SEPTEMBER 22, 1981

VHSIC COMPETITORS REVEAL PHASE I DESIGNS/89

A language that runs on any computer/136

Subscriber-line control chip handles voice and data/126

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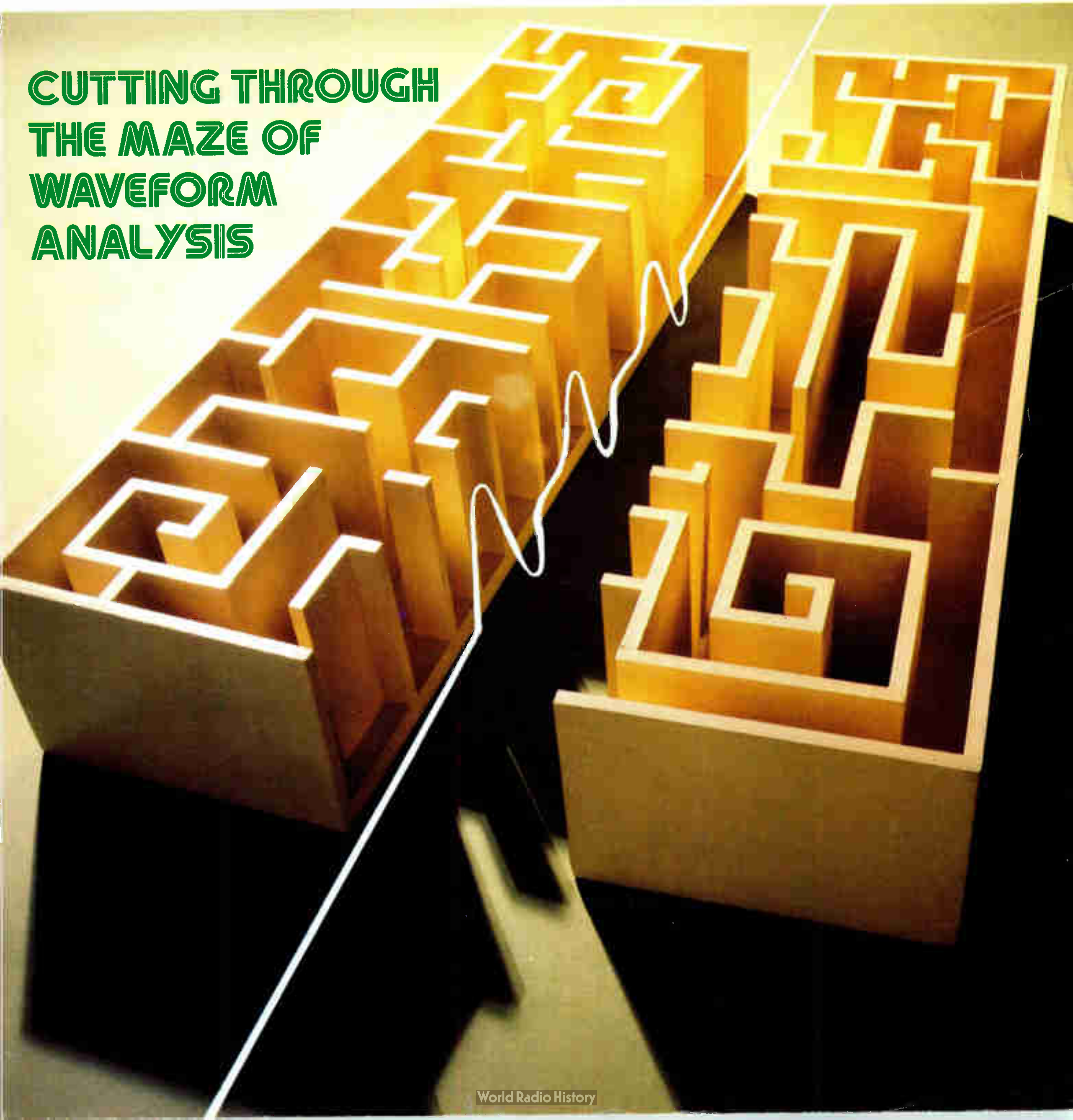

CIRCUIT BOARD TESTING: SHOULD IT BEGIN IN PRODUCTION OR IN THE LAB?

Some successful companies charge production with the responsibility for developing test procedures. Others give the job to the design lab. And with many it's a shared responsibility.

However, if these methods were decided by the standards of yesterday's technology, you may increase today's productivity with a different approach. Consider these points:

Testing options begin in the lab.
With today's product designs using microprocessors, memory and other LSI circuits, the question "How to test?" will arise long before a design is released to production. When asked in the hardware/software definition phase, electronic manufacturers can opt for one of three approaches: 1) Not to design for testability, thus leaving test development responsibility to production. 2) Design for go/no-go self test, covering a "critical" subset of board functions, and leaving fault isolation to skilled technicians in production as well as the field. 3) Design for thorough self test, including diagnostics, which facilitate fault isolation, thus providing a total test solution for R&D, production and field service.

Can you afford to design for testability?
Let's take a look at the trade-offs. Option 1 appears to offer the shortest design cycle. However, the designer will probably take longer than planned in design turn-on. And design follow-up with production often takes more effort than expected. Longer production test development time is also likely to delay shipments.

Designing in a go/no-go self test (option 2) solves some of the problems associated with option 1. However, a limited self test may still lead to failures at system turn-on. And without fault isolation, expensive technician time will be needed in production and field service.

At first glance, option 3 may seem to require too much of the designer's time. However, the payback can be significant in reduced debugging time and enhanced test effectiveness. After all, the designer best understands the product structure and critical aspects of its operation. And the designer has the tools and the opportunity to implement design features often required for high fault-coverage testing of complex LSI circuitry.

A decision that impacts production most.
Whatever the decision, production will feel its effect most. A balance must be found between design time and a viable board test solution. HP provides that balance with the 3060A Board Test System. Equipped with the High Speed Digital Functional Test Option (HSDFT), it delivers the flexibility to solve your μP and LSI board testing problems whether you design for testability or not.

For example, the 3060A can activate μP-based, designed-in stimulus firmware and measure the dynamic board response using Signature Analysis. If self-stimulus isn't available you can use the HSDFT programmable stimulus capability (Figure 1).

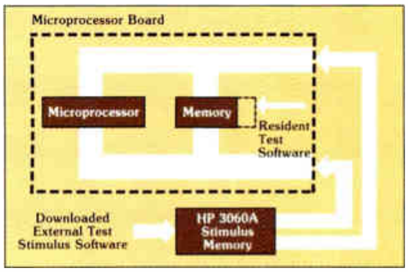

Figure 1 — The 3060A can activate resident test stimulus software or provide that stimulus from its own RAM.

Test stimulus software developed for design turn-on can even be leveraged for production test by downloading from your design system (such as the HP 64000) into 3060A stimulus RAM. Or, alternatively, HP's 3060A Digital Functional Test software provides easy-to-use stimulus and measurement programming procedures.

For fault isolation, the 3060A HSDFT software provides automatic backtracking via in-circuit visibility on the basis of a topological description of the board. And, these procedures can be used as the basis for effective field service repair using HP Signature Analysis instrumentation (HP's 5005A).

The bottom line? Rapid software development, thorough testing, high throughput and efficient field troubleshooting — the complete solution. That's worth investigating.

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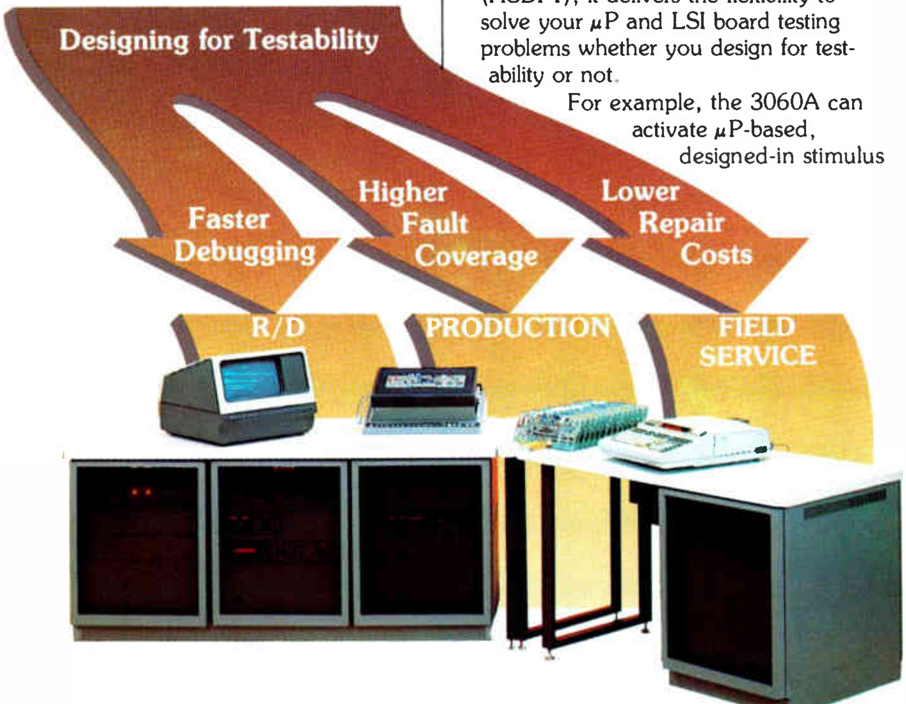

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Shorted Node	546A Pulser[1]	547A Current Tracer	• Pulse shorted node • Follow current pulses to short
Stuck Data Bus	546A Pulser[1]	547A Current Tracer	• Pulse bus line(s) • Trace current to device holding the bus in a stuck condition
Signal Line Short to Vcc or Ground	546A Pulser	545A Probe Current Tracer	• Pulse and probe test point simultaneously (short to Vcc or Ground cannot be overridden by pulsing) • Pulse test point, and follow current pulses to the short
Vcc to Ground Short	546A Pulser	547A Current Tracer	• Remove power from test circuit • Disconnect electrolytic bypass capacitors • Pulse across Vcc and ground using accessory connectors provided • Trace current to fault
Internally Open IC	546A Pulser[1]	545A Probe	• Pulse device input(s) • Probe output for response
Solder Bridge	546A Pulser[1]	547A Current Tracer	• Pulse suspect line(s) • Trace current pulses to the fault • Light goes out when solder bridge passed
Sequential Logic Fault in Counter or Shift Register	546A Pulser	548A Clip	• Circuit clock de-activated • Use Pulser to enter desired number of pulses • Clip onto counter or shift register and verify devices truth table

1. Use the Pulser to provide stimulus, or use normal circuit signals, whichever is most convenient.

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Electronics
The International Magazine of Electronic Technology
Vol. 54, No. 19 • September 22, 1981

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Highlights

Cover: Processor-based instrument performs waveform analysis, 113

A wide range of signal-processing checks may be carried out with a new programmable digital instrument that integrates a full range of analog measurement and computing functions. Its 16-bit microprocessor radically simplifies the operator's set-up tasks.

The cover construction is by Robert Strimban.

VHSIC is in step with civilian strategies, 89

U. S. military electronics is aiming for the same advanced technological goals as are U. S. semiconductor makers. This Inside the News report examines the Phase 1 chip plans of the contractors participating in the Very High-Speed Integrated Circuits program.

Microprocessor tunes camera for photos of TV images, 121

Overcoming the incompatibilities between color cathode-ray-tube images and color photographic media, an 8085-controlled system can produce high-quality color prints, projection slides, and the like from computer-graphics setups or standard TV-encoded color signals.

Telecommunications IC switches signals on its own, 126

Working with a handful of other chips, a new integrated-circuit controller can perform a variety of voice and data chores at the first system interface after the subscriber lines. It will be an important link in the all-digital telecommunications network.

High-level language moves easily among computers, 136

A new general-purpose programming language runs identically on every computer system; all that is required for retargeting it is recompilation of the program source code. Putting source-level features in the language definition enhances portability, thus saving on software investment.

Linear test time dwindles with high-resolution converter, 142

Checking the 4,095 transition points in a 12-bit analog-to-digital converter can take as little as 12 seconds with a test setup that combines a high-resolution, fast-settling digital-to-analog converter as reference and a micro-computer as a speedy controller.

Lasers find a role in terminating flexible printed wiring, 149

To speed up the termination of flexible printed wiring, a new process uses one gas laser to strip the insulation and another to make a connecting weld.

In the next issue . . .

C-MOS comes of age: a special issue on complementary-MOS applications ranging from telecommunications to automotive spark control.

September 22, 1981 Volume 54, Number 19
105,244 copies of this issue printed

Electronics (ISSN 0013-5070). Published every other Tuesday except the issue of Monday, Nov. 30, by McGraw-Hill, Inc. Founder: James H. McGraw 1860-1948. Publication office 1221 Avenue of the Americas, N.Y., N.Y. 10020; second class postage paid at New York, N.Y. and additional mailing offices.

Executive, editorial, circulation and advertising addresses: Electronics, McGraw-Hill Building, 1221 Avenue of the Americas, New York, N.Y. 10020. Telephone (212) 997-1221. Teletype 12-7960 TWX 710-581-4879. Cable address: M C G R A W H I L L N E W Y O R K.

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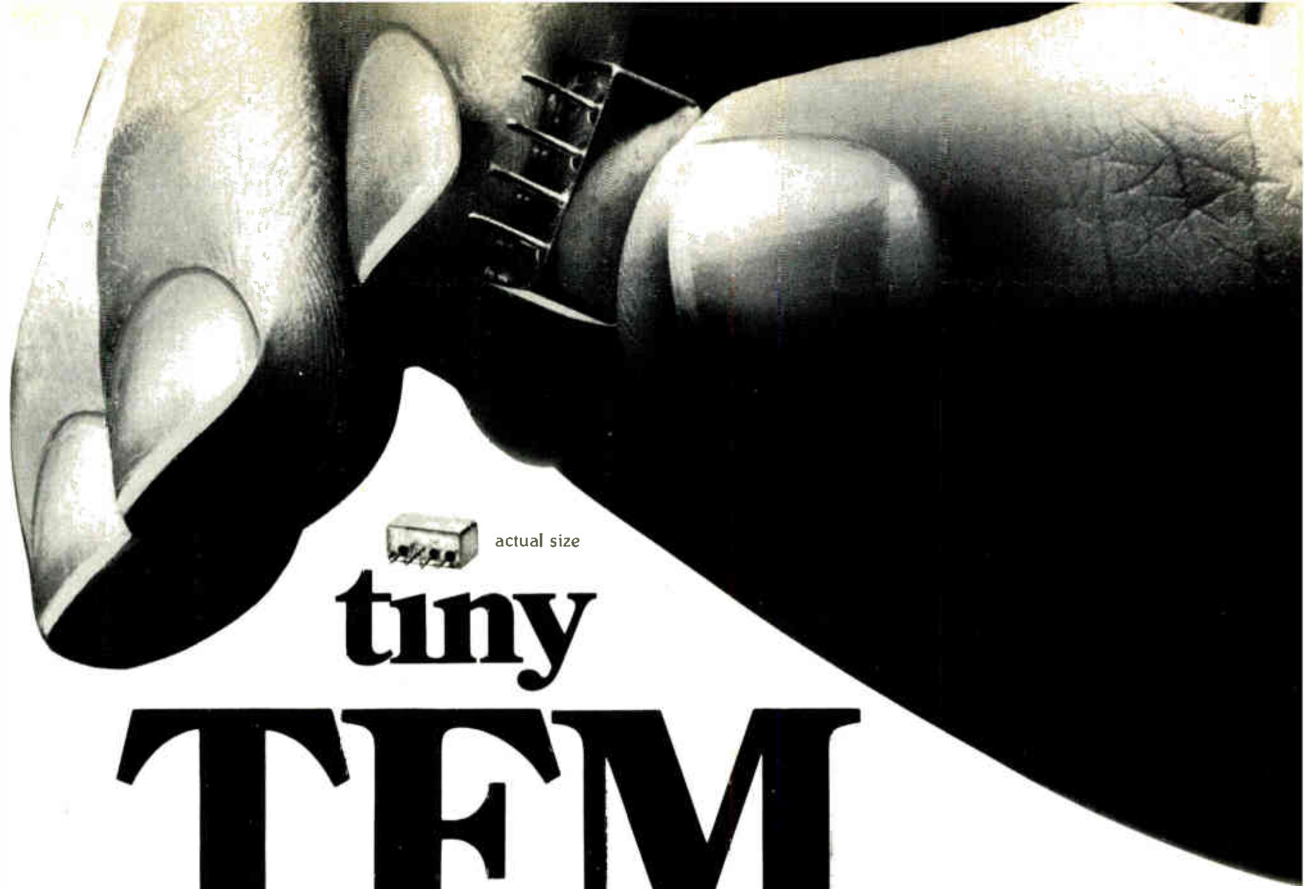

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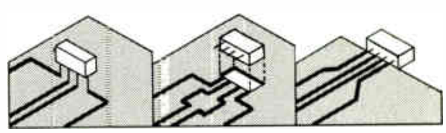

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TFM-4	5-1250	DC-1250	6.0	7.5	50	45	40	35	30	25	21.95	(5-49)
•TFM-11	1-2000	5-600	7.0	7.5	50	45	35	27	25	25	39.95	(1-24)
•TFM-12	800-1250	50-90	—	6.0	35	30	35	30	35	30	39.95	(1-24)
••TFM-15	10-3000	10-800	6.3	6.5	35	30	35	30	35	30	49.95	(1-9)
••TFM-150	10-2000	DC-1000	6.0	6.5	32	33	35	30	35	30	39.95	(1-9)

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Circle 5 on reader service card

Americans have a certain sense of pride in the U. S. government's Very High-Speed Integrated Circuits program—its results should be truly representative of the nation's technological capabilities, and extremely advanced devices promise to emerge from the program. Indeed, no one is more excited about the VHSIC program than our solid state editor, John Posa, who received a through briefing about its status at the Institute for Defense Analysis in Arlington, Va., last June 15–19.

"I found the VHSIC meeting very exciting," says John, who combined notes from the meeting with subsequent reporting to prepare the Inside the News story on p. 89. "The program's goals are right in keeping with those of the semiconductor industry—very fine lithography, submicrometer work using electron beams, dry processing—only stepped up," he adds.

The VHSIC endeavor has excited us since its inception. The story was first broken in the pages of *Electronics* by Washington bureau chief Ray Connolly [*Electronics*, Sept. 14, 1978, p. 81], who has stayed abreast of its developments from his capital vantage point. Ray was first to reveal the winners of VHSIC's study phase, the so-called Phase 0 [*Electronics*, March 27, 1980, p. 41]. The program is now well enough along into Phase I, which will result in operational brassboards by 1984, that the contractors have completed their functional descriptions of the chips, as John details in his story.

Phase I breaks down into two stages: the first will yield integrated circuits with 1.25-micrometer features, which will go into the 1984 operating brassboards. While fabricating those devices, the manufacturers must put facilities in place for the second stage—shrinking the chips' geometries to a remarkable 0.5 μm. "That will certainly speed up the devices," John declares.

Although the contracts have been awarded and the goals spelled out, Phase I is far from free of controversy. In fact, two specific issues are brewing right now.

The first has really more to do with the way manufacturers are realizing their complex chip assignments: whereas some are building many job-specific ICs, others are building just a couple of highly programmable chips to suit a wide range of applications. "Although they'll be highly software intensive, and probably more difficult to get to meet specs, the highly programmable devices stand a much better chance of being spun off into commercial products—the manufacturers can get much more mileage out of them," John explains.

Another issue involves the teaming up of contractors: some are going their contracts alone, while others are joining forces with many other manufacturers. "I see the big teams having a rougher go of it," says John, "because manufacturers may be reluctant to reveal all the nuances of their processing."

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Circle 216 on reader service card

Readers' comments

Defending the FAA

To the Editor: While one can agree with many of the things you say about the Federal Aviation Administration in your Aug. 25 editorial ["The FAA's sins of omission," p. 24], I think there is an aspect of the FAA that we in the U. S. tend to overlook—namely, that the FAA runs what is unquestionably the world's largest, densest, and most efficient air traffic control system, 24 hours a day, 365 days a year. I speak as one who has crossed the Atlantic 182 times, observed the ATC operations of 40 other countries, and devoted a lifetime to the avionics business.

Sven H. Dodington
Mountain Lakes, N. J.

Footnote on a Notebook

To the Editor: The back-to-back opto-isolator arrangement described in the July 28 issue ["Twin optocouplers raise serial transmission speed," p. 159] has been in use in short-haul modems around here for some time. However, one significant improvement was omitted: the outputs of the isolators should not be tied together, but rather fed into the R and S inputs of an RS flip-flop.

The Q output of the RS flip-flop is then used to drive the receiver. This effectively "debounces" the signal by adding hysteresis.

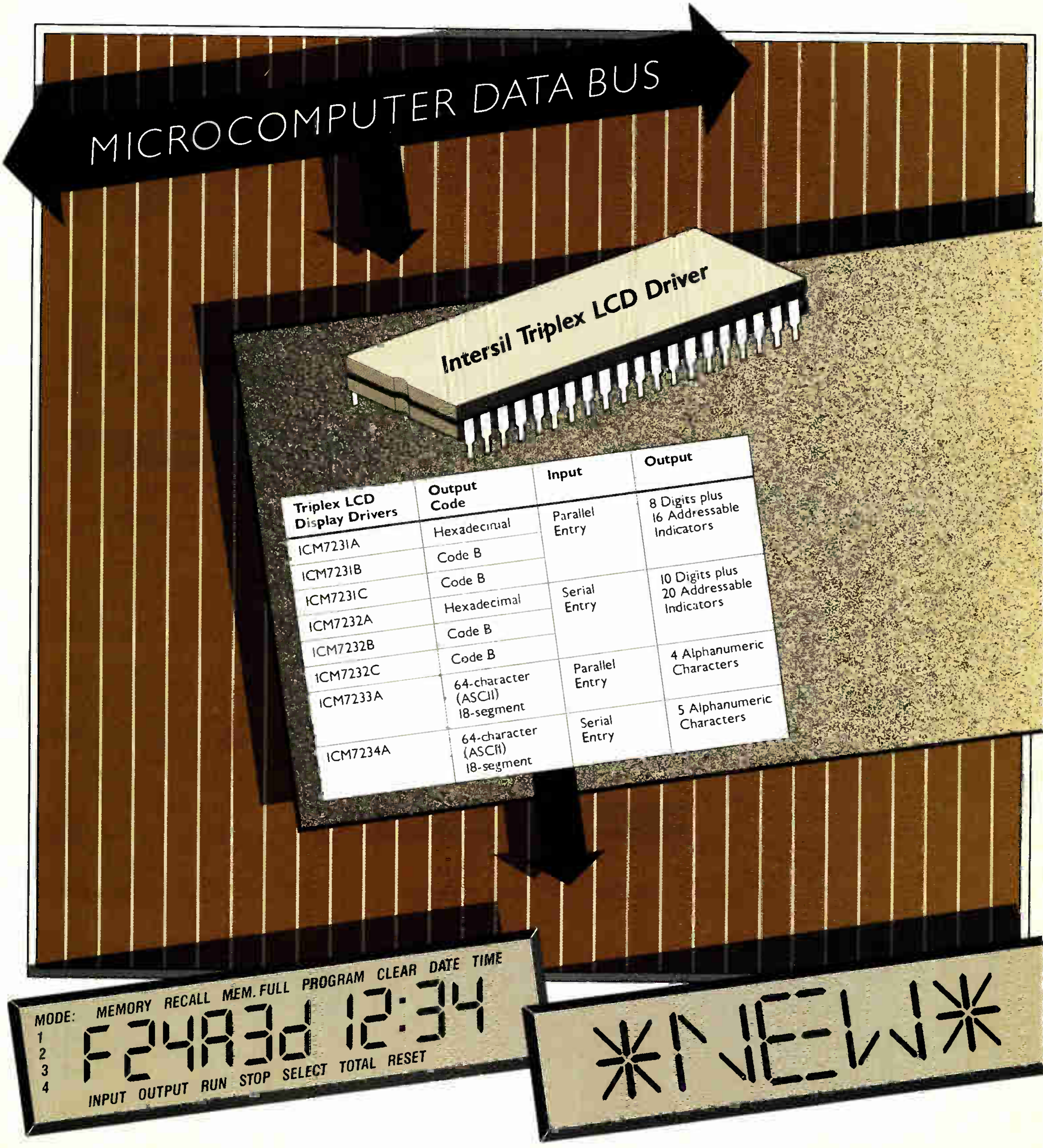
Minor noise on the line that activates one opto-isolator will not produce a false result. Only noise strong enough to extinguish the correct light-emitting diode and ignite the other one will produce a bad signal. Assuming complementary 5-volt TTL signals, this improves the noise margin from about 2.5 V to 7.5 V.

Dwight D. Hill
Bell Laboratories
Naperville, Ill.

Correction

In "Calculator plots time response of inverse Laplace transform" (July 14, p. 149), the first line in the run prompting instruction was inadvertently omitted. It should read: XROM "PRPLOT." Thus, to execute the program, the key sequence is (XEQ), ALPHA, (PRPLOT), ALPHA.

NOW GO FROM µP TO
WITH ONE



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ICM7232B	Code B		
ICM7232C	Code B		
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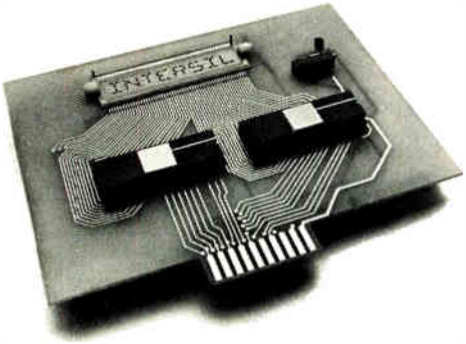

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News update

■ The wraps are still not ready to be removed from the titanium boride crystals with which Frederick W. Vahldiek has exhibited superconductivity at room temperature [*Electronics*, Oct. 9, 1980, p. 41]. Vahldiek refuses to discuss the process that turned TiB_2 into a superconductor without patent protection, which he now expects sometime next year.

Both the Air Force, which employs Vahldiek as a materials research engineer at Wright-Patterson Air Force Base, Ohio, and hundreds of firms throughout the world have shown interest, he says. To them he offers a few new, tantalizing statements about the properties of his material, which operates under high pressure.

For one, it need not be a superconductor. Vahldiek says that a continuous resistance per length of 10^{-3} to 10^{-12} ohm per centimeter is possible. Unlike with cryogenic superconductors, resistance does not suddenly fall from a higher to a lower figure at a given temperature; by varying the purity of the TiB_2, anything from a semiconductor to a superconductor can be obtained.

Good sizes. The crystals that have been fabricated are not tiny, laboratory curiosities. The largest obtained to date are 12 to 14 millimeters long by 2 to 4 mm in their other axes, with the size limit now imposed by the equipment available in Vahldiek's home laboratory. He also notes that superconductive crystal growth should be compatible with thin-film technology, with TiB_2 film being grown in varying directions across a substrate.

The technique should also be compatible with the processes now used to make monolithic integrated circuits. This would open an almost limitless range of power, control, and ultra-high-speed computer applications using superconductors, without sacrificing the miniaturization achieved with IC technology.

Vahldiek also has thought about superconducting wire. He is confident that TiB_2, with zero resistance along only one of its three axes, could be drawn into wire or grown as a wire cladding. **-James B. Brinton**

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People

Rockwell's Kaliher to widen telecommunications horizon

Although Rockwell International Corp. claims to be the world's largest supplier of integral modems, eight years in the arena have not made it a household word ,in the U. S. Dennis L. Kaliher, general manager of the newly formed Telecommunications Products operation, plans to rectify that while diversifying the operation's production, which now consists almost solely of modems built into data-generating equipment.

The Anaheim, Calif.–based organization, which is part of the Electronic Devices division, combines sections of the firm's Microsystems Products organization with Collins Switching Systems and Wescom Inc., a manufacturer of private automatic branch exchanges that was purchased last year. Although Kaliher plans to maintain the dollar volume of Rockwell's high-speed modems, now sold largely to Japanese facsimile-machine makers, he also foresees using the expertise from Collins and Wescom to increase the share of telecommunications products to about 50% of total revenues.

This foray into new areas coincides with Kaliher's appointment and the start of the organization, which were formally announced last week at Wescon. Kaliher has been involved in communications during most of his 17 years at Rockwell's Communications Switching Systems division in Cedar Rapids, Iowa. He says his first objective is "to bring large-scale integrated-circuit technology to support our internal divisions," including his former division, and expects many of the products designed for internal use to have commercial applications.

Additional revenues will derive from custom work for major telecommunications equipment producers. But the bulk of the non-modem dollars will come from captive products, Kaliher predicts, with custom and commercial work together not equaling internal sales until 1987.

Although the firm plans to do custom work in other telecommunications areas as well, it hopes to strengthen its modem business with more standard products. One of the first is a 2,400-bit-per-second single-board modem for personal and small-business computers.

Image maker. Dennis Kaliher plans to increase Rockwell's visibility in the integral modem area.

Kaliher says he will rely heavily on Rockwell's experience in p-channel MOS, n-MOS, gallium arsenide, and a forthcoming move into bulk complementary-MOS technology to help him "siliconize" Rockwell products. "We'll bring our system expertise and technology and respond to the problems," promises Kaliher, who holds a master of science degree in electrical engineering from Iowa State University.

Kloss ready to ride the projection TV tide

If a wave of projection television sales starts rolling, Henry E. Kloss should find himself on its crest. Four years ago he founded Kloss Video Corp. of Cambridge, Mass., a video projection product manufacturer to exploit his ingenious method for making a one-piece projection tube

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9448-32	16	16	2 13.7MB RP02's	2 13.7MB RP02's	YES
			2 13.9MB RK06's	2 13.9MB RK06's	NO
9448-64	16	48	4 13.7MB RP02's	4 13.7MB RP02's	YES
			4 13.9MB RK06's	4 13.9MB RK06's	NO
9448-96	16	80	6 13.7MB RP02's	6 13.7MB RP02's	YES
			6 13.9MB RK06's	6 13.9MB RK06's	NO
9730-80	—	80	3 20.8MB RP02's	3 20.8MB RP02's	NO
				1 67.4MB RM02	NO

MODEL	STORAGE CAPACITY		OPERATING SYSTEM EMULATION		MODIFIED HANDLER
	Removable	Fixed	RT-11	RSX11-M / RSTS/E	
9730-160	—	160		2 67.4MB RM02's	NO
9762	80	—	3 20.8MB RP02's	3 20.8MB RP02's	NO
				1 67.4MB RM02	NO
9766	300	—		1 253.7MB RP06	YES
				1 256.1MB RM02	YES
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called the Novatron. It is used in the firm's handful of video projection units to produce a high-quality picture in a $3,150 unit that today is acclaimed throughout the industry.

Kloss does not take credit for inventing the one-piece tube behind his latest venture and namesake that left in its wake other, higher-priced systems. He says it is a classic optical design and his work merely led to the manufacturing technique.

No newcomer to either business ventures or consumer electronics, he helped form Acoustic Research Corp., popularly called AR, back in 1954 and there developed the first acoustic suspension speaker. Then in 1958 he and some associates started KLH Research & Development Corp. (Kloss was the K), which later became known for its line of high-quality audio products. In 1967 he founded Advent Corp. specifically to develop and manufacture projection TV for the home, although its first products were more for the audiophile. The company eventually went bankrupt.

Kloss recalls some high spots at Advent before its difficulties: "For years Advent speakers were a tremendous hit, and Dolby noise reduction and chromium dioxide [two innovations in magnetic-tape recording] were first used with the Advent model 200 cassette deck." He smiles. "I don't know how we did it then."

Probably he did it with the same instinct that led to his latest product, a video beam monitor that omits the tuner section of a video projector [*Electronics*, June 16, 1981, p. 44]. The monitor is aimed at owners of video-cassette recorders; since a VCR already contains a high-quality tuner that can be used with the monitor, a buyer can save at least $600 on a wide-screen video projector. The way Kloss sees it, the video-beam monitor is in fact a precursor of a trend in video systems toward component sections, much like today's hi-fi systems.

As for projection TV, Kloss predicts "this is the year sales will double to 100,000 units." It's the only way to watch TV, he says.

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		Output	✓							✓	
	> 1000W	Input				✓		✓			
		Output			✓				✓		
Mounting Style Options	Direct P.C. Board		✓	✓			✓		✓	✓	✓
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Capacitance Range (μF's)			3-28,000	.33-4,700	110-700,000	75-1,000,000	30-73,000	80-600,000	2800-200,000	19-17,000	.47-4,700
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Operating Temp. Range			-40 to +85°C	-40 to +85°C	-55 to +105°C	-40 to +85°C	-40 to +85°C	-40 to +85°C	-55 to +85°C	-55 to +105°C	-40 to +85°C

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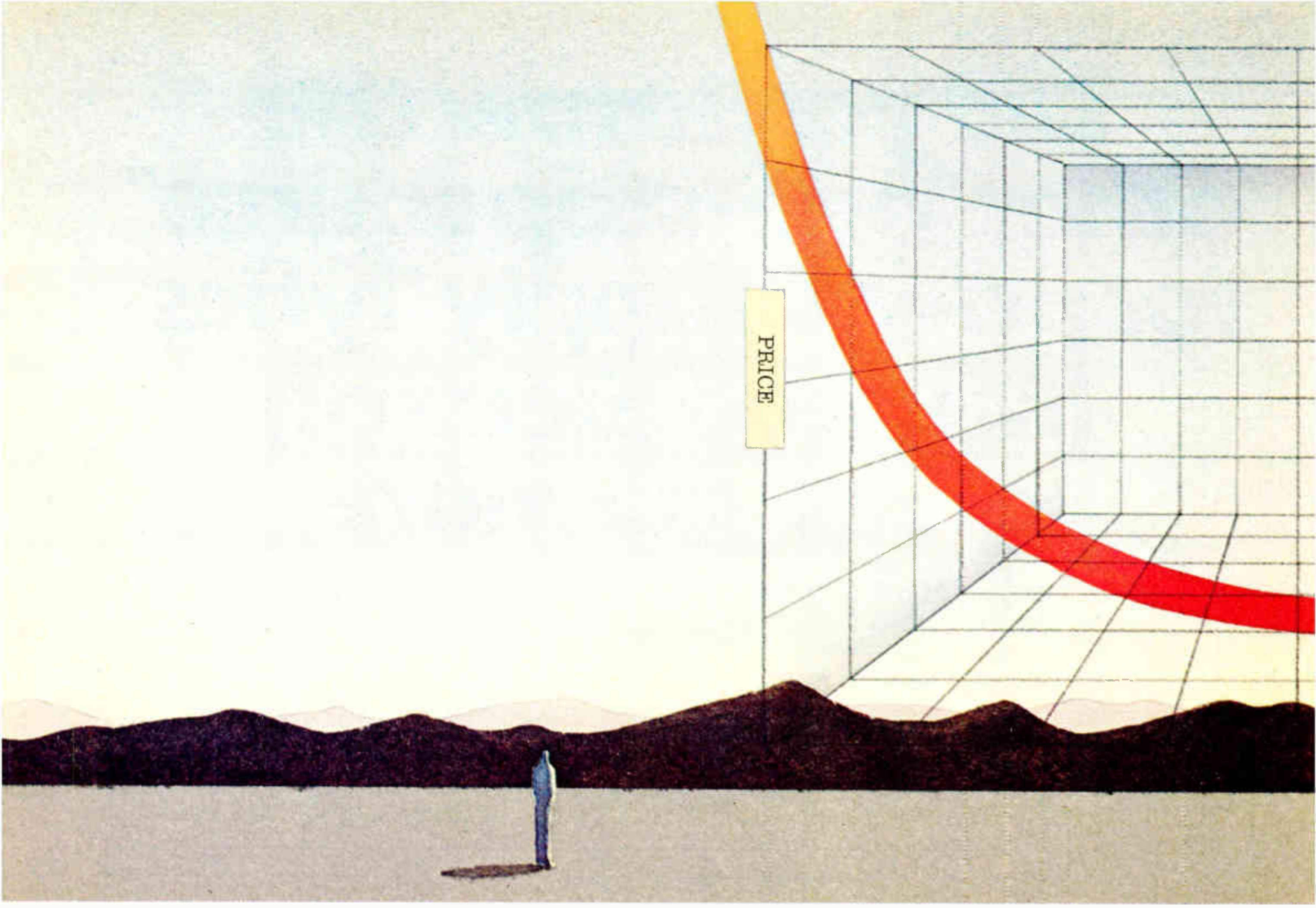

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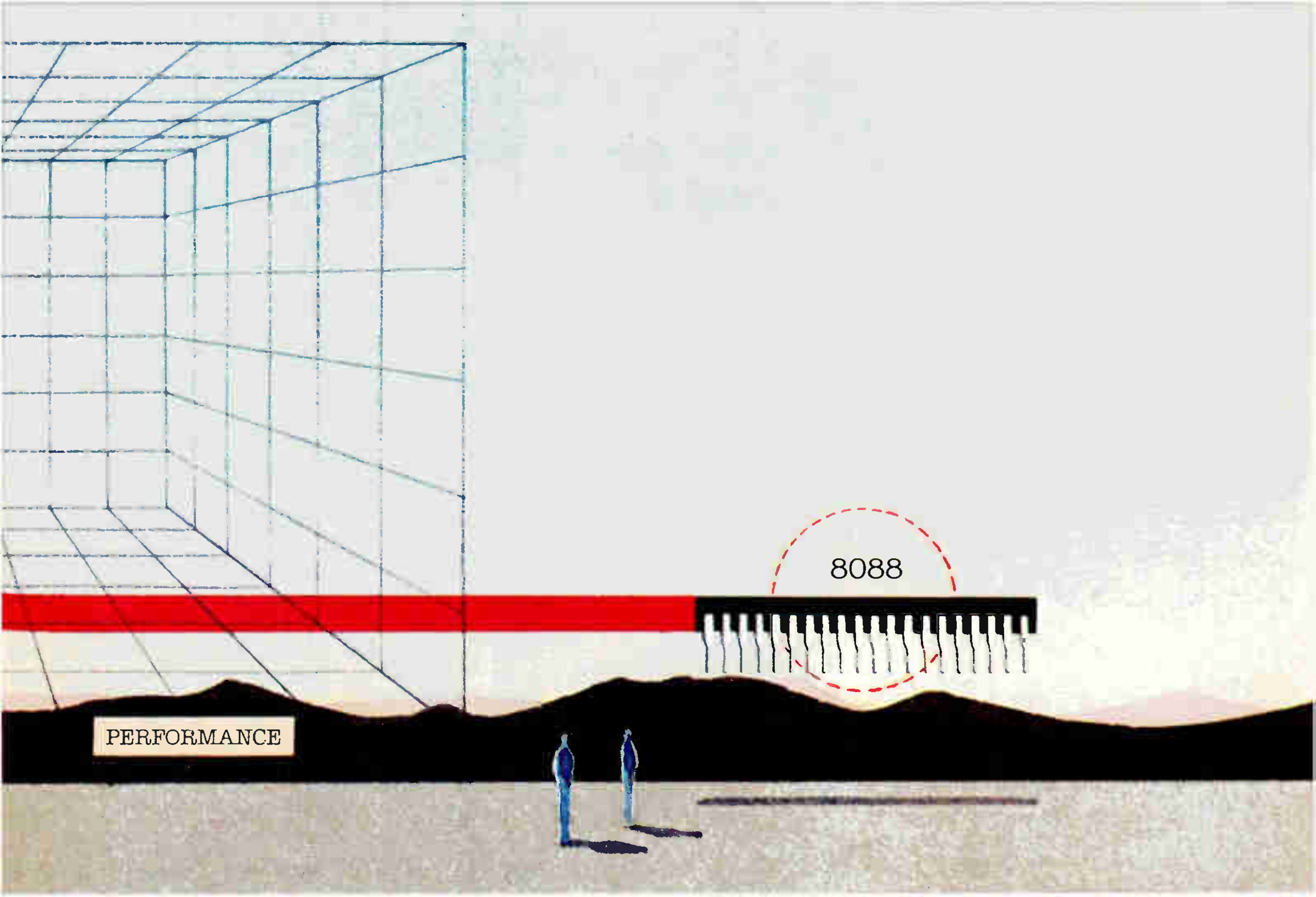
16-bit Multiply	*1.0*	*0.17*	*0.5*
Block Move	*1.0*	*0.75*	*0.49*

Full details of these benchmarks available in the iAPX 88 Book.



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Meetings

Careers Conference, IEEE (Jill Gerstenzang, Suite 609, 1111 19th St. NW, Washington, D. C. 20036), Stouffer's Denver Inn, Denver, Colo., Oct. 22–24.

123rd Technical Conference and Equipment Exhibit, Society of Motion Picture and Television Engineers (Conference Department, 862 Scarsdale Ave., Scarsdale, N. Y. 10583), Century Plaza Hotel, Los Angeles, Oct. 25–30.

37th Annual National Electronics Conference and National Communications Forum, National Engineering Consortium Inc. (Oak Brook Executive Plaza No. 2, 1211 W. 22nd St., Oak Brook, Ill. 60521), Hyatt Regency O'Hare Hotel, Chicago, Oct. 26–28.

5th International Printed Circuits Conference/Exhibition, Benwill Publishing Co. (1050 Commonwealth Ave., Boston, Mass. 02215), Los Angeles Convention Center, Los Angeles, Oct. 26–28.

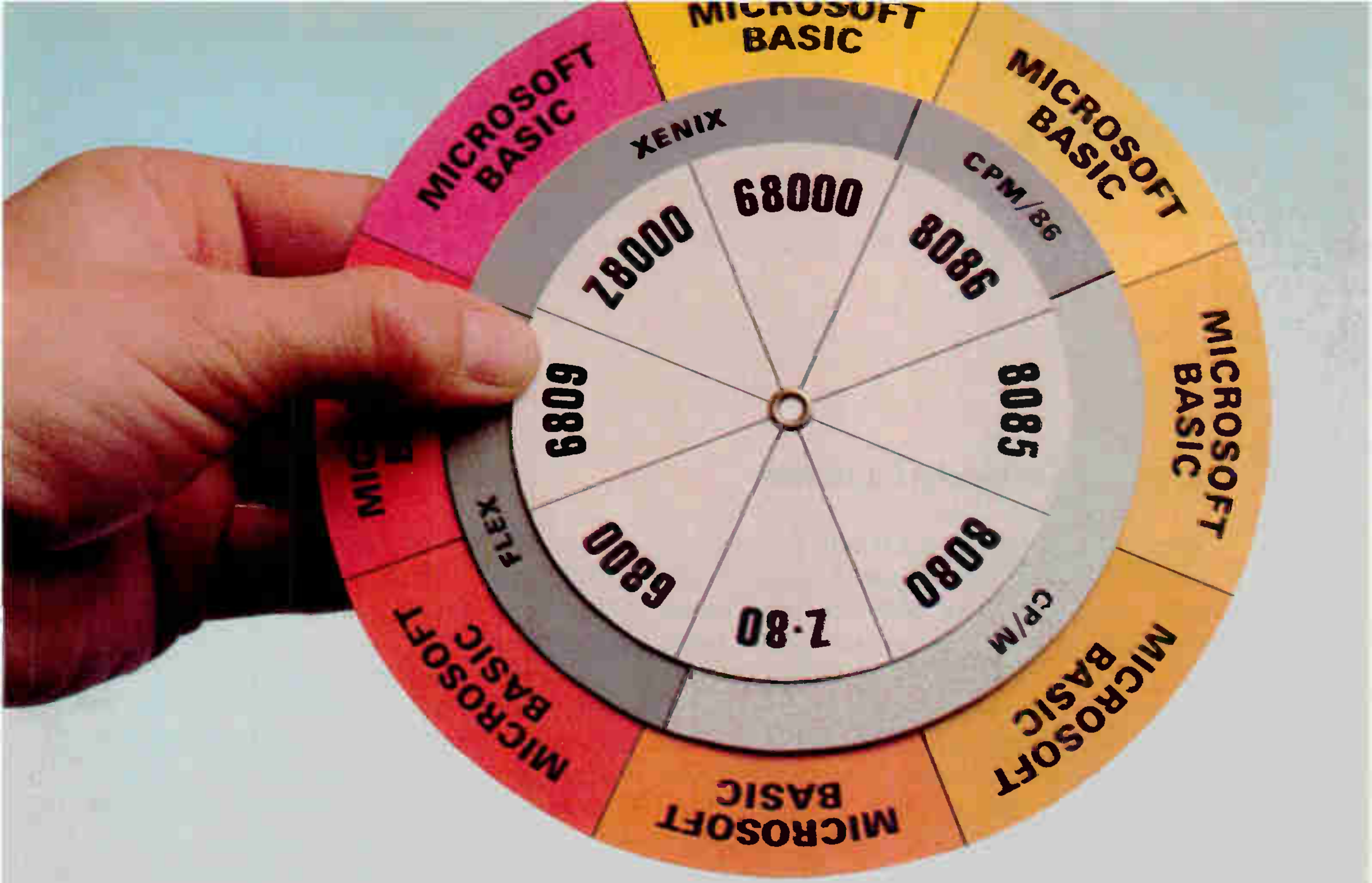
Gallium Arsenide Integrated Circuit Symposium, IEEE (Varley L. Wrick, Westinghouse Research and Development Center, 1310 Beulah Rd., Pittsburgh, Pa. 15235), Town and Country Hotel, San Diego, Oct. 27–29.

Defense Department Electronics Market: Impact of the Administration, Electronic Industries Association (Frank A. Mitchell, EIA, 2001 Eye St. NW, Washington, D. C. 20006), Hyatt Union Square Hotel, San Francisco, Oct. 27–29.

1981 International Test Conference—Cherry Hill '81, IEEE (Doris Thomas, P. O. Box 371, Cedar Knolls, N. J. 07927), Franklin Plaza Hotel, Philadelphia, Oct. 27–29.

Seminars

Digital Speech Coding, Oct. 19–21, and **Speech Vocoders,** Oct. 21–23, Department of Continuing Education—R, Georgia Institute of Technology, Atlanta, Ga. 30332.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Editorial

VHSIC takes the right direction

When the Pentagon established the requirements for its Very High-Speed Integrated Circuits program, many potential participants welcomed the concept as a much-needed boost for the U. S. semiconductor industry in its battle against what it considered the unfair government subsidization of Japanese semiconductor makers. However, some companies chose to scorn the program, saying in effect that the return would not be worth the trouble and the occasionally irritating attention likely to emanate from the military.

But now that the competitors' direction is clear in their pilot-production work for Phase I (see p. 89), it is also clear that the program, on which the Defense Department now wants to spend $320.5 million over a six-year life, is headed unswervingly down the same roads and toward the same destinations the manufacturers would have selected if left to their own devices. The major difference is that the Government's infusion of money and other encouragement is hastening their estimated time of arrival.

It is still too early to tell if the scoffers were correct in their decision to stay away from VHSIC and its red tape, contractors' meetings, and seemingly endless forms. But it is interesting to note what the Army, Navy, and Air Force want: nothing extreme, just emphasis on what the services call FTR, functional throughput rate. That rate must be 5×10^{11} gate-hertz per square centimeter. And to arrive at such speed, the semiconductor industry and the military in the U. S. are also getting advanced submicrometer lithography, automated design, and a host of other bonuses that would most likely have eventually turned up anyway, given the continuation of the present rate of development.

Also, the people in charge of VHSIC have wisely chosen twice as many contractors as originally planned—six—to cover all possible technologies, such as bipolar, bulk complementary-MOS, C-MOS on sapphire, and n-type MOS. This is another guarantee that the integrated circuits the program generates will have commercial applications.

With Phase I's requirement of a pilot-line production capability, an early payoff is in sight. In the words of Larry W. Sumney, who is director of the VHSIC program in the Department of Defense, "Minimum requirements of reliability, testability, and environmental immunity will be demanded."

Not to be overlooked, incidentally, is the all-important problem of testability in the world of submicrometer design rules. "A feature of both Phases Ia and Ib will be the development of built-in, on-chip testing technology, including design for testability. This aspect of the program is considered important, and attention will be given in each Phase I contract to ensure that the problems are addressed. Specific requirements for reliability and testability were part of the Phase 0 efforts," Sumney notes in something of an understatement.

While the program director is quick to add that commercial success is not a direct goal of the VHSIC effort, all the signposts point in that direction.

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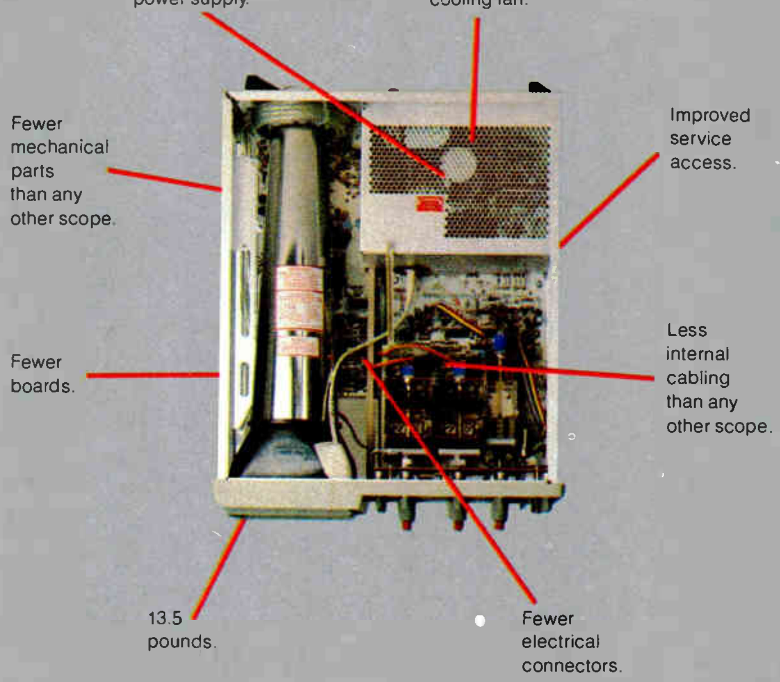

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These innovations eliminate the need for a cooling fan and help make the scopes smaller, lighter and cleaner.

In addition, the power supply works all over the world (90-250 Vac, 48-62 Hz) without needing a line switch or a bulky line transformer. This special power supply also regulates fluctuations in line voltage, to assure calibrated measurements.

These are just some of the innovations built into the 2213 and 2215 to reduce costs and improve performance.

Performance that's written all over the front panels.

The bandwidth for digital and high-speed analog circuits. The sensitivity for low signal measurements. The sweep speeds for fast logic families. And delayed sweep for fast, accurate timing measurements.

The advanced trigger system features a vertical mode for true alternate triggering on both channels. It even has a convenient signal-seeking auto mode. And it also triggers on either TV lines or fields at any sweep speed for video service.

These scopes have it all. They're lightweight for field work. They've got a bright, easy to view display. Automatic CRT focus and intensity. Beam finder. And the operating simplicity to fit a wide range of operator skills.

These are the advances in performance, cost savings and convenience that break tradition. But other traditions remain. Like fast, reliable service support. Nearly 1300 people around the world to service Tektronix products exclusively. Plus the customer documentation, training programs and applications assistance that help to make Tek service the most comprehensive in the industry. And make your 2200 scope an even greater value.

For literature on the 2213 and 2215, contact the Tek office nearest you. Or call us toll-free. 1-800-547-6711.
In Oregon, 1-800-452-6773.

For further information, contact:

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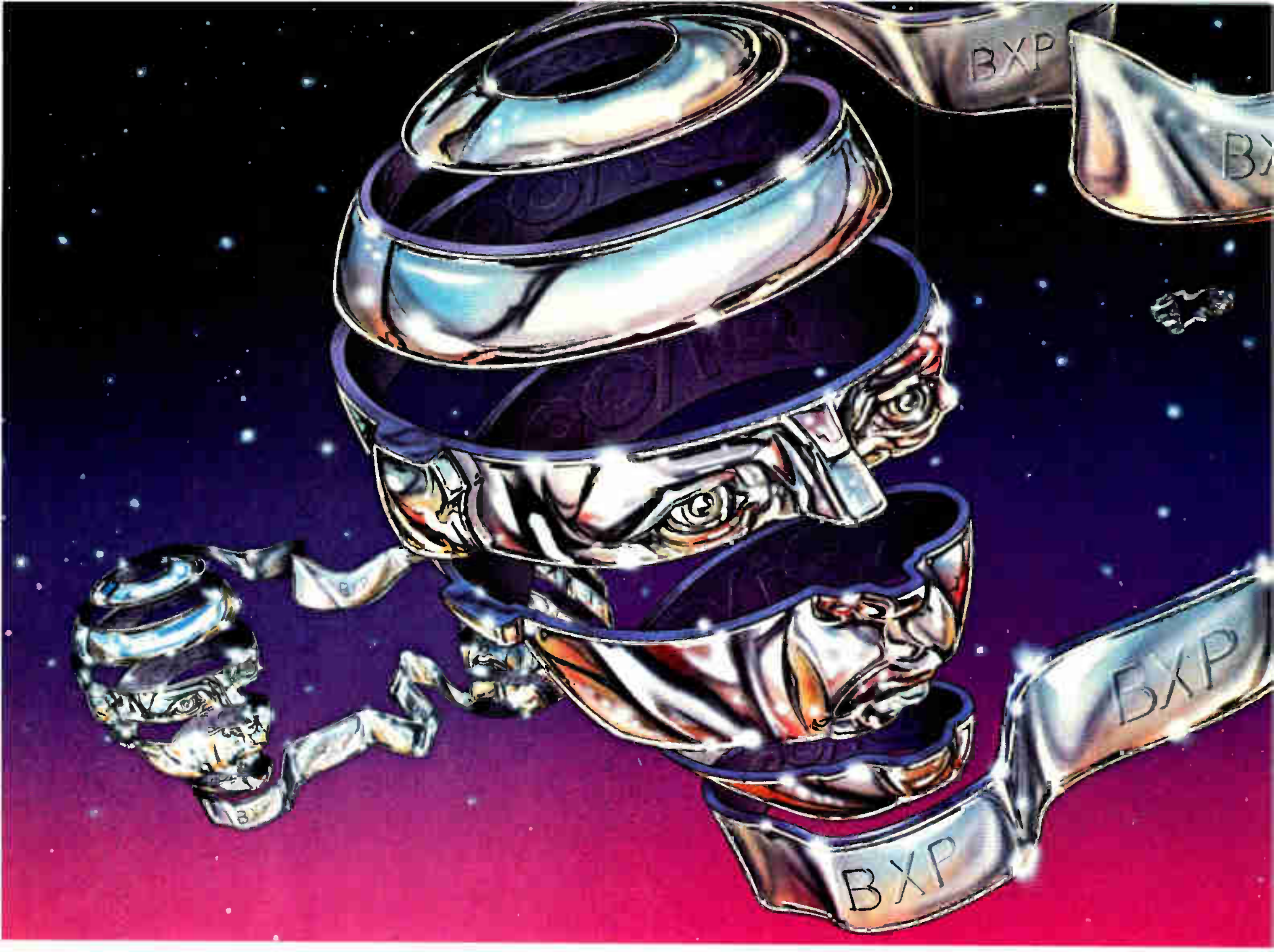

Intel's Series 90/iQX. The memory

Intel's new Series 90/iQX is the first standard Intelligent Memory System to offer continuous operation and high maintainability at low cost.

Now, for the first time, OEMs can design systems with built-in protection against errors, downtime, and excessive maintenance costs. How? With Intel's new Series 90/iQX.

Series 90/iQX Intelligent Memory System

The iQX controller adds the intelligence of an iAPX 86 microcomputer to the standard Series 90 Memory System. Intelligence that monitors memory operation directly, detects and corrects errors, runs local or remote diagnostics, and reallocates memory space as required. All without burdening the host system.

Fault-tolerant operation

Hard errors or soft, Series 90's iQX controller uncovers them. Soft errors are simply "scrubbed" and corrected. In case of hard errors or device failure, the controller routes data around the problem, allocating spare memory as needed. It then logs the error for future reference.

With protection like this, the Series 90 system will continue operating uninterrupted until all spare memory is filled. And thanks to the iQX's memory status reporting, your customer will know well in advance of memory resource problems. Which not only improves data integrity, but increases reliability and reduces maintenance dramatically.

Instant diagnostics

To keep users continually apprised of conditions within their memory system, the iQX controller provides easy access to its complete diagnostic file. Information can be accessed by the host system either automatically via a simple message-driven software interface, or manually, using the iQX's Service Communicator. This detachable terminal allows technicians to instantly retrieve diagnostic data in plain English through a compact, alphanumeric keyboard/display. With no interruption of the host computer's operation.

For fast, simple maintenance, system diagnostics inform the user of any

machine with non-stop intelligence.

errors it has tracked—soft or hard, correctable or avoidable—and their precise location by row and column.

Many problems can also be solved using the iQX's memory tasking capability to move data blocks as required. Then too, the iQX monitors the system's power supply and signals a warning if voltages drop critically. As a final, double protection, the iQX controller even diagnoses its own operation continuously.

Diagnosing from a distance

To reduce maintenance costs for remote systems and networks, iQX diagnostics can be accessed over phone lines through a single diagnostic station. By being able to analyze problems from afar, you'll eliminate unnecessary service visits and shorten those that are required. And since one diagnostic station can easily serve up to 150 installations, the set-up and ongoing diagnostic costs are contained as well.

Consider the economics

The iQX's protection features offer important economic advantages for systems OEMs. Because of the increased demand for fault tolerance in today's marketplace, systems equipped with iQX capability add significant value to your products. In fact, many applications simply could not be justified economically *without* such self-healing and remote maintenance. Now, through Intel's leadership in 16-bit microprocessing, the Series 90/iQX brings you this capability at an incremental price only nominally above that of ECC alone.

In sum, iQX gives your systems state-of-the art fault protection, reduced maintenance costs, and therefore increased value. Best of all, Intel is delivering Series 90 systems with iQX right now. For detailed information, return the coupon to Intel Corporation, 3065 Bowers Avenue, Santa Clara, CA 95051. Telephone (408) 987-8080. For hot line service, call (800) 538-1876.

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With its 50 MHz clock rate, 48-channel recording and 16 triggering levels, the K101-D isolates software bugs faster and more precisely than ever before. Sophisticated disassembly firmware generates precise mnemonics that cut analyzing time. And 12 external clocks (AND or OR) let you demultiplex 16-bit microprocessors, 16- and 32-bit minicomputers and bit-slice processors.

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For powerful software debugging, K101-D data domain capabilities include disassembly, 50 MHz clocking, 48-channel recording, 12 external clocks, 515-word memory, demultiplexing, 16-level trace control for triggering, 6 display code formats, and reference memory.

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Expansion of selected area in above photo, for detailed analysis.

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Circle 32 on reader service card

Motorola, Intel package processors for industrial use

Two of the world's biggest makers of microprocessors, Motorola Inc. and Intel Corp., are making inroads into the market for industrial process control and other embedded-computer applications long the exclusive domain of the minicomputer houses. Intel will soon announce a Multibus-compatible line of boxed systems. They will be 8086-based, though 8-bit configurations will also be available. The new line, from Intel's Hillsboro, Ore., operation, **will use the standard family of Multibus board-level products.** Like Motorola's line, it will support both floppy and hard disks, but can add processors, including a numeric coprocessor, to multiply performance in the field by a factor of five. Motorola's vehicle is the line of 68000 Versamodules that have been available for a while. But now the Phoenix, Ariz., operation is enriching that line by offering more versatility, as well as complete packaged systems. First off the line is a single-board computer with up to 512-Kbytes of random-access memory.

Data General unveils 32-bit MV6000 at Paris show

Look for Data General Corp. of Westboro, Mass., to unveil its new medium-sized 32-bit computer system, the MV6000, at the Paris information-processing equipment show, Sicob, beginning Sept. 23. **The new system is said to be two times faster than the Digital Equipment Corp. VAX-11/750, with which it will compete.** The system also will sell against IBM's 4331-2 and Prime Computer's 550-11. The MV6000 will cost $100,000 to $250,000 and service as many as 64 concurrent users.

In-circuit emulator sports $1,495 tag

An in-circuit emulation system for 8-bit microprocessors that offers the same performance as rival systems at a lower price is being shown by MicroTek Lab Inc. of Gardena, Calif. The $1,495 MICE (for microcircuits emulator) **acts as a slave with software drivers written for uploading and downloading** through an Apple II personal computer and an Intel development system. It has control over direct memory access and can disable it in software.

IBM bipolar part attains 0.4-pJ speed-power figure

Engineers at IBM Corp.'s General Technology division in East Fishkill, N. Y., are providing a reminder that bipolar technology is still a factor in high-performance, very large-scale integrated circuitry. Using saturated transistors instead of bulky capacitors for ac coupling, an experimental NOR logic circuit has yielded a speed-power product of just 0.4 pJ—**the lowest of any bipolar gate in the industry, says IBM.** In a memory circuit, the new technique is expected to transform, for example, a 20-ns, 2-to-3-W chip into a 12-ns, 1.5-W unit while doubling density.

Low-cost scopes coming from Philips

Opening Round 2 in the fight for the title of champion low-end oscilloscope maker, Philips Test & Measuring Instruments Inc. has introduced two low-cost 5-MHz units, the model 3215 (with a single time base) and 3217 (with a dual time base and delayed sweep). Intended to compete with Tektronix' 2200 series, the scopes will sell for $1,175 and $1,495, respectively. Unlike Tektronix' scopes, which are a totally new design, the Philips models are extensions of the Mahwah, N. J., company's existing 32XX series, **employing faster transistor arrays in the front end to gain speed.** Along with the two units, the company also introduced a $4,195 50-MHz scope, the 3219, which features a burn-resistant storage tube.

Electronics newsletter

5-V–only EE-PROM due from Xicor

Xicor Inc., the Sunnyvale, Calif., chip maker that got attention when it introduced a 5-V–only nonvolatile random-access memory, is using the same triple-polysilicon process to build a 2-K-by-8-bit electrically erasable read-only memory for introduction next year. **Intended as a direct replacement for Intel's 2816 16-K EE-PROM,** the memory will need only 5 V for any operation but will accept the higher programming and erasure voltages specified for the Intel part.

DEC combines word, data processing

Digital Equipment Corp. is moving into direct competition with IBM and Wang Laboratories for the word- and data-processing portions of the electronic-office market. The Maynard, Mass., firm's new offerings are two related systems with mid-range pricing: **DECword and DECword/DP take advantage of DEC's PDP-11 minicomputers,** both as system cores and as a potentially huge aftermarket for word- and data-processing retrofit. DECword will be offered as a $50,000 expandable system based on the PDP-11/34 and dedicated to word processing. The DP version, available on PDP-11/24s, /44s, and /70s, will combine word and data processing—a pairing that has proven difficult for most vendors to achieve.

AT&T joins IBM in X.25 camp

Support for the X.25 packet-switching protocol continues to grow in the U. S. Just a few months ago, the last of the two major holdouts, IBM, announced it would support X.25. Now, the other, AT&T, has released a "technical reference" **describing the network X.25 interface that the Bell System plans to support** if, as the company puts it, business and regulatory decisions permit. Bell's acceptance along with IBM's means that packet switching by means of X.25's rules will be the *de facto* standard.

TI pushes up debut of 99000

After succeeding with the first batch of chips for the TMS99000, Texas Instruments Inc. has moved up the introduction data of its upgrade for its 9900 family of 16-bit microprocessors from the first quarter of next year to before the end of this year. TI reports that the first material to run through wafer fabrication in Houston **produced a large number of parts that were fully functional** in the sense of meeting all chip specifications, performance and power goals, and power-supply requirements.

Addenda

Joining the scramble to produce voice- and data-handling private branch exchanges, the Lexar division of United Technologies Corp. in West Los Angeles has introduced **an all-digital system designed for the 200-to-1,000-line market.** An analog voice is converted into a digital bit stream in each user phone by a custom codec. . . . A nucleus of employees from Rockwell International Corp.'s canceled commercial bubble memory programs [*Electronics*, Feb. 24, p. 35], along with some from the recently closed bubble operations at National Semiconductor and Texas Instruments, are forming their own company. **The group is currently looking for venture capital** to help buy Rockwell's bubble equipment. . . . This may be an off year for the electronics industries, but don't tell that to the people who run Wescon. The annual California electronics show, which closed its three-day San Francisco run on Sept. 17, **counted more than 60,000 registrations for the first time in its history.** The previous records were 53,103 at Anaheim last year and 43,960 at San Francisco in 1979.

Memorabilia.

Yesterday, designers used UV PROM and RAM microcircuits for applications where non-volatility was critical. Today belongs to General Instrument's versatile EAROM.

With EAROM you can design a memory system that will store data for at least ten years even if the power goes off. And unlike RAMs, you don't need battery backup to retain memory.

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GENERAL INSTRUMENT

COULD THE INDIVIDUAL HOLD THE KEY TO AN ENTIRE COMPANY'S PRODUCTIVITY?

Many factors contribute to productivity: producible designs, superior tools, clever processes, minimal regulations.

But, heading the list is people. Most of us are aware of the impressive productivity improvements Japanese companies have realized with their people by using teams of cooperating workers called Quality Circles.

Wisely, hundreds of American companies now are duplicating these efforts in their factories.

At Motorola, over a decade ago, we initiated a plan of our own. Today we call it the Participative Management Program (PMP), and it reaches beyond the factory floor. We believe it has helped us achieve the same, and often better, quality and productivity results for which Japanese companies get credit.

PMP is an effective way to get the individual worker more involved, responsible, informed, and therefore, more productive.

Any individual worker can suggest things about any job he or she does that a supervisor may not know as well. As management listens and acts, quality and output rise.

In PMP, teams of employees meet frequently, sometimes daily, among themselves and with support groups to tackle the basics. Everyone is encouraged to define problems and suggest solutions. The management listens, contributes, acts. Each team operates to high, published standards which it participates in setting. The teams measure their improving performance to these standards daily, weekly, monthly. And everyone benefits.

Employees who want to can communicate additionally by submitting written recommendations. These are posted on prominent bulletin boards and must be answered in 72 hours. Not just with words, but with changes in tools, procedures or policies when humanly possible.

The results have been dramatic. Quality, output, and customer service are way up. Costs are down. Our jobs are more satisfying.

One-third of our 45,000 U.S. employees are operating under PMP today. Building on our years of experience, the balance of our U.S. operations will be fully managed through employee participation in 1983.

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PHOTONICS

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SOURCES		Laser Diode	NDL3108	850nm (multimode)	8.0mW	—	0.5ns	±20° ±5°	1.5	—	SELFOC* LENS PIGTAIL** monitoring detector
		Laser Diode	NDL3205	850nm (single mode)	5.0mW	—	0.5ns	±20° ±5°	1.0 (max.)	—	SELFOC* LENS PIGTAIL**
		Light Emitting Diode	NDL4103A	850nm	2.0mW	—	10ns	—	40nm	—	PIGTAIL**
DETECTORS		Avalanche Photodiode	NDL1102	—	—	500-1000nm	<1.0ns	—	—	0.4A/W	—
		Avalanche Photodiode	NDL1202	—	—	500-1000nm	<1.0ns	—	—	0.4A/W	PIGTAIL**
		PIN Photodiode	NDL2102	—	—	600-1100nm	1.0ns	—	—	0.4A/W	—
		PIN Photodiode	NDL2104	—	—	600-1100nm	4.0ns	—	—	0.4A/W	—
		PIN Photodiode	NDL2208	—	—	600-1100nm	10.0ns	—	—	0.4A/W	PIGTAIL**

* All devices can be operated in pulse modes.

** Pigtail fibers are graded index silica with a core diameter of 50μm, cladded diameter of 0.9mm and numerical apertures of 0.21. Other types of fiber available upon request.

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Circle 38 on reader service card

Scaled-down DIPs catch on for hybrid needs

by Jerry Lyman, Packaging & Production Editor

Called SOICs, the packages are winning the support of U. S. chip houses, especially for telecommunications uses

Great in significance but small in size, a new integrated-circuit package called the SOIC looms on the hybrid-circuit horizon.

The SOIC, for small-outline IC, resembles the ubiquitous dual in-line package in everything except its smallness. After its introduction some years ago in Europe and Japan, the SOIC now seems as if it might be a hit in the U. S., particularly in the telecommunications field with its thick-film hybrids using dense component layouts.

Motorola Inc. and Signetics Corp. began producing devices in the SOIC package, which has relatively few leads, in the fall of 1980; they soon may be joined by Texas Instruments, and National Semiconductor also is evaluating their use. In 1982, for example, Motorola will be able to ship as many as 15 million such devices, says Tom Newenhouse, manager of linear product marketing for the Bipolar Integrated Circuit division in Mesa, Ariz. He sees some 40% of these parts replacing conventional DIPs.

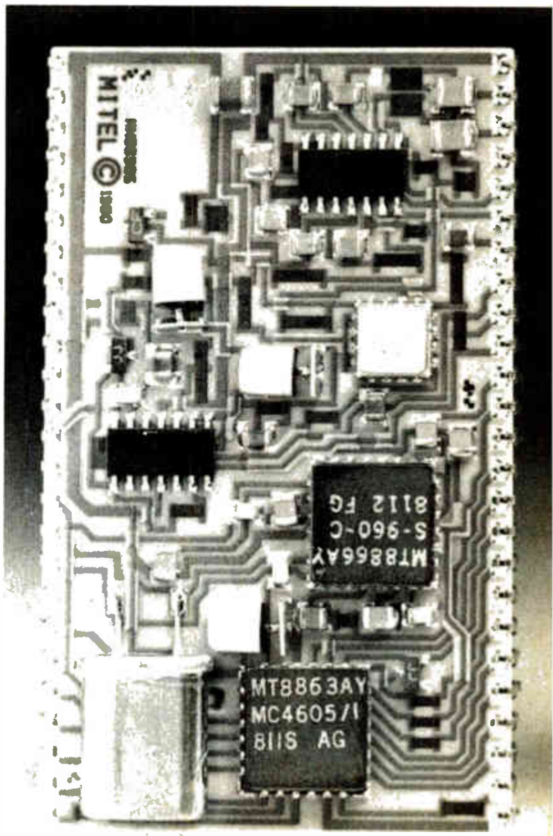
Signetics at present has 30 linear circuits in SOIC packages, as well as C-MOS logic and series 74 TTL, says a spokesman. By the middle of 1982 it will have more than 20 series 74 part numbers, he adds. It is also considering devices that have as many as 20 leads.

The package was originally developed by Philips of the Netherlands in 1976. (Signetics is a North American Philips subsidiary.) At present, SGS-Ates of Italy, Sescosem of France, and Siemens of West Germany also supply products in standard SOIC packaging with leads on 50-mil centers, as do Nippon Electric, Toshiba, and Hitachi in Japan.

Not alone. Actually, no one supplies the SOIC package by itself. Rather, chips are first attached to a miniature lead frame and epoxy is molded around the chip, just as with a conventional DIP.

The SOIC has many advantages over other ways of dealing with chips for hybrid work. With its leads, it can be more easily handled than bare chips for automated assembly and test. It can also be reflow– or vapor-phase–soldered, an advantage over more cumbersome wire bonding. Also, there are none of the worries associated with leadless ceramic chip-carriers regarding attachment to printed-circuit boards. And SOIC packages can be surface-mounted to the boards to eliminate the plated through-holes that raise cost and lower board yield.

Motorola and Signetics are currently supplying devices with 8, 14, and 16 leads. A typical 16-lead package, for example, measures 390 mils long and 155 mils wide and takes up less than one third the area on a pc board of a DIP, while occupying one eighth the volume.



SOIC. Dual-tone multiple-frequency receiver from Mitel has two 14-lead SOIC packages (black), each measuring 340 mils long by 155 mils wide. The 1.5-by-2.5-inch thick-film hybrid also contains two 24-pin leadless ceramic chip-carriers (large gray devices).

The devices as yet are more expensive, however, than DIPs. For instance, in lots of 100 or more, a standard 741 operational amplifier from Motorola costs about 50¢ in the SOIC package but 37¢ in a standard plastic DIP.

Possibilities. At the present time, most SOIC products in the U. S. are linear. However, only die size and power dissipation limit what can be encapsulated. Motorola, for one, is currently considering units with higher lead counts. It is also investigating placing a three-terminal voltage regulator with a 1-watt power dissipation in a package (the SO-89) only slightly larger than an eight-lead SOIC.

At least two thick-film hybrid-circuit makers, Mitel Semiconductor in Ottawa, Ont., Canada, and Centralab Inc., Milwaukee, Wis., also a North American Philips company, have introduced SOIC devices into their telecommunications products. Many other firms have ordered samples and are considering using the mini-packages for both hybrid and conventional pc boards, according to Motorola's Newenhouse.

Mitel's dual-tone multiple-frequency receiver, shown on page 39, is unusual for mix of surface-mounted, reflow-soldered IC packages. LSI digital chips are in leadless ceramic chip-carriers on the thick-film module, while linear bipolar circuits are in SO-14 SOIC packages.

Packaging

TI shows ways to use plastic chip-carriers

In an effort to promote greater use of its new plastic leaded chip-carrier packages, Texas Instruments Inc. has begun demonstrating two methods of direct board attachment to a number of potential package customers and to manufacturers of integrated-circuit equipment.

The move comes several months after TI began offering samples of low-power Schottky products in 20- and 28-pin plastic carriers [*Electronics*, June 30, 1981, p. 39]. The Dallas firm will also supply samples of other products in 44-, 68- and 84-pin packages by year's end.

TI believes the plastic packages will be used predominantly in flush-mounted applications, where they are mounted on top of, or flush with, printed-circuit boards. Flush-mounted systems offer 40%-to-75% area reduction compared to dual in-line packages inserted in plated through-holes.

Plastic leaded chip-carriers, like the current ceramic leadless chip-carriers, offer a condensed IC package compared to conventional DIPs. Unlike the more expensive ceramic chip-carriers, TI says, the plastic versions do not require the tricky task of matching them carefully to boards with the same thermal-expansion characteristics.

Stirring interest. With the flush-mounting demonstrations, TI is hoping to stir up interest in the development of automated insertion equipment, explains John W. Orcutt of the company's central packaging operation in Dallas. "We are merely showing the technology to customers and equipment firms, and we are showing how the process works," Orcutt says. It is up to the visitors to come up with implementation of the technology, on which TI has been working for the past six months.

In one approach, a plastic carrier is wedged into a steel collet, which heats it. The collet is then aligned over the pc board, which has fused solder bumps in the footprint of the carrier's leads. The collet, heated to 250° C, is lowered on to the board and reflows the solder bumps.

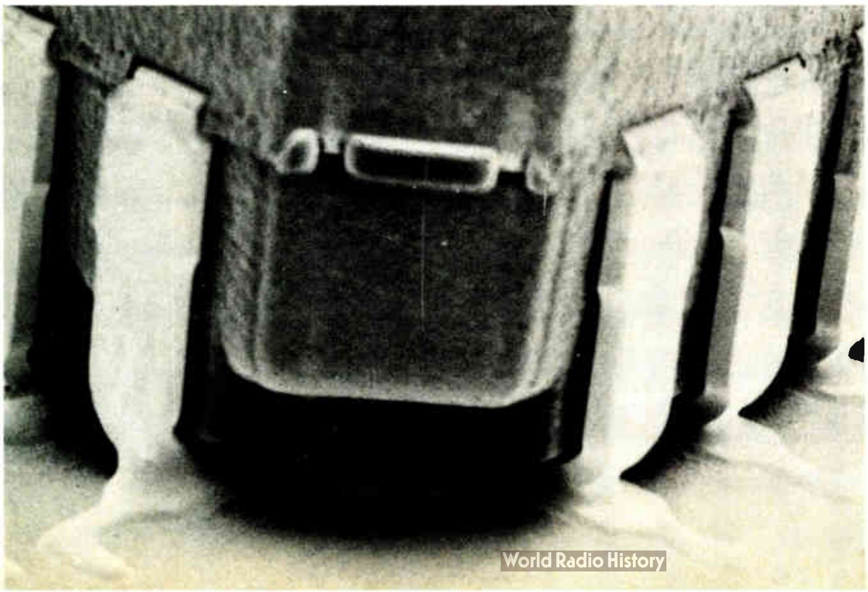
A pneumatic plunger inside the collet presses the chip-carrier down onto the solder. With the plunger still holding the carrier in place, the collet rises and allows both the chip carrier and the board to cool. Once the solder has hardened (usually after 1 second), the plunger withdraws into the collet.

This individual-carrier reflow technique would most likely be used by customers who are wave-soldering most of their components, Orcutt explains. Some visiting firms have suggested the creation of an automatic system using a number of heated collets working at the same time on the same board.

Another way. Also, TI is suggesting a vapor-phase reflow technique for customers using a large number of surface-mounted components. This method requires the use of a pc board with solder paste stenciled or screened on. The units are put on the paste. After being placed in an oven and the paste cured, the boards are taken to a vapor-phase station where the solder is reflowed.

Although evaluation tests are still being conducted, the company indicates promising results on 20-pin packages. To evaluate the techniques on many-pin packages, the packaging operation has begun testing 68-pin carriers. **-J. Robert Lineback**

Good joints. Enlarged photo shows the high quality of the solder joints obtained by Texas Instruments when it affixed a plastic chip-carrier to a printed-circuit board. It used a specially designed collet that places the carrier on the board and then heats it to melt the solder.



Small-business systems

'Old' local net wins big new backer

John Roach has a simple explanation for choosing a local networking scheme from Datapoint Corp. for his small-business computers. "It's the lowest-cost high-speed network implementation we could find," says the president and chief executive officer of Tandy Corp., the Fort Worth, Texas, parent of Radio

Custom chip handles local net interface

The first large-scale integrated circuit for connecting data-processing equipment to a local network turns out to be an n-channel-MOS device in a 40-pin dual in-line package. Datapoint Corp.'s director of development technology, George Beason of the company's Computer Systems Group, San Antonio, headed the team that designed it, and the chip's masks were made by Silicon Systems International of Irvine, Calif.

It is not a general-purpose interface but is designed only to connect Datapoint's proprietary Attached Resources Computer local network, Arcnet, to the low-cost ($7,500) model 8600 work station also introduced by Datapoint. The chip is incorporated into the processor box and replaces the relatively large resource interface module (RIM) used by earlier processors.

The chip carries data at 2.5 megabits per second by means of a proprietary protocol developed almost five years ago, before protocol standards were even proposed by the IEEE local networks committee. The protocol is based on the concept of self-polling so that no master station is needed in the local network.

According to executive vice president for research and development Victor Poor, in the self-polling mode the chip handles the equivalent of the physical- and data-link functions of a layered communications architecture. As such, its equivalent of 7,000 transistors, which consumes 1.5 watts from a 5-volt supply, handles packet framing, including packet boundary delineation and address recognition, error detection, transmission retry, and preamble generation and removal, among other chores. System functions include interfacing with the 8600's bus, handling data moving to and from the 8600's buffers, and interfacing with its transmit and receive chips.

Each RIM chip has a unique identification number or address that is software-loaded by the system operator. Thus, packets may be sent either to one specific RIM and its associated processor or to all the processors in the local network via a broadcast operating mode. **-Harvey J. Hindin**

Shack. Moreover, "most of the alternatives were relatively untried."

Thus, in an announcement made jointly earlier this month with Datapoint of San Antonio, Texas, Radio Shack, the giant electronics retailer and leader in the low end of the small-business-computer field, became the first manufacturer of such machines to offer a networking scheme. The scheme chosen is Arcnet, the local network that goes with the Attached Resource Computer system offered by Datapoint, a supplier of distributed data-processing and office-automation equipment.

Arcnet will be used to link TRS-80 model II microcomputer systems, which retail for between $4,000 and $10,000. The units will be able to share disk-file processors and printers and even connect to Datapoint computers and peripherals.

One at a time. Radio Shack is aiming at the small business that installs one computer and then, as it grows, needs to add one or two more at a time and would like to be able to interconnect them, says Roach. He finds Arcnet easy to install for this purpose. For a computer user with limited experience, the fact that both computer and network will be offered by the same vendor is important, he adds.

By providing Arcnet, Tandy hopes to stay ahead of its competitors at the low end of the small-business computer market, such as Apple Computer and Commodore. The products from these companies, along with such recent entries as the Xerox 820 small-business computer and the IBM Personal Computer, do not yet have local network interface cards supplied by the vendor.

Arcnet, a baseband local network that runs at 2.5 megabits per second, has been offered by Datapoint for the past four years and boasts over 2,000 commercial installations. Radio Shack will be using the protocol and software developed by Datapoint and a new interface card developed for the model II. This card, to be available in the second quarter of 1982, will be built by Texas Peripherals, a Tandy and Datapoint joint venture in Midland, Texas, that has been building 5¼- and 8-inch floppy-disk drives since last year.

The interface card will retail for about $400 and will slip into an existing slot of any model II. It gets its efficiency and low cost from a specially developed interface chip (see "Custom chip handles local net interface").

Tandy looked at several local networking possibilities before selecting Arcnet. Its investigators found that the cost of attaching a single microcomputer to a network using, for example, the DEC-Xerox-Intel Ethernet protocol would be three to five times as much as the Arcnet interface card.

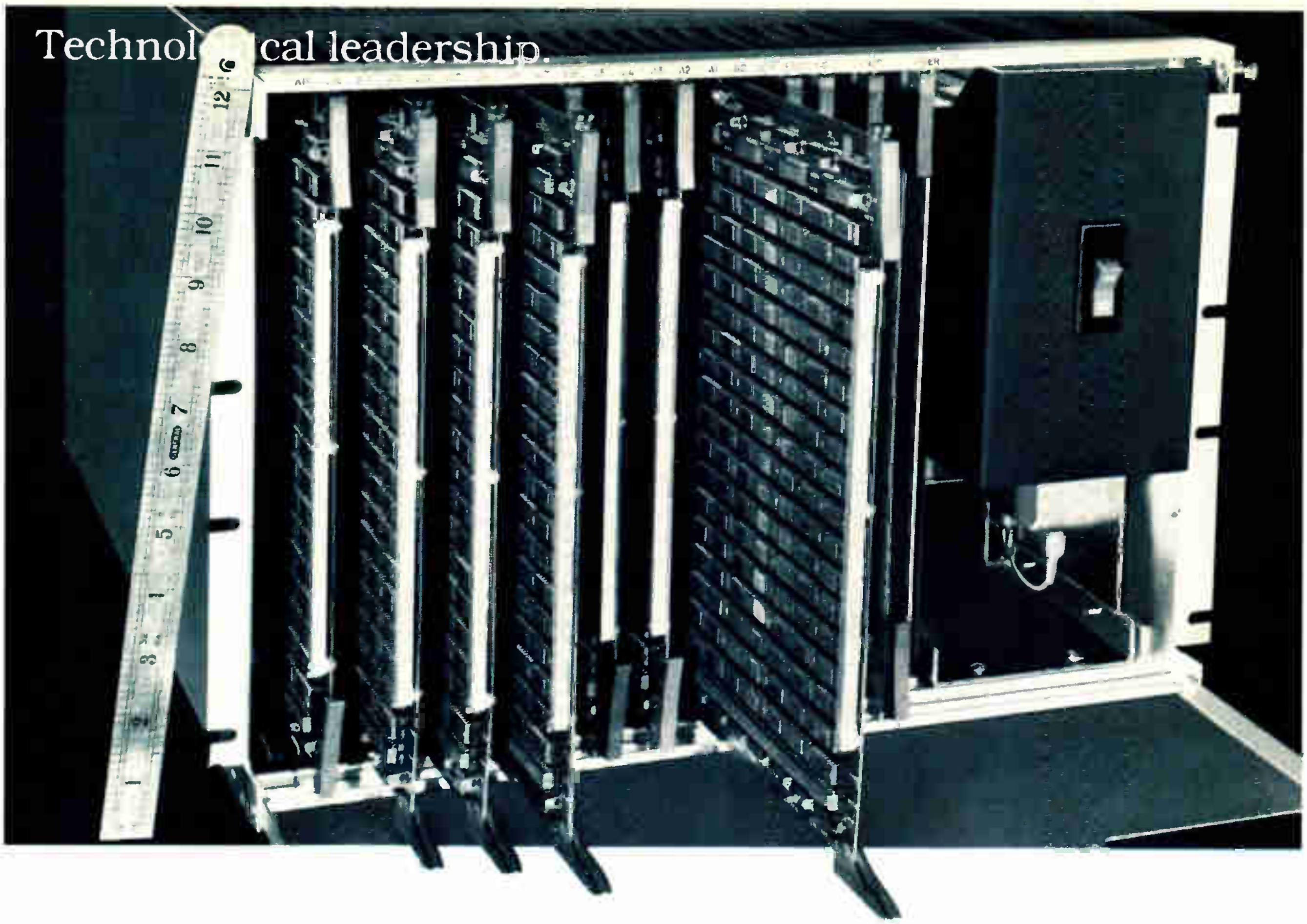
Others. Several independent local-network vendors also offer interface products [*Electronics*, Aug. 25, 1981, p. 119]. These include the Cluster/One Model A from Nestar Systems, Inc. and Corvus Systems Inc.'s Omninet, both available for Apple II computers. Nestar's network interface card is only $395, but it is for a 240-kilobit/s communications system. Corvus's Omninet Transporter for its 1-Mb/s net costs $500.

Few commercial installations have been made of these relatively new networks. Ethernet, though, has been extensively used within the Xerox organization, and a few other special installations have been in operation for a number of years. The Xerox 820 can be connected to Ethernet, but only through a so-called Communications Server—a $14,000 interface box from Xerox that accepts many computers and terminals. **-Tom Manuel**

Industrial

Chip readied for factory networks

The ability to tie the elements of industrial control systems into a local communications network may receive a big boost next spring if Western Digital Corp., the Irvine,



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MOTOROLA INC.

Calif., chip maker, has its way. The company is readying a new controller chip that could do for industrial systems what Ethernet-like interfaces do for the office.

At a projected unit price of $150, and even less in quantity, the model 2840 could have a considerable impact. At present, access to existing networks, such as Allen-Bradley Co.'s Data Highway and the Modway system offered by the Modicon division of Gould Inc. [*Electronics*, Aug. 11, p. 88], requires board-sized interfaces. With the new chip, these boards could sell for between $500 and $600, well below today's prices, asserts Franz Zihlmann, director of marketing for Western's Telecommunications division.

Indeed, the chip has already caught the eye of at least one network manufacturer. "It's a very smart idea, if they can do it," says Odo J. Struger, director of engineering at Allen-Bradley's Programmable Controller Systems division in Cleveland. "It should create a lot of activity among network designers."

The 2840 uses a token protocol, which passes messages from node to node much as a baton is passed between relay runners, instead of the carrier-sense multiple-access (CSMA) scheme used by Ethernet. Token passing works much better in the industrial environment, since the collisions of messages inherent in CSMA cause delays that cannot be tolerated with process-control equipment and processing machinery, says Mark Stieglitz, Western Digital's local network program manager.

The 2840 has a data rate of 1 megabit per second and can support up to 254 nodes. These nodes can be up to a mile from the controller before time delays become unwieldy, Stieglitz says.

The chip itself is divided into three microcontrollers, one each for serial transmission and reception and the third for handling algorithms, formatting, protocol and other chores. The use of a separate microcontroller to handle general tasks increases the data rate by permitting parallel processing. Transmission and reception are split to provide better diagnostics by allowing loopback testing, Stieglitz explains.

Although the chip also controls network initialization, addressing, coordination, and other chores, it does need external processing assistance. The 2840 pulls information from memory in a predefined structure, which must be determined by an external processor; but it is possible to integrate the chip into an industrial controller having excess power without adding a separate microprocessor, Stieglitz says.

Next May. Production of the 2840, scheduled for late next May, will come some six months after a packet-switching chip, the 2501, first announced by Western Digital two years ago [*Electronics*, Aug. 30, 1979, p. 40], reaches production. Samples of this chip were originally set to be available in late 1979, but prototypes were not ready until April of this year.

Apparently there were problems, but Zihlmann maintains that they are all in the past and the 2840's timetable—with first silicon in February—is realistic.

The new control chip uses an architecture similar to the 2501 and retains some of its cells and circuitry, but new logic has been added and the firmware for the chip was completely rewritten. "We know we can build [the 2840] since we built the 2501," Zihlmann says. "We bit the bullet on that." **-Terry Costlow**

Price of 32-bit minis hits new low

This time around, Perkin-Elmer Corp. made it not bigger and faster but smaller and less expensive than any other 32-bit minicomputer on the market. At $49,900 for a minimum configuration with 512-K bytes of memory and 27 megabytes of cartridge-disk storage, the model 3210 is an entry-level system in the firm's 3200 family. Yet it has better than half the performance of the company's top-of-the-line 3240 system. Perkin-Elmer introduced its first commercial 32-bit computer in 1974.

Additional main memory using 64-K chips is available at $15,900 for 1 megabyte, or $25,900 for 2 megabytes. The 3210 can have up to 4 megabytes of directly addressable memory on its 8-megabit/second direct-memory-access bus. It is compatible with all Perkin-Elmer software, including the Reliance transaction processing system and its recently introduced version of Unix, the Bell Laboratories timesharing system [*Electronics*, Sept. 8, 1981, p. 34].

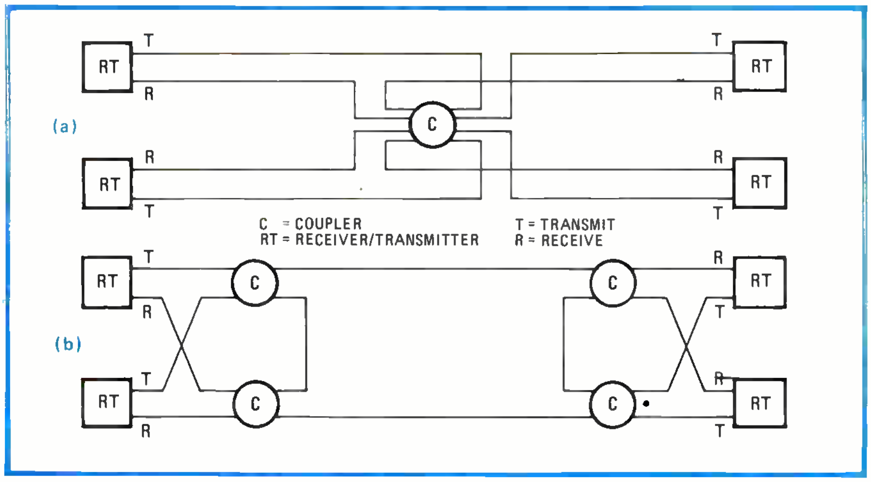
The price-performance ratio of this aggressively priced machine from the company's Oceanport, N. J., Computer Operations Group puts it in a very competitive position among 32-bit minicomputer vendors. For example, the smallest VAX-11/750 system (512-K bytes of memory and two cartridge disk drives) from Digital Equipment Corp., Maynard, Mass., costs about $90,000, and a model 250-II in a comparable configuration from Prime Computer Inc., Newton, Mass., sells for about $66,000. A 3210 in a similar configuration, which has a total throughput performance greater than the Prime 250 and almost equal to the DEC VAX 750, is priced at $58,700.

With this low price being the starting point for 32-bit systems, Perkin-Elmer expects to compete with the biggest 16-bit minicomputers as well. The larger 16-bit configurations from various competitors can easily cost from $80,000 to over $100,000, whereas prices for similarly configured systems using the 32-bit, higher-performance 3210 will range from $55,000 to $80,000. **-T. M.**

Fiber optics

Couplers simplify data bus design

For senior engineer Steven L. Storozum and his supervisor, staff engineer Roger W. Uhlhorn of McDonnell Aircraft Co., a Disco bus is not transportation to a dance palace but the fiber-optic data bus they invented for aircraft applications. Their Distributed-Star Coupler topology is significant because it does not suffer from the power distribution problems of conventional de-



Disco. Four-terminal optical data bus being studied by McDonnell Aircraft replaces single-central-star topology (a) with a distributed arrangement that relies on four couplers (b).

signs that are based on single-central-star or directional couplers.

When a single-central star fails, as shown in (a) of the figure, the whole bus distribution system is knocked out. In operation, there also may be intolerable port-to-port variations in the optical power reaching each receiver when the number of arms of the star is large. With a bus based on a directional coupler, port-to-port variations will be excessive in a multidrop network and a single cable break can cause the whole system to go down.

Passive. The topology the St. Louis, Mo., designers came up with, unlike other designs, is completely passive. It needs no expensive amplifiers to restore signal levels since, in theory, the distribution of the optical power can be made equal from each transmitter to each receiver. This is true because Storozum and Uhlhorn use a star-coupler configuration with relatively few ports. Such ports suffer less from differences in internal transmission lengths and internal signal losses.

The McDonnell designers—in the electronic engineering technology department—replaced the single-central-star coupler with the simpler couplers as shown in (b). The failure of one or even two couplers does not take the system down. In addition, the arrangement uses much less cable than the conventional approach. However, it does require more connectors, which will cause some additional signal losses, admits Storozum.

According to Uhlhorn, the topology can be expanded with few problems. For example, a design serving nine remote terminals needs six couplers. Power loss and signal variation could be minimized if the couplers are built in integrated pairs. The practical limits to expansion of these designs are set by the optical power budget of the system; with too many terminals, a receiver will just not receive enough power.

Tests. Storozum and Uhlhorn tested their concept with small-scale models that were configured as illustrated. They used only commercially available couplers, connectors, fibers, light generators, and detectors.

Storozum concedes that the path losses from each transmitter to each receiver were not equal, a condition they had hoped to be able to achieve. The variation was small enough to have proved the concept, he asserts. He declines to give the actual numbers for power loss. This depends on the components used in the test, he points out, and the test was meant only to prove the concept, not develop an actual design.

The company is so satisfied with the possibilities of the passive data bus, one which cannot fail catastrophically, that Storozum and Uhlhorn are moving on to implement a full-scale bus. Still to be determined by the McDonnell engineers are the practical expansion limits in terms of

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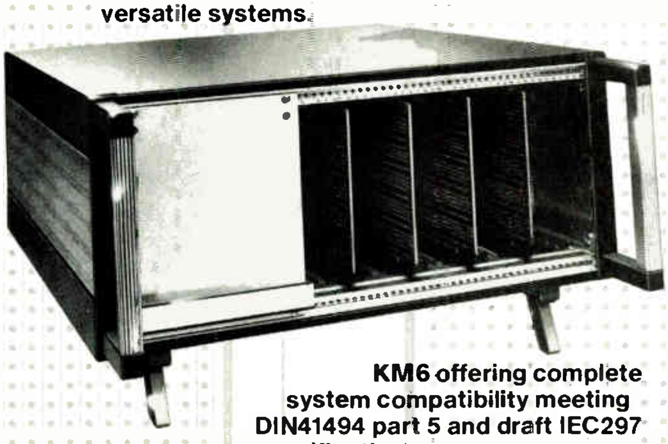

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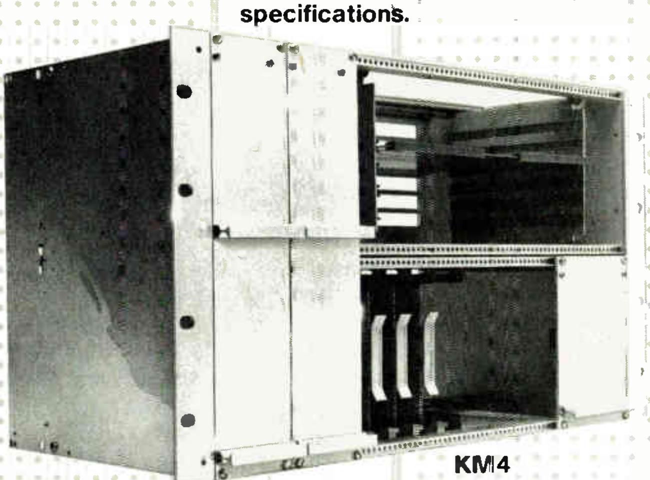

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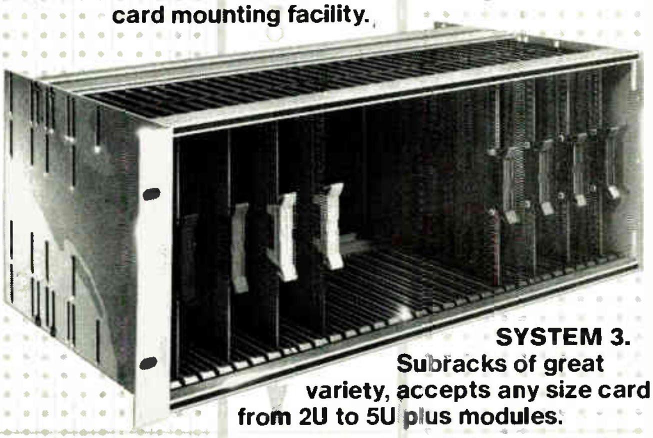

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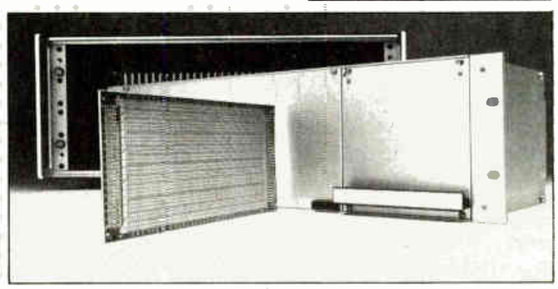

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the number of receivers and transmitters, the data protocols needed, and how the survivability of the bus may best be applied in an aircraft system. -**Harvey J. Hindin**

Instruments

New gear digitizes 100-MHz waveforms

Although the concept of a programmable digitizing 100-megahertz oscilloscope has been announced before, the real battle in the marketplace is just beginning with the nearly simultaneous announcement of the HP 19860, a digitizing version of Hewlett-Packard Co.'s HP 1980 oscilloscope, and Data Precision Corp.'s Data 6000 [*Electronics*, Sept. 8, p. 205]. Both systems allow the user to configure an oscilloscope-like instrument that can digitize repetitive waveforms using analog-to-digital circuitry having 3-decibel bandwidths of 100 MHz.

Digitizing waveforms received by an oscilloscope is not a new idea, nor is that of making the scope programmable. Such instrumentation dates back to the early 1960s with sampling oscilloscopes having 1-gigahertz bandwidths.

Overkill. These instruments, however, represent bandwidth overkill for the day-to-day measurements encountered in most system design and production environments. The great bulk of the market is clearly in the under-100-MHz range, as demonstrated by the huge success of the analog Tektronix 465 scope. With the difference in bandwidth, there is also a significant difference in pricing, since fully configured 1-GHz oscilloscopes cost well over $20,000, whereas the HP and Data Precision instruments are around $10,000.

The microprocessor has also made a big difference between the new wave of programmable scopes and the old. In the gigahertz models, the system central processing unit is left to process the acquired data, while in the HP and Data Precision instruments, a microcomputer manipulates the digitized data, leaving an IEEE 488 host controller free to handle the rest of the system.

Another key to the two designs is the 100-MHz bandwidth a-d converters, which were not available in the earlier instruments. This element also differentiates the HP and Data Precision offerings somewhat, in that the HP 19860 uses 10-bit a-d conversion to 100 MHz, while the Data 6000 uses 8-bit converters up to 50 MHz, going to 7 bits between 50 and 100 MHz. The Data 6000's 100-kilohertz plug-in uses 14-bit conversion.

One plug-in. Both the HP and Data Precision designs have room for only one plug-in. This represents a balance between the multiple plug-in approach of the nonprogrammable Tektronix 7000 lab scope series and fixed, monolithic designs. "The one plug-in approach was strictly an economic decision to avoid the extra cost of multiple plug-in slots," notes Wayne Gutschick, product manager for oscilloscopes at HP's Colorado Springs division.

While the older programmable scopes usually had no front-panel controls at all, both the units from HP and Data Precision, Danvers, Mass., have gone to multiple-function, soft-key control to enhance the ease of manual operation. Both instruments offer versions of menu-option selections and use alphanumerics to prompt the user in English or another language. The HP oscilloscope also uses a single knob to vary any desired parameter.

Less skill. The prompting feature will probably figure most heavily in the cost justification of these scopes because it lowers the skill needed to perform sophisticated measurements. These scopes cost four times the price of an analog scope with equivalent bandwidth. However, they can be justified by the increase in throughput that comes with their automated measurements.

Marketers also point out that there is a shortage of highly skilled technicians and that such personnel are better used in the design labs doing unique measurements and devising the test sequences that will later be used by production workers. Over time, the difference in labor rates for the two kinds of workers makes the new scopes the more economical. -**Martin Marshall**

Communications

Deregulation heats up in courts, Congress

As the fall session for telecommunications litigation and legislation opens, American Telephone & Telegraph Co. has won one and lost one in separate Federal court rulings. AT&T failed to win dismissal of the Government's antitrust suit, but it won a decision that could lead to expanded unregulated offerings.

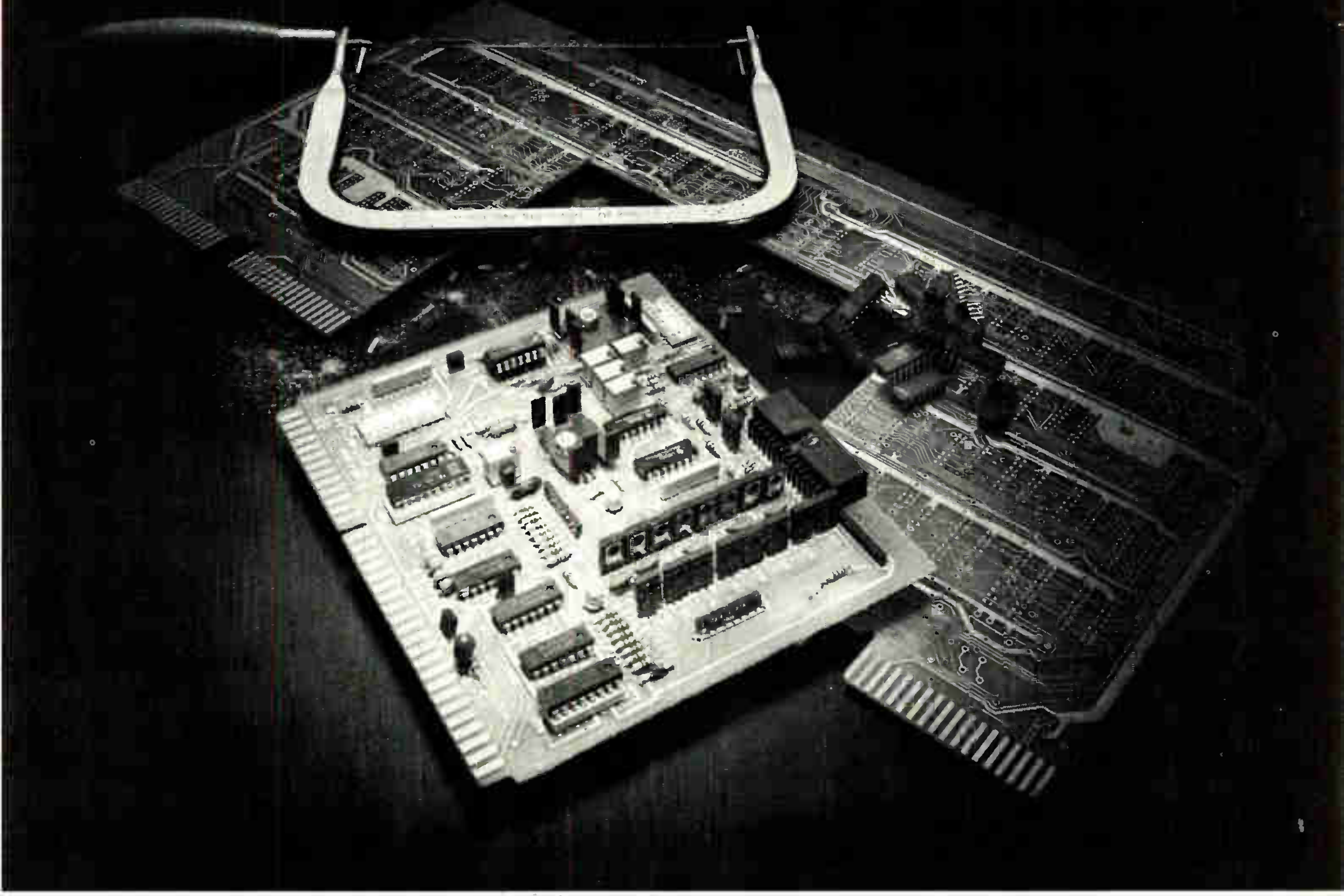
And with the Senate moving to consider S. 898—a new telecommunications act that would permit AT&T to enter unregulated markets for information processing equipment and services through a fully separated subsidiary, rather than spinning off a new company—a new heavyweight lobbying team joined other industry groups seeking to get the legislation modified (see "Tele-Cause: a match for AT&T?", p. 48).

AT&T lost its petition in Washington, D. C. Federal District Court to have the Justice Department's antitrust suit dismissed. Judge Harold H. Greene concluded in mid-September that the prosecution has demonstrated "that the Bell system has violated the antitrust laws in a number of ways over a lengthy period of time."

The burden of proof, Green said in a 74-page opinion, is on AT&T to refute charges that its actions were anticompetitive in the interconnection of customer-owned terminal equipment, its treatment of competitors in intercity services, and in its equipment procurement.

Judge Green's action dampened AT&T's enthusiasm over a ruling a week earlier in the U. S. District Court, for New Jersey, where Judge Vincent P. Biunno held that nothing in the antitrust consent degree by AT&T in that court in 1956 pre-

Common sense logic.



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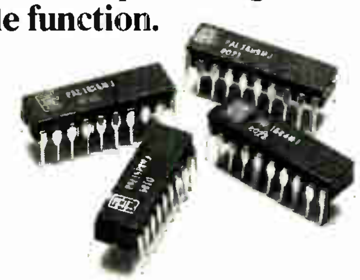

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vented the company from offering unregulated services through a separate subsidiary under the Federal Communications Commission's second computer inquiry. AT&T had requested the Newark court earlier this year to consider the consent decree in the light of the FCC ruling.

Narrow. The Biunno decision, the first judicial construction of the consent decree since it was filed 25 years ago, is one of narrow scope, the judge points out. It is limited to ruling that the FCC regulatory decision does not conflict with the 1956 antitrust settlement.

However, the issue of whether the FCC exceeded its statutory authority in the Computer II decision is pending before the District of Columbia Federal Appeals Court, Biunno notes, adding that those factual and policy issues will be decided there.

"No decision is intended or made on any issue on direct review in the District of Columbia" by his N. J.-based court, Biunno wrote. But AT&T says the decision means the company "may provide telephone switchboards, other customer-premises equipment, and enhanced services through a separate subsidiary on a detariffed basis." The D. C. court moves next. **-Ray Connolly**

Solid state

Microcontrollers expand their power

As manufacturers of industrial controllers and electronic toys and games become more familiar with microcontroller chips like the TMS1000 4-bit unit from Texas Instruments Inc., they are beginning to demand more processing power in the same low-cost packages. Intel Corp. is therefore expanding its 8-bit offerings both upward—into very high-speed 16-bit units—and downward—into price-reduced 8-bit units with more power than the 4-bit ones.

Early next year, the Santa Clara, Calif., company will be offering a special-purpose single-chip 16-bit microcomputer that is not based on any of its previous parts. The microcomputer will have a very fast multiplier and several peripheral input/output circuits, and was designed for industrial control. This 16-bit unit will compete with TI's 9995 16-bit microcomputer.

Motorola Inc., on the other hand, is concentrating on distributing processing tasks with multiprocessor implementations by broadening its 6805 family of special-purpose peripheral circuits. These circuits at present include an on-chip phase-locked loop (6805T2), a zero-crossing detector (6805P4), and an analog-to-digital converter (6805R3).

Shrinks. On the low end is Intel's new 8021H, which is a cut-price version of the popular 8021 that can execute a subset of the 8048 instructions. The 8021H has been shrunk 20% from a 5-micrometer n-channel MOS to a high-performance MOS, or H-MOS-I unit, enabling it to be squeezed into a 20-pin package after lopping off an I/O port (thereby saving 8 pins). In addition, the 8021 is being offered in an 11-megahertz high-performance version, along with the 8739H and the 8749H erasable programmable read-only memories.

The 8021H is aimed at applications that need more speed than 4-bit designs can provide. It will compete with TI's TMS7000 series, National's souped up 4-bit COPS series of multichip solutions and parts from Japanese companies like Matsushita, Nippon Electric, and Oki. Intel will also offer more complementary-MOS versions of standard parts. It has 11-MHz C-MOS 8039 and 8049 parts and plans for an 8048 to follow next year. **-R. Colin Johnson**

Tele-Cause: a match for AT&T?

A big new barrier is being erected in front of American Telephone & Telegraph Co.'s drive to enter new markets for information-processing equipment and services through a separate subsidiary, instead of forming a new corporation. The barrier is a new lobby that calls itself Tele-Cause. It says it speaks for some 5,000 corporations representing communications users, suppliers, and equipment makers. The chief legal counsel for Tele-Cause is the former chairman of the Federal Communications Commission, Dean Burch. Now with the Washington law firm of Pierson, Ball & Dowd, he also served as chairman of the Republican National Committee.

As the Republican Senate leadership pushes for agreement on a position on S.898—the bill that would deregulate much of the nation's telecommunications industry and let AT&T form a fully separated subsidiary to compete unfettered [*Electronics*, July 28, p. 42]—Tele-Cause was circulating 13 proposed amendments to the bill. Chief among these is one that would require minority public ownership in any new AT&T affiliate, thereby requiring it to publish separate financial reports, plus another preventing the affiliate from owning its own transmission facilities over any given routes until the FCC determines that there is effective competition.

The names of Tele-Cause members reads like a listing of companies on the national stock exchanges. Examples include General Telephone & Electronics, International Business Machines, International Telephone & Telegraph, Control Data Corp., and Satellite Business Systems. **-R. C.**

Instruments

Signal generator opts for cavity tuning

To achieve IEEE-488 programmability in signal generators, most manufacturers have turned to all-electronic designs, namely frequency synthesis. But Marconi Instruments Ltd., St. Albans, Herts., England, has taken a different tack for its new model 2017 signal generator.

According to Keith Elkins, executive vice president of the British firm's U. S. marketing group, Marconi Electronics Inc. of Northvale, N. J., others have basically chosen the path of "synthesizing the signal and then trying to clean it up." In

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contrast, Marconi has chosen to stay with the very clean output that is directly achievable with an electromechanical cavity-tuned oscillator.

Way down. With cavity tuning, the 2017's sideband noise at an offset of 20 kilohertz from the carrier frequency is typically −144 decibels below the carrier level over a range of from 5 to 500 megahertz, and it rises to only −131 dB at the generator's maximum output frequency of 1,024 MHz. In the midrange, that noise figure is about 6 dB lower than competitive units, such as the Fluke 6071A. The 2017's price is the same as the 6017A—$17,000.

Elkins also claims that the unit's frequency-modulation performance, accurate to within ±2%, is better than the competition's. However, the tuning time for the unit is about 10 seconds, much slower than for synthesizers but still much faster than manually tuned units.

Anthony Rudkin, product manager for signal generators, says the company uses a motor with an iron-free rotor controlled by an 8080 microprocessor to drive a pushrod linearly into the cavity to adjust the output frequency.

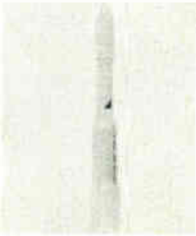
The microprocessor is also responsible for housekeeping and control functions, such as servicing the front panel display, setting up the modulation parameters for the various subsystems in the unit, and controlling the IEEE-488 interface.

Hollow. Quite unusual is the low-inertia design of the rotor. It is wound of copper wire and is hollow. Held stationary inside the rotor is a magnet around which the rotor turns. Rudkin describes the motor as similar to a d'Arsonval movement or a motor inside out.

The motor's low inertia allows the cavity to be set accurately and quickly without overshooting the desired frequency. To reduce overshoot as much as possible, the processor directs the motor to run at full speed until the output is within 0.5% of final frequency. It then reduces the speed until the frequency is within 0.1%, at which point a phase-locked loop takes over for the final adjustment. **-Richard W. Comerford**

Circle 51 on reader service card

A CONTINUING SAGA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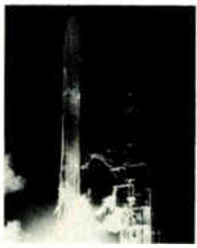
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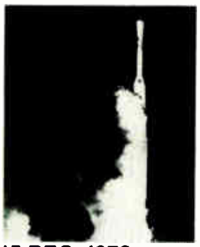
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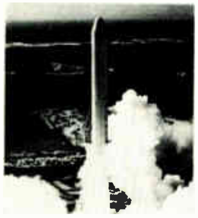
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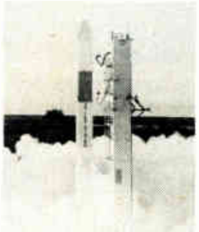
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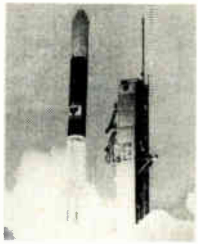
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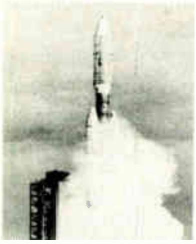
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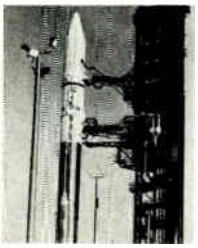
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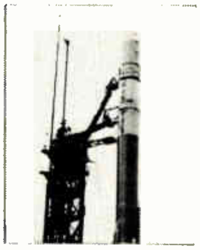
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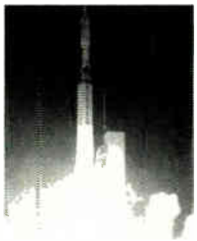
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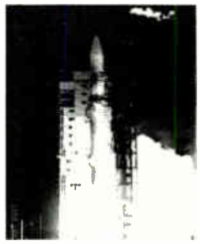
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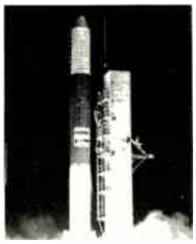
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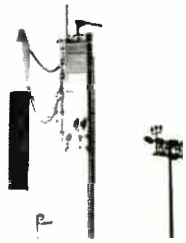
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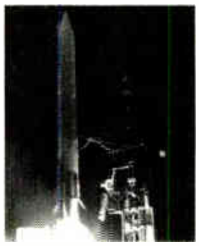
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Washington newsletter

VCR sales boom continues, says EIA

Retailers still can't get their hands on enough video-cassette recorders as the market continues to boom. Sales to retailers climbed nearly 75% in August, to almost 99,000 units, according to the Electronic Industries Association. That put VCR sales for 1981's first eight months at more than 730,000—85.5% ahead of last year's. **The EIA also increased its 1980 figures for color TV sales by 6.7% to nearly 10.9 million units** after determining its earlier figures were understated. The EIA says that August color TV sales this year continued to rise by 5.7% to more than 886,000 units, putting total color sales for the first eight months at more than 6.8 million sets, or 6.7% more than last year—despite the upward revision for 1980. A 13.3% drop in August monochrome receiver sales, however, had little impact on this year's total monochrome sales, which are still 9.4% ahead of the 1980 level at more than 3.5 million units.

Air Force seeks more countermeasures for air-traffic radar

The Air Force wants to upgrade the Raytheon AN/GPN-22(V)—precision approach radar known as HI-PAR by giving it an electronic counter-countermeasures capability. Officials at the Air Force Systems Command, Andrews AFB, Md., say **bids to modify two HI-PARs for testing are being sought from General Electric, Raytheon, and Sperry Univac.** The Electronic Systems division, Hanscom AFB, Mass., is handling the procurement for the high-density air-traffic-control radar system. Tests of the winning bidder's ECCM modifications to the system will be conducted at Eglin AFB, Fla.

Univac to upgrade ARTS III for FAA

The Federal Aviation Administration is moving, albeit slowly, to upgrade its automated radar terminal systems, known as ARTS III. A three-year design and development contract worth $4.8 million has been awarded to the system's original developer, Sperry Univac's Defense Systems division in St. Paul, Minn. After completion and evaluation of the sole-source award, **the FAA will move to procure the upgrades for as many as 60 major U. S. airports.** Among the improvements designed to reduce the number of tasks now performed by controllers will be a much-needed backup capability when a system computer fails or is shut down for maintenance. However, the backup will only provide aircraft identification, altitude, and ground speed—not tracking capability, the FAA says. Also scheduled for development is the capability for ARTS III to display information from multiple radar sites.

Army to unify communications, computer groups

The Army is drafting plans to create a new Automation and Communication Command, integrating the functions of the Army Communicatons Command at Ft. Huachuca, Ariz., and the Computer Systems Command at Ft. Belvoir, Va. Responsibility for the plan has been assigned to Ft. Huachuca by Army headquarters at the Pentagon, **where the two functions were intitally integrated at the command staff level in 1978** under the assistant chief of staff for automation and communications. The new unified command will pull the two functions together below that level because of their increasing interdependence, the Army says. Timing for establishment of the new command and the location of its headquarters have yet to be determined.

Washington commentary

The threat of DOD's new economies

It's time to put into perspective the cuts in military outlays proposed by the Reagan Administration earlier this month and the even larger reductions being urged on the President by his own Republican leaders in the Senate.

When reports of military spending reductions surfaced, David Stockman, Director of the Office of Management and Budget, pushed for a $13 billion rollback in the fiscal 1983 defense budget that goes to Congress next January [*Electronics*, Aug. 11, p. 50]. In addition, Stockman was promoting further reductions of some $20 billion in the two following years. But Defense Secretary Caspar W. Weinberger, an old Reagan friend, was able to capitalize on the President's announced commitment to rearm the U. S., and the proposed reductions in outlays were held to $13 billion over three years beginning with fiscal 1982, starting next month.

As Weinberger's victorious compromise now stands, Congress will be asked to cut outlays—actual dollars spent—by $2 billion in fiscal 1982, followed by reductions of $5 billion in 1983 and $6 billion in 1984. That will leave the Pentagon with total budgets for those respective years of $181.8 billion, $214.9 billion, and $242.6 billion.

On Capital Hill, however, there are other views that could foil the Reagan plan. As the Administration seeks to cut another $20 billion from overall Federal spending in fiscal 1982, even Senate Majority Leader Howard Baker (R., Tenn.), is saying that a $2 billion defense cut in the coming year is not enough if the Congress is to squeeze more blood from social programs. Baker wants at least a $5 billion military spending reduction in fiscal 1982. Most Democrats, looking toward next year's elections, are saying little publicly, but their pleasure in the President's dilemma is obvious.

The realities for procurement

Whatever the ultimate outcome of the latest military numbers game, the reductions hardly warrant such early hysterical judgments as those of James R. Schlesinger, who served during the Nixon Administration as acting budget director, Secretary of Defense, and Director of Central Intelligence. Claiming that Reagan faces a budgetary Dunkirk, Schlesinger argues that "the great rearmament boomlet of 1981" is over. A more rational assessment would be that while the degree of growth will be admittedly slow, military spending—particularly in electronics—will remain nonetheless enormous.

Indeed, there has been much skepticism within both the military and industrial communities that the original Reagan defense spending projections represented overreaching and were beyond the nation's industrial capacity—particularly when high interest rates discourage capital investment to meet the buildup [*Electronics*, June 30, pp. 58, 88].

Reassessing priorities

What is more troubling, however, is where the cuts will come from and what their impact will be on national security, not corporate profits. But budget line items—the MX intercontinental missile, a new manned bomber, and modernization of the missile-launching nuclear submarine force—have large constituencies on Capital Hill, and most such programs can be considered safe. But that cannot be said of such areas as command, control, and communications, or operating and maintenance, or munitions and manpower. The OMB's William Schneider Jr., associate director for national security and international affairs, says C^3 may be least vulnerable to cutbacks because "the deficiencies are so glaring in the military's aging networks."

Yet Schneider suspects that other areas of modernization, including O&M as well as force mobility, are the most likely targets for cuts. Others who heard Schneider's estimates at a mid-September conference of the American Institute of Aeronautics and Astronautics in Washington, D. C., not only concur but see cuts in munitions stockpiles and some manpower reductions as well. "These can be done quickly and effectively," said one Army official privately, "and they will also hurt us like hell."

Recalling the long-standing complaint of Gen. Edwin C. Meyer, Army chief of staff, that he is operating with "a hollow army," the official noted that any cuts in manpower, munitions, or operations "will reduce readiness even further." A senior naval aviation officer echoed the complaint, arguing that "the increasing number of carrier flight-deck accidents is a direct product of our inability to fly more training missions." Constraints on aviation fuel use and aircraft missile firings in training "are not only false economies,' he argued, but "they are seriously damaging our pilot reenlistment rates and mission capabilities."

These are representative of the fears of the nation's weapons systems users, not their builders. Their fears are valid. And they deserve a far higher priority than they have received from the Congress as it moves to reconsider the economies of military spending. **-Ray Connolly**

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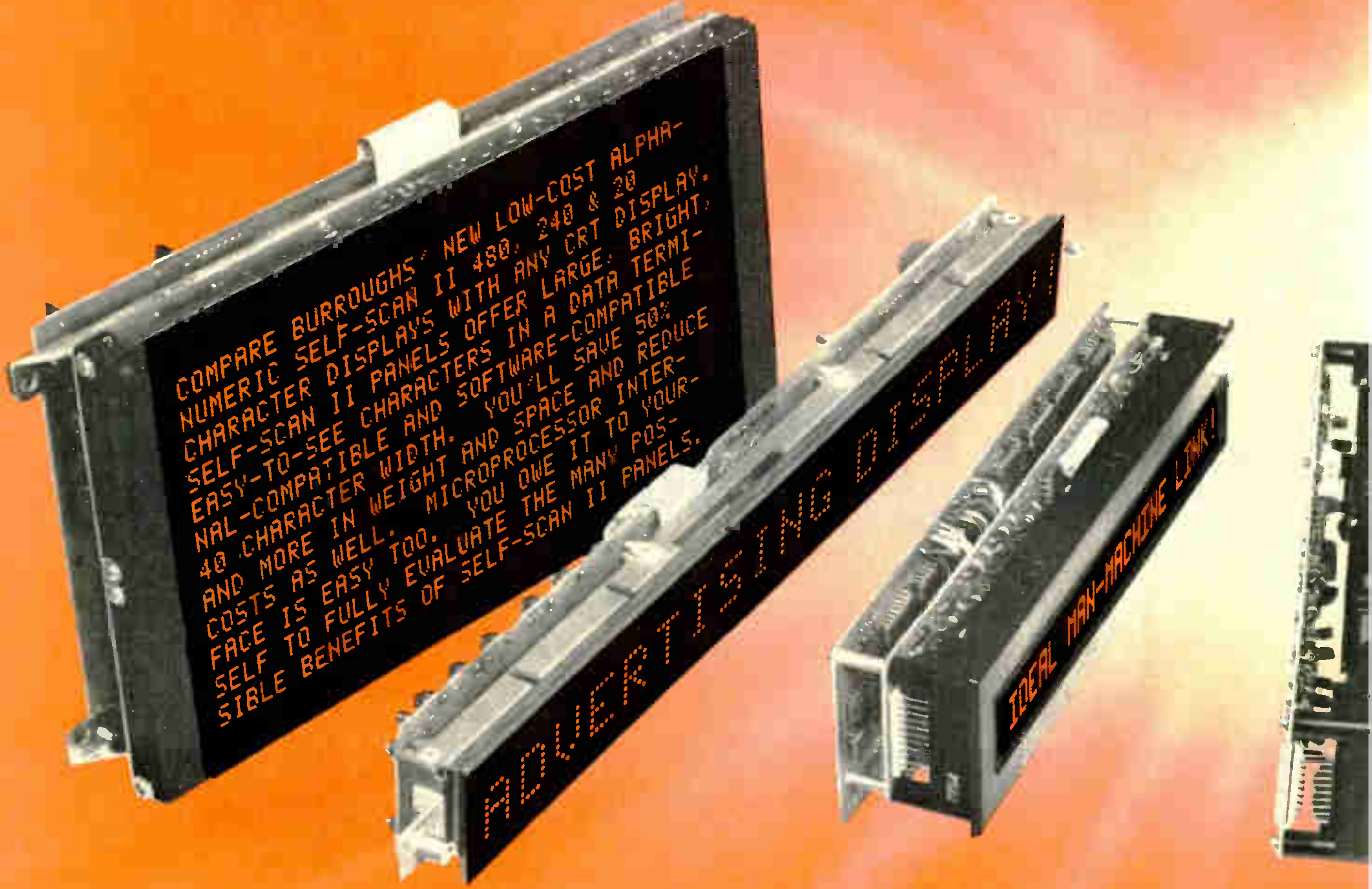

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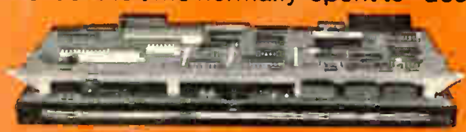

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Circle #264 for general information

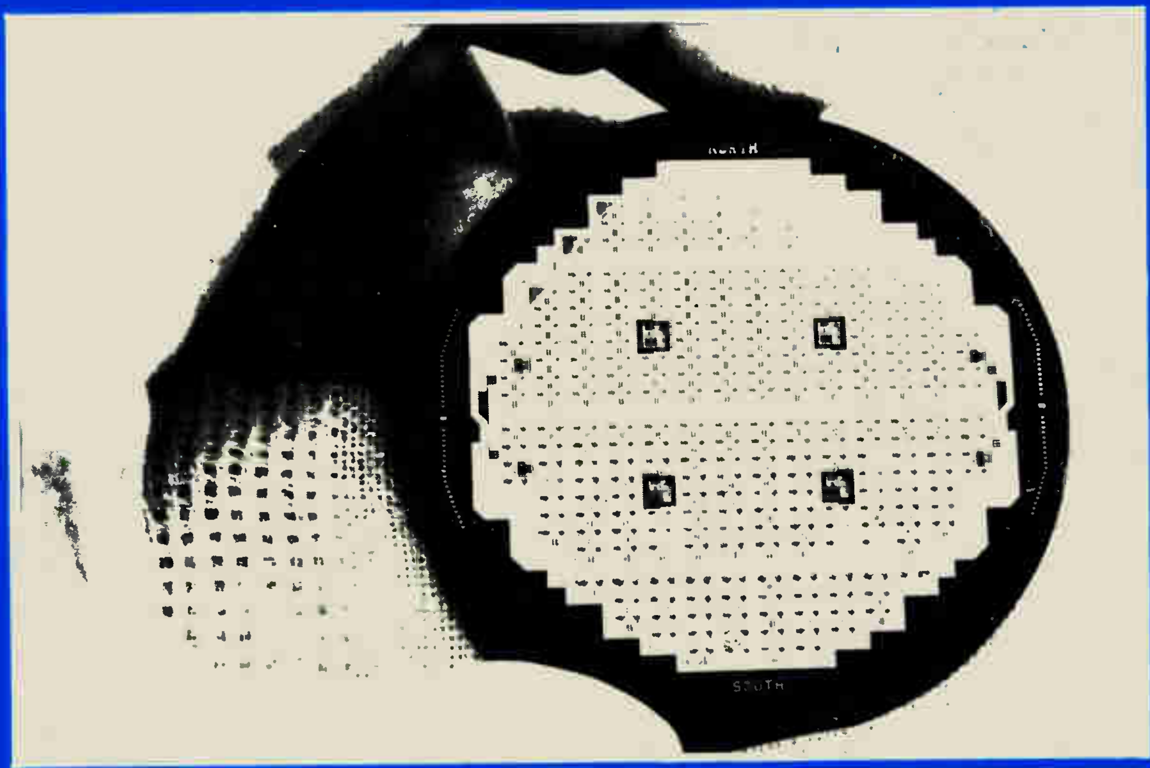
Circle #59 for detailed specifications

Sept. 22, 1981

Electronics International

IBM Japan fights back from second place: page 74

The good chips on a 532-chip wafer like this one could soon be configuring themselves into a spiraling data-flow computer: page 73



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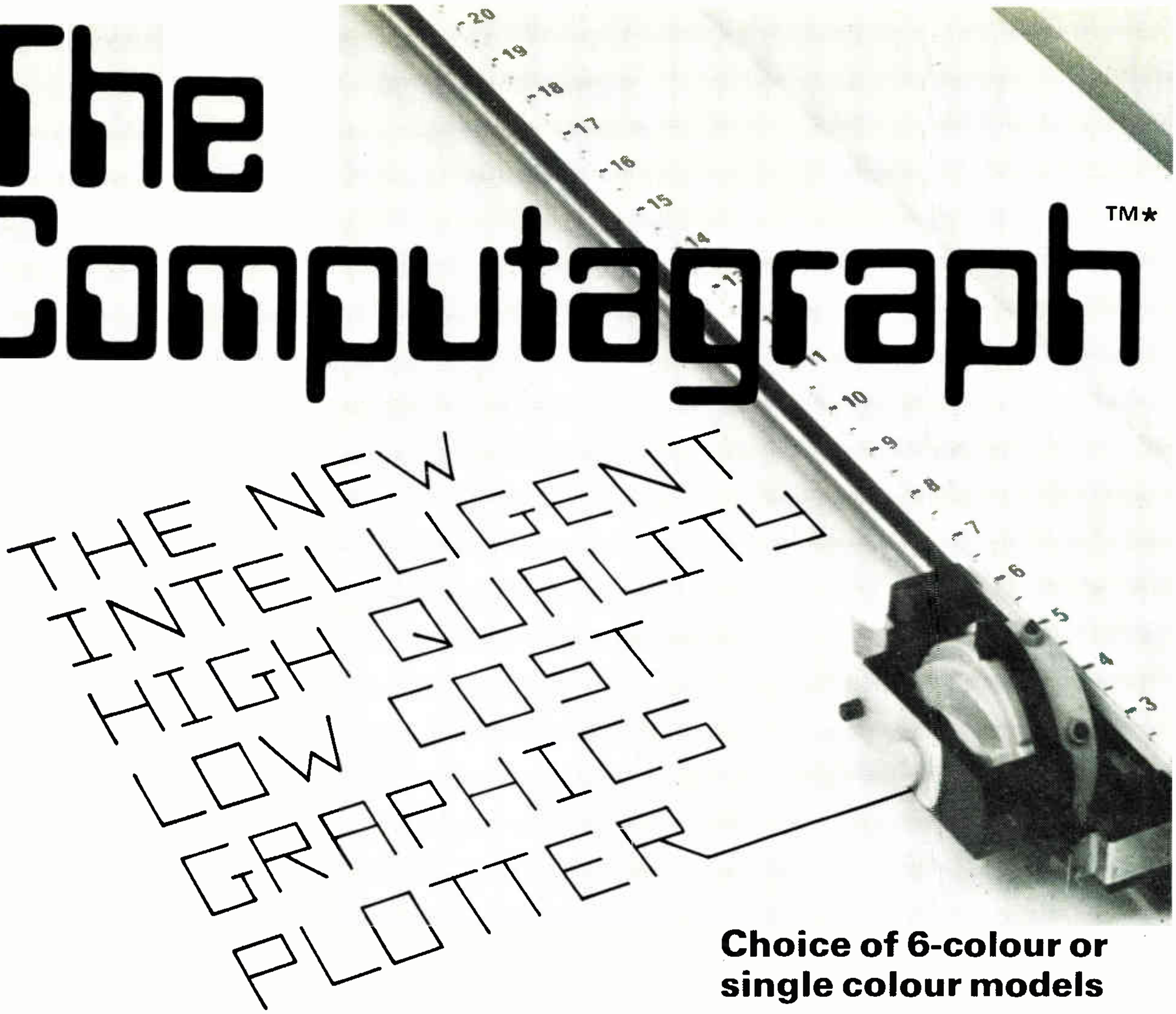

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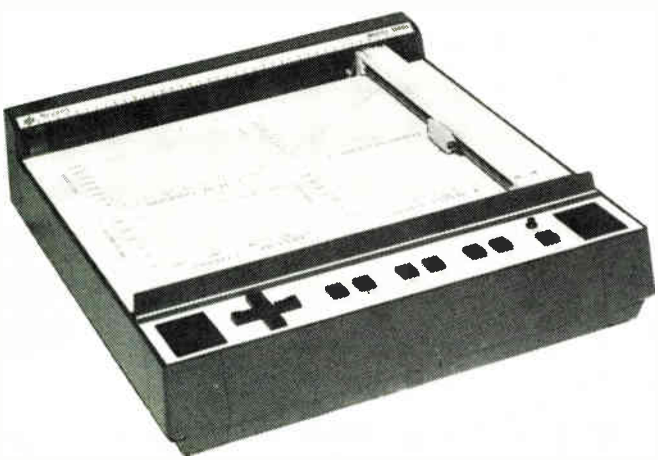

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International newsletter

Japanese agency to promote software work

Now that Japanese computer hardware has caught up, Japan's Ministry of International Trade and Industry is turning its attention to software, which most experts agree lags behind the U. S. levels. On Oct. 1, MITI's information technology promotion agency **will open a software technology center funded at $1.7 million for its first six months of operation.** The Tokyo-based center will play host to engineers from industry, government, and academe, who will work on about three projects at a time, each lasting two-and-a-half to four years. Results will be open to all comers. Among topics being considered for initial research and development are computer-aided design and microcomputer languages.

Many opto-electronic functions fit on single chip

Most of the device functions needed for the realization of opto-electronic integrated circuits have been realized on a single test chip by Plessey Ltd.'s Allen Clark Research Centre, Caswell, Northants. Light generation, detection, guiding, and electronic processing functions are performed by light-emitting diodes reverse-biased for detection and by gallium-aluminum-arsenide slab waveguides working with gallium-arsenide field-effect transistors and resistors. **Such components could be configured into single-chip transmitters, receivers,** repeaters, opto-isolators, and electro-optical processors—although devices have not so far been interconnected. To optimize material states for each type of device, a GaA1As heterostructure layer is grown epitaxially on a semi-insulating GaAs substrate.

Hitachi puts 64-K in plastic . . .

On Oct. 1 a new 64-K dynamic random-access memory in a plastic package will come on the market from Hitachi Ltd. It will be compatible electrically and pin for pin with the company's earlier 64-K RAMs, which come in Cerdips and ceramic packages. A new chip was needed, partly because it had to be narrower to fit into the slightly smaller space inside the plastic package and partly because it had to be able to **resist alpha particles without being coated with a plastic (polyimide) incompatible with the package material.** Changes to the chip include optimized dummy cells and an increase in memory cell capacitance from 60 to 90 femtofarads. According to a Hitachi design engineer, its soft error rate is two orders of magnitude below that of the earlier chips when uncoated. The firm says that by year end it expects to be shipping 700,000 64-K RAMs a month, 10% to 20% will be the lower-priced plastic-packaged variety.

. . . joins gate-array sellers

Hitachi Ltd. is now the fourth manufacturer of gate arrays in Japan that will sell to outside customers. It has started sales of both 1,200-gate complementary-MOS arrays and 400-gate low-power Schottky TTL arrays, both initially in Japan only. The C-MOS arrays, which are made with a 3-μm process, have **a typical propagation delay of 5 ns per gate and a power dissipation of 0.2 mW at 10 MHz,.** The Schottky TTL arrays have a typical propagation delay of 2.5 ns per gate and a power dissipation of 2.4 mW per gate.

Moreover, in October Hitachi will kick off sales of advanced low-power Schottky packages—initially four gates and two flip-flops—that are fully compatible with Texas Instruments' new series. The devices, which feature a propagation delay of 4 ns at a power dissipation of 1 mW, operate over the temperature range of $-20°$ to $+75°C$.

International newsletter

Deflection yoke clarifies TV image

The world's largest entertainment electronics producer, Philips Gloeilampenfabrieken NV, is offering samples of a deflection yoke that sharpens the picture received by color TV sets using the company's 30AX tube. The new yoke contains an auxiliary coil to which is applied modulation information in the form of transients selected from the video signal. The coil thus produces **an additional deflection field that varies the tube's horizontal scanning velocity** in such a way as to sharpen the video image's edges. According to the Netherlands-based company, a minimum design change is needed to equip a 30AX system with the new AT1271 yoke, which costs only $3 to $4 more than its forerunner, the AT1270.

Two ICL machines aim at local nets

ICL Ltd., Britain's computer heavyweight, is fleshing out its networking strategy with two small computer systems both of which can be incorporated in local networks. First, ICL is to manufacture and market under license from Three Rivers Corp. of the U. S., its Perq—a power microcoded minicomputer with advanced graphics and an Ethernet interface that is **targeted at scientific and engineering applications.** Second, to be launched next month is ICL's DRS 20 Distributed Resource System, a family of processors developed at its Utica, N. Y., facility, whose smallest member is an 8-bit work station. DRS 20 will use a simple 1-Mb/s local area network called Microlan.

Swiss post office taps SEL for videotex gear

For its future telephone-based videotex service, Switzerland has come out in favor of the videotex exchanges that the West German ITT subsidiary Standard Elektrik Lorenz AG has developed and that the West German post office will use for its videotex service. **Swiss postal authorities have been conducting nonpublic videotex trials since 1979,** using a British trial system. Last year, eight European communications houses submitted proposals for the exchanges to the Swiss post office, and Stuttgart-based SEL came out the winner. Public videotex trial services, with about 2,000 subscribers, will start in Switzerland in 1983.

LCD achieves strong contrast

Britain's Standard Telecommunications Laboratory in Harlow is using a phase-change effect in a black dichroic dye to fabricate a black and white liquid crystal display with a printlike **contrast strong enough for even avionics use.** A prototype display has been formed on a 3-in. n-channel MOS wafer incorporating the drive electronics for a 40-by-40-element matrix measuring 36 mm (1.4 in.) on a side.

Addenda

Sweden's two television and consumer electronics makers, Luxor and Svenska Philips, are talking about possible production and marketing cooperation. Each company has about **30% of the Swedish TV market and 25% of the hi-fi market but is losing money in both areas.** . . . A high-speed laser printer **capable of 14,100 lines/min at 8 lines/in.** has been jointly developed by Fujitsu Ltd. and Toray Industries Inc. and will rent for $8,300 month under a three-year lease. . . . The U. S. Armed Forces in West Germany have put into operation the first of more than 130 digital telephone switches that a West German consortium headed by Siemens AG are building as **part of the European Telephone System,** a $100 million military modernization project.

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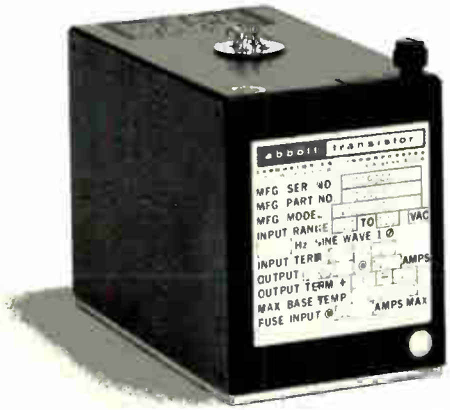

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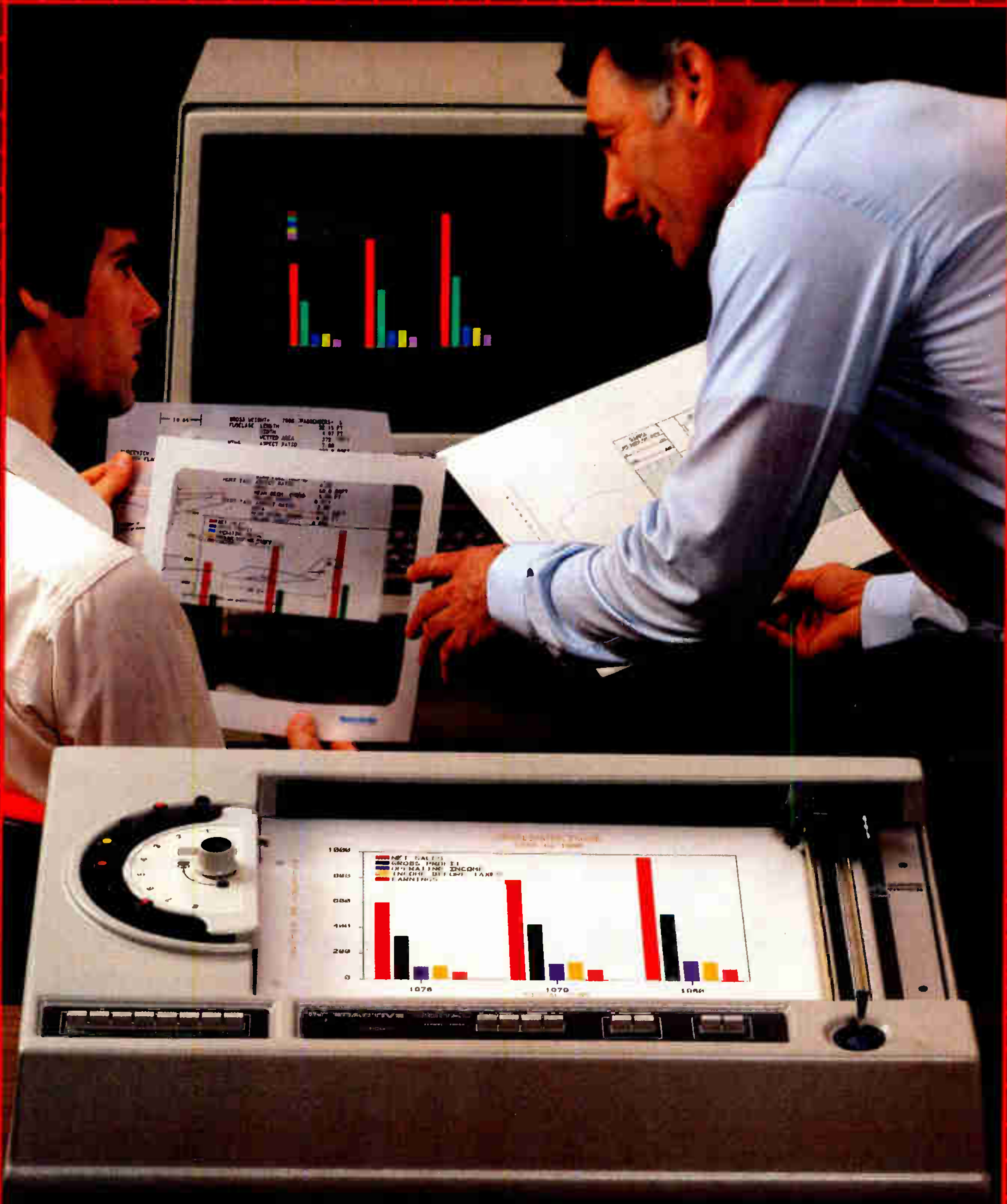
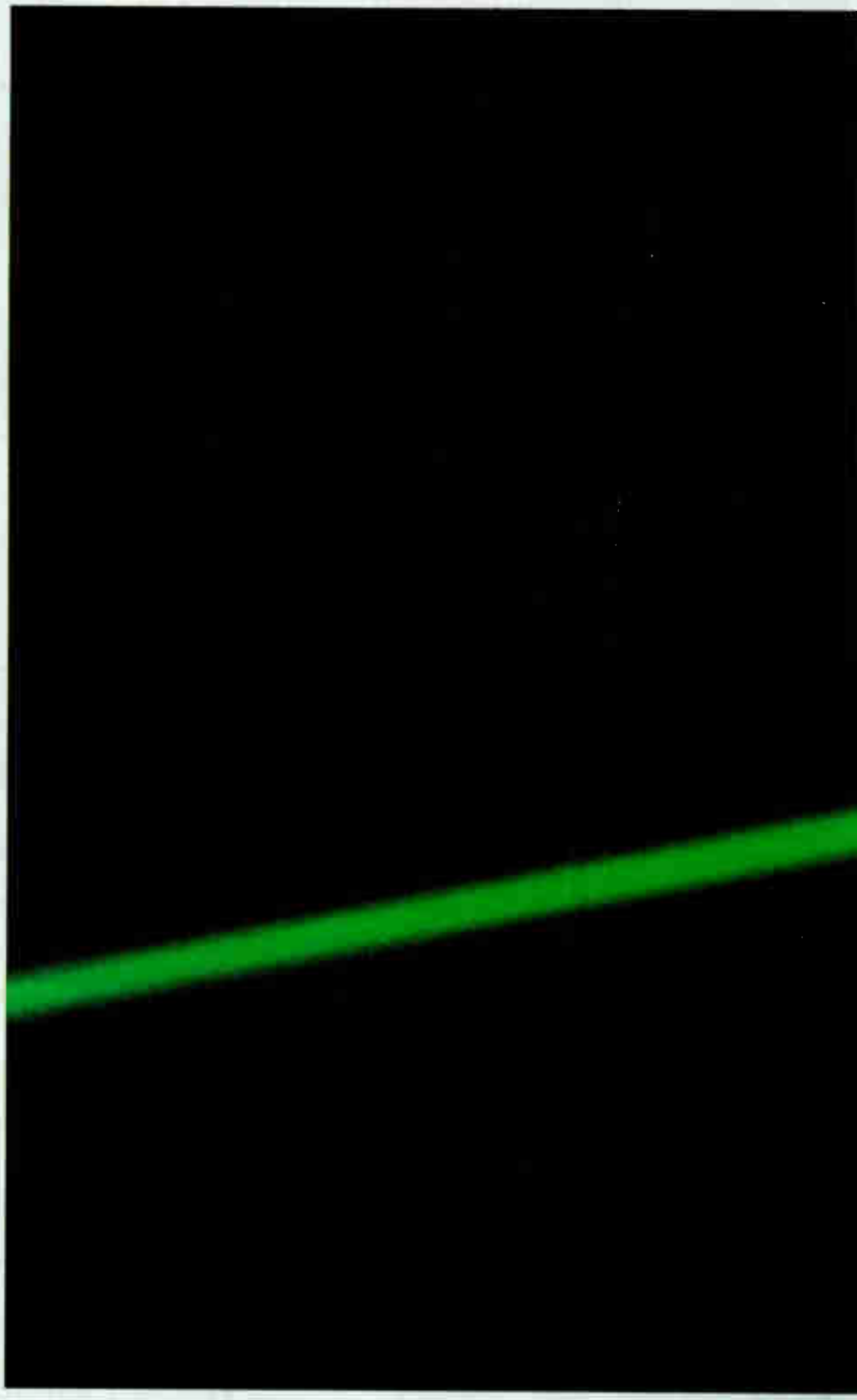


The practical 8-pen 4662 Option 31 Plotter by Tektronix

Introducing the 16K static RAM that's seen the light.



Component level redundancy with laser-blown polysilicon links. Smaller die size. High speed and superior performance. This is just part of the story behind our new MK4167 static RAM.

The MK4167 has a JEDEC-proposed, standard 20-pin configuration. It's organized as 16K x 1. Has fast 55ns access and cycle times. Low 120ma active and 40ma standby currents. A single +5 volt power supply. It has speed, low power, reliability — everything you've been looking for in a 16K static RAM. So, we could have stopped there.

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LASER PULSES VAPORIZE LINKS

We use laser pulses to open polysilicon links and select redundant columns within the circuit. This technique completely isolates the non-functional bits. Mostek is one

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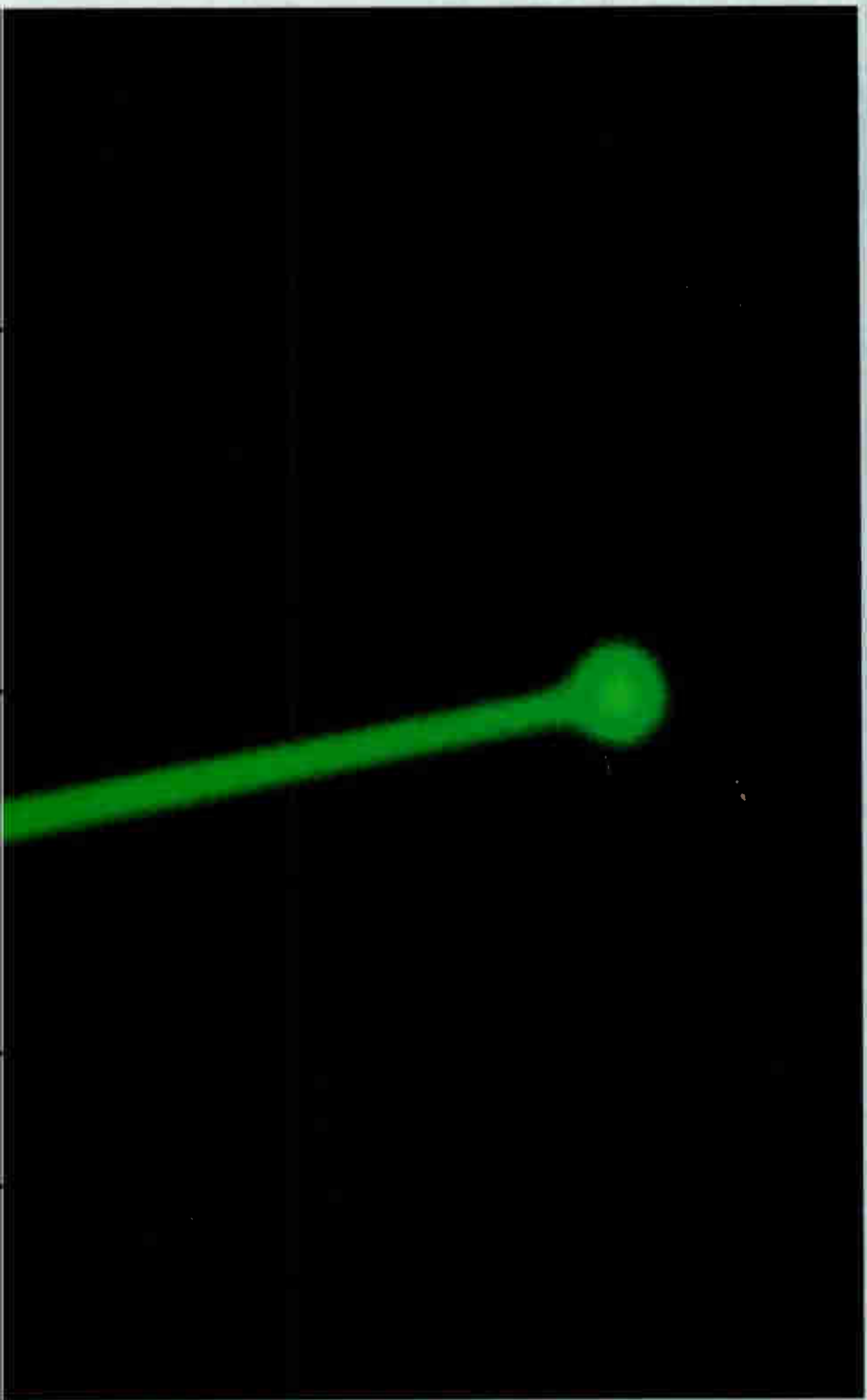

of the pioneers of this state-of-the-art process.

The MK4167 has the ideal organization, speed, and power characteristics for a broad range of applications, including main, buffer, cache, and control storage memories. With its superior performance, high density, and low cost, many new applications for this device are possible. So, once you've designed it in, you will need a supplier you can depend on to deliver next week. And next year.

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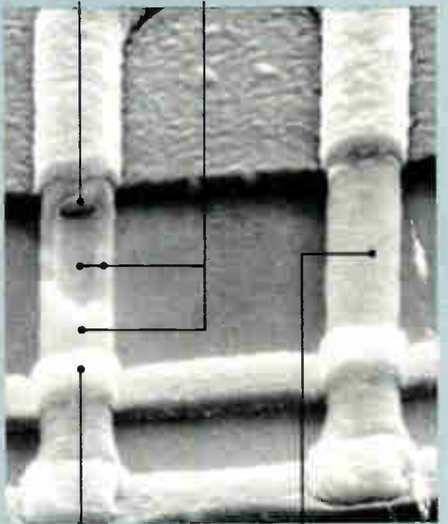

Scanning Electron Micrograph of a polysilicon link which has been opened to select a redundant column. The link was vaporized by a precision laser pulse.

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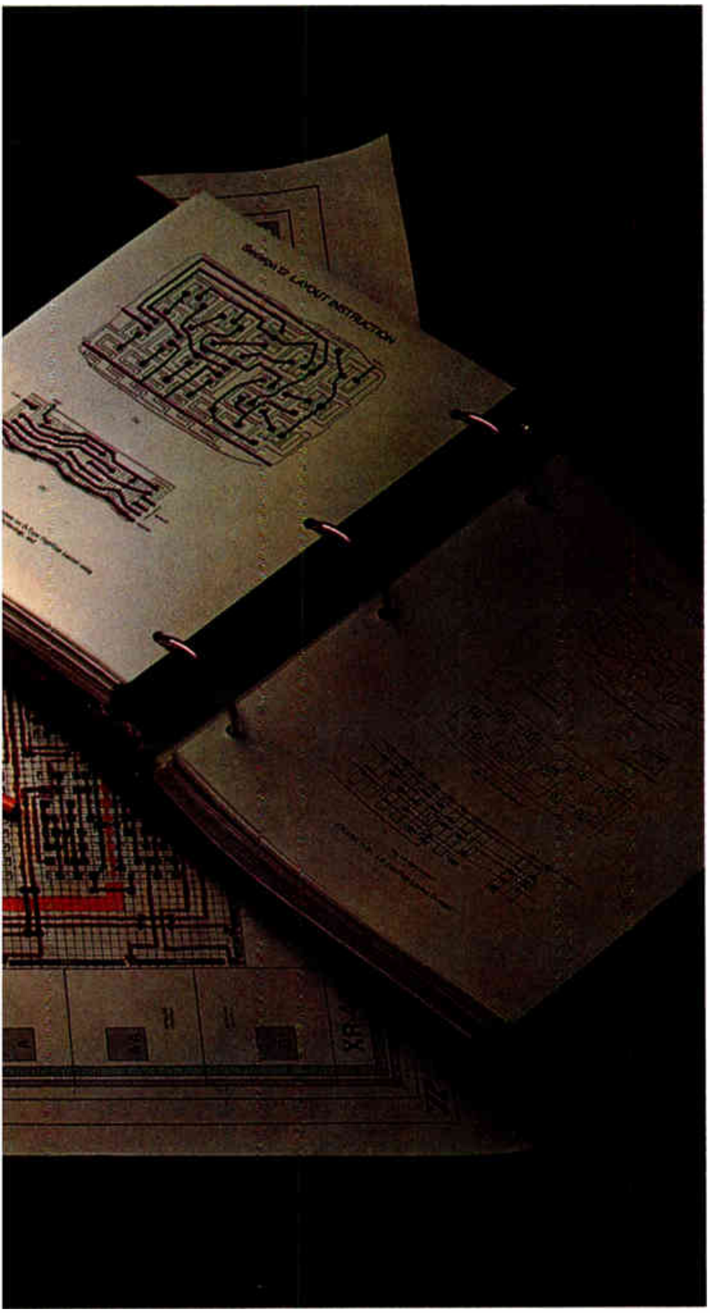

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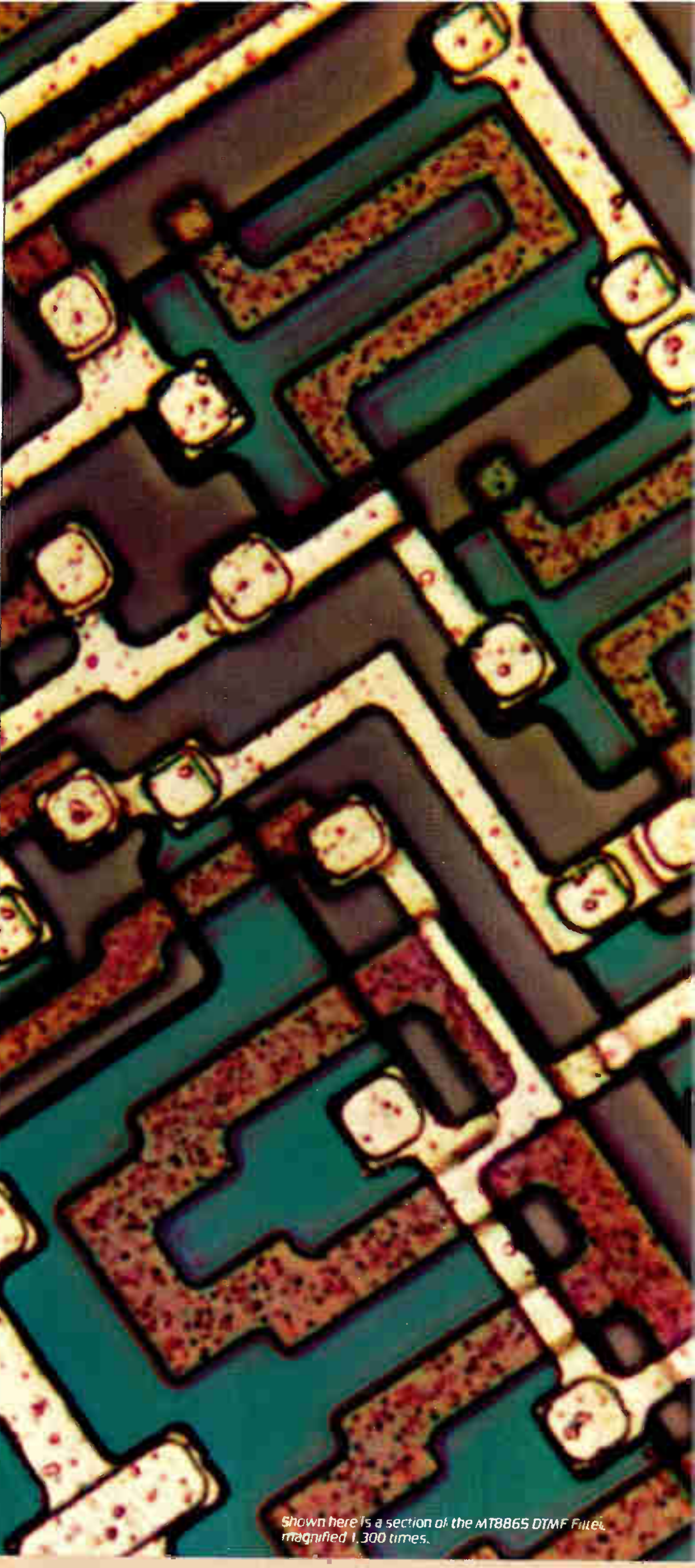

Shown here is a section of the MT8865 DTMF Filter magnified 1,300 times.

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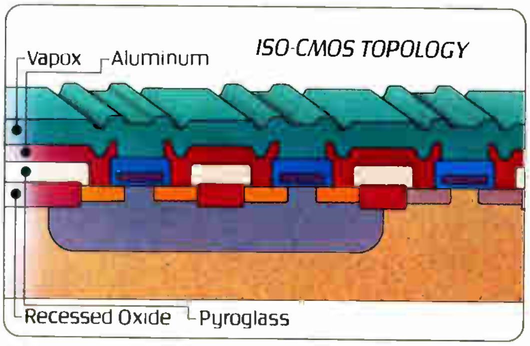

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BUILDING BETTER COMMUNICATIONS

Circle 94 on reader service card

Wafer prepares to turn itself into a computer

by Kevin Smith, London bureau manager

Self-testing chips link up with neighbors on wafer into a spiral of devices capable of forming a data-flow computer

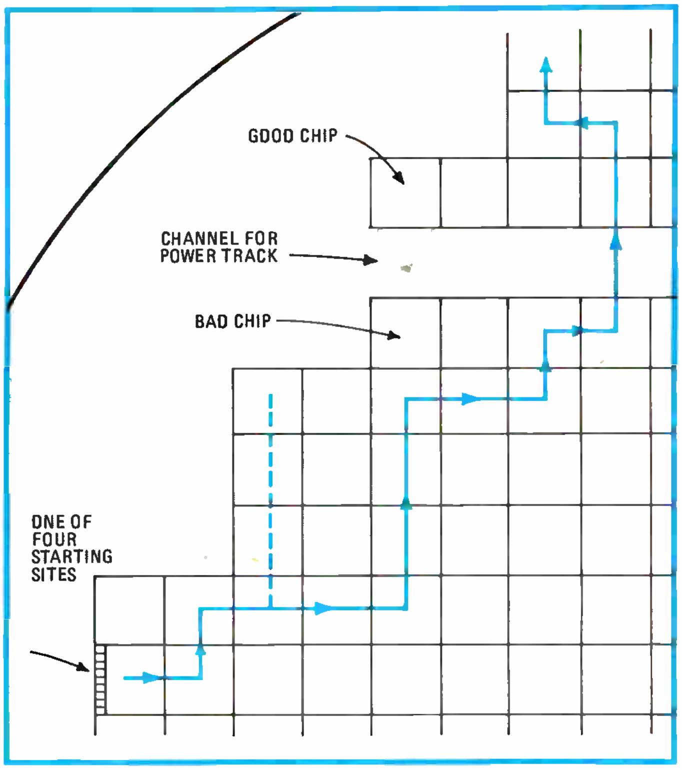
Though the past decade or so has seen many attempts to integrate an entire system on a wafer, only the occasional huge memory has ever left the laboratory. But now a technique for linking up a distributed-logic system on a wafer is ripe for commercial exploitation, says J. Malcom Wilkinson, manager of electronics and new technology at Burroughs Machines Ltd.'s Cumbernauld, Glasgow, Research Centre.

The approach uses absolutely conventional semiconductor production techniques with no new production wrinkles to iron out, as in fusible-link and Texas Instruments' 1967 discretionary wiring approaches. Instead, the circuitry is virtually self-testing and self-configuring—it builds itself into a spiral of several hundred good chips under the control of an external processor. When the first chip passes functional testing, it addresses a neighbor and, if it also proves good, links onto it—but otherwise it tries another neighbor until it finds a good one.

Burroughs researchers derived their system from a patent of theoretician Ivor Catt (see "Configuring a processor on a wafer," p. 74). They are the first to produce a batch of working wafers using the approach, though there have been computer studies of it and one actual wafer-scale attempt [*Electronics*, March 2, 1978, p. 48].

The slices are relatively simple, intended only to demonstrate feasibility, and comprise 532 identical memory cells, each with its own testing and interconnection logic. Each 80-mil-on-a-side chip site incorporates a 320-bit shift register designed to operate at 2 megahertz. The area per bit is 9 square mils, so there is plenty of room for optimization.

A first batch of 3-inch wafers, processed at Burroughs' San Diego plant, worked first time with what Wilkinson calls "acceptable yields." Earlier computer simulations indicate these should be better than 65%—350 good chips in terms of Burroughs' wafer. However, Wilkinson predicts that a fully optimized design, using an n-channel MOS process with 3-micrometer, instead of 5-μm, design rules would put 1.6 million bits of usable serial data storage on a 4-in. wafer. Since typical power dissipation is 8 watts, air cooling proves adequate.



Purposeful. The start of a chain of good chips, this spiral rejects dead ends due to bad chips, crosses power tracks via diffused underpasses.

Sensible. A colossal segmented shift register of 1.6 megabits might at first sight seem an odd system to integrate. But the addition of just a little extra logic to every cell converts this dumb serial memory into an extremely powerful distributed-logic system. Wilkinson is not prepared to discuss Burroughs' possible applications of it, but these can be inferred from Catt's patent. In a simple serial memory, both send and receive ends of the spiral terminate on a chip site at the wafer's edge, creating a segmented shift register down which data is slowly streamed. Extra control lines, traversing every chip, add intelli-

Configuring a processor on a wafer

Ninety percent of the cost of a digital integrated circuit arises at the stage of dicing, testing, sorting, packaging and bonding, and final testing, according to British electronics theoretician Ivor Catt. His cost-cutting idea, which also improves component density and reliability, was to work out a distributed-processing architecture that lends itself to integration at the wafer level even when many chips on the wafer are defective.

The essential feature of the wafer-scale integrated approach, patented by Catt in 1972 and further developed by Burroughs, is the ability to link good chips on wafer without additional metalization or even a prior knowledge of which chips are good.

Each chip incorporates all the test logic and logic it needs to address its four nearest neighbors. Connections are made to the input and output of a start chip at the wafer edge and to the power supply. Clock grids supply all chips on the wafer. A known bit pattern is fed into the first chip and the output pattern is compared with the input to ensure the chip register is functioning correctly. If good, the chip is instructed by the external controller to address the adjacent chip due east, and the test sequence is repeated. If an error is detected in the returned data, indicating that the newly selected device is faulty, the penultimate chip is instructed to access another chip. The process continues until a spiralling chain of predetermined length has developed or until all accessible chips have been tested and connected.

The steering logic in this first chip amounts to just 260 transistors that together with interconnections occupy 2,500 square mils—an overhead that is offset by the absence of bonding pad and scribing line areas. **-K. S.**

gence. Down them both data and instructions are more rapidly streamed. For an associative memory, simple serial on-chip processing logic could compare fields specified in an instruction with those stored in the on-chip register a bit at a time. In a data-flow computer, the on-chip logic power would be further increased, so that many different operations could be performed on the data stream simultaneously.

According to Mike Lea at Brunel University in Uxbridge, who has modeled wafer-scale distributed-logic systems of this kind on a computer, they are ideal for processing data on the fly in, for example, the communications channels of computer networks or for searching and updating files in data-base management systems. Also, as self-contained processors, they could be used for text editing, digital filtering, fast Fourier transforms, sampled data processing, and so on.

Japan

IBM Japan reacts to being No. 2 by homing in harder on domestic needs

A recent flurry of moves by IBM Japan Ltd. dramatizes the determination of officials there to crank growth up to at least the Japanese computer industry rate of 15% a year. Mired in single-digit sales growth for the five years since it started publicly reporting its results, the wholly owned subsidiary of International Business Machines Corp. watched helplessly two years ago as Fujitsu Ltd. stormed past it to become the largest computer company in the world's second-largest computer market. Last year Fujitsu widened its lead by boosting computer sales by 17% to $1.7 billion, while IBM Japan's revenues rose by a paltry 4.5% to $1.5 billion.

IBM Japan's president, Takeo Shiina, is disgusted with this flaccidity and is moving with a vengeance to whip his firm into shape. A measure of his resolve is his recent public avowal to achieve double-digit growth for the rest of the decade, starting with this fiscal year. A series of maneuvers culminating in August shows just how he intends to do it.

Starting last month, Shiina became the only country head in IBM's worldwide organization to win responsibility for local General Business Group activities. Until August, the GBG staff reported to group headquarters in Atlanta, a state of affairs that IBM Japan officials felt diminished their ability to respond quickly to local needs.

With the new integration, says IBM Japan's managing director Kazurou Ito, "we can effectively develop products and manufacture and market them to meet Japanese customers' requirements, some of which are unique. We had wanted to improve our situation through worldwide IBM, but due to market environment changes we think now we should be more self-sufficient. We have the full support of top corporate management."

Following through. In one key example of this, IBM Japan's highly regarded Fujisawa Research Laboratory, which heretofore has concentrated on telecommunications and high-end kanji (Japanese character) systems, will start developing GBG products especially for the local market. To do this, Shiina is doubling its staff to 1,000 engineers.

Last month IBM Japan also launched an intensive study of alternative marketing channels to its traditional direct sales approach—in particular, the use of dealers or agents. Such *dairiten* have been a key to the rapid growth of Japanese computer makers and are especially appropriate for single-unit and small-system sales as they provide software support but leave the lucrative maintenance business to the maker. A special project office directly under Shiina is conducting this feasibility study.

In June, Shiina established IBM Japan's first subsidiary, whose express task is to penetrate Japan's

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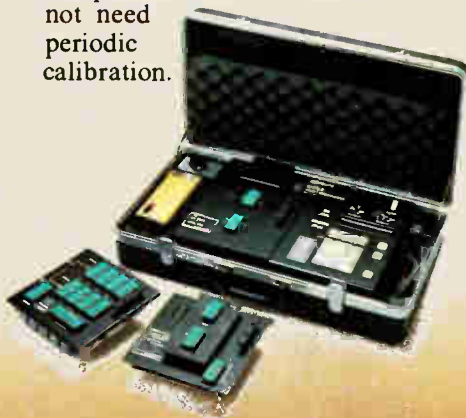

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huge but formidable government market, which constitutes 10% to 20% of Japan's entire data-processing market. Called Systems Development Ltd., the new subsidiary hopes to get its foot in the door by landing some government research contracts. Ito says a separate unit is necessary because government-related business practices differ somewhat from those of private industry. Japanese makers already have similar subsidiaries.

Earlier still, Shiina last January created a new office of corporate planning to coordinate all divisional planning. And even before that he announced plans to start making memory chips in Japan by 1983 by expanding the company's Yasu computer plant in Shiga prefecture. "This will help give us more self-sufficiency," Ito says, adding that Yasu will become the first completely vertical manufacturing plant in the worldwide IBM family.

Freebies? Besides these various organizational steps, IBM Japan is growing more aggressive in the marketplace. Although Ito denies it, competitors claim to be seeing price slashing and discounting by the computer giant. Moreover, a computer marketing official at Fujitsu says IBM salesmen have recently started offering free extra service "behind the scenes" while formally heeding IBM's cherished policy of sticking to list prices.

This executive also sees IBM salesmen entertaining clients more often and spending more time with prospects. But he thinks IBM still suffers from an image of arrogance and inadequate "Japanization" among Japanese users. "The general impression is that they offer only products that are established somewhere else. And if a customer asks for help with his software, IBM won't admit that the software may be faulty."

In a similar vein, other industry insiders think Shiina's "double-digit growth" strategy will not succeed overnight. "You can't make that kind of one-year turnaround, at least in domestic sales," declares the Tokyo-based marketing manager of a foreign computer maker.

Indeed, Ito admits that most of this year's growth, as in recent years, will come from exports. And IBM Japan clearly is counting on sales to the People's Republic of China as a key growth area. A year ago it won marketing rights to China from corporate headquarters and next year alone will install more than 20 model 4331 and 4341 mainframes there.

But Ito agrees that for its image, if nothing else, IBM needs to be the industry leader in Japan proper, the most competitive computer market in the world. What is more, he adds, "unless we grow as fast as the local industry, we can't maintain the strength of the company. For IBM to be competitive here, we need many changes to strengthen our capabilities." **-Robert Neff**

The Netherlands

Two buses organize the electronic home

Imagine a system that, with a single command, starts any desired sequence of operations on home electronic equipment—perhaps turning on the video recorder and a television set, then switching the recorder to the proper operating mode and setting it to the correct spot on the tape, and finally starting the tape to play back a movie on the TV screen—all at the push of just a single button.

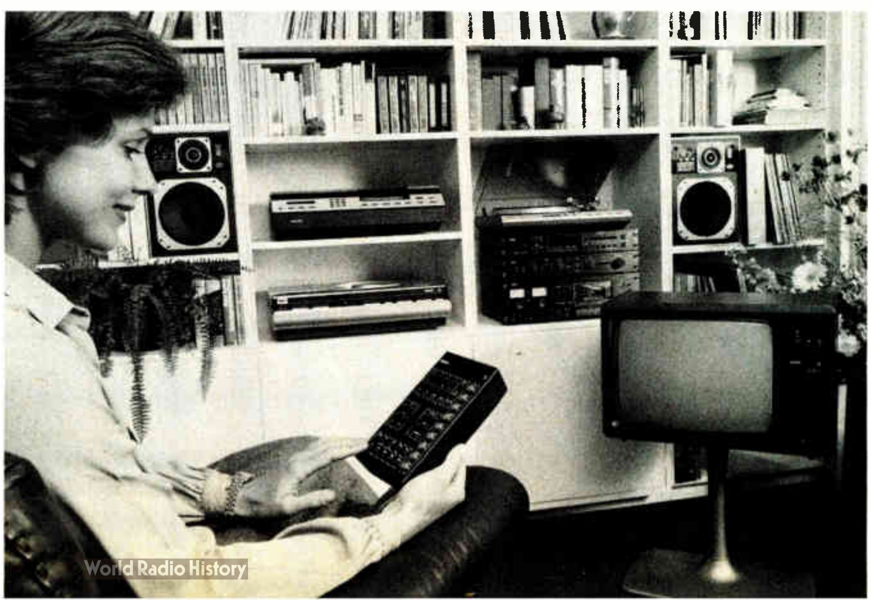
To engineers at Philips Gloeilampenfabrieken NV, such a system is no longer a thing of the imagination but is coming in the form of the domestic digital bus—the D^2B. "We think there is a big need for such bus because it greatly simplifies equipment operations," says Adrian Moelands, strategic product marketing manager at the company's Elcoma division in Eindhoven, the Netherlands.

Moelands's reasoning: people with an aversion to a lot of knobs and controls will become even more bothered by them as more television peripherals enter the home. And with the advent of domestic data terminals and associated monitors, displays, and printers, there will be an even bigger need for a command bus that does away with those tedious device-by-device switch-on and check procedures.

Inside and out. To complement the D^2B, the Dutch engineers have developed the similar Inter-IC, or I^2C, bus. For use inside the equipment, it handles messages coming from or going to the D^2B. So, while the D^2B interfaces and externally ties together all sorts of home electronic systems and TV peripherals, the I^2C bus allows equipment makers to standardize the interfaces between different integrated circuits and modules inside the equipment.

To ensure their commercial success, Philips is actively seeking standardization of its two buses, possibly

Easy does it. This key pad enables a homeowner at the push of one button to coordinate the operation of many pieces of electronic gear tied to Philips' domestic digital bus.



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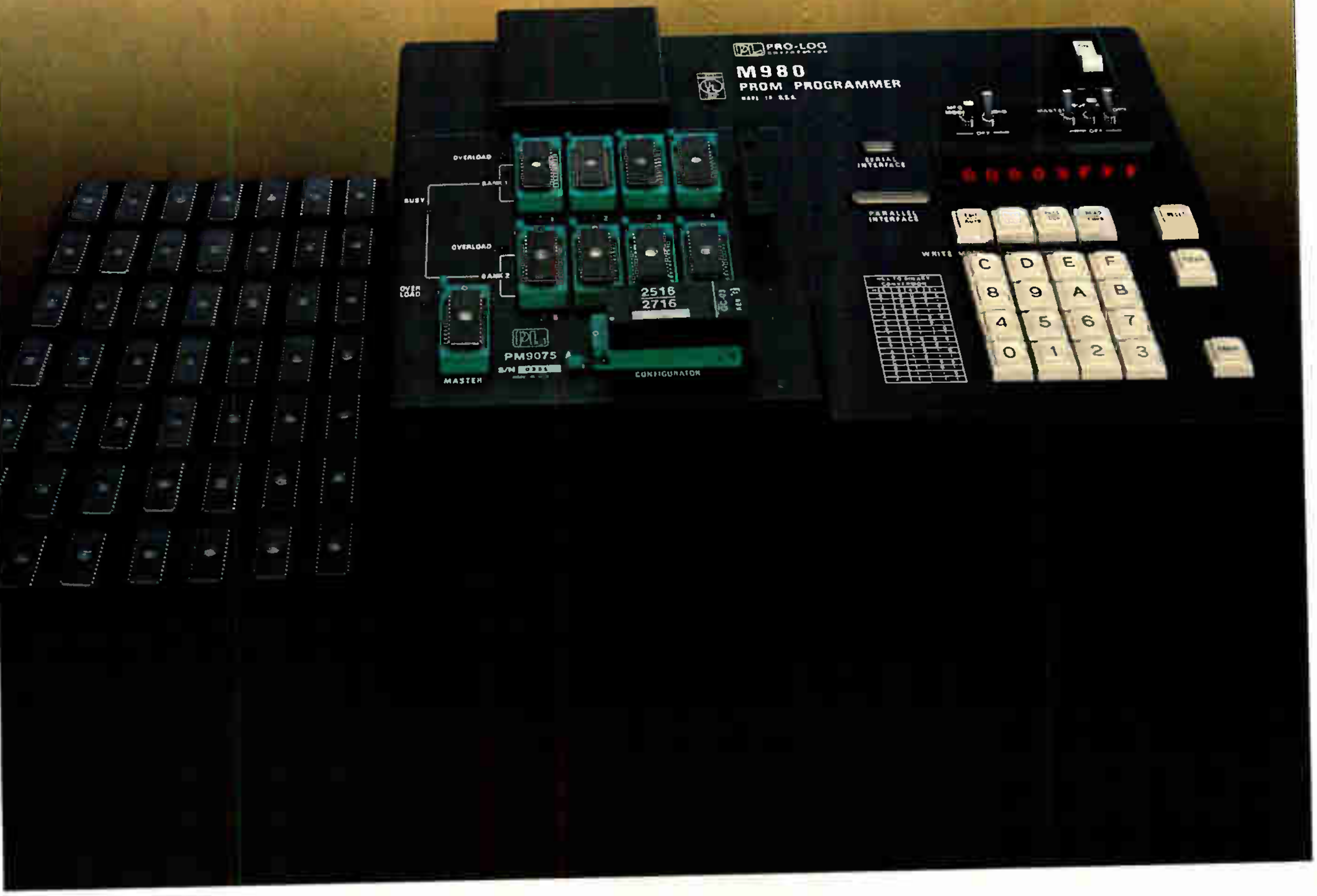


Circle 96 on reader service card

by next year in Western Europe and later in other parts of the world as well. Equipment makers in France and Germany especially are already showing keen interest in the buses [*Electronics*, Sept. 8, p. 63].

The D^{2}B is simple to operate. At a remote unit or a keyboard hooking into a piece of equipment in the user's systems line-up, the operator punches one button. This generates a command that is programmed to perform a specific sequence of operations. At each piece of equipment, an integrated circuit, usually a microprocessor, interprets the command and switches on the appropriate items—for instance, the tape recorder, tuner, and amplifier if the user wishes to record a broadcast.

A joint development of Elcoma and Philips's Audio and Video divisions, the D^{2}B operates in three modes that differ only in their data transfer speeds. In mode 0, used for slow units like TV sets, at most 138 characters are transferred each second. Modes 1 and 2 serve faster peripherals like data terminals and printers and transfer at most 2,585 and 8,290 characters per second.

No master. The D^{2}B is a two-wire bus up to 150 meters long. As many as 50 pieces of equipment out of a possible 4,096 can be connected to it. Any unit connected to the D^{2}B can take control of it—no central bus master is needed—and that unit can communicate with any other unit. Removal of a unit does not affect the functioning of those left. In case several units try to access the bus simultaneously, their claims are settled by an arbitration procedure that is based on the wired-AND property of the D^{2}B interface.

The digital bus is time-multiplexed into time intervals during which one unit, the current master, can send a message to or demand one from another unit, the current slave. Each message's format consists of start bit, mode bits, and master and slave bits, as well as control and data bits.

Like the D^{2}B, the I^{2}C bus is a two-wire bus. Interconnecting circuits rather than equipment, it is also a multimaster bus—any circuit connected to it can assume control of it and can in principle communicate with any other circuit connected to the same bus. It uses a clock line and a data line. Since each master generates its own clock, a clock synchronization procedure ensures that a well defined clock signal appears on the bus. **-John Gosch**

Japan

NEC slates moly for 256-K RAM

Even though 64-K random-access memories with 150-nanosecond access times are barely on their feet, Nippon Electric Co. is ready for the next step. It expects to have available in a year or so samples of a 256-K dynamic RAM that achieves a 100-ns access time through the use of molybdenum- and polysilicon-gate technology.

The 4.96-by-8.63-millimeter MOS chip is packaged in the industry-standard 16-pin dual in-line package now used for 16-K and 64-K RAMs and has a compatible pinout. So it should be easy to assemble into systems.

During the coming year, engineers at Nippon Electric Co., which developed the RAM jointly with the Musashino Electrical Communication Laboratory of Nippon Telegraph & Telephone Public Corp. will be hard at work wringing out the process technology needed to mass-produce the devices, including stable molybdenum gates, 200-angstrom-thick oxide in the storage capacitors, and 1.5-micrometer mask rules. To achieve so fine a pattern, 10:1 optical step-and-repeat alignment is used in exposing the photoresist and a parallel-plate reactive-sputtering etching system and ion implantation are needed for fabrication.

Thinnest. The minimum dimension is used only for contacts, though. The effective length of the channels under the polysilicon gates after lateral diffusion of the implanted dopant is 1.3 μm, which indicates a pattern dimension larger

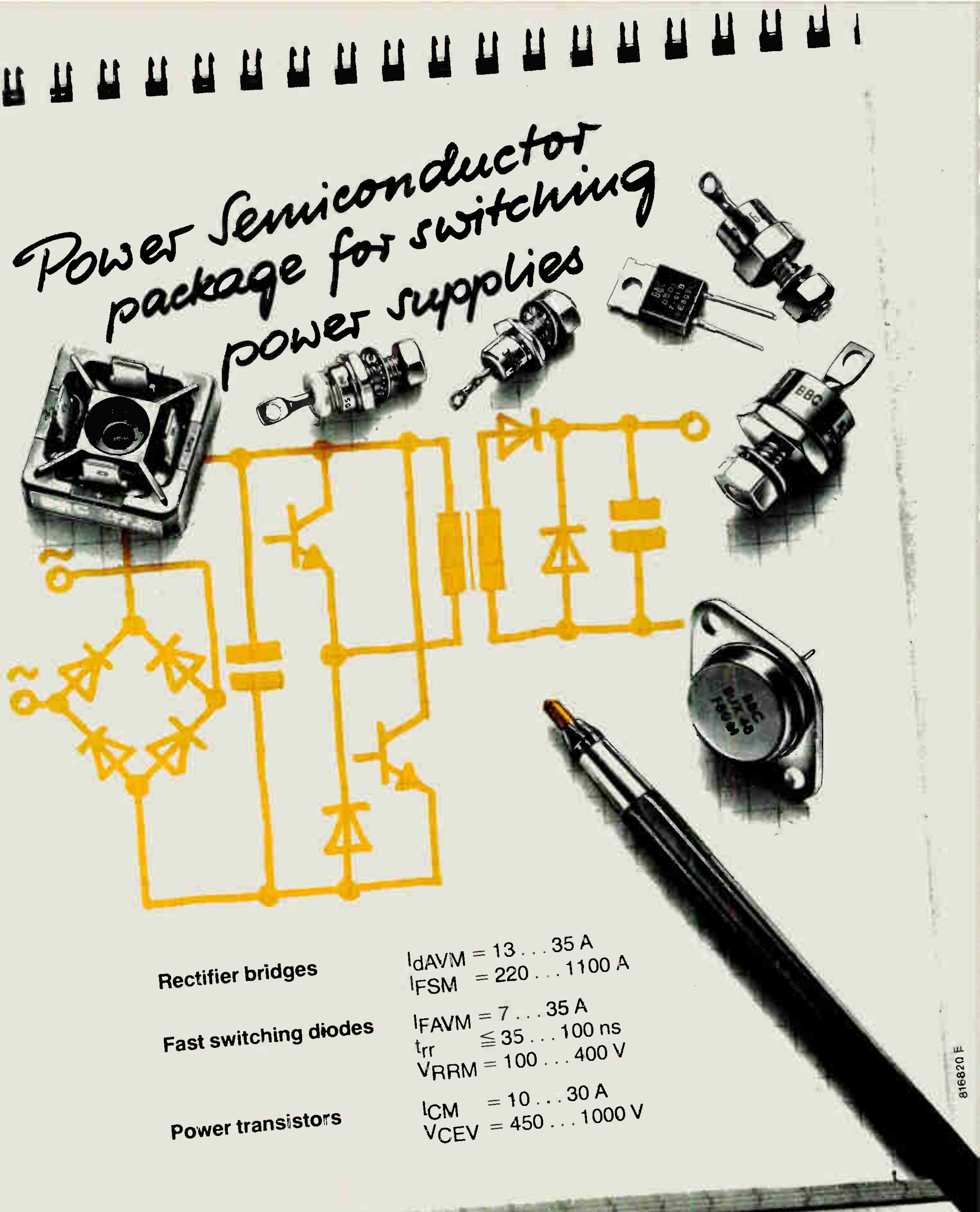
than 1.5 μm. The effective length of the channels under the molybdenum is 1.7 μm. The thickness of the oxides under the polysilicon and molybdenum gates is 400 and 500Å, respectively, both typical values.

In this chip, the molybdenum gates of the memory array cells also serve as word lines. The low 0.3-ohm resistance per square of the molybdenum ensures high-speed read operations. Since aluminum metalization is not required to interconnect the gates, the bit lines utilize it, rather than being diffused as they usually are in dynamic RAMs, and hence achieve much lower parasitic capacitance. The ratio of bit-line to cell capacitance consequently falls from around 30 to 17, increasing the readout margin to a reasonable level. In 64-K and smaller RAMs, it was possible to achieve ratios of 20 or lower with diffused bit lines; but for 256-K and larger devices, the ratio would rise to 30 or more and the read margin would be insufficient.

Storage capacitance, the denominator of the ratio, is increased to 35 femtofarads—a value only slightly smaller than in many 64-K RAMs—by decreasing capacitor oxide thickness to 200 Å.

Comparisons. The chip has the same organization as one using aluminum word lines and polysilicon gates and bit lines that was described by Nippon Electric at last year's International Solid State Circuits Conference. There are two 128-K RAMs, each consisting of two blocks of 128 by 512 memory cells arranged about 512 sense amplifiers and 1-of-512 decoders. Electrically, the chip appears to be a matrix of 256 rows by 1,024 columns with a refresh mode of 256 cycles at 4-millisecond intervals. The A_0 through A_7 addresses correspond to the refresh addresses, and the A_8 address selects one of the two 128-K blocks.

Circuit operation is fairly standard. Transfer transistors isolate the sensing nodes from the bit lines, increasing the readout sensitivity. A transistor between complementary bit lines balances them during the precharge period. **-Charles Cohen**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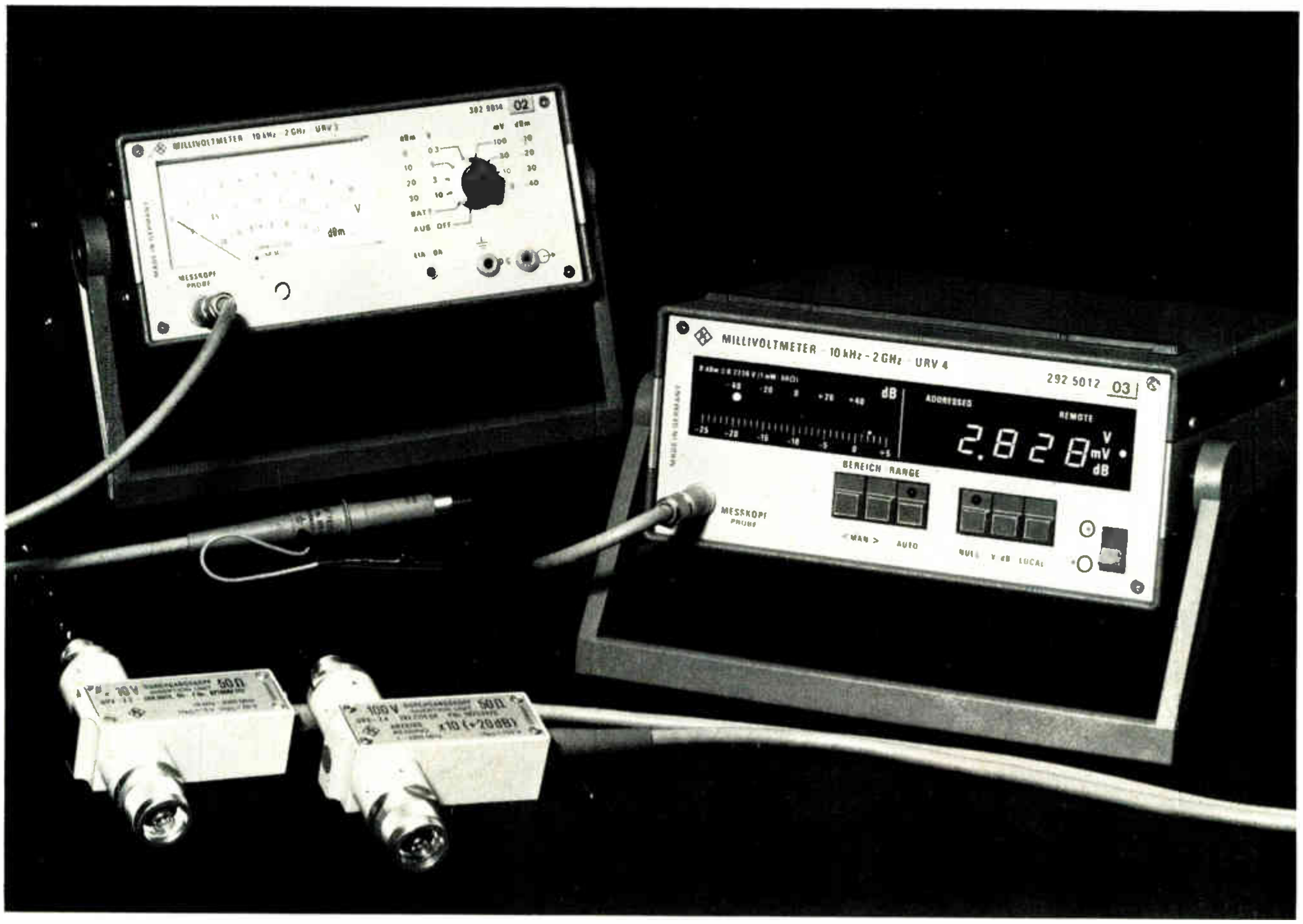

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- line- or battery-powered
- ideal for mobile use too

Simple and easy-to-understand operation with just a single range switch. For powering it you can use a battery, accumulator or line supply (consumption only 0.2 W). There's also a battery check and a recording output. The mechanical design in a compact and rugged case ensures good screening against high electromagnetic fields.

Digital millivoltmeter URV 4
A must for systems applications

- digital and analog display
- resolution 1 μV
- IEC-bus interface

RF voltages or levels can be displayed digitally and at the same time their tendency indicated in quasi-analog form.
The measuring range is selected automatically or manually. Zeroing is automatic and there's digital storage of the derived correction. That all means maximum operating ease: Just switch on and read off the value. What's more there's a level-proportional recording output covering 83 dB.
Over an IEC bus you get complete programming of all functions and conditioning of the measured values ready for further use.

Rohde & Schwarz GmbH & Co. KG
Postfach 80 14 69
D-8000 München 80
Fed. Rep. of Germany

Electronic Measurements and Radio Communications. Development, manufacture, sales and service. Known for "electronic precision".
Independent concern (establ. 1933), represented in 80 countries.

ROHDE & SCHWARZ

Circle 270 on reader service card

Permanent copies. For pennies a page. Introducing the most practical copier of all!

The new Tektronix 4612 video & raster scan hard copier.

For a low purchase price and just pennies a page, the 4612 can copy the graphics and alphanumerics on your raster scan or video display, at the press of a button. Tektronix' unique electrostatic technology produces sharp, high contrast, permanent images. With easy loading of paper and toner. And reliability in the best Tektronix tradition.

The copying process is liquid-free. Our dry powder toner is clean and convenient, and makes electrostatic images of the highest quality. Copies last indefinitely, and are as easy to write on as bond paper.

The 4612 expands the Tektronix family of video copy devices...including the toner-free 4632 for high resolution and gray shading. And the 4634, whose critically sharp photographic quality and extensive gray scale shading is the most economical approach ever to continuous-tone imaging applications.

The Tektronix video copier family is compatible with any RS-170 video signal, and with many others as well. So for the most practical approach to putting your displays on paper, contact your Tektronix sales engineer.

Please send me more information on
Video Copiers.

Name

Position

Company

Address

Telephone

Tektronix International Inc.
European Marketing Centre
Postbus 827, 1180 AV Amstelveen
The Netherlands

THE GRAPHICS STANDARD

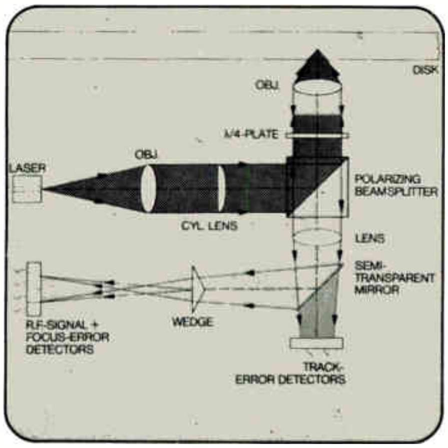
Tektronix
COMMITTED TO EXCELLENCE

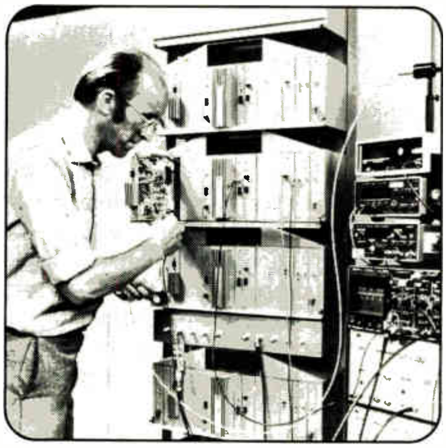
Circle 159 on reader service card

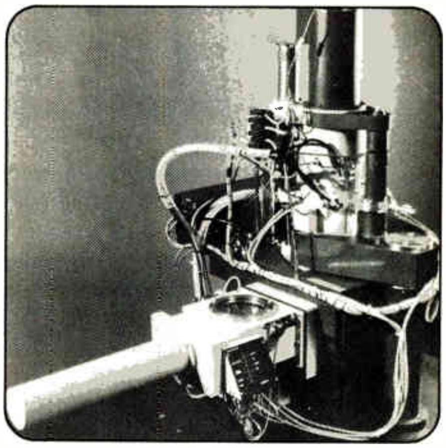
In the field of light-wave communications, our optical fibre transmission systems, employing terminal equipment, optical repeaters and multi-fibre cables of our own design and manufacture, are undergoing acceptance trials by a number of European telecommunications authorities. Meanwhile, fully operational optical fibre systems have been ordered for the 3rd phase, 200,000-line expansion to the Saudi Arabian public telephone system, where they will form an integral part of the digital junction network.

We combined our unique experience in the development of video and audio long playing disk systems with a technological breakthrough in semiconductor diode lasers to invent the world's first digital optical recording system (DOR) which enables the recording and retrieval of 10,000 million bits on a single 12-inch disk.

Philips will continue to set new standards for information technology. For the electronics industry is only at the threshold of the potential these disciplines promise.







High-density data storage and retrieval. Philips digital optical recording system represents the logical integration of micro-electronics, opto-electronics and micro-mechanics. The optical read/write head employs an ALGaAS diode laser that generates a pulse to burn a 1μm pit into a tellurium-based recording film. Reading is by directing a lower power laser-light source at the pits and detecting the difference between the pits and the surrounding material. The read/write head also contains a 40-gram optical system and associated opto-electronics for tracking and focusing, whose precision and compactness is complemented by equally ingenious radial tracking and error-detection correction systems. Each side of the disk has 45,000 tracks, divided into 128 sectors, each of which can be individually addressed. With a storage capacity of 10^{10} bits, a writing speed of 2M/bits/sec and a mean access time of ·150 ms, this new medium may well provide the leading-edge technology for future information storage, retrieval and distribution.

Circle 167 on reader service card

Light-wave telephone transmission. In addition to Philips all digital PRX/D exchanges, the Saudi order includes the integration of 140M/bits optical fibre systems into the existing 2M/bits PCM networks in the Jeddah and Riyadh multi-exchange areas. Six-fibre cables, with a capacity of 1920 calls per fibre, will be used in the repeaterless routes, which total some 45 system kilometers. When completed it will be one of the first operational 140M/bits optical fibre transmission systems in the world. Circle 168 on reader service card

Write for more information to: Philips, C.M.S.D.-Marketing Communications, VOp, Room 22, Eindhoven, Holland.

Or telephone:
Athens 9215311, Brussels 2191800, Copenhagen 01-572222, Dublin 693355, Eindhoven 793333, Hamburg 2812348, Helsinki 17271, Lisbon 683121, London 836 4360, Madrid 4042200, Milan 6994371, Oslo 463890, Stockholm 635000, Vienna 629141 ext. 471, Zurich 432211.

Or telex:
35000-PHTC-NL/CMSD-Marketing Communications, Eindhoven, Holland.

281

Vector scan lithography. Compared to conventional optical lithography techniques, vector scanning produces significant savings in the time taken to produce a set of masks or reticles: hours instead of days. Moreover, as the writing beam is directed only to those points where exposure is required, it is much more efficient than the raster E-beam method. The Philips Beamwriter generates an exposure dosage twenty times greater than other commercially available E-beam systems to provide a faster maximum writing speed and a wider choice of resists, and can produce beam-spot sizes down to 0.025 micron. Thus the Beamwriter is equally suited to both large and very large scale integrated circuit manufacture.

Circle 169 on reader service card

PHILIPS

Philips working on applied electronics

PROM programmer simplifies transfer of data from disk

by Kevin Smith, London bureau

Programming card comes with user-friendly software, plugs into slot of Multibus microcomputer system

Transferring programs from microcomputer development systems to programmable read-only memory can be a simple and painless task for owners of Multibus-based systems. They can plug a PROM programmer module directly into a slot of their Multibus card frame and use it to transfer programs between disk file and PROM under software control. User-friendly instructions guide the programmer every step of the way.

The PROM programming card and the software to drive it have been developed by London-based microcomputer specialists, Bleasdale Computer Systems Ltd. The system comprises a PROM programmer card costing around $1,143, a set of personality modules that configure the programmer for most popular 5-V PROMs, and an 8-in. single-density single-sided floppy disk containing the control software—costing $229—to drive the programmer. Currently personality modules and software are available for the 2708, 2716, 2732, 2732A, 2758, 2764, 2508, 2516, 2532, and 2564.

The programming card is completely self-contained, incorporating power supplies and control logic together with six zero-insertion-force connectors. Bleasdale, a start-up company, has standardized on Intel Multibus-compatible products and produces its own Z80-based microcomputer system that will drive the board; but, says founder-director Eddie Bleasdale, the company's prime target is those users who already have Multibus systems.

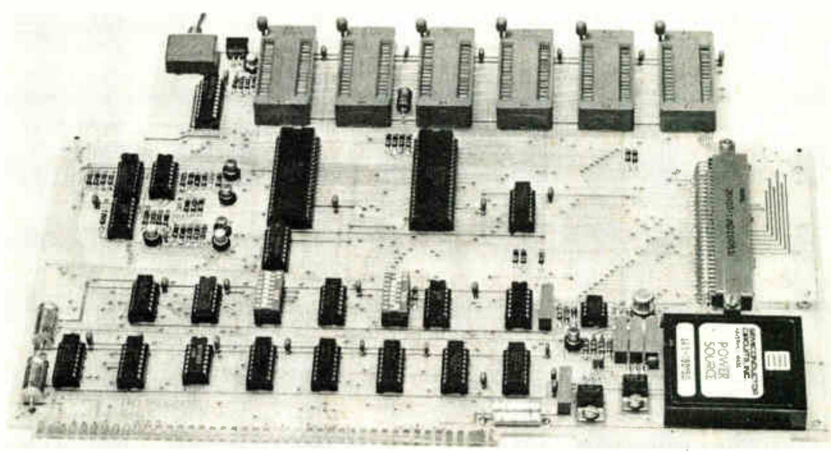
The software currently runs under the CP/M operating system on either the 8080 or Z80. Software to run under Intel's Isis, CPM/86, and 6809 Flex is also being developed and will be available in the last quarter of this year. Up to six PROMs can be programmed simultaneously, allowing programs of up to 48-K bytes to be copied in one operation.

Interactive. The operator controls the PROM programmer through the computer terminal. It guides him at every stage, telling him what is happening and requesting further information. For example, once the personality module has been inserted it demands the PROM type and the number of PROMs to be programmed. The disk file is treated as a series of PROM images, which can be displayed on request. The help command gives the operator detailed information of each command and how it should be used.

Memories 16 bits wide present no problem. Using the double mode, the first byte of each 16-bit word loads to socket 0 while the second byte loads to socket 1. Up to three pairs of PROMs may be programmed with identical data simultaneously, using the multiple-copy mode.

Verification of data programmed into PROMs is an automatic part of the various copy commands, causing the contents of selected PROMs to be compared with their specified file image. There is also a save instruction that copies the contents of one or more PROMs in disk file.

Bleasdale Computer Systems Ltd., Francis House, Francis Street, London SW1P 1DE, England [441]



LSI quietly presents the Hummm Terminal.

From those wonderful folks who brought you the Dumb Terminal® video display, now there's the Hummm Terminal™ Printer.

Featuring quiet operation that's almost unheard of, outstanding reliability and print quality, impressive throughput and a long list of sensible features.

All at a hard-to-believe low price. So low, in fact, that you'll immediately know why we call it Hummm Economics.

A LOT OF IMPACT PRINTER WITHOUT A LOT OF NOISE.

Quite simply, the 310A Hummm Terminal is one of the quietest impact printers in its class. In fact, with its Acoustic Quieter it checks in at a soothing 56dBA. That's quieter than most typewriters. And than most copy machines.

Fine engineering is the quiet secret. The Hummm Terminal hums along bidirectionally at 180 cps.

BELLS AND WHISTLES STANDARD.

You won't find many options on the Hummm Terminal. Because we made most of them standard.

Its logic seeking capability finds the shortest path to the next character on a new line—thanks to space and blank character compression. And with an optionally expanded buffer of 2048 characters, a full terminal screen can be dumped instantly.

You get superior printing capability, including true lower case descenders and underlining—good for an original and five crisp copies on multipart forms. A 9x7 character field. Complete horizontal and vertical forms control. 14 switch selectable form lengths, and 14 perforation skip-over formats. And a 100% duty cycle.

HUMMMAN ENGINEERED.

The Hummm Terminal brings to computer printers the same high standards that made our Dumb Terminal video display the standard for an entire product category. It's rugged, durable, and stylish so it fits right into any office decor.

So call your nearest LSI Authorized Distributor and ask him for some Hummm Terminal information. And when you do, fill out the coupon completely and send it to us. We'll send you a free Hum³ with over 3 billion combinations—and only one right one.

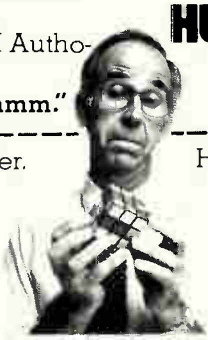
It'll give you something to do during those quiet moments when the Hummm Terminal is humming along.

Lear Siegler Data Products LTD
Orchard House, Connaught Road, Brookwood, Surrey GU24 Oat, United Kingdom Tel: Brookwood (048 67) 80666 Telex: 859415

THE 310A HUMMM TERMINAL.

LEAR SIEGLER, INC
DATA PRODUCTS LIMITED

"Hummmm."



Hummm, Lear Siegler. You've certainly given me something to think about. I asked my distributor about the Hummm Terminal.

Here's his name along with my business card. (I realize that I can't get a Hum³ if I don't include my card.)

Name ____________________

Distributor ____________________

Distributor Sales Rep ____________________

Distributor Location ____________________

Distributor Telephone ____________________

Lear Siegler Data Products LTD, Orchard House, Connaught Road, Brookwood, Surrey GU24 Oat, United Kingdom H

Circle 271 on reader service card

Lear Siegler Authorized Distributors: **AUSTRIA** Micro Automation Vienna Tel 222 835634, **BAHRAIN** Mantech Computer Services Tel 252600, **BENELUX** Computec Waalre Tel 4904 5865, **CYPRUS** Logimetrics Nicosia Tel 44400, **DENMARK** Iversen & Martens Holte Tel 452 424711, **FINLAND** Jertec Helsinki Tel 585133, **FRANCE** Technology Resources Neuilly Tel 747 7051, **GERMANY** Deutsche Eurotech GmbH Meerbusch 1 Tel 2105 73073, **GERMANY** Teleprint/TDC Frankfurt Tel 6196 46060, **GREAT BRITAIN** ITT Microprocessors Harlow Tel 0279 26777, Penny & Giles Christchurch Tel 04252 71511, Peripheral Hardware West Molesey Tel 01 941 4806, Riva Terminals Ascot Tel 03447 5193, **GREECE** Infodata Athens Tel 642 1368, **ICELAND** Ortolvu Taekni Reykjavik Tel 11218, **ISRAEL** Information Systems Tel-Aviv Tel 483261, **ITALY** Stelit Rome Tel 501 2996, Teleprint Milan Tel 2155724, **NORWAY** Kjell Bakke Nygata Tel 711872, **PORTUGAL** Datamatic Braga Codex Tel 27027, **REPUBLIC OF IRELAND** Cara Data Processing Dublin Tel 602066, **SOUTH AFRICA** Data Corporation of S.A. Johannesburg Tel 287911, **SPAIN** Specific Dynamics Iberia Madrid Tel 403 0362, **SWEDEN** Datametrix AB Sigtuna Tel 760 51655, **SWITZERLAND** Rotronic Zurich Tel 523211, Technology Resources Bern Tel 22 39 73, Teleprint TDC Zurich Tel 056 26 30 63, **LEBANON, SAUDI ARABIA, SYRIA** Orcent Computer Division Damascus Tel 456000, Micrelectro Developments Tel 0582 421793

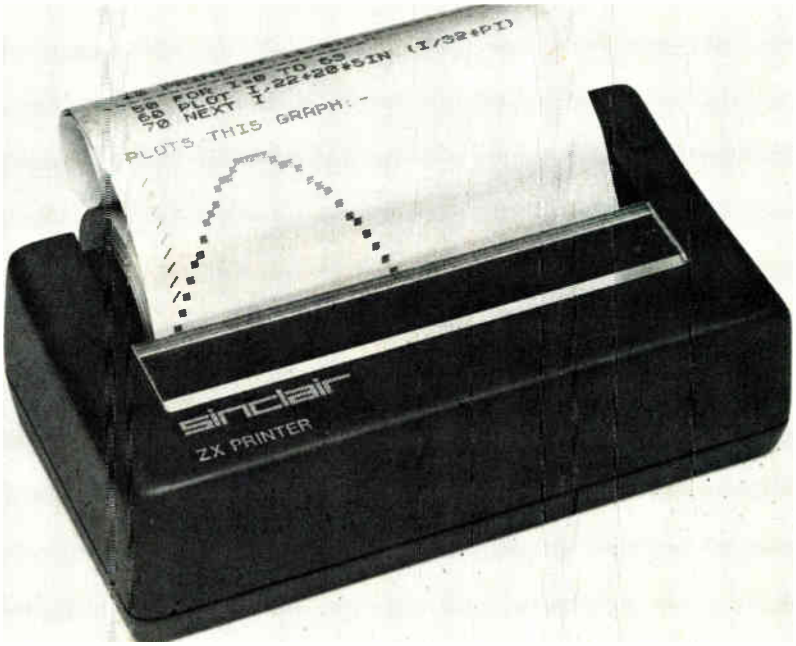
Low-cost printer puts out alphanumerics and graphics

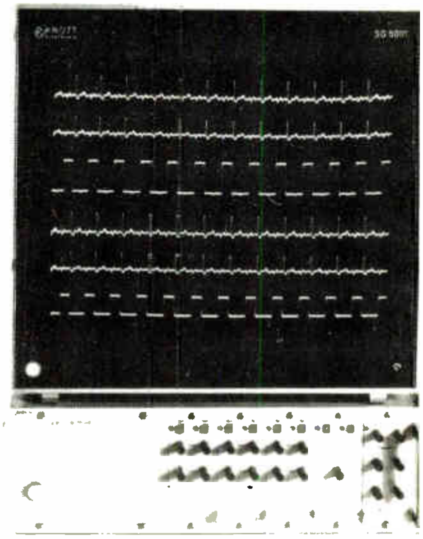
Sinclair Research claims to be selling around 20,000 of its low-cost personal computers per month, and therefore sees a ready market for its ZX alphanumeric and graphics printer. The dot-matrix unit is to sell through the mail for a mere $91.40.

Requiring special aluminized paper, the ZX prints 32 characters per line at 50 characters per second and nine lines to the vertical inch. The unit operates only with the ZX 81 computer, or the ZX 80 with a retrofit 8-K read-only memory. It plugs into the computer using a stackable connector that allows the 16-K random-access memory package to be used at the same time.

The ZX printer is set up to copy the contents of the television screen with a single command, doing so in 14 seconds at an effective cost of about 2 cents, according to the company's estimate. The L LIST instruction tells the system to produce a program listing; L-PRINT directs it to print copy on the printer and not the screen.

Sinclair Research, 6 King's Parade, Cambridge CB2 1SN, England [442]





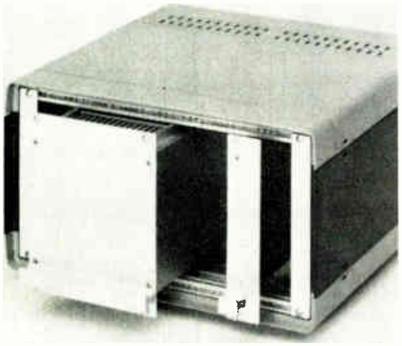
The SG6000 multichannel storage/display unit is for medical and industrial applications. It displays up to eight low-frequency signals simultaneously on a 50-cm-diagonal screen as a continuous scan from right to left or as frozen frames. Knott GmbH, D-8021 Hohenschaeftlarn, West Germany [466]

The TG 1742 miniature surge arrester protects equipment from overloads. It has a high open-circuit resistance, a 2.5-kA surge-flow capacity, and leads for printed-circuit board mounting or axial pins for plug-in holders. Clare International, 32 Avenue Horizon, B-1150 Brussels, Belgium [467]

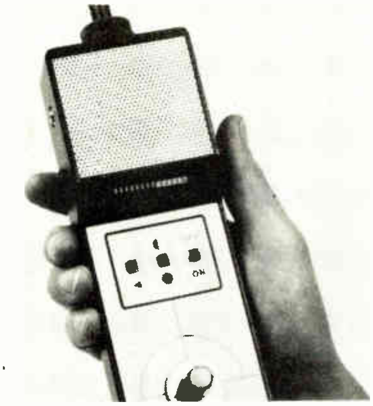
The 710.1 plug-in totalizing counter measures 50 by 25 by 88 mm. It has six decades and a 7-mm-high light-emitting-diode display, and operates from a 24-V dc supply. Its counting frequency is 5 kHz or an attenuated 50 Hz. Hengstler, P. O. Box 100, D-7209 Aldingen, West Germany [468]

Circle 272 on reader service card

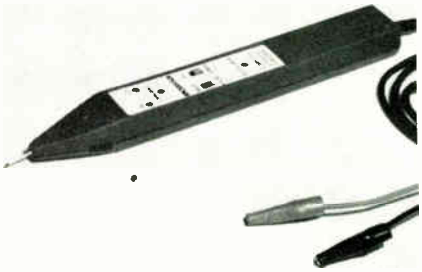
New products international



The 19-in. Europa Package Type 02 accommodates sturdy aluminum card magazines that hold Eurocards measuring 100 by 160 and 160 by 220 mm as well as double Eurocards 233.4 by 160 and 233.4 by 220 mm in size. AKA Mayr AG, CH-8635 Duernten, Switzerland [462]

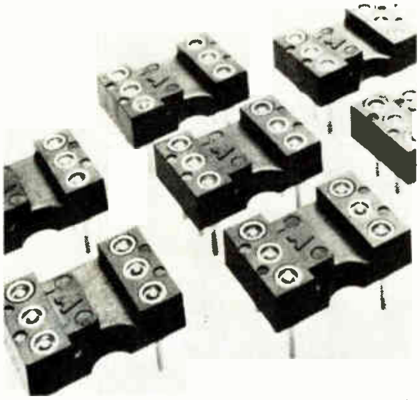


The USLD 110 leak detector spots air, water, gas, hydraulic, and vacuum leaks in doors and tanks and monitors the correct functioning of injectors, steam traps, and valves. It also locates sparks inside electric motors. CNS Electronics Ltd., 61-63 Holmes Rd., London NW5 3AL, England [445]



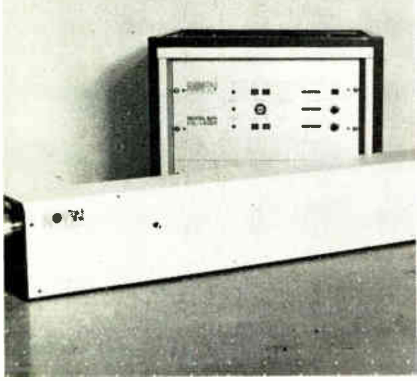
The LDP-076 logic probe has three light-emitting diodes that indicate high-, low-, and open-signal levels for analyzing TTL, DTL, and complementary-MOS logic circuits. It works from dc to 50 MHz. Sinclair Electronics Ltd., London Road, St. Ives, Huntingdon, Cambs. PE 17 4HJ, England [450]

The BUV 30 is a Darlington transistor intended for electronic ignition systems. Housed in a TO-220 package, the 4-by-4-mm element is glass-passivated and has a reverse voltage rating of 400 V. It carries 8 A. AEG-Telefunken, P. O. Box 1109, D-7100 Heilbronn, West Germany [443]



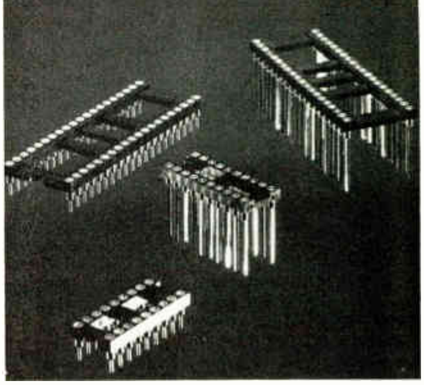
The 500-series six-pin socket is used with six-pin optical isolators. It comes on 7.62-mm centers with wrapped-wire or printed-circuit terminations and has gold- or tin-plated inner contacts and outer sleeves. HB Electronics, Lever Street, Bolton, Lancs. BL3 6BJ, England [446]

The Microax microminiature connector accommodates miniature coaxial cables as used in military and commercial equipment. It has a frequency range of dc to 2,000 MHz, input impedance of 50Ω, and crimpable inner and outer contacts. Huber & Suhner AG, CH-9100 Herisau, Switzerland [451]



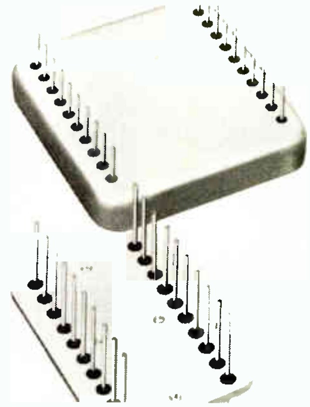
The 8010 laser machine solders and cuts nonmetallic materials like plastics. Its output power is continuously variable up to 50 W and it runs on bottled gas, water, and 10 A of single-phase 240-V line power. Rofin Ltd., Winslade House, Egham Hill, Egham, Surrey TW20 OAZ, England [444]

Model KC-532 LCR meter measures electrostatic capacity and inductance at 120 Hz, 1 kHz, and 10 kHz and resistance at 1 kHz. Measurements are indicated on a 3½-digit display; accuracy is to within 3%. Kokuyc Electric Co., 1-36-15 Ohoka Yama, Meguro-ku, Tokyo 152, Japan [449]



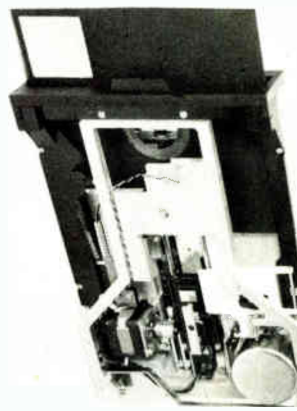
These sockets for dual in-line packages, in solder pin or wire-wrapped versions, have an average contact resistance after 1,000 insertion cycles of 5.3 mΩ. Vero Electronics Ltd., Unit 21-23, Solent Industrial Estate, Shamblehurst Lane, Hedge End, Botley, Hants. S03 2FY, England [452]

New products international



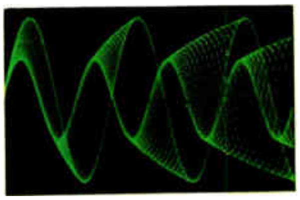
Solid side-wall and platform-style hybrid micro-circuit packages incorporate lead-through seals to meet high hermeticity standards. They are available with either 20, 30, or 50 pins on 0.6- or 0.9-in. centers. Sintered Glass Products Ltd., 1 Hollands Rd., Haverhill, Suffolk CB9 8PX, England [453]

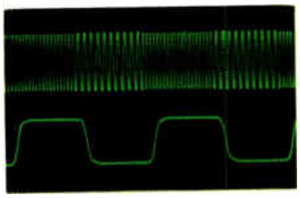
The model UDW 4500 semiautomatic 4½-digit wattmeter is used in harsh environments. It measures current, voltage, and power of up to 7.5 kW with a 100-nW resolution. It operates at dc and over a frequency range of 30 Hz to 50 kHz. Kontron, Breslauer Str. 2, D-8057 Eching, West Germany [454]

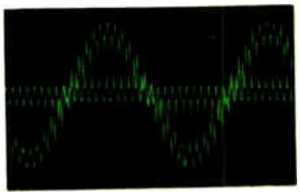


The YD-180 8-in. double-sided double-density flexible-disk drive has 1.6 megabytes of unformatted capacity and is compatible with IBM media. It requires 1 A at +24 V dc and 1 A at +5 V dc. YE Data Inc., Sunshine 60, P. O. Box 1171, 3-101 Higashi Ikebukuro, Toshima-ku, Tokyo 170, Japan [455]

Modulation Analyzer FAM


AM + FM


FSK


STEREO

All-round modulation analysis, manually or automatically, in the carrier-frequency range 55 kHz to 1.36 GHz

Special features:
Residual FM < 1 Hz (CCITT weighted)
Residual AM < 0.01 % (CCITT weighted)
– thus superior for spurious-modulation measurements

Excellent amplitude and phase linearity with stereo crosstalk attenuation of > 50 dB, distortion < 0.1 %

IEC-bus interface for use in automatic test systems

Compact design (12 kg) and low power needs

Easy to operate, ergonomic styling

The FAM is five instruments in one:
- modulation meter
- RF counter
- AF counter
- distortion meter
- psophometer

Versatile AF evaluation facilities:
- AF-level measurement
- weighting filters CCIR and CCITT
- distortion measurement

Indication of measured results by:
- three digital displays, one quasi-analog display

Ask fore more information
Modulation analyzer FAM

Rohde & Schwarz GmbH & Co. KG
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D-8000 München 80
Federal Republic of Germany

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Phone internat. +(4989) 4129-1
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(established 1933)
represented in 80 countries

ROHDE & SCHWARZ
Electronic measurements · Broadcasting
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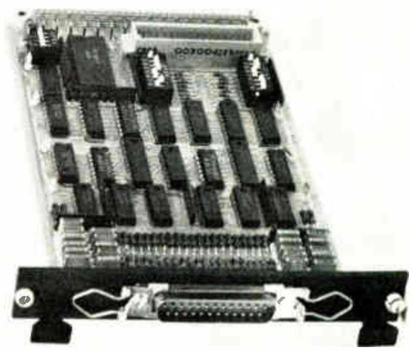
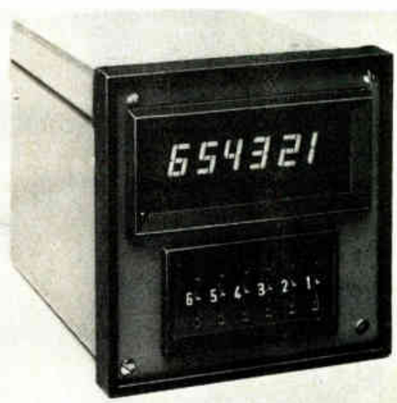
Circle 143 on reader service card

The E3470B subminiature Q-band magnetron for high-vibration duty produces an rf output power of 500 W peak at 33 GHz with an operating pulse voltage of only 2.3 kV. Full output is achieved only 1.5 s after it is switched on. The M-O Valve Co., Brook Green Works, London W.6, England [456]



Comparator card 653 SPS checks whether an actual digital value is smaller or bigger than or equal to a preset value. The preset value may consist of up to 16 bits; the value to be monitored is fed into the card via a 16-pole input device. Kuhnke GmbH, D-2427 Malente, West Germany [457]



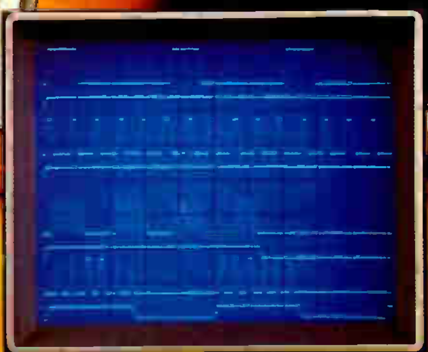
The LE-C50T, which displays in decimal form, and the LE-C60T, displaying in hours, minutes, and seconds are predetermining digital timers with seven-segment light-emitting-diode displays. Britec Ltd., Unit 17, Bermondsey Industrial Estate, Rotherhithe New Road, London SE16 3LL, UK [458]

Catch & Compare

Digital storage on the PM 3310 combines easy signal capture with sophisticated signal comparison and analysis. Here's how:

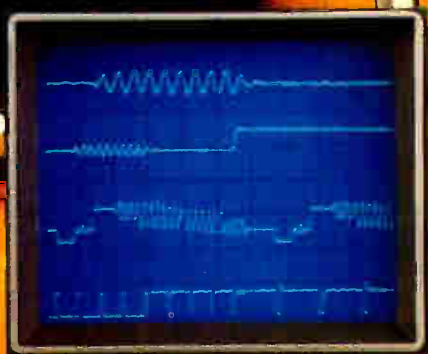
- 50 MHz clock rate (fastest yet in a portable scope) retains signal detail for fast, single-shot phenomena.
- 4 memories and 2 channels give multiple display modes over a 60 MHz bandwidth.
- A trigger delay of −9 to +9999 divisions that effectively stretches memory capacity and provides pre-/post-triggering.
- IEEE/IEC-Bus for systems operation and further signal analysis.
- Multiple single-shot mode for capture of successive transients.
- Plus TV triggering, X-t recorder type roll mode and X-Y recorder output.

PM 3310 sets a new standard in digital storage



Two input channels and four memories allow eight traces to be displayed for detailed analysis and comparison. The in-house developed Profiled Peristaltic Charge Coupled Device (P^2 CCD) allows 50 MHz data to be sampled in a cost-effective manner.

Easy operation is another big PM 3310 plus. Parameter settings, for example, are stored with the relevant signals and can be recalled for display.



An accurate −9 to +9999 division trigger delay extends the basic benefits of A/D conversion. This facility is used here to pick out a particular TV colour burst.

Philips Industries, TQ III-4-62,
Eindhoven, The Netherlands.

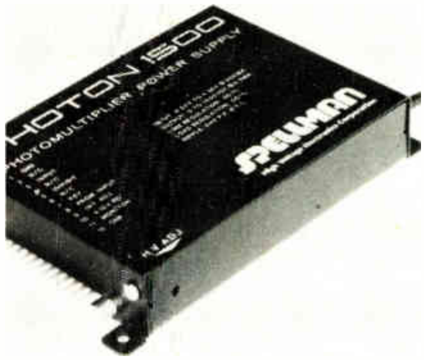
From Philips, of course

Test & Measuring Instruments

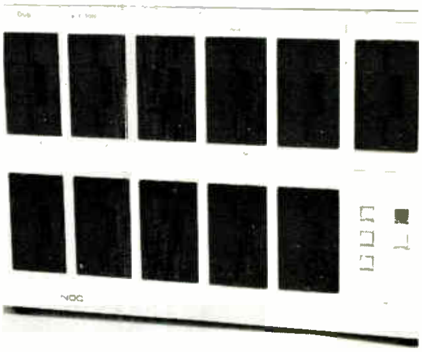
PHILIPS

Circle 145 on reader service card

New products international



The Spellman Photon 1500 Power Supply offers either positive or negative outputs at voltages up to 500 V and current levels up to 3.3 mA and requires 22 to 30 V dc at a maximum of 0.5 A. Hartley Measurements Ltd., Kenward House, Hartley Wintney, Basingstoke, Hants. RG27 8NY, England [459]



The mFC-5010 disk duplicator is designed to reproduce 10 copies of one 5.25-in. double-sided double-density flexible disk in approximately 4 minutes (25 seconds per copy). Nippon Office Communications Co., 1-31-10 Higashi Ikebukuro, Toshima-ku Tokyo 170, Japan [460]

The DCA 1000 logging system is a package of data-collection and -analysis software and hardware. It interfaces with a Hewlett-Packard 1000 minicomputer to record onto a disk at up to 150 kHz. Micro Consultants Ltd., Kenley House, Kenley Lane, Kenley, Surrey CR2 5YR, England [461]

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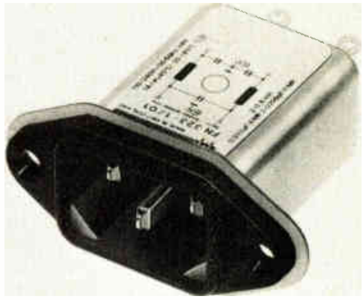
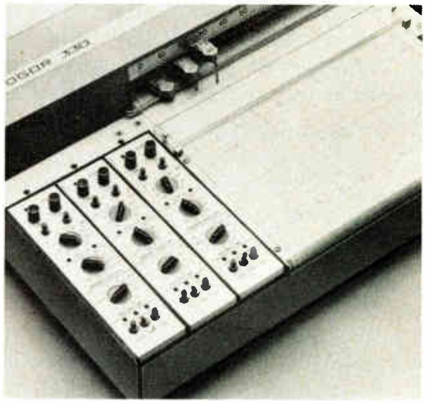
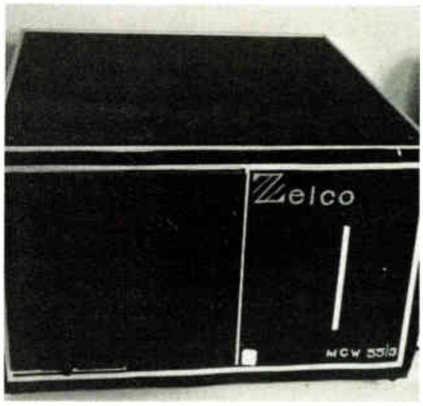


The FN 323 rf-interference-suppression filter has nominal current ratings of of 1, 3, and 6 A and incorporates self-healing metal-foil capacitors. Its closed metal housing provides the filter with good attenuation characteristics. Schaffner AG, CH-4708 Luterbach, Switzerland [463]



The Servogor 300 TR transient recorder records analog signals at over 100 kHz. It handles up to three separate channels simultaneously either in master-slave operation or under a triple-OR condition. Metrawatt GmbH, Thomas-Mann-Str. 16-20, D-8500 Nuremberg, West Germany [464]



The Micro Computer Winchester, based on Zilog's Z80B, is for multiuser operation at 1.3 million instructions per second. It has a minimum of 112-K bytes of random-access memory and 10 megabytes of Winchester storage. Zelco SRL, Via V. Monti 21, 20123 Milan, Italy [465]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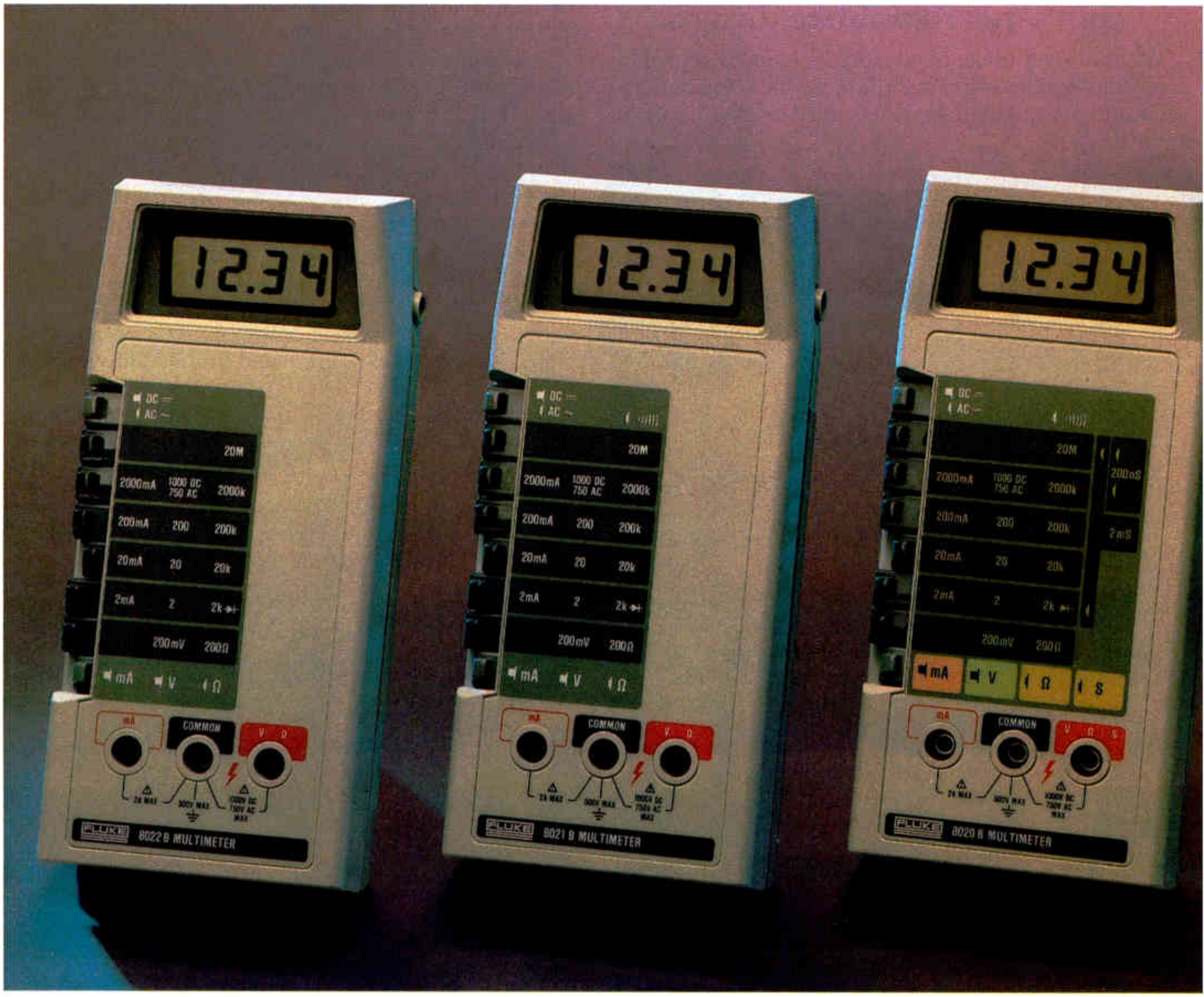
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8021B	•	•	•	•	•	•		•				0.25%
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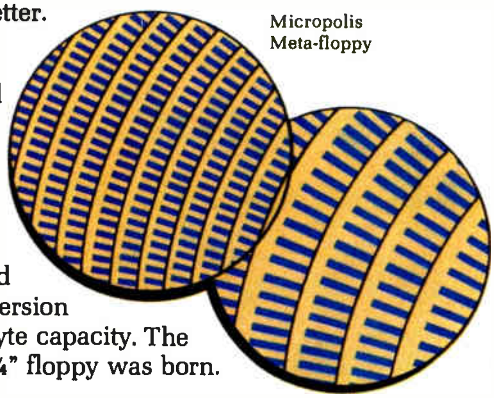
Some plain 96/100 TPI

FACT: We invented 1 megabyte technology.

When the mini-floppy, with less than 100 kbytes capacity was introduced in 1976, we had a choice. Go along with the rest or do better. We chose to do better. Within a year we doubled both bit density and tracks per inch, resulting in a single sided floppy with 0.5 million bytes and a double sided version with one megabyte capacity. The high capacity 5¼" floppy was born.



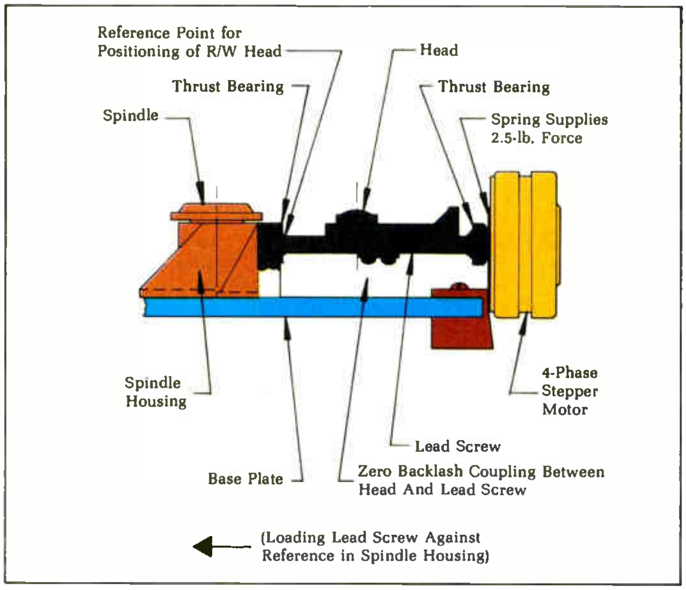
FACT: It took solid engineering to do this.

To quadruple capacity, yet keep interchangeability at the highest level, was no easy task. It took solid, innovative engineering at all levels. The result:

• **Disk Centering Mechanism** - In our drive, the center of the diskette fits over a profiled spindle and is clamped into place while the spindle rotates to assist centering. This technique assures precise centering to within 250 μ-inches and eliminates disk crunching problems.

• **Head Positioning Accuracy** - A precision ground stainless steel leadscrew with metal follower provides more precise positioning than the run-out sensitive pulley and belt approach used by others. Use of a four phase stepper motor and four steps per track averages the effects of all stator and rotor poles, resulting in ± 83 μ-inches positional accuracy.

• **Temperature Compensation** - Our temperature compensation loop includes only the diskette, pre-loaded leadscrew and spindle housing. The baseplate is specifically excluded since its expansion is compensated by a proportional change in the preload of the leadscrew. This approach consistently limits temperature variations to ± 250 μ-inches.



• **Balance Between Speed & Accuracy** — We chose 10ms track-to-track positioning and 380 kbps transfer rate as an optimum balance between speed on one hand, and accuracy and interchangeability on the other.

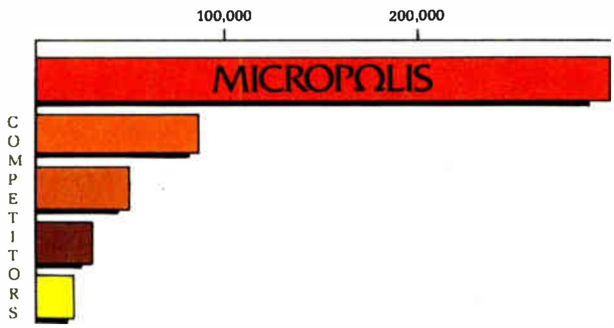
• **Silent Operation** - In band type drives an annoying chatter results from the head's travel from track to track. Our precision stainless mechanism eliminates this noisy irritation.

FACT: Our drives really work.

While others are still learning, our 96/100 TPI drives are operating reliably in systems all over the world. So well, in fact, that we're extending the warranty to 12 months on new OEM agreements. Design and process controls learned years ago, coupled with effective quality control, assures drives ready to work in your system.

facts about 5¼" floppies

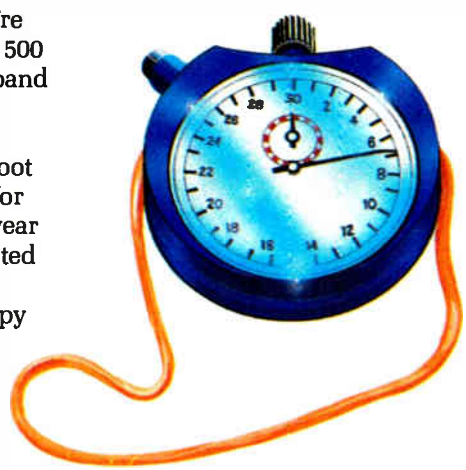
FACT: We've delivered more 96/100 TPI drives to OEM's than all others.



To date we've delivered over 200,000 double track density drives; more than all of our competitors combined. Hundreds of manufacturers of successful small business systems have selected Micropolis drives for their cost effectiveness and proven reliability.

FACT: We're producing more than one each minute.

If you need high performance floppies on time, and in quantity, come to Micropolis. We're producing over 500 a day... and expand ing. Expansion includes a new 60,000 square foot plant planned for occupancy by year end and dedicated completely to 96/100 TPI floppy production.



FACT: We've invented again - A 2 megabyte 5¼ inch floppy.

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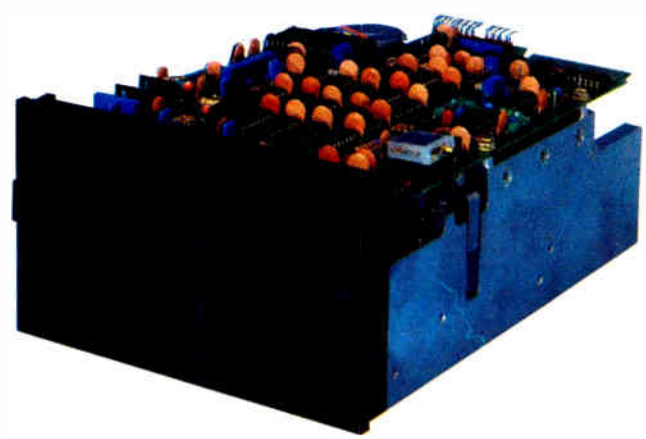

So you win both ways with Micropolis. If you need 96/100 TPI floppies now, order our field proven 1015/1016 series. If you're working on a new system, design in our 2 megabyte Model 1117, the high performance "chassis within a chassis" floppy.

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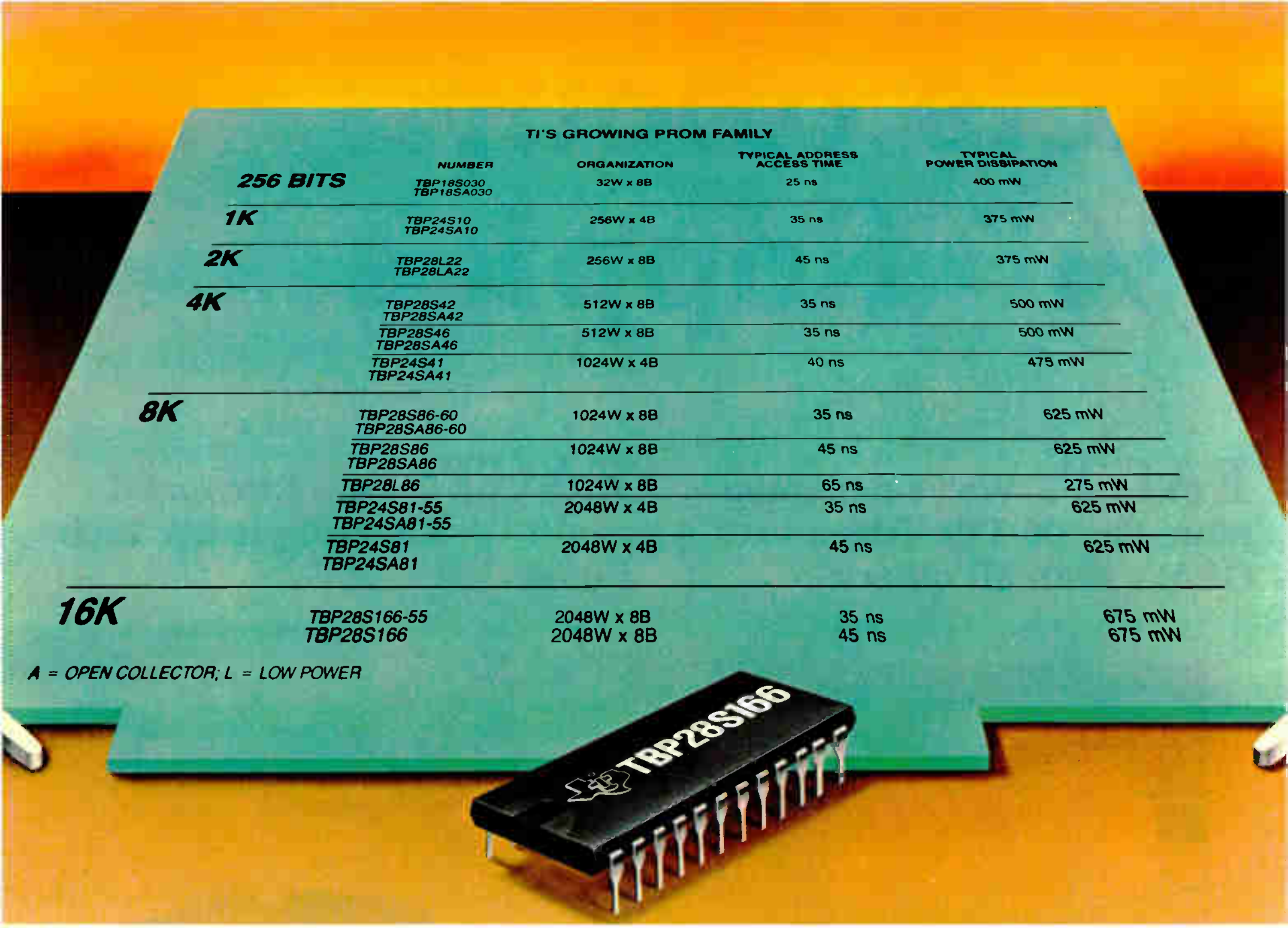

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Five more choices

TI has also redesigned five of its PROMs to give you better performance than ever before: the popular 1K; a low power 2K; two 512W x 8B 4Ks; the "by 8" 24-pin 8K. All offer faster address access times and lower power consumption than previous designs.

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Circle 88 on reader service card

VHSIC proposals take six fast tracks

Military program's requirements match commercial targets, with competitors going to varied technologies

by John G. Posa, Solid State Editor

The Department of Defense's Very High-Speed Integrated Circuits program promises to carry military electronics from the mundane to the fantastic in just a few years. But even more importantly, rather than designing expensive, esoteric hybrid circuits, the targets of the government's VHSIC program—submicrometer lithography, design automation, and cool-running packages laden with input and output pins—are also in the sights of the semiconductor industry.

Of the nine semiconductor manufacturers that vied for a piece of the VHSIC pie during the now-concluded study portion, Phase 0, of the program, six emerged as primary contractors for Phase I—the "prove-it" portion [see Table 1 and *Electronics*, June 30, p. 98]. During the first half of Phase I Honeywell, Hughes Aircraft, IBM, Texas Instruments, TRW, Westinghouse, and their teammates will use 1.25-micrometer lithography to build chips that operate with a minimum clock rate of 25 megahertz and exhibit a functional throughput rate (FTR) of 5×10^{11} gates-Hz/centimeter^2 (see Table 2).

These chips will be installed into military breadboards, called brassboards, by 1984. As a comparison, Motorola's 11-MHz MC68000 16-bit microprocessor, viewed as one of the most sophisticated of consumer integrated circuits, barely meets the FTR requirement with its rating of about 5.3×10^{11} gates-Hz/cm^2.

Even though the 68000's maximum clock rate is now being raised to 12.5 MHz, that is still only half the VHSIC speed requirement. Moreover, for Phase Ib, the VHSIC teams will build chips with FTRs of 10^{13} gates-Hz/cm^2 using 0.5-μm lithography, and that means optical projection will be out of the question.

The VHSIC chips must also meet a radiation-hardness specification of 10^4 radiation-absorbed doses, tolerate faults, and test themselves. The circuits must be able to handle 5-volt logic swings—a subtle but challenging problem with scaled-down geometries—and they must function reliably over the $-55°$-to-$+125°$C military temperature range. On top of this, the contractors are being pressed to find alternate sources for their circuits.

Different strokes. At the first annual VHSIC-program review in Arlington, Va., representatives from the six Phase I contractors put forth their solutions to the Pentagon's puzzle. The approaches are as varied as the rules are strict.

Some, like Honeywell, will build only a few highly-programmable components and personalize them with software. Others, like TRW and Westinghouse, have elected to fashion many less general circuits. In addition, technologies that range from current-mode bipolar to complementary-MOS on sapphire will be used to build the VHSIC chips.

Honeywell proposes only two different, but impressive, chips for its electro-optical signal-processor brassboard: a 40,000-gate programmable parallel processor and a 30,000-gate controller. Together they are capable of 12 billion multiplications and additions per second.

The processor contains a 15-nanosecond 20-K static random-access memory, an input/output controller, and eight identical parallel processing units. The microprogrammable controller will contain an 80-K read-only memory, operate off a 50-MHz clock, and dissipate about 1.4 watts in its 120-pin package. The brassboard will hold 34 chip pairs.

Honeywell Inc., whose Solid State Electronics division in Bloomington, Minn., produces more than 85 mil-

TABLE 1: THE SCHEDULE FOR THE VERY HIGH-SPEED INTEGRATED-CIRCUITS PROGRAM

Phase	Goals	Distribution of grants ($ millions)							
		1979	1980	1981	1982	1983	1984	1985	1986
0	• Define concepts • Detail plans		10						
1a	• Construct system brassboards • Build pilot line for 1.25-μm lithography			25	65	55	20		
1b	• Develop 0.5-μm technology								
2	• Demonstrate systems using Phase 1 brassboards • Build pilot line for 0.5-μm lithography						30	20	20
3	• Support other phases by defining and concentrating on problem technical areas	*	*	20	10	10	5	*	

*less than $5 million

SOURCE: DEPARTMENT OF DEFENSE

lion ICs per year, landed a Phase I contract with team member 3M Co. Active in bipolar since 1962, Honeywell chose this technology for the VHSIC program maintaining that it will exceed the Defense Department's goal for radiation hardness.

With a single process, it will produce integrated-Schottky logic, current-mode logic, and current-sourcing Schottky logic circuits. The three circuit types will span a gamut from low power and high density (150,000 gates/cm^2 of 10 microwatts each in the case of integrated Schottky logic) to high-performance circuits (500 MHz in the case of current-sourcing Schottky logic).

Even at the 1.25-μm level, Honeywell's VHSIC chips will be all-implanted and all-dry-etched. They will also boast three levels of metal, with 0.75-, 2-, and 4-μm lines and spaces on the first, second, and third levels, respectively. The company says that dry etching of the metal layers is particularly difficult.

Designers at Honeywell want to move from parallel-plate plasma etching to reactive-ion etching. The steep walls etched by the former occasionally pose step-coverage problems, whereas the slightly sloped walls possible with reactive-ion etching help alleviate them.

The 0.5-μm process will be used by Honeywell to build its VHSIC Phase Ib circuits (Fig. 1). Only electron-beam lithography will be used, and devices will be isolated with a U-groove to eliminate the "bird's beak" that is prevalent with today's selective-oxidation processes.

Four planar metal layers will be used, instead of three, to expedite the automatic-routing algorithm slated for its VHSIC chips. The company is also working on a geometry-translator program that will scale 1.25-μm features down to 0.5-μm.

A macrocell approach will be used by Honeywell to lay out its VHSIC parts, with its Bloomington facility acting as a silicon foundry. It has already designed 30 such macrocells, including memories, arithmetic and logic units, and multiplexers for the interior of its chips, and level converters, output buffers, and decoders for their periphery.

Honeywell's packaging ideas are consistent with its innovations at the silicon level. For its 1.25-μm ICs, it will use the arrangement shown in Fig. 2a. To be developed by partner 3M, the chip-carrier will support 160 to 240 pins, signals up to 50 MHz, and 160,000-square-mil chips that dissipate up to 5 W. Tape automated bonding will assist in handling and mounting the IC.

For its submicrometer circuits, the package in Fig. 2b will be used. Unlike its predecessor, the chip will be completely covered with solder bumps and attached to a carrier with multiple interconnection levels separated by polyimide insulating layers.

Honeywell's pilot line, to be demonstrated by the fall of 1983, will comprise a 3,000-square-foot class-10 clean room and a 12,000-ft^2 support area. It expects to make mask sets in as few as six weeks and pro-

TABLE 2: VHSIC PHASE I CONTRACTORS AND THEIR CHIP SETS

Contractor	Team members	Award ($ millions)/source	Principal brassboard	Circuits
Honeywell	3M	$19.9/Air Force	electro-optical signal processor	parallel processor and controller made with bipolar ISL, CML, and CSSL[a]
Hughes	Union Carbide	$27.4/Army	battlefield information distribution system	correlator, encoder-decoder, and spread-subsystem analyzer, all complementary-MOS on sapphire
IBM	Northrup	$19.9/Navy	acoustic signal processor	master-image gate array using n-channel MOS, then C-MOS
Texas Instruments	none	$22.7/Army	processors and sensors for multimode missile	gate arrays and vector arithmetic and logic unit using bipolar STL[b]; MOSword-wide memory
TRW	Motorola, Sperry Univac, GCA Mann	$34.4/Navy	electronic-warfare signal processor	window-addressable and content-addressable memories, register ALU, address generator, microcode controller, matrix switch, and input/output controller made with triple-diffused bipolar; C-MOS four-port memory
Westinghouse	National Semiconductor, Control Data, Boeing, Harris Semiconductor, Mellon Institute	$33.8/Air Force	tactical-fighter radar processor	16-bit, 32-bit, and pipelined ALUs; controller, 64-K static random-access memory, 5-K gate array, all built with bulk C-MOS

[a]ISL = integrated Schottky logic; CML = current-made logic; CSSL = current-sourcing Schottky logic [b]Schottky transistor logic SOURCE: DOD AND *ELECTRONICS*

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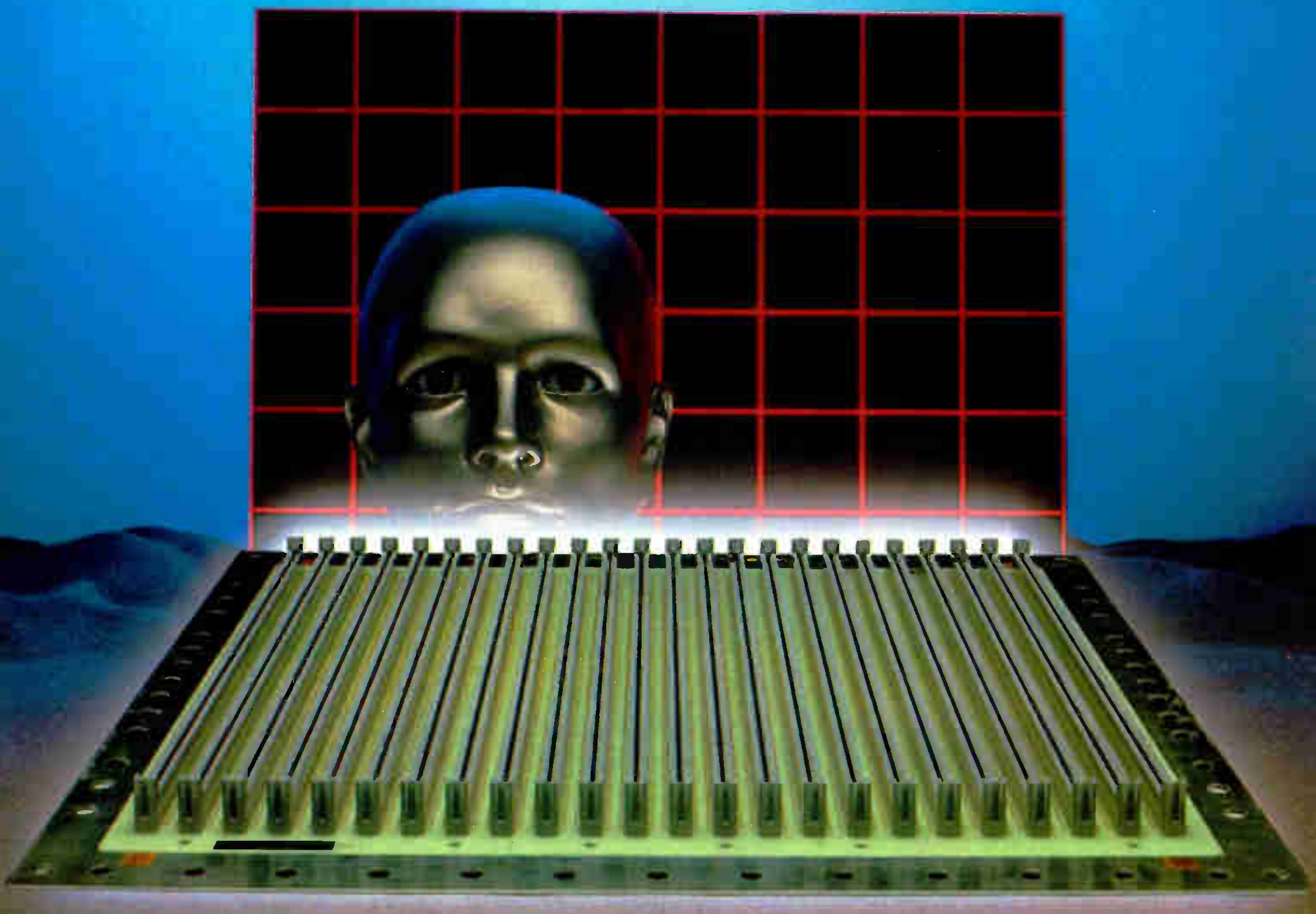

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cess about 200 wafers per week.

All wafer movement and processing will be computer-controlled; fabrication steps will be monitored through an automated measurement system that will collect and analyze process parameters. The company also expects to subcontract some of its brassboard-chip processing in an attempt to develop second sources.

Hughes Aircraft Co., Newport Beach, Calif., the holder of 11 Phase III contracts, has been supplying silicon-on-sapphire circuits to the military for years; for the Phase I circuits, Hughes will use its SOS-III process. Besides 1.25- and then 0.5-μm feature sizes, the process will benefit from mesa isolation, metal silicides, three levels of interconnection, and all-dry processing. Its battlefield information-distribution brassboard chip set will have a high-speed correlator, a programmable encoder-decoder, and a spread-subsystem analyzer.

E-beam next. The lithography equipment at Hughes's disposal for VHSIC circuit fabrication includes an Electromask 700 SLR10X aligner and an EBS-4A electron-beam system. Hughes was teamed with the ETEC division of Perkin-Elmer Corp. in Hayward, Calif., for a special $8.6 million contract to develop, by 1984, a shaped-electron-beam system capable of exposing more than four 100-millimeter wafers per hour. In addition, the direct-writing electron-beam lithography equipment will become commercially available.

Over 12,000 ft^2 of Hughes's planned fabrication environment will be supercleaned through laminar flow. Process flowing, including diffusion steps, will be computer-controlled, Hughes says. In fact, there will be microprocessors tied to every major piece of equipment.

Hughes's design-automation system Hercules (for hierarchical editor and router for chips using logic entry and simulation) has hardware that involves a network linking small processors to a central 32-bit super minicomputer capable of virtual storage. Attached to each remote machine is one or more $10,000-to-$20,000 graphics terminal.

The cell layout on Hughes's system will be done in color. A predefined set of gate-array overlays will be drawn upon to generate temporary and permanent microcells (Fig. 3). These microcells will be combined to form more complex macrocells from which standard or custom ICs will be constructed. This approach, along with Hercules, will allow chips to be designed and built in 16 to 20 weeks, with wafer fabrication accounting for half of that.

SOS was chosen, says Hughes's A. N. Chester, because it is capable of 0.7-ns gate delays and logic-circuit densities in excess of 45,000 gates/cm^2. Another impetus was C-MOS-on-sapphire's inherently high radiation hardness; Hughes has witnessed values as high as 10^7 rads.

Key to this type of radiation hardness is low-temperature processing. Methods like high-temperature annealing can create oxide traps that can capture carriers generated by an energetic particle, causing threshold shifts and other problems.

So, amidst the growing popularity for silicides of molybdenum and titanium, Hughes picked tantalum—in the form of tantalum silicide—because it anneals at a low temperature, yet brings the sheet resistance of polysilicon down to less than 5 ohms per square.

Hughes has observed that electron-beam processing can also damage oxide layers and create traps. Although a 400°-to-550°C anneal will remove the damage, the resulting components are not as resistant as Hughes would like them to be.

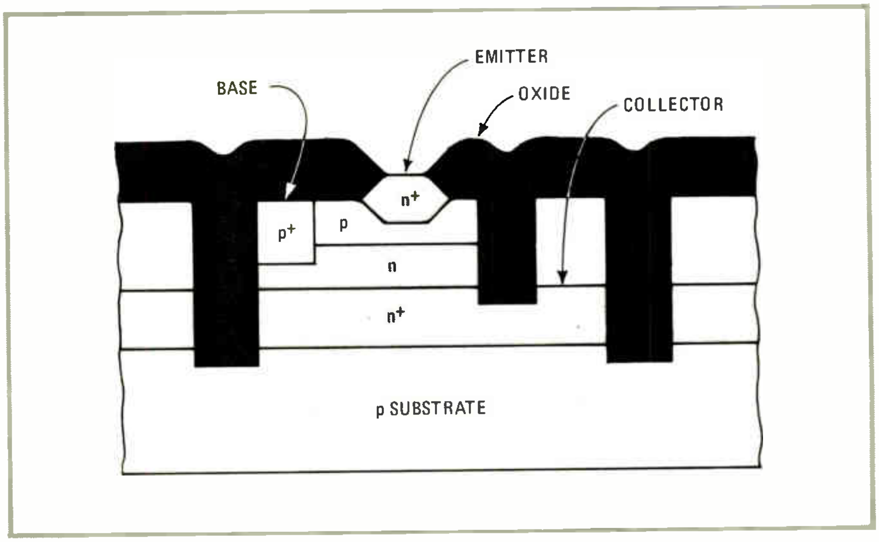
To avoid electron-beam processing, Hughes will relax the pitch of the aluminum layers on its SOS-III circuits to 2.5 μm, and separate them with an oxide that is ultraviolet-light-activated and chemically vapor-deposited—and not one that is thermally grown.

As a minimum, Hughes SOS-III will withstand 10^5 rads and an upset of 10^9 rads for a 10-ns pulse. The basic SOS-III process will feature silicide gates plus two levels of aluminum for an FTR of 1.6×10^{13} gates-Hz/cm^2, 50-MHz clock speeds, and 45,000-gate/cm^2 densities.

Back to one. As an alternative—in case there are problems—Hughes can drop back to one layer of aluminum and still achieve an FTR of 5.8×10^{12} gates-Hz/cm^2. It could even fall back on scaled SOS-II, since that process's 9×10^{11} gates-Hz/cm^2 FTR is already almost twice the VHSIC requirement.

Hughes is also confident about meeting the VHSIC mandate of 5-V logic swings. It is already deciding how to optimize the 0.5-μm process for 5-V operation.

So far, it has achieved subnanosecond gate delays with a 5-V supply; process refinements will push that down to 100 picoseconds—a speed that now demands a 10-V or higher supply. Included in the list of refinements may be a higher-quality epitaxial layer, a goal on which it is working with Union Carbide. But



1. U-groove bipolar. For the second half of Phase I, Honeywell will use electron-beam lithography to build current-mode bipolar circuits that are isolated with oxide trenches.

a big drawback of SOS is the short list of alternative suppliers. Hughes has participated in joint development efforts with the other two SOS chip makers—RCA Corp. in Somerville, N. J., and Rockwell International Corp., in Anaheim, Calif.,—and their processes are fairly compatible with Hughes's.

Swap done. In fact, Hughes has exchanged design rules and mask sets with RCA and agreed to process some of RCA's SOS chips. So either is a second-source candidate for the other.

IBM Corp.'s VHSIC effort is being divided among its General Technology, Research, and Federal Systems divisions, which will handle 1.25-μm process development, the submicrometer process development, and pilot-line brassboard production and packaging, respectively.

IBM points out its readiness for VHSIC on several counts. Initially, it will use a scaled-down n-channel MOS process that is identical to the one it now uses in production. The company already has a quick-turnaround pilot line, proven computer-aided design facilities, and multichip packages with multiple input and output lines.

Its 19,000-ft^2 assembly line in Manassas, Va., has been averaging 40 wafer starts per week using 2-μm features. It also intends to extend the capability of its automatic test systems to handle 30,000 gates.

IBM chose n-MOS because "it is a proven technology that can be made rad-hard," says its H. A. Cloud. However, he adds that "at the end of Phase I we will commit ourselves to a low-power technology." That will be C-MOS, a technology scrutinized by IBM during Phase 0.

In fact, IBM would have started off with C-MOS, but its development would have "thrown delivery of the first brassboard 18 months off schedule," says Cloud. When the time comes, IBM will turn to n-well C-MOS and tungsten silicide—its favorite refractory metal—to lower the resistance of interconnections.

IBM intends to concentrate on a macrochip architecture that adds custom macrocells to a gate array. It is focusing on this parameter-selectable chip to bring the nonrecurring cost per gate—now \$300 or more—down to below \$100. Cloud says, "This is a fundamental issue."

With n-channel technology, IBM anticipates 2-to-3-W chips comprising 100,000 or so 500-ps, 25-μW gates. Its goal for radiation hardness is 5×10^4 rads, though this exceeds the VHSIC goal. To achieve this level of hardness, IBM says the issue is charge buildup, specifically on MOS transistor gates.

However, conventional hardening processes are not in keeping with scaled-down IC structures, says IBM, nor are substrate bias generators, guard rings, and multilayered insulators. So, for its 0.5-μm work, IBM will scale down all horizontal dimensions and partially shrink vertical geometries.

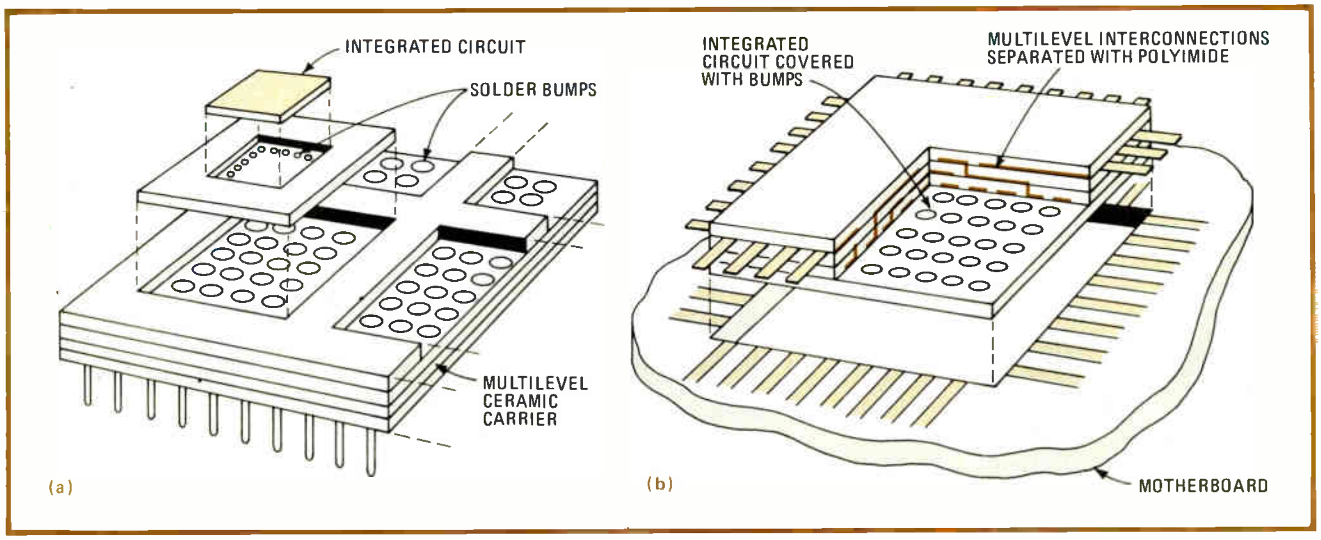
Gate oxides will be trimmed from 450 angstroms down to 250 Å to facilitate internal operation from a 1.5-V supply. In addition, field oxides will be grown to variable heights and implants will be varied for threshold control.

With its scaled-down MOS processing, IBM will build what it calls a master-image chip (Fig. 4). For versatility, the slice marries some 8,500 uncommitted logic cells with complete subsystems like RAMs and arithmetic and logic units for a total of about 30,000 gates on about a 100,000-mil^2 die.

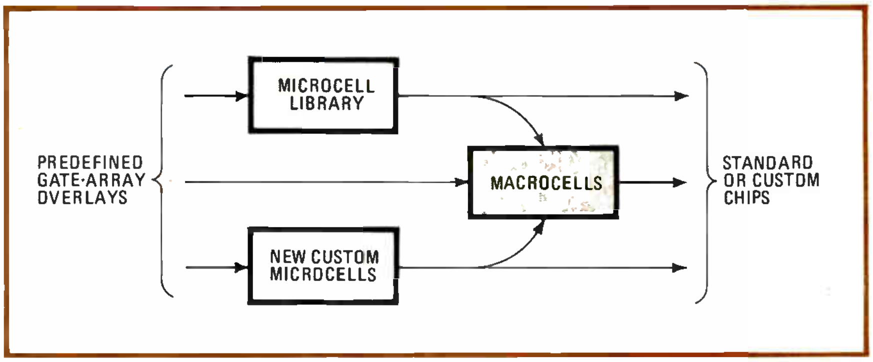
Chips like this will be built with 1.25-μm rules, but when the 0.5-μm lithography is put into effect, different versions of the same chip may result. For instance, the gate count could be held at 30,000, resulting in a higher-performance set of the same macrofunctions.

Rich slices. Alternatively, the die size could be held constant and much more complex macrofunctions could be devised. IBM foresees 100,000-gate slices with hierarchical macrocells embracing entire microprocessors, signal processors, and high-density memories.

To test these complicated units, IBM will use three on-chip methods. One will be its level-sensitive scan design, used on previous chips and boards [*Electronics*, March 15, 1979, p. 108]. Along with level-sensitive



2. Building blocks. Honeywell proposes two different packages for its VHSIC Phase Ia and Ib circuits. For phase Ia, chip-to-chip interconnections will be contained in a multilevel ceramic carrier (a). For phase Ib, the integrated circuit will be covered with solder dots (b).



3. Hierarchical. Hughes will use a structured, semicustom approach to design its very high-speed circuits. Gate-array overlays will help build libraries of microcells and macrocells.

scan design, on-chip monitors that incorporate some of the same techniques as monitor communications over sophisticated backplane wiring will be used. Finally, IBM's master-image ICs will feature availability-management subsystems that are still in the developmental stage.

To package these and other VHSIC chips, up to nine dice will be put into a hermetically sealed ceramic carrier measuring 50 mm on a side. Each chip will have an array of 17 by 17 bumps that adhere to the multilayer ceramic sustrate. More than 350 input and output pins will emanate from the bottom of the carrier.

The alternate source for IBM's VHSIC chips will be Texas Instruments Inc. of Dallas—currently the largest component supplier to the U. S. government—though TI has its own VHSIC contract with the Army for a small set of multiuse, programmable system components, gate arrays, and word-wide memories. N-channel MOS will be exploited for the memory chips, whereas the company's Schottky transistor logic will be the basis for the logic components.

Getting together. At present, roughly 90% of TI's VHSIC effort is internally funded. Its military memories illustrate how it plans to mesh its VHSIC projects with its commercial ones. Sometime in 1983, using the same 1.25-μm n-MOS technology, TI will introduce its 256-K dynamic RAM and 8-K-by-8-bit static RAM for commercial customers, in addition to its VHSIC chips.

In STL, TI is currently building an 8-bit-slice microprocessor, a 14-bit microcontroller, and a 16-by-16-bit multiplier for selected commercial customers. For the military, it will construct 4-K and 10-K gate logic arrays, a vector arithmetic and logic unit with integral 96-K read only memory, and an 8-K-by-9-bit static RAM.

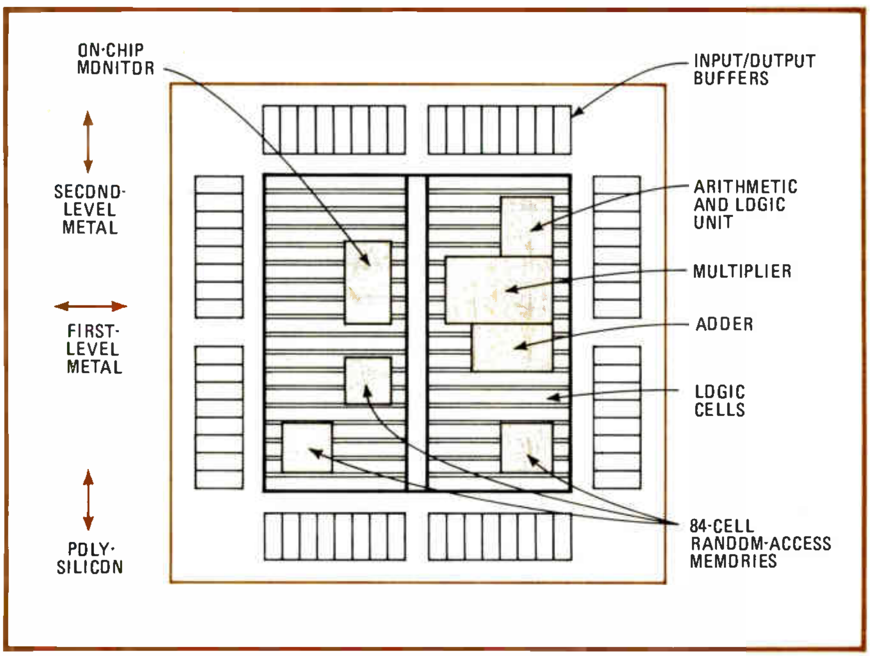
TI maintains that STL has the reliability of integrated injection logic and is perfect for gate arrays because performance hardly varies with captive loading.

So far, using 4-μm rules, it has characterized an STL version of the 9900 microprocessor (the 9989), and a 64-K ROM using 2-μm polysilicon diodes is currently in layout. On the basis of ring oscillators, 1.25-μm STL circuits having 10-microampere gate currents will have clock speeds of 40 MHz, and pushing the gate current to 50-μA will allow 100-MHz toggle rates.

In scaling down its MOS and STL technologies, TI will also be looking into silicon-on-insulator and metal-semiconductor field-effect transistors structures. TI has done extensive silicon-on-insulator work, particularly with laser-annealed polysilicon on silicon dioxide. But the firm has not yet defined how it will package the circuits, which are to be made with 0.5-μm lithography.

TRW Inc., along with team members Sperry Univac in St. Paul, Minn., Motorola Inc. in Phoenix, Ariz., and GCA Corp., of Bedford, Mass., will construct brassboards for electronic warfare, communications, and general-purpose processing under a Navy contract. TRW will contribute its triple-diffused bipolar processing know-how, Motorola its C-MOS and dry-etching expertise, Sperry its CAD prowess, and GCA its knowledge of photolithography equipment and techniques. All CAD software will be available during Phase I, says TRW.

For Phase I, the Cleveland-based firm has defined eight ICs: a content-addressable memory, a window-addressable memory, a register-arithmetic and logic unit chip, a four-port memory, an address generator, a microcode controller, a 40-ns 8-by-8-bit switch, and an I/O controller. All, with the exception of the



4. Master image. IBM will add standard functional blocks like memories and processors to gate arrays to arrive at a versatile semicustom chip that can be used for various applications.

four-port memory, will be built with the triple-diffusion process.

The memories, which will afford two simultaneous read or write operations, will be fashioned from bulk C-MOS. The window-addressable memory is a particularly complex design, incorporating 176 microprocessors on one chip, each capable of executing 12 million instructions per second, for nearly 2.2 billion equivalent operations per second.

These TRW chips are primarily intended for the electronic-warfare brassboard. At least four ICs have been defined for the general-purpose board and two others for the communications board: a 2,000-gate array and a convolver [*Electronics*, Dec. 4, 1980, p. 44]. In a related design effort, TRW is using 1-μm bipolar technology to build an 8-bit analog-to-digital converter, smaller than 40,000 mil^2 and capable of 75 million samples per second [*Electronics*, Aug. 11, p. 37].

TRW's triple-diffusion process, already responsible for ICs in more than 300 defense systems, is characterized by junction isolation and a low five-to-eight-mask count. Lately, however, TRW has not only added a second metal layer, but it, too, has discovered how to dry-etch them. The second metal level reduced some circuits almost 50% in area; its 16-bit multiplier went from 250 mils on a side to 158, for example.

The lower metal layer consists of a platinum-silicide–titanium-tungsten sandwich—for Schottky-diode formation—beneath an aluminum or aluminum-copper conductor for signal routing. Aluminum-copper is also sputtered on for the second metal layer.

TRW's metal levels are separated with a plasma-deposited silicon-dioxide dielectric, which is also dry-etched. It is using laser annealing—and is investigating rapid isothermal annealing—as a means for controlling the content and distribution of trap-causing oxygen ions. Future chips from TRW will incorporate arsenic-doped resistors—instead of using transistor collector regions for this purpose—to facilitate independent optimization of both.

Twin-well–like. As for the bulk C-MOS process due from Motorola Inc., it will use p-wells, but the resulting structure will exhibit twin-well behavior. Around February of 1982, refractory metals, buried contacts, polysilicon resistors, and three levels of interconnection will be added. With 1.25-μm features, the Phoenix, Ariz., IC operation already has ring oscillators with 1.7-ns stage delays.

For Phase Ib, gate oxides will be trimmed down to the 100-to-200-Å range, and two test chips will be built: one with different logic-gate implementations, and another with three 65-stage ring oscillators.

For its radar-processor brassboard for the advanced tactical fighter, Westinghouse Electric Corp.'s Baltimore operation has defined six chips: a 16-bit arithmetic and logic unit, a controller, a pipelined arithmetic and logic unit, a 32-bit arithmetic and logic unit, a 64-K static RAM, and a 5,000-gate array. All are built with a bulk C-MOS process, and all measure about 200 mils on a side.

Particulars of the process include full ion implantation, n wells in a lightly-doped p-type substrate, selective field oxidation, and silicide gates. The process will also feature a registration-tolerant dual-level metal interconnection system, four levels of polyimide, and a 1.25-μm contact plug that should improve density by 25% to 30% (Fig. 5a).

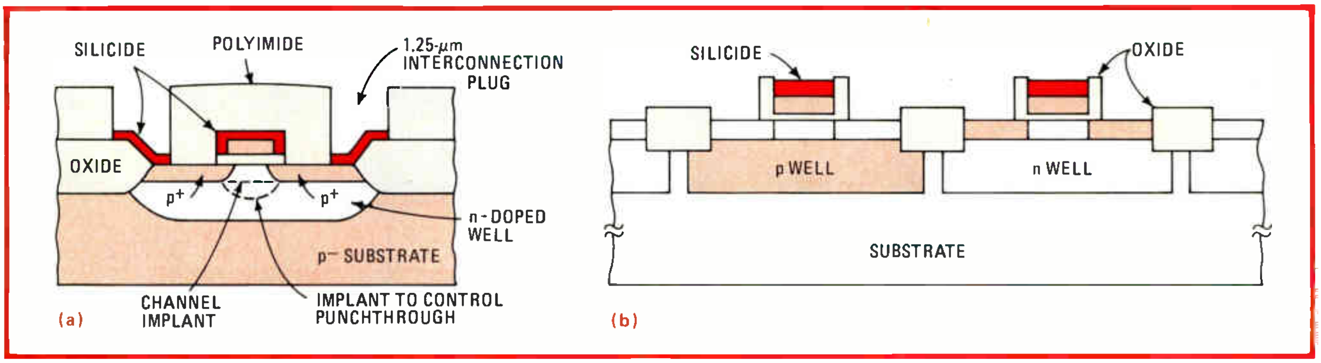
Westinghouse's half-micrometer development project is independent of its 1.25-μm work. Though it is eyeing SOS and silicon-on-insulator techniques, it will probably go with the twin-well structure (Fig. 5b).

The company will probably build it with a combination of electron-beam and X-ray lithography. New methods of contact and channel formation are also under development. Steep-walled field oxide regions—lacking a bird's beak—will be achieved with advanced radio-frequency liftoff.

Westinghouse will fabricate three test vehicles to prove its 0.5-μm technology to be viable. The first will contain three sections to test for optical exposure, gate, and cell structures, respectively. A serial shift register will also help check for process uniformity.

The second test vehicle will evaluate two-level metal patterns, and the third chip will contain an 8-by-8-bit multiplier with a fast-in, slow-out buffer to size up memory cell and logic configurations simultaneously.

Westinghouse will draw minicells containing from 1 to 20 logic gates from a common library and, using metal and polysilicon conductors, interconnect them to form macrocells. A complete bit-slice microprocessor architecture might require anywhere from 200 to 1,000 gates. Hermetic chip-carriers allowing up to 200 pins per package are also being developed. □



5. Bulky but capable. Westinghouse intends to use bulk C-MOS technology for its VHSIC chips. Its 1.25-micrometer process featuring n-type wells and interconnection plugs (a). When the 0.5-μm level is reached, it will probably switch to a dual-well design (b).

IEDM entries continue to push limits

Panopoly of devices at the upcoming meeting will range from fast logic gates and dense plasma displays to vacuum tubes

by J. G. Posa, Solid State Editor; H. J. Hindin, Communications and Microwave Editor; R. Beresford, Components Editor

Each year at the International Electron Devices Meeting, the premier gathering for designers of solid-state components, the density, speed, and power levels of the devices discussed inch closer to their theoretical limits. The 1981 edition, to run Dec. 7–9 at the Washington, D. C., Hilton Hotel, will be no exception.

Listeners will get news of digital logic gates that operate at gigahertz rates, memories that store a quarter million bits of information, discrete components that can block or deliver hundreds of volts, and plasma displays with hundreds of thousands of picture elements, to name but a few. And there are even some new "fire bottles"—that's right, vacuum tubes—that are more efficient and easier to build.

In the field of integrated circuits, Hitachi Ltd. will provide more clues to how its Hi-C-MOS-II technology builds 300-picosecond complementary-MOS inverters exhibiting power-delay products of only 1 femtojoule [*Electronics*, Feb. 24, p. 141]. Partly responsible is the use of twin rather than single wells for p- and n-channel transistor formation.

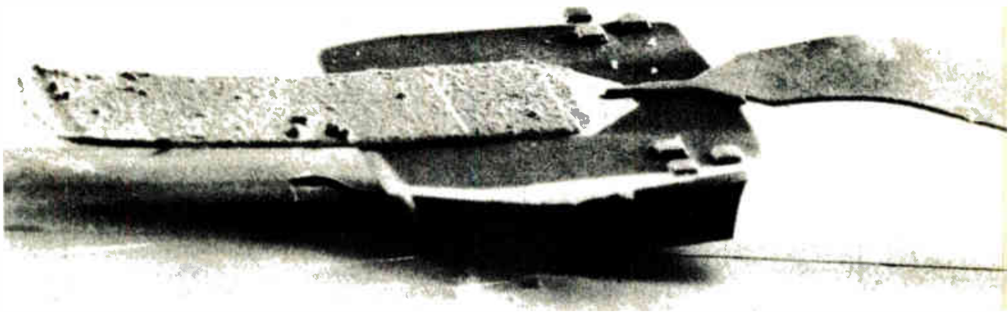
Over the years, much attention has been paid to the downward scaling of n-channel MOS field-effect transistors; but with advanced C-MOS, the reduction of p-channel devices, too, must be considered. Two papers will show how the p- and n-channel devices can be stacked vertically to help shrink C-MOS gate size. Both the Massachusetts Institute of Technology's Lincoln Laboratory and CNET-CNS of Meylan, France, suggest a double-polysilicon structure with the upper film laser-annealed to serve as a second substrate. Then the heavily doped first-level–polysilicon gate can control two channels, one above it and one below. Harris Semiconductor will also reveal how it gets C-MOS logic to function at 350°C.

Better. Conferees will hear Bell Laboratories explain why 0.5-micrometer p-channel MOS FETs exhibit fewer second-order effects and a higher source-drain series resistance. Texas Instruments Inc. will tell them how the latter can be reduced by placing silicides directly on contact openings. Moreover, with the growing popularity of silicides for gates and interconnections, it is rather convenient to use the same material for contact enhancement and to improve gate conductance. So Bell Labs and Intel Corp. will also describe processes for applying silicides directly to source-drain regions; like TI, Bell uses titanium silicide, whereas Intel uses tungsten silicide.

Worth noting among the other conference highlights may be Toshiba Corp.'s 64-K electrically erasable programmable read-only memory and its single-transistor cell made with three polysilicon layers. The middle layer acts as a floating gate, and the other two control its charging and discharging. During erasure the charge on the floating gate is continuously monitored to prevent depletion. Also, Motorola Semiconductor will discuss its 32-K EE-PROM, which can endure well over 10^5 program-erase cycles. And Fujitsu will describe how it dopes the floating gate in its EE-PROM cells to form a pn junction, thus enjoying single-polysilicon processing and avoiding leakage-prone tunnel oxides.

To strike back at alpha particles, Bell Labs is using ion implantation to bury an n-type perforated grid 2.2 μm below a substrate's surface. The method, which promises efficient collection of superfluous charge, needs no epitaxy or diffusions.

Toshiba will show off its new sense amplifier that compensates for transistor threshold differences on paired bit lines. The new amp will be a key technique for 256-K and 1-megabit dynamic RAMs. The Musashino Electrical Communication Laboratory of the Nippon Telegraph &



Two beams. At the AIL division of Eaton Corp.'s Central Research group, engineers have come up with a beam-lead mixer diode with the previously unattained cut-off frequency of 5,500 GHz.

Probing the news

Telephone Public Corp. will also detail a 256-K chip, and both use molybdenum to lower polysilicon's sheet resistance.

Saving space. Hitachi will prescribe a direct approach to conserve silicon real estate: it simply flips the bonding pads right on top of the active areas. Hughes Aircraft Corp.'s Malibu, Calif., Research Labs will propose a more arcane solution. Using the electromigration of metal, it is able to form thin aluminum conductors right through a wafer. Then it processes both sides of the wafer, using the aluminum filaments as feed-throughs.

Several papers will be given on advanced lithographic techniques. General Electric Co.'s Schenectady, N. Y., Corporate Research and Development Center describes a working two-level photoresist that can support a throughput of more than 200 wafers per hour. NTT's Musashino lab scores again with an electron-beam exposure system that uses laser interferometry and high-speed data processing to correct for wafer distortions—the result: 0.05-μm alignment accuracies.

The Musashino lab is using mega-electronvolt ion implants to eliminate epitaxy in processing bipolar circuits. Hitachi has found that typical circuit delays of 100 ps and power delay products of 0.1 picojoule are possible as bipolar devices are scaled down. Fairchild Camera & Instrument Corp. will present papers on scaling Schottky diodes and injection logic gates. It says that with 0.5-μm technology, injection logic gates will have 300-ps delays and chips with nearly 1 million gates per square centimeter will be possible.

The ultimate in speed, though, comes from Josephson-junction technology. Niobium is desirable as a replacement for lead in Josephson chips because it is durable and resistant to thermal cycling, but all-niobium junctions are hard to make and often slow. Bell Labs will explain how it covers the niobium in its Josephson circuits with aluminum as a neat solution to both problems.

Fast integration. One area where integration of devices is proceeding nicely is the combining of optical devices with circuits such as detecors because the resulting devices are immediately useful for data communications. At Cornell University, this means the monolithic integration of an optical FET photoconductive transit-time detector and a high-speed broadband gallium arsenide metal-semiconductor FET amplifier that has a midband voltage gain of 5 with a 4-GHz bandwidth into a 50-ohm load.

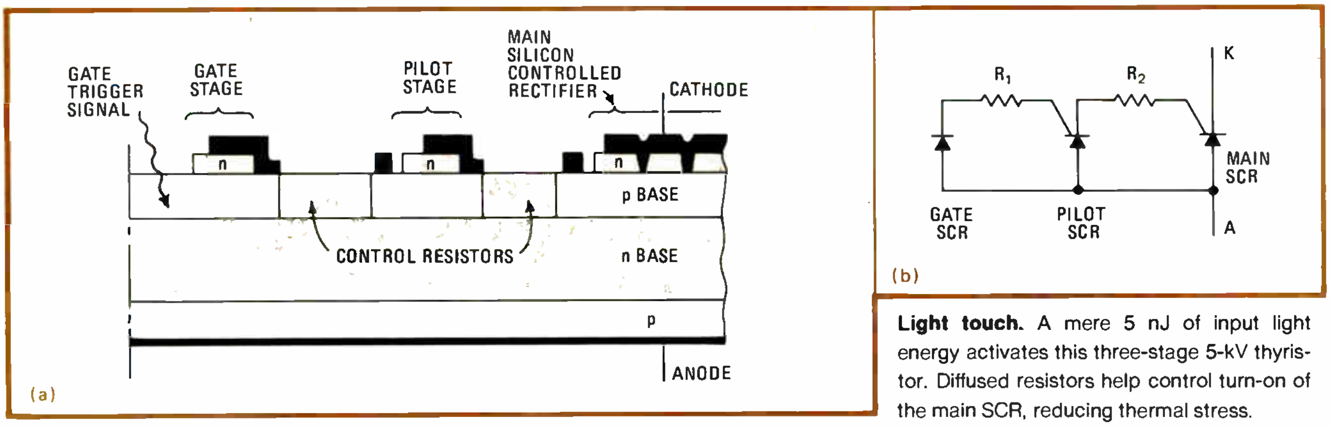
At Microwave Semiconductor Corp. in Somerset, N. J., an engineering team has triumphed with the highest power-efficient device reported for a solid-state device at X band. The GaAs FET amplifiers, in 1-, 2-, and 4-watt versions, are internally matched and use a self-aligning flip-chip mount. The low-impedance transmission lines used are made of a low-loss substrate of zirconium titanium and selenium combined with oxygen. In England, at Plessey Research in Caswell, GaAs FETS have been put to use at Q band (26 to 40 GHz).

In an area considered moribund—tube design—the Northrup Defense Systems division in Rolling Meadow, Ill., which has shown that the peniotron, a fast-wave device designed to convert the rotational energy in a beam rotating at a cyclotron frequency into rf energy, can deliver hundreds as compared to the tens of watts previously obtained. Northrup's oscillator worked at 8 GHz and modeled devices that are expected to deliver the same power levels at millimeter wavelengths.

Electron gun. At Fort Monmouth, N. J., researchers have also built a test vehicle for future millimeter-wave tubes: a multipactor electron gun. This is an rf-activated, nonthermionic electron gun that employs the principle of secondary electron resonance (multipactor) to phase-focus electrons into high-density electronic bundles. Classic magnetic electron focusing is eliminated, thereby decreasing tube size, weight, and cost. Also, reliability and life are in-

HIGHLIGHTS OF THE INTERNATIONAL ELECTRON DEVICES MEETING

Session	Description	Source
Tuesday, Dec. 8 (continued)		
15.2	Complementary-MOS process withstands 350°C.	Harris Semiconductor
15.5	Buried drains in double-diffused MOS device eliminate short-channel effects.	Bell Labs
15.6	Schottky contacts on MOS transistor reduce short-channel effects and raise breakdown voltage.	Bell Labs
17.1	Three-stage light-activated thyristor blocks 5 kV, needs only 5 nJ of input energy.	GE
17.4	Power MOS FET designed for switching power supplies conducts 60 A with 0.014-Ω on-resistance.	GE
18.8	Base voltage controls light output of three-terminal bipolar AlGaAs/GaAs LED.	Oki Electric
19.4	248-by-192-element photocapacitor imaging array allows video recording at 2,000 frames per second.	Kodak
20.4	15-kW C-band traveling-wave tube operates in low-cost inverted-slot mode without lossy resonators.	Hughes Aircraft
Wednesday, Dec. 9		
24.6	Laser annealing the upper of two polysilicon films makes vertical C-MOS logic gates possible.	MIT Lincoln Lab
24.7	Multiple ion implantation and laser annealing create shared gates for high-density C-MOS inverter.	CNET-CNS
26.6	Integrated circuits based on silicon permeable-base transistors may operate at speeds of 30 GHz.	Hughes Research Malibu, Calif.
27.3	Current-mode logic based on heterojunction bipolar devices points to high-speed digital ICs.	Rockwell International
28.5, 28.6	Two 256-K dynamic random-access memories incorporate molybdenum-silicide gates.	Toshiba and NTT's Musashino Lab
29.3	GaAs FET with 4-dB gain at 40 GHz shows mean time between failures of 10^7 hours.	Plessey



Light touch. A mere 5 nJ of input light energy activates this three-stage 5-kV thyristor. Diffused resistors help control turn-on of the main SCR, reducing thermal stress.

creased because there is no thermionic emission.

At Sharp Corp.'s Central Research Labs in Nara, Japan, a new channeled-substrate gallium-aluminum-arsenide double-heterostructure visible-light laser on p-GaAs has been developed. A built-in optical waveguide and internal current confinement result in 770-to-790-nanometer continuous-wave emissions at lasing current thresholds of 25 to 50 milliamperes. A single transverse mode generates up 20 milliwatts per diode facet. And at what is claimed as the highest single-mode power level ever recorded for semiconductor lasers, RCA Laboratories in Princeton, N. J., has generated 40 mW per diode cw in a single mode.

While light sources are getting more powerful, light sensors are getting faster. Kodak Inc. takes solid-state image sensors into the realm of transient phenomena analysis: video recording at 2,000 complete frames per second is possible with an array of 248 by 192 photocapacitors. The imaging area is divided into six blocks, each with 32 parallel outputs, reducing the required analog transmission rate to 3.1 megahertz.

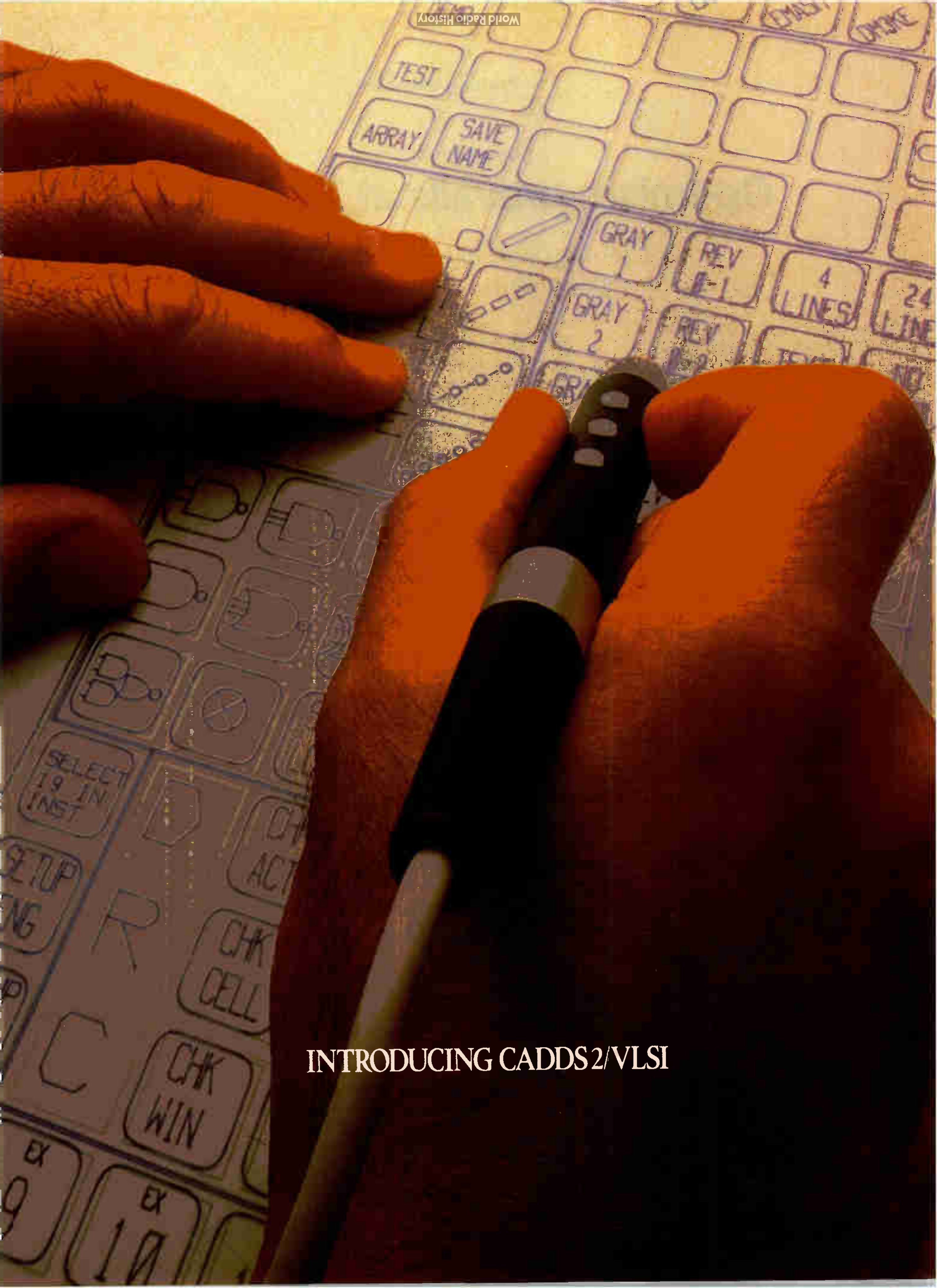
Color image sensing by Hitachi uses hydrogenated amorphous silicon for the first time as the photoconductor on top of an n-MOS FET array. Nitrogen doping of the silicon heightens the sensitivity to 40 nanoamperes per lux and reduces the operating voltage to −9 V. With a top electrode of indium tin oxide, quantum efficiency is 0.9 or higher over the visible spectrum. Hitachi also uses thin-film silicon deposited on glass substrates or active drivers for flat-panel display.

Actually however, the big progress in flat displays is with plasma panels. Burroughs Corp. scales up its Self-Scan Memory technology to 300 by 576 elements with a combined ac-dc cell design that cuts back on driver requirements without sacrificing brightness. And IBM Corp. describes the operation and construction of an experimental ac plasma panel whose 960-by-768-line display is capable of scanning multiple pages.

The need for integrated drivers for plasma displays is one factor in the push toward combining high-voltage MOS devices with MOS logic. Tektronix Inc. and Xerox Corp. both extend a field plate from the source contact in high-voltage MOS structures to control breakdown and leakage between source and drain. Tektronix achieves blocking voltages of 1,000 V with leakage below 30 nA in a 0.7-square-millimeter device that has only 300 Ω of on-resistance. □

HIGHLIGHTS OF THE INTERNATIONAL ELECTRON DEVICES MEETING

Session	Description	Source
Monday, Dec. 7		
2.1	64-K electrically erasable programmable read-only memory is made possible by a single-transistor cell.	Toshiba
2.6	Buried n-type grid blocks up to 85% of the charge generated in an IC by an alpha particle.	IBM Watson Research Center
3.4	Chip area is saved by placing the bonding pads directly on top of active areas.	Hitachi
5.3	Self-aligned n-channel indium-phosphide FETs show electron mobilities of up to 1,000 $cm^2/V\text{-}s$.	Naval Research Laboratory
6.7	Cascade solar cell promises 30% efficiency using vapor-phase epitaxial growth of GaAlAs on GaAs.	Varian
Tuesday, Dec. 8		
10.3	MOS transistors built on laser-recrystallized polysilicon compare favorably with single-crystal devices.	Carleton University Ottawa, Canada
11.1	Operation with 530-V signals is achieved in an integrated diode gate for switching applications.	Bell Labs
12.3	Photoconductive transit-time FET detector shares chip with GaAs MES FET preamplifier for clean GHz bandwidth.	Cornell University
13.1	Combined ac-dc plasma displays reach 300 by 576 elements thanks to Self-Scan Memory technology.	Burroughs
13.2	960-by-768-line ac plasma display eases multipage scanning and cross-referencing.	IBM
13.4	Polysilicon thin-film transistors on glass substrates drive flat-panel displays.	Hitachi
14.4	Peniotron microwave oscillator generates hundreds of watts at 8 GHz by converting cyclotron frequencies into rf.	Northrup
14.7	Rf-activated nonthermionic electron gun employs secondary emission resonance to bunch electrons for millimeter-wave radar tubes.	Fort Monmouth Army Base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SAVE NAME
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GRAY 2
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Consumer electronics

Optimism prevails at Berlin show

Mood of Europe's entertainment electronics industry uplifted by advent of digital and stereo TV, as well as by VCR prospects

by John Gosch, Frankfurt bureau manager

There was no hint of concern about Western Europe's stagnating and beleaguered entertainment electronics industry among the 544 exhibitors during West Berlin's International Audio and Video Fair. In fact, the atmosphere at the city's flowered fairgrounds ranged from subdued optimism to outright exultation, depending on what product line the exhibitors—from 27 countries, east and west—were representing.

To be sure, these are not the best of times for Europe's entertainment-products industry, which once enjoyed annual growth rates of 10% and more. With fuel prices twice as high as they were two years ago, consumers are saving money by holding back on purchases of electronics equipment. Moreover, in some countries, there are television sets and sound systems in so many homes that first-set sales have slowed to a shuffle. On top of that comes the competition from Far Eastern producers, which is putting the Europeans through severe profitability tests.

Still, to any of the half million visitors at the Sept. 4–13 Berlin show who wanted to hear it, the refrain from the exhibitors was that things are not all that bad. On the TV front, many of the sets bought during the big sales years of the early 1970s are being retired so that replacement purchases are becoming increasingly important. Putting bounce into the market are second-set purchases.

Add to that, brisk sales of videocassette recorders in major West European countries—pointing to booming markets reminiscent of the color-TV mania that prevailed a decade ago. Other video peripherals like disk players and projection-TV equipment could increase the consumer market even more in the mid-1980s.

Future look. One of the hopes of the industry is the video cassette recorder. Philips spent $200 million on its VCR plant in Austria, where a technician is shown inspecting a set.

Spurring the replacement market will be the two landmark developments that were unveiled at Berlin this year: digital TV receivers and stereophonic two-channel sound TV sets—stereo TV, for short. West Germany-wide stereo-TV broadcasts started on the opening day of the Berlin show. Other European countries, among them Britain, Belgium, Austria, Italy, Sweden, the Netherlands, and Switzerland, are reported to be interested in the new medium. According to marketing experts at Philips GmbH, a West German subsidiary of the giant Dutch group, 40% to 50% of all color receivers sold on the domestic market next year will have stereo capabilities.

Although much fanfare accompanied the start of stereo broadcasts, the news on TV sets going digital was made rather quietly in a hotel on Kurfürstendamn, West Berlin's fashionable main boulevard. There, ITT Intermetall GmbH, the Freiburg, West Germany-based headquarters company of the ITT Semiconductors Group, unveiled eight large-scale and very large-scale integrated circuits for digital signal processing in TV receivers, a development that will benefit consumers and set makers alike [*Electronics*, Aug. 11, p. 97].

To the consumer, digital TV introduces large improvements in set performance, with pictures free from ghosts, flutter, and noise. Also, digital sets will easily interface with future home data networks and videotex services. As for set makers, "they cannot afford not to turn to digital TV," points out Thomas Fischer, one of the Intermetall developers. Typically it takes the company 160 to 180 minutes to put together a 26-inch color receiver, he says. "Our new circuits will bring that time to below 100 minutes."

TV über alles. For all the hoopla over VCRs at the Berlin show, the industry's mainstay is still the ubiquitous TV set. For example, in West Germany, Europe's biggest consumer-equipment market, TV receivers, both color and black and white, are expected to ring up sales of $1.75 billion this year, thus accounting for

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Circle 127 on reader service card

Probing the news

nearly 36% of the total entertainment electronics business of about $4.89 billion.

Considering color sets by themselves, about 2.45 million units will be sold domestically this year, roughly the same as in 1980. But because of increasing replacement purchases, the annual market should rise to some 2.65 million by 1985, says Hanns-Dieter Horn, head of the entertainment electronics division of Philips in Hamburg, West Germany. Already, the penetration of color sets into German homes is higher than that of black-and-white receivers—72% versus 70%, according to marketers at Grundig AG.

Simultaneously, in the UK, despite a recession that has thrown nearly 3 million people out of work, consumers are buying more color receivers than ever. Sales are remarkably buoyant, says a Philips market researcher. In 1980, total unit sales were up 10% to 1.95 million and could be up 15% this year, thanks particularly to the growth in small-screen set sales.

Color-set sales in France are expected to rise by about 13% next year for a total of around 1.9 million units, while black-and-white receivers should remain flat at about 720,000 sets, according to the Syndicat des Constructeurs d'Appareils Radiorécepteurs et Téléviseurs. The agency gives no particular reasons for these figures except that many people are replacing black-and-white sets with color receivers.

While the market for TV sets is shuffling along, that for VCRs is increasing by leaps and bounds in much of Europe. In West Germany, for example, sales bounced from a piddling 170,000 in 1979 to 420,000 in 1980 and could reach 600,000 to 700,000 units this year, according to Horn of Philips.

Lots of room. The forecast from Grundig is for 660,000 VCR units this year and 1.4 million in 1985. With the penetration into West German homes only at 3% last year, VCR makers should have little to worry about. Only in 1985 will the saturation level be around 22%. Grundig predicts even faster VCR growth for Western Europe as a whole—from 1.2 million units this year to 3.4 million in 1984.

In the UK, sales of VCRs have been spectacular, with demand outstripping supply, a situation that is not expected to stabilize until about this time next year. In 1980, the industry sold 410,000 units, while during the first quarter of 1981, yearly sales were up 190%.

The market in France for VCRs should show a net decrease this year—125,000, down from 140,000 last year. This figure is deceptive because of large inventory holdings by retailers, resulting in fewer orders. Next year, however, the market is expected to jump up to 220,000 units.

Japanese joy. The happiest lot of VCR producers at the Berlin fair were the Japanese, for they are cashing in the most on the upward sales trend. They hold about 70% of the German market, including shares of European firms selling Japanese-made recorders under their own labels. But Philips and Grundig, Europe's only VCR producers, are determined to wrestle percentage points away form their Far Eastern competitors with their jointly developed Video 2000 system, which has eight hours of playing time on a reversible cassette.

Both companies have invested heavily in VCR development and in production facilities—Philips to the tune of about $200 million. Its plant in Austria, a 320,000-square-feet complex in Vienna that employs 3,000 workers, is "one of the biggest investments in the history of Philips," says Horn. The two European firms and those licensed to build the Video 2000 system expect their combined share of the German market to go from 25% in 1980 to 30% this year.

To help them increase their share are the new VCR models that Grundig and Philips have introduced at the Berlin fair. For its part, Grundig has added a microprocessor-based unit, the Video 2-by-4 Super, featuring a display that indicates whether a two-, four-, six-, or eight-hour cassette has been inserted into the recorder. The Super also shows how much of the tape is already recorded and how much is left. □


21.8
32.2

The logic analyzer for

The solution to your problems.
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Design Problem: Adapting your logic analyzer to work with a specific processor.

7D02 Solution: Just plug the μP-specific 7D02 probe directly into the prototype microprocessor socket and press START. Acquired data is immediately disassembled and displayed in your processor's own mnemonics.

Design Problem: Sorting error-related data from other program flow.

7D02 Solution: Programmable data and clock qualification filters the data and stores only information pertinent to the problem.

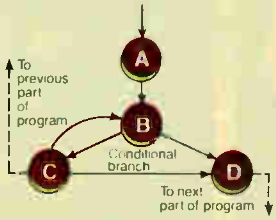
Design Problem: Relating hardware activity to program flow.

7D02 Solution: State and timing sections are included in a single logic analyzer, with each section able to trigger or qualify data acquisition by the other.

Design Problem: Monitoring I/O activity on the system bus.

7D02 Solution: Acquire both synchronous and asynchronous data through interactive triggering to examine both slides of an I/O transaction.

Design Problem: Tracking program flow through non-sequential algorithms with conditional branches to pinpoint an error.



7D02 Solution: The 7D02 can monitor multiple events and conditionally branch as part of its trigger or data qualification sequence. As a result, it can detect an error condition anywhere in your program flow.

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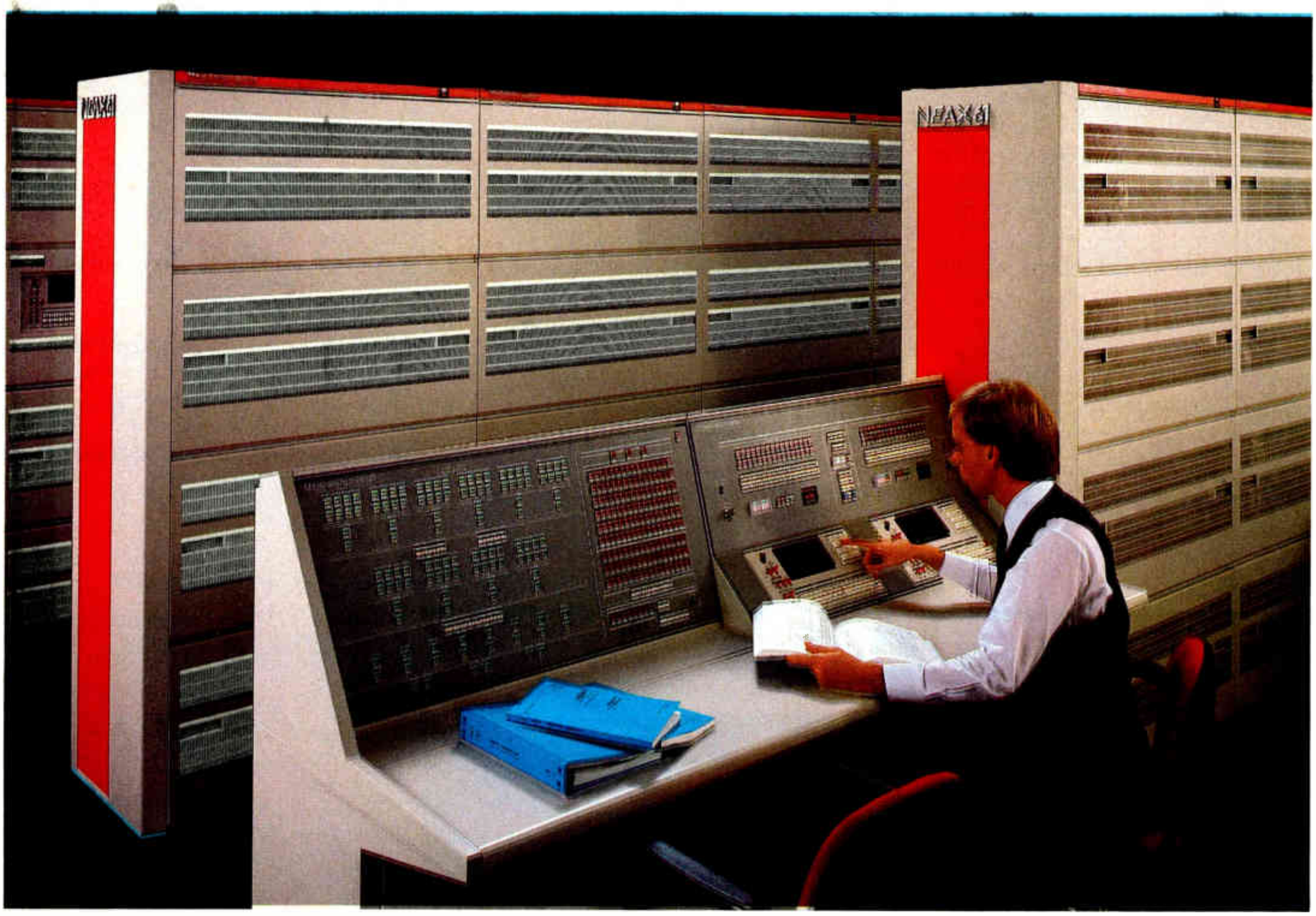


NEAX61 WILL SERVE TWO MILLION SUBSCRIBER LINES IN MALAYSIA

In 10 years, Malaysia expects to have a nationwide digital telephone network with some 3 million subscriber lines.

A contract to supply and install on a turnkey basis NEAX61 digital switching systems for about 2 million subscriber lines has been awarded to PERNAS NEC Telecommunications SDN, BHD (PERNEC) by the Telecommunications Department, Government of Malaysia. PERNEC is a joint venture between the PERNAS Group, a state-owned corporation of Malaysia, and NEC.

The NEAX61 is one of the most advanced stored-program-controlled digital switching systems. The NEAX61 can be used as a local, toll, tandem, remote, mobile, and international gateway switch, and can handle up to 100,000 subscriber lines. It owes its flexibility primarily to its building-block configuration. Intensive use of LSIs and ICs contributes greatly to its reliability and space-saving dimensions.

With the Malaysian contract, NEC has become the world's leading manufacturer/supplier of digital switching systems. NEC has installed, or is set to install, NEAX61 systems in 17 countries for the equivalent of approximately 3,600,000 subscriber lines in all.

NUMBER 120

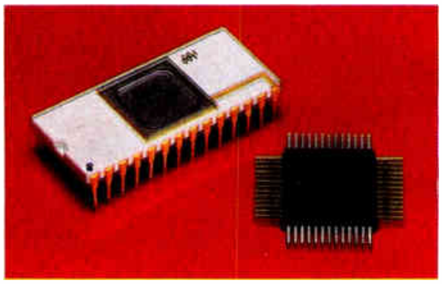
WORLD'S FIRST 128K BIT N-MOS AND C-MOS ROMS

Two new large capacity high-speed mask ROMs from NEC represent the first of their kind in the world.

The n-channel MOS ROM—μPD 23128D—has a memory capacity of 128K bits and features a fast access time of 250 nanoseconds. The μPD23128D, in a standard 28-pin ceramic DIP, operates on a single 5-volt supply with maximum power consumption of 275mW (82.5mW during standby time).

The other product, μPD73128G, is a C-MOS device which also has a memory capacity of 128K bits. It comes in a 52-pin plastic flat package, has an access time of 5 microseconds and operates on a single 5-volt supply with power consumption of 22mW (11 microwatts during standby time).

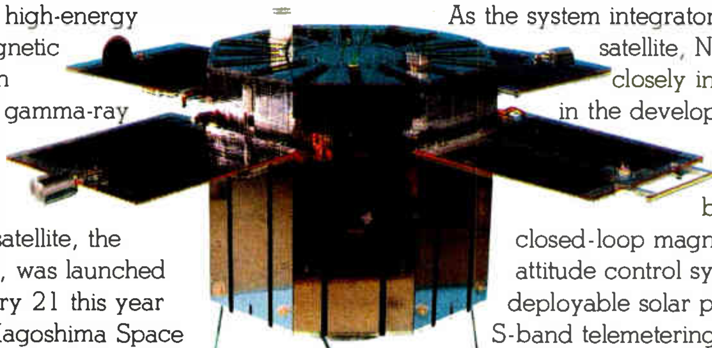
The requirement for large capacity ROMs is constantly increasing in such applications as computer terminals and communications equipment, to



enable such systems to become ever more compact and cost-effective. NEC's two new devices, already in production, completely satisfy these requirements.

NEC-EQUIPPED SATELLITE OBSERVES SOLAR FLARES

Every eleven years, the frequency of explosions on the sun's surface increases. These explosions, or "solar flares", release a great amount of high-energy electromagnetic radiation in X-ray and gamma-ray regions.



A solar flare observation satellite, the ASTRO-A, was launched on February 21 this year from the Kagoshima Space Center of the Institute of Space and Aeronautical Science, University of Tokyo. It is the world's only satellite now on a full mission observing the sun, which is presently in a period of maximum activity.

The ASTRO-A weighs 188kg. It is now in a semicircular orbit with a perigee of 480km, apogee of 640km, and inclination of 31.5 degrees. The spin-axis of the ASTRO-A is controlled to point the sun for observation of its surface with a solar X-ray telescope, solar X-ray crystal telescope, solar gamma-ray instrument, etc.

As the system integrator of the satellite, NEC was closely involved in the development of the on-board closed-loop magnetic attitude control system, deployable solar paddles, S-band telemetering system, and other subsystems.

The ASTRO-A is now operating perfectly and sending valuable data on solar flares.

SARAWAK GAS, OIL FIELD GETS OFFSHORE TELECOMS NETWORK

NEC is to install an integrated offshore telecommunications network in Sarawak, Malaysia.

The network, ordered by oil producer Sarawak Shell Berhad, will include almost all types of telecommunications systems. The onshore terminal at Bintulu will be linked with offshore oil and gas platforms some 130km away by means of a 900MHz troposcatter radio communications system. Offshore platforms will be interconnected by a 2GHz line-of-sight microwave communications system.

In addition, the network will have subscriber VHF radio telephone systems between a platform and associated drilling rigs, air-to-ground VHF radio systems, ship-to-ground VHF radio systems, public address systems, hot-line telephones, subscriber telephones (explosion proof type), radio beacons, teleprinters, and private automatic branch exchanges.

Construction is scheduled to be completed in December 1982.

NEC

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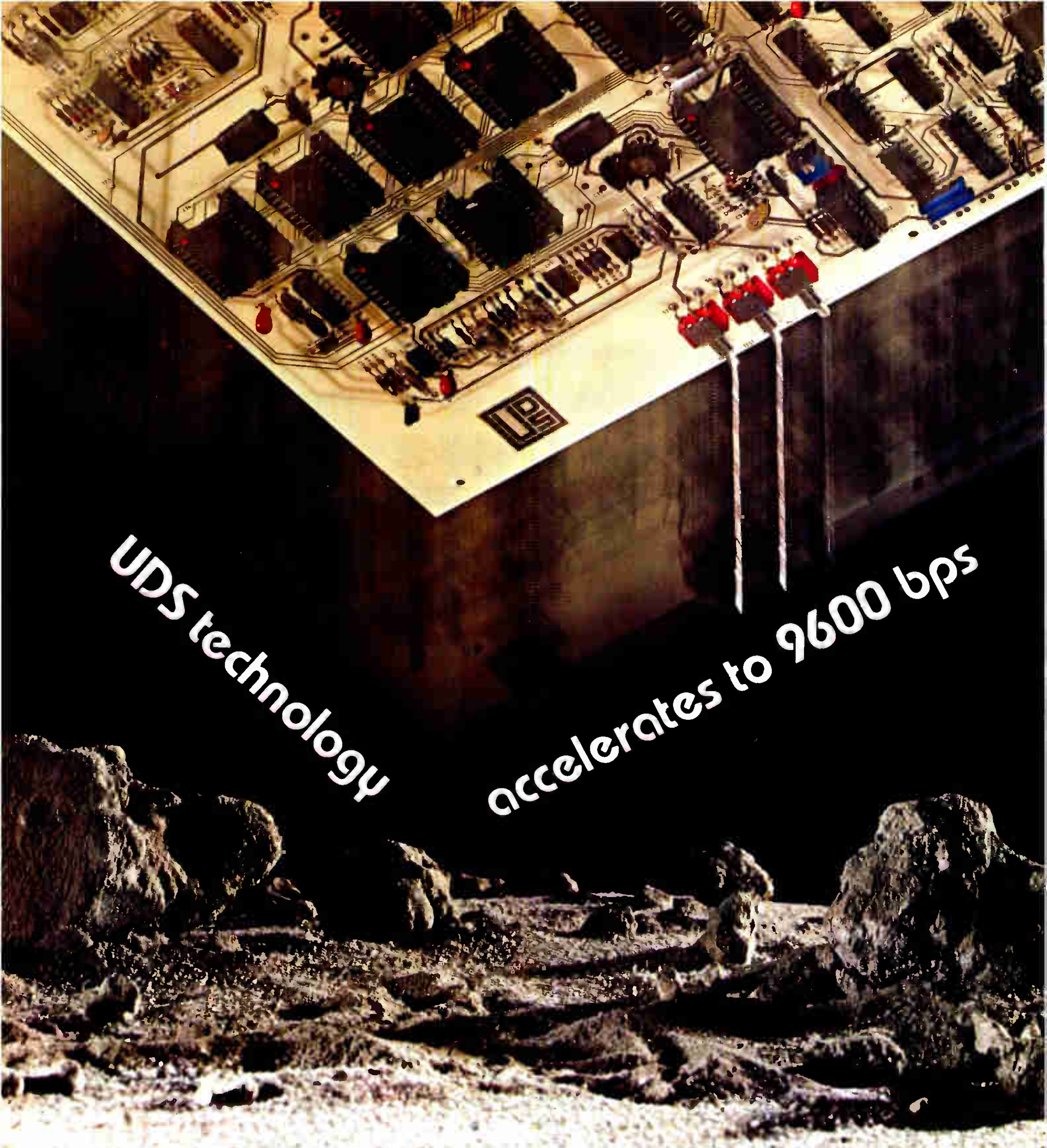

The accelerating growth in modem technology at Universal Data Systems has now produced the Company's first 9600 bps unit on a super-compact OEM board. Occupying about 100 square inches of PCB space, this microprocessor LSI modem offers dramatic space savings for designers who wish to package data sets internally in microcomputers, minicomputers or interactive terminals. The traditional UDS economy and reliability are inherent in the new 9600 bps modem.

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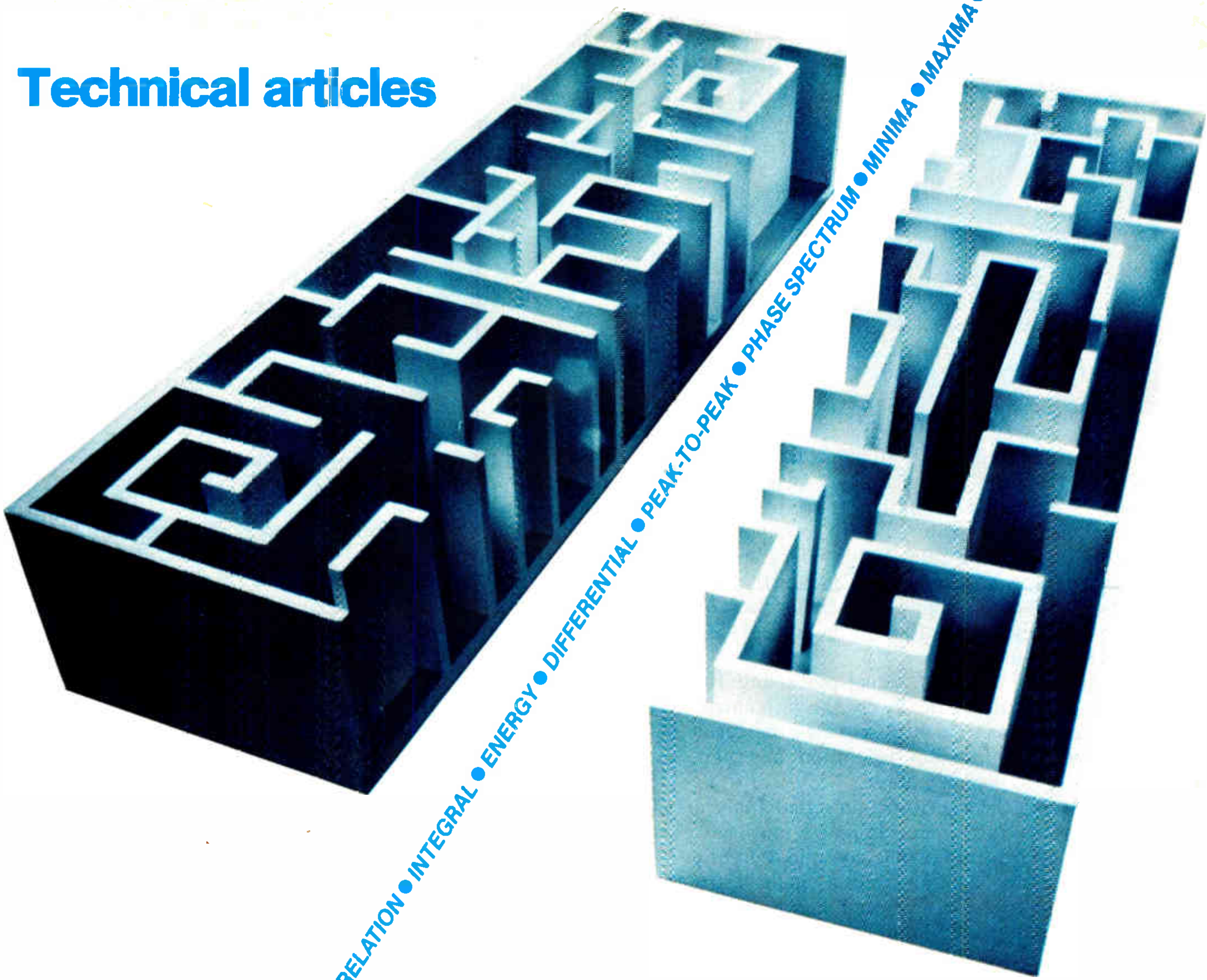


Measurement computer eases waveform analysis

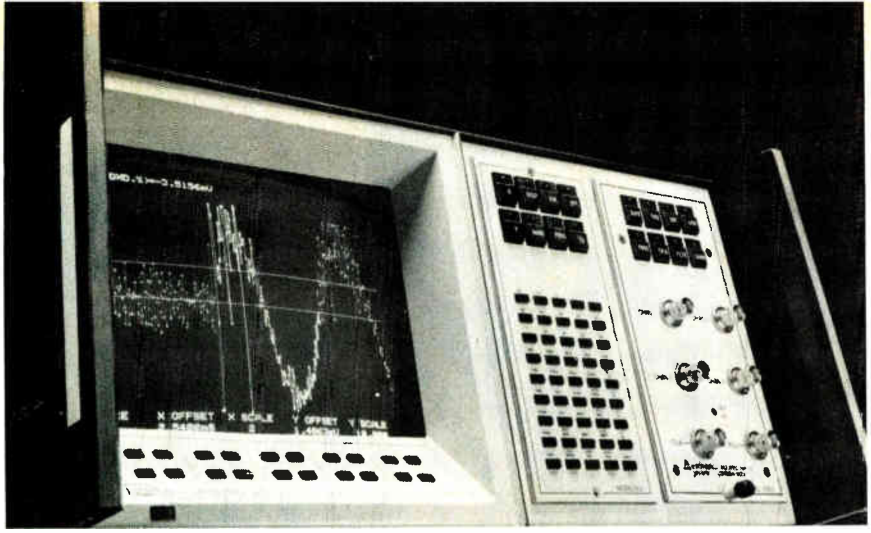
System digitizes input with 100-kHz and 100-MHz plug-ins so its 68000 can make complex measurements at a key stroke

by W. Sapankevych, E. Stebbins, J. Levy, and A. Crooke, *Analogic Corp., Data Precision Division, Danvers, Mass.*

☐ One programmable instrument integrating a full range of analog measurement and computing functions would greatly boost an engineer's productivity—provided it handled all those functions at a high enough level of performance and efficiency. For example, conversion resolution of more than 12 bits is required in digital audio and many other signal-processing applications, while high sampling rates and large storage blocks are often required for transient analysis. Moreover, the time spent setting up and operating an instrument often increases exponentially with its versatility—a distinctly counterproductive tendency.

The Data 6000 digital waveform analyzer (Fig. 1) provides human-engineered, key-programmed control of precision signal acquisition, conditioning, digitizing, and storing, as well as computing, displaying, and transferring functions—all in one low-power portable instrument. Further, it does so for the price of a high-quality oscilloscope.

Modularly designed, this instrument offers reconfigurability of both hardware and software to meet a broad



1. All in one. The model 6000's terminal-like appearance connotes its powerful processor-based design, which lets it function as a digital oscilloscope, spectrum analyzer, data logger, and other kinds of analog waveform instrument. Signal-acquisition capabilities can be varied by changing the plug-in module seen at right.

range of signal-processing problems in research, development, and manufacturing. Its plug-in front-end modules range in digitizing resolution from 14 bits at a 100-kilohertz sampling rate to 7-bit resolution at a 100-megahertz sampling rate. Its on-board storage may be expanded to 56-K 16-bit words and further extended by external storage on floppy disks. Allocation of recorded phenomena and information in the memory is under the control of the user.

Chaining of selected signal-processing functions is accomplished automatically by the instrument's unique system generator, which also scales the result of each operation for maximum resolution and allocates the scaled result to system storage.

To judge by the multifunction signal analyzers available up to now, instrument designers must have been on the horns of a dilemma. The consolidation of ever more signal-processing functions into a single instrument has led to more complications and hence apparently less, rather than more, efficient use of the resources. Past solutions to this problem have typically resulted in compromises—instruments that are reduced in scope and in setups that are hardwired for simplicity.

The Data 6000 is an escape from the dilemma. It can perform unlimited sets of signal-processing functions. In addition, it uses software-programmed groups of simple, direct-performing buttons in a multilevel access mode for setup and control. Essentially, the instrument is key-programmed as needed for the specific application.

The number of control setups required is directly proportional to the number of functions configured for that application. As each configuration is set up, or as each processing function is programmed, groups of value-setting buttons are manipulated on the front panel.

Their possible actions are determined by the parameters for that configuration, and unnecessary or invalid actions are not even visible. Thus, only the minimum number is required, and the two-line display over the button groups defines the parameters and values in plain language for rapid setup and operation.

To achieve that programmable functionality, the architecture shown in Fig. 2 was devised. While it might at first seem like a standard microprocessor-controlled instrument, there are significant differences. For one thing, all the front-panel controls, including those mounted on a plug-in front-end module, are activated through the system manager program. No control is directly connected to an adjustment potentiometer, capacitor, switch, or other electromechanical device.

For another, the mainframe processor is a 16-bit microprocessor, the 68000, supported by expandable on-board system read-only and random-access memory. And the 9-inch cathode-ray-tube display is driven by a relatively low-bandwidth composite X-Y-Z video signal that may be independently connected to a remote display. The keys on the mainframe and plug-ins select the parameters to be controlled, while those under the display select the values (or states) for specific measurement-related parameters.

The instrument mainframe accepts plug-in front-end modules with sampling rates of up to 100 MHz. Each plug-in contains its own on-board ROM to communicate its protocols, capabilities, and configurable characteristics to the 6000's managing software, and each plug-in receives module-configuration control and signal-conditioning commands from this software.

For signals sampled at rates of up to 100 kHz, the mainframe bus transfer is of adequate speed, and an intermediate buffer storage is not used. For higher sampling frequencies, a buffer memory is provided within the module.

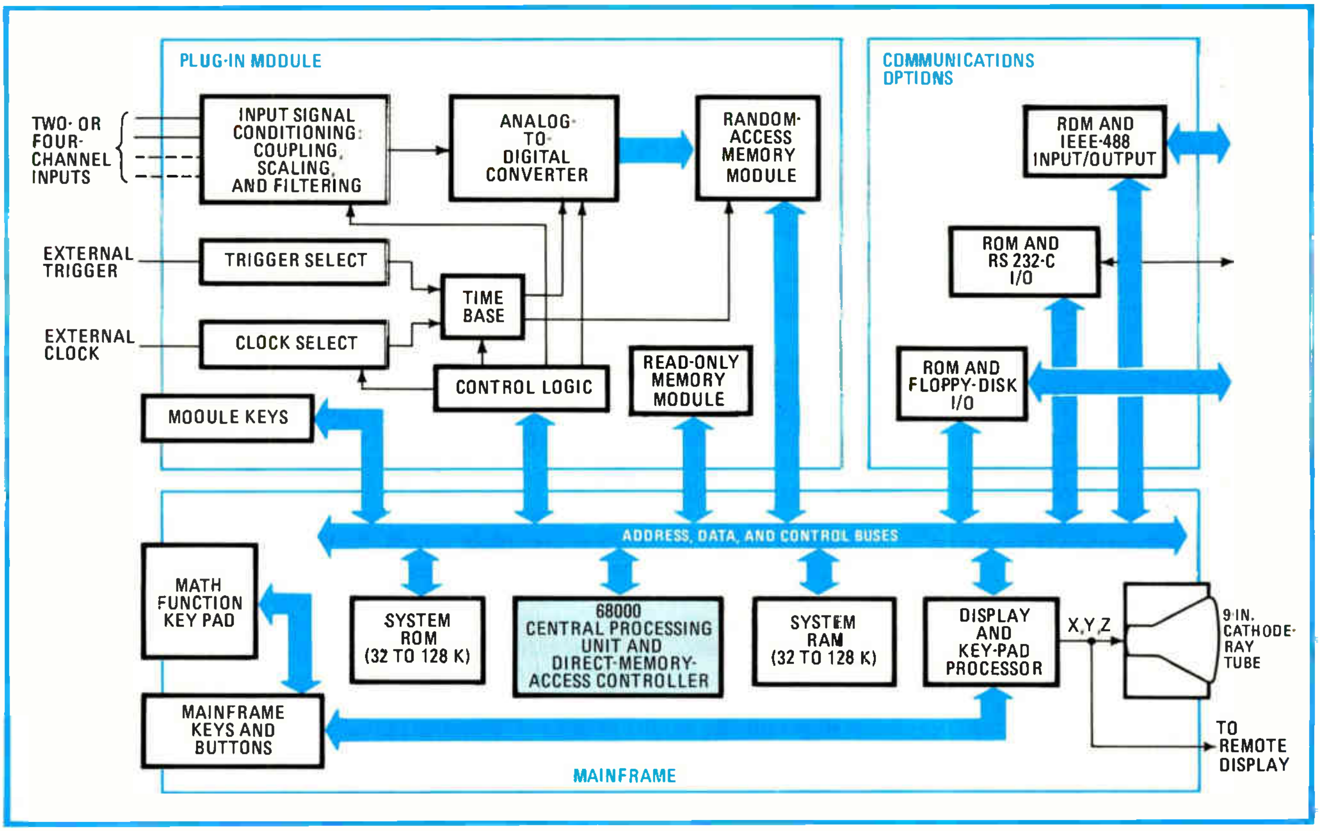
Keys and buttons

Despite its sophisticated architecture, the instrument's front-panel controls are easily learned. The front-panel controls are divided into three groups: keys, key pad, and buttons. The key pad is a set of keys that control the programmed processing of stored records using selected functions (operators). Keys, on the top center of the mainframe and on the plug-in, select parameters or functions. The display buttons cause a coarse or fine movement through a table of possible values or states below the CRT, as shown in Fig. 3.

Some functions and parameters have only two states—on or off—and the button then toggles between the two. Other parameters may have a long table of values (such as the names of records), and the button operation scrolls sequentially up or down the table.

The lower two lines of the CRT display the title of a parameter or function and the selected value for each four-button group. The current value (or state), as selected by button operation, is displayed under the title, up to five related parameters (titles) at one time.

Two groups of parameter-selection keys are provided



2. Computer as instrument. The mainframe of the 6000 is a full-fledged 16-bit microcomputer and is almost completely digital save for the X, Y, and Z signals used for display generation. All signal conditioning and conversion is done by the various plug-in modules.

on the instrument's front panel. Plug-in module keys in conjunction with the display buttons program the signal processing from the input connectors to the data-frame storage and arm or disarm the trigger. Mainframe keys (including those in the key pad) are used in conjunction with the buttons to program display of the trace, to position the mark, to configure the options and input/output modules, and to perform mathematical operations on stored and displayed data.

Thus, the operator may focus on the plug-in keys to set up the capture and storage of signal waveforms and then his shift his attention to the mainframe keys to display all or some of the captured data (see "A digital window on analog waveforms," p. 116). To illustrate the use of this self-prompting instrument, consider the operations of acquiring a signal.

Signal capture

As in any measurement installation, the operator must connect the signal to the instrument, adjust scaling to compensate for any attenuation that may be introduced by a probe, and band-limit the signal to be digitized to remove the effects of any aliasing in the sampled-data processing. In the 6000, these input characteristics are set up in a very flexible way.

By making use of the plug-in module input key, the operator sets up the 6000 to program the display button groups for a correlated set of five input control operations. The five jobs are:

■ To select the input analog signal channel to which the value-setting actions of the other buttons will be applied. The table of possible inputs "scrolled" by the buttons in this group is predefined by the plug-in module's ROM as having one, two, or four channels.

■ To configure the input for the single-ended or differential mode. Because this is a two-state value group, the buttons toggle between the alternates. For two-channel plug-ins, the differential mode selection results in the subtraction of channel 2 from channel 1 before subsequent conditioning; for four-channel plug-ins, the differential mode selection subtracts channel 2 from channel 1 and or channel 4 from channel 3.

■ To provide button-selectable alternatives for coupling (ac, dc, or short to ground in the plug-in) a selected channel. The ground coupling may be used in programmed zero calibrations and tests.

■ To select the full-scale range to be digitized by the plug-in analog-to-digital converter. For the 100-kHz module, the conversion is performed with a 14-bit resolution, and the scrolled values range from ±500 millivolts to ±500 volts, providing amplitude resolutions of 60 microvolts to 6 mV for the conditioned signal.

■ To select a gain factor to set up a scaling in the processing to compensate for any attenuation introduced by any probe. This automatic scaling in the instrument gives direct-reading results with respect to the signal at its source. The number of possible gain factors to be scrolled by the buttons in this group is determined by information received from the plug-in ROM and is designed for compatibility with the type of signal expected to be sampled by the plug-in. For 100-kHz modules, for example, there are three possible factors

An digital window on analog waveforms

With the Data 6000 the user acquires, digitizes, stores, processes and displays waveforms in a wide variety of ways. To understand the relationships among the various signal parameters that can be controlled, definitions of the relationships among the several elements in the signal-processing chain are required.

The first of these elements is the analog signal itself, and in general the instrument user has little control of the signal outside the instrument.

The second is the portion of the signal captured by the instrument. This is now done digitally, and capture is a function of the trigger time, the positive or negative delay, the period between sample points, the full-scale value to be resolved by analog-to-digital conversion, and the number of points to be recorded. All these variables make up what can be called the acquisition window.

All the information associated with one point in the sample can be referred to as the data record, or frame. The coordinates of the frame are measured in units of time and voltage; the point of origin from which these coordinates are taken are the trigger time and the midpoint zero value of the selected full-scale range. The number of points that may be recorded in a frame is limited by amount of memory available. For some applications, a frame of any length may be transferred to some peripheral (disk, tape, and so forth).

The third link is the displayed portion of a stored record. Data is displayed as a function of offsets in time and voltage from the data record origin and the scale of the horizontal and vertical display. The full set of parameters that determine the display makes up the display window.

The scale of the display may be set independently for both the horizontal and vertical coordinates. In effect, the operator may determine the mapping of the record (stored data of any kind) onto a fixed number of points in the horizontal and vertical coordinates of the display. Normally, the waveform display, or trace, has 512 horizontal intervals and a resolution of 1,024 display increment levels in the vertical displacement selected for that trace. The vertical displacement for any one trace may represent the full vertical section of the CRT for overlapped traces, half the vertical section for separated dual traces, or quarter that section for separated quadruple traces.

Zooming action enables the user to "magnify" any selected portion of a record, either horizontally or vertically or both. Any portion of the signal may be blown up to reveal amplitude or time or both amplitude and time phenomena at the basic resolution of the module. For 100-kilohertz sampling rates, the phenomenon may be resolved into 10-microsecond time and 0.006% of full-scale–range voltage intervals. For sampling rates of 100 megahertz, the phenomenon may be resolved into 10-nanosecond time and 0.8% of full-scale-range voltage intervals.

The operator zooms horizontally by selecting fewer than 512 points from the record to be displayed in the trace. Each pair of selected points appears on the display with horizontal point-spaces between them. A selected "magnification" of 8, for example, will place 64 of the recorded points over the horizontal interval normally occupied by 512 points. By selecting less than the resolution increment of voltage in the record for the increment on the display, the operator zooms vertically.

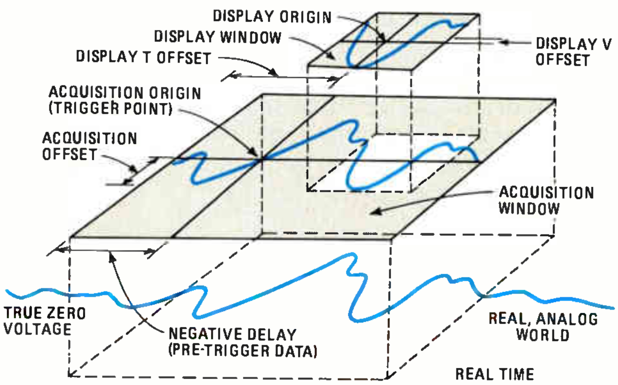
To form a connected waveform display in zoom operations, the operator may choose to fill the intervening point-spaces with any of several available processed points. A point-to-point connection, linearly interpreted points, or a filtered point value may be selected, for example.

Conversely, by mapping more than the horizontal or vertical recorded points to the display constants, the operator may compress the selected portion of the acquisition window in the trace. Up to 64 record points may be compressed into one display point. Compressing is useful to reduce the interference in noisy signals; the action may accomplish a digital filtering.

For compressing operations, the operator may choose to select the displayed point by any of several available weighting schemes. A simple Nth selection (dropping the intervening points), a linear average, or a filter weighting may be used, for example.

A marker that selects or highlights portions of the trace is an aid to precision measurements or further processing. This is a function of the type of marker selected (none, baseline, cursor, crosshair, or grid).

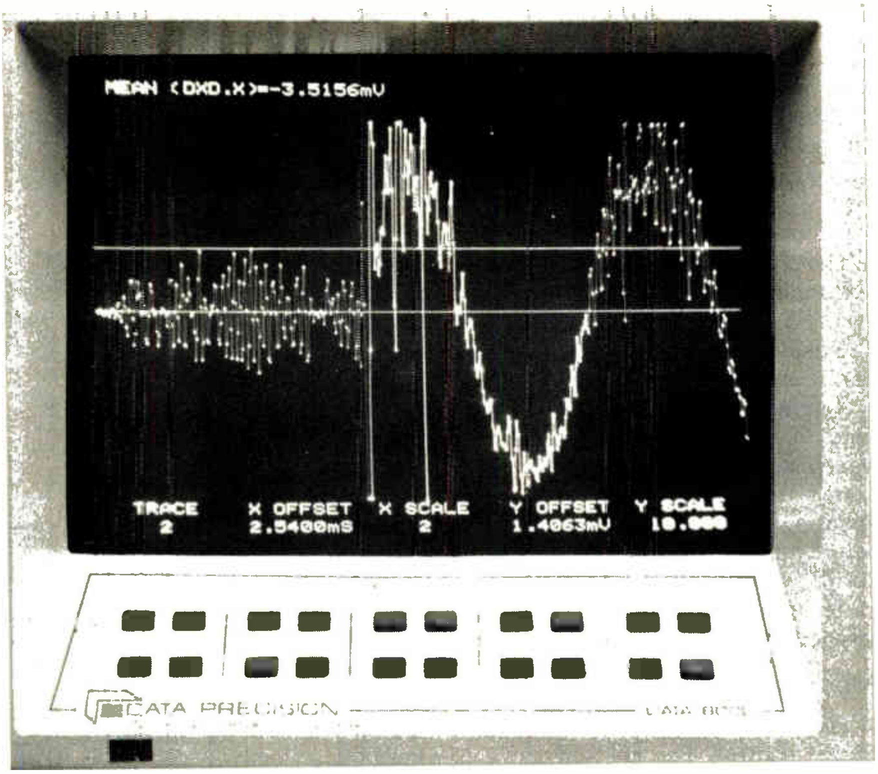
The baseline, for example, may be used to single out points in a record above a meaningful threshold. Its position is determined by selecting a vertical voltage offset only. The cursor may be used to delimit a portion of the trace for measurement or for further processing. It is set up by selecting a starting point specified as a time or voltage, with the interval specified independently. Moreover, some markers may be set relative to the origin of the data record, or to the trace or the display's points.



from which the user may choose: 1, 10, and 100.

With the plug-in module filter key, the operator can insert or take out of the input circuit the plug-in's anti-aliasing filter. Other plug-in module keys in conjunction with their buttons set trigger conditions and the signal sampling parameters and select and store some intermediate-processed records. The particular plug-in module will specify the parameters by their key-identifiers; the available titled groups of values and the table of such button-selected values will depend upon the information communicated by the plug-in ROM.

For a 100-kHz plug-in, a typical module, the trigger key gives the user the capability of selecting the source of the trigger the level at which the system will detect a



3. Button-down parameters. The set of buttons below the Data 6000's screen are used to specify precisely the values of various parameters. Depending upon which parameter is selected using other keys, the processor sets button labels and lets them scroll through a table of allowable values.

trigger event, the slope of the crossing (positive or negative of either an ac or dc component), and mode of triggering (automatic or normal).

In the automatic triggering mode, the 6000 generates triggers internally after a preset delay following each data-frame update, if the instrument does not otherwise detect a valid trigger. In the normal triggering mode, the 6000 will detect a trigger when it has been armed and when user-selected trigger conditions have been met. The arming conditions are also selected from the front panel. A hold-off time interval between data-frame updates may be selected using buttons from a table that includes a zero limit (triggering occurs as soon after a data frame is updated as a valid trigger is detected), a hold-off until the display is updated with new frame data, and an infinite hold-off (no trigger is recognized after the first data frame is stored). Intermediate, selectable hold-off values range from 1 to 50 seconds.

The time-base key permits the sample period of the conditioned and scaled input signal to be chosen. A plug-in module may have two such time bases, and each may be set up independently. For each time base, the user may choose the clock source (internal or external), the sample period (in units of seconds, milliseconds, microseconds, or nanoseconds, depending upon the plug-in specifications), the number of points in the frame (up to 56-K for the 100-kHz sampling plug-in), and the delay (positive or negative number of sampling periods with respect to the detected trigger time) using buttons. The time segment of the signal recorded in the frame is thus equal to the product of the selected number of points by the selected sampling period between points. Choosing appropriate values for sample periods lets the instrument capture trends over a period of many hours or days.

Two plug-in keys complete the process of storing digitized data so that it will remain unchanged: process and buffer. The process key sets up the parameter selection for the storage of averaged multiframe data; the buffer key sets up the combination of input signal and time base for the storage of processed frame data.

The 6000 automatically sets up storage registers for frames defined by user-selected combinations of input channels and time bases. Thus, for a two-channel plug-in with two time bases, there can be four such frame storage locations, and for a four-channel plug-in there will be eight such locations. The buffer key enables the operator to define the particular combination, if any, that will be assigned to each of the possible frame-storage locations. It also may determine which of these will continue to be gated with new frames according to the triggering conditions (live gate) and which will be frozen after one input (hold gate).

Choice view

The 6000 displays a trace that may be updated as a whole, so that it will always represent a record in the same time interval with respect to a valid trigger. The instrument automatically sets up a buffer store of each data frame that it will use as a basis for the display via the display trace controls. Although the data frame is updated point by point after a valid trigger is detected, the corresponding buffer is updated only when a new frame record has been transferred to memory. (For sample periods of 20 ms or more, the trace is updated point by point for the same record, so that updated information can be seen without great delay.) The process key provides the 6000 user with the capability of configuring some read-only records of processed data frames without further key programming.

Each of the data frames may be processed and stored in a designated buffer by the button operation after the buffer key is operated. The types of such buffered storaged include:

- Subsets of any selected data frame. The subset starting point may be offset from the start of the frame record, and the number of selected points may be less than or equal to those in the frame.
- Calibrated points by gain and offset, delay.

The multiframe processing sets up buffers for:

- Running averages of any selected data frame, whose averaging base number may be button-selected.
- Exponentially weighted averages of any data frame that is selected.
- Retained maximum and minimum points at a sample time. With this feature, the 6000 captures and displays waveform envelopes.

In setting up a buffer, the user may also control its updating mode in order to compare waveform records before and after significant events. The user may reset a buffer, delete a buffer (off mode), freeze a selected buffer at the last frame update (hold mode), or have it respond to each change in the data frame (live mode).

Arm, disarm, and frame status

The 6000 provides the user with several levels of trigger control. The hold-off mode previously described allows the user to evaluate the results of a signal-processing chain before allowing a new data frame to add different information. Front-panel program control buttons may selectively set up a live or a frozen status for some frame or buffer to facilitate planned comparison of time-separated signals.

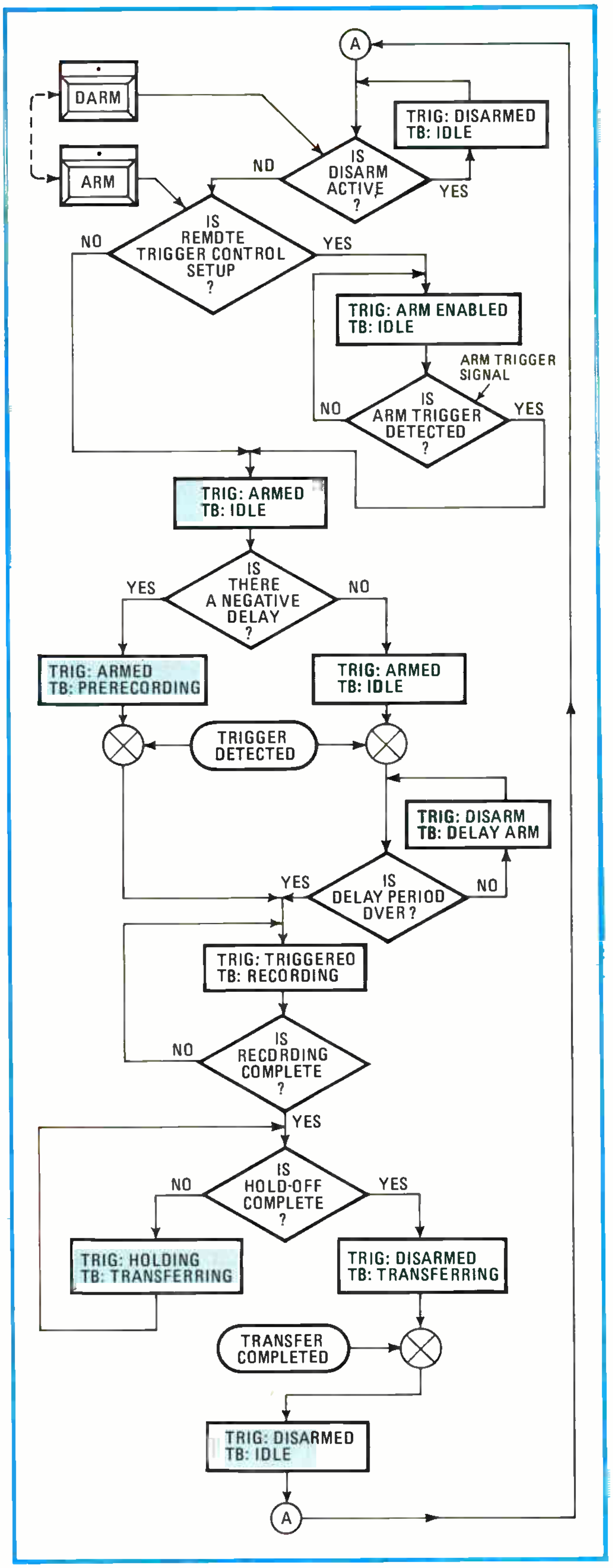
In addition to these controls, the triggered update of all data frames may be controlled via the plug-in's arm-disarm key. This key interrupts the live updating of source inputs to allow the study of some interesting signal phenomena on the fly.

Two top lines of the CRT display indicate the status of the instrument with respect to its recording, storing, or transferring of updated frame information. Figure 4 illustrates the correlation between the messages that may appear on these lines and the status of the recording or transferring operations. The top line of the status message describes the trigger status (TRIG:), while the second line describes the sampling or transferring status of each of the two time bases (TB).

As long as the disarm key is actuated, no updating can take place. If the arm key is actuated (interlocked with the disarm key), the succeeding action depends upon whether a remote signal control of the trigger is instrumented (via one of the I/O communication options.) While waiting for a remote enable, the display will define an armed trigger.

If a negative delay has been programmed for a time base, the instrument begins prerecording as soon as the trigger is armed. Otherwise it remains idle until the trigger is valid or until after the programmed positive delay has occurred.

When the frame recording is completed, the instrument automatically holds off the next trigger until the updated frame data is transferred to its buffer for the next display. It will hold off the trigger for an additional



4. Keeping posted. As the 6000 goes through the various steps to determine whether trigger conditions have been met, it informs the user of the status of the measurement process by placing the messages shown in the boxes above on the top of the display.

TABLE 1: SCALAR RESULT FUNCTIONS OF THE DATA 6000 DIGITAL WAVEFORM ANALYZER		
Function type	Key label	Description of function
Threshold detection	MAX	maximum voltage value
	MIN	minimum voltage level
	PKPK	peak-to-peak voltage level
	LMAX	local maximum: voltage where slope first changes from plus to minus
	LMIN	local minimum: voltage where slope first changes from minus to plus
	MSLP	maximum slope: time of first maximum voltage
	CRS	crossing time: time of first crossing of 0 or base-line voltage
	CRS+, CRS−	time of first minus to plus crossing time of first plus to minus crossing
Interval detection	PER	average period: time from first to last crossing of the same polarity divided by the number of such crossings
	FREQ	frequency: the reciprocal of the average period
	HCYC	half cycle: time from first crossing to next of opposite polarity
Pulse parameter	RISE	time from 10% to 90% of cursor-set 0% and 100% values
	FALL	time from 90% to 10%
	PLSW	time from first 50% to last crossing of 50% of opposite polarity
	DLY	time from 0% to 50%
	OVSH	ratio of maximum to 100%
	STL	settling time: from 0 to within 1% or 0.1% (selectable) of 100% value
Statistic	RMS	root mean square
	MEAN	average value
	AREA	area under the curve
	ENGY	integral of square of voltage multiplied by time

delay if a hold-off time has been button-programmed as described earlier. The status lines will indicate the trigger status as holding (until the hold-off interval is completed) or disarmed (when the hold-off is either 0 or completed). Then, when transfer is completed, the time-base indication returns to OFFE, and the cycle starts over again.

Making measurements

The 6000 system provides the operator not only with the usual "eyeball" methods of making waveform measurements by positioning the screen marks (cursor, cross-hair, baseline) or by changing the scale of the grid but with digital readout as well. Precision numeric readouts of mark positions and movements are readily available in the two-line display at the bottom of the screen.

They are much more accurate than eyeballing and exploit the unit's precision front-end signal processing. They are valid readouts, as well as precision ones. The user is not misled by observing results of arithmetic operations that are carried out to a resolution not supported by the precision of the digitized input signal.

The instrument-programmed digital processing is designed to improve throughput rates by several orders of magnitude both for making test measurements and in performing chains of simple or complex processing functions on the recorded data segments.

The 6000's power, flexibility, and simplicity are evident from a brief review of the set of key-pad–programmable operations that may be performed on operands formed from the digitized signals.

Not only is there an unlimited set of operations (the user may even program the system in Basic, the microprocessor-supported language), but also the operands and results may be delimited by modifiers appended to the operational statements (equations). Unless otherwise modified, the operation will use the complete stored record (all points, no fill) from which the trace is derived. However, the operand may be defined as either all the points of a trace (TR) or a full subset of a trace by positioning the cursor (CR) or the base line (BL) or by beginning with a next (NX) point in the selected trace interval. When defined in any of these ways, the operand will include any fill points or use the compressed points of the trace.

The result of an operation is always displayed on the CRT. A scalar result will be displayed in digital form, and by adding a simple 2-alpha modifier to the operational statement (equation), a designated mark may be located according to the scalar result. The cursor, baseline, crosshair, or offset may be positioned to the result value by appending modifier SC, SE, SB, or SX, respectively, to the statement (equation).

Scalar result functions

The key-pad–selectable scalar result functions operate on the operand, and the result is a single value of voltage (or voltage difference), time (or time interval), or frequency (the reciprocal of time interval). The operation and the result are displayed as a statement at the top of the CRT (replacing the status lines of the TRIG/TB messages). The statement includes the name of the parent record for the primary displayed trace that has been used as the operand. The scalar result functions are grouped as shown in Table 1.

An example of how these functions would be used is finding the pulse width of a signal. The beginning of a cursor would be set on the trace at the apparent zero-crossing level of the pulse and extended until it reached the apparent final value of the pulse. The precise values

TABLE 2: VECTOR RESULT FUNCTIONS OF THE DATA 6000 DIGITAL WAVEFORM ANALYZER

Key label	Description of function
CPY	copy operand 1 to a new record name (automatically assigned by Data 6000)
+	add operand 1 and operand 2 and automatically scale the result
−	subtract operand 1 from operand 2 and scale
X	multiply operand 1 by operand 2 and scale
÷	divide operand 1 by operand 2 and scale
MAG	take magnitude spectrum (fast Fourier tranform) of operand 1 and scale; if operand is real, the result is real magnitude only; if the operand is complex, the result is complex
CMAG	take complex magnitude spectrum (FFT): operand 1 is the real input and operand 2 is the imaginary
PHS	take phase spectrum
CPHS	take complex phase spectrum: operand 1 is the real input and operand 2 is the imaginary
LMAG	take logarithmic magnitude spectrum
CLMG	take complex logarithmic magnitude spectrum
CORR	correlate operand 1 with operand 2 and scale
ACORR	autocorrelate operand 1 and scale
DIFF	differentiate operand 1
INTG	integrate operand 1
5PTA	derive five-point sliding average of operand 1
9PTA	derive nine-point sliding average of operand 1

in voltage and time for the start and end of the cursor would appear on the screen at the lower-value set lines.

After pressing the modifier key, CR, pressing the PLSW key of the key pad would then cause the CRT's top status line to display PLSW (record name) (S5) XX.XX, where the final characters represent time. Similarly, and without adjusting the cursor, a wide range of scalar parameters can be gathered using the key pad. Such values include a signal's rise time, fall time, settling time, overshoot, and delay.

Vector result functions

Key-pad functions that produce a vector result (a series of point values) are grouped for convenience and identified with mnemonic alpha descriptors on the keys. They may operate on only one designated operand (for example, the derivative d/dt function), or they may relate two operands with a functional connector (for example, operand 1 × operand 2).

Operands are selected by displaying traces on the CRT. In the same manner as for the scalar result functions, the user may modify the operands for vector result functions so that they will be performed on the entire record, unless modified for a particular trace subset of the record. The instrument automatically designates the name of the result record and, unless the primary record (operand 1) is a data frame and buffer, the result record will replace the primary record in storage and on the display. However, one of the vector result functions allows the operator to copy a record, and this can be done to obtain a work record without losing an original.

Vector operation results are automatically scaled where appropriate; derivative and integration functions, for example, are not scaled. The autoscaling operation assures that at least one point in the result will be above half full scale value. The digital readouts will be corrected for the scaling, but the display will provide maximum sensitivity. Table 2 lists vector result functions.

Chaining operations

Unless chained, the instrument will perform only the most recently entered function. If directed to repeat the function (EX key), it will execute that function again any time one of the operands is updated or a modifier repositioned and will display the new result on the CRT. As soon as any other mainframe or plug-in key is actuated, the repeated function execution is not performed, but the equation is stored for recall and later use.

Two or more functions may be executed in series by using a result record name of a prior operation as an operand for a subsequent operation and appending the EX at the start of the statement (equation). The 6000 links that operation to the previous one and will perform the indicated equations in series beginning with the first one with the EX designation. It will reexecute the entire chain whenever any one of the records in the chain is updated. The status line in the display will retain the last equation in the chain, while the trace is updated with the result of the last function executed.

Thus, the user may start with a recorded time-domain signal, obtain the Fourier transform of it, apply a prerecorded convolution function to the transform, and generate the inverse transform of the result. Appropriate selection of hold-off time intervals will permit the full chain to be processed and evaluated before the next update occurs.

At any time, the user may recall and edit the records and equations automatically stored in memory. By actuating the directory (DIR) mainframe key, the user recalls the list of stored records. These are displayed in a column six deep on the lower part of the CRT. Using the button labeled EXPAND, the operator may recall information about any one record, that is, scale, offset number of points, and sampling period. The operator may remove any of the listed records by using the appropriate mainframe stepping button until the index mark appears alongside the record to be removed. Pressing the two delete buttons simultaneously twice then removes it. When more than six records are stored, the next group in sequence (above or below in the list) will be displayed when an attempt is made to move the index mark beyond the first or last displayed name.

The list of stored equations may be recalled and displayed by operating the mainframe program key. The stored equations are displayed, six at a time, in place of the status lines at the top of the CRT. A designated group of stepping buttons lets the operator place an index mark alongside one of the equations and delete it when desired. Scrolling is used to review all the executable equations. The operator may insert an equation in its appropriate place by locating the pair to be separated by the new equation and operating the insert button before setting up the new equation. □

Microprocessor-controlled system prints color TV pictures

Good-looking hard copy from a color television source is achieved by controlling a camera with a microprocessor

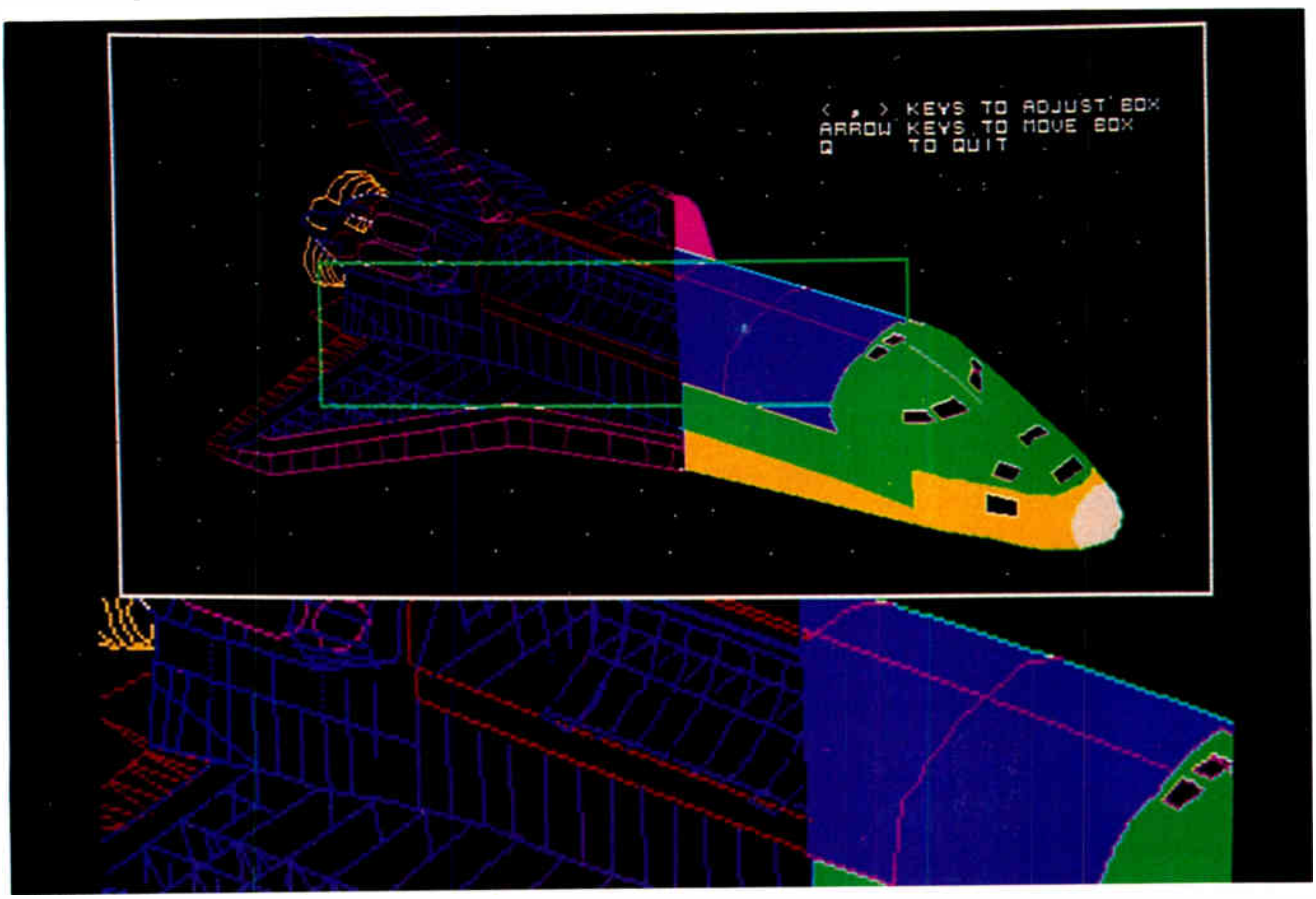
by Leon Levinson and Edmund Newbert, *Image Resource Corp., Westlake Village, Calif.*

☐ Taking a color photograph of a color cathode-ray-tube image can be frustrating, because the incompatibilities of the two media are likely to produce bad photos. A microprocessor-initiated triple exposure can avoid this problem, with the processor separately controlling to a very fine tolerance exposure-time and contrast for each primary color. The result (Fig. 1) is far superior to photographing the video screen directly, producing color prints, projection slides, and overhead transparencies.

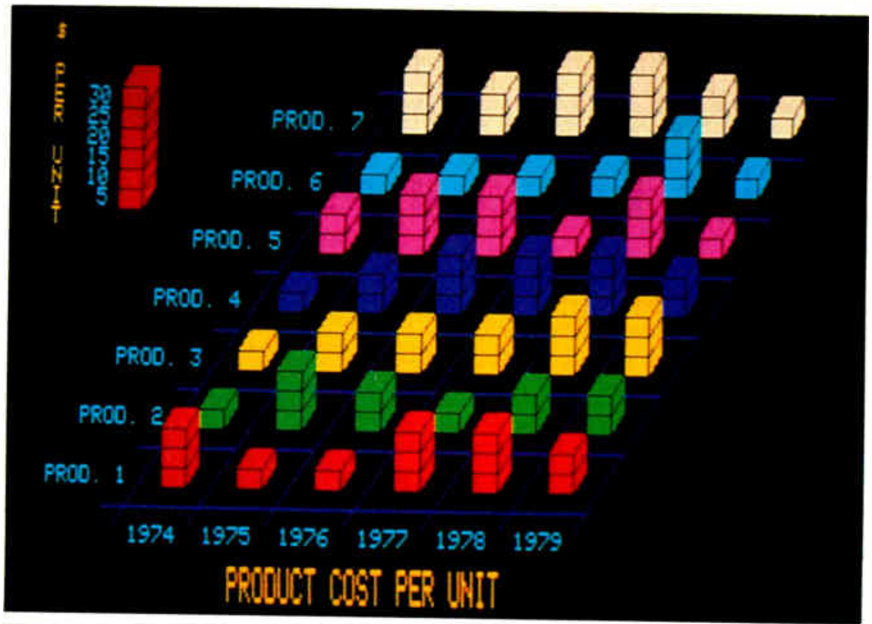
By combining stored control parameters and operator adjustments, the system can even enhance picture quality beyond that of the video image. In terms of subjective viewer preferences, the photograph may appear better than the original picture from a computer graphics system or a single-frame image from a television camera.

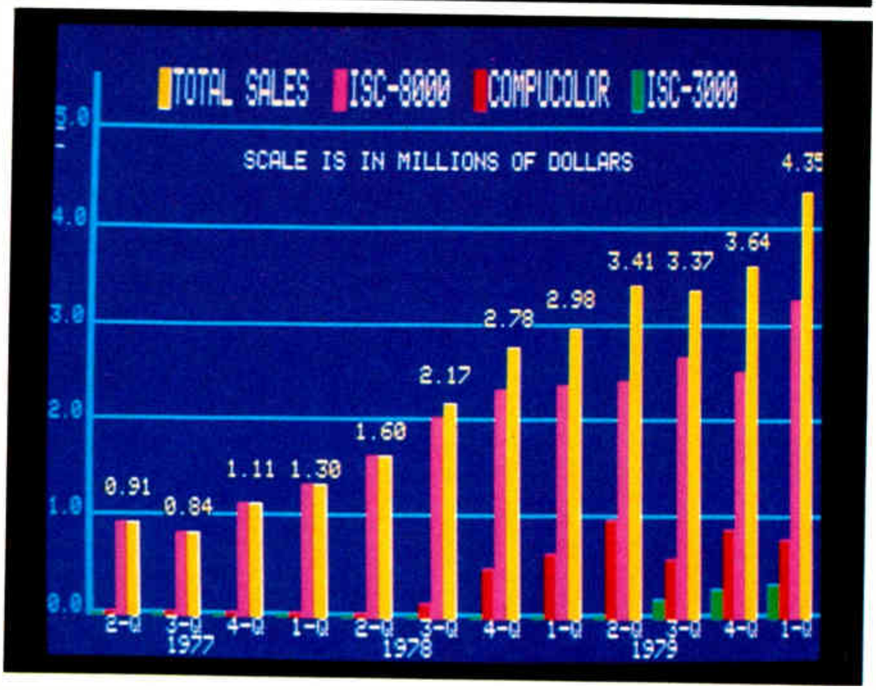
Videoprint [*Electronics*, May 8, 1980, p. 194] is in effect a camera with an interchangeable back and fixed-focus lens trained on a high-resolution cathode-ray tube. The image fed to this CRT is controlled by the microprocessor system.

Problems with off-the-screen photos start with the disparities between video and photographic technology. Video colors are created by adding the red, green, and blue primaries; photographic colors are generated by superimposing the minus primaries, cyan, magenta, and yellow (see "Incompatibilities between video and photographic images," p. 123). When the source is a color-



Highlights. The Videoprint camera produces brilliant color pictures from computer graphics, such as this space shuttle design.





1. Pretty pictures. The microprocessor-controlled Videoprint system can print a 3-D bar graph (a) and a standard bar graph (b), cases where the addition of color makes business graphics eminently more readable.

separated CRT signal and the destination medium is a photographic emulsion where minus primaries are superimposed, the colors get muddy or desaturated if photographed directly from a standard color CRT.

Familiarity also plays a part in how the image will be perceived. For example, nearly everyone is accustomed to horizontal raster lines in a video display, but not in a photograph. Observers are also accustomed to different video and photographic dark-to-light contrasts, so video colors would appear garish if exactly reproduced in a photo. At the same time, the photo must retain all the information of the video image without any loss of detail in the highlights or shadows.

Compounding these difficulties is the fact that almost every viewer is likely to have an opinion on how to resolve the incompatibilities. Judgments of the quality of any image are highly subjective. Personal taste may dictate a cooler or warmer hue for flesh tones, or the designer of a business chart may want to make a particular color more dramatic to emphasize an important point. Therefore, a system for producing photographs must have the capability for viewer alteration.

All of the video-to-photograph difficulties can be minimized by bypassing the conventional three-gun color CRT and using an optical, rather than electronic, technique to combine the red, green, and blue video information into a full-color photographic image. In the Videoprint system, separate primary-color video images are displayed in sequence on a high-resolution monochrome CRT. The proper color filter is placed between the CRT and the lens, and the control system sets the exposure time and video contrast individually for each of three color exposures, made on a single piece of film. The operator can modify the settings, usually working from instant color prints, since the CRT is part of the reproduction scheme within the unit, and not an external monitor.

The microprocessor in the system is an Intel 8085. Microprocessor software for the image-conversion process is stored in a 6-K-byte read-only memory, along with conversion factors for a variety of photographic media, including 35-millimeter slides, Polaroid Corp. SX-70 instant prints, and 4-by-5-inch color negatives, black and white negatives, overhead transparencies, and other instant prints (Fig. 2).

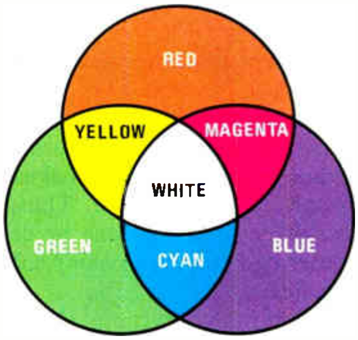
Alternative conversion factors reflecting the user's personal preferences are stored in a 1-K-byte random-access memory. The user-defined parameters can apply to any standard or nonstandard photographic material and for such specialized applications as the generation of color images from monochrome CRTs.

A 6.144-megahertz system clock incorporated into the processor circuitry serves as a timing and frequency source for all control functions, including the frequency-to-voltage and voltage-to-frequency interfaces allowing the digital microprocessor to communicate with analog elements within the system. The complete Videoprint package fits into a light-proof desktop unit.

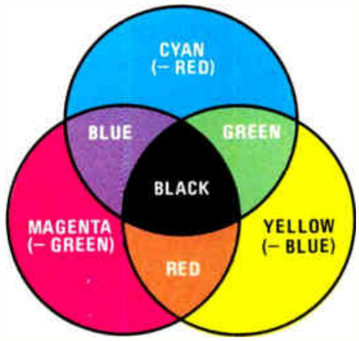
The video-information input can be any standard TV encoded-color signal, or three separate red, green, and

Incompatibilities between video and photographic images

- Video images are formed by additive primary colors—red, green, and blue (RGB)—which combine to form white on a black video screen background (part a of the figure). Photographic images are formed by three subtractive dyes—cyan (minus-red), magenta (minus-green), and yellow (minus-blue)—which combine to form black on a white reflective background such as photographic paper or a projection screen (part b of the figure).
- Intermediate video colors like orange or purple are produced by controlling the amount of light generated by spatially separated phosphor dots. Intermediate photographic colors are created by superimposed dyes. An off-the-screen photograph preserves the spatial separation of the video image, creating color effects that do not match photographic colors.
- Video RGB colors differ distinctly from one cathode-ray tube to another, but minus-RGB photographic dyes vary even more widely between film types. Moreover, the minus-primary photo dyes rarely match the spectrographic signatures of their corresponding video RGB primaries.
- Video screens radiate light, resulting in relatively high-contrast images with a wide range of intermediate grays and color shades. Photographic prints depend on lower-luminance reflected light, limiting the contrast and introducing yet another variable when the conversion process must accommodate a variety of photographic media.
- Video screens also have a high-luminance glare that masks the raster-line pattern, the spatial separation between phosphor dots, and the dark spots produced by nonilluminated dots. A lower-luminance, off-the-screen photograph reveals these discontinuities, resulting in muddy, desaturated colors and a lower apparent resolution.



(a)
ADDITIVE
VIDEO COLORS (LIGHT SOURCES)



(b)
SUBTRACTIVE
PHOTOGRAPHIC COLORS (DYES)

blue (RGB) signals from a computer-graphics display. Both applications are expanding at a rapid rate in response to growing demands for hard-copy documentation, audiovisual presentations, and color reproductions.

Encoded-color sources could be any of a number of different entertainment or industrial TV equipment with a freeze-frame capability, such as still stores, videotape recorders, and the new video discs. Separate RGB color-signal inputs would most likely be from the display-signal output of a computer-graphics controller or special-effects generator.

Encoded-color inputs are immediately decoded to form red, green, and blue color signals identical to those of an RGB input. The first task of the microprocessor, therefore, is to select one of the signals so that, at any instant, only a single primary-color image is presented on the screen of the monochrome monitor contained within the enclosure.

The processor simultaneously positions a color-filter wheel so that, during the period the selected primary-color image is displayed, a corresponding filter is placed between the CRT and the camera. The control program then rotates the filter wheel to a second and third position while the corresponding primary-color signals are displayed. A complete print cycle consists, then, of three separate exposures with all three primary-color images superimposed on the film.

The three filters have been carefully selected to match the monochrome-CRT's phosphor as closely as possible to the spectral sensitivities of the three emulsion layers that characterize nearly all color films and print material. The three layers are usually balanced so that they will produce a pure white or gray image when exposed to white light with approximately equal radiant energy across the visible spectrum.

Such a light source differs significantly, however, from the three narrowband primary-color outputs of a conventional color CRT, and this can create a major problem when a straight off-the-screen-photograph is attempted. There is, for example, no assurance that the blue-sensitive emulsion in a color film will respond efficiently, without color crosstalk, when exposed to the blue portion of a conventional color CRT image. With a monochrome CRT and a separate color filter for each primary, a much closer correspondence can be obtained.

Hue, intensity, and saturation

The superimposed exposures create a full spectrum of colors. More importantly, each of the three exposures can be separately controlled, allowing the user to alter the colors simply by changing the exposure values stored in the microprocessor memory.

The relationship between the three exposures and the way most users would perceive and control the resulting colors is summarized in Fig. 3. The size of each of the three colored bars represents the relative magnitudes of the red, green, and blue exposure values at any specific location within the image area. The two highest-magnitude primaries determine the hue of the color, such as orange, yellow, or blue-green.

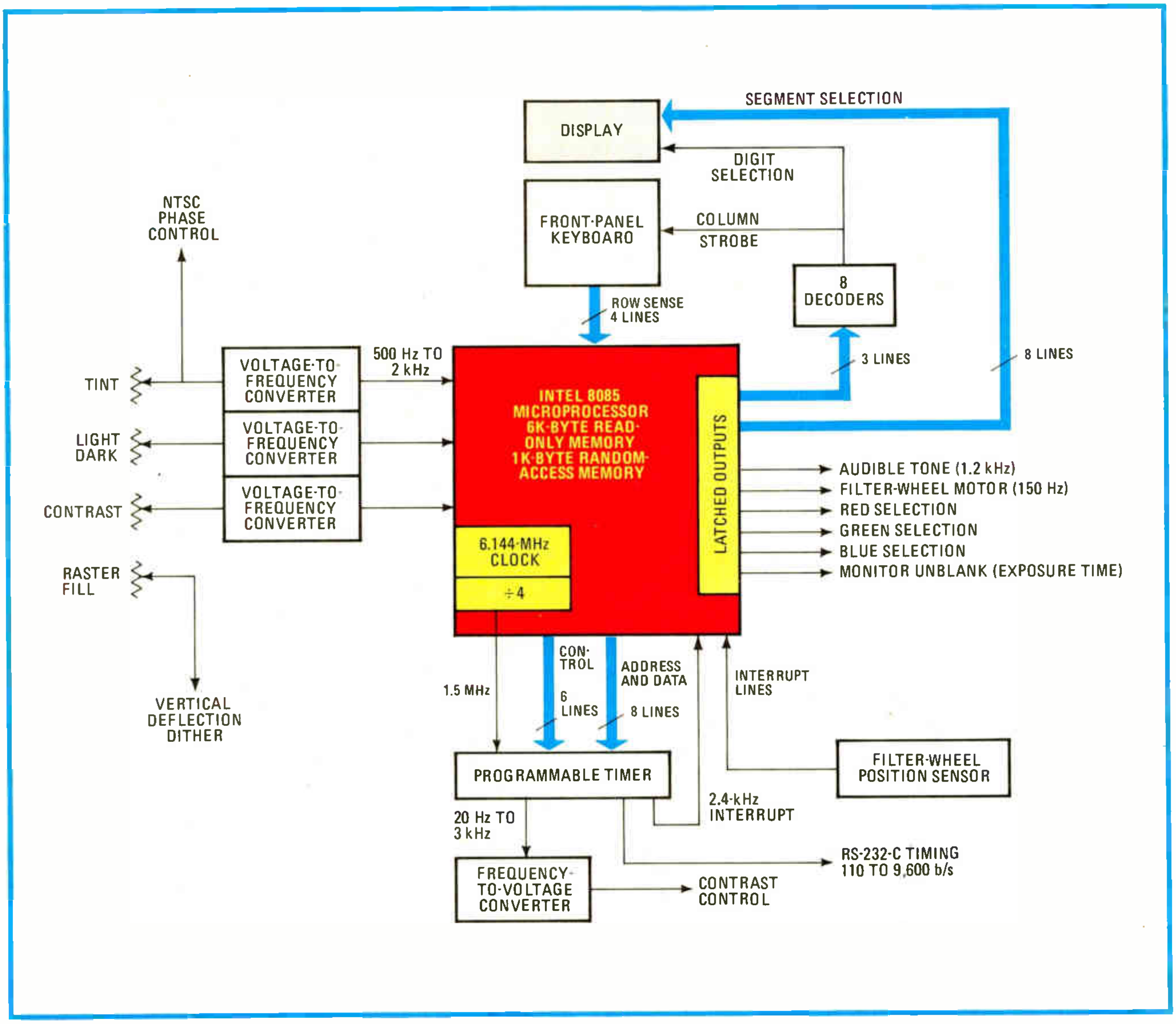
The sum of the three primaries determines the intensity, or dark-to-light brightness. The lowest-magnitude primary is not directly apparent to the eye, but combines with the other two primary colors to form white. Therefore, it determines the saturation, or colorfulness, of the color, such as pale, pastel, or vivid. Thus, by directing the microprocessor to alter any one or combination of exposures, the user can change a color's subjective qualities as well as its hue.

As in any photographic system, the result of each Videoprint exposure is a function of the two independent variables, exposure time and amount of light. It is these two variables that the microprocessor controls.

Exposure-time control is straightforward. The selected primary-color signal is displayed by the processor for an interval controlled to an accuracy of a hundredth of a second and programmed or user-defined to within a tenth of a second. Typical exposure times for each primary color range from a half second to several seconds, depending on the type of film.

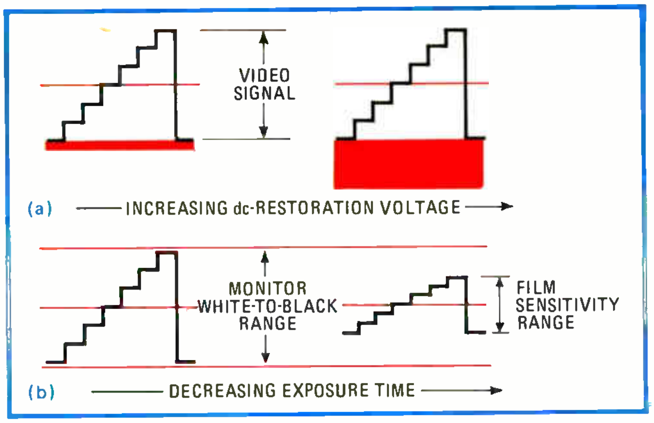
Processor control over the amount of light generated by the monochrome monitor is more complex. Programmed values assume that the video signal will generate an average intensity across the entire image area. But the system must also take into account the light-to-dark contrast range of the image, and this is complicated by the differences between the range of grays perceived by the human eye and the range that can be generated by a video screen or recorded by a film. Too much light at the high end of the gray scale may result in a loss of highlight detail; too little light at the low end can black out important information.

As might be expected, the combination of eye and brain has by far the widest contrast range: on the order of 2,000:1 between white and black. By comparison, high-performance CRTs can rarely display a white-to-



2. Color control. The Intel 8085 microprocessor, using software stored in the 6-K-byte read-only memory, controls the process of converting a video color image to a color print or transparency. The random-access memory stores user-defined parameters for modifying the image.

3. Electronic palette. The heights of each of the three color bars represent the relative exposure values for each of the primary colors for a particular part of an image. The two biggest determine the hue (left), the sum of the three produce the intensity of the color (middle), and the lowest color combines with the other two to determine how much white is added (right).



4. Matching. The wider video contrast ratio is reduced to match the film's sensitivity range by increasing the dc restoration voltage (the brightness of the monitor); the expanded signal is attenuated on film by decreasing the exposure time.

black contrast ratio greater than 100:1. Photographic films and prints have similar limitations. Depending on the type of film, the ratio may be as low as 20:1.

Fortunately, the human vision system can easily interpolate between light-to-dark relationships compressed into a limited number of intermediate grays or colors. However, it is imperative that the full contrast range be retained during the transition: there may be fewer intermediate gray or color intensities, but the contrast should run from white to black.

The microprocessor control system achieves this objective by altering the dc restoration (bias) applied to each of the three primary-color input signals. The effect (Fig 4) is to raise or lower the overall intensity of the displayed image, but appropriate changes in the exposure times will return the altered picture to the center of the film's sensitivity range to light intensities.

Most photographic materials are designed with equal contrast ranges for all three primary colors. Programmed contrast values for the CRT image are therefore the same for the three primary-color exposures, but the individual values can also be reset by the user. By decreasing one of the contrast values, for example, the user can remove an unwanted highlight tint without affecting the midrange color balance. Another typical alteration is to increase all three contrast values to create a diagram or chart with greater contrast.

The CRT's contrast ratio is controlled by the output of a frequency-to-voltage converter. The frequency is generated by a timer module set by the processor in response to a programmed or user-defined contrast value.

The timer module has two additional outputs. One is used to establish a switch-selectable baud rate for an RS-232-C interface allowing the user to program and control the Videoprint system from a remote source, such as a graphics terminal. The third and most important output is a 2.4-kHz signal interrupting the microprocessor program to initiate a control subroutine.

The subroutine first produces a 1.2-kHz audible tone at the end of each print cycle, then steps the filter-wheel motor to position the next filter, selects the appropriate primary-color video input, and displays the video signal on the CRT for the specified exposure time. The latched processor outputs, which transfer these commands, also include a set of 600-hertz signals for driving a five-digit display and sensing the status of the system's keyboard.

The user has two levels of control for altering the output of the system. One is based on numerical values stored in the microprocessor memory. The other consists of front-panel potentiometer adjustments, which are read by the processor and applied to the stored values during each print cycle. Each time the system is powered up, the processor checks the status of the film-selection switch on the rear panel to determine what type of film is being used. An appropriate set of programmed exposure values is transferred from ROM to RAM to be used as the values for operating the system.

User fine tuning

Keyboard switches can then be used to display any one of the programmed contrast-ratio and exposure-time values and to change it to any other value for subsequent print cycles. A clear key can be used to return the user-defined value to the programmed setting, which is still in memory. A query command on the RS-232-C interface returns a status report including both the programmed and the current values, which can be displayed or printed on the device connected to the interface.

The group of controls for fine tuning are potentiometers. A light or dark control varies the effective exposure time; a contrast control increases and decreases the contrast ratio. A tint control changes the red-blue exposure times for RGB inputs and the green-magenta balance for a TV-signal input.

The microprocessor senses the status of the controls at the start of each print cycle by jumping to a subroutine that includes tests for the inputs from three voltage-to-frequency converters, each associated with a pot. The subroutine repeats at the full 2.4-kHz interrupt rate for a sufficient number of cycles to assure that accurate frequency measurements have been made.

A fourth potentiometer on the front panel allows the operator to fill in the dark stripes created by the raster pattern. Its output controls a vertical-deflection dither circuit, and the amount of fill can range from zero to a complete raster-line overlap. □

Controller chip handles voice and data switching

For all-digital telecommunications nets, new IC brings sophisticated switching capabilities to the first level of system control

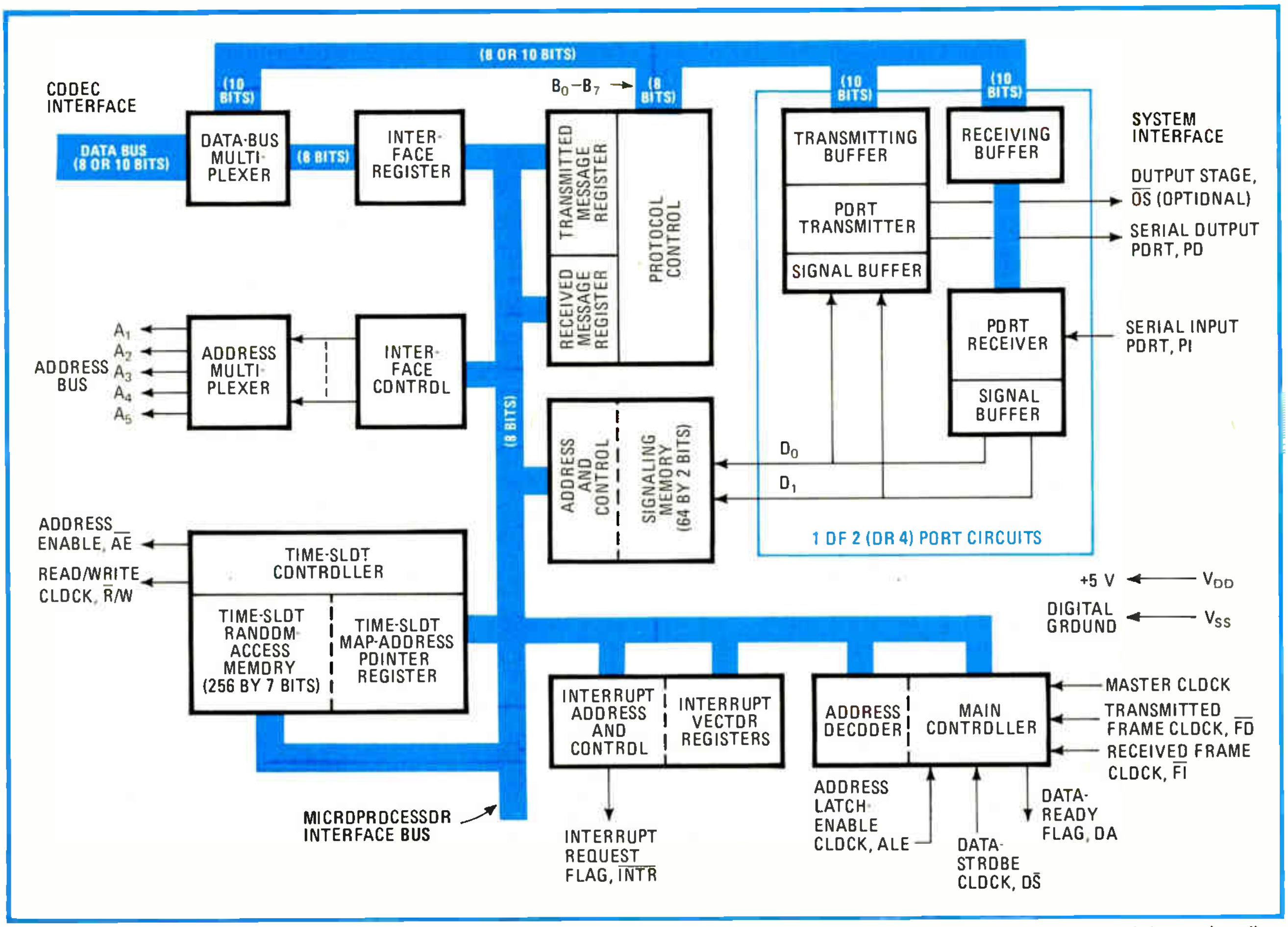
by James W. Smith, *National Semiconductor Corp., Santa Clara, Calif.*

☐ A crucial link in the all-digital telecommunications network is about to be forged in silicon. The digital-line–interface controller (the DLIC integrated circuit) will work with a handful of other ICs, including a special codec-filter combination and a standard microprocessor, to bring intricate switching capabilities to the first level of control after the individual subscriber lines.

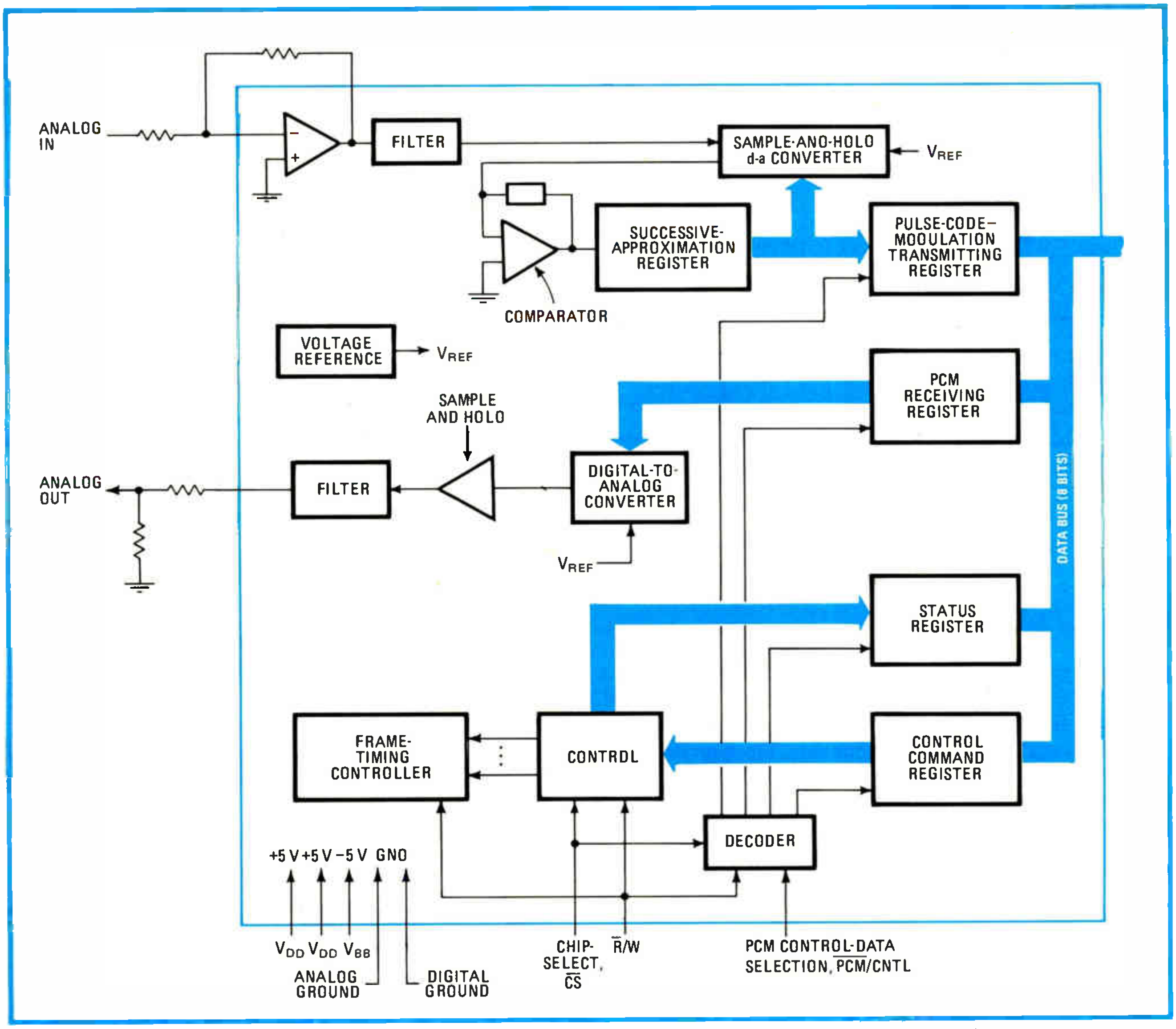
Equally important, the TP3100A/B DLIC is intended to enhance the modularity of the telecommunications net. It is envisioned as a first step towards a cost-effective software-programmable hardware set that can be easily adapted to many different network configurations and at levels ranging from the private branch exchange to the main switching office.

A three-way controller

The TP3100 (Fig. 1) acts as a three-way controller at the first interface after the individual lines, on what is called the subscriber-line interface card. It arbitrates the signal flow between the subscriber lines and the rest of the network, and it provides a control-link protocol that configures the system control signal into a form amen-



1. DLIC architecture. The digital-line–interface controller integrated circuit provides all the control logic needed for voice and data subscriber lines and special-service cards. It also provides a high-level data-link control protocol, which it uses for system control.



2. Two parts in one. The TP3051 μ-law codec-filter and its 3056 A-law counterpart are unusual in that their data buses are parallel. They were designed to interface with either the two-serial-port TP3100A DLIC or the four-port TP3100B.

able to error detection. The 3100 also provides all the control logic needed for the on-card microprocessor to perform such functions as local switching among the lines connected to the card.

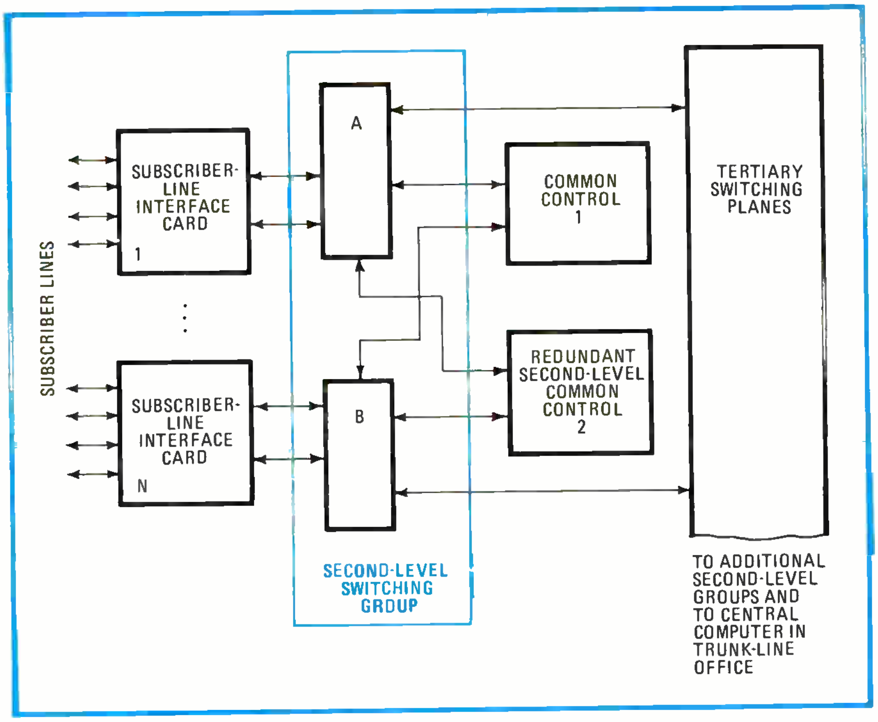
With the DLIC, the local processor can handle all the control functions and gather all the low-speed signaling data at the level of the interface card. What is more, a central controller, acting as a high-level system processor presumably at the main, or trunk, switching office, can communicate with local processors using the HDLC high-level data-link protocol provided by the DLIC. Simultaneously with these two control operations, the 3100 also maintains the space- and time-switching activities for customer-generated voice and data signals.

Benefits and options

With a DLIC architecture, subscriber-line interface cards benefit from a highly integrated control device that simplifies the system interface while generating a standard serial port access for voice and data flow. These interface cards also benefit from a flexible control structure that will not readily become obsolete. Also, many different cards can be constructed using the same basic control hardware.

There are benefits, too, at the system level. For example, the second-level switching function—one step up from the interface card—becomes homogeneous throughout the network because specialized switching takes place at the first level. This standardization allows a modular structure that can grow almost linearly with the total system. Also, full system redundancy is inherent in the DLIC concept, encouraging system designs with improved service and traffic characteristics.

Even the central control function is enhanced. For example, the use of multiple local processors results in a modular software structure for the whole system. Unique signaling and control operations like coin-telephone or emergency services can be handled by the local processors. This assumption allows the central controller to concentrate on communications with any interface card



3. All digital. It is possible to define an all-digital architecture for a private branch exchange or central switching office to handle voice, data, and control signals simultaneously. All system interfaces are identical, regardless of the type of traffic.

in the system, using a single high-level protocol to do so.

The DLIC-based interface card is usually arranged with 128 duplex serial-access channels. There are what amounts to 120 switching channels for signals from subscriber lines. The remaining eight channels are usually reserved for system control signals and the like.

Two models

The TP3100A DLIC has two full-duplex serial 2-megahertz ports, and the B version has four, each handling 6 to 32 channels with bandwidths of 64 or 80 kilohertz. The 40,000-square-mil high-density n-channel MOS IC features 5-volt operation, less than 330 milliwatts of power dissipation, and full compatibility with TTL levels. Its microprocessor interface port is compatible with most commercial processors that use a multiplexed data and address bus.

The DLIC approach is pointless without a codec-and-filter circuit to interface its parallel data bus—but available or announced codec-filter ICs are serial. So National is preparing a parallel chip (shown schematically in Fig. 2): the TP3051/56, with the -51 handling the North American μ-law companding code and the -56 for the European A-law standard.

These 30,000-mil² ICs feature a typical operating power of 50 mW from a ±5-V power supply. Power dissipation during standby operation is less than 1 mW for either part. Typical idle-channel noise is 15 dBrnC0 in the transmit direction (encoder plus filter) and 6 dBrnC0 in the receive direction (decoder plus filter). All sample-and-hold, auto-zero, and voltage-reference circuitry is built into the codec-filter.

The P²C-MOS double-polysilicon-gate complementary-MOS technology used for the DLIC and codec-filter provides a combination of circuit benefits to aid in the optimization of any per-telephone-line analog or digital circuit. For example, it yields a high-gain operational amplifier with good offset characteristics and a minimum of active components. For telephony applications, such an amp provides an open-loop gain typically better than 10,000 V/V, power-supply rejection better than 40 decibels below a standard reference level in the voice band and excellent low-noise characteristics.

Sample availability of the TP3100 DLIC and the TP3051/56 codec-filter is expected early in 1982. Production will begin during the spring.

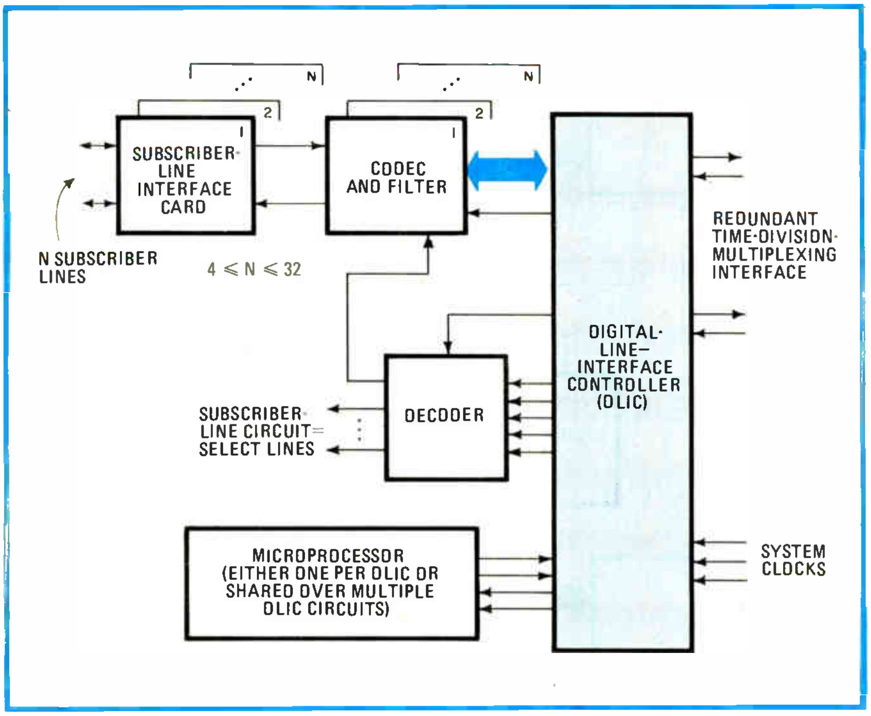
The essence of the DLIC concept is to locate advanced switching capabilities at the level of the interface card. In addition to the advantages already outlined, the concept also makes good economic sense. Putting control functions in the telephone or other subscriber device would obviously cost more, raising subscriber line costs. It also would result in bulkier equipment that would use more power.

The first level

Similarly, assigning advanced capabilities to this first-level card reduces the complexity of the second-level switching function. In fact, it greatly simplifies the control-interface aspects of the entire system, allowing the central controller to treat its own local circuit cards and remote cards in the same manner.

The operating structure is not rigidly dictated by the DLIC, for the chip is adaptable to many different hardware and software schemes. For example, its serial access port may be divided into separate highways for pulse-code-modulated voice, data, and system-control transmission. Also, a multiplexer can be used to combine two or four of the serial port highways into 4- or 8-MHz links. Adding to the flexibility is the control of the switching system software by the central and local processors, rather than by the 3100.

A typical voice- and data-switching system structure using the DLIC is a modular switch that can serve from a



4. Systems approach. The subscriber-line interface card is the heart of the all-digital architecture's approach to line-circuit connections. This card is controlled by signals that are generated by the digital-line-interface controller.

few hundred to a few thousand subscribers. This structure also forms the modular backbone of a much larger switching system.

Within this structure are three major sections (Fig. 3): the common control, a second-level switching network, and the interface cards. Service circuits like conference calling or Touchtone lines are in some or all of the interface cards. This architecture is configured to operate with a simple, redundant, second-level switching group that provides full cross-access between the different subsystems.

A digital highway

Line interface cards are connected to the second level with either two or four multichannel full-duplex time-division-multiplexed serial highways. With each highway operating at 2.048 MHz, as many as 128 channels of bidirectional communications for each interface card are provided. The usual partitioning of this bandwidth is 120 channels of 64 kHz each for voice and data and eight 64-kHz channels for signaling, control, and switch maintenance.

The 120 subscriber channels to each interface card allow 120 simultaneous calls to be connected before call blocking occurs. For calls that are connected to lines off the card, this establishes a nonblocking arrangement for 60 calls.

Local switches

With local-switching capabilities in the interface card, this control level becomes capable of remote switching. Similar to computer links, a remote switch operates at some distance from the main or host switch, yet requires the host's higher-level functions for many of its maintenance and billing activities.

The interface card with local switching included also can configure the remote switch into a unit with higher line density. For example, if the card groups are arranged with four 32-channel TDM highways and have four subgroups of 60 subscribers each, then two highways can be reserved for local switching among each 60-line subgroup. The remaining two highways serve as the intragroup highways or trunk interfaces to the host switch. This arrangement provides nonblocking local service. and moderate blocking service when non-remote calls are being switched.

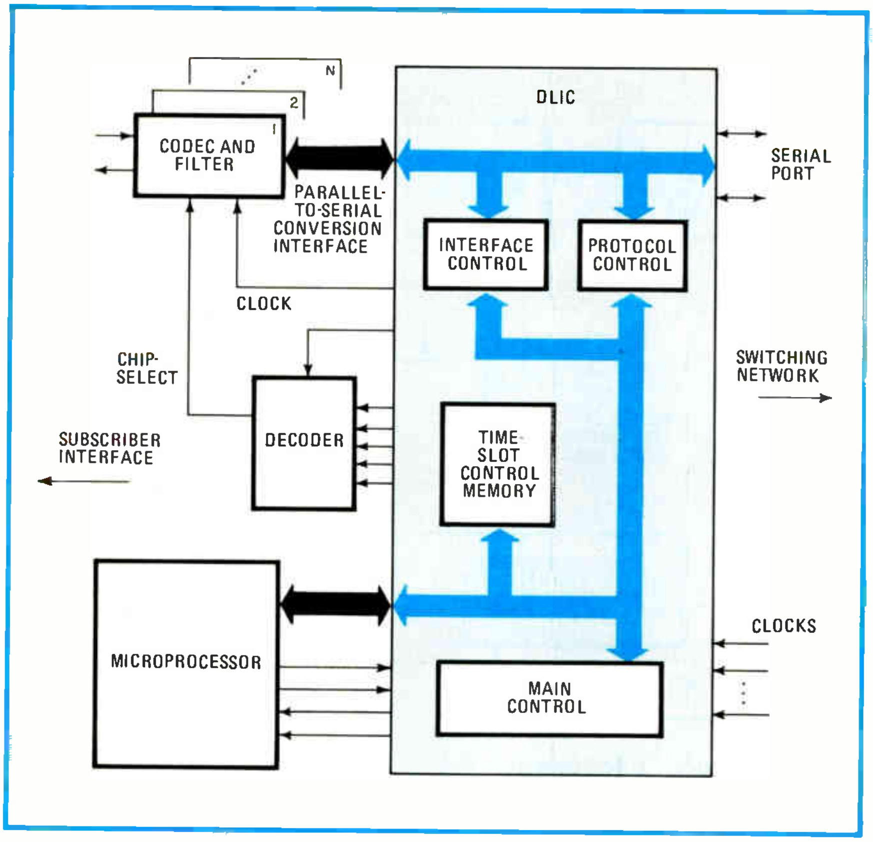
Another important feature of this architecture is redundancy. Multiple highway interfaces throughout the system provide backup routing service during failures. Furthermore, by monitoring the traffic at each critical system node, the central controller can redirect traffic away from faulty routes even when calls are in progress. This capability facilitates a high level of system integrity and a minimum of system downtime.

A complete card

The DLIC-based subscriber-line card is arranged as an octal card, although the actual number of lines can be between 4 and 32 (Fig. 4). For this card, there are eight subscriber-line interface circuits, eight combined codec-filter devices, a local processor or the interface to an off-card processor and the DLIC. Also required are various address-decoder, bus-interface, and standard logic chips, bringing the IC count to 22 if a single-chip is available for the subscriber-line interface circuit (which is not the case presently).

There are three primary signal-flow paths in the interface card (Fig. 5). Two are essentially concerned with interfacing with the rest of the telecommunications net, and the third carries the housekeeping control and data signals between the on-card processor and the individual subscriber lines.

The first interconnecting path is the central-control signal path. It interconnects the local processor with the



5. A signal trio. There are three signal-flow paths in the interface card controlled by the DLIC. Two of the paths are concerned with communication with the system's digital architecture, while the third takes care of on-card housekeeping.

main system controller. This information exchange is handled through the DLIC protocol control logic provided in the HDLC format.

System control data is carried over channels of the serial access port according to assignments established by the system software. This information exchange is a high-level system poll initiated by the central controller.

Information exchange

The function of the central controller is to update the DLIC on current-switching paths, line status such as ringing or busy, and system housekeeping data. In return, the DLIC informs the central controller about card-related activities, such as on-hook and off-hook conditions and pulse counts for dialed numbers. This poll exchange takes place at least once every 100 milliseconds and perhaps as often as once in 10 ms for certain data-oriented architectures.

Because system polling occurs at a moderately high level in the control hierarchy and because error detection is essential in a remote switch arrangement, the high-level HDLC protocol is used for the transmission of system control messages. The protocol control logic of the 3100 automatically processes HDLC messages as they pass in either transmission direction. Furthermore, the DLIC chips arrange this bit-oriented code into a byte-compatible format that is conventional in telecommunications PCM transmissions.

Signal and controls for the second signal-flow path are associated with subscriber signals. PCM voice, subscriber-generated data, or any other subscriber information that must be switched is handled through the synchronous parallel-to-serial conversion interface of the DLIC. This interface is controlled by an on-chip port-and-channel-assignment map that directs the flow of data through the 3100. The map is known as the time-slot control memory. Individual subscriber channels, each of which has its own codec and filter, are accessed via the chip-select parallel port interface managed by the time-slot control memory.

With this data-transmission arrangement, the DLIC is capable of assigning any of the subscriber lines it controls to any of the 128 channels of the serial access port. This represents what is known as a first-level space-and-time switching element with nonblocking characteristics. An equivalent circuit would be a fully accessible 8-MHz data multiplexer (4 ports, each with 32 channels operating at 64 kHz) using four universal synchronous-asynchronous receiver-transmitters.

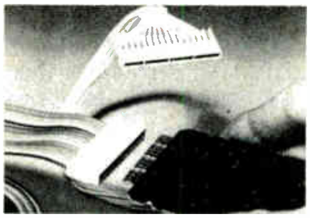
Local links

The third DLIC signal-flow path and control interface is responsible for the local link interface. This circuitry allows the local processor to communicate directly with the individual subscriber-line devices via the DLIC interface-control register. Because this data flow is between synchronous and asynchronous buses, the DLIC is designed to retime the data as it flows between the processor and the subscriber equipment.

This circuit function allows the local processor to communicate with the individual line circuits on the same input/output bus that is used for voice and data transmission. The DLIC automatically multiplexes this control information onto the bus during any time periods that are not actively occupied by assignments from the time-slot control memory. □

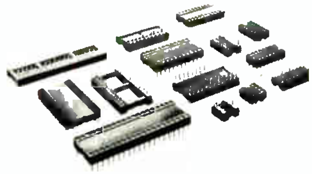
INTERCONNECTION CITY NEWS

September



NEW card edge connector with insulation displacement contacts for mass termination. Fits .062" PC boards, 4 thru 15 positions.

Circle 113 on reader service card



NEW open & closed low-profile frame IC/DIP sockets R-4000 series with anti-wicking contacts, end and side stackable on .100" grid, meet EIA RS-415 standard.

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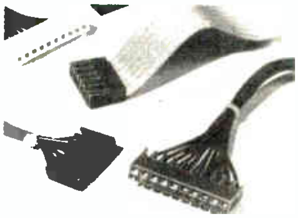

NEW, in line "JAGUAR" IDC series of mass termination .100" and .156" center connectors for wire-to-board discrete wire or ribbon cable applications.

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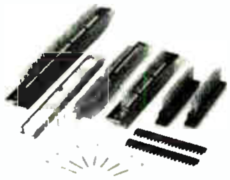

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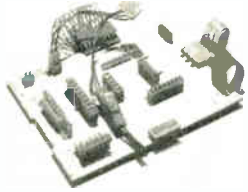

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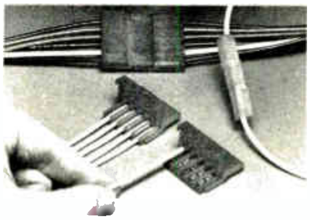

NEW Series 2300, 1-6 circuit power connector insulation displacement termination. Saves crimping & stuffing contacts. Hermaphroditic housing saves handling & inventory.

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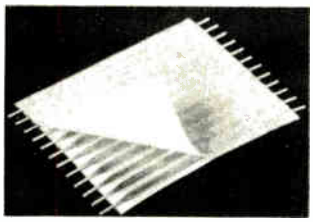

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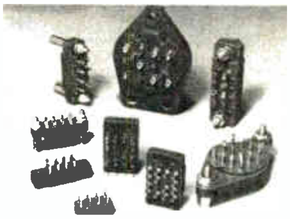

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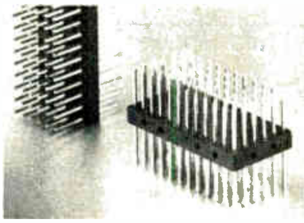

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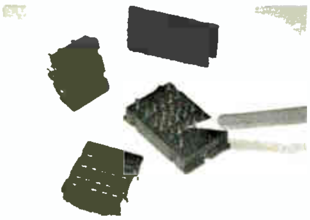

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Stacked voltage references improve supply's regulation

by Wes Freeman and George Erdi
Precision Monolithics Inc., Santa Clara, Calif.

By combining low-cost precision voltage references, inexpensive yet accurate power supplies that work over a wide range of voltages may be built. When suitably stacked, these voltage references even improve the regulating performance of the supply.

Consider the circuit in Fig. 1, which can be built for approximately $10. It uses two 10-volt references so combined that the supply will work over a range of 0 to 20 V, with switch S_1 selecting the 0-to-10- and 10-to-20-V ranges.

An operational amplifier isolates potentiometer R_1, which sets the output voltage to within 300 microvolts of the desired value. The op amp's short-circuit current, approximately 22 milliamperes, limits the maximum base current available to the power transistor. As a result, the maximum available output current is nearly 1 ampere.

The supply's line regulation is within 0.005% of scale reading per volt in the 10-to-20-V range. In the 0-to-10-V range, line regulation is significantly improved to within 0.0001%/V and is mainly limited by the op amp's supply rejection ratio because the output of the second reference regulates the line voltage of the first.

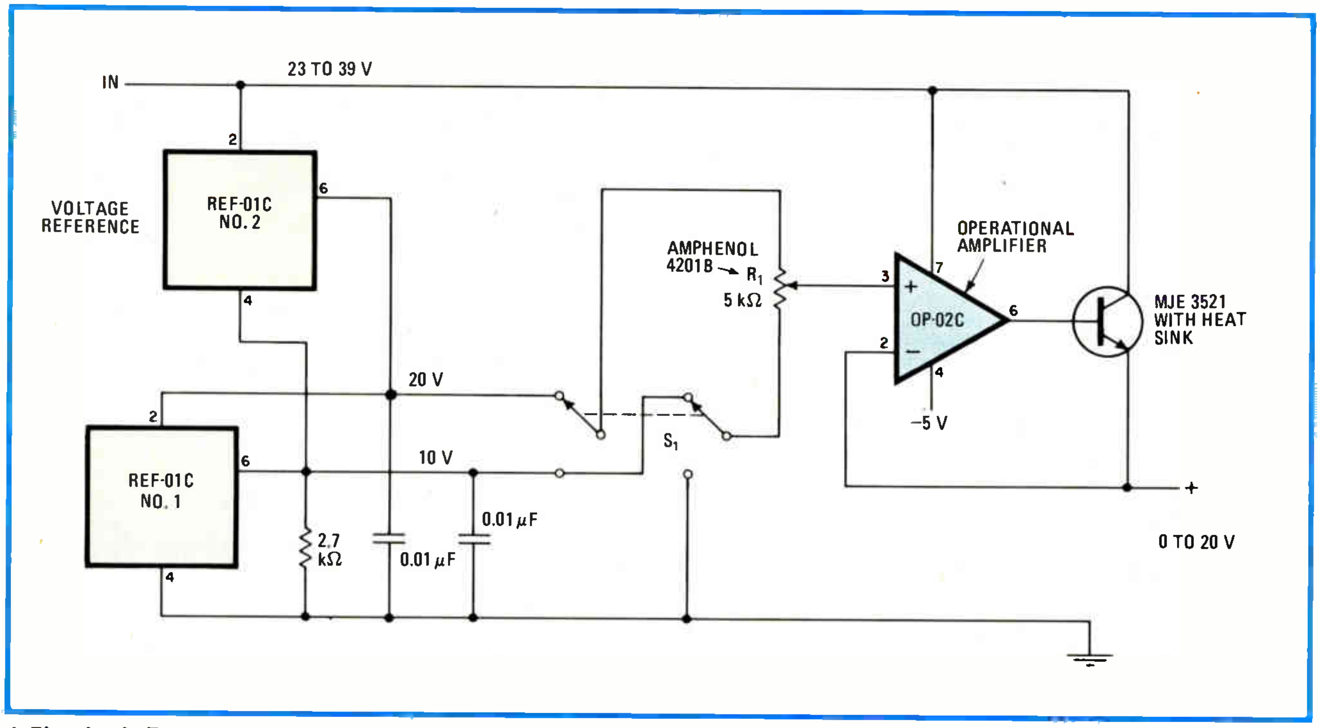
Load regulation is determined by the change in the op amp's open-loop gain versus load current. In this circuit, measured values were ±0.001%/A in the 0-to-800-mA range. Output voltage drift due to temperature is ±0.002% of scale reading per °C.

At an increase in component count and hence also in cost, the performance of the supply may be improved appreciably, as seen in Fig. 2. The addition of a third reference regulates both the 0-to-10- and 10-to-20-V ranges. A Darlington power-output transistor permits a 4-A load current.

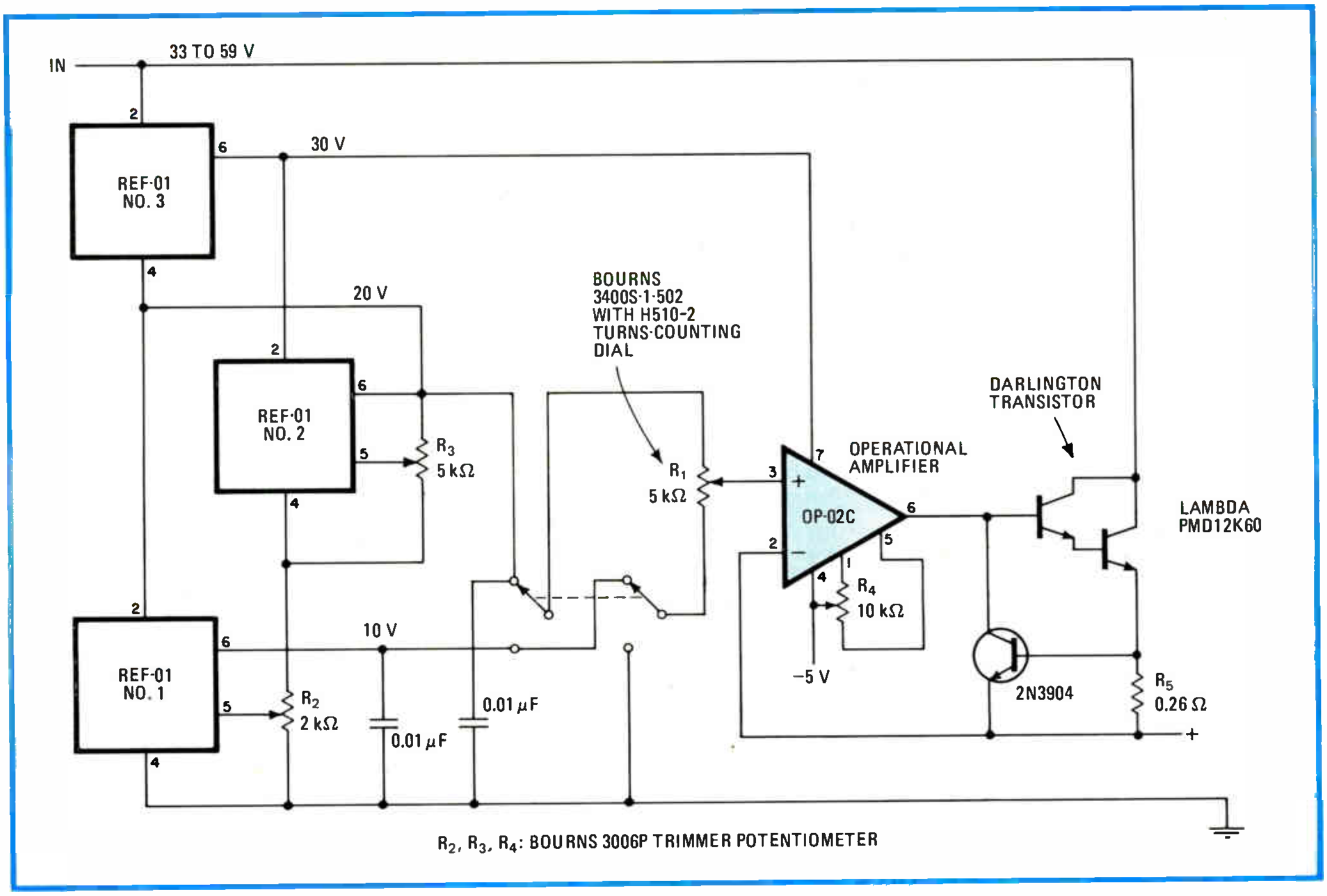
As a result, the total change in output voltage is less than ±0.001% for a change in load current of 0 to 2 A and a change in line voltage ranging from 33 to 59 V. Potentiometers R_2 and R_3 adjust the output voltage for the 10-V and 20-V ranges, respectively, while R_4 nulls the op amp's offset voltage.

The substitution of a highly linear precision potentiometer and turn-counting dial for R_1 permits a dial accuracy of ±2 mV from 0 to 20 V, with a resolution of 200 μV. Moreover, if a better grade of reference (REF-01) is employed, the temperature coefficient is ±0.001% of scale reading per °C. □

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 $75 for each item published.



1. Piggyback. Two series-connected voltage references may be united to yield an extended supply output range with significantly improved line regulation at the lower range. The circuit's output can be set to within 300 μV of the desired value. Maximum output current is 1 A.



2. Extension. When another reference is added, both ranges become extremely well regulated. Load-handling capability and supply precision are improved. Substituting a linear precision pot and turns-counting dial for R_1 permits setting output to within ±2mV over 0 to 20 V.

Low-cost coordinate converter rotates vectors easily

by Arthur Mayer
Sperry Systems Management, Great Neck, N. Y.

Especially useful for graphics display applications, this simple $15 vector rotator, which takes coordinates in the x-y cartesian system and adds an angle of rotation to produce new coordinates x′, y′, is faster and cheaper than others currently available.

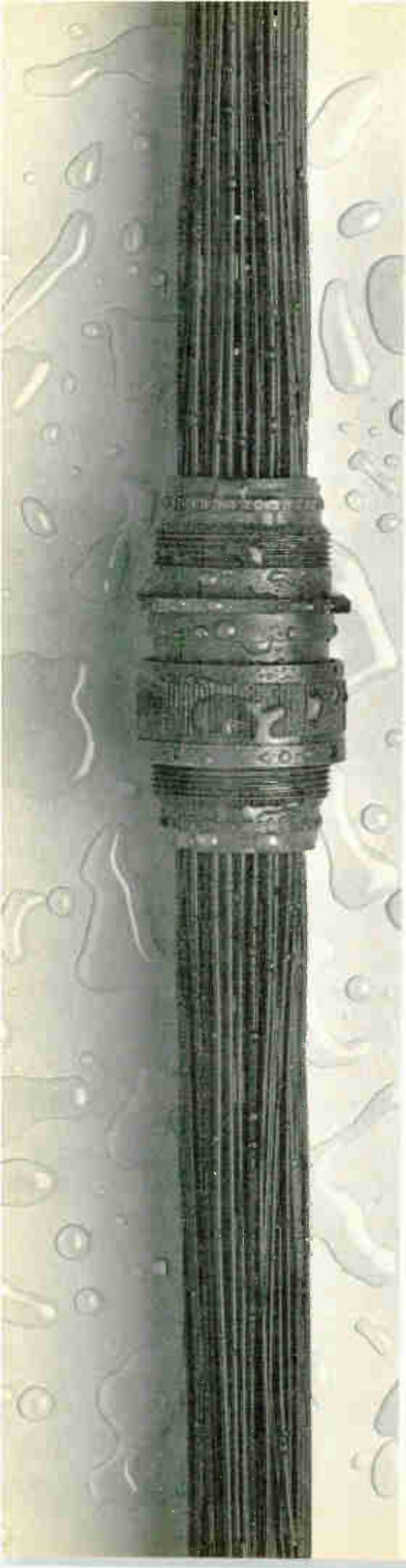
As shown in the schematic, the analog voltage pair (x,y) represents the vector $r\angle\theta$, where $r^2 = x^2+y^2$ and tangent $\theta = y/x$. The two inputs x_{IN}, y_{IN}—together with $-x_{IN}$, $-y_{IN}$ obtained from inverting amplifiers A_1 and A_2—are applied to the CD4052 dual analog multiplexer, which is controlled by the two most significant bits of the binary-coded rotation angle Φ. Each dual multiplexer output signal passes through a unity-gain amplifier, A_3 or A_4, and then through a tandem of inverting amplifiers (A_5, A_7 or A_6, A_8) to the final output.

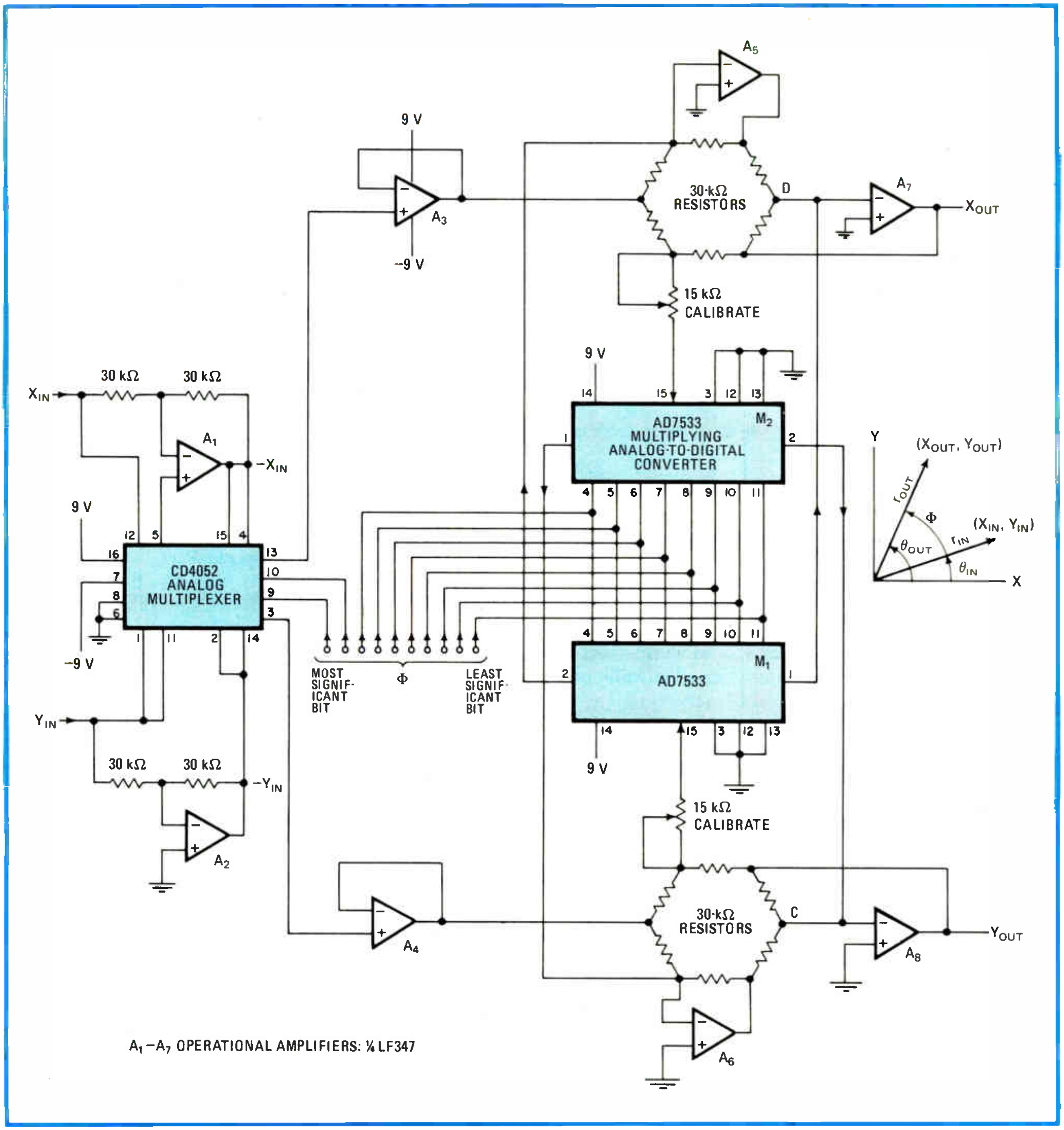
Each tandem of inverting amplifiers is coupled with an AD7533 multiplying digital-to-analog converter to make a four-quadrant multiplier: A_5 and A_7 are coupled with M_1, and A_6 and A_8 are coupled with M_2. The digital input to both converters is provided by the remaining bits of Φ.

The analog input to M_1 is the average of the signals from A_4 and A_8, and the analog input to M_2 is the average of the signals from A_3 and A_7. The output currents from the cross-fed d-a converters feed the summing junctions of A_5 through A_8, where they add to the inputs that have been selected by the multiplexer, thus producing the output voltages x_{OUT}, y_{OUT}.

All resistances in the circuit are 30 kilohms so it is convenient to use dual in-line packages, like Beckman's 698-3, with eight resistors per DIP. Another DIP, Bourns's 7102, could replace the two 15-kΩ trimmers needed to raise the effective input impedance of each AD7533 to $15(2)^{1/2}$ kΩ, the value required in this design.

Regardless of the value of Φ, $x^2_{OUT}+y^2_{OUT} = x^2_{IN}+y^2_{IN}$. In other words, the output vector's magnitude is always equal to that of the input vector. However, the relationship between the input and output vectors is given by $\theta_{OUT} = \theta_{IN}+\Phi'$, where $\tan(\Phi'/2)$ is equal to $(2^{1/2}-1)(\Phi - 45°)/45°$ and Φ is between 0° and 90°. The difference between Φ′ and Φ – 45° vanishes for Φ = 0°, 45°, and 90° and is always less than 1° for other values of Φ in the first quadrant. Note that the error and its





Transformation. Input data for positioning a cursor in graphic displays, often presented in x-y (cartesian) coordinates, may be rotated by Φ in steps of 0.35° to new location x', y'. One analog multiplexer, two multiplying d-a converters and eight op amps in a unique cross-fed summing network perform the operation. Alternatively, the circuit will transform a vector from polar (r,θ) into rectangular (x,y) form.

variation with angle recur in the other three quadrants.

The 45° offset in Φ' is due to the bipolar operation of the AD7533 converter. The offset may be corrected by simply adding 45° to the digital equivalent number at the Φ input lines. The remaining error will be small enough to go unnoticed on most graphical displays.

To calibrate the vector rotator, x_{IN} is set to some constant voltage and set $y_{IN} = 0$. Then the trimmers are adjusted to make $x_{OUT} + y_{OUT} = 0$ when $\Phi = 0°$ and $x_{OUT} - y_{OUT} = 0$ when $\Phi = 90°$.

With the addition of a clock and a counter to make $\Phi = \omega t$, the vector rotator becomes a sine-cosine generator. For example, for a 5-volt root-mean-square output, x_{IN} and y_{IN} is set to 5 V dc; then $x_{OUT} = 5(2)^{1/2} \cos\omega t$ and $y_{OUT} = 5(2)^{1/2} \sin\omega t$.

Because of the functional error in the angle as given by the formula for $\tan(\Phi'/2)$, either output will contain third and fifth harmonics each having a magnitude 0.8% that of the fundamental. Total harmonic distortion, therefore, is 1.1%. □

Highly portable language protects software bankroll

Mainsail unfurled reveals itself to be a general-purpose structured language that is machine-independent for easy adaptation to the latest computers

by Clark R. Wilcox and Gregory A. Jirak
Xidak Inc., Los Altos, Calif.

☐ Taking dead aim at the goal of portability, a general-purpose programming language incorporates source-level features that permit it to be moved from one machine to another with a minimal retargeting effort. Mainsail offers all the features of a modern structured language in a single package that runs identically on all computer systems.

The rapid proliferation of increasingly powerful and inexpensive computers has outstripped programmers' abilities to supply each with its own software. Economic considerations are beginning to dictate that software be written so that it can be easily moved among many computers with little or no alteration.

The traditional preeminence of hardware in the design and selection of computing systems is now giving way to the realization that software can have a value and lifetime greater than any particular hardware environment. The subordination of software to hardware for so many years has resulted in programs that are molded in conformance to the underlying hardware and operating-system environment and hence become useless in its absence. The binding of software to specific computing systems in turn binds the users. This ploy, in fact, has been exploited by hardware vendors to lock users into a particular product line.

Even software packages marketed to run on different computer systems are often substantially modified or rewritten from scratch for each system, giving rise to needless incompatibilities that plague both users and implementers. A software vendor has much to gain from a programming system that can be quickly moved among a variety of computers.

Portable software

Portable software means different things to different people, and is indeed a matter of degree rather than an absolute. For example, there is conceptual portability, in which the problem solved by the software is the same even if done in different languages. At the language level, there is standardized portability, wherein a program is written in a standard language like Fortran or Cobol. Finally there is source-level portability that utilizes a language, such as Mainsail, appearing in precisely the same form on all computing systems, so that the same program source code is simply recompiled for different target systems (see "A portable run-time system," on the following page).

Unfortunately, so-called standard languages are seldom realized identically in different computing systems. Even if two implementations are essentially identical, there are still potentially significant differences in the program-development tools, which are not usually a part of the language definition. Incompatible linkers, loaders, debuggers, text editors, and the like conspire to decrease the effectiveness of standardized portability. As a result, the difficulty of moving, say, a Fortran program from one computing system to another can be more difficult than rewriting the program.

Mainsail strives to be a sufficiently rich environment for the development of large, sophisticated software packages that can be run on many different computer systems. For instance, Intel Corp. is now using Mainsail in its computer-aided-design efforts because these extremely large and sophisticated programs are too valuable to be tied to a particular computer system.

At the same time, support is provided for isolating those parts of a system that must be rewritten, either for ultimate efficiency or for inherent machine dependencies. The system encompasses a complete language definition, a compiler, an expandable set of code generators, a comprehensive run-time system, a source-level debugger, program-monitoring tools, a full-screen text editor, and other utility programs.

The user perceives the same program-development and -execution environment, no matter what computer system is used. A low-cost development machine can be used to write and completely debug portable software packages, compile them into target code for many different computers, and even put the generated code onto distribution media in the proper target-machine formats.

The language syntax and semantics are independent of the underlying hardware and operating system. Every feature described as part of the language is supported in every implementation. This includes compile-time features, such as compiler directives, macroinstructions, and conditional compilation, that are not considered part of many other languages' definitions and hence often vary among implementations.

Language design

The Mainsail language specification is more than a blueprint for various enhanced versions, as is the case for Pascal. Since machine-specific extensions have no place in a portable language, all the facilities required to write sophisticated software systems are provided, some of which are usually considered part of the operating system rather than part of a language specification. For example, Mainsail has a completely self-contained notion of modularity, including linking and loading, and a file model that is identical across all machines and operating systems.

Mainsail is not itself an operating system, such as UCSD Pascal, but rather interfaces with existing operating systems. The host operating system provides the underlying file system and the input/output links with peripheral equipment like terminals. In fact, these components could be written in Mainsail to provide a simple, portable, single-user, single-language operating system for use on personal computers.

To achieve the goal of portability across a wide range of computers, it is of utmost importance to minimize the time required to fit the language to a new system. From the outset, all its components were designed with the intention of facilitating the movement to new computing environments as the need arises.

The compiler was carefully crafted to allow any host machine to generate code for any target machine (see "A compiler that promotes portability," p. 138). For example, all evaluation of compile-time expressions is carried out on string representations of the data, so that the same results will be obtained no matter what host machine is in use.

Care also was taken to provide a code-generation environment that does as much as possible in a target-independent manner, yet retains the ability to generate code for essentially any target machine. The portable run-time system provides everything except the final interface to the host operating system for file and I/O support. Because the language was developed in parallel with the compiler and run-time system, it benefited from feedback concerning the features that are necessary for complete portability.

In addition to the language, compiler, and run-time support, all other phases of program development are provided by Mainsail. This provision eliminates the need to learn new editors, debuggers, and other utilities when moving among machines. As far as interaction with the language is concerned, the programmer need not even know what computer system is being utilized.

The various components of Mainsail work together to unify the program-development process. When the compiler detects a syntax error, it can automatically invoke the text editor to fill the screen with the source text and put the cursor at the point of the error. The user can fix the error, then give a command to the editor to continue the compilation.

Similarly, the debugger can use the editor to show single-step execution, with the cursor moving over the

A portable run-time system

Mainsail necessarily depends on an implementation strategy that minimizes the retargeting effort required to move software to a new machine or operating system. The cornerstone of this strategy is moving the entire software system to a new target environment simply by recompilation. This easy move is largely made possible by the inclusion in the language of low-level features allowing even the essence of the run-time system, like the storage-management algorithms, to be machine-independent.

The run-time system is a collection of modules managing the execution environment, such as the input/output interface and memory allocation, and also provides the user with a predefined set of utility procedures. The source text for the Mainsail run-time system consists of three parts: machine-independent, machine-dependent, and operating-system-dependent.

The machine-independent part accounts for the vast majority of the code. It utilizes compile-time features to incorporate the second and third parts into the portable source text.

For each computer, the machine-dependent part contains constant definitions describing machine resources such as the word size and a handful of procedures that could not be expressed in a machine-independent manner. So it contains those aspects of the implementation outside the realm of the code generator.

For each operating system, there is a file containing the portion of the runtime system dependent on the operating system. This file contains macroinstruction definitions and procedures for interfacing with the host operating system. The actual calls to the operating system usually require some use of assembly language, but it is limited to code to set up parameters for system calls, make the call, then prepare the results for the return to Mainsail.

All such assembly code is in a single part of Mainsail called the boot, which obtains control from the operating system to start execution. This is the only part of Mainsail that is statically linked in accordance with host system conventions and that can be linked with foreign code.

To make the language as self-contained as possible, portable routines are provided for mathematical operations, such as trigonometric and logarithmic functions in both single and double precision. Routines are also provided to convert among the string and internal forms of floating-point values. Mainsail provides portable versions of all the standard routines, but in such a manner that they can be replaced with machine-dependent versions for added efficiency.

A compiler that promotes portability

The Mainsail compiler consists of three parts. The first pass processes the source files to build an intermediate representation, which is then set up by the second pass for processing by the target-dependent code generator. The first and second passes are entirely independent of the target machine, except for a small top-level module that provides some target-dependent information like the size of each data type and the name of the target code generator.

Each code generator, of course, knows about its target machine, but is portable so that any host machine can be used to generate code for any target machine. The output of the code generator is typically position-independent binary code ready for execution, though early code generators produced assembly language. Thus far, all of the Mainsail code generators are operating-system independent. For example, the same code generator is used for the VAX minicomputer, whether it is running the Unix or VMS operating system.

The intermediate form is a tree structure for each procedure, using Mainsail records for the nodes of the tree (the tree is temporarily stored on a file between passes). The nodes of the trees correspond to the language's statements and operators—it is not broken down into a more primitive form. In fact, the original program structure can be regenerated from the intermediate representation.

Each code generator is a member of the class that consists of a fixed set of code-generation procedures. Since it is handed a tree for an entire procedure, it is free to scrutinize the entire tree before generating code, thereby allowing procedure-wide optimization techniques.

Writing a new code generator requires from one to four months, depending on the complexity of the target machine and the validity of the assumptions made by the code's target-independent part of the code generator. The machine-dependent and operating-system-dependent parts of Mainsail can be developed in parallel with the code generators. Since they usually require less time than the code generator, a new implementation can be ready for testing in a couple of months.

Any machine that supports the Mainsail development tools can serve as the host in a new project. For example, the VAX minicomputer utilized both a hard-wire and DECnet connection to a PDP-10, and an IBM implementation used a VAX in California as a host connected to an IBM 3033 in Arizona.

source text as each statement is executed. The user sets breakpoints by issuing a command to the editor to set one at the current cursor position.

The distinction between the compiler, editor, and debugger is thus fuzzy because each consists of many modules, some of them shared by the others. Together they form an environment identical in all implementations. Each such component is similarly available for incorporation into user packages.

Storage management

To avoid machine dependencies and at the same time provide a more flexible program environment, Mainsail was designed to bind neither code nor data to specific memory locations and in fact can move both around during execution (Fig. 1). Program code can be loaded into and executed out of any memory location, and all data is allocated dynamically and can be moved at any time by the storage allocator. Furthermore, there is a complete separation of code from data, with the code portion read-only (except possibly for debugging breakpoints) so that it can be placed in shareable libraries or burned into read-only memories.

All procedures can be invoked recursively, with all modules and data structures like arrays, strings, and records allocated and deallocated dynamically. An interesting side effect of this totally dynamic approach is that the generated code contains no memory addresses and hence is not affected by the size of an address. Base-displacement addressing is used for all memory references, so there is no need to adjust addresses in the code when the module is loaded.

Mainsail partitions the available memory into pages, which need have no relationship to host-machine pages, if such exist. The number of pages used starts out small and increases dynamically, so that large core images—the storage area allocated to a program—are created only as necessary, which is advantageous for some non-paged operating systems.

Mainsail's runtime system allocates control pages at one end of the available memory, and chunk (Fig. 2), string, and static (I/O buffers, primarily) pages at the other. If control and data pages meet in the middle of the memory, more pages are obtained from the operating system (the core image increases), and the control pages are moved to the new high end of memory to make more room in the middle.

The Mainsail string data type involves no declaration of a maximum length; instead any string may grow or shrink as needed. A string variable's descriptor consists of its current length (number of characters) and a starting address. The storage area for characters is allocated as needed in a separate area of memory called the string space. The characters that make up the string are never altered, in contrast to other software systems that store their strings in arrays.

Mainsail uses the storage-reclamation technique called garbage collection to reclaim all chunks no longer accessible and to compress string space by squeezing out characters no longer being used. A garbage collection automatically occurs whenever there is insufficient string space for an operation. The user can invoke or suppress garbage collections, but this level of control is rarely needed.

Dynamic modules

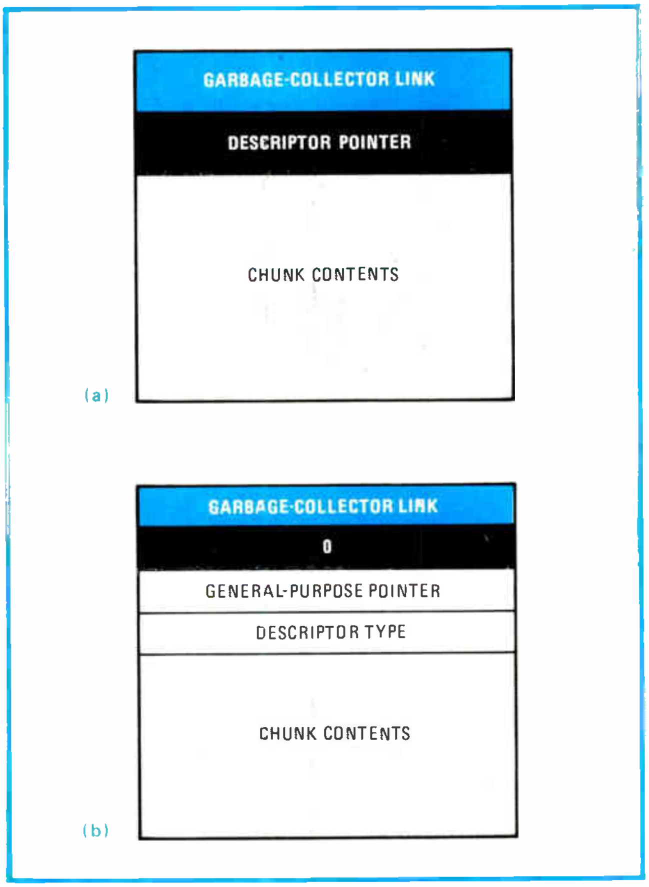
Mainsail uses an innovative approach to modularity that provides portability and flexibility far beyond the usual notion of static modules supported by other programming languages. Unlike statically linked systems that combine separately compiled program components into an amorphous code image, modules retain their identity during execution. Mainsail's more robust notion of a module enables portable formulation of all phases of program development from separate compilation, to intermodule communication, to debugging facilities communicating with the user in terms of modules and procedures rather than of memory addresses.

As in other structured languages, a module consists of a collection of data and procedures, some of which may be made visible to other modules. They cannot be statically nested—a module cannot contain within itself another module. Facilities are provided for sharing compiled declarative information among many modules, thereby avoiding error-prone redundant specifications and the overhead of recompilation of such information for each module.

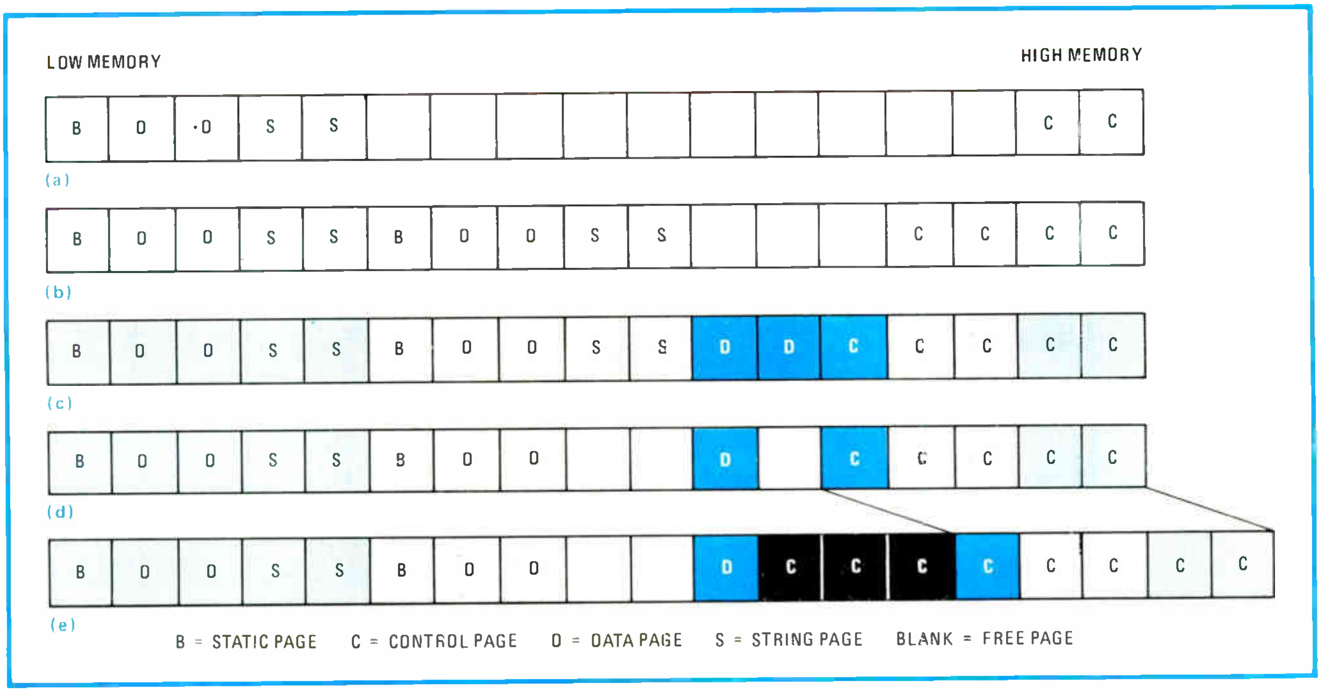
A module's internal structure is hidden, with only the interface fields visible from the outside. These fields can be either data or procedures, so that, especially with respect to implementation, a module is like a record that can also have procedure fields.

In Mainsail, modules can be referenced by pointers and thus incorporated into data structures. For example, a record field can point to a module, an array can consist of module references, and modules can be used in general programming strategies that have previously been available only in interpreted languages like Lisp.

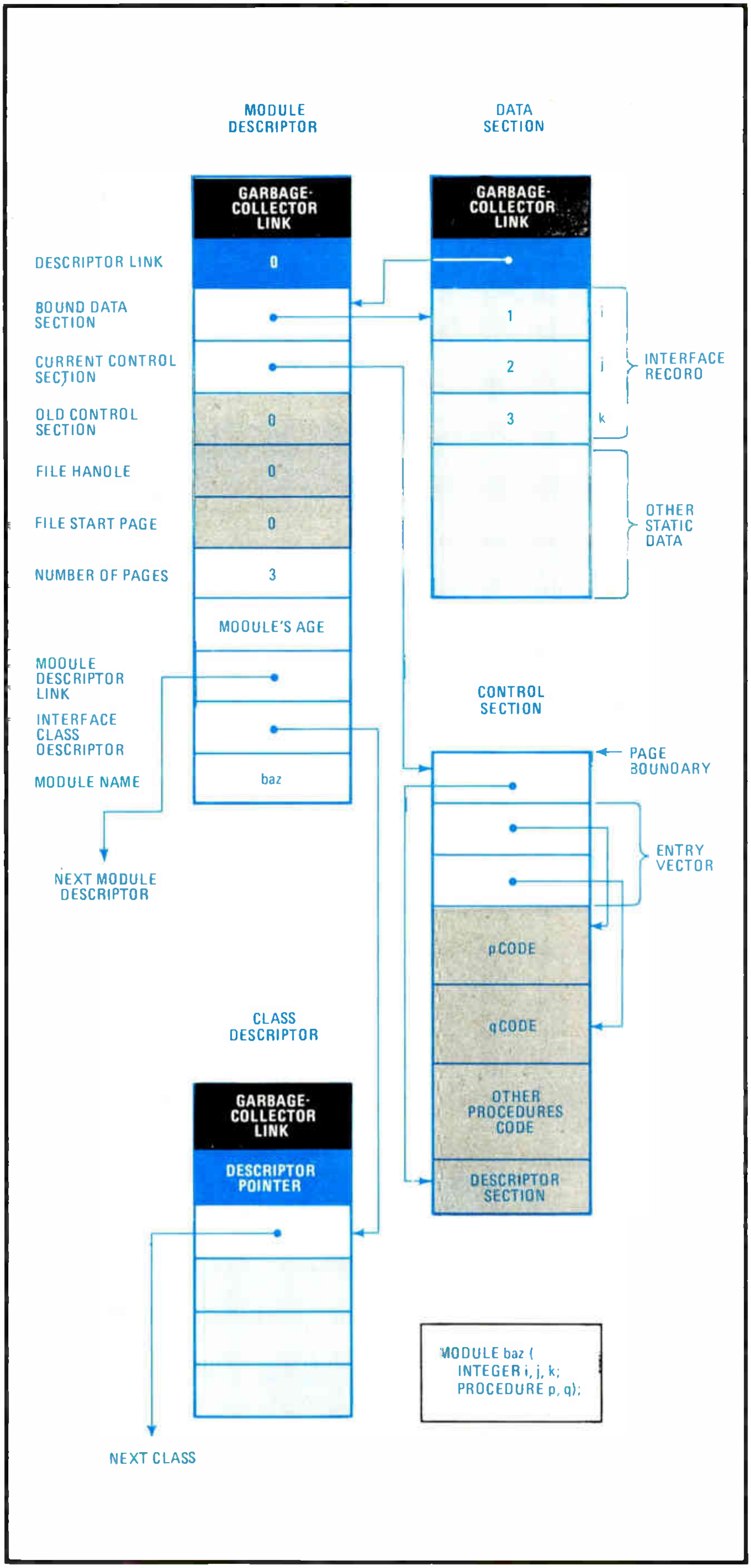
Unlike most languages, Mainsail modules are not combined into a program image before execution. Instead, the run-time system automatically brings modules into memory during execution and dynamically provides for intermodule access. Mainsail does not use machine-dependent linkers, thereby providing an identical program environment across all machines. A side effect of this self-contained loading and linking mechanism is the lack of restriction on the length of an



2. Chunks. These general-purpose storage units called chunks (a) contain a location for linking them together during garbage collection (a way of reclaiming unused or inactive storage space), followed by a pointer to the chunk's descriptor. A descriptor (b) indicates self-description with a null pointer field.



1. Paging through memory. At program initiation, Mainsail loads the first module's code and data (a) into high and low memory respectively. During execution, more pages are dynamically allocated (b) for other called modules until the memory is full (c). Unused pages are then deleted (d) and the core image is expanded (e) to make room. Thus paged memory management is a feature of the language itself.



3. Modularity reigns. This module, declared in the upper left box, has an interface section that only allows the three variables—i, j, k,—to be visible outside of the module. The control section contains the code, and the class descriptor, the format of the interface.

identifier for interface fields, which specify global data and procedures.

Each module can contain an initial and a final procedure. The initial procedure is automatically invoked when the module is first allocated, and the final procedure is invoked when it is deallocated. This gives each module a chance to initialize itself and an opportunity to clean up after itself.

The ability to bring any module into play at any time provides a natural setting for an interactive environment utilizing modules as building blocks. In a statically linked language, in contrast, the debugger would have to be linked into every debuggable core image; every display module would have to be linked with the editor; and all code generators would have to be linked with the compiler—or else separate core images would have to be created for each combination. The editor could be invoked only if it had been linked with the user program. To get around such cumbersome linkages, other languages must rely on the operating system, thereby undermining portability by going outside the language.

Virtual code space

A working set of modules is kept in memory, subject to its availability. If there is insufficient room for an incoming module, those least recently accessed are automatically removed from memory until there is sufficient space. Upon return from an intermodule procedure call, Mainsail will automatically swap in the calling module if it is not in memory.

Thus the user is provided with a completely general and automatic overlay facility. No such mechanism is provided for data, because efficient detection of data absent from a module requires hardware support.

The user need never specify all modules in a program, because new ones can be dynamically brought into play at any time during execution. A program is best viewed as an open-ended collection of modules, and there is no imposed structure on the relationships among modules—each is considered equal to all others and can access any other symmetrically.

A module can reside either in a file by itself or in a module library, which is a collection maintained in a single file by the portable Mainsail module librarian. The language locates a new module by first checking all open module libraries; if unsuccessful, it forms a file name from the module name and tries to open the file and obtain the object module from it.

If there is no such file, or if Mainsail detects that the file does not contain the desired module, then the user is interactively asked to provide it. As an extreme example, the programmer could at this point recursively enter the executive level of Mainsail, use the editor to write the required module, compile it, and then continue execution with the newly compiled module.

Mainsail allows the declaration of a module's interface fields to be separated from the body of the module (Fig. 3). This declaration may be provided in a manner independent of any module body, so that it serves solely as an interface specification.

During execution, any conforming module can be brought into memory to implement the interface specification. The name of the module can be specified by a string variable, so that, for example, the program can read from a terminal which module is to be accessed for the next operation.

The first pass of the compiler is independent of the target machine, but one of many target-dependent code generators is used for a particular compilation. All code generators conform to a fixed interface specification—in Mainsail terms, all code generators belong to the same class—and that class is all that is known to the compiler's first pass.

The top-level compiler module, which is target-dependent, specifies which code-generator module to use. When the compiler first accesses a field of the code-generator class, the run-time system automatically fetches the proper module. The text editor obtains the proper display module in a similar manner.

During execution, a module consists of execute-only code and data allocated separately from the code. A module can have multiple instances of its data, each sharing the same code. For example, a module implementing a symbol table can be used to maintain any number of such tables by creating a new and separate instance of the data for each one. Thus, a single structure can serve any number of customer modules in which each customer's data is automatically kept separate from the others' entries.

Standard I/O

Many languages' failure to achieve source-level portability is at least partly due to inadequate specification of I/O tasks. There is either a total lack of standard I/O routines or an overly simplistic approach that results in incompatible implementations of the language attempting to fill in the gaps.

To provide compatibility, the Mainsail file I/O is stream-oriented. Text files are a stream of characters, and data files are a stream of storage units that may represent any mixture of data types. Repositioning by relative character or storage unit, interspersed by sequential reads and writes, accomplishes random access. Details of various file systems, such as buffering, block size, and the like, are hidden from the user. A Mainsail file variable is a pointer to a record. The file record contains machine-independent information about the file, as well as a pointer to the file's device module, which handles the operating system interface.

The device-module field is an example of how modules can be incorporated into data structures. Device modules are, of course, dynamically brought into memory to handle the input and output. This approach naturally allows the user to contribute his own device modules by simply writing one conforming to the device module class, and then prefixing relevant file names with the name of the device module.

Such user-specific device modules can perform a wide variety of nonstandard processing, all without alteration to the text of the program that does the I/O. Device modules have been written to communicate over networks, thereby enabling all programs to transparently access files remotely, even on networks for which such support is not usually specified via file-name syntax. □

High-resolution converter cuts linearity test to 12 seconds

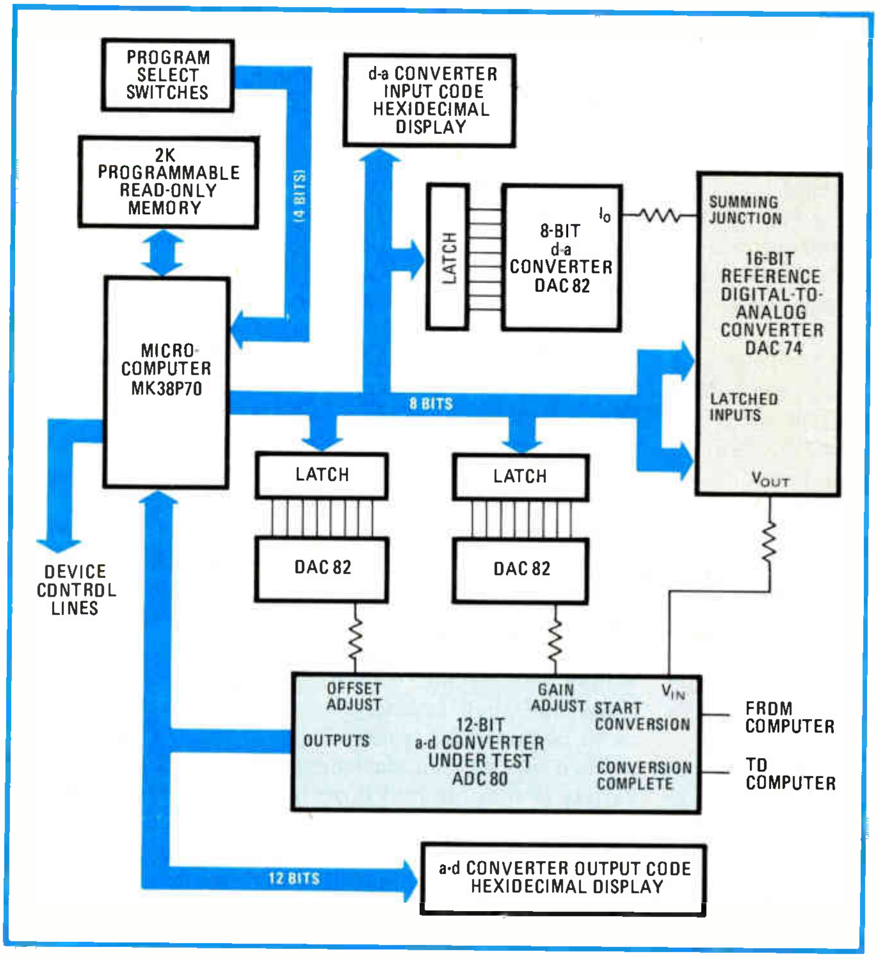
System automatically tests the linearity error for every code of an a-d converter using d-a converters and a microcomputer

by Wallace Burney, *Burr-Brown Research Corp., Tucson, Ariz*

☐ A system that automatically tests 12-bit analog-to-digital converters using a high-resolution digital-to-analog converter as a reference and a microcomputer as a controller, plus several 8-bit d-a adjustment converters can dramatically cut back the time required for a complete characterization of such parts. The fast settling time of the reference d-a converter and the speed with which the microcomputer can execute machine-level language, makes it possible to test for the presence of all of the a-d converter's output codes in a relatively short time. In addition, by incorporating some clever software, integral and differential linearity errors at each code can also be tested with only a small increase in testing time.

Complete testing of data-conversion products consumes costly production time, especially when done manually. To determine the worst-case linearity error of a 12-bit a-d converter requires finding 4,095 transition points, and each added bit of resolution doubles this lengthy procedure. Developing equations and tricks to minimize the number of codes that must be checked to determine the linearity error of the unit under test is of some use, but even with these sophisticated procedures, some errors are missed and, inevitably, several minutes are required to manually test an a-d converter.

Automated test systems using programmable voltage sources, digital voltmeters, and minicomputers can



1. Automation. Directed by a microcomputer, a 16-bit d-a converter provides a precisely controlled reference input voltage to an a-d converter being tested for linearity. Three other d-a units in the test setup serve as digital potentiometers for automatically adjusting the offset, gain, and input.

Testing a-d converters with a reference d-a converter

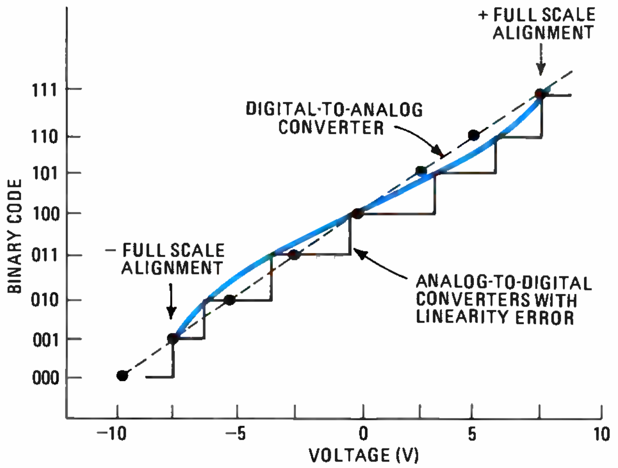
The automated testing of analog-to-digital converters can substantially reduce the time required for thorough checks and reduce production costs. In addition to translating the output of a microcomputer into analog form in order to exercise the a-d unit under test, a high-resolution d-a converter with a known linearity can be used as a reference to determine the linearity of the a-d part.

The accompanying figure illustrates the input-output relationship for an ideal 3-bit d-a converter and a standard 3-bit a-d part, where the d-a unit will produce a precise and unique output voltage for each of its input codes. For example, the code 010_2 on the input gives an output voltage of −5 volts. Since this output voltage is always the same for this code, it is not necessary to measure it with some other device if the input is stored in memory by the test system's microcomputer.

An ideal 3-bit a-d converter with a ±10-V input range has a transfer step, or quantizing uncertainty, of 2.5 V. In this case, when the input voltage to the a-d unit is +5 V, the code on the outputs is 110_2. The input voltage would have to change ±1.25 V before a change in code would be detected at the output.

Since the output voltage of the d-a converter falls in the center of the corresponding transfer step of the a-d converter, there is no easy way of accurately detecting the step's position. However, by adjusting the offset of either the d-a converter or a-d converter, the output voltage of the d-a unit can be aligned to occur precisely where the transfer function of the a-d unit makes its step. Of course, changing the offset has no effect on the linearity.

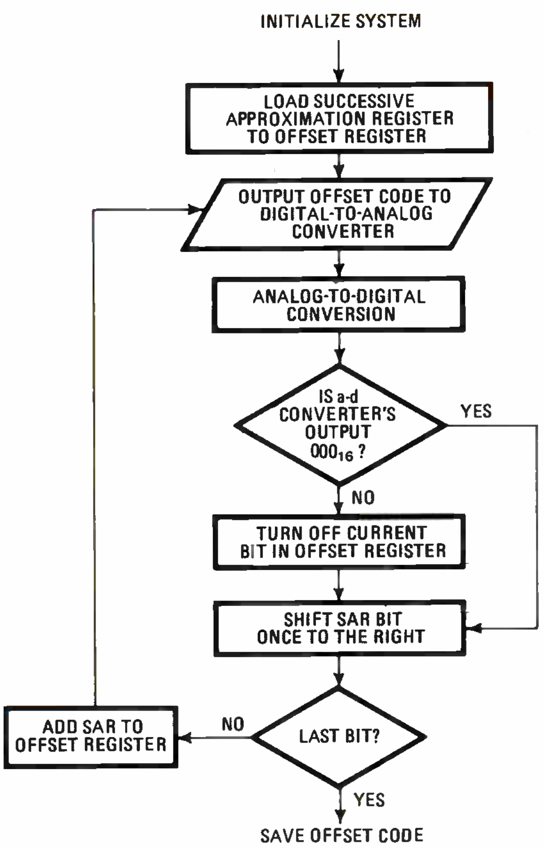
In the figure, the output of a perfect d-a converter is superimposed on the transfer function of an a-d unit having some linearity error. The offset and gain of the a-d converter have been adjusted to align the positive and negative full scale outputs of the two parts: the output of the a-d converter is stepping from 000_2 to 001_2 at the d-a unit's 001_2 output voltage and from 110_2 to 111_2 at the d-a unit's 111_2 output. Now all that is necessary to find the linearity error is to determine how far the rest of the transition steps are from the ideal d-a converter voltages.



somewhat reduce the testing time. Still, because of the time required to execute a program using a high-level language, such as Basic, and the settling time of digital voltmeters—from 5 to 500 milliseconds—manual spot-checking must still be used to predict the overall performance of the converter.

The fully automated system shown in Fig. 1, in conjunction with a machine-language program, however, tests all the codes of a 12-bit a-d converter and determines the worst-case linearity error in less than 12 seconds. It automatically adjusts the offset and gain of the unit under test so that the positive and negative full-scale outputs of the a-d converter and the reference d-a unit coincide. Then, a fast algorithm checks for linearity errors. (See "Testing a-d converters with a reference d-a converter," above). The microcomputer also can be easily programmed to test other parameters of the a-d converter, as well as to perform steps for calibration and self-diagnosis. The accuracy of the test depends on the accuracy of the reference d-a converter.

In the circuit shown, Burr Brown's DAC74 was used because it has 16-bit resolution and a linearity error of ±½ least significant bit. Operated with an output range of ±10 volts, the maximum linearity error is ±0.00075% of the full-scale range or ±150 microvolts. The LSB for the ADC80 under test in the same ±10-V



2. Offset trimming. To simplify differential linearity measurements, the a-d converter's zero is shifted to put the first output transition a full least significant bit above negative full-scale. The offset d-a unit covers a 10-mV range with 8-bit resolution.

A self-calibrating d-a converter

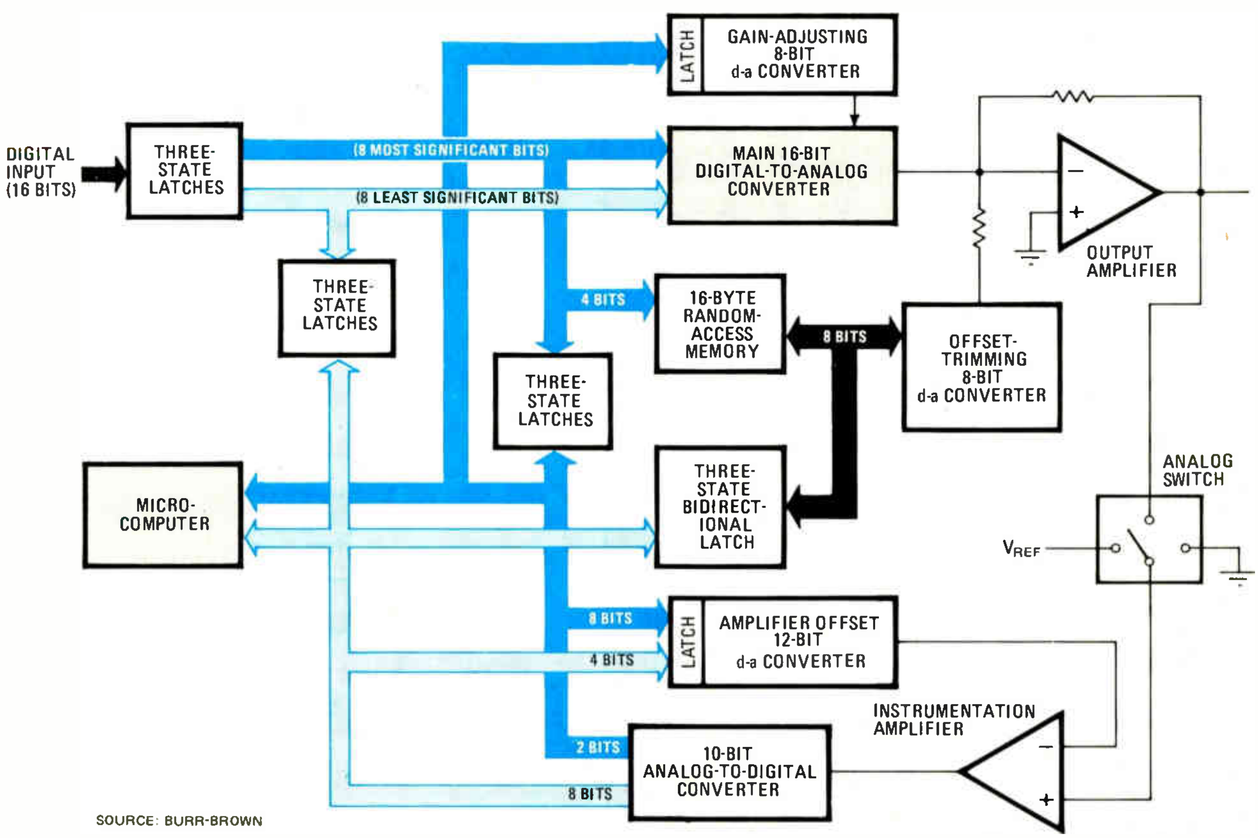
Currently available monolithic and hybrid digital to-analog converters can achieve relative accuracies of 12 to 14 bits, but cannot maintain true 16-bit performance over more than a very limited temperature range, even with laser-trimmed components. However, a microprocessor-controlled calibration circuit that uses lower resolution, relatively low-cost integrated circuits and hybrids to make differential linearity measurements of the digital-to-analog converter can be used to correct errors and insure 16-bit accuracy over a wider temperature range.

Burr-Brown's modular DAC74, which is shown in the figure, contains such a circuit, and maintains a specified total error of ±1 least significant bit—including gain, offset, and linearity—over the range +15° to +45°C. Stability is achieved through an automatic calibration cycle that takes about 3 seconds to complete and must be initiated externally. When the temperature changes by more than about 5°C, a calibration is required to restore specified performance. When a calibration cycle is initiated, the three-state input latches isolate the main d-a converter from external signals, and the resident microcomputer directs measurements of the converter's offset, differential linearity, and gain.

First, the processor applies an input code to the main converter, and its output is compared to the output of a 12-bit offset unit. The difference is amplified by a factor of 512, effectively increasing the resolution of the subsequent analog-to-digital conversion to 19 bits. The offset d-a unit keeps the differential input to the instrumentation amplifier within its range of linear operation—about 20 millivolts. Once the amplified difference signal is digitized in a 10-bit analog-to-digital conversion it is stored in memory. Then a second comparison between the same offset voltage and either a 1 LSB increment of the d-a unit's output, or a reference voltage is digitized and stored. The processor subtracts the two readings, and in doing so, removes the accumulated errors of the offset d-a converter, instrumentation amplifier, and a-d converter.

This scheme requires that the low-resolution measurement components be stable only over the time it takes to complete two readings. To check offset, the two readings are the d-a converter's 0000_{16} output and a ground potential (or a reference voltage in the case of bipolar operation); for a gain adjustment, they are the $FFFF_{16}$ output and a precision reference voltage; and to check nonlinearity, they are successive d-a converter outputs at the major carries in the 4 most significant bits—for example, $0FFF_{16}$ to 1000_{16}. By adjusting the 1 LSB intervals at major carries, each of the upper MSBs is trimmed; it is assumed that errors in the 12 lower-order bits will not limit converter accuracy because their contribution to the total error is proportionately smaller.

After calculating the necessary corrections, the gain correction is sent to an 8-bit d-a converter that trims the main d-a unit's full-scale output. Offset and nonlinearity are corrected by storing digital codes in 16 random-access memory locations—every possible combination of the upper 4 MSBs addresses a unique byte of memory whose contents are delivered to an 8-bit d-a converter that supplies the required correction current to the summing junction of the output amplifier. Each time a calibration cycle is started, this memory is cleared, so that new codes based on updates of the main d-a converter's errors can be stored. **-Roderic Beresford**



SOURCE: BURR-BROWN

configuration is 4.88 mV, and a linearity test need resolve only ½ LSB, or 2.44 mV. Since the linearity error of the d-a converter is only about 3% of the a-d unit's LSB and an error of 50% is being sought, a 16-bit reference d-a converter is ideal for this application.

Other considerations in using the DAC74 in particular are its latched inputs and a self-calibrating feature that gives the test equipment longer intervals between trips to the calibration laboratory—a process required to assure continued accuracy in high-resolution instruments (See "A self-calibrating d-a converter," p. 144). The DAC74 also has a relatively fast settling time of 20 microseconds for an input change from negative full scale to positive full scale, thereby speeding system operation.

Traffic control

A Mostek MK38P70 microcomputer controls all traffic flow and data manipulation in the system. One of its ports, which interfaces with device-control lines, handles the routing of the gain, offset, and reference data to the appropriate d-a converters. Two additional ports are used to take the output code from the unit under test and display it to the operator. Three-state devices are necessary on these two ports to allow data to flow into or out of the computer. These interface devices are also controlled by the device-controlling port.

Other microcomputers and reference d-a units can replace the MK39P70 and the DAC74. However they must meet the critical requirements of this system—the high accuracy of the d-a converter, its relatively fast settling time, and the speed possible using a machine-language program instead of a slow high-level interpretive language, such as Basic.

Three 8-bit d-a converters serve as digital potentiometers for trimming the offset, gain, and input of the a-d converter under test. The DAC82 has 8-bit resolution, 8-bit–accurate current and voltage inputs, and requires no external components for offset or gain correction. As a dither, or trimming, d-a converter, one of these has its current output summed through a current divider into the summing junction of the reference d-a converter. This setup allows the analog input voltage to the unit under test to be moved in very small increments to find its output transitions without changing the reference d-a converter's input code.

Once a transition is located, the input code to the dither d-a converter and the range of the current divider determine the actual error magnitude. The output of the 8-bit dither d-a device in Fig. 1 is scaled so that its full-scale range covers ±1⅓ LSB of the 12-bit ADC80 a-d converter under test, or ±6.50 mV.

The offset and gain d-a converter's outputs are scaled down to swing ±5 mV. Their input codes need not be saved once the offset and gain have been successfully adjusted. Voltage outputs are used instead of current outputs for easier interfacing with the a-d converter's offset and gain inputs.

Adding octal latches in front of the dither, offset, and gain d-a converters—along with the latched inputs built into the reference d-a device—lets one port handle all of the data going to the four data converters. The data port of the microcomputer also has an associated strobe that sends out a pulse when data from the port is valid. The device-control port can be used to preselect the latch controlling the d-a converter for which the data is intended. This eases programming and speeds execution time, because by preselecting the latches, the only clocking that is necessary to assure proper data transfer is the strobe of the data port.

If the offset and gain of the unit under test are matched with the offset and gain of the reference d-a unit, the a-d converter's output codes should match the reference d-a converter's inputs. Initially, the offset and gain d-a devices are set to send an output of 0 V to the device under test and the reference d-a converter is set to provide the lowest voltage possible, −10 V. The dither d-a unit's input is set to 80_{16}, which is the middle of its current range; the system is calibrated to compensate for the resultant 1-milliampere offset.

Adjusting the offset

Figure 2 shows a flowchart of part of the program used to adjust the offset of the a-d converter using a DAC82 as a potentiometer. A successive-approximation register within the computer is initialized to 80_{16} at the start of the routine, and an offset register keeps track of the current value of the offset code applied to the offset d-a converter's input. The entire routine is repeated several times to give an average value of the offset, reducing any errors due to system noise that may occur during the adjustment.

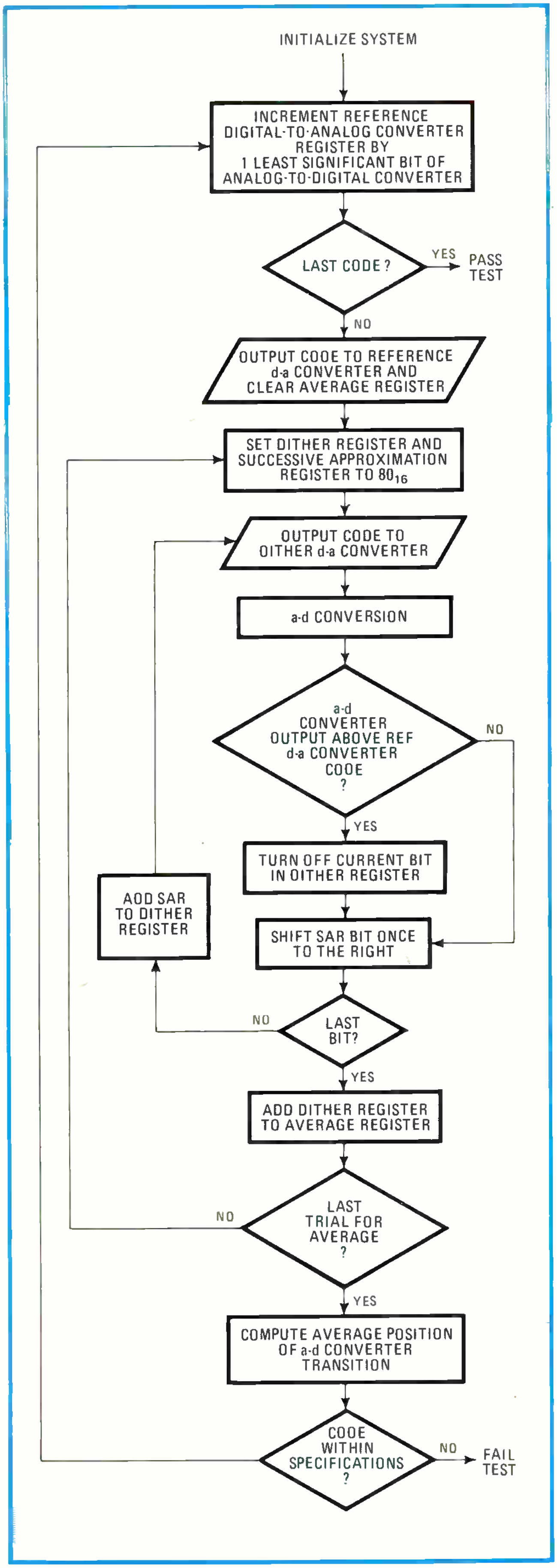
A similar algorithm is used to adjust the gain of the a-d converter. First, the offset d-a unit must be set to the code found in the offset-adjust routine. The reference d-a converter is set to positive full scale −1 LSB, and then the routine searches for the transition from FFE_{16} to FFF_{16} at the a-d converter output.

Most automated systems test the linearity of an a-d converter by first noting at what input level the output transition to be tested should occur and setting the reference d-a converter's output just below or above this level. Then the reference is increased or decreased in small increments until the output code of the a-d unit changes, indicating that the transition has occurred. This method of sequential searching is time-consuming, since the a-d device's input voltage is changed in small steps and a large number of conversions—up to 256—might be needed to find the transition.

Efficient search

A more efficient successive-approximation search algorithm for finding the output transition point of the unit under test is charted in Fig. 3. After the offset and gain have been adjusted and the dither d-a converter is set to 80_{16}, the reference d-a converter is set to produce the output voltage at which the transition should occur. After a conversion is made, the output of the a-d converter is read by the microcomputer to determine if the code is above or below the transition.

If it is above, the dither d-a unit's most significant bit is turned off and the next bit to the right is turned on to form a new code. If the output code is below the transition, the bit is left on and the next bit to the right is added for the new code. This process continues until all



3. Search and save. To locate the a-d converter's output transitions, a binary search algorithm is used to trim its input voltage. Although the reference d-a converter is set at the ideal transition voltage, a dither d-a unit provides an offset from this value.

eight bits of the dither d-a converter are examined. For each output code of the a-d device, only eight conversions are required to find which of the dither d-a converter's 256 input codes gives the analog voltage level for the transition being checked.

The ADC80 converts in 25 μs maximum, so that all 4,095 of its codes can be checked in less than 1 s of conversion time. The other 11 s of testing time are spent by the microcomputer in determining whether the codes fall within the specified margins. To compensate for noise in the system, each code is checked eight times. For the system in Fig. 1, the 12-s execution time for testing the linearity of all 4,095 codes of the 12-bit a-d converter includes the time needed to adjust the offset and gain.

Hysteresis check

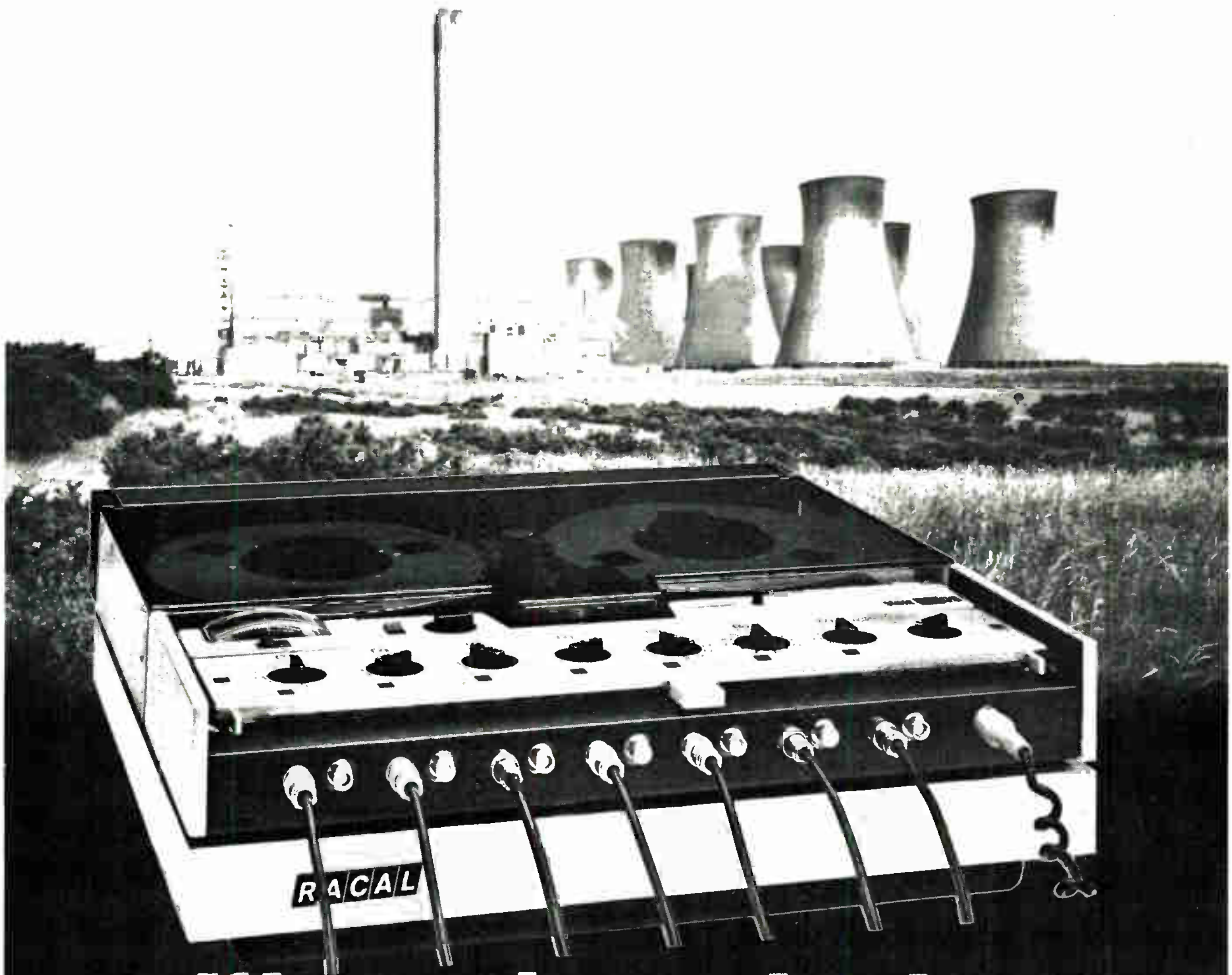
Another error source that often must be tested in a-d converters is hysteresis: the difference in the input voltages at which upward and downward output transitions between successive codes occur. The linearity test described is designed so that the upward transition to the next highest code is always the one located. Once this transition is found, a hysteresis test routine can be called to check that the converter is within its specification.

The test makes use of the fact that hysteresis shifts the downward transition to a lower input voltage. Thus, the test only requires that the a-d converter input be below the transition of interest at the start of the test by an amount less than the specified maximum hysteresis error. When the reference d-a converter is stepped up by two of the a-d unit's LSBs and then returned to the initial code, the a-d converter will either put out the same code as the d-a converter input, or fail the test. The dither register code must be checked initially to insure that the a-d converter's output is below the transition of interest at the start of the test. If it is not, ⅓ LSB is substracted from the dither register code, bringing the output down below the transition.

A test head

Since all of the data about the a-d converter's important specifications can be gathered in a matter of seconds, the system can serve as a test head for a larger computer that handles calculations and plotting of the raw data obtained by the microcomputer, without degrading the overall throughput. In such an application, additional random-access memory is included on the test board, so that the microcomputer can save the results of the measurements at each code.

Then a larger computer, such as Hewlett-Packard's HP9845, reads these memory locations, signals the test head to start another measurement sequence, and plots the test results. By the time the graphs or tables are finished, the microcomputer can complete another series of tests. This measurement system is a useful tool in a development lab, where complete testing of a fairly large number of converters is required. □



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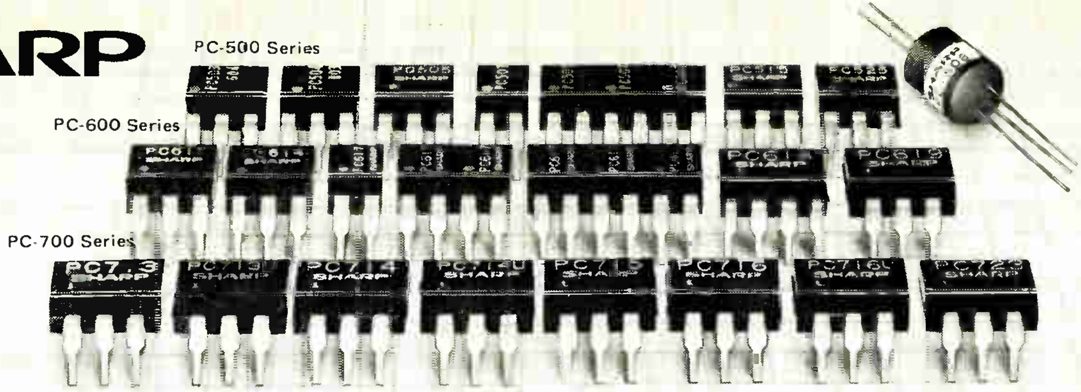

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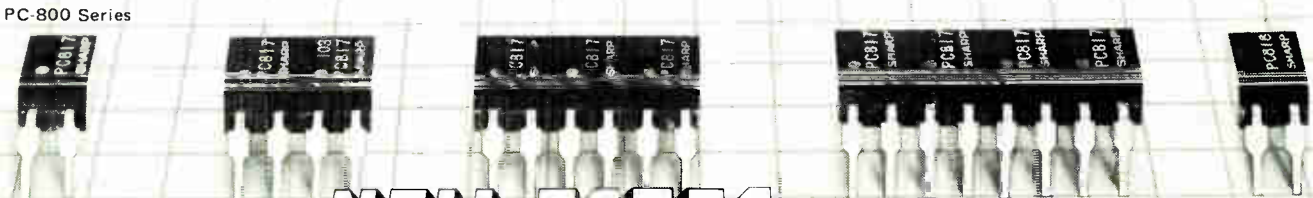

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*PC 614	General	DIP 6 pin	70	35	150	2,000		50		○	○	○				○	○	○	○	○
PC-714(*U)	High isolation voltage	DIP 6 pin	50	35	150	5,000		50		○	○	○	○			○	○	○	○	○
*PC-613	General	DIP 6 pin	70	35	150	2,000		50		○	○	○				○	○	○	○	○
PC-713(*U)	High isolation voltage	DIP 6 pin	50	35	150	5,000		50		○	○	○	○			○	○	○	○	○
PC-723(*U)	High BV_{CEO} type	DIP 6 pin	50	80	150	5,000		50		○	○	○	○			○	○	○	○	○
*PC-617	General	DIP 4 pin	70	35	150	2,000		50	○	○	○	○		○		○	○	○	○	○
PC-817(*U)	High isolation voltage	DIP 4 pin	50	35	150	5,000		50	○	○	○	○	○	○		○	○	○	○	○
PC-627	General	DIP 8 pin	70	35	150	2,000		50	○	○	○	○				○	○	○	○	○
PC-827(*U)	High isolation voltage	DIP 8 pin	50	35	150	5,000		50	○	○	○	○	○			○	○	○	○	○
PC-637	General	DIP 12 pin	70	35	150	2,000		50	○	○	○	○				○	○	○	○	○
PC-837(*U)	High isolation voltage	DIP 12 pin	50	35	150	5,000		50	○	○	○	○	○			○	○	○	○	○
PC-847(*U)	High isolation voltage	DIP 16 pin	50	35	150	5,000		50	○	○	○	○	○			○	○	○	○	○
PC 508	High isolation voltage (explosion-proof TYPE)	Tubular 5 pin	50	45	70	5,000	−25 ~ +100	6.7					○				○		○	○
*PC 505	High sensitive	DIP 6 pin	50	35	150	1,500		100		○										
PC 715(*U)	High isolation voltage high sensitive	DIP 6 pin	50	35	150	5,000		600		○			○					○	○	○
*PC 515	High sensitive	DIP 6 pin	50	35	200	1,500		1,000					○	○	○				○	○
PC 716(*U)	High isolation voltage, high sensitive, large collector power dissipation	DIP 6 pin	50	35	300	5,000		1,000					○	○	○			○	○	○
*PC 525	High BV_{CEO} type, high sensitive, large collector power dissipation	DIP 6 pin	70	200	300	1,500		300				○	○	○	○				○	○
PC-818(*U)	High isolation voltage	DIP 4 pin	50	35	150	5,000		10	○	○	○	○	○	○		○	○	○	○	○
PC 618	High speed	DIP 8 pin	25	※ 8	100	2,000		15	○	○	○	○	○	○	○	○	○	○		○
PC 619	Bi-lateral	DIP 6 pin	60	_ 100	300	2,000		TYP 0.1	○	○	○	○	○	○	○	○	○	○	○	

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Dual lasers speed termination of flexible printed wiring

Along with a new type of sealing and molding epoxy, laser welding can produce 500 assemblies per 8-hour shift in automated processing

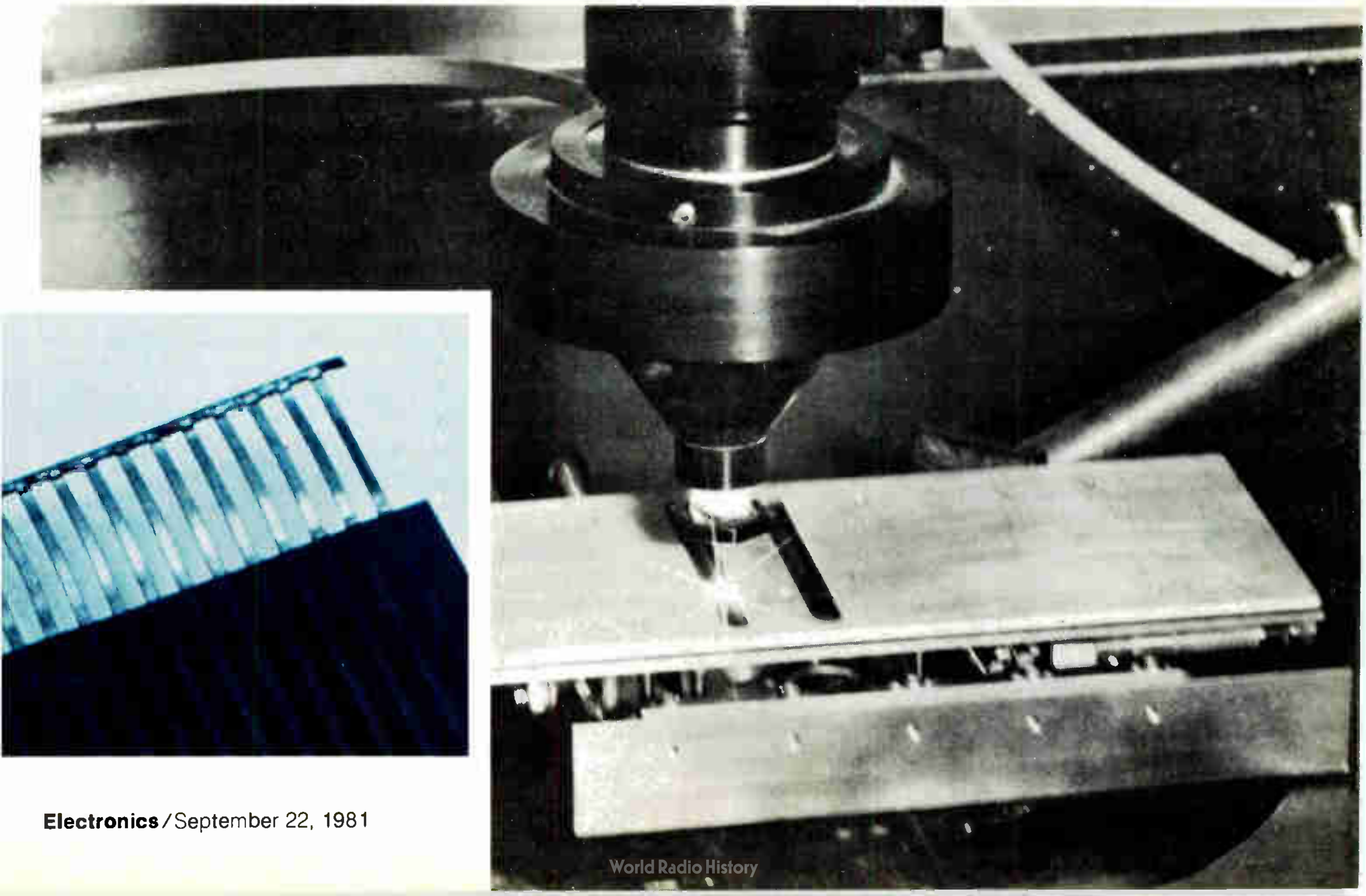
by James A. Henderson, *Westinghouse Electric Corp., Baltimore, Md.*

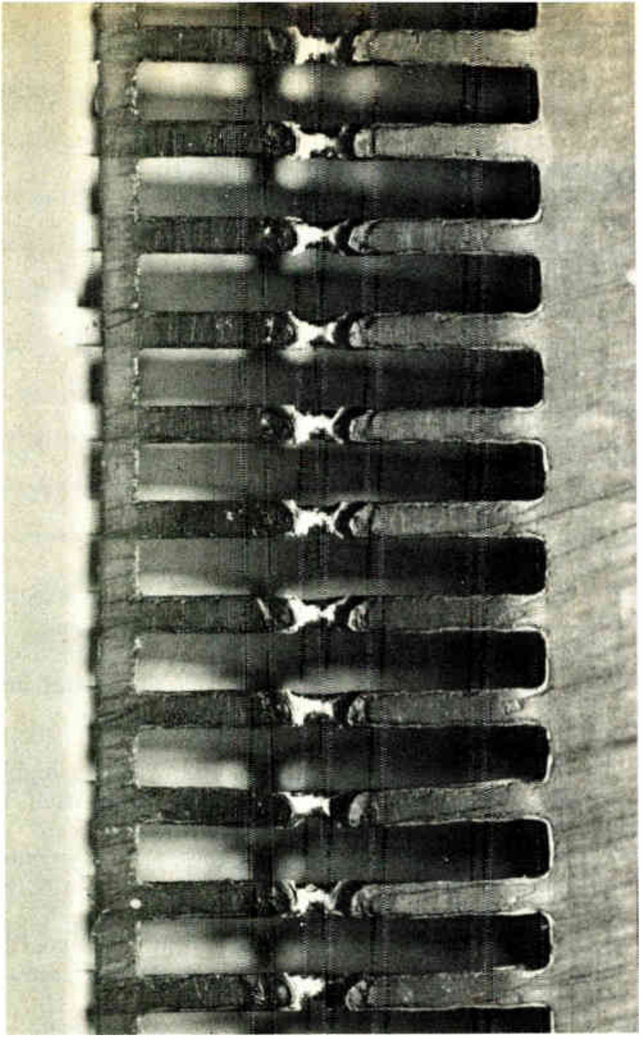
☐ If accuracy were the only criterion, flexible printed wiring would be the preferred wiring method to use since all the wires can be easily terminated in one shot with a minimum of mistakes. However, current termination methods like hand soldering, crimp-style pressing, and brazing are not cost-effective because they are time-consuming and expensive and require excessive preparation and setup time.

A contract with the U. S. Army Command, Redstone Arsenal, Ala., that included a thorough review of available processes and connector styles has now found a new approach in linking flexible printed wiring to connectors that is commercially as well as militarily viable. The new approach has five basic features:

- It is capable of being used with any planar connector having one or two rows of conductor pins on its back.
- The cables are stripped by a carbon dioxide laser beam, not by abrasive or open-cover coat techniques, and only half of the wire's insulation need be removed.
- Welding flexible printed wiring to connectors using a neodymium: yttrium-argon-garnet laser yields a highly reliable joint. This type of weld also lends itself to automatic visual as well as electrical inspection.
- A new type of epoxy for sealing and molding provides both support for the weld area and flexibility for the wiring egress, ensuring a highly reliable interface.
- The process was developed with the intended goal of using it in a fully automated facility, capable of produc-

1. Laser stripper. In Westinghouse's insulation removal process, a carbon dioxide laser is sequentially focused on a flexible printed wiring substrate's conductors. The beam removes organic insulation and leaves the copper conductors unmarked (see insert).





ing 500 wiring assemblies per eight-hour shift.

By using industrial-laser technology, fast-curing epoxy, and microprocessor-controlled automation, it is possible to cut the cost of termination systems by 85% and significantly improve system reliability when flexible printed wiring is linked to connectors.

Purpose

Among the principal benefits of flexible printed wiring are cabling cost reductions of 30% to 50%, weight reductions of as much as 70%, and volume reductions of as much as 80%. In addition, such wiring has repeatable electrical characteristics and affords substantial quality and cost improvement over other termination methods, as well as improved aesthetics.

However, acceptance of this technology has not been as rapid as hoped because of the initial design cost, product inflexibility once designed, and the various reliability problems associated with most termination practices. But with the advent of interactive graphics designs systems, front-end design costs of this technology can be reduced significantly.

In addition, many users realize that most of the reliability problems associated with interconnection technology have been caused by design changes in the wiring pinout sequence, in which the integrity of the cable joint is compromised by rework. Therefore, nonchangeable approaches like flexible printed wiring are becoming much more acceptable.

2. A welded contact. A neodymium: yttrium-argon-garnet pulsed laser can weld the conductors of a flexible printed-wiring circuit to the pins of a planar conductor. Repeatability and consistency of weld joints are significant characteristics of laser-welded terminations.

Reliability of other connection methods to flexible printed wiring, particularly when interfacing with circular connectors, required that special termination patterns be included in the design. Many of these techniques are limited because they use processes having tight tolerances that decrease yields and increase costs.

Three basic items are needed to resolve reliability inconsistencies of termination processes: flexible printed wiring and reliable connectors that are inexpensive; low-cost termination processes that are reliable; and a high degree of automation capability for running both multiproduction and low-volume quantities.

Flexible printed wiring was chosen because it is a planar technology—all the conductors are in a single plane, laminated or extruded in an insulated jacket. This kind of wiring is also inexpensive to use when the jacket does not have to be removed with a tool. Insulation-removal techniques require either separate operations after the cable has been made or special operations before the cable is laminated, sometimes even before laminating the copper foil to the insulation and etching the copper in the cable.

Planar connectors are noted for their low cost, particularly if provision for a separate contact insertion is not required. Thus, the marriage of low-cost planar connectors to flexible printed wiring is natural, provided that a highly reliable termination process could be found. This project basically used connectors having two rows of contacts on 50-mil centers from AMP Inc. of Harrisburg, Pa., and Hughes Connecting Devices division of Irvine, Calif. These processes have since been extended to other connectors, most notably 100-mil-center connectors.

But developing a method with a high degree of automation implies not only the ability to produce many items of one particular configuration, but also being readily adaptable to produce a few items of many different configurations. As a result, the approach taken toward automation was aimed at maximizing the concentration on software and microprocessor controls and minimizing hardware automation.

For process identification and connection selection, the required processes were divided into creating a metal-to-metal interface, a conductor-to-connector contact; then permanently joining that metal-to-metal contact, and finally sealing it and providing strain relief for protection against handling and moisture.

Insulation removal

Current techniques of removing insulation are not cost-effective because of the additional setups and operations that are required. Flexible printed wiring is currently prepared either by prepunching and aligning cover coats of insulation where completely open circuitry is required, by drilling and skiving after laminating the cover coat to the cable, or by using insulation-piercing techniques that require no preparation.

When cover coats of insulation are prepunched, often before the thin copper foil is laminated to the insulation, the alignment process is difficult and time-consuming. Drilling and skiving is done by hand and takes a long time. It also removes any surface protection that might be on the copper and may scratch the surface of the thin copper foil.

Needless to say, caustic baths for etching are highly undesirable because of their lack of controls and environmental problems. Where no preparation is required, the flexible printed wiring may be produced with a continuous cover coat that is laminated over the etched circuitry at the least expense for fabrication.

Insulation removal by laser

But removing insulation with a continuous-wave CO_2 laser requires a minimal amount of circuitry alignment or handling. In addition, the process works well for many different powers, permitting the removal of organic insulations and leaving the underlying metallic circuitry unaffected by the laser. This effect occurs because the polymeric insulation and related adhesives absorb the longer wavelength of the CO_2 laser at low energy-density levels, while conductors reflect it.

The surface of the copper circuitry for flexible printed wiring may be tinned, treated with an oxide surface, or untreated. The copper-circuitry surfaces used in this program were made with standard oxide-coating techniques to promote insulation adhesion. The removal of polyimide insulation from 50-mil-center flexible printed wiring is shown in Fig. 1.

In the insulation-removal process developed at Westinghouse, a CO_2 laser beam with a 10.6-micrometer wavelength is used. The laser cuts and removes insulation by rapidly vaporizing the insulation into its basic constituents.

Approximately 100 kilowatts per square inch of radiation incident on the surface of the insulation is needed to remove it. Oxygen or air may be used to accelerate the ablation process. It is also advisable to keep a positive pressure of air in the area of the laser's optical system to prevent deposition of vapors onto lenses or mirrors.

By removing insulation with a laser, mechanical contact with the circuitry is eliminated, and the narrow width of melted or vaporized insulation can be controlled. With this method, too, high-temperature insulation is easy to remove, quality-control requirements are minimal, and conductor metallurgy is unaffected.

The power density needed to remove the insulation is achieved by focusing the incident beam. When a numerical controller or a microprocessor is used to program beam location and movement, the beam may be guided rapidly across the insulation to be removed, making the process fast, reliable, and flexible.

In this case, the laser beam is held constant while the flexible printed wiring is programmed to move a table underneath it. A beam with a diameter of 0.033 in. and a useful power of 135 watts was applied, and insulation with a 0.020-in. diameter was efficiently removed. Pulsing the laser was synchronized with the table's speed to provide a single pulse every 0.005 in., giving a sufficient overlap to remove the insulation and adhesive on both oxidized and untreated copper surfaces. To ensure that vapors would not be deposited on the optical system of the laser, pressurized air at 35 pounds/in.^{2} was used.

The absorptivity of the insulation and reflectivity of the copper allow a wide range of beam power, approximately 33-100 kW/in.^{2}. Within this power range, the effect upon the grain structure of a stripped conductor under 200X magnification is nondetectable and the microhardness of the conductor material is unchanged.

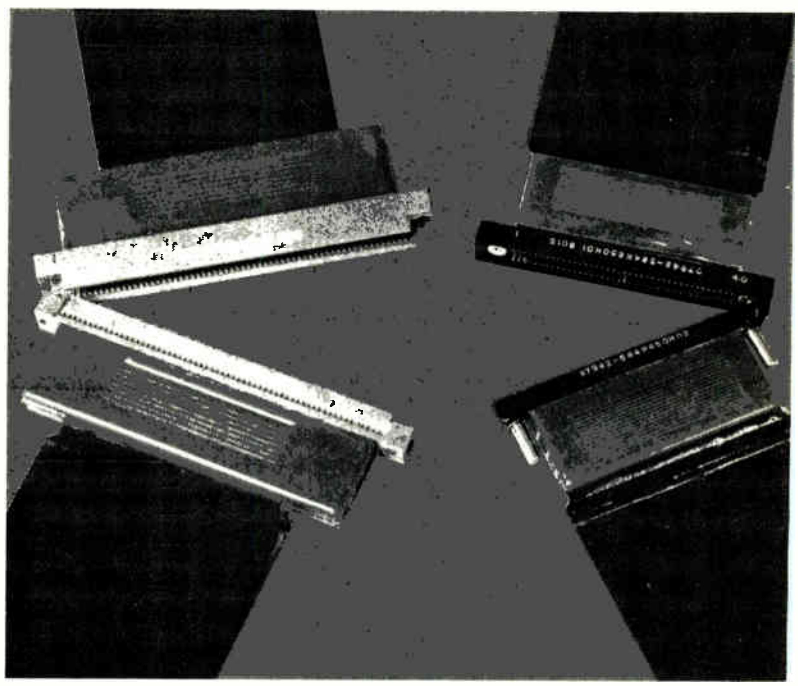
Deposits that remain on the flexible printed wiring and the surrounding insulation after the laser is used are carbonized byproducts and may be easily removed with a light brushing or a solvent rinse. Testing circuits with only a 0.0025-in. spacing between the laser-stripped conductors showed a 55-megohm resistance from conductor to conductor before removal of the byproducts. However, after cleaning, the insulation resistance was approximately 2×10^6 MΩ.

Laser welding

Welding flexible printed wiring to connector contacts was done with a laser operating at a wavelength of 1.06 μm. Three basic factors affected the weld and reliability characteristics of the joint: material and surface condition, the fit of the joint, and the weld parameters and control.

The material and surface condition affects the absorptivity of the laser beam because of the reflective characteristics of metal surfaces. The greatest welding variation was caused by differing surface conditions and depended on whether a slight or a strong film of oxide had been left on the metal or whether the metallic surface itself was highly reflective.

Initial attempts to resolve the problems centered on



3. Molded protection. The laser stripped and welded terminations are covered by an injection molded housing for both strain relief and environmental protection. Hydantoin, at left, and Bisphenol epoxies yield excellent protection for the flexible termination.

TABLE 1: PREFERRED THERMOSET COMPOUND FOR FLEXIBLE-PRINTED-WIRING CONNECTIONS

Materials (parts by weight)	Dimethyl hydantoin epoxy resin, CIBA XB-2869	70
	Polycarboxylic acid anhydride hardener, CIBA HY-920	157
	Neopentyl glycol diglycidyl ether, reactive modifier, viscosity diluent, CIBA XU-193	30
	N-butyl-T-amine phenate salt accelerator, CIBA DY-069	1
	Boron trichloride amine complex curing agent accelerator, CIBA XU-213	3
Physical characteristics	Specific gravity	0.93
	Glass-transition temperature, T_g	8° C
	Cure conditions	5 min at 150° C (302° F)
	Optional postcure	1 h at 150° C (302° F)

TABLE 2: PREFERRED THERMOPLASTIC COMPOUND FOR FLEXIBLE-PRINTED-WIRING CONNECTIONS

Materials (parts by weight)	Bisphenol epoxy resin, EPON 828	100
	Polyoxypropyleneamine hardener, Jeffamine D400	52
	Polyoxypropyleneamine hardener, Jeffamine D2000	8
	Piperaline proprietary mixture, Jefferson 399 accelerator	10
	Mica-dust filler (−325 mesh)	43
Physical characteristics	Cure	7 min at 100° C
	Postcure	1 h at 100° C

using oxidizing solutions to darken the surface of the conductors. These steps did make the melting process uniform, but at the expense of adding undesired steps.

A good mechanical joint is necessary in order to transfer heat from the flexible printed wiring to the contact tails. Area and contact conditions influence the energy transfer to the connector contacts and a poor fit will cause the copper conductor to melt back upon itself with the lack of fusion to the connector pin.

Weld parameters must have enough flexibility to accommodate manufacturing and material tolerances and still create a good weld. Excess speeds will spread the energy pulse, with incomplete and erratic results.

At 10 in./minute, a pulse rate of 15 hertz, and a pulse width of milliseconds, the Nd:YAG laser can deliver two pulses to each conductor on a 50 mil-center-spaced interface. With the extremely high accuracy available in numerical-control equipment, these 15-Hz pulses may be precisely situated on each conductor to give uniform results.

Better welds

However, if insulation is removed from only one side of the flexible printed wiring, an even better weld will result. The comblike ends of the wiring are opened as with removal from both sides, but the insulation is removed only from the side of the conductors that will be placed against the connector's contact tails.

The insulation remaining on the opposite side of the conductor, which will be receiving the pulse from the laser, is the width of the conductor. This insulation provides a uniform surface for the incoming laser beam, thus eliminating reflection-caused welding variations.

When the insulation is struck with the first pulse from the Nd:YAG laser, it vaporizes, creating a gas pressure directly behind the thin conductor that makes a powerful thermal contact between the conductor and the contact tail. This technique minimizes material and surface condition and joint-fit problems so that the weld is far more tolerant than required and very consistent (Fig. 2).

Using this technique, several tests were conducted on poor welds that ranged from ones that were just barely complete to welds that had half of the conductor material and the contact tail missing. In all cases, conductor failure occurred away from the weld area with no failure of the weld itself.

Metallurgical examination of the welds revealed excellent cross sections with a little gas trapping due to rapid cooling. The welds were very consistent physically and visually, so visual inspection became a practical way to inspect and ensure the quality of a weld.

Environmental protection

By molding welded terminations, a strain relief is provided so that there is no loading or flexing of the circuits at the welding areas and a barrier is created to prevent contamination.

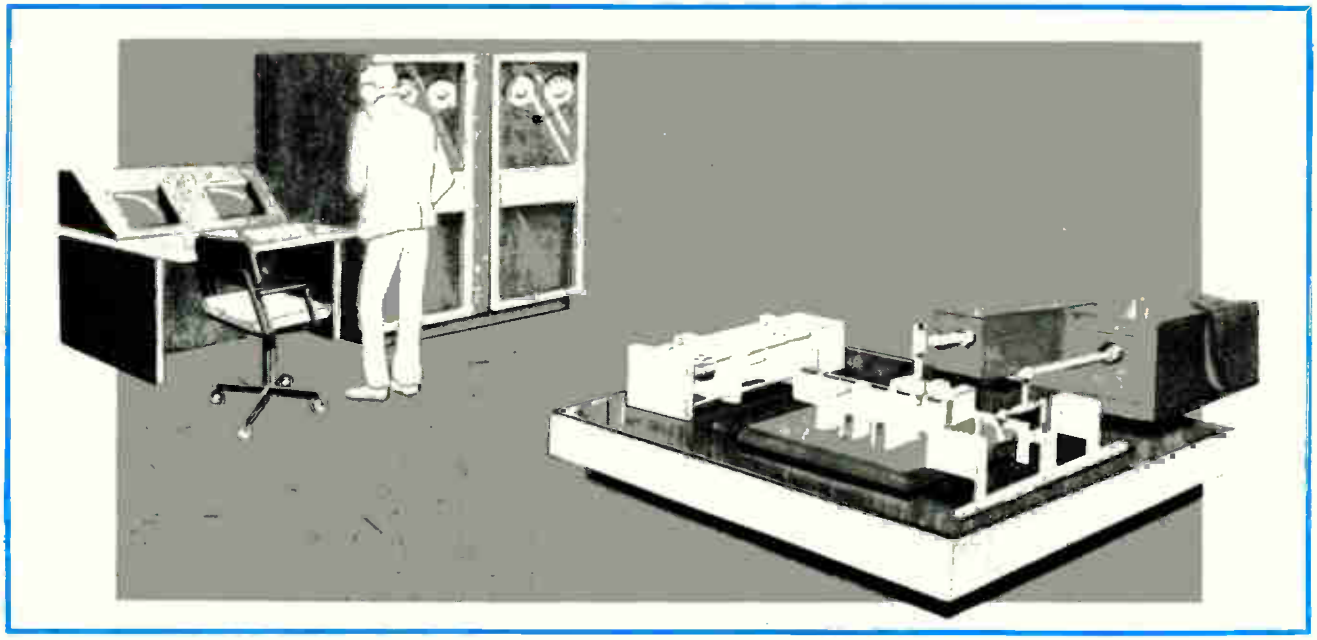
Finding a molding compound that would meet all the requirements of the process was not easy, particularly one capable of being used at an assembly rate of 500 units per eight-hour shift.

Molding compounds that cure quickly tend to be rigid. In addition, a molding compound applied to flexible printed wiring tends to terminate at the wiring in a fine meniscus that leaves a sharp point of material against the wiring. This material, if it is rigid, acts as a knife that causes flexible printed wiring to bend right at the molding, leading to failure in a few flexes.

If this material is partially flexible, however, it tends to act as a graduated-spring strain relief that significantly improves the circuit's flex life. Therefore, the molding compound had to support the welds, adhere well to the flexible printed wiring, allow the cable to be semiflexible, and cure quickly.

Two molding materials were finally selected. For connectors made with a thermoset material that could withstand a 150°C temperature for a 5-min cycle, a Hydantoin epoxy using liquid-injection–molding techniques was selected. Other connectors made with thermoplastic materials (such as Valox) required a lower-temperature material (100°C), and a Bisphenol epoxy was selected for them. The formulation and processing conditions for the liquid injection-molding compounds are shown in Tables 1 and 2 for the Hydantoin and Bisphenol epoxies, respectively. Typical connectors molded with these materials are illustrated in Fig. 3.

The three methods of terminating flexible printed wiring with integral molded connectors were semiautomated for use in industry demonstrations and to estab-



4. Automation. This conceptual drawing shows a fully automated line for processing connector-to-flexible-wiring interconnections. The facility concept emphasizes the extreme flexibility through integral microprocessor control of all steps of the termination process.

lish cost information for the program. The molding operation was the simplest to set up and required only a timer to operate the pneumatic-control system employed.

Welding and removing insulation with a laser was done with an Airotech controller. Information derived from the semiautomated operations was applied to developing automated facilities (Fig. 4).

Programmable control may be applied to all aspects of the automated system, thereby minimizing hardware tooling dedicated to a specific assembly. By using programmable control, many aspects of machine and process parameters are removed from hardware definition and brought under software control, thereby making the process more flexible and automatic.

While fidelity to the program is maintained during any machine cycle, an infinite number of programs may be generated and rapidly changed to deal with assembly style changes or process variables. Accordingly, the geometric character of the connector and flexible printed wiring (number of wires and number of connector leads to be welded) are controlled by software and can easily be changed or modified, necessitating only minor hardware modifications.

Program control

The application of programmable control falls into three categories: control of processes, parts position, and system timing.

The components of the systems are arranged to provide in-line processing through all steps, ending with a finished, tested assembly. The system has, as its central feature, tooling that is mounted on a computerized numerically controlled linear slide table that moves in the horizontal plane.

Programmable control of the tooling position relative to the fixed positions of the lasers and mold press allowed system design to be simplified. A more detailed description of the proposed automated system is described in "Automatic termination of flexible printed wiring" on page 154.

Throughout this program,* several evaluations and tests were conducted on materials and processes to verify that the program's approach would be acceptable in a military airborne environment. The most critical portion of the testing was specific environmental testing of the assembled systems after they had been terminated in the semiautomated facilities.

Evaluations

Using CO_2 lasers for insulation removal had no detrimental effect on the dielectric characteristics of organic insulation. Also, the Hydantoin epoxy-molding material has excellent moisture resistance. Although the Bisphenol epoxy exhibits adequate characteristics from a technical point of view, discoloration occurs in humid environments. Resistance measurements of the welded joints indicate that the dc resistance of 3 to 6 milliohms on the weld joint could be expected.

The cost benefits calculated for connectors requiring a moisture seal in, for example, a military airborne environment are due to three factors: connectors are less expensive with the new process than prior connectors; flexible printed wiring for the new process (not requiring open cover coats) is only about half as expensive as the prior required flexible printed wiring method; and because of automation, the added value at assembly has been reduced by a factor greater than 20:1.

For assembly quantities on the order of 500 assemblies per eight-hour shift, a projection of the mated-pair cost of connector assemblies with flexible printed wiring is approximately ⅙ of that experienced with other qualified processes.

The value of any manufacturing technology can only be realized by investigating the technique in a manufac-

Automatic termination of flexible printed wiring

On the automated system proposed by Westinghouse and shown here, the X-Y positioning slides are mounted centrally on a granite surface plate. The various tooling that supports and will reference the connector and the flexible-printed-wiring assembly through the welding, test, and inspection processes is mounted on the positioning tables.

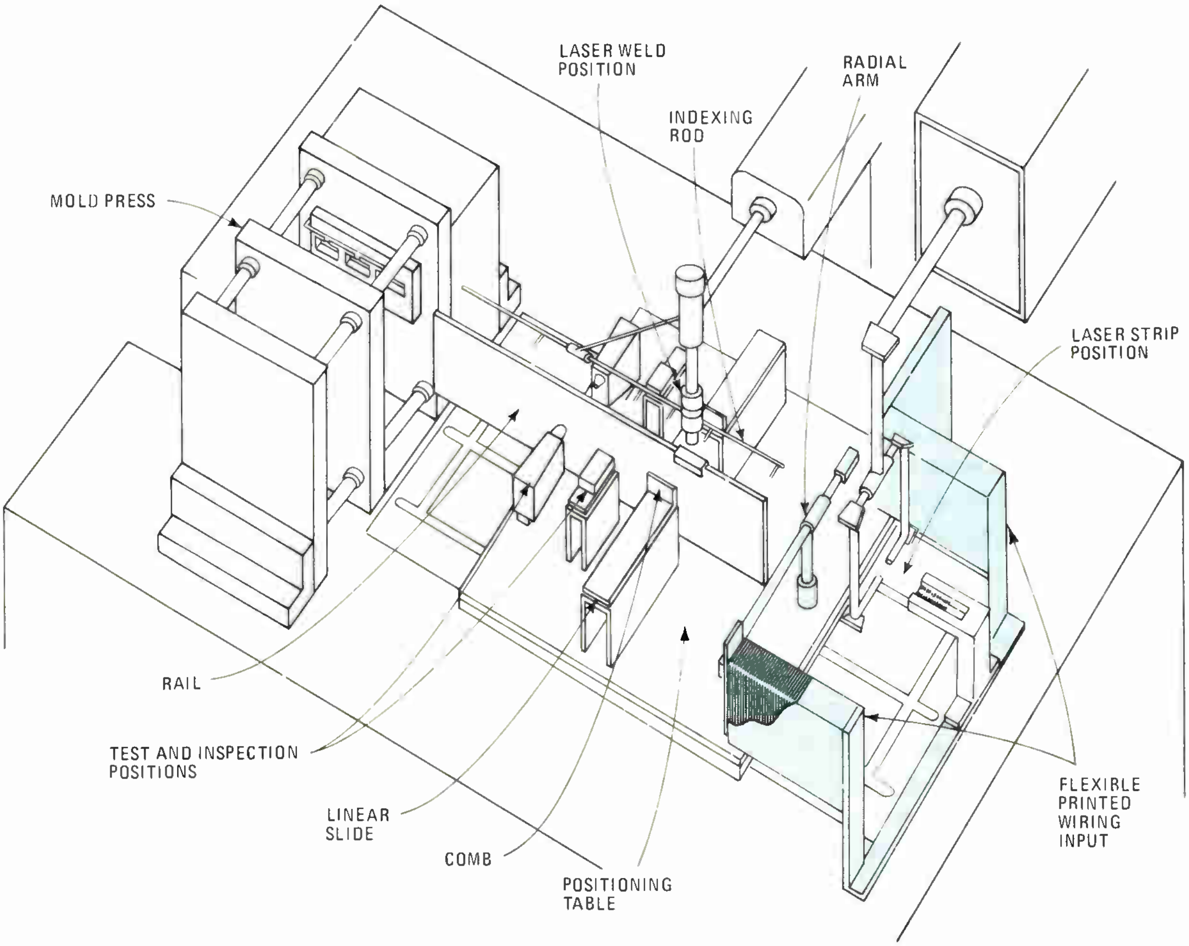
The carbon dioxide laser-stripping facility is positioned in the right-hand foreground. Both the stripping laser and the neodymium: yttrium-argon-garnet laser are referenced to the granite base. On each side of the stripping facility, containers are situated on it to present preoriented flexible printed wiring to the system.

At the opposite end of the granite base is the press used for molding. A structure with radial arms that is mounted on the positioning table in the foreground, it functions to load connectors onto the center rail and to manipulate the flexible printed wiring through the stripping cycle and present it to the carriers for welding.

These welding carriers are actually two small linear slides that are positioned on each side of the rail. Each side supports a vertical vacuum platten with a comblike feature at its upper edge. The ends of the comb interlock with the stripped conductors of the flexible printed wires to mechanically register the wiring with the system.

Welding occurs when the connector and the registered flexible printed wire are transported in the focal plane of the horizontally oriented Nd:YAG laser beam. Downstream from the weld station sit the probing and inspection stations. Positioning these stations at this point permits concurrent testing and the inspection of previously welded assemblies.

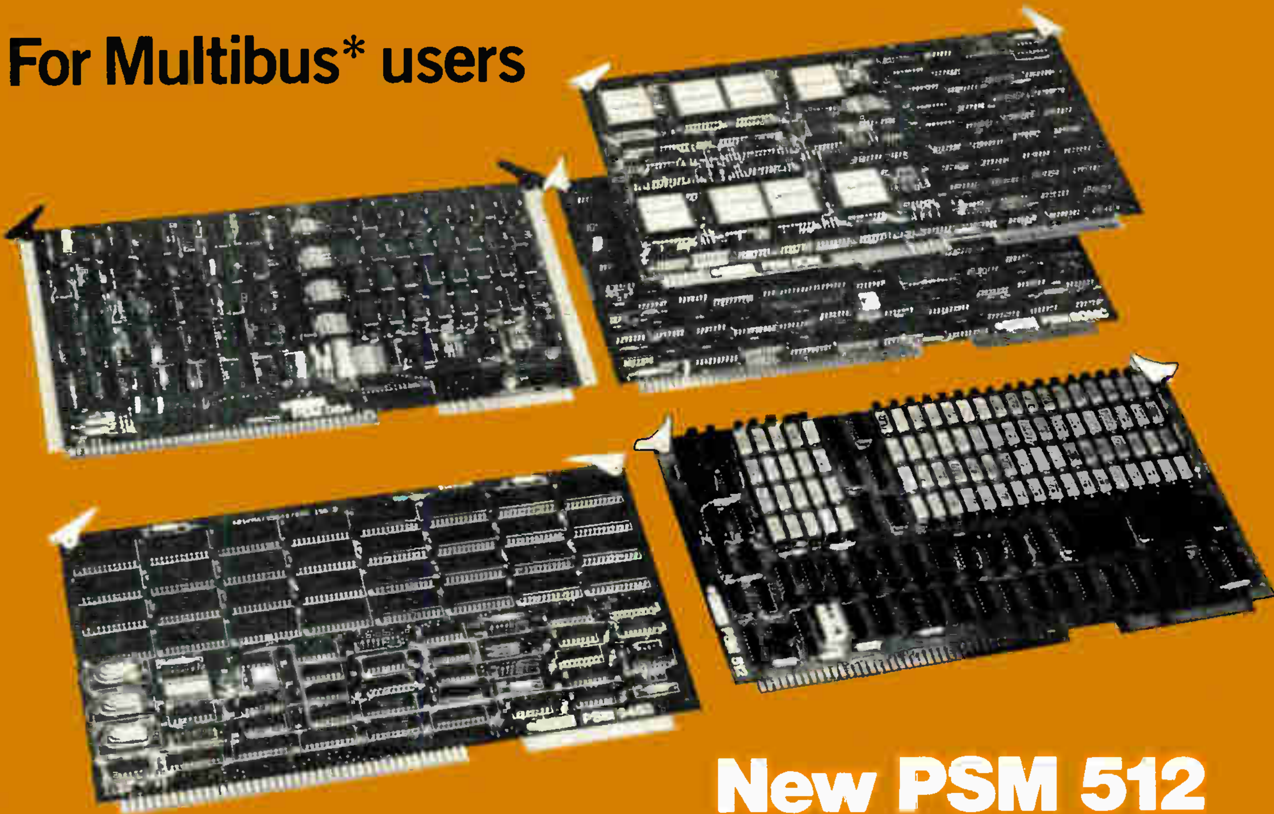
The overhang of the rail beyond the positioning tables provides temporary work-in-process storage space for queuing acceptable assemblies. When the queue is full, the table must be moved in between the mold halves to initiate the mold cycle.



turing environment. In order to do just this, Westinghouse is currently applying the laser termination processes to four major military systems. Two are currently in production, with two more scheduled to start production in the latter part of 1981. In addition, two connector suppliers and two laser machining service suppliers have shown significant interest and are already performing work in this area. □

*The author wishes to thank his colleagues Al Bosna, Jeff Emmel, Dick Hall, and Richard Zucker for their assistance in this project.

For Multibus* users



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PSM 6463	CMOS + battery	64k	—	20	8-16
PBS 80	Magnetic Bubbles	256k to 8M	Detection	20	8

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Digital phase meter updates measurement each cycle

by R. E. S. Abdel-Aal
Department of Electronic Science, University of Strathclyde, Glasgow, Scotland

Because this meter measures the phase delay between two low-frequency square waves once every cycle, it is useful in applications where instantaneous readings of this delay are continuously required. The circuit resolution is within 1% for signal frequencies of up to 250 kilohertz.

Generally, the meter counts the number of pulses of a 25-megahertz clock for a time equal to the phase delay between the two incoming waveforms. Then it strobes the measured value into output latches once a cycle. The result is a continuously updated value expressed as a 15-bit binary number plus a sign bit.

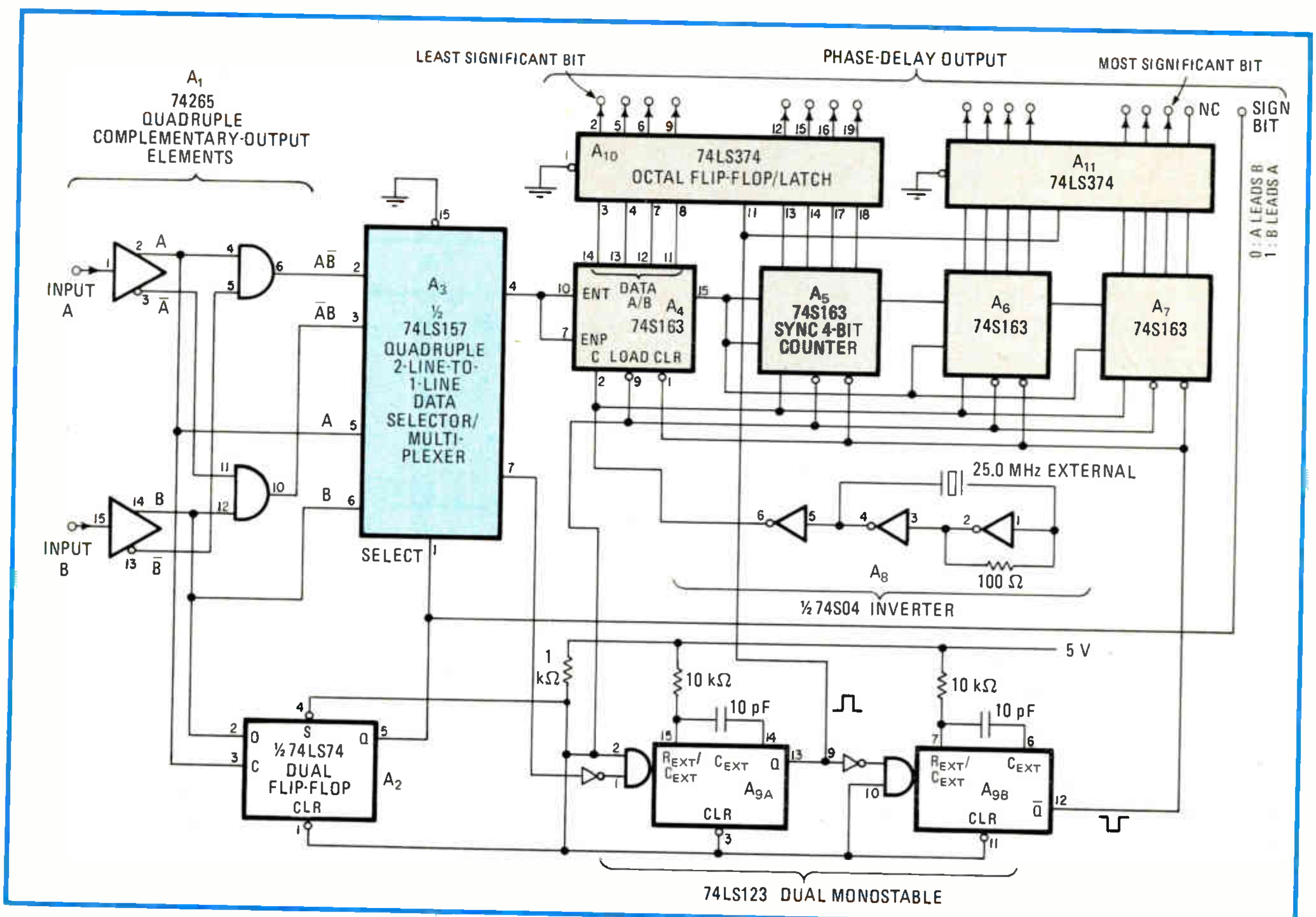
To achieve this, the cycle is viewed as one that varies from plus to minus 180°. By using only one half of the cycle for measurement, the circuit is free during the other half to store the results in the output latches and to clear the phase counters for the next measurement.

The circuit automatically determines which of the signals is to be the reference, with the phase delay measured from the rising edge of the leading signal to the rising edge of the lagging waveform. The falling edge of the reference serves as the latching signal and to set up the counters for the next cycle.

In operation, the two incoming signals, A and B, are applied to two gates of A_1. Here, the complemented signals $\bar{A}$ and $\bar{B}$ are obtained with negligible differential delay. The other two gates in the chip generate gating signals corresponding to $A\bar{B}$ and $\bar{A}B$. Flip-flop A_2 determines which input signal is the reference.

If A leads B, then the Q output of A_2 goes low and gating signal $A\bar{B}$, together with input signal A, drives the 74LS157 selector chip, A_3. Otherwise, gating signal $\bar{A}B$ together with input signal B will be selected.

The selected phase-gating signal is used to enable a chain of synchronous counters, A_4–A_7, which are driven



Instantaneous. Circuit continuously compares phases of two incoming square waves, providing a 15-bit and plus-sign output that has a resolution of $(f_{kHz}/250)$%. With a 25-MHz clock, the practical upper frequency limits that can be handled for incoming signals is 250 kHz, with lowest-frequency boundaries being about 400 Hz. Lower limits can be reduced further by decreasing the clock frequency.

from a crystal-controlled 25-MHz clock built around three inverters in A_8. When the phase-gating signal drops, A_4–A_7 stop counting, holding their final result, which indicates the phase delay, at their parallel outputs. Following this, a short pulse from one-shot A_{9A} latches the results of the count in A_{10} and A_{11}. Then the pulse-counter chain is cleared by a second pulse from A_{9B}. To ensure a proper count and store cycle, the sum of the widths of the two short pulses should be less than half the period of the highest-frequency input signal. Also, the short pulse used to clear the counters should be greater than the clock period.

The upper limit on the frequency of the input signals is set by the resolution of the phase measurement that can be tolerated. With this circuit, the resolution is given by (f/250)%, where f is the frequency in kilohertz.

The lower limit of the signal frequency is set by the overflow of the phase counters before the end of half a cycle of the input signal (that is, the maximum phase delay measured). With a 25-MHz clock and a 15-bit binary number representing the magnitude of the phase (excluding the sign bit), the minimum input frequency will be $25(10^6)/(2(2^{15}-1)) = 381$ hertz. At low input frequencies, however, a lower-frequency clock can be used while maintaining good resolution, and thus the frequency limit can be brought down even further. □

Computer notes

Pocket computer tackles classical queuing problems

by Cass R. Lewart
System Development Corp., Eatontown, N. J.

This program, written in Basic, permits pocket computers such as the Radio Shack and the Sharp PC-1211 to tackle problems in classical waiting-line (queuing) theory that has proved so useful in solving the tradeoffs that have to be made between utilization and capacity in telecommunications systems. The program can easily be translated to work on other machines.

The classical queuing considerations assume an expo-

SOLUTION OF QUEUING EQUATION IN RADIO SHACK/SHARP BASIC

```
10 "Z" CLEAR: USING "##.##^ "
15 PAUSE "QUEUING PROG. C.R.LEWART"
20 INPUT "ARRIVAL RATE?";L: IF L <= 0 GOTO 45
25 INPUT "SERVICE RATE?";M: IF M <= 0 GOTO 45
30 INPUT "# SERVERS?";S: IF (S <> INT S)+(S <= 0) GOTO 45
40 X=L/M: U=X/S: V=1-U: IF (V > 0)*((S-1)*LOGX < 100)*
   (S < 70) GOTO 50
45 BEEP2: GOTO20
50 Y=S: GOSUB 200
55 T=Z: FOR I=0 TO S-1: Y=I: GOSUB 200
60 P=P+X^I/Z: NEXT I
65 Y=S: GOSUB 200
70 P=1/(P+X^S/T/V): B=X^S*P/T/V
75 W=B/SMV: R=W+1/M: BEEP 1: PRINT "READY"
80 "B" PRINT "P(ALL BUSY)=";B
85 "X" PRINT "UTILIZATION=";U
90 "A" PRINT "P(0)=";P
95 "S" PRINT "AV. WAIT=";W
100 "V" PRINT "AV. RESP.=";R: D=√(2B-BB:SSVV)*W/B
105 PRINT "ST.DEV.(TR)=";D
110 "N" D=LR: PRINT "AV. IN SYS.=";D
115 "D" D=LW: PRINT "AV. IN QUEUE=";D
120 "F" INPUT "# ITEMS IN SYSTEM?";N: D=PX^N:
    IF N < S GOTO 130
125 E=D/TS^(N-S): GOTO 140
130 Y=N: GOSUB 200
135 E=D/Z
140 PRINT "P(N=";N;")=";E
145 "C" INPUT "TIME?";H
150 F=B*EXP -SMVH: A$="W"
155 PRINT USING "##.#^";"P(T";A$;">";H;")=";
    USING "##.##^";F
160 G=V-1/S: A$="R": D=EXP -MH: IF G=0 GOTO 170
165 F= D*(1+B/S*(1-EXP -MSGH)/G): GOTO 155
170 F=D*(1+BMH): GOTO 155
200 Z=1: FOR J=1 TO Y: Z=JZ: NEXT J: RETURN
```

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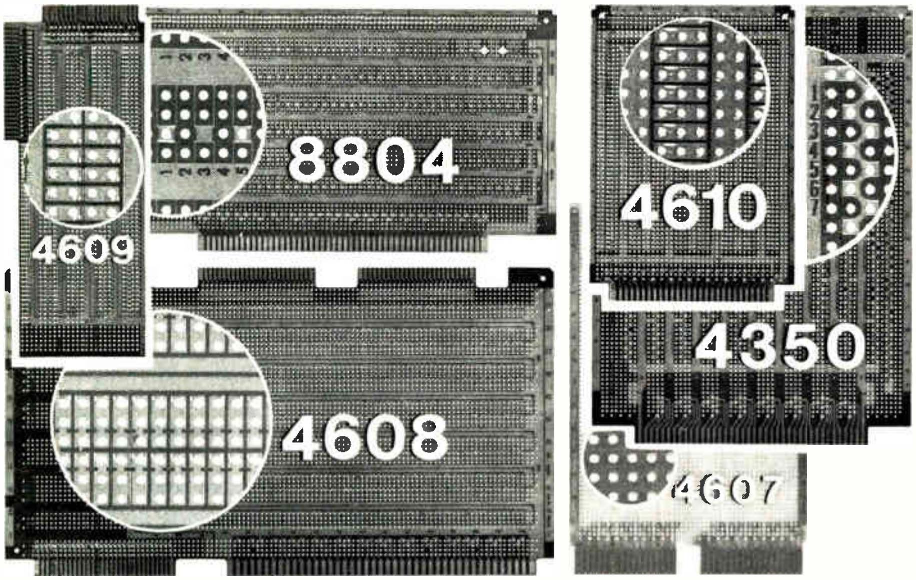

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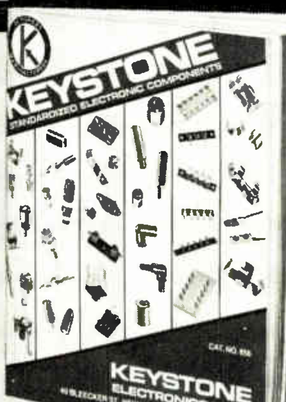

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CALCULATION PROCEDURE FOR SAMPLE PROBLEM		
Key entry	Display	Remarks
SHIFT Z	QUEUING PROGRAM C.R.LEWART	CLEAR ALL VARIABLES
	ARRIVAL RATE?	
16 ENTER	SERVICE RATE?	
4 ENTER	# SERVERS?	
5 ENTER	(BEEP TONE) READY	INITIALIZATION COMPLETED
SHIFT X	UTILIZATION = 8.00E−01	UTILIZATION FACTOR
SHIFT B	P(ALL BUSY) = 5.54E−01	
SHIFT A	P(0) = 1.29E−02	P (OF NO JOBS IN SYSTEM)
SHIFT F	# ITEMS IN SYSTEM?	
2 ENTER	P(N = 2.00E00) = 1.03E−01	P (2 ITEMS IN SYSTEM)
SHIFT S	AV. WAIT = 1.38E−01	WAIT IN QUEUE
SHIFT V	AV. RESP. = 3.88E−01	WAIT + SERVICE
ENTER	ST. DEV. (TR) = 3.35E−01	STANDARD DEVIATION OF ABOVE
SHIFT C	TIME?	P (WAIT > T)
0.25 ENTER	P(TW > 2.5E−01) = 2.03E−01	P (QUEUE WAIT > 0.25)
ENTER	P(TR > 2.5E−01) = 5.71E−01	P (TOTAL WAIT > 0.25)
SHIFT O	AV. IN QUEUE = 2.21E00	QUEUE LENGTH
SHIFT N	AV. IN SYSTEM = 6.21E00	
RUN 30 ENTER	# SERVICES?	RECOMPUTE FOR S = 6
6 ENTER	(BEEP TONE) READY	
SHIFT S	AV. WAIT = 3.55E−02	

nential distribution of customer arrival rates and serving times, identical servers, and a first-in, first-out order of service. Exponential distribution implies independence of events: customers seek service independent of the queue length and the servers operate at a steady rate independent of the load and queue length. Such assumptions usually result in safe estimates of waiting times and other queuing parameters and can be turned into simple equations that can be solved in a reasonable time on this pocket computer.

Given the customer's average arrival rate, r, the average serving rate, m, and the number of servers, s, the program first finds the system's utilization factor, u, from u = r/sm. It then finds the probability of finding all servers busy from:

$$B = \sum_{n=s}^{\infty} P(n) = (r/m)^s P(0)/[s!(1-u)]$$

where

$$P(0) = (r/m)^s/s!(1-u) + \sum_{j=0}^{s-1}[(r/m)^j/j!]^{-1}$$

Following this, the probability of finding n items already in the system is calculated from:

$$P(n) = P(0)(r/m)^n(1/n!) \qquad n<s$$

or

$$P(n) = P(0)(r/m)^n[1/(s!s^{n-s})] \qquad n \geq s$$

Next, the average waiting time in the queue is computed from $T_w = B/sm(1-u)$, with the average response time being $T_r = T_w + 1/m$. The standard deviation of T_r is then found by:

$$S_{TR} = (T_w/B)[B(2-B)+s^2(1-u)^2]^{1/2}$$

and from this, the probabilities of T_w>T and T_r>T:

$$P(T_w>T) = B\exp[-smT(1-u)]$$
$$P(T_r>T) = \exp(-mT)\times\{1+[1-\exp(-msTK)\}\times(B/SK), \qquad K \neq 0$$
$$P(T_r>T) = \exp(-mT)\times(1+BmT), \qquad K = 0$$

where $K = 1-u-(1/s)$.

Finally, the average queue length is determined from $Q = rT_w$ and the average number of jobs in the system from $N = rT_r$. The 33-line program for finding all desired queuing parameters is shown in Table 1.

Consider the case where a computer having five terminals averages 16 customers per hour who arrive at random intervals, with each job taking an average of 15 minutes (four per hour). The aim is to ascertain several queuing parameters, as well as the reduction in waiting time if a sixth terminal is installed.

If the program is initialized as illustrated in Table 2 (the average initialization time will vary from 10 seconds for s = 1 to 18 minutes for s = 69), it will find that u = 0.8, B = 0.554, P(0) = 0.0129, P(n = 2) = 0.103, T_w = 0.138 hour, T_r = 0.388 h, S_{TR} = 0.335 h, P(T_w>0.25 h) = 0.203 h, and P(T_r>0.25 h) = 0.571 h. With s = 6, T_w is reduced to 0.036 h. □

Engineer's notebook is a regular feature in Electronics. We invite readers to submit original design shortcuts, calculation aids, measurement and test techniques, and other ideas for saving engineering time or cost. We'll pay $75 for each item published.

Engineer's newsletter

NiCad cells are tricky to charge

Approach with caution the recharging of primary batteries. Although the technique advocated by Cass Lewart can effectively recharge nickel-cadmium batteries from a radio's ac adapter [*Electronics*, Aug. 11, p. 140], it may easily lead to trouble, warns Robert L. Barnard of General Electric Co.'s Housewares and Audio Business division, Syracuse, N. Y. Indeed, the American Standards Institute's publication C18.1-1972, Item 7.6, does not recommend charging NiCad batteries from this type of ac-dc source at all because it can result in personal injury or extensive damage to equipment.

Lewart's method is to solder a current-limiting resistor across the two contacts of the radio's ac adapter that are normally closed in order to form a charging path for the installed NiCad batteries. **This setup may cause the cells to overcharge and rupture,** notes Barnard. And they may catch fire, too, he says, unless charged under scrupulously controlled conditions. Safe techniques are described in National Bureau of Standards Circular LC-965 (1949), and additional information will be found in Media Bulletin No. 2006 (1969), issued by the National Better Business Bureau Inc.

IEEE seeks experts in surge protection

Interested in working on problems in the area of low-voltage circuitry protection? If so, the Institute of Electrical and Electronics Engineers wants you—for a Low Voltage Surge Protective Devices subcommittee it's forming to expand efforts in this area. The IEEE's SPD Committee is recruiting qualified members for the new subcommittee, which will be chaired by Edward J. Cohen of the U. S. Department of Agriculture's Rural Electrification Administration. The subcommittee will consist of five working groups, of which two **will develop procedures for testing and specifying surge protection devices,** one will produce a guide to the best way to use them, another will characterize surges on low-voltage circuits, and the last will investigate the surge vulnerability of components attached to these circuits.

The subcommittee's initial meeting will coincide with the four-day SPD session in Charlotte, N. C., Sept. 29 to Oct. 2; subsequent meetings will be semiannual. Anyone interested should send a brief summary of his or her experience and a list of preferred tasks to chairman Cohen, IEEE LVSPD Committee, EMSE/TESD, Rural Electrification Administration, U. S. Department of Agriculture, Washington, D. C. 20250. For further information, call (202) 447-4561.

Newsletter focuses on fiber optics

Changes in the burgeoning fiber optics industry happen in the blink of an eye, so a newsletter to keep up is a handy item. Fiber Optics Now, published by Canstar Communications of Scarborough, Ont., Canada, is available free of charge from the company. Slated for regular publication, the newsletter keeps track of new applications, manufacturing techniques, and equipment standards for fiber-optic equipment manufacturers. The newsletter is not geared to Canadian industry alone; **the current issue includes inputs from the U. S., Japan, and England.** For a subscription, write the editor at 1240 Ellesmere Road, Scarborough, Ont. M1P 2X4, or call (416) 293-9722.

-Vincent Biancomano

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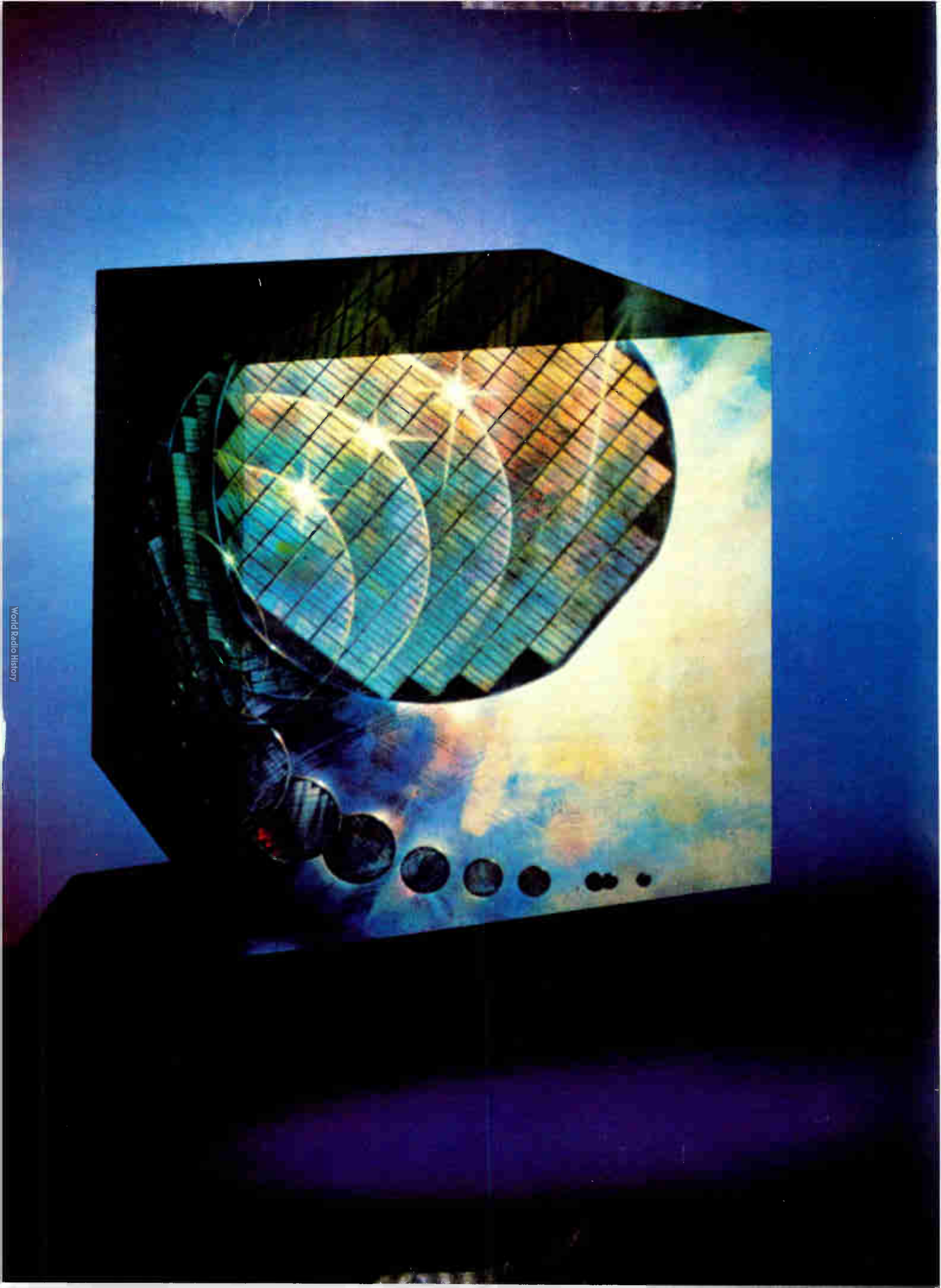
Circle 161 on reader service card



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		Chip Enable/Select	Address	Active	Standby
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IMS1420-55	4K x 4	55ns	50ns	600mW	110mW
IMS1421-40	4K x 4	30ns	40ns	600mW	NA
IMS1421-50	4K x 4	40ns	50ns	600mW	NA
IMS1400-45	16K x 1	45ns	40ns	660mW	110mW
IMS1400-55	16K x 1	55ns	50ns	660mW	110mW

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Circle 162 on reader service card

Interchangeable ROMs and EPROMs from Texas Instruments, the total memory supplier.

Here are tips from Texas Instruments on which to use when. Your decision may hinge on economics.

There are times when your system design will clearly dictate either ROMs or EPROMs. At other times, the dividing line between the two is hazy. That's when a careful analysis of the economics involved — particularly the recent substantial pricing changes in the marketplace — may tip you to one or the other with considerable long-term savings as a result.

Texas Instruments, a leader in non-volatile memories and a broad-based supplier, can deliver the byte-wide ROMs or EPROMs you need. And from its years of experience with these memory devices, TI offers suggestions that may help you decide on the least expensive solution for your system.

The case for ROMs

In general, ROMs provide more memory for less cost than any other semiconductor memory. The key to their use is high volume and high memory capacity — on the order of 32K and 64K. Coupled with programming — performed by the supplier — that will not change or need to be updated.

In these circumstances, ROMs are especially cost effective. Total costs are spread so widely that per-bit cost is relatively inexpensive.

Consumer and computer peripheral applications where the volume of end products is large can make very economical use of ROMs.

The case for EPROMs

Prices for 16K and 32K EPROMs have declined significantly, and those for 64K devices will follow suit. Making EPROMs economically attractive, especially for applications where the program is likely to change.

Programming is easily performed by the user, and there is no mask charge. One EPROM type can be used for many different programs. Which means lower inventory costs and no write-off costs when programs vary.

TI's High-Density ROMs

Device	Density	Power Dissipation*	Access Time*
TMS4732-35	32K	440 mW	350ns
TMS4764-35	64K	440 mW	350ns

TI's Leadership EPROM Family

Device	Density	Power Dissipation*	Access Time*
TMS2564-35	64K	840mW	350ns
TMS2564-45	64K	840mW	450ns
TMS2564-50	64K	840mW	500ns
TMS2532-25	32K	840mW	250ns
TMS2532-35	32K	840mW	350ns
TMS2532-45	32K	840mW	450ns
TMS25L32-45	32K	500mW	450ns
TMS2516-35	16K	525mW	350ns
TMS2516-45	16K	525mW	450ns
TMS2508-25	8K	446mW	250ns
TMS2508-30	8K	446mW	300ns

*Worst case over operating temperature range

If you are in a hurry to get to market, EPROMs can be your best bet. They are available from multiple sources on short lead times.

One additional advantage: Because of their programming flexibility, EPROMs are an excellent prototyping tool prior to conversion to ROMs. And, at the end of a product's life when both volume and the number of ROMs being used decline, converting back to EPROMs can cut costs.

The case for Texas Instruments

Whether ROMs or EPROMs or both, Texas Instruments fills your requirements with reliable, proven-in-the-marketplace memories that are fully compatible with each other.

A system designed with appropriate memory addressing can utilize TI's 16K or 32K EPROMs or TI's 32K or 64K ROMs on the same printed circuit board in the same 24-pin socket.

In ROMs, you have a choice of the high densities that spell economy — 32K and 64K (see table). These are fully static memories — no clocks, no refresh — that require only a single 5-V power supply. They are fabricated using N-channel silicon gate technology for utmost dependability. All inputs and outputs are TTL compatible. Maximum access and minimum cycle times are 350 ns.

In EPROMs, you have the broadest choice in the industry — 8K through 64K. All have the same basic pin configuration to ease memory capacity expansion.

Weigh the pros and cons of ROMs vs. EPROMs. Evaluate your system requirements and carefully check out the economics. Then call your nearest TI field sales office for prices and delivery on your choice. Of course, if you still have doubts about which is best for you, we are ready to consult with you at any time.

Texas Instruments invented the integrated circuit, microprocessor and microcomputer. Being first is our tradition.

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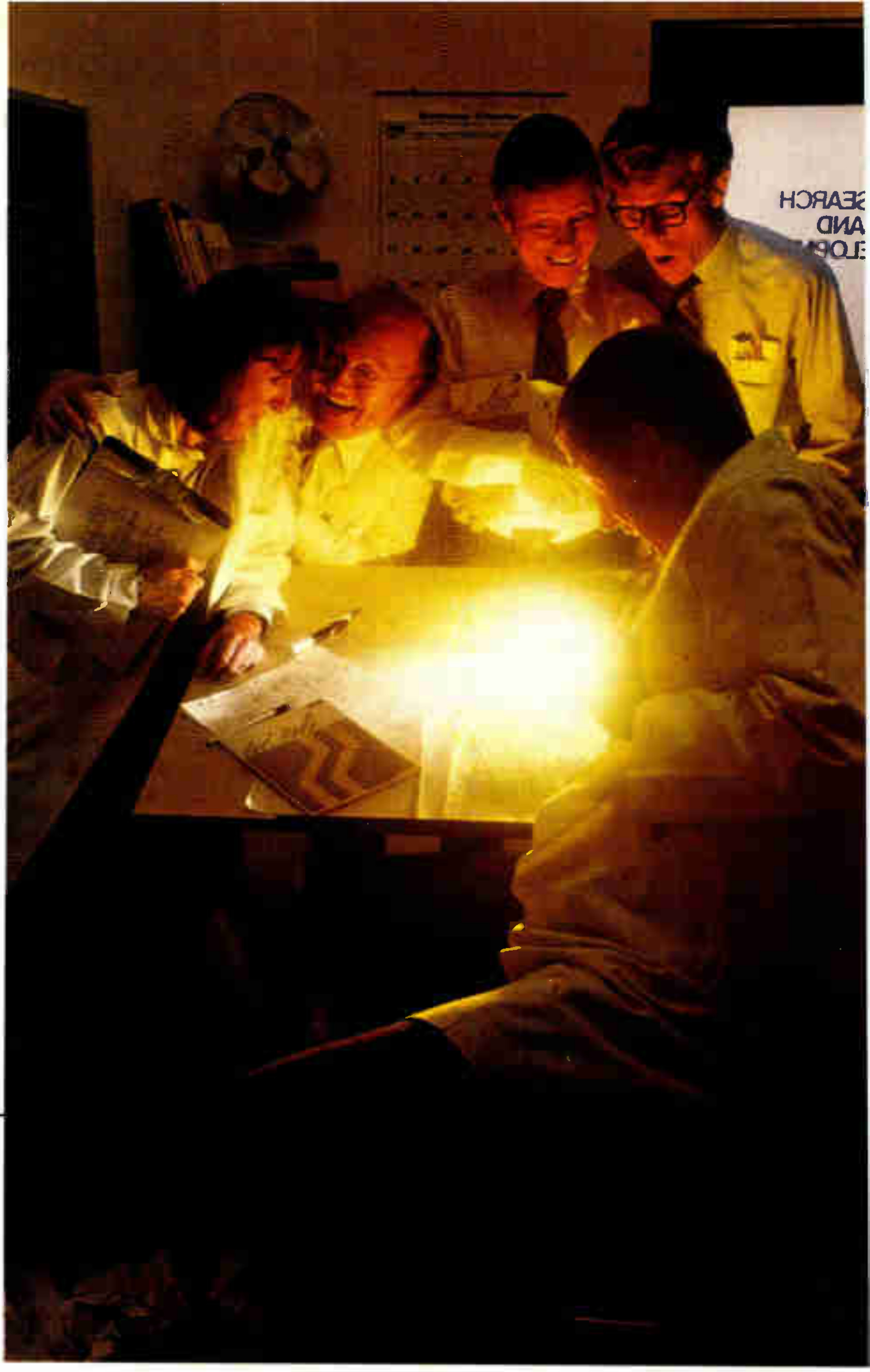

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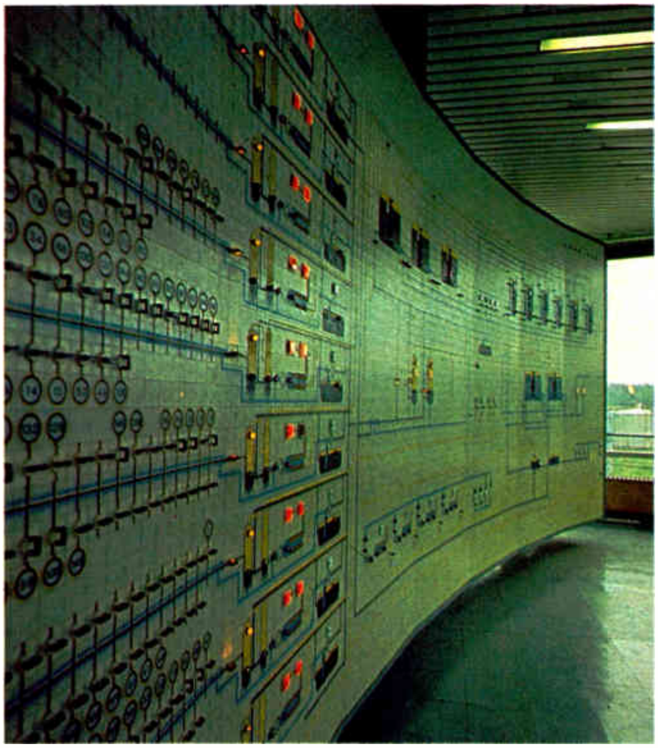

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Multiplexing adds pins to board testers

Larger of two GenRad systems handles 30-inch-square boards in a 3,584-pin fixture; multiplexing ups pin count economically

by James B. Brinton, Boston bureau manager

With the rapid increase in the complexity and size of circuit boards, GenRad Inc. should have little trouble marketing its new high-pin-count board test systems. The 2271 and 2272 extend the capabilities pioneered with the firm's 2270 test system to encompass boards requiring as many as 3,584 pins and using any mix of analog or digital test circuits, including emitter-coupled logic.

The 2271 can test boards as large as 17 by 20 in. using a multiplexed 960-pin bed-of-nails test fixture. Its big brother, the 2272, takes 30-by-30-in. boards on a 3,584-pin fixture. The 2270, introduced in 1979 [*Electronics*, Aug. 30, 1979, p. 194], accepts up to 480 pins.

According to GenRad, the 400 to 500 2270s now in the field make the system a *de facto* standard. And since users rarely want to endure the teething pains of a system coming on line for the first time, the company stresses that the 2271 and 2272 are evolutionary, not total redesigns, and therefore promise high reliability.

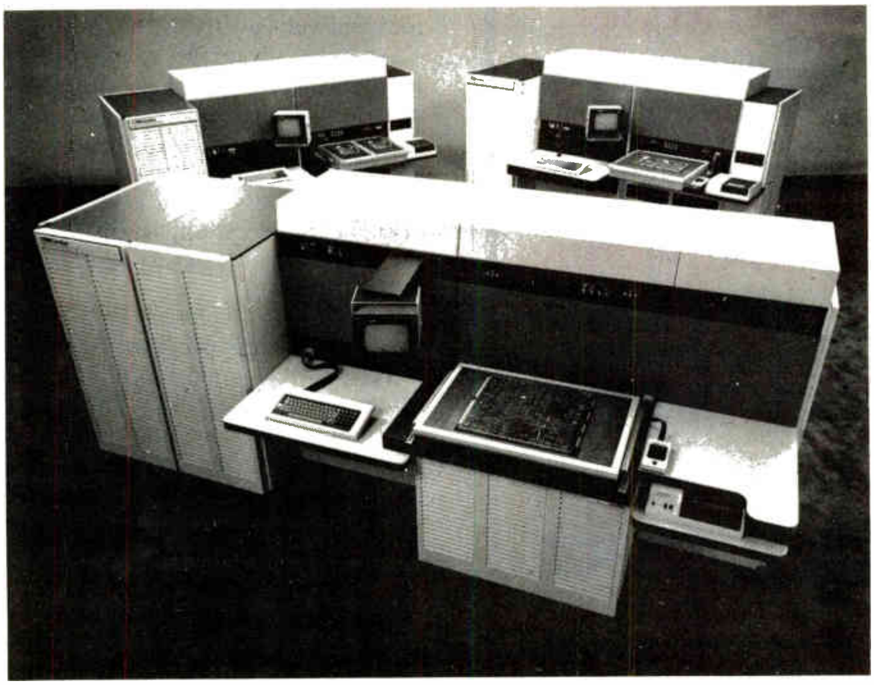
Of course, pin count is not equivalent to node-test capability. The systems make four-terminal guarded measurements to eliminate errors caused by parallel components and to separate bulk reactances into their component resistances, capacitances, and inductances. Thus, node count will always be smaller than pin count. But the new systems can address an impressive number of nodes: 700 nodes for the 2271 and 1,700 nodes for the 2272. In contrast, the 2270's 480-pin configuration accommodates 300 nodes.

Even though the new systems offer from two to eight times more pins and a mix of analog and digital testing at all pins, GenRad spokesmen stress the family relationship. Test software for the 2270 is compatible with the newer, larger systems, and even though it has been refined for the new machines, GenRad's new Release Seven software is compatible with the earlier 2270.

All three testers use the Digital Equipment Corp.'s LSI-11/23 computer system with a floating-point math package and both floppy- and hard-disk bulk data stores. Whereas the 2270 has 10 megabytes of hard-disk storage, the larger machines each offer 64 megabytes.

Many of the operating features of the new machines parallel those of the 2270 as well. Retained are:

- A test-if-possible strategy, which continues testing after faults are found. This increases throughput by exercising all testable parts of a board on the first pass.
- Scratch probing, in which a probe is run quickly across an IC's contacts rather than addressing each pin individually. This speeds diagnostics at the package level, and removes inaccurate probing as a source of error.
- 1-K of memory at each pin.
- Automatic test-generation software, improved in Release Seven.
- Beyond-the-node fault location to target specific component failures, even in bus-based boards. The system makes parametric measurements of bus activity to determine which circuit on a bus has failed; GenRad calls this Busbust.
- Fault printout by device designation rather than node number for the purpose of speeding repair.
- A growing library of active device



characteristics. The test and performance parameters of more than 1,200 active devices are now available off the shelf, including 16-bit microprocessors.

■ Finally, destined for new devices, a learn-mode test library data-generation system.

With these accommodations, users with a prior investment in 2270 test software and fixtures will be able to upgrade without penalty to the 2271 or 2272 as their test requirements increase. Nevertheless, the challenge of pin counts in the thousands forces key differences between the older and newer systems.

For example, like the 2270, the new machines use a bus-based architecture with dc voltage and current sources, dc ammeters and voltmeters, a quadrature reactance test module, and optional IEEE-488-bus–controlled instruments appended to the bus. But unlike the 2270, the two new machines multiplex drivers and sensors so as to address more pins at moderate cost.

Driver-sensor pairs are hard-wired to twin analog scanners, which in turn are switched among as many as 16 points on the device under test. This results in an 8:1 multiplexing ratio; thus in the largest 2272, only 448 driver-sensors are needed to serve as many as 3,584 pins—and inexpensively, at that.

Another advantage of GenRad's multiplexing approach is the sufficiency of available drive-sense electronics to allow testing of the coming generation of very large-scale ICs. The 2272's users should have no fear of the largest VLSI applications since the unit is capable of testing 256-pin and larger ICs.

According to GenRad, little overhead is incurred using multiplexed driver-sensors as opposed to hard-wired units. Perhaps 10% more time is required, but the time needed to load successive test routines in pin memory overlaps the time taken by the multiplexing reed relays. Thus the total time penalty is actually somewhat less than 10%.

Release Seven, GenRad's new test software package, includes features that enhance test capabilities, facilitate use, and cut program preparation time. Program preparation time, a costly overhead item, is reduced by Release Seven's digital debugging display, which presents driver- and sensor pin activity in a timing-diagram format. This format makes it far easier to verify performance than it was with the numeric cathode-ray-tube display formerly used on the 2270. As a further aid, reverse video serves to highlight failed pin states.

With Release Seven's real-time debugger, the programmer can work directly on device tests and monitor the results of program changes, speeding the program's preparation for the production floor.

Library. With the new release's analog-component library function, users can create descriptive files for complex analog devices, multiple component devices, and custom circuitry. These descriptions can subsume other descriptions of individual parts and therefore speed the analysis that accompanies automatic test program analysis, according to GenRad, providing more precise diagnostics.

Response also will be quicker, thanks to a new menu-style monitor and cursor-controlled option selection. Other features include automatic prompting for the input of circuit-description data during programming; the LOCpin routine, which indicates the number and type of contacts being probed; routines to program in languages other than GenRad's; and On-Load, for more efficient board revisions.

GenRad's low asking prices may be surprising; it is possible to pay much more for systems addressing fewer pins. The 2272 will sell for $200,000 in its smallest usable configuration; the 2271 is priced at $170,000. First shipments of the 2271 are due in October, with the 2272 due in November. Delivery times thereafter should run about 10 to 12 weeks. The Release Seven software is available separately to 2270 users for $5,000.

GenRad Inc., Board Test Division, 300 Baker Ave., Concord, Mass. 01742. Phone (617) 369-4400 [338]

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From shorts and opens to LSI devices, the new Fairchild 303S will give you test results faster, easier and more accurately than ever before.

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The 303S isn't just built for speed, it's built for versatility. It comes with the largest number of uncompromised hybrid test points (927) in the industry, so it can be used to test either analog or digital points. By simply adding another low-cost terminal, our Foreground/Background programming feature enables programming to be done without tying up the system. And our datalogging feature gives you hard copy documentation of faults—by shift, day, week, or any other time increment—to accurately pinpoint manufacturing problems as they occur.

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If you're looking for a faster, easier and more accurate solution to in-circuit testing, take a closer look at the Fairchild 303S. It's got more speed, where speed counts most.

For more information on the Fairchild 303S, contact your nearest Fairchild Test Systems sales office, or write Fairchild Test Systems Group, 299 Old Niskayuna Rd., Latham, NY 12110; Tel. (518) 783-3600.

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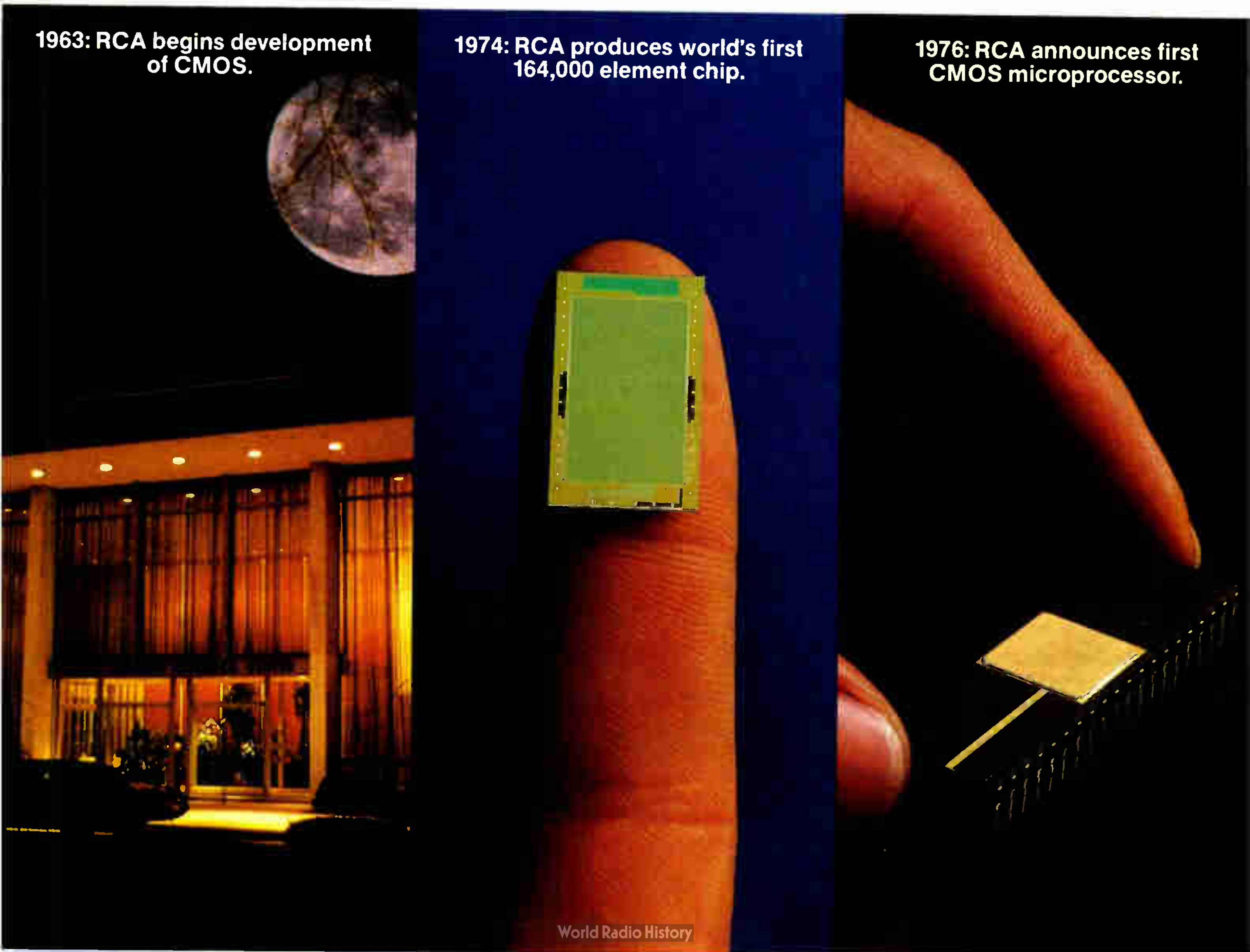

As you can see, we've been innovators for years.

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In 1976, we introduced BiMOS technology. Since then its parametric and performance advantages have set new standards in op amp technology.

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To make sure that we maintain the highest standards of quality and reliability, RCA Solid State is stepping up its investments in new equipment and personnel. Further, the RCA Princeton Laboratories plus our Solid State Technology Center provide some of the most advanced R&D capabilities in the industry.

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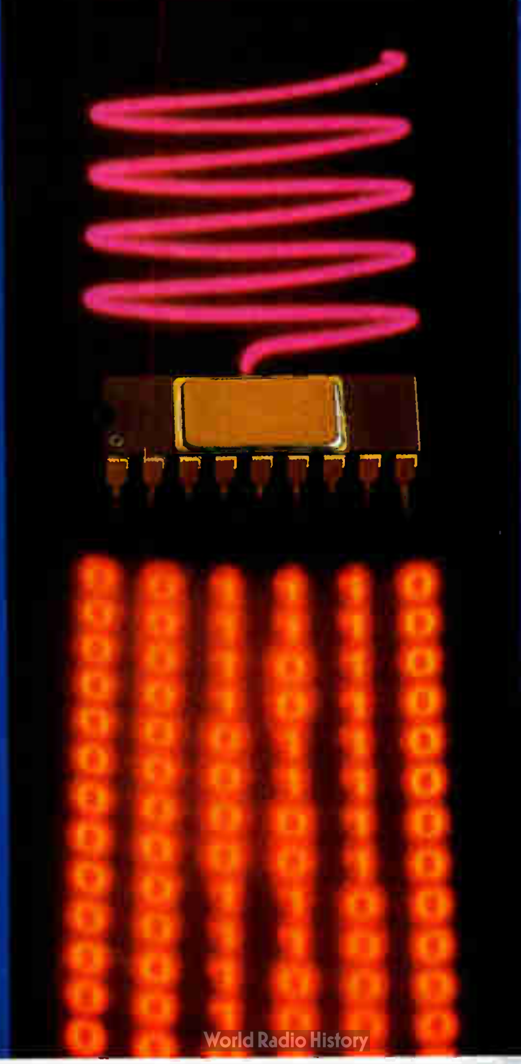
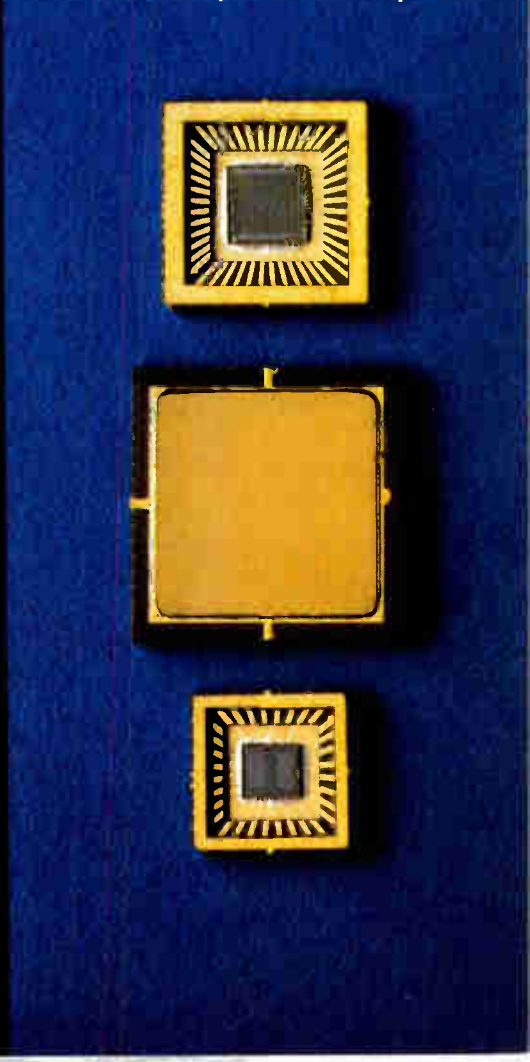
RCA

1976: RCA pioneers the first BiMOS op amp.

1980: RCA produces first CMOS 6-bit flash A/D converter.



1981: RCA announces expandable CMOS microprocessor chip set.



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Circle 177 on reader service card

4-K RAM has nonvolatile backup array

Shadow RAM's nonvolatile array is made with silicon nitride, using 22-V pulses to store data for up to one year

by Wesley R. Iversen, Chicago bureau

Nonvolatile random-access memory fast enough to work with many of today's microprocessors ascends to the 4-K density level with the introduction of the NCR 4485. With an access time of 250 ns, the 512-by-8-bit device from NCR Corp. can be used just like a 5-V–only volatile static RAM. But the 4485 adds to its 4-K of standard n-channel silicon-gate RAM, a backup 4-K of nonvolatile silicon-nitride-oxide semiconductor elements that shadow the volatile array.

When system power fails, +22- and −22-V pulses store the data in the volatile RAM in the backup memory for recall as much as a year later. The backup memory also could be used on a routine basis in some applications to replace read-only memory, disk, or cassette, points out Darrel D. Donaldson, one of the part's designers.

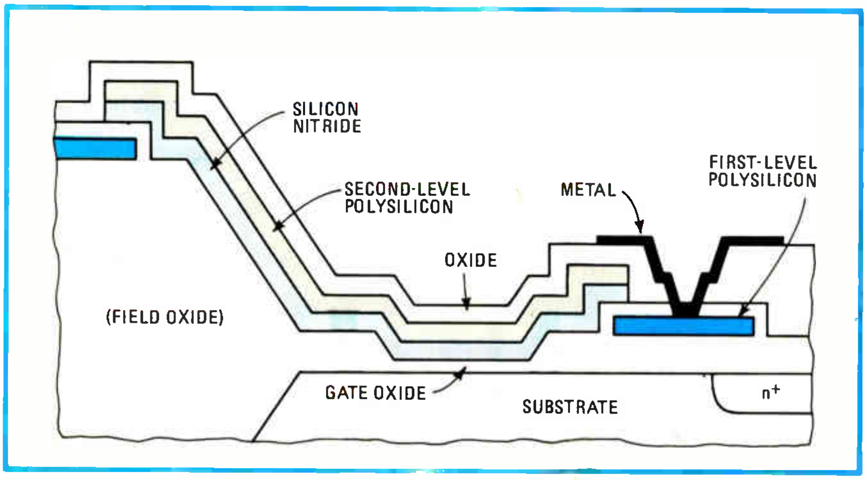
For NCR, which only recently entered the merchant semiconductor market [*Electronics*, July 14, p. 48], the 4485 is the first of a planned family of nonvolatile devices. By employing an n-channel process and substituting double-level polysilicon for metal gates in the part's nonvolatile backup, NCR has picked up significant speed advantages over the company's 10-year-old p-channel metal-nitride-oxide semiconductor process.

Minimum 5-μm geometries used in the 4485 will be scaled to 4-μm for an 8-K nonvolatile RAM planned for the first half of next year. Denser nonvolatile RAMs as well as n-channel electrically erasable programmable read-only memories are expected later.

At 4-K, the 4485 is the densest nonvolatile shadow RAM currently on the market. In the short term, NCR officials identify 1-K parts supplied by Xicor Inc. of Sunnyvale, Calif., as the primary competition, though a number of other companies including General Instrument, Hitachi, Toshiba, Hughes Aircraft, and Intel are also working in the area. Xicor's X2201 and X2202 devices do not need the higher erase and program voltages: they employ a floating–polysilicon-gate technology and require only a 5-V power supply for operation.

22-V pulses. In order to transfer data from the NCR part's volatile memory to the backup, a −22-V pulse is first applied to erase the backup. A series of +22-V pulses can then be applied to transfer the data. Storage endurance depends on the duration and number of pulses.

For example, a 1-ms erase pulse followed by a 1-ms store pulse will assure 30-day data retention, probably long enough for power-down protection. For other applications requiring up to a year's data retention, a 10-ms erase pulse followed by ten 1-ms store pulses is specified. The maximum number of erase-store cycles is set at 10,000 for the backup



Charge keeper. To build a nonvolatile static random-access memory cell, NCR adds a transfer transistor in series with a polysilicon-nitride capacitor (both shown) connected to each side of the conventional cross-coupled flip-flop latch.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memory, though an unlimited number of read-write accesses is permitted in the volatile memory.

To build in the nonvolatile backup, NCR designers added two capacitors and two transistors to each standard six-element cross-coupled static flip-flop cell. With an eye toward ease of manufacture, layout rules were loose on this first part, notes designer Donaldson. Thus, the 4485 has a large 4.51-mil² cell and an overall die of 50,299 mil² (281 by 179 mils).

Though the same cell design will be used on the coming 8-K device, design rules will be tighter, to contain cell and die size, Donaldson says. NCR is exploring alternative cell designs for future generation parts and is also working on a capability for power-down on deselect that will reduce power dissipation on future nonvolatile RAMs. Dissipation on the 4485 is specified at 300 mW typical and 575 mW maximum.

The 4485 is housed in a 28-pin package, with the upper 24 pins complying with the Joint Electron Devices Engineering Council standard for byte-wide static devices. The lower four pins are used for nonvolatile memory operations. Two versions, with 250- and 450-ns access times, are offered. In a plastic package, the faster NCR 4485-25 will sell for $40 and the 4485-45 for $30, both in 1,000-unit lots. The device will also be available in a ceramic side-brazed package.

For evaluation. To aid designers, NCR will also offer an evaluation kit priced at $200, says Dave Major, product marketing manager for NCR's Microelectronics division. Five 4485s will be included in the kit, as well as a switching voltage regulator and other components needed to generate the necessary +22- and −22-V potentials using a standard 5-V power supply.

Evaluation kits and 4485 qualification samples are available now. Production quantities are scheduled for availability during the first quarter of 1982.

NCR Microelectronics Division, Box 606, Dayton, Ohio 45401. Phone (800) 543-5618 or (513) 866-7217 [339]

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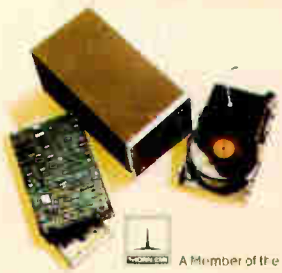

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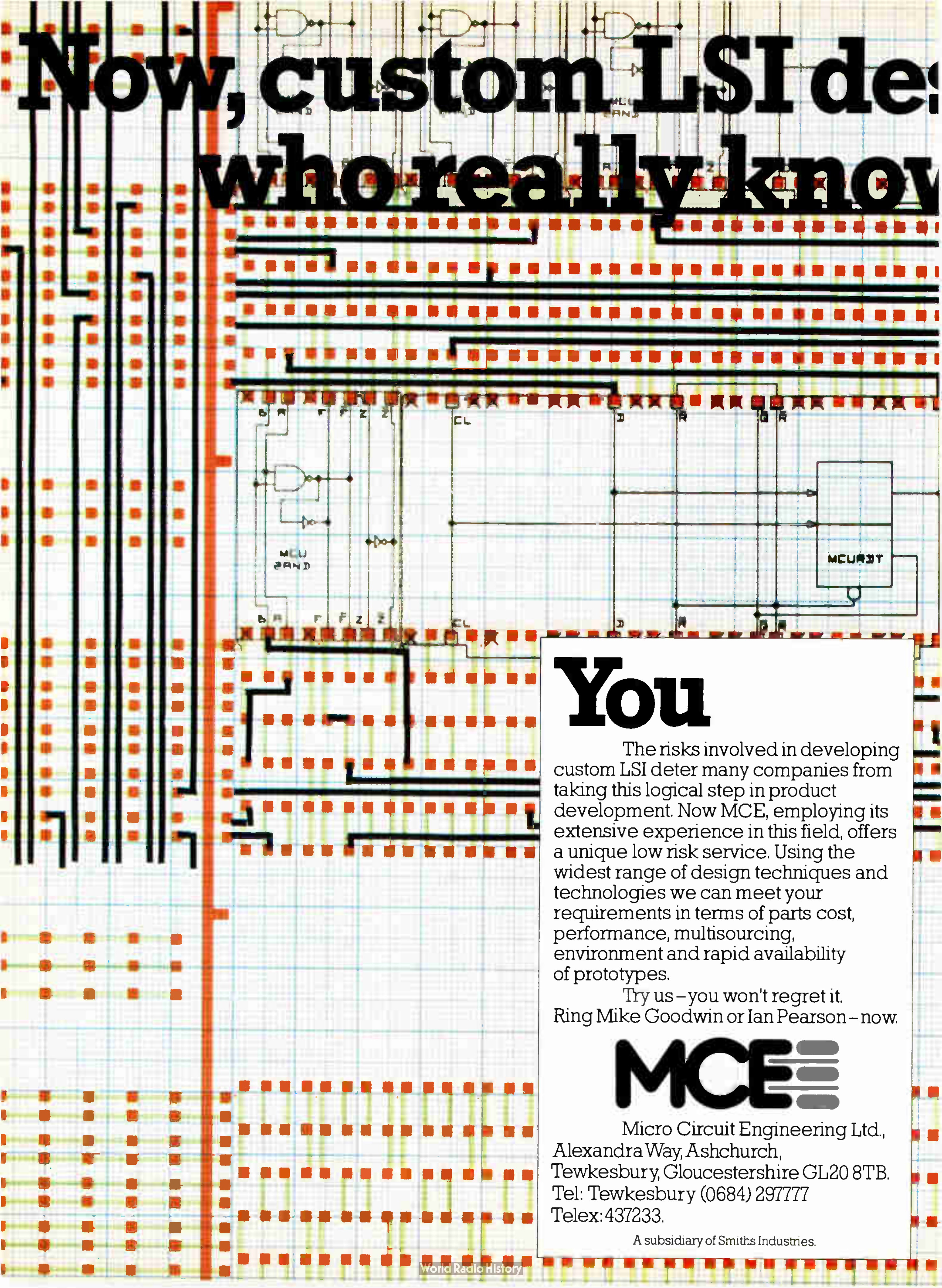
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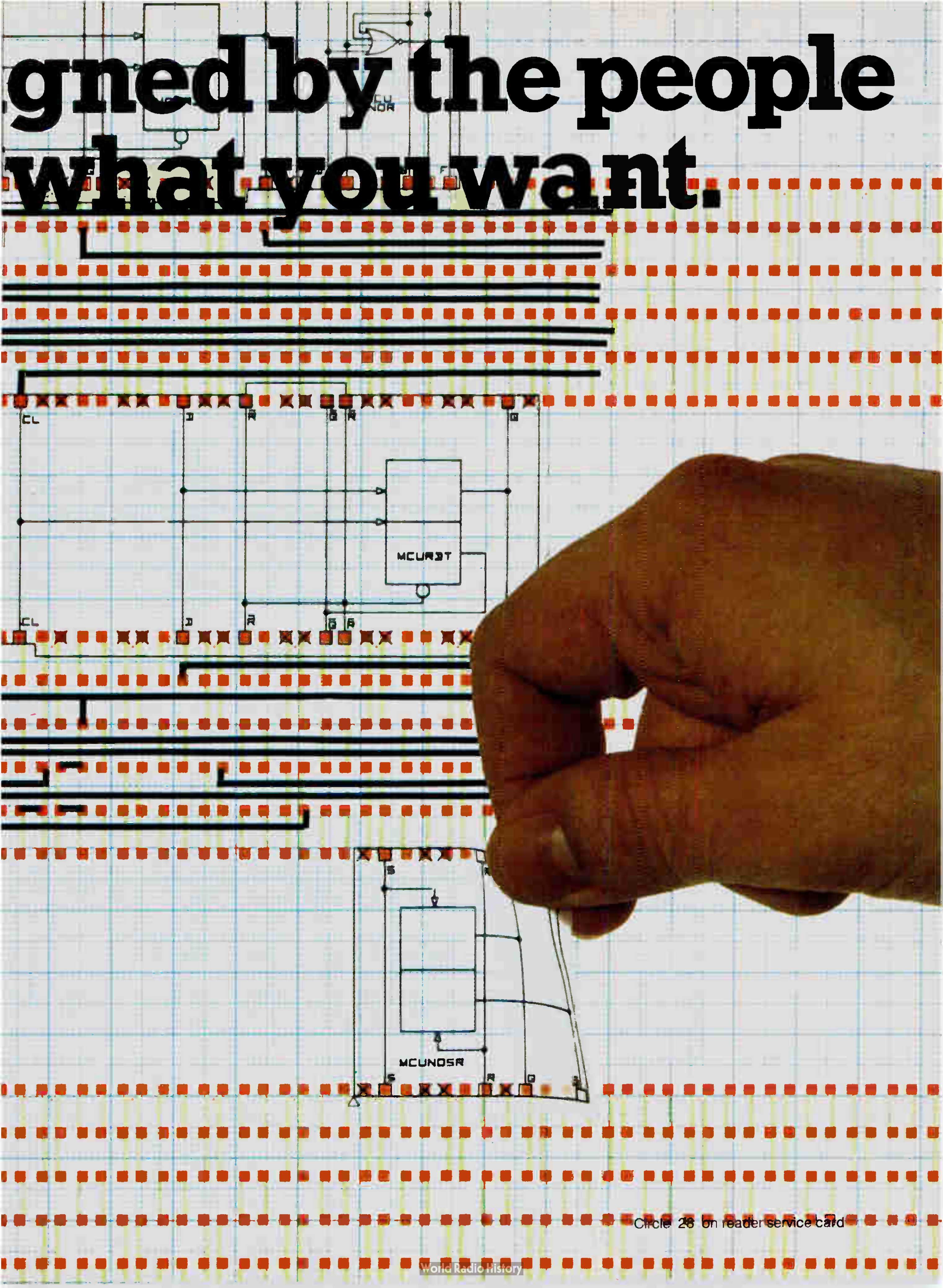
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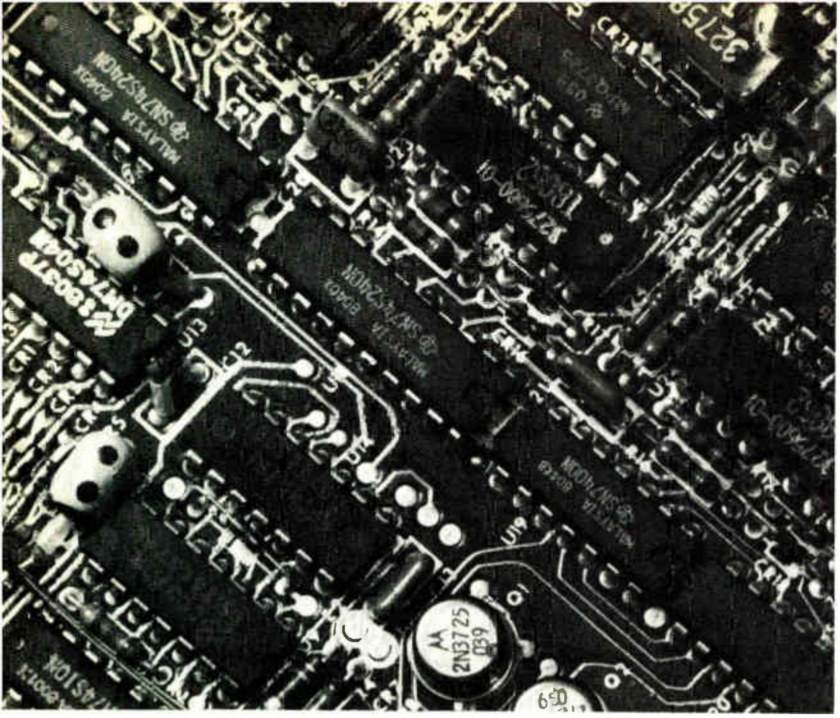

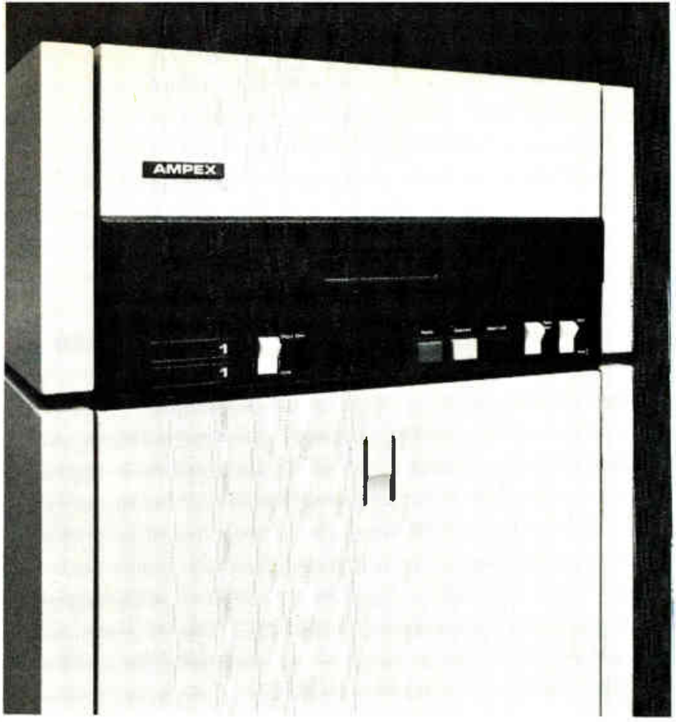

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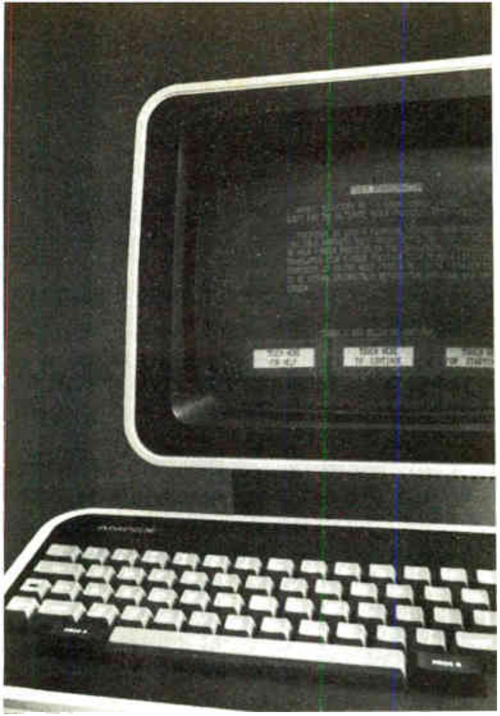

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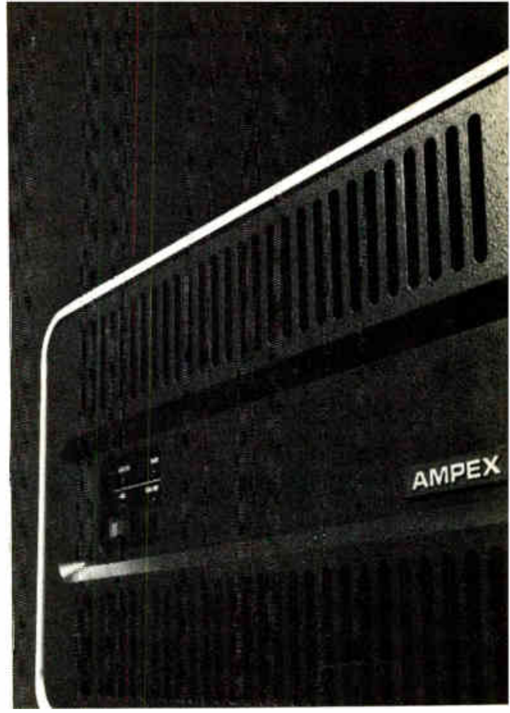

Memory. The UNIBIT™ temperature-independent ferrite core is only one of many significant product improvements generated by Ampex in memory technology. Other products include: Megastore® Memory solid-state peripheral memories for DEC, Data General and Honeywell CPU's; Multibus-compatible memory modules; add-in core memories; semiconductor MOS RAM modules; and DEC System 10, 20 and 1170-compatible main memories.

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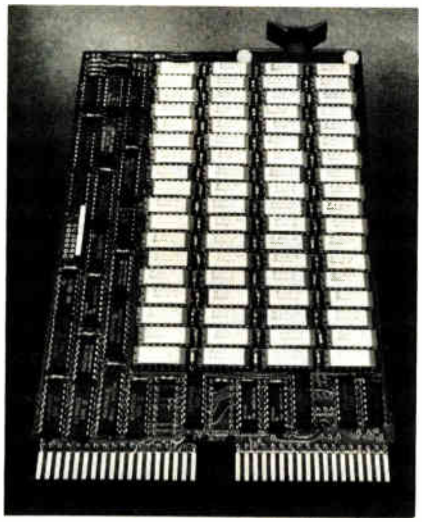
Computers & peripherals

RAM density rises for DEC machines

64-K chips ready for duty in LSI-11/23, PDP-11; boards anticipate 22-bit addressing

Enhanced add-in memories from Cambex Corp. offer users of Digital Equipment Corp.'s PDP-11 and LSI-11/23 systems some of the densest memory boards available. By substituting 64-K random-access memories for the 16-K RAMs used on earlier boards, Cambex succeeds in packing half a megabyte onto its dual-width add-in for the LSI-11/23, and a full megabyte onto the hex-sized add-in for PDP-11 family computers. The firm, formerly Cambridge Memories Inc., also is increasing to 5 megabytes the storage capacity of its semiconductor replacement for DEC's RK05 disk drive [*Electronics*, Aug. 25, p. 34].

The two Cambex memories anticipate DEC's extension of its systems' 18-bit addressing to 22 bits for greater main-memory capabilities, says John R. Robinson, marketing manager for mini-micro products at Cambex. Robinson already reports "a good-sized waiting list" for Cambex's LSI-11/23-compatible memory, the MicroStor-11/23, based on users' expectations that DEC will complete its system enhancements in short order.



The 512-K-byte MicroStor-11/23 will be the largest dual-height memory available for LSI-11/23 systems this year, Robinson asserts. "The only other half-megabyte board I know of in this class is a quad-height board," he notes, referring to Mostek Corp.'s recently announced MK-8023. The MicroStor-11/23 costs $2,400; like the other Cambex memory, it will also come in depopulated-board versions and is available with discounts for original-equipment-manufacturer, educational, and government orders. Delivery time for both memory boards is 20 days.

Fitting into a standard LSI-11 Q-bus dual-width slot, the MicroStor-11/23 is organized as 256-K words with each 18-bit word including 16 data bits and 2 parity bits. Jumper-selectable memory addressing can start at any 32-K-byte boundary through 4 megabytes. The board contains its own refresh circuitry.

Cambex also equips the MicroStor-11/23 with on-board parity checking, rather than error detection and correction, enabling very fast operation, Robinson notes. Memory cycle time typically is 450 ns, and access time is 145 ns. The MicroStor-11/23 runs on a single 5-V power supply and includes standard battery backup facilities.

Megabyte. The 1-megabyte SuperStor-11M hex-sized memory board interfaces with DEC's PDP-11 computers via the Unibus. Organized into 512-K 18-bit words, the unit also contains on-board refresh and parity checking. Besides conventional address-selection switches, the SuperStor-11M contains logic, enabling organization as separate memory pages with up to 4-K bytes per page. Typical memory cycle time is 450 ns; access time is 290 ns. Initial pricing of the SuperStor-11M is under $6,000.

The ExpandaStor-11 solid-state bulk storage system for PDP-11 computers incorporates Cambex's SuperStor-11M boards and affords from 256-K bytes to 5 megabytes of storage. Compatible with DEC's

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With a frequency coverage of 0.005 Hz to 5 MHz, the new 3025 is more than able to handle most lab and field function generator applications. In addition to sine, square and triangle waveforms, the 3025 offers a haversine function. Linear sweeps to 1,000:1 and log sweeps to 10,000:1 with settable start/stop limits.

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New products

RK11D operating system, ExpandaStor-11 is a direct replacement for the RK05 fixed-head disk drive. The unit can improve overall system performance tenfold, Robinson estimates, in applications requiring extensive disk swapping, frequent access, high-speed data transfer, and manipulation of large data bases.

Available as an add-in unit, ExpandaStor-11 needs room in the host computer for a four- or nine-slot backplane, which Cambex provides; as an add-on system, it comes in a 5¼-in.-high expansion chassis that mounts in a 19-in. rack and houses its own power supply. ExpandaStor-11 can be configured as two 2.5-megabyte disks or as a single 4-megabyte continuous disk. Its typical data-transfer rate is 231 μs for a full 256-word sector or 900 ns for a single-word transfer; access time typically is 350 ns, compared with 70 ms typical time in the RK05.

The system incorporates error checking and correction, as well as write-protect features. Other maintenance features permit the user to isolate error locations, microcode in a single step, and force errors for ECC testing. Light-emitting diodes on each system board serve to indicate parity errors.

ExpandaStor-11 is priced at approximately $11,000 for the first megabyte as an add-in unit, with incentive discounts for each successive megabyte. As an add-on with expansion chassis, the system costs about $15,000 for the first megabyte. Delivery takes 30 to 45 days.

Cambex Corp., 360 Second Ave., Waltham, Mass. 02154. Phone (617) 890-6000 [361]

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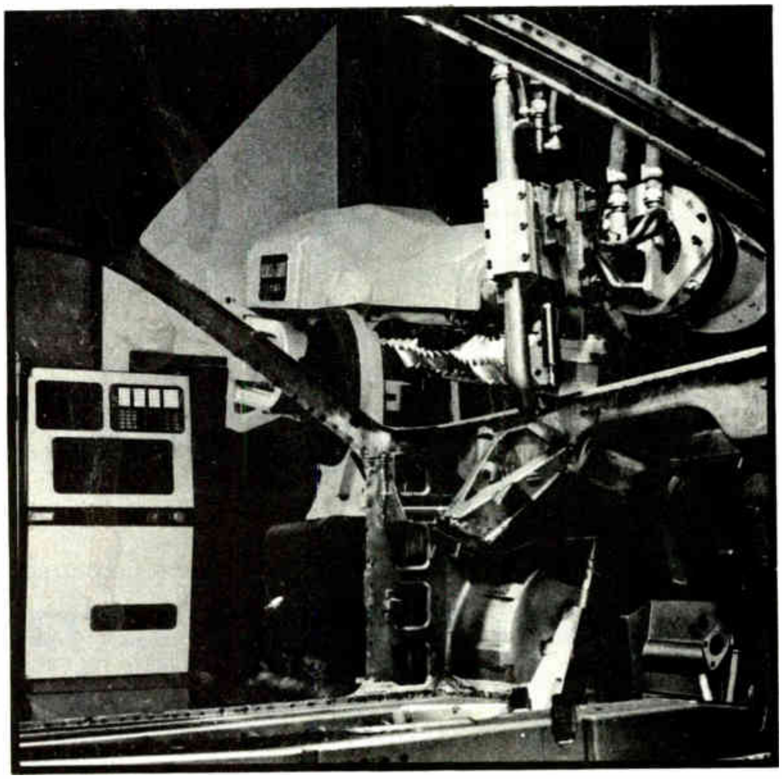

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▪ Austria: Universal Elektronik Import GmbH 54 15 88 ▪ Canada: Associated Test Equipment Ltd. (416) 497-2208 ▪ Chile: Importadora Janssen Y Cia. Ltda. 72 3956 ▪ Denmark: Danstrument aps (03) 28 34 31 ▪ England: ITT Instrument Services 0279 29522 ▪ Finland: Oy Etra AB 780 122 ▪ Italy: Radiel Spl (02) 213.30.56 ▪ Netherlands: Klaasing Electronics BV 01620-51400 ▪ New Zealand: G.T.S. Engineering Ltd. 546-745 ▪ Norway: Solberg & Andersen A/S (02) 19 10 00 ▪ Sweden: Teleinstrument AB 08/38 03 70 ▪ West Germany: NBN Elektronik GmbH (0 81 52) 390

columns by 24 rows. A 5-by-9-dot character matrix is used in a 7-by-10-dot cell. Two sets of user-definable characters can supply 128 symbols in addition to the terminal's 128 upper and lower case ASCII characters. The user-definable characters can also be used to construct line and bar charts. For international use, Danish-Norwegian, French, German, Spanish, and Swedish-Finnish, as well as American and British character sets, reside in the terminal. The keyboard is configured in the language ordered by the user; the other six alphabets can also be used under the host computer's control.

Support for the D280C is provided by Data General's Eclipse, Nova, and microNova computers using standard software. An RS-232-C interface is standard, but a 20-mA current-loop interface can be specified. The display and keyboard list for $3,750; delivery is 120 days after receipt of order.

Data General Corp., Rt. 9, Westboro, Mass. 01581. Phone (617) 366-8911 [363]

Real-time image processor subtracts continuously

The Trapix real-time image processing system has single- or multiple-channel image-display resolution of from 256-by-256 by 12 bits to 1,024-by-1,024 by 16 bits. The arithmetic-pipeline image processor has averaging for up to 256 frames, continuous subtraction, a 9-bit linear-log video digitizer, and input video formatting, which gives the unit cinematic display capability. The desired logical operation can be performed with either incoming video and stored images or between stored images. The image system includes a Q-bus interface with interconnecting cables, memory management, image-display controller, image magnification, X-Y scrolling and real-time image windowing. It is packaged in an EIA standard 19-by-5.25 in. rack-mountable enclosure. Prices start at $11,800 for a Trapix 22/48, which includes four channels of 256-by-256–by–12-bit planes of image memory. The Trapix 55/32 has four 512-by-512–by–8-bit planes or two 512-by-512–by–16-bit planes and sells for $18,200.

Quality discounts are available on the image-processing systems, which are deliverable 30 days after receipt of order.

Recognition Concepts Inc., 924 Incline Way, Incline Village, Nev. 89450. Phone (702) 831-0473 [364]

Printer has 22 character sets, runs at 320 characters/s

IBM's 3268 bidirectional printer boasts improved dot-matrix technology and printing speeds of 340 characters/s, which is three times faster than the company's 3287 printer. Other improvements include a longer ribbon life, longer printhead life of up to 300,000,000 characters per head, and larger dots in the matrix—0.014 in. per dot rather than the 3287's 0.011 in. per dot. The 3268 can operate with the 3270 information display system, the 4341 processor, or the 8100 information system.

The printer includes variable paper widths and spacing formats, accommodating multiple-copy paper up to 16 in. wide and printing in standard 10 c/in. or condensed 16.7 c/in. horizontal formats. It is mounted on a pedestal to give two

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A Schlumberger Company

One year ago, we announced the Fairchild 96LS488, the world's fastest single-chip IEC625-1 bus. And now we've got something even better to announce: It's available in production quantities.

As we've told you before, the amazing 96LS488 performs all the functions of Talker, Listener and Talker/Listener on a single low-power Schottky chip. And it's microprocessor-*independent*.

It operates at the full bus specifications of 1MHz data rate – four times faster than its closest competition. Four times!

And it's loaded. With separate Talk and Listen address capability. Secondary address capability. Talk Only and Listen Only capability. Source handshake delay programmable for low- or high-speed drivers. And there's more where that came from.

For more information, contact your local Fairchild office.

France: Fairchild Camera & Instrument S.A., 121 Ave d'Italie, 75013 Paris. Tel: 331 584 55 66. Telex: 0042 200614. **Italy:** Fairchild Semiconduttori S.P.A. Viale Corsica 7, 20133 Milano. Tel: 02 296001-5. Telex: 843-330522. **Germany:** Fairchild Camera & Instrument (Deutschland) GmbH. 8046 Garching Hochbruck, Daimlerstr. 15, Munchen. Tel: 089 320031. Telex: 52 4831 fair d. **England:** Fairchild Camera & Instrument (UK) Ltd., 230 High St., Potters Bar, Hertfordshire EN6 5BU. Tel: 0707 51111. Telex: 262835. **Sweden:** Fairchild Semiconductor AB, Svartengsgatan 6. S-11620 Stockholm. Tel: 8-449255. Telex: 17759. **Japan:** Fairchild Japan Corporation, Pola Bldg., 1-15-21 Shibuya, Shibuya-Ku, Tokyo 150. Tel: 03 400 8351. Telex: 2424173 (TFCTYO J). **Hong Kong:** Fairchild Semiconductor (HK) Ltd., 135 Hoi Bun Road, Kwun Tong, Kowloon. Tel: 3-440233. Telex: HX73531.

If you want the fastest bus, we've got it made.

Circle 195 on reader service card

paper paths—a bottom opening for stacking lengthy reports or production runs, and a top-slotted opening for the quick retrieval of one or two page printouts.

Most national languages are represented with the 22 character sets that can be operator-selected. The 3268 is priced at $7,500, with a 15% discount for orders of 25 or more. First shipments are expected in the first quarter of 1982.

International Business Machines Corp., Data Processing Division, 1133 Westchester Ave., White Plains, N. Y. 10604. Phone (914) 696-1900 [365]

Ballpoint-pen printers can create graphic symbols

The models 1200 and 1100 microminiature alphanumeric graphic printers use a ballpoint pen to write graphic symbols, including letters, numbers, and Chinese ideograms, and to create drawings and graphs on a standard 2.28-in. roll of paper. The model 1200 uses four different colored pens and follows programmed directions from a computer to create four-colored alphanumerics in 15-, 18-, 24-, and 36-column sizes. The Model 1100 uses a single pen and, by changing the program, can create alphanumerics in sizes from 40 to 10 columns per line.

Both printers are available as stand-alone units that can be plugged into most personal computers or as a printing mechanism for installation into other computers or devices that require hard-copy printouts. They use two stepping motors with increments of 0.1 mm for the Model 1200 and 0.2 mm for the model 1100 to move the pen in the X and Y axis.

Sample price for the one-pen stand-alone printer is $325 and for the four-pen printer, $450. The mechanisms can be purchased for $140 and $180, respectively. Production quantities will be available in the fall of 1981.

Alps Electric Inc., 100 North Center Ave., Rockville Center, N. Y. 11570. Phone (516) 766-3636 [367]

Synertek's 2K x 8 Static RAM... Not Just Another Jelly Bean.

For today's demanding microprocessor-based systems, you don't need another jelly bean. You need the most advanced 16K static RAM available anywhere.

Introducing Synertek's family of 2Kx8 static RAMs. With important system design features. The SY2128 offers Automatic Power Down for significant system level power savings. And for systems where speed is critical, the SY2129 offers a fast Chip Select Access of 50nsec (max.).

Mix and Match. With JEDEC approved 24-pin pinouts, both allow you to make the switch between RAMs, ROMs, EPROMs, and E^{2}PROMs as your needs dictate. With minimal board changes.

Process Plus. You also get the cost benefit of our advanced process technology. We manufacture the SY2128/SY2129 family with our state-of-the-art double-poly process – where we add a second layer of polysilicon to our advanced HMOS process – so that densities are increased dramatically.

Together, and individually, our 16K static RAMs offer you choice and flexibility to make the perfect match with your micro-based system design needs.

Call on the company that makes it in MOS technology. Call Memory Product Marketing direct at (408) 988-5611. Or contact your nearest Synertek sales representative or distributor.

Synertek is a major MOS supplier of high volume products with advanced technologies and techniques behind everything we make. Static RAMs. ROMs. Custom circuits. Single-chip microcomputers. 6500 microprocessors and peripherals. Systems.

SY2128/SY2129

Part Number	Access Time (Max)	Operating Current (Max)	Standby Current (Max)
SY2128-2	120nsec	100mA	30mA
SY2128-3	150nsec	100mA	30mA
SY2128-4	200nsec	100mA	30mA
SY2128L-2	120nsec	70mA	20mA
SY2128L-3	150nsec	70mA	20mA
SY2128L-4	200nsec	70mA	20mA
SY2129-2	120nsec	100mA	N/A
SY2129-3	150nsec	100mA	N/A
SY2129-4	200nsec	100mA	N/A
SY2129L-2	120nsec	70mA	N/A
SY2129L-3	150nsec	70mA	N/A
SY2129L-4	200nsec	70mA	N/A

SYNERTEK
A Subsidiary of Honeywell
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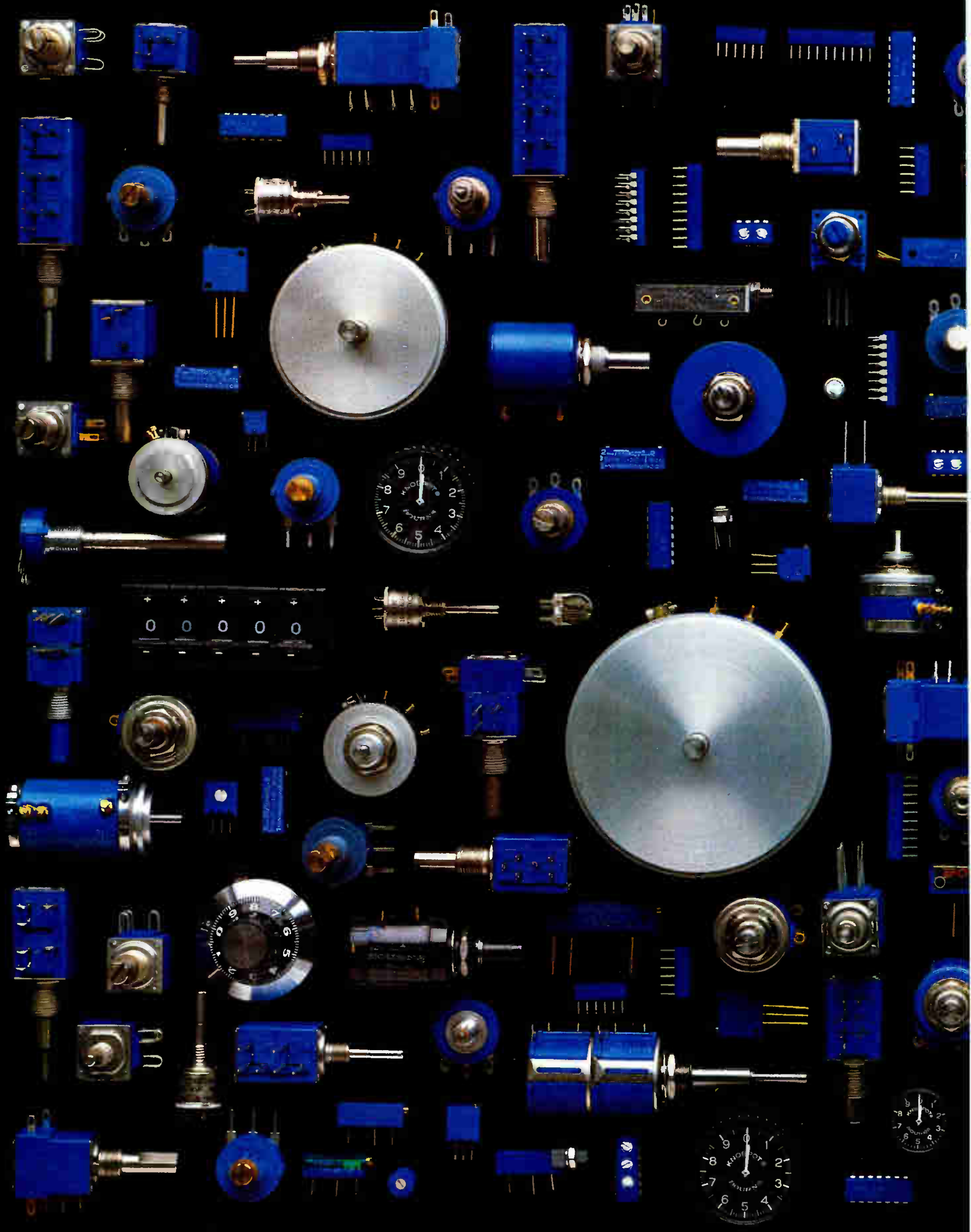
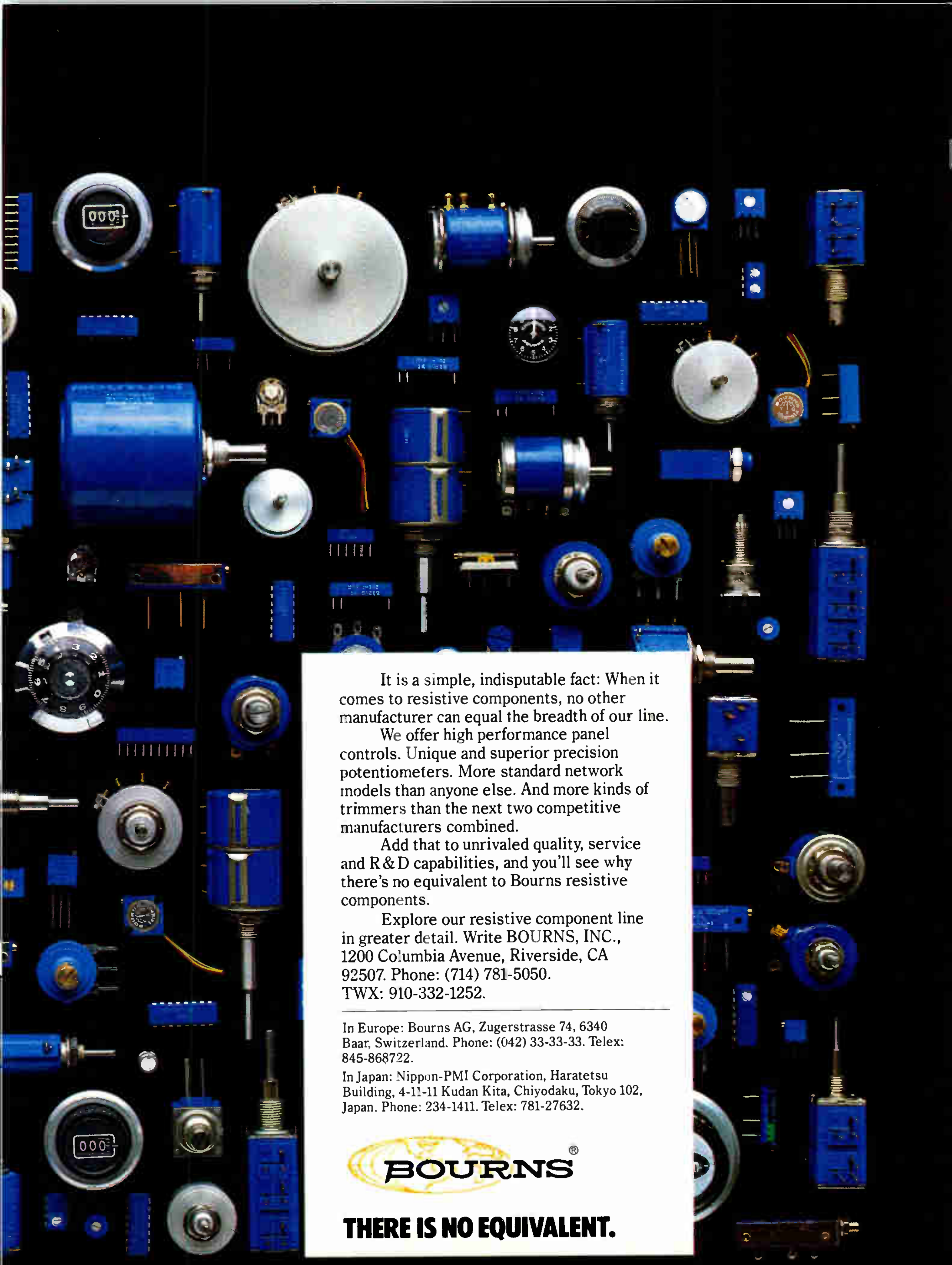
Santa Clara, California 95052
(408) 988-5600
TWX: 910-338-0135

THERE IS NO EQUIVALENT LINE.





Circle 199 on reader service card

Cover yourself with our shielded connectors.

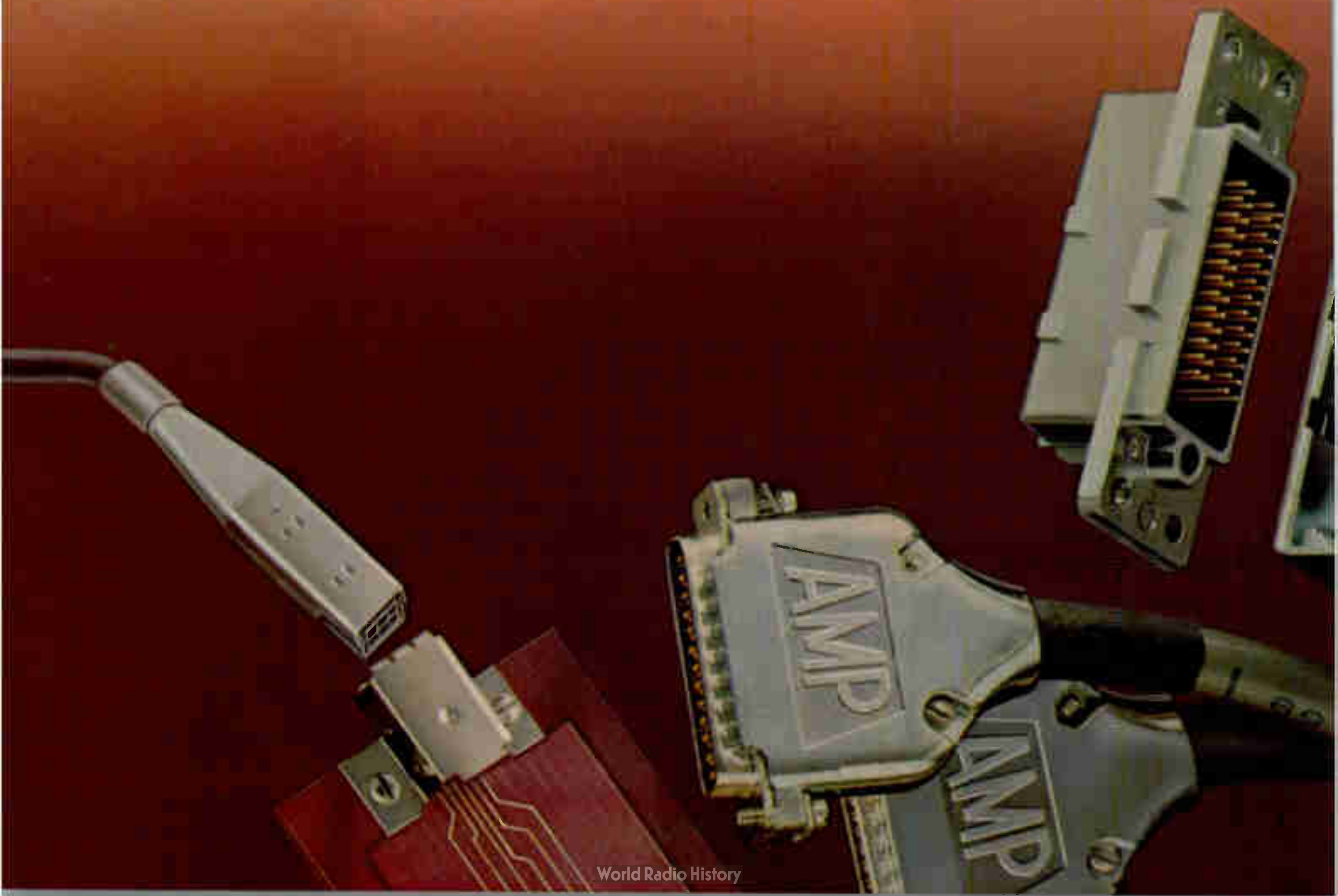
They are the cost-effective way to reduce your equipment's electromagnetic emissions, and help you comply with the new FCC emissions regulations.

Choose from a wide range of interface styles, all AMP proven designs with compact, easy-to-assemble shields.

Our AMPMODU MT connector offers mass termination savings in .100" centerline post/receptacle format. AMPLIMITE connectors mate with similar subminiature D designs.

If you prefer a circular connector, our shielded version offers a positive one-turn locking ring. And for high pin counts, the CR Series gives you zero insertion force mating.

You couldn't ask for better protection.




Get colors without losing properties by specifying LEXAN resin in standard or custom-matched opaque and translucent colors, or by using compatible paints. (Available clear too.)
For functional or decorative metallic finishes, molded LEXAN resin lends itself to cathode sputtering, flame spray, arc spray and RFI shielding as well as vacuum-metallizing.
Drill, tap, thread, mill, turn cut, rout. Standard metal-cutting tools easily machine LEXAN resin prototypes or parts to close tolerances.

LOOK TO LEXAN® RESIN FOR THE FINISHING EDGE.

Self-adhesive decals, hot transfers, silk-screening and other printing methods can produce exact, durable images on molded LEXAN resin.

Designing with LEXAN resin lets you choose from a variety of wood, metallic or colored hot-stamping foils tailored specifically for the resin and your design.

The first time you put pencil to paper is the time to call us in. That way, you can take full advantage of the finishing techniques, functional and decorative, open to you with LEXAN resin. And we'll help all the way. Help make sure finishing enhances design (and vice-versa). Help with processing and performance considerations. Help select supplies and suppliers. In short, we've got the experience and resources to help you see what finishing can be. For a free booklet on finishing and secondary operations, write to LEXAN Products Division, Dept. 491, General Electric Company, One Plastics Ave., Pittsfield, MA 01201. Or call (413) 494-4621.

We bring good things to life.

GENERAL ELECTRIC

Circle 203 on reader service card

Packaging & production

System picks out defective wafers

Laser scans wafer surface for defects; unit sorts wafers according to user-set limits

With commercially available chips reaching the very large-scale level of integration, the condition of a wafer's surface has become critical in achieving acceptable fabrication yields. Addressing this problem is an automatic wafer inspection system capable of pass-fail sorting according to the level of wafer surface defects.

Surfscan scans the entire wafer surface with a laser beam, detecting any surface defects that would be visible to a skilled human inspector using dark-field illumination under collimated light, including particles, pits, scratches, cracks, and large-area defects such as fingerprints or unpolished regions. The system performs cassette-to-cassette handling, and its sorting subsystem sorts wafers according to user-set limits for point, line, and area defects as well as average haze.

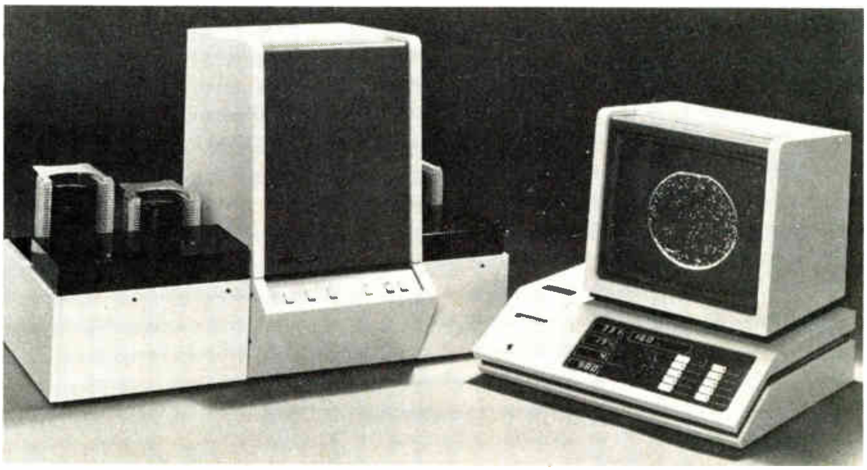
Once cassettes are loaded into the sorter sender, no operator intervention is required, eliminating possible wafer damage and contamination in addition to problems arising from human inspector fatigue. The instrument produces a graphic display of each wafer's defects on a cathode-ray tube, plus hard copy listing the number and type of defects found.

The sharply focused helium-neon laser sweeps the surface of the wafer at 800 scans per second in a lateral raster motion as the wafer moves on a drive belt through the instrument's scan unit. The beam is scattered at a variety of angles by a defective or contaminated surface. An integrating light collector and photomultiplier tube measures this scattering on small cells of the substrate's surface. Any defect within a cell that is equal to or greater than the user-programmed defect size will cause the control unit to report a defective cell. The instrument can detect submicrometer particles with 100-μm spacing on any opaque polished surface that scatters less than 0.2% of incident collimated light.

Surfscan accepts wafers from 2 to 5 in. in diameter and is programmable via a keyboard for wafer size, minimum defect size, edge exclusion, and pass-fail limits. Automatic wafer handling gives the unit an hourly throughput of 430 wafers that measure 3 in. in diameter.

Among the instrument's more productive applications are inspection after wafer cleaning and analysis of the effects of substrate defects on deposited metal, silicon, and dielectric films. The laser will not expose photoresist, so sensitized wafers and photomasks can be examined.

Surfscan is priced at $40,000 and



POWER-ONE
D.C. POWER SUPPLIES

Our customers select their favorite models

The choice wasn't easy. Not with 105 open frame linears and a full switcher line to choose from. Still, the top models of the past year — proudly pictured below — have been named.

Actually, this is a statement of Power-One's most popular D.C. power supplies — as determined by our customers. Obviously, applications vary widely, from small floppies and micro-computers to large main-frame systems.

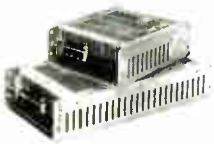
But one thing they all have in common. They're built by Power-One. Which means the most reliable power supplies available, at the lowest cost possible.

So take a look at our entire line. Send for our new 1981 Catalog and Facilities Brochure for details.

Switchers

- Hi-Tech Design
- High Efficiency - 75% min.
- Compact/Light Weight
- 115/230 VAC Input
- 20 msec Hold-up
- Totally Enclosed Packaging
- Two Year Warrantee
- 24 Hour Burn-in

SINGLE OUTPUT

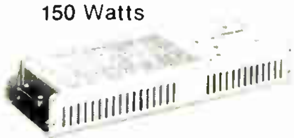


5V to 24V Models

SD, 60W : $115.00
SF, 100W : $170.00
SK, 200W : $250.00

MULTIPLE OUTPUT

150 Watts



5V @ 20A
12V @ 5A
-12V @ 3A
5V to 24V @ 3.5A
User Selectable

SHQ-150W : $295.00

QUME PRINTER SUPPLY

5V @ 10A
± 15V @ 4.5A/16A Peak

SP305 : $345.00

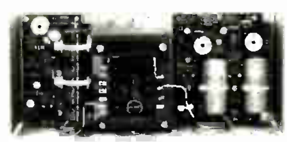
Disk-Drive

- Powers Most Popular Drives
- 7 "Off the Shelf" Models
- Powers Drives & Controller
- UL & CSA Recognized
- 115/230 VAC Input

5¼" FLOPPY SUPPLIES

CP340, 1 Drive : $44.95
CP323, Up to 4 Drivers : $74.95

8.0" FLOPPY SUPPLIES



CP205, 1 Drive : $69.95
CP206, 2 Drives : $91.95
CP162, Up to 4 Drives : $120.00

WINCHESTER SUPPLIES

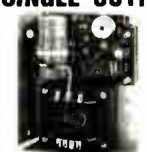
2 Models to Power any Manufacturer's Drive

CP379, CP384 : $120.00

Open-Frame Linear

- Industry Standard Packages
- 115/230 VAC Input
- ± .05% Regulation
- Two Year Warrantee
- UL & CSA Recognized
- Industry's Best Power/Cost Ratio

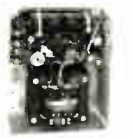
SINGLE OUTPUT



5V @ 3A
12V @ 1.7A
15V @ 1.5A
24V @ 1.2A
28V @ 1.0A
250V @ 0.1A

HB Series : $24.95

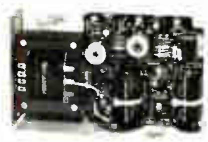
SINGLE OUTPUT



5V @ 6A
12V @ 3.4A
15V @ 3.0A
24V @ 2.4A
28V @ 2.0A
48V @ 1.0A

HC Series : $44.95 to $49.95

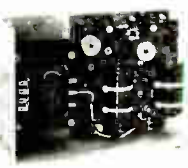
DUAL OUTPUT



± 12V @ 1.0A or
± 15V @ 0.8A

HAA15-0.8 : $39.95

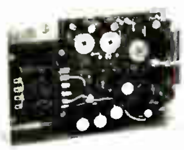
DUAL OUTPUT



± 12V @ 1.7A or
± 15V @ 1.5A

HBB15-1.5 : $49.95

TRIPLE OUTPUT



5V @ 2A
± 9V to ± 15V @ 0.4A

HTAA-16W : $49.95

TRIPLE OUTPUT

5V @ 3A
± 12V @ 1A or
± 15V @ 0.8A

HBAA-40W : $69.95

POWER FAIL MONITORS

- Indicates pending system power loss.
- Monitors AC line and DC outputs.
- Allows for orderly data-save procedures

PFM-1 : $24.95 PFM-2 : $39.95

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Circle 205 on reader service card

can be delivered in 120 days.
Tencor Instruments, 2426 Charleston Rd., Mountain View, Calif. 94043. Phone (415) 969-6767 [391]

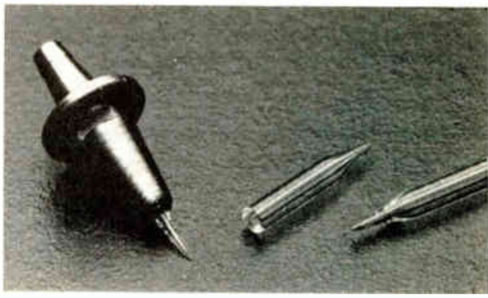
Price falls for quartz capillaries

Fused-quartz capillary tubes aid volume production of high-quality wire bonds

Fused-quartz capillary tubes are not new to wire-bonding applications, but in volume production where thousands may be needed annually, capillaries made of ceramic and tungsten carbide are more generally used because of their price advantage. Micro Glass Inc., however, has been able to reduce the fabrication cost of quartz capillaries, bringing them into the price range of other types. With quartz capillaries, bond quality is equal to or better than when other types are used, says Micro Glass, and converting automated thermosonic wire-bonding equipment to quartz is not costly.

One advantage of fused quartz in this application is its ability to conduct ultrasonic energy efficiently. Another is its transparency, which allows operating personnel to see the condition of the wire inside when problems arise. Troubleshooting time is thus cut down.

The 472QA series of fused-quartz capillaries is available for 1.0-, 1.3-, 1.5-, 2-, and 3-mil wire diameters; other sizes can be supplied upon request. The capillaries are available with or without metal mounting



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Z8 unprecedented design options.

The Z8 family gives you the clear advantage in single-chip design—powerful 8-bit CPU, ROM, RAM, counter/timers, UART, interrupt logic—all under dynamic program control. Choose the world's most versatile performer from the Z8 family of single-chip microcomputers.

- **Z8601—with on board 2K ROM**
- **Z8602—with interface to 2K external memory**
- **Z8603—2K EPROM Protopak™**
- **Z8611—with on board 4K ROM**
- **Z8612—with interface to 4K external memory**
- **Z8613—4K EPROM Protopak**
- **Z8681—ROM-less single-chip microcomputer**

And now, the exciting new Z8 family member:

- **Z8671—single-chip BASIC/DEBUG interpreter**

To order, or for more information, call your nearest Zilog sales office. Or contact us at 10460 Bubb Road, Cupertino, CA 95014. Phone: (408) 446-4666

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Circle 207 on reader service card

shanks, which measure 1/16, 3/32, or 1/8 in. in diameter.

Delivery of 472QA capillaries is from stock for evaluation quantities. In small lots, the price is approximately $13 each.

Micro Glass Inc., 6200 E. Malloy Rd., East Syracuse, N.Y. 13057. Phone (315) 437-7571 [392]

Fiber-optic kit sets up 5-m, 200-kb/s link

A complete 5-meter, 200-kb/s digital link can be assembled and evaluated for under $40 by using Honeywell Inc.'s Sweet Spot Connection digital fiber-optic kit. The kit comes with a standard Sweet Spot light-emitting diode and Schmitt trigger detector, a printed-circuit board with a TTL and complementary-MOS driver, Amp Inc.'s Optimate Field-Appliable Connectors, and 5 m of terminated ESKA plastic fiber.

The Sweet Spot kit is aimed at low-cost applications such as card-to-card digital data transmission, high-voltage isolation, and RS-232-C interconnections. It can be combined with various Honeywell Sweet Spot components and will operate at data rates of up to 10 Mb/s and distances of up to 20 m.

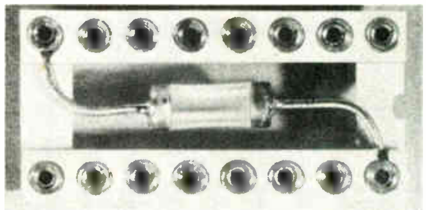
Honeywell Inc., Honeywell Plaza, Minneapolis, Minn. 55408. Phone (612) 870-2207 [393]

Integrated-circuit sockets have integral decoupling capacitors

The Quiet Socket from Garry Manufacturing consists of a highly reliable open-frame integrated-circuit socket and a decoupling capacitor mounted diagonally between the voltage and ground pins. The socket not only cuts decoupling cost by 50% over conventional methods but chops a minimum of 12% off board space. It eliminates noise at the chip's power source and also does away with the labor of separately loading, soldering, and wiring capacitors.

The Quiet Socket may be used

where low noise levels are required, as in high-speed logic (ECL and Schottky TTL) and memory. It comes in standard 0.300-, 0.400-, and 0.600-in. space configurations that can be stacked end to end and side by side on a standard 0.100-in. grid, and has a capacitance range of 0.01 to 1 μF at 50 V with either solder-tail or wrapped-wire Swiss



screw machine terminals. Prices vary with the value of the capacitor and the quantity ordered; delivery is 8 to 10 weeks after receipt of order.

Garry Manufacturing Co., Box 94, North Brunswick, N. J. 08902. Phone (201) 545-2424 [394]

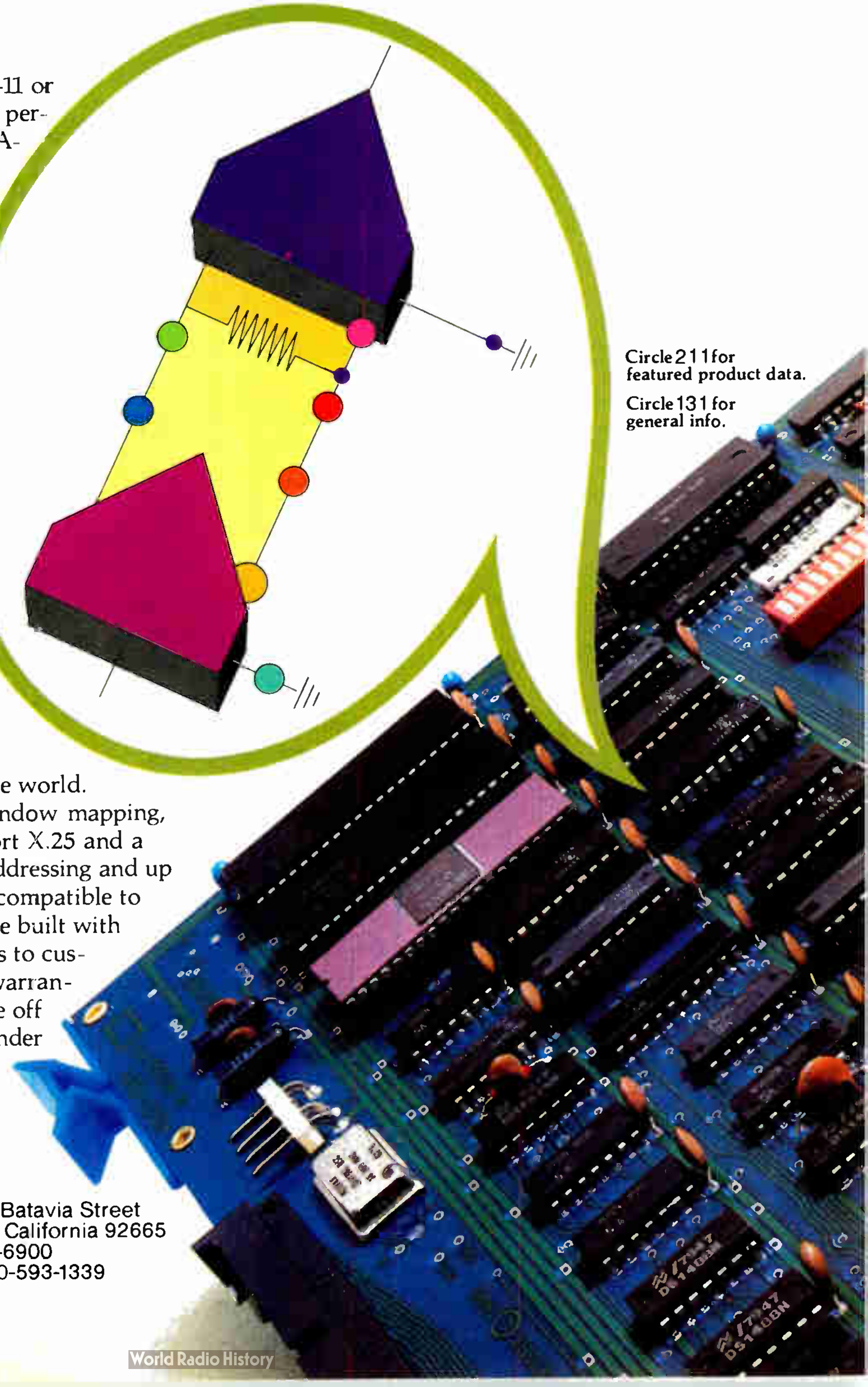
Profiler has adjustable scan length of 1 to 65 mm

The Sigmascan surface- and thick-film profiler is composed of a scan and control unit to measure resistor and conductor film thicknesses that have been screen-printed onto ceramic substrates. Measurements are made by a semiautomatic push-button–control leveling mode for hybrid substrates and by a fully automatic mode for smooth surfaces such as glass or polished alumina substrates.

The Sigmascan has an adjustable scan length of 1 to 65 mm, a resolution of better than 0.02 μm (200 Å), switch-selectable vertical ranges of 1 to 250 μm in eight steps, three stylus scan speeds, two chart speeds, and a choice of six horizontal magnifications. It is available with such options as a digital interface module at $2,800, a variable-force stylus for use with soft films at $610, and an X-Y stage for expanded travel at $1,465. The standard unit with a 12.5-μm-radius stylus is priced at $11,850, including scan and control unit. Delivery is within 90 days after

The only DZ11 Compatible Multiplexor for LSI-11. And it has RS-422 plus RS-232 and current loop capability-

MDB makes the difference!



Now you can have it all for your LSI-11 or PDP* 11 system! Full DZ11 multiplexor performance with the added benefit of EIA-RS-422 long line capability—communicates at distances to 3000 feet (914.4m) at rates to 19.2K baud. What's more, MDB's DZ11 multiplexors let you combine RS-422 with EIA-RS-232 in any combination up to a total of eight lines on a single board. Or combine RS-232 with current loop in the same way. Eight and sixteen channel RS-232 DZ11 multiplexors are also available. No more doubling up on boards, distribution boxes, rack space or price. You see the results in your system's performance and cost.

And that's not the only difference we can make to you. MDB has line printer controllers that are completely self-testing and we make more controllers for more computer/printer combinations than any company in the world. MDB offers PROM modules with window mapping, communications interfaces that support X.25 and a unique LSI-11/23 system with 22 bit addressing and up to 4 Mbytes of memory. From purely compatible to purely incredible all MDB products are built with exceptional quality and responsiveness to customer requirements. Our boards are warranted for a full year, many are available off the shelf and they can be purchased under GSA contract #GS-OOC-02423.

Call toll free for literature. Calif. 800-852-7777; other states 800-824-7888. Ask for operator 544.

*Trademark Digital Equipment Corp.

Circle 211 for featured product data.

Circle 131 for general info.

MDB SYSTEMS INC.
1995 N. Batavia Street
Orange, California 92665
714-998-6900
TWX: 910-593-1339

New products

receipt of order, says the firm.
Tencor Instruments, 2426 Charleston Rd., Mountain View, Calif. 94043. Phone (415) 969-6767 [395]

Automatic aluminum etcher detects end point

The APT model 990 cassette-to-cassette aluminum etcher incorporates an automatic end-point detection system for etching wafers 3 to 5 in. in diameter at the same level (wafer to wafer, lot to lot). It has a 13-in. process chamber for splash-free processing that can be used with all types of aluminum etchant solutions.

The etcher includes temperature control of the etchant solution from 40° to 80°C ±1°C, which can be read on a front-panel display, a chuck that holds the wafers securely in place without a vacuum for rinsing and drying the wafers' top and bottom surfaces, and a programmable dual-drain system that recirculates and refurbishes the etchant solution for later use. The 990 sells for $45,000 with deliveries in 12 to 16 weeks.
APT Inc., 3310 Victor Court, Santa Clara, Calif. 95050. Phone (408) 988-7595 [398]

Liquid burn-in baths handle boards 24 by 24 in.

Two liquid burn-in baths, each consisting of a set-point refrigeration system, put a halt to thermal runaway, allow the manufacturer to screen electronics devices for premature failures, and prevent oxidation. They are available in a tabletop model for testing boards of up to 5.5 by 6 in. and a floor model for boards of up to 24 by 12 in.

Both baths are heated and mechanically refrigerated from −10° to +150°C. When either unit reaches a set point, the bath is automatically refrigerated to maintain that temperature. A separate refrigeration system cools a reclamation coil at the top of the bath to minimize the amount of fluid lost. The baths

16K Static RAMs in Volume Supply

OKI's got it! 16384 bits of NMOS static memory on one VLSI chip. MSM2128-1: available today from stock, in production quantity.

OKI MSM2128-1. The first **usable** high-density 16K NMOS static RAM. Because it's the only high-technology VLSI product currently backed by a strong on-going, on-line production capability.

Right now only OKI Semiconductor can assure you volume availability, off the shelf, immediately after qualification.

No stalling. No hang-ups.

No kidding: shipping from inventory, OKI's sent nearly a quarter-million pieces of 2128-1 into the field since its introduction a few months ago. Snapped up by industry leaders for a broad range of microprocessor-related applications where 16K bits of static RAM on a single chip fill critical functional needs.

Starting with super compactness. Knocking out four 4Ks with one 24-pin 16K memory saves a sizable chunk of board real estate.

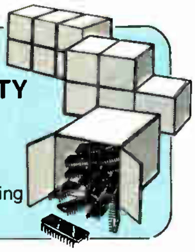
And OKI's advanced VLSI technology has raised performance specs to a sophistication level that a whole fistful of standard 4Ks can't match. (Features below.)

OKI's pulled out all the stops in VLSI. And 16K volume availability means you don't have to wait till your usual memory supplier learns how to debug production. You can jump on board with 2128-1 today.

Easy to get

VOLUME AVAILABILITY

- 237,853 VLSI RAMSs shipped
- Quantity orders filled from standing 80K inventory



ON-LINE PRODUCTION

Manufacturing capacity for MSM2128-1: 50K/month now, 100K rate 1Q81. Reason: OKI's 3-year lead in the E-Beam VLSI development process.

LOCAL ASSISTANCE

Contact your OKI rep or distributor for 2128-1 data sheet, qualification samples, and off-the-shelf stock.

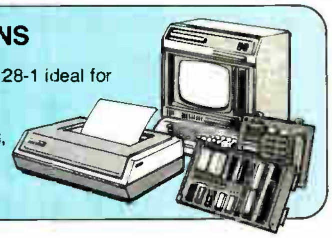
Easy to use

OKI MSM2128-1 — FEATURES

- One-chip 16K NMOS static RAM
- 2048-word x 8-bit organization
- 200ns max. access time
- Single +5V supply
- Directly TTL compatible
- Common I/O capability using three-state outputs

APPLICATIONS

2Kx8 org. makes 2128-1 ideal for multi-system designs, upgrades for MCUs, terminals, printers, add-on memory products.



Production VLSI—a big number at OKI Now, 64K dynamic RAMs to go!

Just one more way OKI's making it in real-world VLSI memory production: MSM3764. A state-of-art 64K NMOS dynamic RAM, available in three access times.

If you haven't placed your qualification order yet for leading-edge 120ns, 150ns or industry-standard 200ns MSM3764s, contact Ron Engelbrecht, Sales Director, OKI Semiconductor, 1333 Lawrence Expressway, Santa Clara, CA 95051. (408) 984-4844.

OKI MSM2128-1 — 16K NMOS static RAM

( ) Please send data sheet and volume pricing.

( ) Have OKI rep call for immediate requirements.

Name ____________________

Title ____________________

Attach coupon to company letterhead and return to OKI Semiconductor, 1333 Lawrence Expressway, Santa Clara, CA 95051. (408) 984-4842.

OKI
SEMICONDUCTOR

For 64K dynamic RAM qualification samples, call Ron Engelbrecht, (408) 984-4844.

range in price from $2,000 to $6,000 and can be delivered in six weeks.

FTS Systems Inc., P. O. Box 158, Route 209, Stone Ridge, N. Y. 12484. Phone (914) 687-7664 [396]

Connector, laminator work on solar-cell modules

An interconnection system and a photovoltaic laminator have been developed by Spire Corp. to meet the needs of the photovoltaic industry. The Spi-Connector SAS14 solar cell interconnect system is a semiautomated solder-reflow machine that allows an operator to interconnect a 100-cell module in approximately 13 minutes with a cycle time of less than 5 seconds per cell. The standard model sells for $30,000 and handles modules of 40 by 120 cm.

The Spi-Laminator photovoltaic module laminator laminates photovoltaic modules using thermoplastic encapsulants such as ethylene vinyl acetate or polyvinyl butyral. When the modules are placed in the chamber, the machine operates automatically until the desired time and temperature cycle are reached. It sells for $35,000 and can accommodate modules of up to 40 by 120 cm. Delivery of either takes five months.

Spire Corp., Photovoltaic Process Equipment Sales, Patriots Park, Bedford, Mass. 01730. Phone (617) 275-6000 [397]

Anyone can promise you a telephone line circuit as good as ours. For 1983.

Promises, promises. They're OK if you can put everything on hold and gamble on the outcome. But you don't have to.

ITT North Microsystems specializes in service to the telecommunications industry. Over 500,000 of our solid state subscriber line interface circuits (SLIC s) are in service today, meeting central office specifications.

Now we are proud to introduce a new generation of a proven design. VES™, Value Engineered SLIC.

VES is available in both central office (2001) and PBX (2002) versions, and features lower cost, improved power dissipation and superior performance.

VES meets or exceeds industry standards for longitudinal balance, transhybrid loss and idle channel noise.

What's more, we can deliver production quantities!

It's your choice. You can lie back and wait for the promises of tomorrow. Or you can specify ITT and get the latest technology at the lowest cost.

Today.

For more information, contact ITT North Microsystems Division, 700 Hillsboro Plaza, Deerfield Beach, FL 33441. Phone: 305/421-8450; TLX: 51-2329; TWX: 510-953-7523.

ITT

ITT North Microsystems Division

Circle 215 on reader service card

Engineers of Earth:

Behold the next dimension

Zehntel's new TROUBLESHOOTER 900 expands the universe of complex digital in-circuit board testing.

Test any combination of advanced technologies.

ECL. TTL. LSTTL. CMOS. All on one board. In one pass. In standard system configuration.

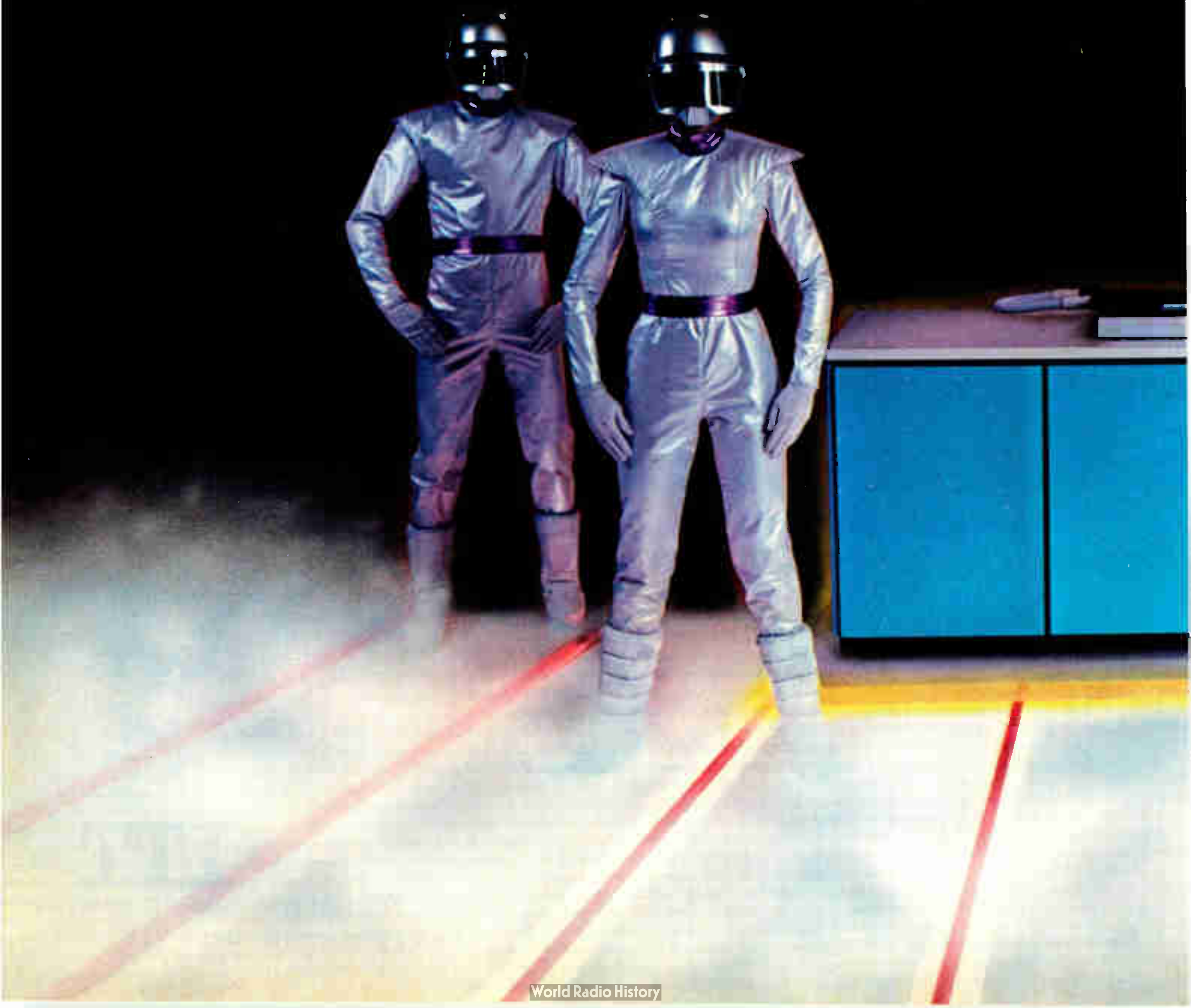
The all-new TROUBLE-SHOOTER 900™ features 3024 universal test points for in-circuit testing of complex digital boards you thought were untestable. Mixed-logic. Multiple-voltage. The TROUBLESHOOTER 900 tests them all.

With 63 driver/receiver cards—each individually programmable for a different logic or power supply level—you're ready for board designs they haven't even thought of yet.

Faster than any other in-circuit tester.

Now you can test high-speed microprocessors and other LSI devices at their own speed.

The TROUBLESHOOTER 900 features a 2 MHz master clock with three-channel sync-start and 4 MHz external clock synchronization. And it delivers



in board testing!

up to 30 amps of programmable bipolar power, with noise reduced to an absolute minimum.

Human-engineered for board test productivity.

Like all members of the Zehntel in-circuit test family, the TROUBLESHOOTER 900 is designed for easy programming and efficient production-floor operation.

THE PRODUCER,™ Zehntel's advanced test program generator, minimizes test programming time and costs. With our optional remote access terminal, you can even program and test boards at the same time.

Our new self-aligning test fixture makes it easy to handle even the largest digital boards.

The TROUBLESHOOTER 900 possesses all the production-minded features for fast board test throughput that have made the TROUBLESHOOTER 800™ the industry standard for analog/digital testing.

Behold your future—now.

For full details, write or call for our new TROUBLESHOOTER 900 brochure. Plantronics/Zehntel, 2625 Shadelands Drive, Walnut Creek, CA 94598, (415) 932-6900.

PLANTRONICS
Zehntel

NEW
TROUBLESHOOTER
900

Circle 217 on reader service card

chemicals for high technology

As electronic systems have become more complex, purity in chemical cleaners has become more critical. To keep pace with these changing needs, Miller-Stephenson has assembled a diverse family of high-purity products, each designed to do a specific job, and do it well.

new catalog

We show some star performers here, but we also offer release agents, contact cleaners, anti-static agents, and many other specialized products. All are listed in detail in the new Miller-Stephenson catalog, along with properties and specification charts to help you select the right product for your special use or application. For your copy of this informative, useful catalog, write: Miller-Stephenson Chemical Co., Inc., George Washington Highway, Danbury, Connecticut 06810

aerosol solvent cleaners

Our wide range of aerosol spray cleaners meets the demanding need for chemical purity in high technology industries.

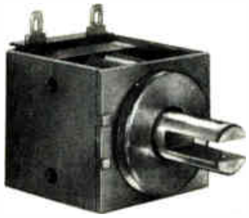
Since both cleaning action and compatibility with materials to be treated must be considered in selecting the right spray cleaner, our new Miller-Stephenson catalog includes a color-coded Aerosol Specification Chart listing formula and physical properties of each cleaner.

flux removers

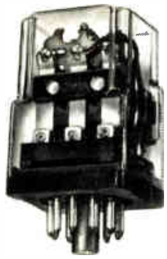
Especially formulated for specialized cleaning, Miller-Stephenson flux removers dissolve all types of organic flux from PCBs and other electronic assemblies. Excellent for spot flux removal and prototype cleaning.

When combined with our new design Cobra® Spray Brush, the flux removal aerosol is converted into an efficient system that combines chemical action of the spray with scrubbing action of the brush. Finger-tip control directs the spray for spot application.

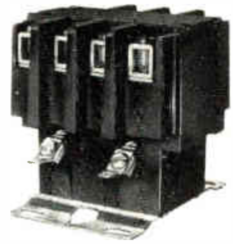
World Radio History



SOLENOIDS.
This box frame S3H is designed for smooth, pull-on-operate actuation. Its molded coil cover provides excellent coil and terminal protection. Intermittent and continuous duty cycles available for AC or DC.



NEW KRPA.
This new, low-cost version of the famous KRP relay features a clear dust cover and octal-type plug termination. 5 and 10 amp contacts are available in arrangements up through 3 form C. UL recognized.



DEFINITE PURPOSE CONTACTORS.
The P30 and P40 series switch motor loads up to 30 and 40 amps at 600V AC or resistive loads up to 40 and 50 amps at 600V AC. Three and four pole models are available.

CIRCUIT BREAKERS.
This W58 thermal is the inexpensive alternative to fuses. Contacts "snap" open and reset button extends when breaker trips. From 0.5 through 35 amps. UL & CSA.

GENERAL PURPOSE RELAYS.
Save space with the compact, ruggedly constructed K10 series. 2 form C contacts rated 13 amps at 120V AC (resistive), 10 amps at 277V AC or 28V DC (resistive). UL and CSA.

SOLID STATE RELAYS.
This ECM hybrid is packaged in a .875" high, screw terminal enclosure. Reed-triggered triac switches 120 and 240V AC loads from 0.75 through 40 amps. Potted and non-potted versions are UL recognized.

P&B isn't just relays.

Circuit breakers, solenoids, solid state relays, time delays, definite purpose contactors—now they're all designed and manufactured to meet the same high standards Potter & Brumfield has set for general purpose and power relays. And since they're P&B components, they're all available off-the-shelf from leading distributors backed by P&B's sizeable factory inventory. Potter & Brumfield Division AMF Incorporated, 200 Richland Creek Drive, Princeton, IN 47671. 812/386-1000.

AMF
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We're demanding so you don't have to be.

Potter&Brumfield

Type MS Non-Inductive Power Film Resistors from CADDOCK optimize high-speed power switching:

1. Caddock's "Non-Inductive Design" can improve rise and fall times to minimize losses in power switching circuits.

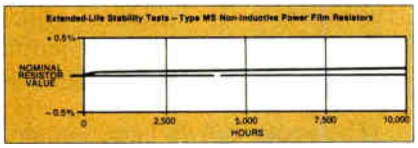
To keep the inductance to an absolute minimum, the special serpentine pattern provides for neighboring lines to carry the current in opposite directions to achieve maximum cancellation of flux fields over the entire length of the resistor.

The result is a truly non-inductive resistor that is about as inductive as a straight piece of wire the length of the resistor body.

This makes it possible for engineers to design new circuit configurations with superior non-inductive performance.

2. Extended-life stability that is typically better than 0.05% per 1000 hours.

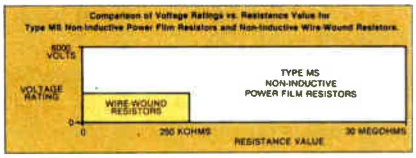
Extended load-life tests at full power have demonstrated typical stability better than 0.05% per 1000 hours.



Detailed stability data is included in the "Reliability Test Summary—Caddock Report #1" which is available on request.

3. Higher voltage and power ratings extend the maximum 'critical' resistance value.

Caddock's Micronox® film resistor technology permits single-resistor voltage ratings as high as 6000 volts to be combined with power ratings of 12.5 watts at +25°C. This combination of power and voltage provides a 'critical' resistance value of 2.88 Megohms - more than 10 times higher than can be achieved with wire-wound construction.



The higher voltage rating of Type MS resistors also overcomes the resistance value limits imposed on wire-wounds by the minimum wire size and spacing.

4. The special construction of Micronox® resistors assures high performance through harsh environments.

Type MS Power Film Resistors are produced by firing high-stability Micronox® resistance films directly onto a solid ceramic core - in air - at +1400°F to achieve a structure with these special performance advantages:

- Operating temperatures as high as +275°C.
- Repeatable temperature characteristics that include a TC of only 50 PPM/°C.
- Verified reliability through environmental extremes encountered in both 'down-hole' oil exploration and deep-space instrumentation equipment.

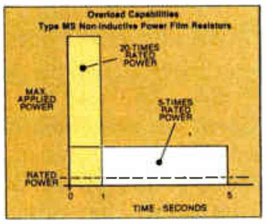
5. The family of Type MS Power Film Resistors includes 14 models with single-resistor values to 30 Megohms.

To overcome the construction *and* cost limitations inherent in wire-wound resistors, Caddock Micronox® film resistor technology gives circuit designers a *practical* balance between performance, value, size and cost, as the specifications for the Model MS 313 demonstrate:

- Non-inductive performance.
- 12.5 watt power rating.
- Resistance values from 50 ohms to 30 Megohms.
- Resistance tolerances from ±1.0% to ±0.1%.
- Maximum operating voltage of 6000 volts.
- Unit prices below $2.50 on 1000-lot orders for any value between 100 ohms and 200 Kohms.

6. Overloads of 5-times rated power for 5 seconds and 20-times rated power momentary are standard on all models.

After repeated power overload tests that apply 5-times rated power for 5 seconds, Type MS resistors have demonstrated stability typically better than 0.1%



For even higher overload situations, Type MS resistors can be subjected to 20-times the rated power for one second.

Caddock's advanced film resistor technology is the source of these outstanding advantages—advantages that are matched by an 18-year record of outstanding 'in-circuit' reliability.

Discover how easily these problem-solving resistors can improve the performance and reliability of your equipment, too. For your copy of the latest edition of the Caddock 20 page General Catalog, and specific technical data on any of the more than 150 models of the 13 standard types of Caddock High Performance Film Resistors, just call or write to—

Caddock Electronics, Inc., 1717 Chicago Avenue, Riverside, California 92507 • Phone (714) 788-1700 • TWX: 910-332-6108

CADDOCK

HIGH PERFORMANCE FILM RESISTORS

Semiconductors

32-K PROM has 40-ns access time

4-K-by-8-bit bipolar device has four redundant rows, draws only 0.23 mW per bit

Original-equipment manufacturers of mainframe computers, minicomputers, and central-processing-unit boards will be glad to note the arrival of the 3632, a 32-K bipolar fuse-programmable read-only memory sporting a maximum read access time of 40 ns, 30 ns typical.

Organized as 4-K by 8 bits, the chip facilitates the design of highly compact microcode storage systems, among others; even better, the upgrade from 4-, 8-, or 16-K devices does not result in either a sacrifice in performance or a higher cost per bit. A single 3632 can store an entire 4-K-byte program module, trimming board space and power consumption by 50% or more over designs based on parts of lower density. Expansion to larger PROM arrays is easy with the 3632's two chip-select inputs.

Like the recently announced 3636B 16-K bipolar PROM, the 3632 typically draws 150 mA for a single 5-V power supply with a 10% tolerance. The per-bit power consumption of the 3632, however, is only 0.23 mW per bit or half the per-bit dissipation of the 35-ns 3636B, and only 25% that of currently available 8-K PROMs.

Stacked fuses. The 3632, like all Intel bipolar PROMs, is manufactured with the company's exclusive polysilicon stacked-fuse bipolar technology [*Electronics*, March 27, 1980, p. 147]. The process makes devices more reliable by decreasing junction spiking and ensuring that a uniform programming current is presented to the array's fuses.

The 3632 includes four spare rows of bits, each of which may be exchanged for a row containing one or more defective cells discovered during wafer sorting. This redundancy raises production yields, which in turn reduces the 3632's price.

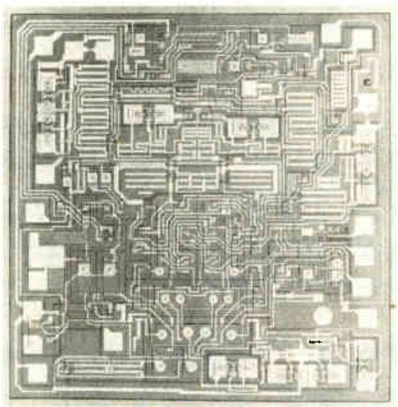
The 3632 uses the same programming algorithm as Intel's 16-K PROMs. To program the 3632 via PROM programmer requires a personality card that contains programming circuitry and firmware dedicated to the part. Such cards are now available from several sources, including Data I/O Corp. of Issaquah, Wash., as Part No. 0042-001, and Pro-Log Corp. of Monterey, Calif., as Part No. PM 9048.

The 3632 is available now in a 24-pin ceramic dual in-line package through Intel sales offices and licensed Intel distributors. The U. S. price for the part is $55.50 each in quantities of 100.

Intel Corp., 3065 Bowers Ave., Santa Clara, Calif. 95051. Phone Jean Davia at (408) 987-7602 [411]

Instrumentation amplifier has trimmed on-chip resistors

The LM363 is a monolithic instrumentation amplifier for telemetry and data-acquisition systems and process control. Thin-film resistors and on-chip trimming eliminate the need for external components or adjustments. The LM363's offset voltage is specified at 30 μV, with offset drift guaranteed at 0.5 μV/°C. It has a 2-nA input bias current and a 7-nV/Hz$^{1/2}$ input voltage noise. Common-mode rejection is specified at 126 dB, while nonlinearity is kept under 0.01%. The LM363 can operate from ±5- to ±18-V supplies and drive a 5-mA load.

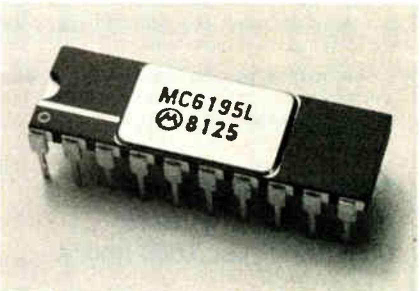


The device is offered in fixed-gain versions with gains of 10, 100, and 500. Although internally preset and trimmed, these gains can be increased externally with a resistor divider. The unit is housed in an 8-lead TO-5 package; a 16-pin dual in-line package will soon be available. In quantities of 100, the 8-pin version is $9.60, with delivery from stock.

National Semiconductor, 2900 Semiconductor Dr., Santa Clara, Calif. 95051. Phone (408) 737-5000 [413]

PLL synthesizer chip is heart of tuner

The MC6195 phase-locked–loop frequency synthesizer is an n-channel MOS silicon-gate device that is the nucleus of a digital tuning system for



cable TV converters and broadcast TV receivers. It interfaces with a linear control chip and an emitter-coupled-logic prescaler to form the tuning system.

The phase-locked–loop section of the MC6195 consists of a 100-by-15-bit channel-conversion read-only memory that converts the channel number into the preset code for a 12-bit programmable divider. The chip also has remote-control capability for on-off control and for up-down channel scanning; automatic fine-tuning circuitry that supplies the tuning voltage to the external linear amplifier; and binary-coded-decimal channel-information output for external light-emitting-diode display drivers.

The MC6195 synthesizer chip will

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CSPI's MAP™ FAMILY IS DESIGNED FOR SPEED. Our 32- and 64-bit floating point array processors enhance the computational speed of 16- and 32-bit minicomputers by 10 to 200 times. MAP gives FAST results through parallel processing which permits arithmetic operations to proceed at peak speed while I/O data is rushing through. MAP maintains 12 MFLOPS of arithmetic with up to 18 megabytes per second of concurrent I/O. Arithmetic and I/O proceed at peak rates while the host minicomputer stays free for other activity. MAP's unique multiprocessor architecture supports up to 8 of our standard analog and digital peripheral device interfaces. The results — real time processing for your most demanding requirements.

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Circle 223 on reader service card

XR-30
4 speeds 7 channels plus one memo-announce channel

Two new data recorders using 1/2-inch videocassettes, the XR-30 and the XR-50, combine 7- and 14-track recording capability and open reel performance with the convenience of a cassette recorder. They're light, compact and ideal for field work—both have DC operated power supplies. The XR-50 provides 14 channels of recording flexibility, while the XR-30 provides 7 channels plus one memo-announce channel. Four switchable speeds range from 7-1/2 ips to 15/16 ips, and wide-band FM recording is standard, permitting high frequency data recording. Any channel can be modified for direct recording by simply popping in an optional DR amplifier board.

Tape position is indicated by a highly accurate digital linear counter, and such parameters as time-base error, jitter and dynamic skew can be further improved by switching in the Tape Servo mode.

An optional AC power supply is available for lab use, so whether your applications are in the field or in the lab, if you'd like cassette convenience, open reel performance and multitrack capability, you really should take a closer look at TEAC's XR-30 and XR-50.

An important new data recorder development from TEAC

The convenience of a cassette recorder with the performance of open reel machines is now a reality.

XR-50
4-speeds
14 channels

TEAC

TEAC CORPORATION: 3-7-3 Naka-cho, Musashino, Tokyo, Japan Tel: (0422) 53-1111

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Circle 20 on reader service card

sell for $2.50 in quantities of 100,000 or more and $4 in quantities of 1,000 or more. Delivery is immediate.

Motorola Inc., MOS Integrated Circuits Division, 3501 Ed Bluestein Blvd., Austin, Texas 78721. Phone (512) 928-6369 [414]

Thyristors handle 90 A average at up to 1,200 V

The 91RC and 92RC series of all-diffused, center-gate-constructed thyristors carry 90-A average loads and have ratings of 50 to 1,200 V. They can upgrade existing 70-A designs as direct socket replacements to provide higher power and improved reliability for phase control applications. The devices support 140 A root mean square of continuous current and up to 1,800 A peak in a one-cycle, nonrepetitive surge after any rated load condition.

The thyristors require a typical 30-mA dc gate current to trigger, with a maximum trigger requirement of 100 mA at a case temperature of 25°C. The maximum rate of change of voltage is 200 V/μs at a junction temperature of 125°C. Switching characteristics include a typical delay time of 1 μs, and a maximum nonrepetitive rate of rise of turned-on current of 300 A/μs when operating between 50 and 600 V, and 200 A/μs when operating between 700 and 1,200 V. Their typical turn-off time is 90 μs. The units operate over a −40° to +125°C temperature range, and are available in a selection of voltage ratings. The 91RC is housed in a TO-94 package and the 92RC in a TO-83 case. In quantities of 10 to 99 they are priced at $12.65 to $38.33, with delivery from stock.

International Rectifier, 233 Kansas St., El Segundo, Calif. 90245. Phone (213) 772-2000 [415]

Chip multiplies, divides for 8-bit processors

The CDP1855 multiply-divide unit is designed to interface directly with the CDP1800 series of complementary-MOS 8-bit microprocessors to provide a hardware alternative to software-only implementation of arithmetic and signal processing. It interfaces with the CDP1800 series and can be configured to fit in either the memory or input/output space of generalized 8-bit microprocessors. As many as four CDP1855s can be cascaded in order to handle operands of up to 32 bits.

The 1855 has three 8-bit registers that are loaded with operands prior to the multiply or divide operation and that contain a product or quotient when the process is completed. The unit also includes an 8-bit control register that defines and initiates the operation and a single-bit status register for indicating overflow.

The CDP1855s are available from stock in either 5- or 10-V versions, with each available in 28-lead dual in-line plastic or ceramic packages. In quantities of 1,000, prices range from $5.56 to $8.35.

RCA, Solid State Division, Box 3200, Somerville, N. J. 08876. Phone (201) 685-6423. [416]

Diodes, rectifiers operate at temperatures up to 200°C

Electronic Devices' proprietary diffusion and passivation processes let its series of diodes and assemblies operate at temperatures of up to 200°C with no leakage drift. The HTD5 diode is available with 175°C ratings with 5,000 peak reverse voltage and 8 μA typical leakage. The HTD3 diode is rated at 200°C at 3,000 V peak reverse voltage with typical leakage of 15 μA at 200°C.

The rectifier assemblies are rated at 175°C and peak reverse voltages of 15 kV for the HT15 and 30 kV for the HT30, each with a typical leakage of 8 μA at 175°C.

In quantities of 100 to 999, the HTD3 is priced at $15 each, with delivery taking three weeks.

Electronic Devices Inc., 21 Gray Oaks Ave., Yonkers, N. Y. 10710. [417]

Six-decade up-down counter has presignaling, recycling

The LS7055 is a six-decade up-down counter that includes power-on reset and an internal scan oscillator with override capability. A zero blanking override for decimal-point operation is offered as an option to take the place of lamp test.

Like the earlier 7050, the 7055 offers the user a wide choice of presignaling and recycling modes, a seven-segment and binary-coded decimal output, a divide-by-5 or -6 input, latches, and high noise immunity. Hysteresis is equal to 30% of the power-supply level on all inputs.

When counting down, the circuit will give two presignals before reaching zero and recycling to the number in the preset store. When counting up, the circuit will give one presignal before reaching the number in the main signal store and recycling to zero. Recycling can be inhibited and resetting done manually. The preset, presignal, and the main signal stores can be programmed by thumbwheel switches or a microprocessor.

The circuit operates from a single power supply of +5 to +15 V, and all outputs are complementary-MOS–compatible over the entire range. The 7055 is $6.65 in 1,000-piece lots; delivery is from stock.

LSI Computer Systems Inc., 1235 Walt Whitman Rd., Melville, N. Y. 11747. [418]

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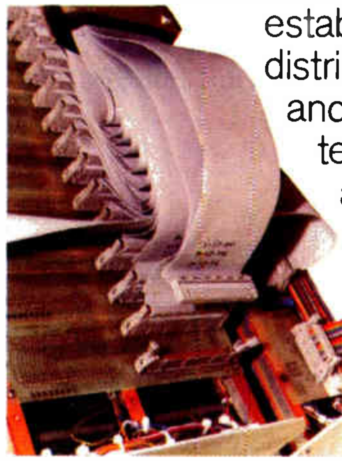

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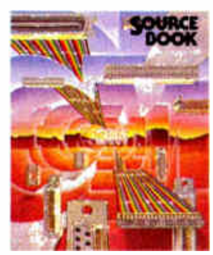

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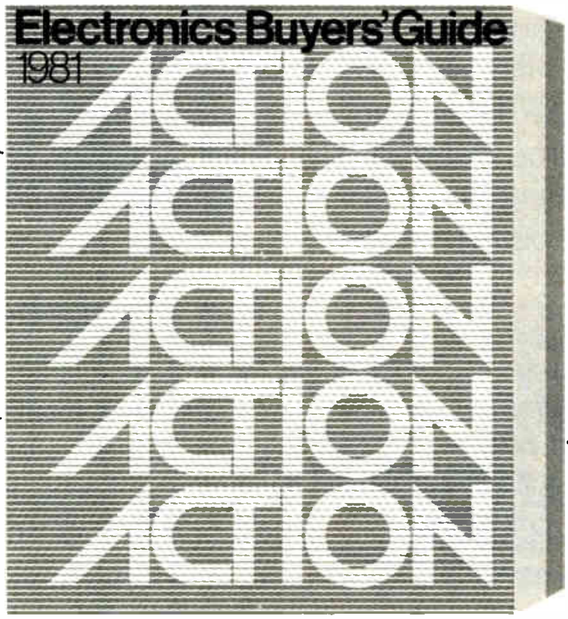

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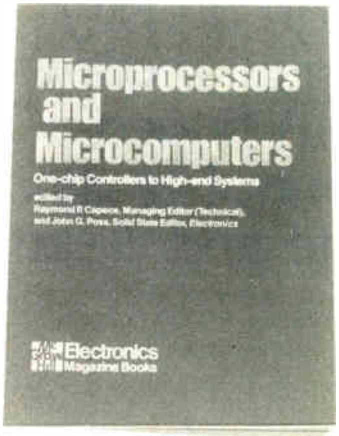

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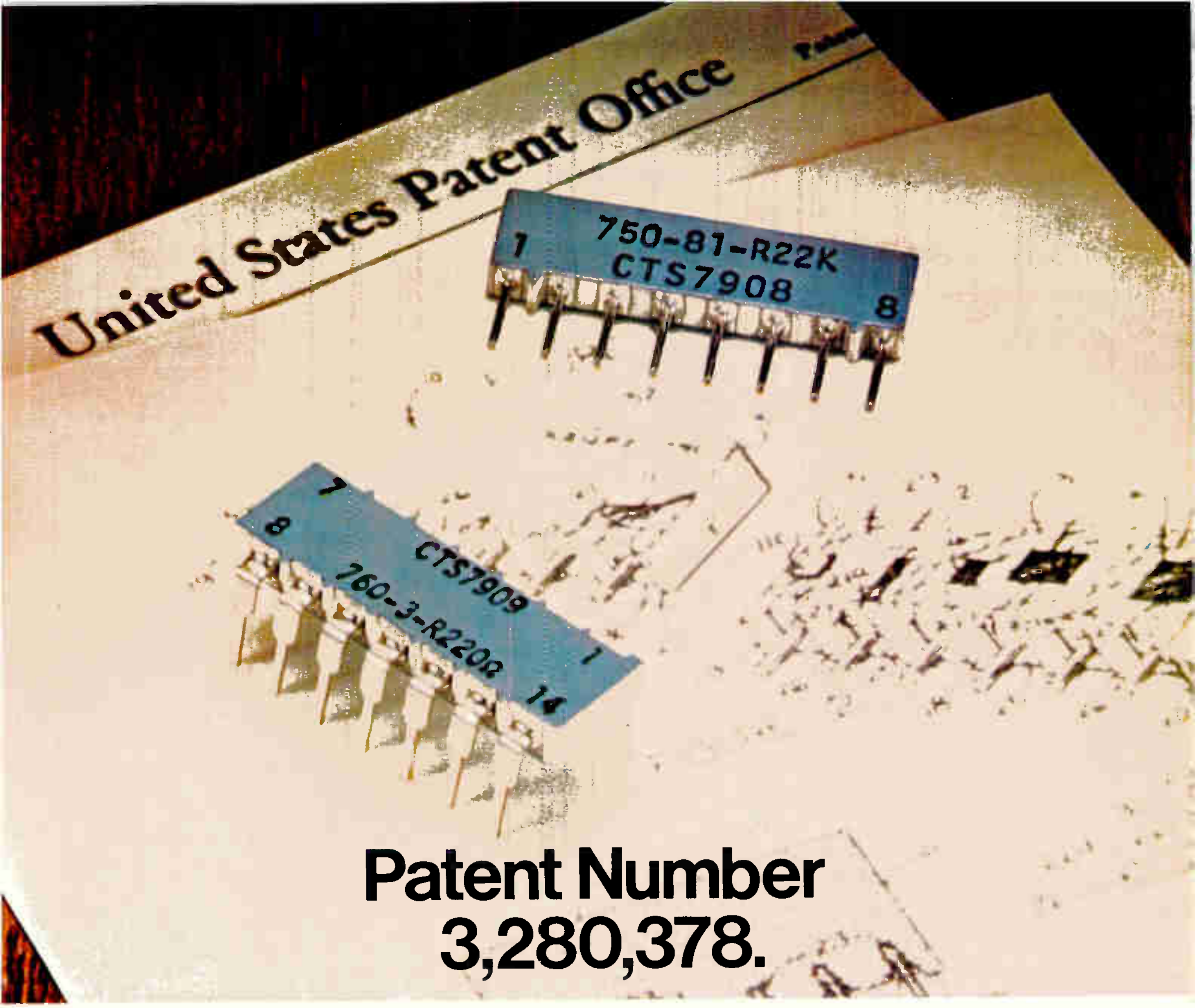

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Microcomputers & systems

Registers, latches are 10 bits wide

Bipolar family features 8-, 9-, and 10-bit registers and latches, convenient pinouts

In building bus interfaces for 8-bit microprocessor-based systems, quite often more than 8 bits are needed. A parity scheme requires a ninth bit, and carrying the clock signal requires a tenth. This can be implemented using an octal register combined with a 4-bit register, but it can also be accomplished using a 10-bit part belonging to a new family of bus-interface devices.

The AM29800 family will appear in stages over the next 18 months, with the first members being offered now in handfuls for free, in quantities of 100 to 1,000 in November at about $4.50 each, and in high-volume shipments in six months. The first group to appear will include 10-bit registers, both noninverting (AM29821) and inverting (AM-29822), 9-bit noninverting (AM298-23) and inverting (AM29824) registers, and similar versions (AM29825 and -26) 8 bits wide. Also available on a sample basis in the fourth quarter of this year will be the AM29841 through -46 series of latches, which includes among its members both noninverting and inverting 10-bit, 9-bit, and 8-bit latches.

All parts in the bipolar family, implemented in AMD's Imox oxide-isolated process, will be bus-compatible. They can sink 48 mA in the commercial temperature range and 32 mA over the military range. Their speeds will typically be 7 ns from clock pulse to output into a 50-pF load. This compares with the typical 9- or 10-ns delays of comparable Schottky parts and 18 to 20 ns for low-power Schottky devices.

The buffered AM29821 and -22 registers have three-state outputs and can function like 10-bit wide versions of the popular 374-type register (AM25LS374). The 9-bit AM29823 and -24 registers add clock enable and asynchronous-clear functions, which aim them at parity-bus interfacing.

The buffered latches have typical propagation times of 4.5 ns for the noninverting and 6.0 ns for inverting versions. The AM29841 and -42 latches are 10-bit versions of the 373-type 8-bit latch. The AM29843 and -44 are 9 bits wide, but offer preset and clear lines. The AM29845 and -46, like the -25 and -26, are 8 bits wide and add multi-user control.

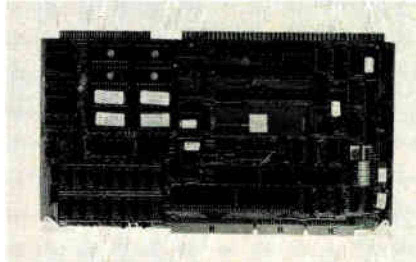
Rational layout. All members of the 29800 family will be packaged in a 24-pin dual in-line package 0.3 in. wide, and they are laid out so that all the inputs are on one side of the dual in-line package and all the outputs are on the other. Large-volume pricing on both the registers and latches is expected to range between $3.50 and $4.25 when high-volume (10,000-piece) production begins about next March.

Following the registers and latches by about three months will be the 10-bit buffers (AM29827 and -28) and 10-bit and 9-bit transceivers (AM29861 to -64). The buffers are expected to cost about $0.25 each more in volume production than the registers. The buffers have NORed output-enable lines to give control flexibility, and their inputs—as well as those of the transceivers—have a 200-mV minimum input hysteresis for improved noise rejection.

Advanced Micro Devices Inc., 901 Thompson Pl., Sunnyvale, Calif. 94086. Phone (408) 732-2400 [371]

68000-based board is Multibus-compatible

With a powerful 68000 as a central processing unit, the OB68K1 single-board computer is compatible with the Multibus that is so popular in the microprocessor world. The 16-bit computer can function as a stand-alone system or as the central processor card in a large microcomputer



system.

The board can be ordered with either 32- or 128-K bytes of random-access memory, eight sockets for up to 64-K bytes of erasable programmable read-only memory, seven prioritized vectored interrupts, and a 16-MHz crystal-controlled clock. Other features include two RS-232-C serial ports, two programmable 16-bit parallel ports, and a crystal-controlled bit-rate generator with 16 standard rates from 50 b/s to 19 kb/s, and a triple 16-bit programmable timer-counter.

An off-the-shelf operating system is available from Hemenway Corp., Boston, Mass., and high-level languages will be available from several major software houses by early fall. Single-unit prices range from $1,495 with 32-K bytes of RAM to $1,995 with 128-K bytes. Volume discounts are available, and evaluation quantities can be delivered in two to four weeks.

Omnibyte Corp., 245 W. Roosevelt Rd., West Chicago, Ill. 60185. Phone (312) 231-6880 [373]

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The S1410 disk-drive controller, designed for Seagate-compatible double-density 5½-in. drives, uses VLSI circuitry for a highly compact configuration. Contained on a 5¾-by-8-in. card, it is 48% smaller than the comparable Data Technology Corp. DTC 510. The S1410's multi-sourced very large-scale integrated circuitry results in 55% fewer ICs than the DTC 510. The controller is compatible with the 510 and with Shugart Associates' SA1400 series host interface, allowing it to operate

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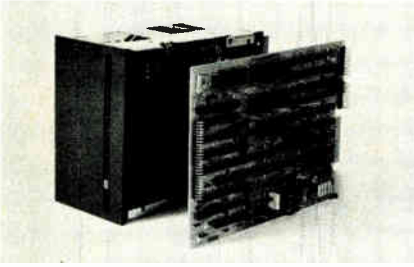


with host adapters supplied by Data Technology and Shugart, such as those for Apple, Q-bus, Multibus, and S-100 buses.

Commands are issued to the controller over an 8-bit bidirectional bus connected through an adapter to the host computer. The S1410 makes use of the 32-bit polynomial-error-correction Fire code, which allows for up to 22-bit burst-error detection and up to 11-bit burst-error correction. In addition, it allows the user to configure the size of the drive through software commands. The $295 controller is available for immediate delivery.

Xebec Corp., 432 Lakeside Dr., Sunnyvale, Calif. 94086. Phone (408) 733-1340 [374]

VT640S board lowers cost of VT100 graphics capability

By using the existing white cathode-ray-tube, the VT640S Retro-Graphics conversion package cuts the cost of bringing graphics capabilities to Digital Equipment Corp.'s VT100 alphanumerics terminal. It eliminates the add-on green CRT that was part of the VT640 package introduced last year and features the standard resolution of 640 by 240 picture elements, rather than the 640 by 480 pixels that was offered by the earlier version.

An advantage of the VT640S is that it enables the VT100 terminal to perform both as an alphanumerics terminal and as a graphics terminal with features like vector drawing, point plotting, mode-independent selective erasing, a standard cross-hair cursor, and optional light pen and printer interface.

Retro-Graphics hardware is compatible with industry-standard graphics software, including Integrated Software Systems Corp.'s Disspla and Tellagraf and Tektronix's Plot 10. The VT640S is priced at $1,230; delivery is 90 days after receipt of order.

Digital Engineering Inc., 630 Bercut Dr., Sacramento, Calif. 95814. Phone (916) 447-7600 [375]

Microprocessor board carries 16-K bytes of RAM

On a single board, the BLC-80/116 combines the BLC-80/10 (or SBC-80/10) single-board computer and 16-K bytes of random-access memory. The board contains an INS8080A n-channel large-scale integrated microprocessor, 16-K bytes of RAM chips with provisions for battery backup, 48 parallel input/output lines, a serial port for RS-232-C or current-loop interface, and the capacity for 16-K bytes of programmable read-only memory. The BLC-80/116 is compatible with National's BLC-80/11 and BLC-80/11A, and with Intel's SBC-80/10A and SBC-80/10B.

Two BLX bus connectors allow for the addition of incremental I/O, letting users customize the system from off-the-shelf parts, reduce system costs, gain a card slot, and increase system throughput by eliminating Multibus system-bus latency.

The BLC-80/116 is priced at $850 in single units, with delivery promised for four weeks after the receipt of an order.

National Semiconductor Corp., 2900 Semiconductor Dr., Santa Clara, Calif. 95051. Phone (408) 737-5000 [377]

Digital signal processors have 300-ns instruction cycle time

The first two members of a new family of digital signal processors offer user programmability for a wide range of applications and fast Fourier transforms in a single-chip implementation. The S2811 signal-processing programmable peripheral and the S2814A Fourier transformer are made in vertical-groove-MOS technology.

The S2811 arithmetic processor can be custom-programmed for telecommunications, biomedical analysis, speech processing, and process-control applications. A parallel multiple-bus architecture links the 12-by-12 multiplier and 16-bit add-subtract unit with the instruction memory, a 256-word read-only memory, and the data memory, a 128-word random-access memory, and with a 128-word ROM, to make an instruction cycle time of 300 ns.

The S2814A is a preprogrammed signal processor that uses a decimation-in-frequency technique to calculate 32-point fast Fourier transforms and inverse fast Fourier transforms in as little as 1.3 ms.

Each is $250 in 100-piece lots. Delivery takes six weeks.

American Microsystems Inc., 3800 Homestead Rd., Santa Clara, Calif. 95051 [376]

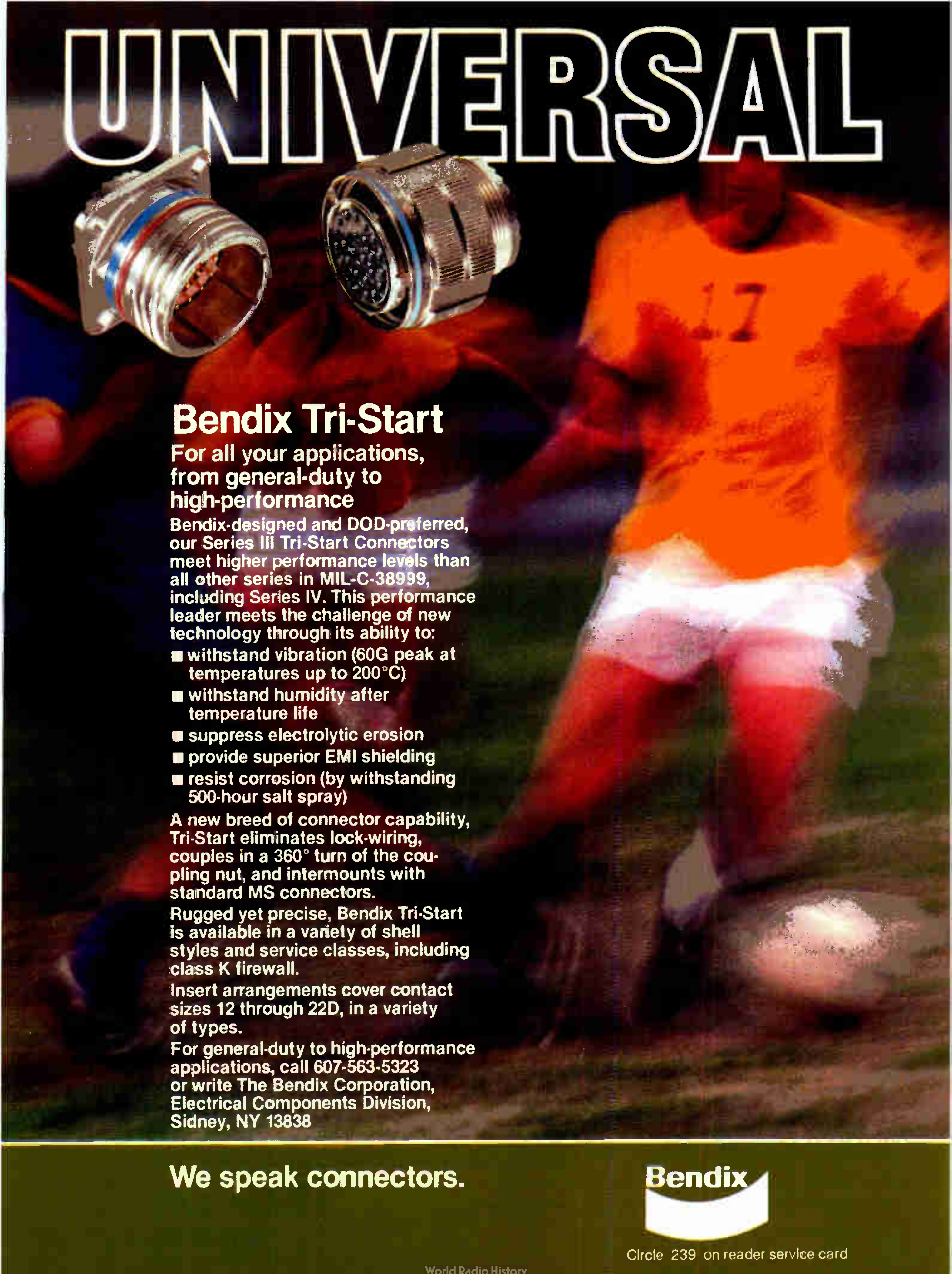
Controller supports 2 floppies, 2 Winchesters on Multibus

Overseeing as many as two Winchester-technology and two floppy-disk drives, the FWD8001 controller is compatible with the Intel iSBC 215A/iSBX 218 controller board set. It has 40% fewer integrated circuits and fewer printed circuit boards than the equivalent Intel implementation and only requires 5 V from the Multibus backplane at 5 A. Both 16- and 20-bit address support may be selected by jumpers.

The controller supports the Shugart SA1000 and Quantum 200 series 8-in. Winchester disk drives, plus the Shugart 800/850 floppy-disk drives. A maximum of two 8-in. Winchester drives and two floppy disks are supported to provide over 70 megabytes of storage.

In quantities of 100, the FWD8001 is priced at $1,400 each; delivery takes 30 to 60 days after receipt of order.

Scientific Micro Systems Inc., 777 East Middlefield Rd., Mountain View, Calif. 94943. Phone (415) 964-5700 [378]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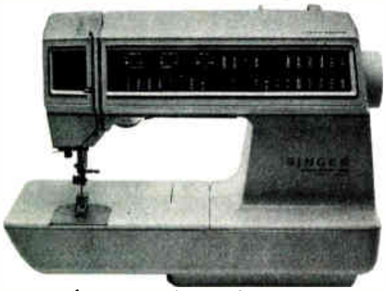

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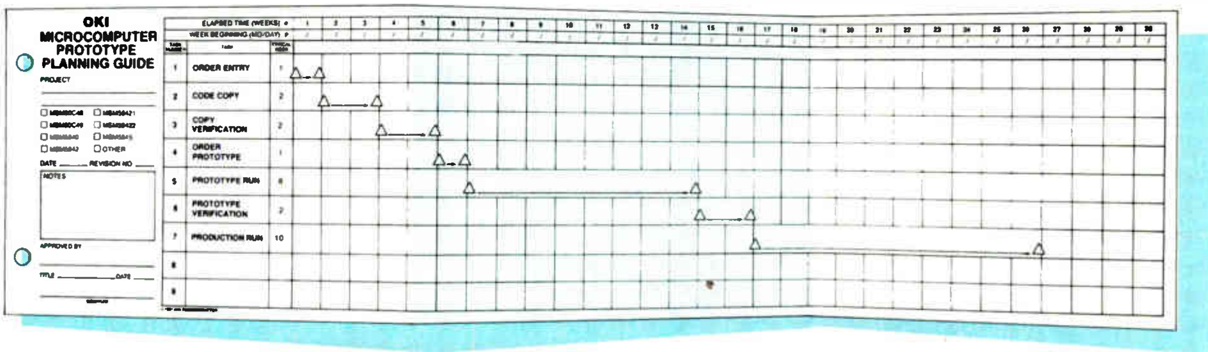

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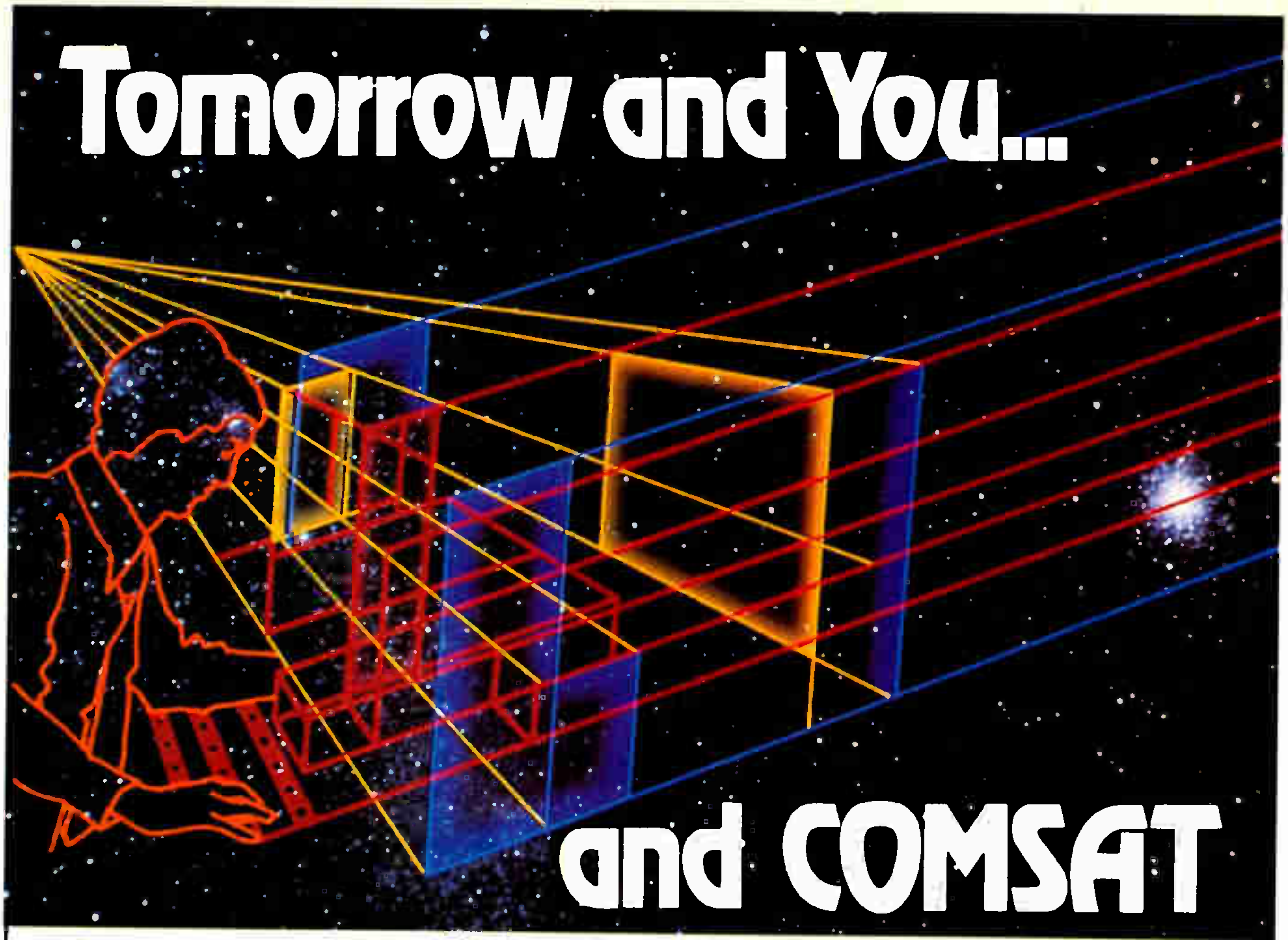

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Data acquisition

D-a converter has control logic

Registers of 10-bit C-MOS converter interface with bus, count up or down to ramp

Process- and machine-control applications are moving more intelligence into the devices controlled and monitored. Analog Devices Inc.'s new AD7527, for example, has considerable local-control logic on chip, along with other convenient features also located on chip.

The AD7527 is a 10-bit digital-to-analog converter in a 28-pin plastic or ceramic dual in-line package. The monolithic complementary-MOS device provides capabilities available as recently as two to three years ago only in discrete form and thereafter only in modules.

The unit interfaces directly with either 8- or 16-bit data buses using two 10-bit registers. Data can be read in either right- or left-justified format. The two registers can either be used to latch control data from an associated computer or be implemented as an up-down counter for local control.

Simplifying this application is an on-chip oscillator with which the user can ramp the analog output up or down by clocking the counter. Clock frequency is controlled with either an RC network or an external input; frequencies up to 1 MHz can be applied to the clock input.

Input register contents are read back to the parent computer in response to commands at pin 22. This can be especially important in process control applications, where line noise and power problems often cause confusion between the last word sent to the converter and the last word it has received. This read-back function aims to prevent those disasters that can occur when the controlling computer momentarily goes off line and returns with incorrect data regarding commands stored elsewhere in the system. Also, since the converter need not follow if the main computer goes down, the AD7527 ensures that certain processes can continue uninterrupted.

Company spokesmen also like to point out that although the 7527 is designed for computer-controlled applications, almost all its features can be used with low-cost switches for manual operation if necessary.

Pins 4, 5, and 6 enable a data-override function. By addressing these pins, the data words in the input registers of the 7527 can be replaced with a word corresponding to the device's zero, mid-range, or full-scale outputs. In this mode, a special register is filled with all 0s, a 1 followed by nine 0s, or all 1s. This makes rapid calibration possible without writing over stored instructions. Normal data inputs are stored elsewhere, and at the end of a calibration cycle the converter's output returns to an analog level keyed to the input word that is retained in its data register.

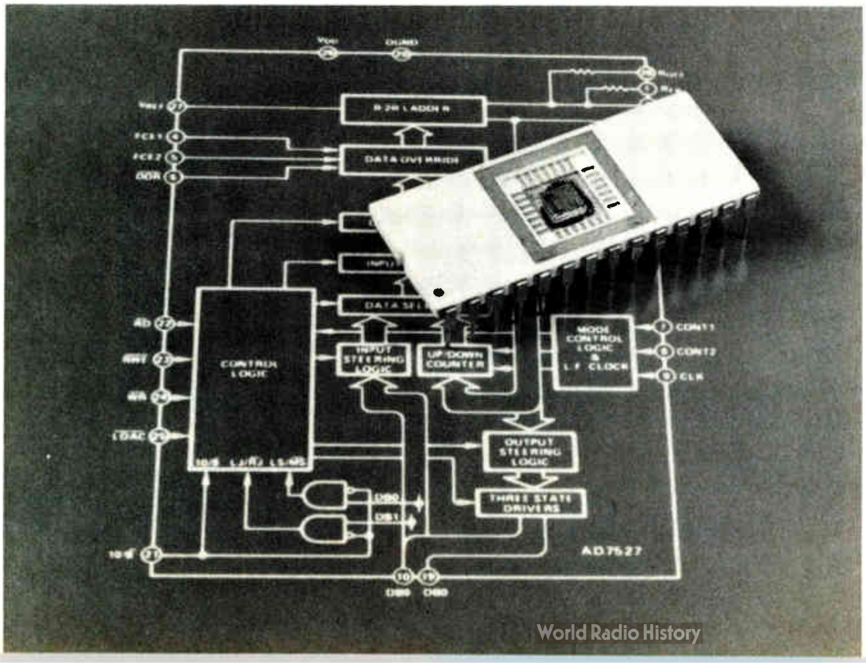
The AD7527 comes in three operating temperature ranges: the 0° to 70°C range is served by the plastic-packaged model, and the industrial and military temperature ranges by ceramic DIPs. The unit also is available in chip-carriers.

Only a single 5-V supply and voltage reference are needed. Relative accuracy varies with the model; at worst it is ±1 least significant bit, but more often it is ±½ LSB. Units are available with gain errors of ±10, ±5, and ±1 LSB. The gain temperature coefficient is typically 2 ppm/°C with a maximum of 5 ppm/°C. Output reaches 90% of its final value in a maximum of 950 ns after the arrival of the leading edge of the write-input signal.

Sensitivity to power-supply variation is 0.005% maximum; monotonicity is offered in the user's choice of either 9 or 10 bits. Feedthrough is 2 mV maximum.

Prices range from $13 to $63.75 in lots of 100, based on package selection, temperature requirements, and other specifications. Delivery is from stock.

Analog Devices Inc., Route 1 Industrial Park, P. O. Box 280, Norwood, Mass. 02062. Phone (617) 329-4700 [381]



16-bit a-d converter boasts 0.004% typical THD

A hybrid analog-to-digital converter from Burr-Brown has its maximum total harmonic distortion limits specified for use in stereo equipment, industrial vibration-analysis equipment, and also sonar and acoustic instrumentation.

Two models, the PCM75KG and PCM75JG, are available. The KG offers a 90-dB (or more) dynamic range, 16-bit resolution, and 0.02% maximum total harmonic distortion with input levels of 15 dB below full scale, 0.004% typically at full-scale

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For more information, call or write Fairchild about the 93422 or 93L422. Fairchild LSI Products Group, P.O. Box 7880LSI, Mountain View, CA 94042. Telephone: (415) 962-3951. TWX: 910-379-6435.

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Fairchild Camera and Instrument Corp.

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input. Its maximum conversion time is 17 μs for the full 16 bits. The JG version, with 16- or 14-bit resolution, provides 0.05% maximum total harmonic distortion with input level at 15 dB below full scale. Its conversion time is 15 μs at 14-bit resolution.

The speed of both models permits multiplexing between the two channels of a stereo with only a slight increase in distortion, and an internal digital-to-analog converter is also accessible for other system applications such as the playback mode of a recording system. Each converter contains an internal reference and a clock with rate control. The devices use precision laser-trimmed thin-film components and are packaged in a bottom-brazed 32-pin ceramic dual in-line package. In 100-unit lots, the KG is $189 and the JG is $145; delivery of either part is from stock.

Burr-Brown, International Airport Industrial Park, P. O. Box 11400, Tucson, Ariz. 85734. Phone (602) 746-1111 [383]

12-bit hybrid d-a converter uses monolithic design

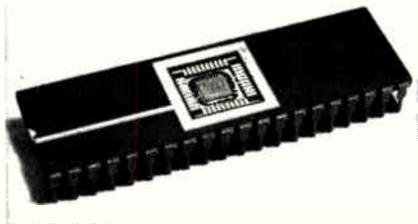
With a single monolithic integrated circuit design, the Monobrid ADH-030 II increases the reliability of ILC Data Device Corp.'s 12-bit, 35-ns hybrid digital-to-analog converter, the replacement for an earlier model. The ADH-030 II provides 12-bit linearity, settling in 35 ns to within 0.01% with a low glitch energy of 50 mV-ns. Its mean time before failure is 3,000,000 h and comes with an operating temperature range of -55° to $+105^\circ$C.

Measuring 1.4 by 0.8 by 0.2 in., the converter weighs only 0.4 oz and is in a hermetically sealed 24-pin dual in-line package. Applications include cathode-ray-tube displays, TV and radar video reconstruction, x-y deflection positioning, and digitally controlled frequency-agile oscillators. Prices start at $139 in single-unit quantities, with delivery either from stock or within four weeks.

ILC Data Device Corp., 105 Wilbur Place, Bohemia, N. Y. 11716. Phone (516) 567-5600 [384]

8-bit a-d converter reconfigures analog inputs

Operating under microprocessor control, the MC14444 multiple-input complementary-MOS 8-bit analog-to-digital converter can, on command, change up to six of its analog inputs into digital ones. The versatile converter can also reconfigure three of its six digital inputs as



digital outputs; the other three are dedicated digital inputs.

The 40-pin package also interfaces directly with the 1-MHz buses used with the entire MC6800 microprocessor family. It operates from a single 5-V supply and performs 8-bit conversions in 32 μs. Able to handle up to 15 analog inputs, the device uses a binary-weighted, all-capacitor digital-to-analog converter and a chopper-stabilized comparator to perform successive-approximation a-d conversions.

The MC14444 sells for $14 each in quantities of 1,000. Production volumes will be available at the end of the month. Initially, the converter will be available in plastic dual in-line packages.

Motorola Inc., 3501 Ed Bluestein Blvd., Austin, Texas 78721. Phone (512) 928-6897 [385]

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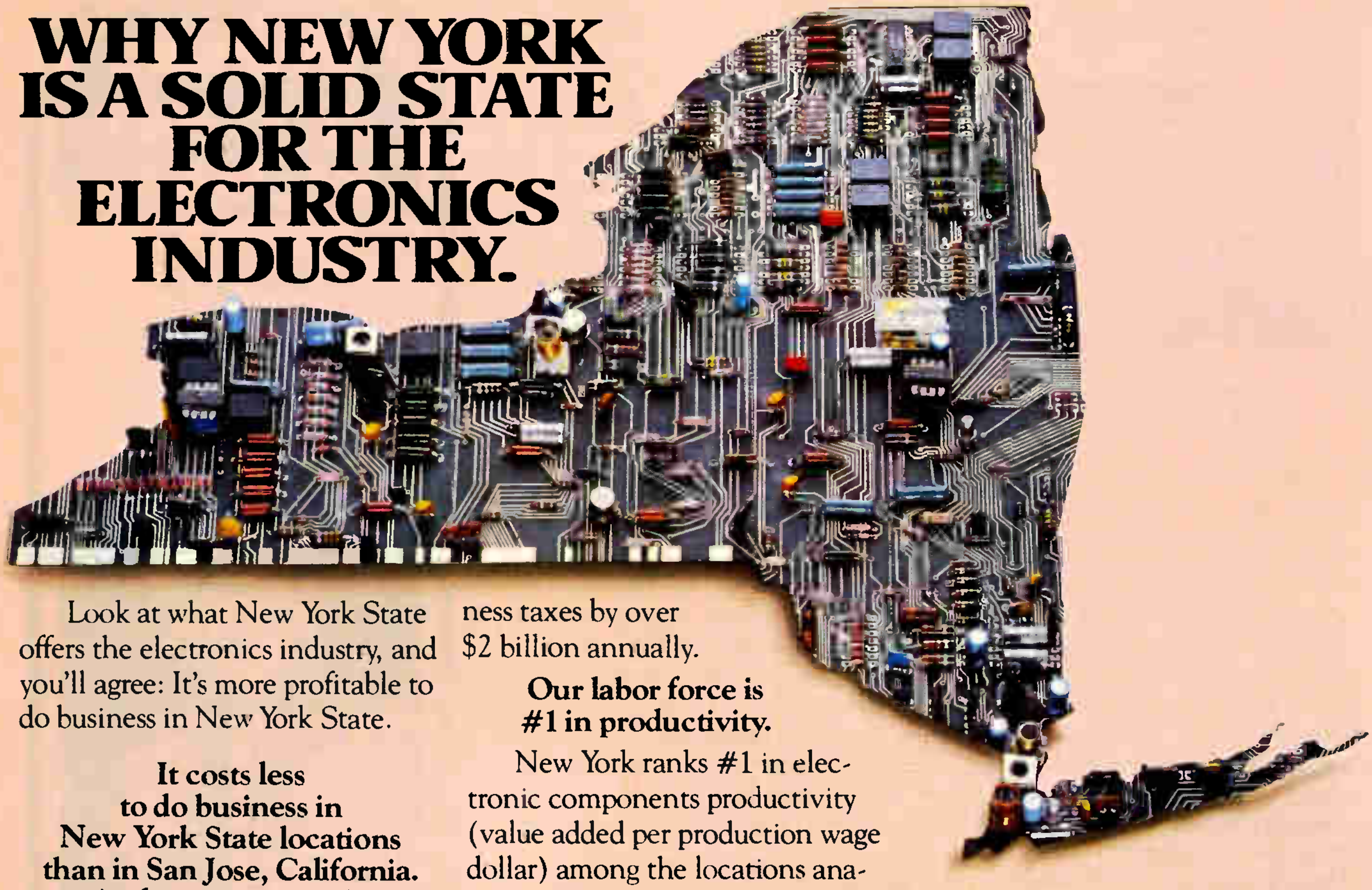

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An independent study analyzed the four critical costs of taxes, wages, power and construction for a model new electronics firm. It showed that New York State offers locations where these costs are less than they are for choice electronics industry locations around the country.

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Our labor force is #1 in productivity.

New York ranks #1 in electronic components productivity (value added per production wage dollar) among the locations analyzed. And in the past five years, New York's number of idle man-days due to work stoppages was half that of the national average.

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- ☐ Semiconductors

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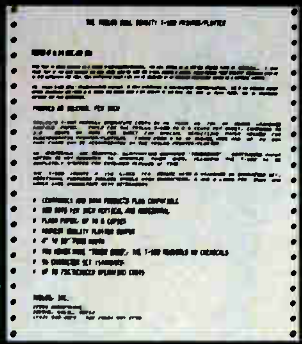

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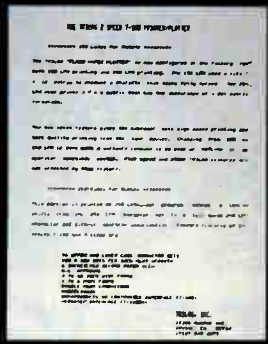

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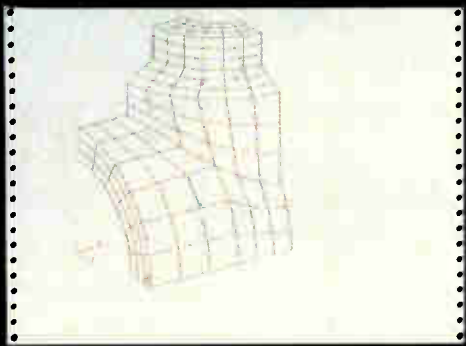

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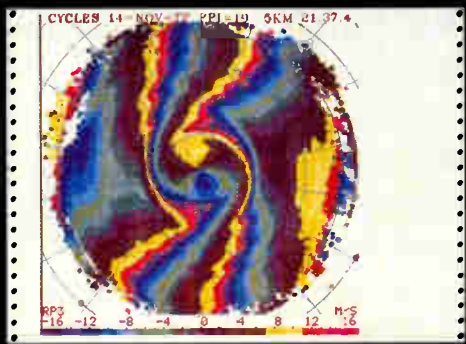

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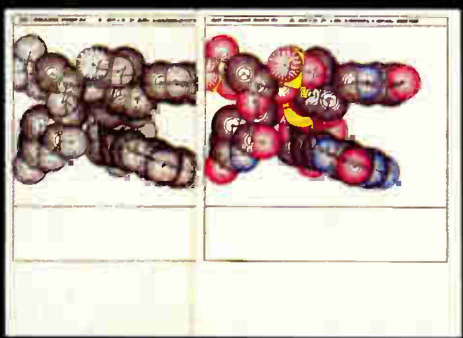

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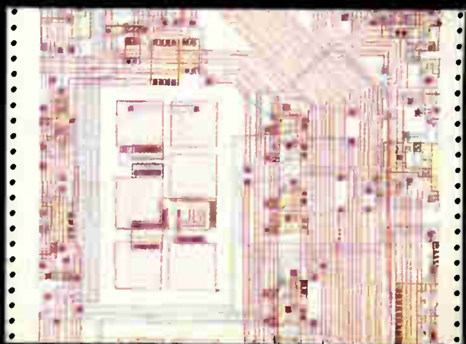

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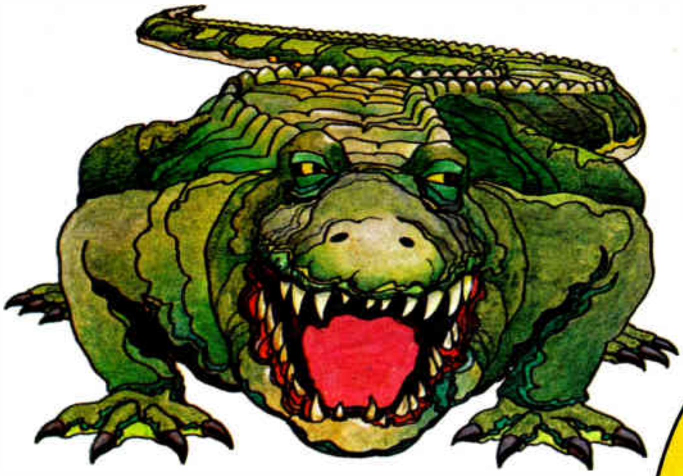

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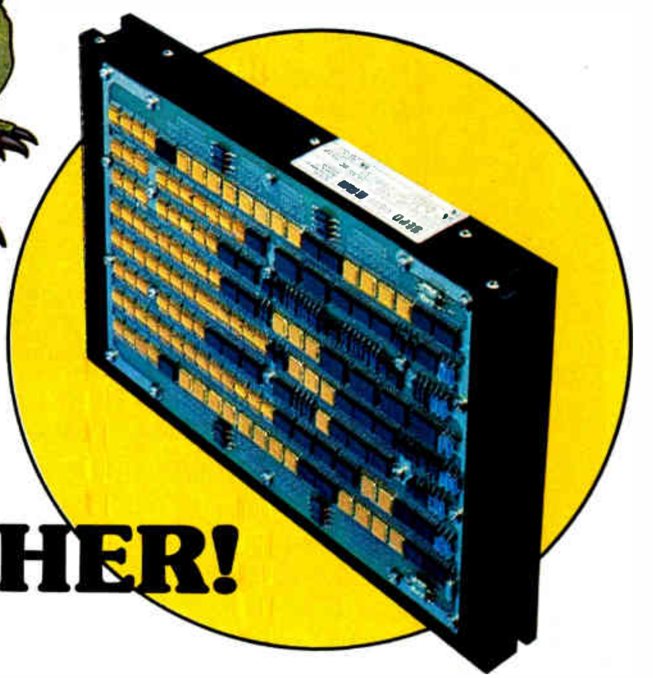

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The STR-810 digital recorder is designed for data logging, data acquisition and as a system loader. Using either the 3M DC-300A or DC-300XL cartridges, packing density is 1600 bpi, for respective data capacities of 2.3M bytes and 3.4M bytes per cartridge, using four tracks. Features include microprocessor-controlled tape movement and read/write electronics. For maximum versatility, interfaces include RS-232 and IEEE-488. Or, using control and status lines available, you can interface to specific microcomputers such as LSI-11 and 8080. EPI's optional ANSI X3.56 formatter, with NRZI or phase-encoded personality cards, turns the 810 into a plug-in component for industrial instrumentation and mini/microcomputer-interfaced peripheral markets. Price: $756 in quantities of 100. **STR-STREAM** is a high-speed, high-capacity version of the 810 designed for Winchester disc backup. Density is 6400 bpi for 17M bytes capacity per cartridge. Features include advanced head design, MFM formatting and compatibility with 8" or 14" discs.

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EPI's STR-610 is a compact, low cost digital recorder that's ideal for use with POS terminals, smart CRT terminals and as a general peripheral for mini/microcomputer-based systems. The 610's recording density is 800 bpi for a capacity of 168K bytes/track, using a two-track 3M DC-100 mini-cartridge. Formatting is ANSI Standard and interfacing is parallel, with a variety of options. Price: $280 in quantities of 1,000. **The STR-LINK III** is a high-speed (9600 baud). portable program loader that uses the STR-610's drive system and shares the same specifications. It is used as a field service tool for diagnostic work or as a peripheral in a mini/microcomputer system. STR-LINK III uses a serial RS-232 interface for data communications or data terminal applications, and it can be controlled through RS-232, ASCII control codes, or manually. Price: $1,615 in single quantity.

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STR-LINK II is EPI's proven medium-speed (1200 baud) universal portable program loader for programmable controllers and process control systems. Using a standard cassette, it features switch-selectable transmission modes for maximum flexibility. Price: $1,889 in single quantity.

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Software

Code links board tester to any CPU

Communications package lets CPU see in-circuit board tester as intelligent terminal

To put together a test-system network, most automatic test equipment manufacturers require users to employ special central processing units, protocols, and hardware—in effect basically dictating the nature of the user's network and brand of tester. However, Plantronics/Zehntel Inc. maintains that test-system users should have more freedom and is taking a different approach toward networking.

The company, according to marketing executive Craig Pynn, "does not feel it should ram a protocol down anybody's throat." Thus it devised a software package that lets test personnel hook the firm's Troubleshooter 800 in-circuit board tester with any host CPU. The package, called Netcomm, makes the tester look like an intelligent terminal that can address or be addressed over an RS-232-C line. The software package is free to those who already own 800 systems and will be included, at no charge, in future versions of the system.

Netcomm consists of a floppy disk and an operating manual describing the format of the tester files and how to set up communications. The floppy-disk data augments the tester's operating system, which is written in Forth, with a mere 700 bytes of additional code that controls RS-232-C communications. It permits the user to choose data-transfer rates of 110 to 9,600 b/s and to configure data for transfer in 6-, 7-, or 8-bit characters so that the system can fit existing protocols. It also permits operation in full- or half-duplex communication modes.

One of the primary reasons for such networks is that they permit greater control over test software. The software may be stored at a central point and downloaded to testers, thereby ensuring that tests are being performed exactly in the same way and with the latest version of the program.

Tradeoff. For the Troubleshooter 800, a typical test program consists of about 20-K bytes of code, and at the maximum transfer rate it takes about 2 minutes to transfer a program. While that is not as fast as some networks, Toby Bolles, product marketing manager, points out that "the fact that it takes a couple of minutes to transfer a program has to be weighed against the cost of the other systems. The extra few seconds can save $30,000 in the price of a tester."

Other uses for such networks include gathering and analyzing production data, such as failure and throughput rates. In these areas Zehntel plans to rely on existing computer systems. "The users I've spoken to already have some sophisticated statistical analysis programs in their mainframe CPUs. All they need is a way to get the data in more quickly," says Bolles.

In the area of tester networks, she notes, the company's software efforts will be directed at providing similar capabilities for its model 900 board tester and model 110 development station, whose operating systems differ from that of the Troubleshooter 800.

Plantronics/Zehntel Inc., P. O. Box 8016, Walnut Creek, Calif. 94596. Phone (415) 932-6900 [401]

Program transfers waveforms from Nicolet scope to HP-85

Nicolet Explorer digital oscilloscopes can be interfaced with HP-85 desktop computers from Hewlett-Packard Co. using a program named Nicolet/85. A waveform captured by the scope, consisting of 4,096 sampled data points, is transferred to the HP-85 in 1.3 seconds via the IEEE-488 bus.

Once the data is in the HP-85, the program allows the user to plot the waveform on the computer's cathode-ray tube or an HP plotter; store the data on tape or floppy disk; decode and format the data to permit use of the HP-85's Waveform Analysis Pac for fast Fourier transforms; and transmit waveform data from the HP-85 to the scope. Named waveform data files can be created on tape or disk. Each waveform requires 8,448 bytes of storage, so about 20 waveforms will fit on a tape cartridge, 30 on a HP-82901-type 5¼-in. floppy disk.

The computer must be equipped with a 16-K memory module, an IEEE-488 interface module, and an input/output read-only memory. The Nicolet/85 program, including data cartridge, disk, and manual, is priced at $150.

Tensegrity Inc., 2424 W. Addison St., Chicago, Ill. 60618. Phone (312) 935-8192 [402]

Multipass Pascal compiler optimizes code for speed

The Pascal-2 multipass optimizing compiler from Oregon Software produces object code that compares in size and execution speed with that of Digital Equipment Corp.'s Fortran IV Plus compiler. Output code is smaller and an order of magnitude faster than that of interpretive or threaded languages such as UCSD Pascal, Basic Plus, and Basic Plus 2. Pascal-2 output is typically 30% to 40% smaller and twice as fast as that produced by Oregon Software's single-pass Pascal-1 compiler.

Pascal-2 is available now for all PDP-11 computers from DEC, as well as DEC's LSI-11 and VAX-11 computers in compatibility mode. It comes for use with all DEC operating systems for the PDP-11. Written in Pascal, it is portable and produces portable programs. Already implemented on a Honeywell computer, it is being prepared for the 68000 and other 16- and 32-bit machines.

Pascal-2 uses virtual-memory techniques to compile very large programs. Optimization includes global register allocation, dead-code elimi-

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The Model 6100 is comparable to TEK's Model 465B and HP's 1742 but displays more traces (six compared with three), and offers more screen brightness, more flexibility, greater simplicity of operation and a two-year warranty that substantially reduces the second year cost of ownership. The Model 6100 also features an auto-dynamic focus circuit for clear, sharp pictures and a metal housing that minimizes RFI interference.

Now for the surprising news: Despite all the extra features, the 6100 costs less than either the TEK or HP scopes.

For versatility of operation, an alternate trigger permits viewing a very wide range of non-synchronous signals. For simplicity of operation, a level-lock on the trigger level control for both A and B channels activates a peak-to-peak detector that automatically sets trigger level and triggers without operator intervention.

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Oregon Software, 2340 S. W. Canyon Rd., Portland, Ore. 97201. Phone (503) 226-7760 [403]

Real-time executive software supports 8080, 8086, 8089

REX-80/86 and MPX are two additions to the REX-80 family of microcomputer executive software. REX-80/86 is a real-time executive with co-processing support designed for Intel iAPX-86/88 systems. It does intertask synchronization, asynchronous event coordination, interrupt handling, memory management, and co-processor synchronization. It requires under 4-K bytes of read-only memory and 512 bytes of random-access memory, a priority interrupt controller, and a real-time clock. REX-80/86 is compatible with Intel, GenRad 2300, and Tektronix 8002 development systems; it is licensed for $2,750.

MFX is an architectural extension available for use with the REX-80 executive for the 8080 or REX-80/86. It supports multiple-processor organizations with shared memory, allowing interprocessor communications and task synchronization and performing arbitration of the shared bus. With it, tasks running on an 8080 can be synchronized with tasks running on one or more 8086 processors. Its message-passing scheme allows use of Ada's remote prodecure (entry) call.

Supplied as a set of linkable object modules, MPX is licensed for $1,000 to users with REX-80 licenses. The 8086 version supports the 8089.

Systems & Software Inc., 2801 Finley Rd., Suite 101, Downers Grove, Ill. 60515 [404]

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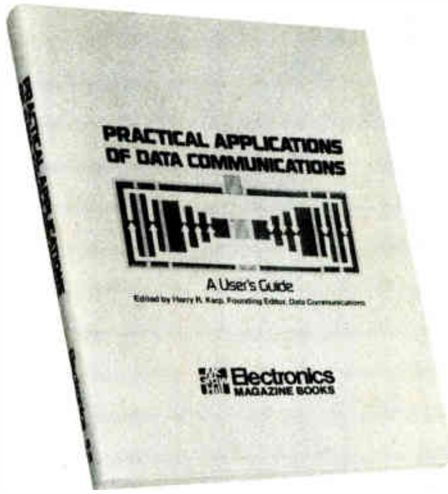

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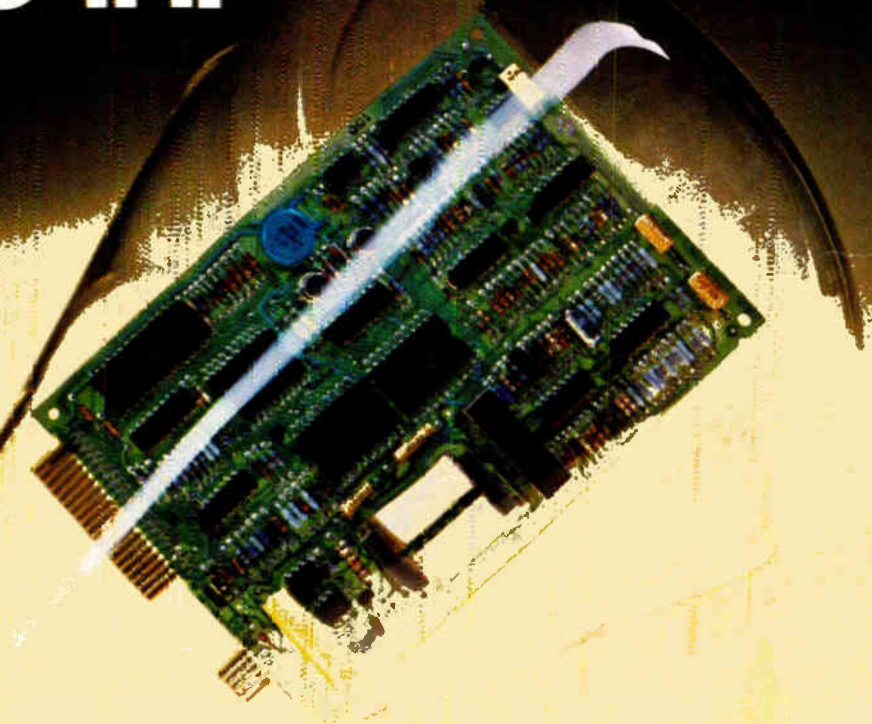

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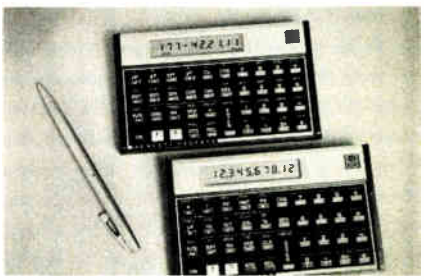
Both units perform self-tests. Suggested retail price for the HP-11C is $135; for the HP-12C it is $150.

Hewlett-Packard Co., 1820 Embarcadero Rd., Palo Alto, Calif. 94303 [421]



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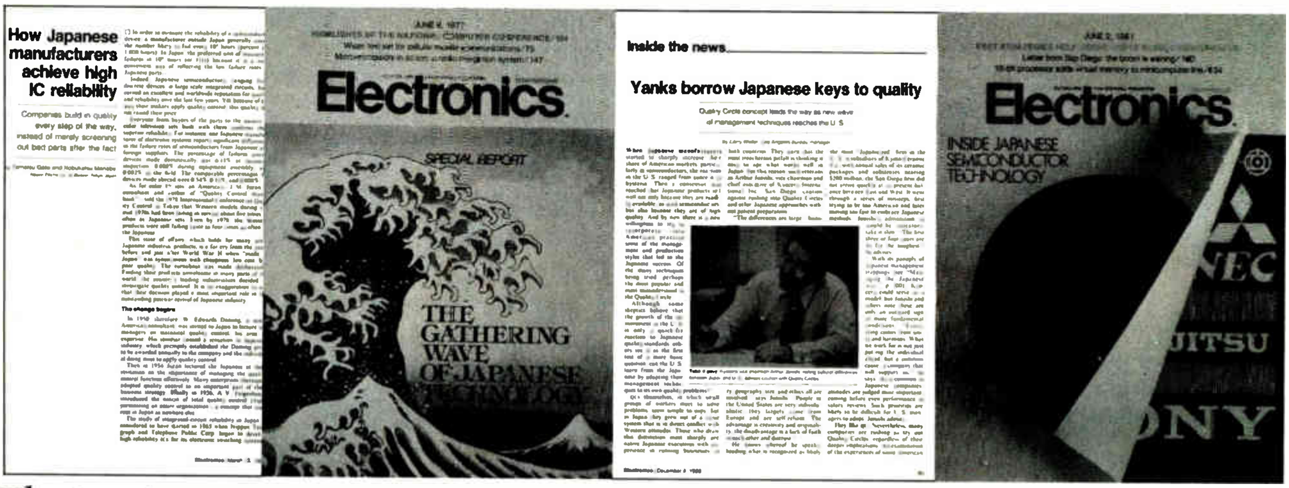

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In April 1980, Electronics alone reported on the quality and reliability comparison figures which showed incoming and field failure rates for Japanese memories to be consistently lower than comparable U.S. products, shocking American manufacturers into action.

In the following months, Electronics provided the international forum for industry debate with a series of outspoken editorials and special articles. This persistent coverage of Japan, Inc. drew both praise and fire from every sector of the business community and from the Congress.

In May, 1981, Electronics again announced exclusive IC comparison information from Hewlett-Packard stating that the gap had been closed between American and Japanese semiconductor quality and reliability.

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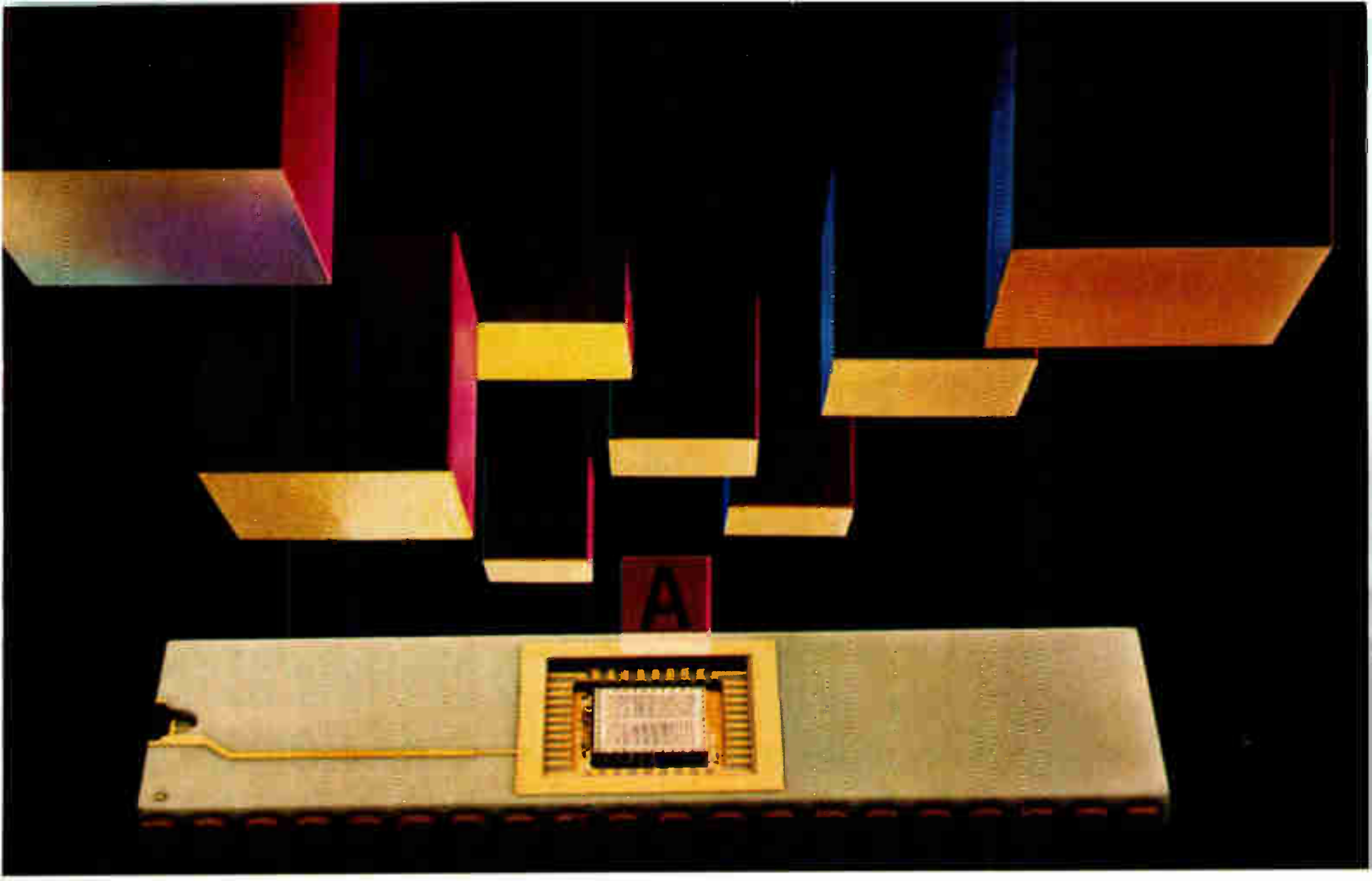

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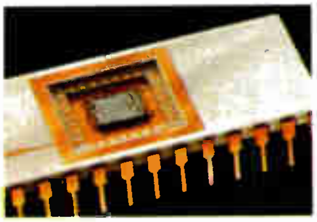

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Microelectronics Division

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Products Newsletter

Intel offers less expensive EE-PROM

Having learned that many of its customers do not need the 10-ms write and erase times of the 2816 electrically erasable programmable read-only memory, Intel will offer a lower-cost part that erases and writes in 50 ms. The new 2815 EE-PROM will have the same set of access times (450, 350, and 250 ns) as the 2816, but it will cost about 30% less. In addition, **yield improvements in the 2816 have allowed the Santa Clara, Calif., firm to drop the price of the 2816.** The 250-ns versions of the 2816 have dropped from $73 to $57.70 in quantities of 100 and from $48 to $38 in 10,000-unit lots. The comparable 2815 prices are $40 for 100-unit lots and $26.50 for large orders. The 350-ns 2816's prices have dropped to $49 and $33, respectively, while the 450-ns 2816's have been lowered to $46 and $33.50. The 450-ns 2815's are likely to be the most popular at $32 in 100-unit lots and $19.50 in 10,000-unit lots, while the 350-ns 2815's will be $34 and $23 in like quantities.

16-K dynamic RAM is pin-compatible with 64-K parts

With the introduction of its 100-ns 16-K dynamic random-access memory chip, Mostek Corp. is hoping to attract a number of customers waiting for 64-K dynamic RAM volumes and speeds to increase. The MK4516, which is pin-compatible with the Mostek MK4564 64-K RAM, operates on a single 5-V power supply and is now available for delivery in 16-pin ceramic and plastic dual in-line packages. The Carrollton, Texas, firm also **plans to offer the 4516 in an 18-pad leadless chip-carrier.** In lots of 100, the 100-ns part sells for $8.60 each, while 120-ns and 150-ns versions are $7 each. The MOS maker anticipates greatest interest among customers requiring fast access times and low power consumption. With the 64-K pin compatibility, Mostek also believes a number of 4516 users will eventually upgrade systems to a fast 64-K RAM when the high-density devices become more plentiful and prices decline.

5¼-in. Winchester bolsters HP-85

Noting that Hewlett-Packard does not supply a hard disk drive for its popular Series 80 personal computers, Microcomputer Systems Corp. of Sunnyvale, Calif., has stepped in to supply the MSC 9800H. It will interface directly with the HP-85, appearing to the central processing unit as four files containing 1.2 megabytes each. It emulates the protocols of the HP9895 dual 8-in. floppy disk unit while costing less. **The 2.5-megabyte HP9895 sells for $6,800 and the MSC 9800H is priced at $3,995.**

In November, the firm will also introduce the 9800L, which will interface with the HP 1000, the desktop HP 9800, and the HP 125/250 series computers. The MSC 9800H employs a Seagate 506 drive; the controller board and packaging are the company's. The 9800L versions, also priced at $3,995, will be formatted as one 4.8-megabyte file.

Rockwell unveils revised modems

Rockwell International Corp. unveiled two revised modems last week as part of the kickoff of its newly formed Telecommunications Products operation. The R24DC, a direct-connect version of the R24 2,400-b/s module, **features a protective circuit and a microcomputer controlled line connect/disconnect.** The V96 single-board modem, with more large-scale integrated devices than its predecessor, communicates at 9,600, 7,200, 4,800, or 2,400 b/s in full- or half-duplex modes. The R24DC is priced at $450; the V96's price is negotiated on the basis of quantity.

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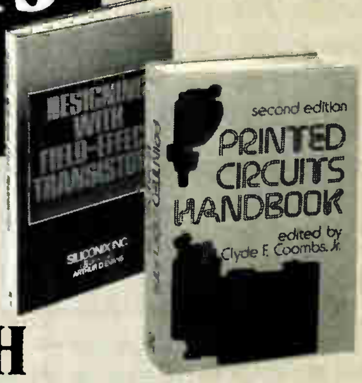

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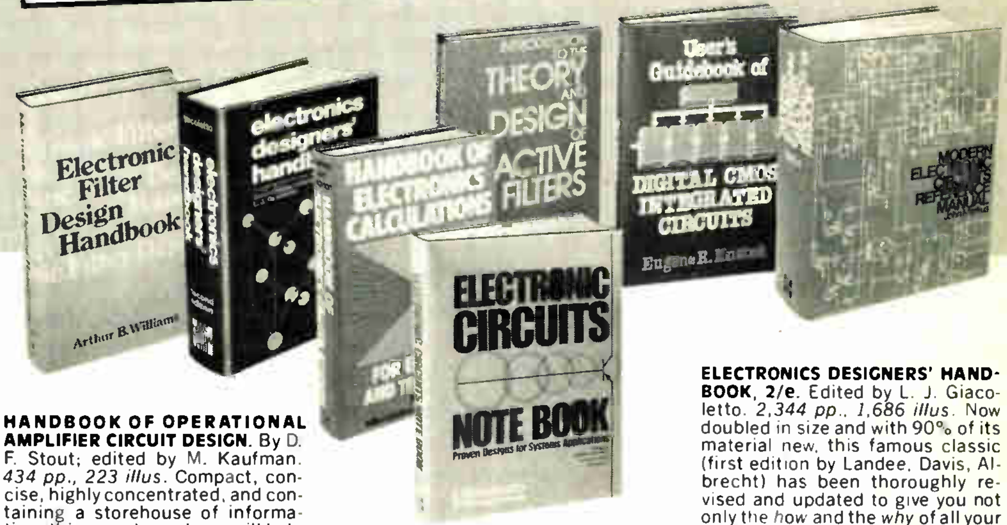

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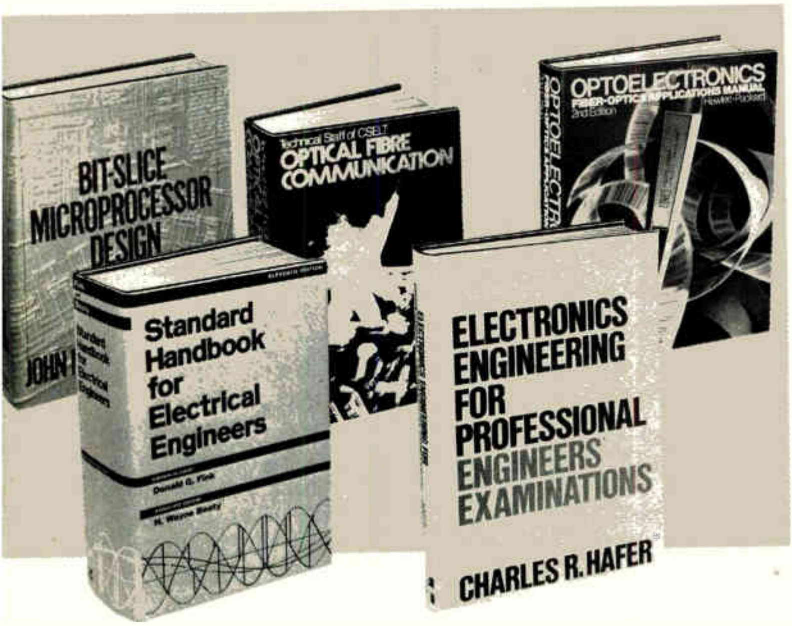

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Career outlook

A peaceful election?

For some, this part of the year means back to school; for others it signals a return of Monday night football or Saturday afternoon games. But for the Institute of Electrical and Electronics Engineers, the diminishing daylight and cooler evenings mean that it is once again election time.

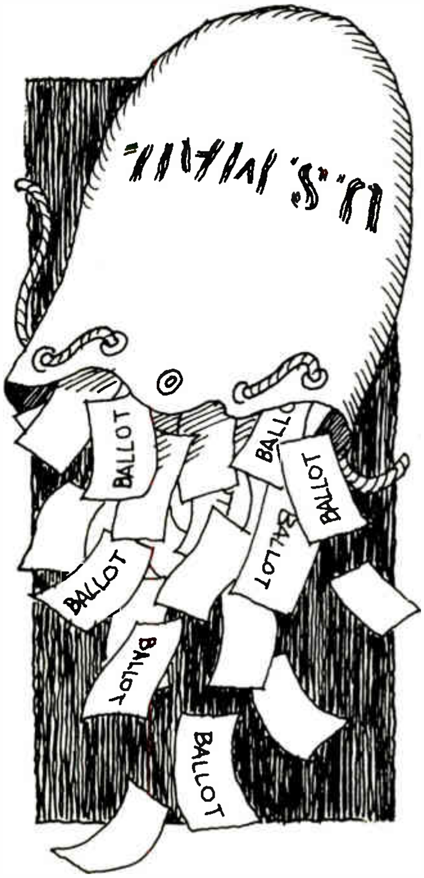
The ballot this year is a relatively uncontroversial one, with no burning questions on it, no petition officers for the top three one-year posts, and no appearance of the frequent candidate and untiring gadfly Irwin Feerst. The board of directors' nominee for president is Robert E. Larson, for president-elect James B. Owens, and for executive vice president Thelma A. Estrin.

But this is not to imply that the institute is quit of all controversial issues. At the moment, one of the hotter debates is the nature of its affiliation with the American Association of Engineering Societies, an umbrella organization that promotes the common interests of engineering societies (such as the IEEE) based on the premise that in unification there is strength.

However, several sections of the IEEE do not see it that way. They wonder why the institute, as they perceive it, wants to transfer certain of its key responsibilities to the AAES. At least two of these sections, in Columbus, Ohio, and Philadelphia, have passed resolutions saying that affiliation with the AAES is not in the best interests of the IEEE. The sections have also requested that the institute's board of governors depart from the association.

These critics point to such AAES functions as dealing with problems of engineering schools and with the Federal government on matters like research and argue that these tasks are properly the IEEE's.

For its part, the AAES maintains that the "fundamental issue at stake is that all societies have long recognized the need to work together," according to the association's executive director, Carl Frey. "They have recognized there is a single engineering profession. Aside from the *quid pro quo*, what they get out of it should be self-evident. For example, there is the work of the Engineering Manpower Commission and other joint committee activities. It's not simply a case of getting one's money's worth," Frey says.



There are other issues, too, most of them raised by watchdog Feerst. Among them: the recruiting of foreign engineers to work in the U.S. for less than the going rate; whether there really is a shortage of engineers; and college accreditation.

But however these issues are resolved, the election is proceeding apace. Ballots are due in the hand of the IEEE's election managers, the Independent Election Corp. of America, by Nov. 2. On Nov. 5, the institute's tellers committee will meet to certify the election results and notification telegrams will go out to candidates. Only then will the general membership be able to read all about it, in The Institute, a monthly newspaper published at IEEE headquarters in New York.

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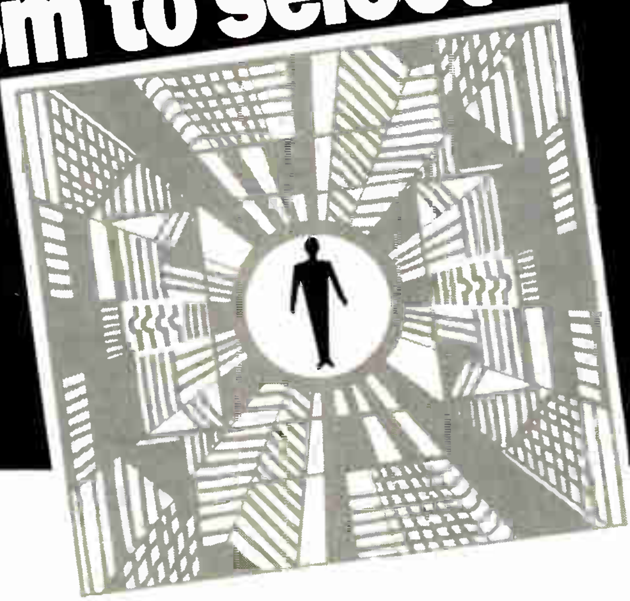

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Electronics **September 22, 1981** This reader service card expires December 22, 1981

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x ☐ I do electronic design or development engineering work.
y ☐ I supervise electronic design or development engineering work.
z ☐ I set standards for, or evaluate electronic components, systems and materials.

Your principal job responsibility (check one)
t ☐ Management
v ☐ Engineering Management
r ☐ Engineering

Estimate number of employees (at this location): 1. ☐ under 20 2. ☐ 20-99 3. ☐ 100-999 4. ☐ over 1000

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3 18 33 48	63 78 93 108	123 138 153 168	183 198 213 228	243 258 273 350	365 380 395 410	425 440 455 470	485 500 705 720
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e ☐ Test & Measuring Equipment
f ☐ Consumer Products
g ☐ Industrial Controls & Equipment
h ☐ Components & Subassemblies
8 Source of Inquiry—All Other INT'L.
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3 18 33 48	63 78 93 108	123 138 153 168	183 198 213 228	243 258 273 350	365 380 395 410	425 440 455 470	485 500 705 720
4 19 34 49	64 79 94 109	124 139 154 169	184 199 214 229	244 259 274 351	366 381 396 411	426 441 456 471	486 501 706 900
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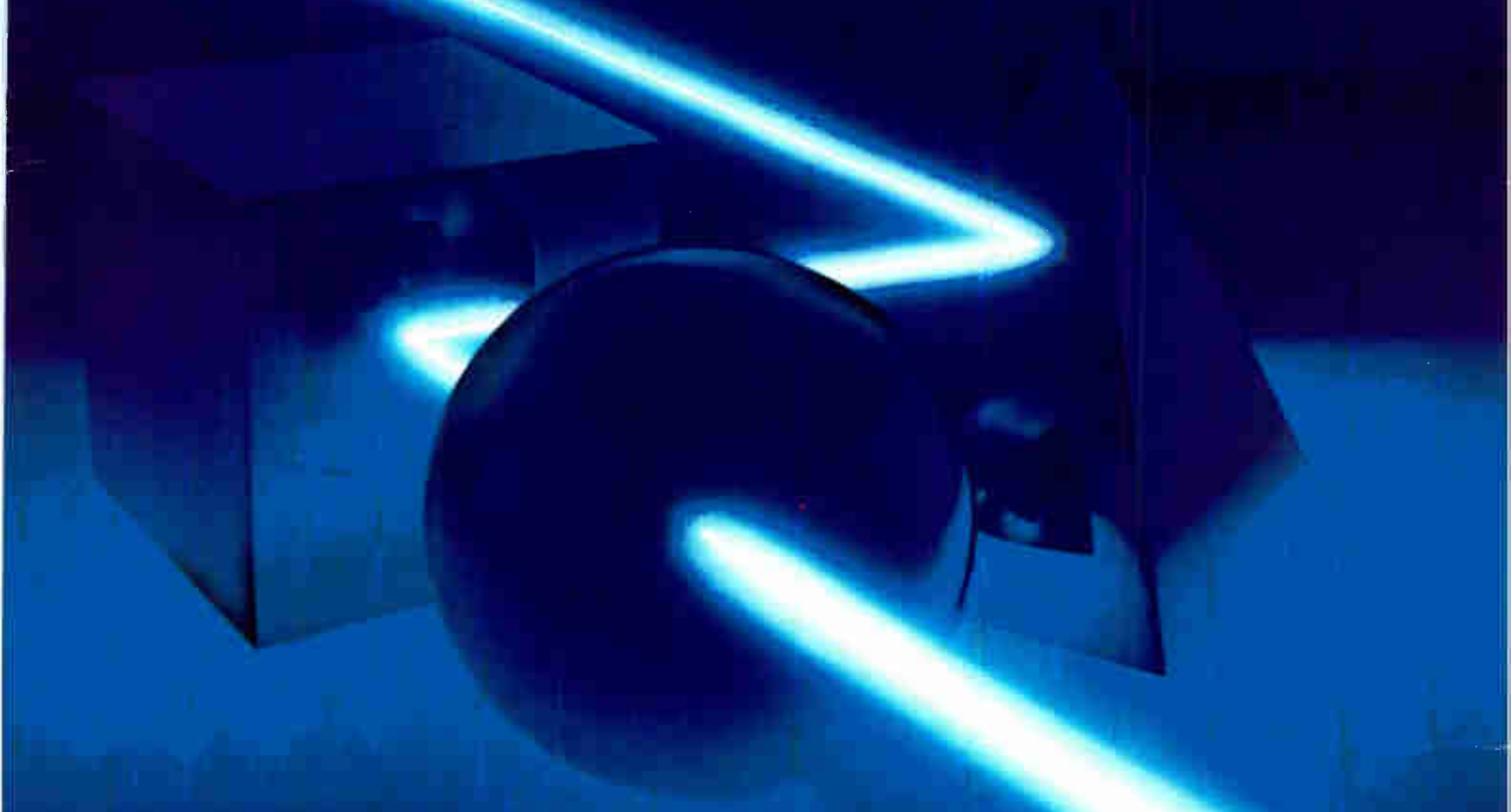

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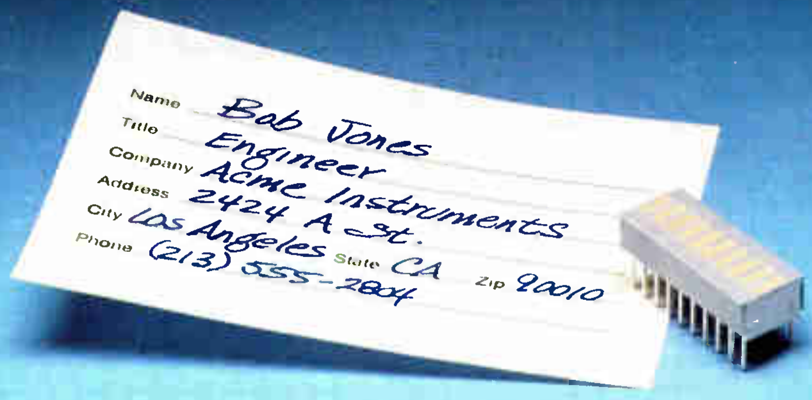

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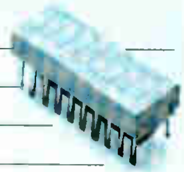

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