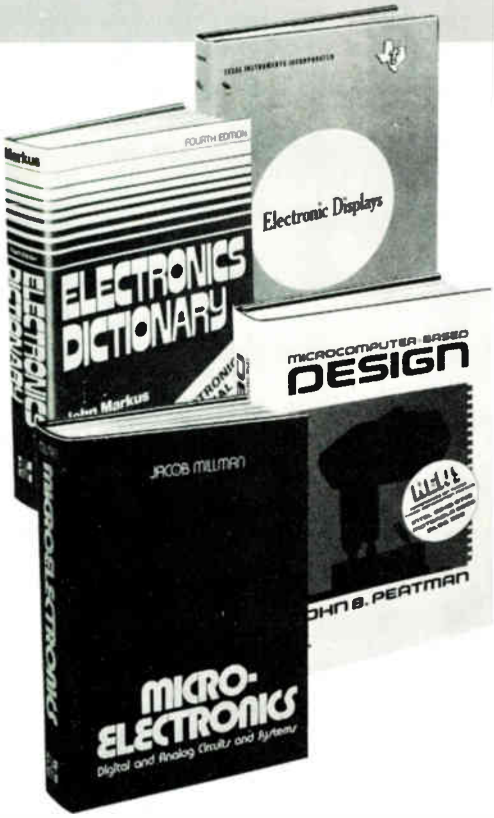


The instrument also accepts a variety of accessories, including those for dual viewing and multi-viewing, photomicrography and differential interference contrast. Ask your dealer for details.

An introductory Electronics





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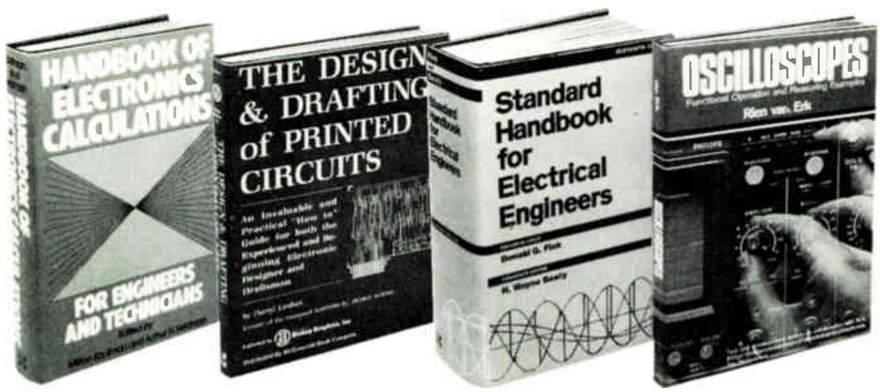

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ELECTRONIC DISPLAYS. By E. G. Bylander, Texas Instruments Incorporated, *172 pp., illus.* The book describes current electronic displays by family types, discussing all aspects of their operation, application, and circuit requirements. You cover photometry and contrast enhancement, together with the fundamentals of such critical components as mounts and drives, interface requirements, and other necessary engineering information.
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DIGITAL FILTERS. By A. Antoniou, *524 pp., illus.* This all-inclusive, up-to-date treatment guarantees your thorough understanding of today's digital filters and the theories, techniques, and procedures you'll be using in their analysis, design, and implementation. The book gives you many design examples, together with the numerous possible approaches and engineering tradeoffs relating to their hardware implementation.
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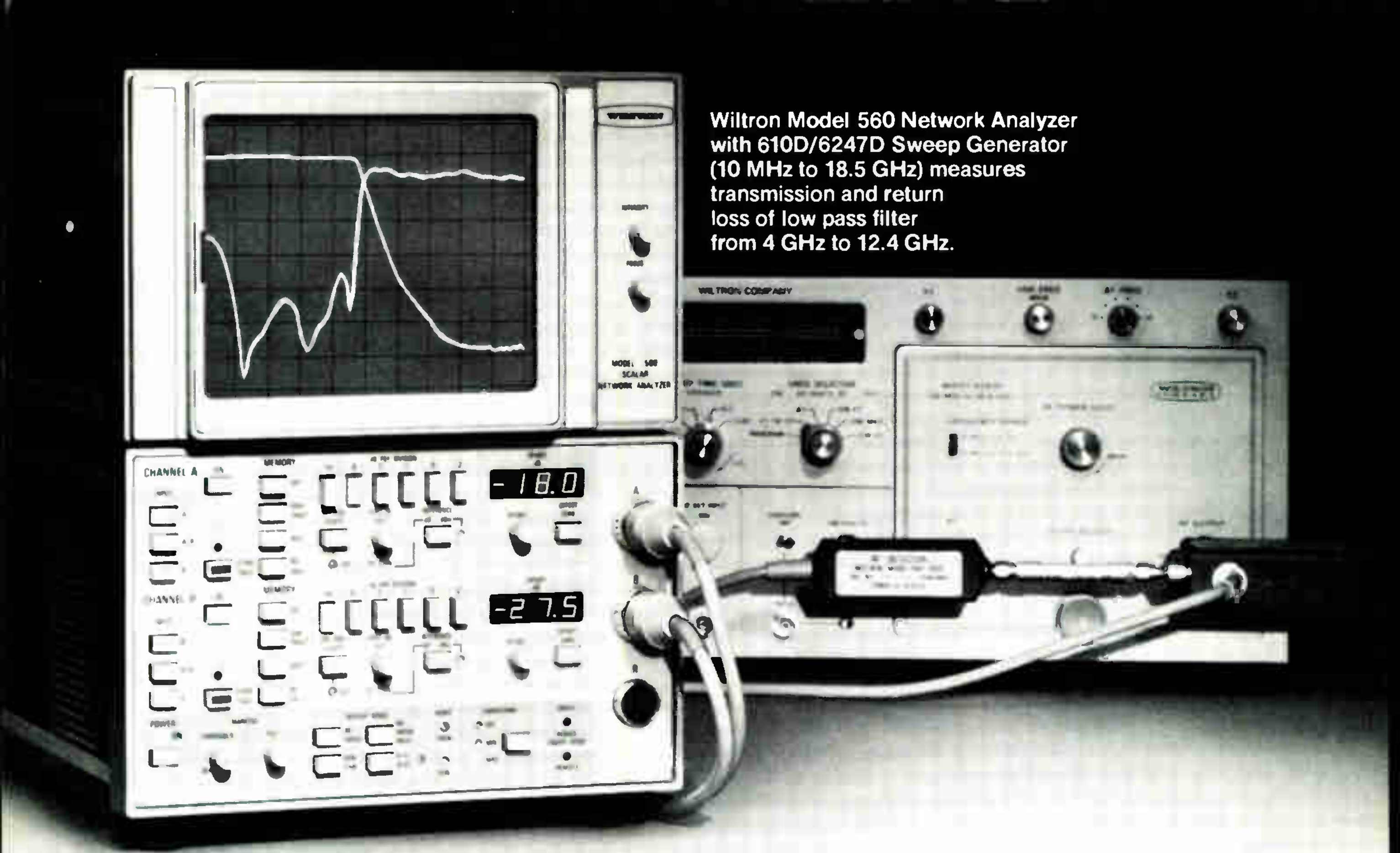

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Wiltron's 560 offers GPIB programmability and 0.01 dB resolution. With 40 dB directivity from a 10 MHz to 18 GHz SWR Autotester, you get unmatched accuracy. Broadband components let you make uninterrupted measurements over more than 10 octaves. A new WSMA (SMA compatible) detector has an upper frequency limit of 34 GHz.

Prices begin at $5900.

At $5900 for the manual unit or $7250 with GPIB, the 560 is an exceptional value in microwave instrumentation. A fully automated turnkey system (Model 5610) is available too.

For an early demonstration or more data, phone Walt Baxter, (415) 969-6500 or write Wiltron, 825 East Middlefield Road, Mountain View, CA 94043.

WILTRON

Circle 236 on reader service card

Mostek enters general data conversion market

In a move signaling the entry of Mostek Corp. into the growing market for general-purpose data-conversion circuits, the Carrollton, Texas, company has introduced **the MK50808 and MK50816 analog-to-digital converters. Accepting 8-channel and 16-channel inputs respectively,** the devices employ low-power complementary-MOS technology and are intended to serve as pin-compatible replacements for National Semiconductor's ACS0808 and ADC0816.

In 100-unit quantities, the 50816 is available in a 40-pin plastic package priced at $10.85. Model 50816-1, an extended-temperature industrial-grade version, sells for $16.85 (also in 100-unit quantities). Both versions of the 50808 come in a 28-pin plastic package and sell for $9.70 and $15.55, respectively, in the same quantities.

Zilog founder's new firm readies with first product

Ungermann-Bass Inc. is currently developing the prototype of a local-area network for distributed processing, called New/One. The Santa Clara, Calif., company was **formed last summer by Zilog Inc. founder Ralph K. Ungermann and Charles Bass, former general manager of Zilog's systems division.** First deliveries of Net/One are slated for June.

Ungermann-Bass also just landed its first venture capital funding from three investment sources in equal amounts: Oak Investment Partners in Westport, Conn., and Bessemer Securities Corp. and Adler and Co., both of New York. The last firm is headed by Frederick R. Adler, the Wall Street wizard who is chairman of Data General Corp. and former chairman of Intersil Inc.

TI shrinks 92-K bubble diameters

Texas Instruments Inc. is reducing the 5-μm diameter of its three-year-old 92-K bubble memory chip—the TIB0203—to 3 μm. Designated model number TIB0203S, the smaller chip has been designed as a transparent replacement for the older 0203. The 0203S, which achieves **a chip size of about 58,000 square mils,** is available now for $100 each in 100-unit quantities. The original 0203 measured about 123,000 square mils in area.

Next, the Dallas firm will turn to a technique that stays with the 3-μm bubble diameters, but **uses a folded-loop concept to reduce device sizes even further to around 30,000 square mils.** The part made with that technique is also planned to serve as a drop-in replacement to the earlier 92-K parts and is expected to become available some time during the second half of this year.

Solitron Devices sells resistors on sapphire for $4.85

Solitron Devices Inc. is making nickel-chromium resistors on single-crystal sapphire. The Port Salerno, Fla., company says the new chip-type resistors on sapphire (ROS) **almost totally eliminate the diode or punch-through effect** all too commonly associated with silicon-substrate film resistors.

In comparison with such thin-film resistors on silicon, the ROSs are said to have lower temperature coefficients of resistance and better power dissipation, not to mention higher ratio accuracies. ROS pairs matched to within 0.01% of each other in plastic single or dual in-line packages are to sell for $4.85 in hundreds.

Indispensable references for the professional engineer

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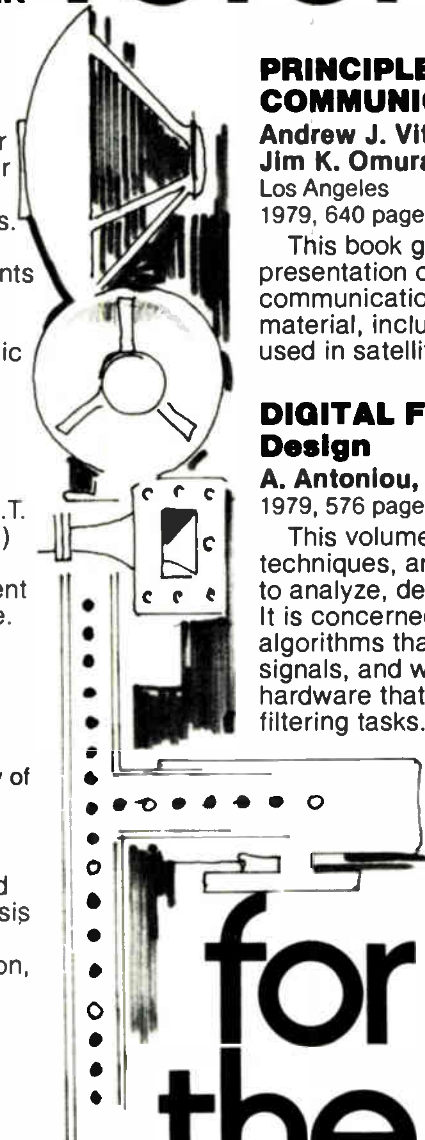
INTRODUCTION TO RADAR SYSTEMS, Second Edition
Merrill I. Skolnik, Naval Research Laboratory
1980, 592 pages (tent.), $34.95

In this second edition, the author has incorporated advances in radar capabilities to fashion a thorough introductory book on radar systems. The volume's systems orientation successfully integrates the rudiments of electrical engineering from the perspective of radar systems.

In the second edition. . . Synthetic Aperture Radar, Over-the-Horizon Radar, 3D Radar, and Millimeter-Wave Radar are among the most current areas highlighted, and completely new sections on M.T.I. (Moving Target Indication) and A.D.T. (Automatic Detection and Tracking) have been included. All of the revisions conform to the most recent changes in nomenclature and style.

INTRODUCTION TO THE THEORY AND DESIGN OF ACTIVE FILTERS
Lawrence P. Huelsman, University of Arizona, and **Phillip E. Allen,** Texas A&M University
1980, 448 pages (tent.), $26.95

This reference provides a unified view of modern active filter synthesis techniques and provides detailed coverage of their design, application, and evaluation. It develops techniques for analyzing and evaluating the quality of the filters designed.



PRINCIPLES OF DIGITAL COMMUNICATION AND CODING
Andrew J. Viterbi, LINKABIT Corporation, and **Jim K. Omura,** University of California, Los Angeles
1979, 640 pages, $29.95

This book gives a clear, comprehensive presentation of basic principles of digital communication and coding. It presents new material, including the most current techniques used in satellite communication systems.

DIGITAL FILTERS: Analysis and Design
A. Antoniou, Concordia University, Canada
1979, 576 pages, $24.95

This volume brings together theories, techniques, and procedures that can be used to analyze, design, and implement digital filters. It is concerned with both the construction of algorithms that can be used to filter recorded signals, and with the design of dedicated digital hardware that can be used to perform realtime filtering tasks.

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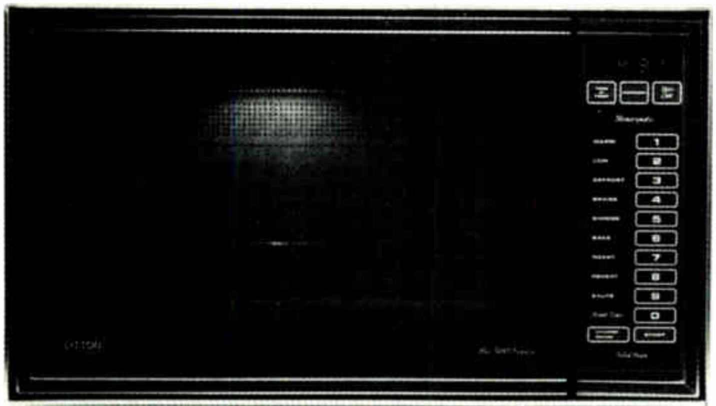

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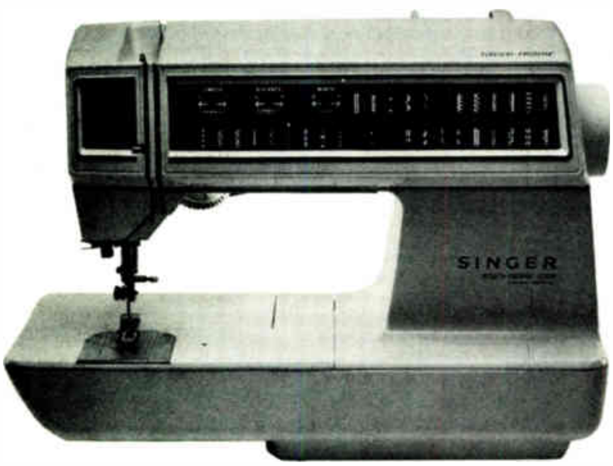

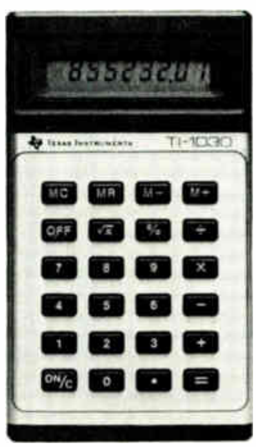

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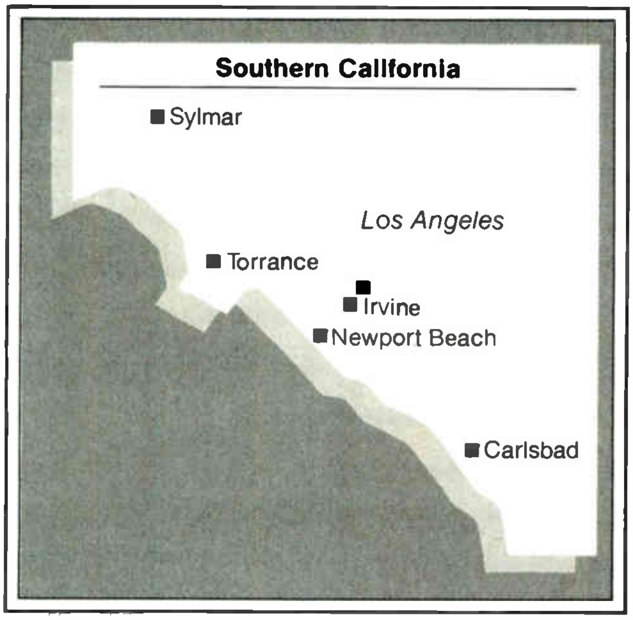

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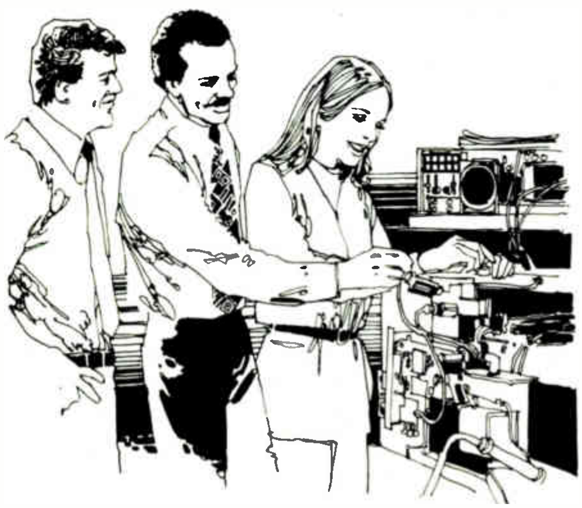

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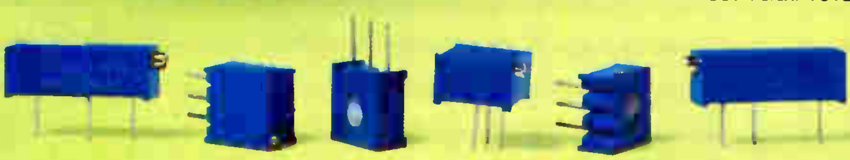

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